KELRON
Environmental

LOG OF BORING MW40M

(Page 3 of 3)

New East Ash Pond Hydrogeologic Investigation
Wood River Power Station
Dynegy Midwest Generation, Inc.

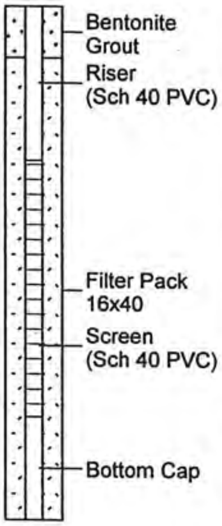
Location: Twp 5N, Rng 9W, 20 SE/SW/SW

Date Started/Finished : 6/10 - 6/14/2004
Hole Diameter : 12.5 / 8.5 inches
Drilling Method : Hollow Stem
Sampling Method : Split-Spoon
Drilling Company : Harriss Drilling Services, Inc.

Driller : John McMullan
Geologist : Stuart Cravens (Kelron)
Land Surface Elevation: 441.05
Top of Casing Elevation 444.20
X,Y Coordinates : 510477, 800633

Depth in Feet	DESCRIPTION	Surf. Elev. 441.05	Samples	Recovery inches	Qp TSF	Blow Count	USCS	GRAPHIC
50	SAND (fine to medium), well graded, dark gray, wet	391	23	5		3 4 6 6	SW	
55		386	24	15		1 5 13 23		
			25	13		3 6 18 23		
60	END BOREHOLE AT 60.0 FEET BLS	381						
65		376						
70		371						
75								

Well: MW40M
Elev.: 444.20



08-13-2004 c:\powerp~1\woodri~1\hydroi~1\drilling\boring~1\wr_mw40m.bor

KELRON
Environmental

LOG OF BORING MW40S

(Page 1 of 2)

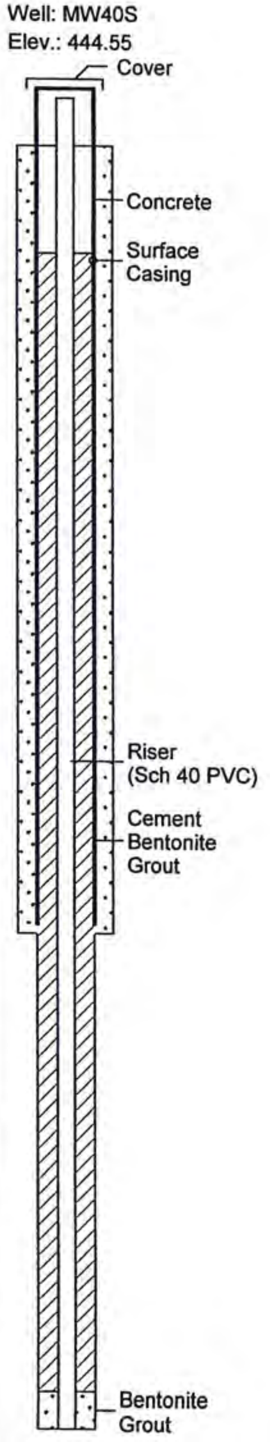
New East Ash Pond Hydrogeologic Investigation
Wood River Power Station
Dynegy Midwest Generation, Inc.

Location: Twp 5N, Rng 9W, 20 SE/SW/SW

Date Started/Finished : 6/18 - 6/21/2004
Hole Diameter : 12.5 / 8.5 inches
Drilling Method : Hollow Stem
Sampling Method : Split-Spoon
Drilling Company : Harriss Drilling Services, Inc.

Driller : John McMullan
Geologist : Stuart Cravens (Kelron)
Land Surface Elevation: 441.25
Top of Casing Elevation 444.55
X,Y Coordinates : 510473, 800637

Depth in Feet	DESCRIPTION	Surf. Elev. 441.25	Samples	Recovery inches	USCS
0	FILL - Gravel (coarse), sand, clay, brown, dry	441	1	21	FL
	FLYASH, trace coal, medium to dark gray, moist WELL MW40S DRILLED BASED ON ADJACENT BORING MW40M. SEE BORING MW40M FOR FULL LOG.		2	18	
5	- wet - moist - bottom ash with flyash seams	436	3	22	
	- flyash - bottom ash with trace coal, moist to wet		4	22	FL
			5	24	
10	- flyash, wet Note: Surface Casing = 10.75-inch O.D. PVC installed to 15.2 feet below grade.	431	6	24	
			7	24	
	Silty CLAY, few roots, low to medium plasticity, dark gray, moist				CL
	SILT, dark gray, wet		8	21	ML
15	SAND (fine to medium) with clay, well graded, brown, moist	426			SW
	Silty CLAY, low plasticity, light ray, moist				CL
	SAND (fine to medium) with clay, trace fine gravel, well graded, light brown, moist		9	18	SW
			10	18	
20	SAND (fine), poorly graded	421	11	19	SP
	- fine to coarse, well graded		12	20	SW
	- fine, poorly graded				SP
25					



08-13-2004 c:\powerp~1\woodri~1\hydroi~1\drilling\boring~1\wr_mw40s.bor

KELRON
Environmental

LOG OF BORING MW40S

(Page 2 of 2)

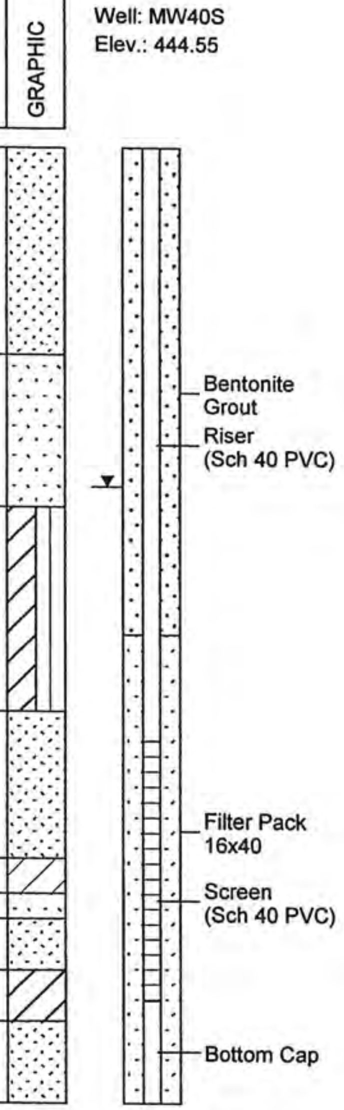
New East Ash Pond Hydrogeologic Investigation
Wood River Power Station
Dynegy Midwest Generation, Inc.

Location: Twp 5N, Rng 9W, 20 SE/SW/SW

Date Started/Finished : 6/18 - 6/21/2004
Hole Diameter : 12.5 / 8.5 inches
Drilling Method : Hollow Stem
Sampling Method : Split-Spoon
Drilling Company : Harriss Drilling Services, Inc.

Driller : John McMullan
Geologist : Stuart Cravens (Kelron)
Land Surface Elevation: 441.25
Top of Casing Elevation 444.55
X,Y Coordinates : 510473, 800637

Depth in Feet	DESCRIPTION	Surf. Elev. 441.25	Samples	Recovery inches	USCS
25		416			SP
30	- fine to medium, well graded, wet	411	13	19	SW
	CLAY, Clayey SILT, and Silty CLAY in alternating layers		14	22	CH-ML
35	- Clayey SILT at 34.75 to 35 feet has trace roots, black organics, non-plastic, olive gray	406	15	21	
	SAND (fine), poorly graded, olive gray, wet		16	23	SP
	Silty CLAY, non to highly plastic, olive gray, moist		17	24	CL
40	SAND (fine to medium), trace coarse sand, well graded, olive gray, wet	401			SW
	SAND (fine), poorly graded				SP
	Silty CLAY, high plasticity, moist		18	24	CH
	SAND (fine), poorly graded, medium gray, wet		19	24	SP
	END BOREHOLE AT 43.6 FEET BLS				
45		396			
50					



KELRON
Environmental

LOG OF BORING MW41

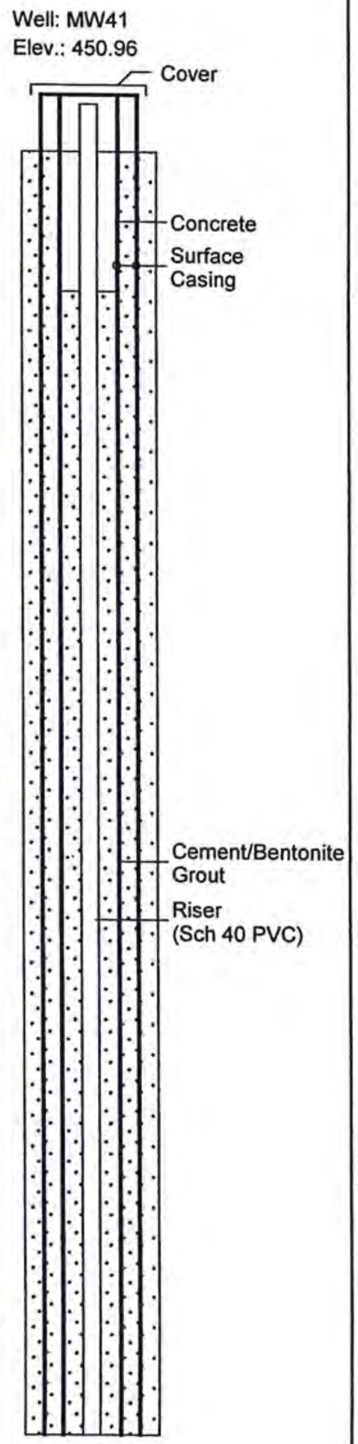
(Page 1 of 3)

New East Ash Pond Hydrogeologic Investigation
Wood River Power Station
Dynegy Midwest Generation, Inc.

Location: Twp 5N, Rng 9W, 20 SE/SW/SW

Date Started/Finished	: 6/21 - 6/23/2004	Driller	: John McMullan
Hole Diameter	: 12.5 / 8.5 inches	Geologist	: Stuart Cravens (Kelron)
Drilling Method	: Hollow-Stem	Land Surface Elevation	: 448.11
Sampling Method	: Split-Spoon	Top of Casing Elevation	450.96
Drilling Company	: Harriss Drilling Services, Inc.	X,Y Coordinates	: 509910, 800592

Depth in Feet	DESCRIPTION	Surf. Elev. 448.11	Samples	Recovery inches	Blow Count	Qp TSF	USCS	GRAPHIC
0	FLYASH, medium gray, moist	448	1	20	2 3 5 8			
5	Note: Surface Casing = 10.75-inch O.D. PVC installed to 24.5 feet below grade. Cement-bentonite grout around surface casing extends to 30 feet below grade.	443						
	- wet		2	24	8 12 12 11	2.5		
10		438					FL	
	- moist							
	- bottom ash, trace coal, wet		3	18	1 5 8 5	0.5		
15		433						
	- alternating layers of bottom ash and flyash, light to medium gray, moist to wet		4	21	7 9 7 7	1.0		
20								



08-13-2004 c:\powerp~1\woodri~1\hydroi~1\drilling\boring~1\wr_mw41.bor

KELRON
Environmental

LOG OF BORING MW41

(Page 2 of 3)

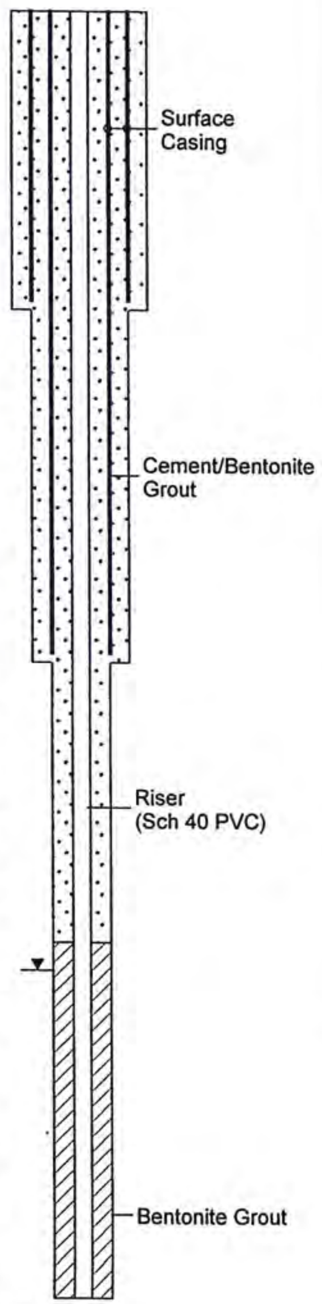
New East Ash Pond Hydrogeologic Investigation
Wood River Power Station
Dynegy Midwest Generation, Inc.

Location: Twp 5N, Rng 9W, 20 SE/SW/SW

Date Started/Finished	: 6/21 - 6/23/2004	Driller	: John McMullan
Hole Diameter	: 12.5 / 8.5 inches	Geologist	: Stuart Cravens (Kelron)
Drilling Method	: Hollow-Stem	Land Surface Elevation	: 448.11
Sampling Method	: Split-Spoon	Top of Casing Elevation	450.96
Drilling Company	: Harriss Drilling Services, Inc.	X,Y Coordinates	: 509910, 800592

Depth in Feet	DESCRIPTION	Surf. Elev. 448.11	Samples	Recovery inches	Blow Count	Qp TSF	USCS
20		428	5	20	5 7 7 5	1.5	
			6	21	5 8 7 6	1.0	
25		423	7	22	6 13 13 8	1.5	FL
	- bottom ash, dark gray, wet						
			8	7			
	- flyash						
	CLAY, few roots, high plasticity, dark gray, wet		9	21	0 2 3 3	2.25	
30		418					
	Silty CLAY, high plasticity, light gray, moist						
	- dark gray		10	23	0 2 2 3	1.0	CH
35		413					
	CLAY, few silt, high plasticity, medium gray w/ intermittent brown mottling		11	24	1 3 3 5	1.75	
40							

Well: MW41
Elev.: 450.96



08-13-2004 c:\powerp~1\woodri~1\hydroi~1\drilling\boring~1\wr_mw41.bor

KELRON
Environmental

LOG OF BORING MW41

(Page 3 of 3)

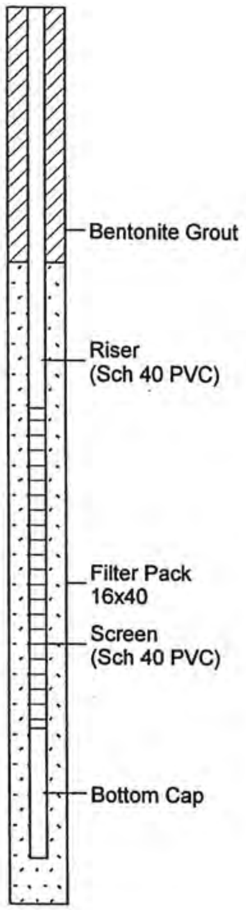
New East Ash Pond Hydrogeologic Investigation
Wood River Power Station
Dynegy Midwest Generation, Inc.

Location: Twp 5N, Rng 9W, 20 SE/SW/SW

Date Started/Finished	: 6/21 - 6/23/2004	Driller	: John McMullan
Hole Diameter	: 12.5 / 8.5 inches	Geologist	: Stuart Cravens (Kelron)
Drilling Method	: Hollow-Stem	Land Surface Elevation	: 448.11
Sampling Method	: Split-Spoon	Top of Casing Elevation	450.96
Drilling Company	: Harriss Drilling Services, Inc.	X,Y Coordinates	: 509910, 800592

Depth in Feet	DESCRIPTION	Surf. Elev. 448.11	Samples	Recovery inches	Blow Count	Qp TSF	USCS
40		408	12	24	2 2 2 2	1.75	CH
	SILT, brown, wet						ML
	SAND (fine), few silt, poorly graded, light grading to medium brown, wet		13	24	2 12 16 17	1.5	SP
45	CLAY, trace silt, medium gray, moist	403	14	24	3 8 12 16		CL
	SAND (fine to medium), trace coarse sand and fine gravel, well graded, light brown, wet - medium brown		15	20	0 6 13 15		SW
50		398					
	- medium brown-gray		16	15	8 10 8 7		
	END BOREHOLE AT 54 FEET BLS						
55		393					
60							

Well: MW41
Elev.: 450.96



KELRON
Environmental

LOG OF BORING MW42

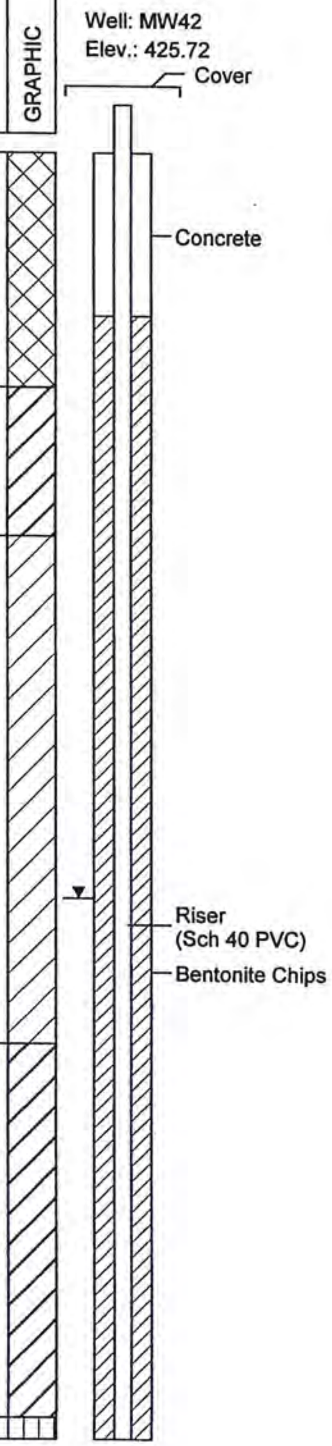
(Page 1 of 2)

New East Ash Pond Hydrogeologic Investigation
Wood River Power Station
Dynegy Midwest Generation, Inc.

Location: Twp 5N, Rng 9W, 20 NW/SW/SW

Date Started/Finished	: 6/22/2004	Driller	: John McMullan
Hole Diameter	: 8.5 inches	Geologist	: Stuart Cravens (Kelron)
Drilling Method	: Hollow-Stem	Land Surface Elevation	: 422.97
Sampling Method	: Split-Spoon	Top of Casing Elevation	425.72
Drilling Company	: Harriss Drilling Services, Inc.	X,Y Coordinates	: 509319, 801288

Depth in Feet	DESCRIPTION	Surf. Elev. 422.97	Samples	Recovery inches	Blow Count	Qp TSF	USCS
0	FILL - Silty CLAY with large white gravel, few sand, roots, dark brown, dry	422	1	8	4 5 6 6		FL
2	CLAY with roots, high plasticity, medium brown with light gray mottling - light brown	420	2	21	2 4 4 4	1.5	CH
4	Silty CLAY, trace fine sand, roots, low-medium plasticity, light brown, moist	418	3	16	1 2 3 3	1.25	CL
6	- no roots, black organics, with light gray mottling	416	4	19	1 2 2 3	1.0	
8	- 0.5-inch sand seam (fine to medium grain size), light brown, wet - 1.5-inch sand seam (fine to medium grain size)	414	5	16	0 1 2 3	1.5	
10	CLAY, high plasticity, light gray with orange-brown mottling, moist - 1.5-inch clayey sand seam (fine), medium brown, wet	412	6	23	0 1 2 2	1.5	CH
12		410	7	22	0 1 1 2	1.5	
14			8	20	0 2	1.0	ML



KELRON
Environmental

LOG OF BORING MW42

(Page 2 of 2)

New East Ash Pond Hydrogeologic Investigation
Wood River Power Station
Dynegy Midwest Generation, Inc.

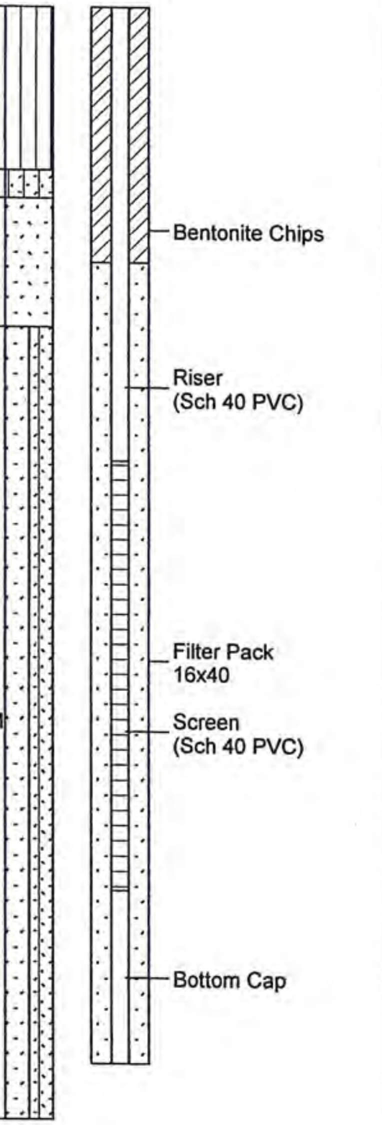
Location: Twp 5N, Rng 9W, 20 NW/SW/SW

Date Started/Finished	: 6/22/2004
Hole Diameter	: 8.5 inches
Drilling Method	: Hollow-Stem
Sampling Method	: Split-Spoon
Drilling Company	: Harriss Drilling Services, Inc.
Driller	: John McMullan
Geologist	: Stuart Cravens (Kelron)
Land Surface Elevation	: 422.97
Top of Casing Elevation	425.72
X,Y Coordinates	: 509319, 801288

Depth in Feet	DESCRIPTION	Surf. Elev. 422.97	USCS
15	SILT, trace fine sand, non-plastic, light brown, wet - few fine sand Clayey SILT, brown-gray	407	ML
17	Silty SAND (fine), medium brown		SM
	SAND (fine to medium), well graded, medium brown	405	SW
19	SAND (fine) with silt, trace medium sand poorly graded, medium brown-gray	403 401 399 397	SW-SM
28	END BOREHOLE AT 28 FEET BLS	395	

Samples	Recovery inches	Blow Count	Qp TSF
8	20	4 6	1.0
9	21	2 3 5 5	<0.5
10	24	5 8 9 9	
11	22	3 4 5 5	
12	24	3 8 15 4	
13	24	2 3 4 4	
14	24	2 3 3 4	

Well: MW42
Elev.: 425.72



APPENDIX B

STATISTICAL PROCEDURE FOR BACKGROUND

APPENDIX B
STATISTICAL PROCEDURE FOR CALCULATION OF BACKGROUND
Wood River West Ash Complex Closure
Groundwater Monitoring Plan
Wood River Power Station East Alton, Illinois

Introduction

The purpose of the statistical calculations documented in this appendix is to determine the maximum background concentrations likely to occur upgradient of the West Ash Complex at Wood River Power Station in the primary sand aquifer. High predicted background concentrations relative to the Illinois Class I groundwater quality standards may suggest that downgradient concentrations for those parameters in the primary sand are due to a background source.

The statistical analysis procedures used here are consistent with procedures described in the document: 2009 Unified Guidance. "Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities—Unified Guidance," March 2009, EPA 530/R-09-2007 (USEPA, 2009).

Compliance Data Operations - Limit Calculations

The range of potential background concentrations was statistically determined using parametric and non-parametric tolerance intervals. Tolerance intervals were chosen rather than prediction intervals because a tolerance interval makes no assumption about the future number of samples, while a prediction interval assumes a finite, and known, future number of samples.

The flow diagram (Figure A-1) outlines the logic flow for calculation of limits. Background values were calculated using parametric tolerance intervals for normally distributed data, and non-parametric tolerance intervals for data with no underlying distribution or with non-detect frequencies greater than 50 percent. Parametric tolerance intervals were calculated at a 95 percent coverage rate and a Type I individual comparison error level of 0.01 (i.e., false positive rate). Parameters with 100 percent non-detects were handled with the upper tolerance limit being set to the last Reporting Limit (RL).

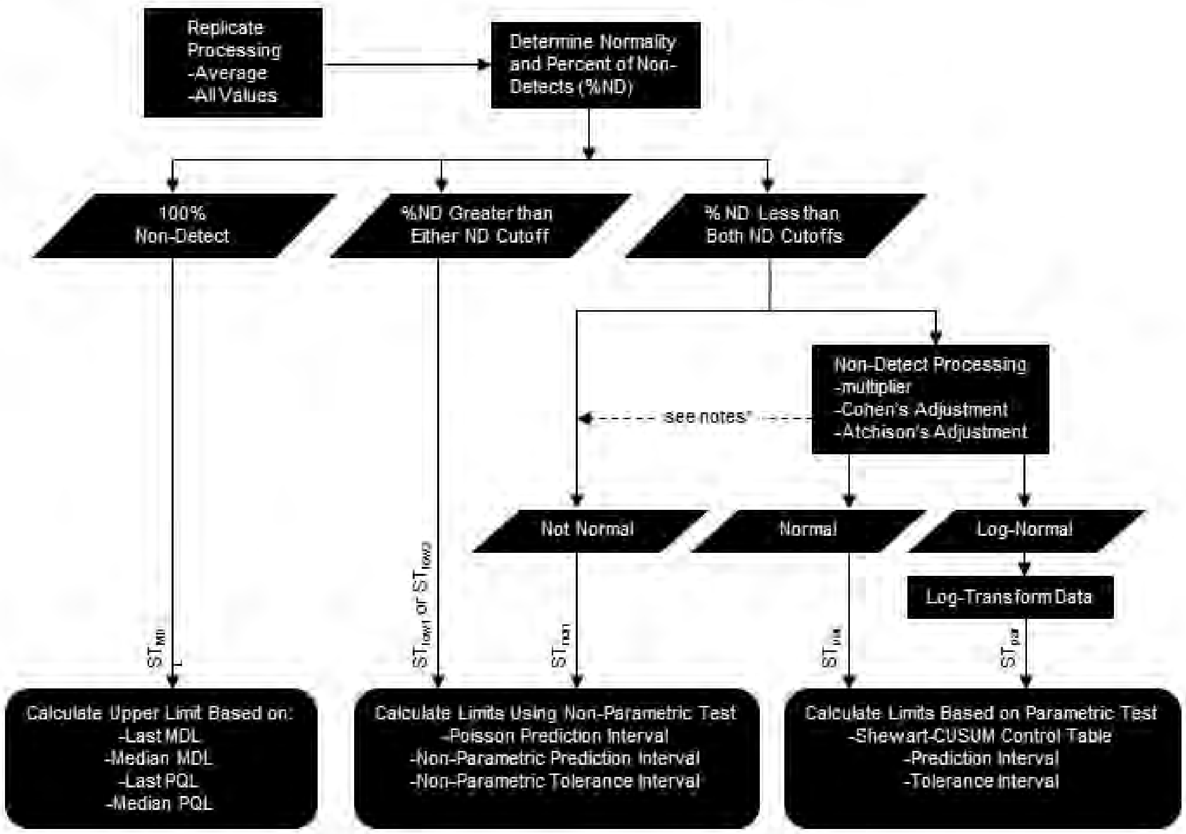
Statistical Data Evaluation and Results

The input dataset (attached to this summary) for background calculations were evaluated for the monitoring data from monitoring wells 25, 31, and 36, collected from January 2010 through December 2015, for a subset of the inorganic parameters listed in 35 IAC 620.410(a), specifically sulfate, total dissolved solids, and pH (both upper and lower limits). Background concentrations for additional parameters will be calculated following collection of 8 rounds of data. All water quality data were stored, prepared, and statistically analyzed using MANAGES^{TM} Version 3.4.49 software (EPRI, March 2014).

A statistical summary of the background water quality data from 25, 31, and 36, and includes the mean, median, minimum, maximum, standard deviation, Sen Slope trend, normality determination, and percent non-detects for the background dataset. The statistical analysis procedure inputs and results are also provided in this Appendix.

Calculated background values for the tested inorganic constituents and pH are listed in the following Table A-1 along with the percent non-detects, normal or lognormal distribution, test method, and confidence level.

Figure B-1. Statistical Analysis Flowchart



Notes

** If the option for Cohen's or Atchison's adjustment is selected and neither is appropriate, then the non-normal comparison test will be used*

Table B-1. Tolerance Limits for Background Monitoring Wells 25, 31, and 36

Parameter	Count of Backround Results	Percent of Non Detects	Normal/ Lognormal	Test	Confidence Level	Upper Limit	Lower Limit
SO4, total, mg/L	12	17.14	No/No	STnon	83.39	307	
TDS, mg/L	35	0.00	No/Yes	STpar	99.00	7,712	
pH (field), std	35	0.00	Yes/Yes	STpar	99.00	7.7	6.0

* Key to Tests

STmdl = Comparison method if all background results are non-detect = Last MDL
STpar = Parametric Tolerance Interval on background
STlow1 = Non-Parametric Tolerance Interval on background (ND Frequency > 50%)
STnon = Non-Parametric Tolerance Interval on background

Wood River
Statistical Summary for Pooled Locations

User Supplied Information

Date Range: 01/01/2010 to 11/05/2015 **Option for LT Pts:** **x 0.5**
Pooled Locations: **25,31,36**

Parameter	Units	Count	Mean	Median	Maximum	Minimum	Std Dev	Sen Slope Units/yr	Normal / Log Normal	% of Non-Detects
pH (field)	SU	35	6.850	6.880	7.460	6.100	0.311	0.093	Yes / Yes	0.00
Residue, total filtrable	mg/L	35	1,705.314	1,500.000	6,000.000	430.000	1,359.056	-176.438	No / Yes	0.00
Sulfate, total	mg/L	35	147.971	161.000	307.000	5.000	104.757	-39.539	No / No	17.14

Shapiro-Wilk Normality test performed at 0.05 significance level.

Wood River
Wood River West Ash Complex Background Well Data

Date Range: 01/01/2010 to 11/05/2015

Well Id	Date Sampled	Lab Id	pH (field), SU	Residue, total filtrable, mg/L	Sulfate, total, mg/L
25	06/14/2010		6.880	1,500	260
	11/09/2010		6.640	1,600	290
	06/23/2011		6.690	1,200	180
	11/01/2011		6.540	1,700	300
	06/26/2012		6.740	1,600	270
	11/14/2012		6.770	1,140	192
	05/02/2013		7.010	690	104
	11/25/2013		7.460	1,710	307
	05/22/2014		7.100	742	89
	11/18/2014		6.870	1,410	283
	05/21/2015		6.920	974	124
	11/04/2015		6.730	1,320	219
31	06/14/2010		6.210	2,800	270
	11/09/2010		6.510	4,800	250
	06/23/2011		6.360	6,000	230
	11/01/2011		6.390	5,100	230
	06/26/2012		6.100	3,700	240
	11/14/2012		7.020	2,490	206
	05/02/2013		7.270	1,720	164
	08/29/2013		6.860	2,040	169
	11/25/2013		7.390	1,860	149
	05/22/2014		6.600	1,620	129
	11/18/2014		7.030	2,020	161
	05/21/2015		7.020	2,240	118
	11/04/2015		6.980	2,170	149
36	06/14/2010		6.960	620	11
	11/09/2010		6.810	600	11
	11/01/2011		6.870	620	33
	06/26/2012		7.090	530	11
	11/14/2012		6.650	768	<10
	11/25/2013		7.320	474	<10
	05/22/2014		6.880	468	<10
	11/18/2014		7.010	474	<10
	05/21/2015		6.930	556	<10
	11/03/2015		7.140	430	<10

Wood River

West Ash Complex Background Statistics (2010-2015)

Background Date Range: 01/01/2010 to 11/05/2015
Background Locations: 25,31,36

Compliance Date Range: 01/01/2010 to 11/05/2015
Compliance Locations: 25

Comparison Method if all Background Results are Non-Detect:	STmdl = Last MDL
Statistical Test for Parametric Background Data Distributions:	STpar = Parametric Tolerance Interval on Background
Statistical Test for Cases with High Percentage of Non-Detect Background Data:	STlow1 = Non-Parametric Prediction Interval on Background (ND Frequency > 50%)
Statistical Test for Cases with High Percentage of Non-Detect Background Data:	STlow2 = Non-Parametric Tolerance Interval on background (ND Frequency > 50%)
Statistical Test for Non-Parametric Background Data Distributions:	STnon = Non-Parametric Tolerance Interval on background
Background Comparison:	Interwell
Number of Verification Samples:	0
Default Type 1 Individual Comparison Error Level (False Positive Rate) for tests other than Prediction Interval	0.01
Non-Detect Processing (Parametric Tests):	<=15% using MDL * 0.5 >15% using MDL * 0.5
Non-Detect Processing (All Other):	<=50% using MDL * 0.5 >50% using MDL * 0.5
Tolerance Interval Coverage:	95%

Compliance Location	Parameter	Sample Date	Count Of Bkg Results	Percent of Non detects	Normal / Lognormal	Test	Confidence Level	Upper Limit	Lower Limit	Analysis Result	Exceedance	Trend

Compliance Location	Parameter	Sample Date	Count Of Bkg Results	Percent of Non detects	Normal / Lognormal	Test	Confidence Level	Upper Limit	Lower Limit	Analysis Result	Exceedance	Trend
25	Chloride, total, mg/L		0	0.00	Yes/Yes	STpar	Insufficient Background Data: Minimum 3 data points.					
25	pH (field), SU	06/14/2010	35	0.00	Yes/Yes	STpar	99.00	7.705	5.995	6.880	No	
		11/09/2010	35	0.00	Yes/Yes		99.00	7.705	5.995	6.640	No	
		06/23/2011	35	0.00	Yes/Yes		99.00	7.705	5.995	6.690	No	
		11/01/2011	35	0.00	Yes/Yes		99.00	7.705	5.995	6.540	No	
		06/26/2012	35	0.00	Yes/Yes		99.00	7.705	5.995	6.740	No	
		11/14/2012	35	0.00	Yes/Yes		99.00	7.705	5.995	6.770	No	
		05/02/2013	35	0.00	Yes/Yes		99.00	7.705	5.995	7.010	No	
		11/25/2013	35	0.00	Yes/Yes		99.00	7.705	5.995	7.460	No	
		05/22/2014	35	0.00	Yes/Yes		99.00	7.705	5.995	7.100	No	
		11/18/2014	35	0.00	Yes/Yes		99.00	7.705	5.995	6.870	No	
		05/21/2015	35	0.00	Yes/Yes		99.00	7.705	5.995	6.920	No	
		11/04/2015	35	0.00	Yes/Yes		99.00	7.705	5.995	6.730	No	
25	Residue, total filtrable, mg/L	06/14/2010	35	0.00	No/Yes	STpar	99.00	7,712		1,500	No	
		11/09/2010	35	0.00	No/Yes		99.00	7,712		1,600	No	
		06/23/2011	35	0.00	No/Yes		99.00	7,712		1,200	No	
		11/01/2011	35	0.00	No/Yes		99.00	7,712		1,700	No	
		06/26/2012	35	0.00	No/Yes		99.00	7,712		1,600	No	
		11/14/2012	35	0.00	No/Yes		99.00	7,712		1,140	No	
		05/02/2013	35	0.00	No/Yes		99.00	7,712		690	No	
		11/25/2013	35	0.00	No/Yes		99.00	7,712		1,710	No	
		05/22/2014	35	0.00	No/Yes		99.00	7,712		742	No	
		11/18/2014	35	0.00	No/Yes		99.00	7,712		1,410	No	
		05/21/2015	35	0.00	No/Yes		99.00	7,712		974	No	
		11/04/2015	35	0.00	No/Yes		99.00	7,712		1,320	No	

Compliance Location	Parameter	Sample Date	Count Of Bkg Results	Percent of Non detects	Normal / Lognormal	Test	Confidence Level	Upper Limit	Lower Limit	Analysis Result	Exceedance	Trend
25	Sulfate, total, mg/L	06/14/2010	35	17.14	No/No	STnon	83.39	307		260	No	
		11/09/2010	35	17.14	No/No		83.39	307		290	No	
		06/23/2011	35	17.14	No/No		83.39	307		180	No	
		11/01/2011	35	17.14	No/No		83.39	307		300	No	
		06/26/2012	35	17.14	No/No		83.39	307		270	No	
		11/14/2012	35	17.14	No/No		83.39	307		192	No	
		05/02/2013	35	17.14	No/No		83.39	307		104	No	
		11/25/2013	35	17.14	No/No		83.39	307		307	No	
		05/22/2014	35	17.14	No/No		83.39	307		89	No	
		11/18/2014	35	17.14	No/No		83.39	307		283	No	
		05/21/2015	35	17.14	No/No		83.39	307		124	No	
		11/04/2015	35	17.14	No/No		83.39	307		219	No	

APPENDIX C

GROUNDWATER MONITORING DATA 2010-2015

Wood River
Groundwater Monitoring Data for the West Ash Pond System: 2010 - 2015

Date Range: 01/01/2010 to 12/31/2015

Well Id	Date Sampled	Lab Id	Boron, dissolved, mg/L	Manganese, dissolved, mg/L	pH (field), SU	Water level, relative to, ft
02	03/02/2010					406.4
	06/14/2010		2.400	1.000	6.770	414.4
	09/27/2010					413.5
	11/09/2010		2.200	0.7700	6.730	406.7
	03/03/2011					412.8
	06/23/2011		2.200	0.8400	6.740	418.8
	09/27/2011					405.7
	11/01/2011		2.700	0.9600	6.870	403.0
	03/28/2012					408.2
	06/26/2012		2.300	0.7700	6.600	404.6
	08/21/2012					400.5
	02/27/2013					401.8
	05/06/2013		2.890	1.300	6.960	417.9
	08/20/2013					404.2
	11/25/2013		2.560	1.210	7.040	401.9
	02/26/2014					403.7
	05/22/2014		3.230	1.070	7.190	409.8
	09/03/2014					406.6
	11/18/2014		2.890	1.180	7.000	404.0
	03/11/2015					402.7
	05/21/2015		2.500	1.360	6.830	408.1
	09/04/2015					405.7
	11/03/2015		3.450	1.980	6.950	402.2
04	03/02/2010					407.1
	06/14/2010		0.3300	8.700	6.600	411.9
	09/27/2010					411.7
	11/09/2010		0.3600	5.400	6.670	407.3
	03/03/2011					411.2
	06/23/2011		0.3800	5.200	6.540	414.4
	09/27/2011					405.7
	11/01/2011		0.4900	6.300	6.570	403.2
	03/28/2012					408.9
	06/26/2012		0.4300	5.800	6.480	405.4
	11/14/2012		0.3600	5.980	6.760	404.1
	02/27/2013					404.4
	05/06/2013		0.3300	6.770	6.640	415.1
	08/20/2013					407.4

Wood River
Groundwater Monitoring Data for the West Ash Pond System: 2010 - 2015

Date Range: 01/01/2010 to 12/31/2015

		Boron, dissolved, mg/L	Manganese, dissolved, mg/L	pH (field), SU	Water level, relative to, ft
04	11/25/2013	0.3200	6.460	6.970	404.3
	02/26/2014				406.5
	05/22/2014	0.3510	4.910	6.970	410.8
	09/03/2014				409.2
	11/18/2014	0.3480	6.120	6.890	405.7
	03/11/2015				405.2
	05/21/2015	0.4440	5.230	6.880	408.7
	09/04/2015				406.9
	11/03/2015	0.3970	6.400	7.010	403.3
12	03/02/2010				407.4
	06/14/2010	2.000	0.4200	6.760	413.6
	09/27/2010				412.3
	11/09/2010	1.300	0.3100	6.950	408.1
	03/03/2011				409.5
	06/23/2011	1.900	0.3900	6.740	416.7
	09/27/2011				407.5
	11/01/2011	1.700	0.3800	6.670	405.0
	03/28/2012				407.0
	06/26/2012	2.000	0.4300	6.700	405.7
	08/21/2012				402.8
	11/14/2012	2.070	0.5400	7.000	402.1
	02/27/2013				402.6
	05/02/2013	2.320	0.5000	6.950	415.3
	08/20/2013				407.1
	11/25/2013	2.120	0.4500	6.540	403.5
	02/26/2014				403.5
	05/22/2014	2.270	0.4690	6.960	408.6
	09/03/2014				407.1
	11/18/2014	1.970	0.6160	7.210	405.9
	03/11/2015				404.3
	05/21/2015	2.210	0.5640	6.930	407.0
	09/04/2015				408.2
	11/05/2015	2.050	0.6350	6.990	404.0
20	03/02/2010	0.2800	<0.005000	6.330	406.8
	06/14/2010	0.2900	<0.005000	6.450	412.6
	09/27/2010	0.3700	<0.005000	6.120	410.8
	11/09/2010	0.3000	<0.005000	6.170	407.4

Wood River
Groundwater Monitoring Data for the West Ash Pond System: 2010 - 2015

Date Range: 01/01/2010 to 12/31/2015

		Boron, dissolved, mg/L	Manganese, dissolved, mg/L	pH (field), SU	Water level, relative to, ft
20	03/02/2011	0.3200	0.01100	6.120	406.6
	06/23/2011	0.3700	<0.005000	6.410	415.8
	09/27/2011	0.4700	<0.005000	6.770	407.4
	11/02/2011	0.3700	<0.005000	6.270	404.8
	03/28/2012	0.3900	0.009000	6.780	405.2
	06/26/2012	0.3200	<0.005000	6.490	404.7
	08/21/2012	0.3400	<0.005000	6.450	402.3
	11/14/2012	0.3500	0.04000	6.590	401.1
	02/27/2013	0.3300	0.1200	6.250	401.6
	05/02/2013	0.3300	<0.005000	7.140	413.1
	08/20/2013	0.2500	<0.005000	6.660	407.0
	11/25/2013	0.2600	0.05000	6.620	402.8
	02/26/2014	0.2400	0.01000	6.680	402.0
	05/22/2014	0.2100	<0.005000	7.130	406.8
	09/03/2014	0.2940	<0.005000	6.250	405.8
	11/18/2014	0.2000	<0.003000	6.350	405.7
	03/11/2015	0.2180	0.04210	6.250	403.4
	05/21/2015	0.2230	0.006900	6.250	406.5
	09/04/2015	0.2180	<0.005000	6.420	408.1
	11/05/2015	0.1920	0.006800	6.130	404.8
21	03/02/2010				408.5
	06/14/2010	0.2700	<0.005000	6.720	413.4
	09/27/2010				411.6
	11/09/2010	0.2500	<0.005000	6.900	409.2
	03/03/2011				407.0
	06/23/2011	0.2500	<0.005000	6.900	416.2
	09/27/2011				409.3
	11/01/2011	0.4100	<0.005000	6.440	406.9
	03/27/2012				406.3
	06/26/2012	0.3800	<0.005000	6.690	406.4
	08/21/2012				406.0
	11/14/2012	0.3100	0.008400	6.480	403.0
	02/27/2013				403.4
	05/02/2013	0.4100	0.3500	7.320	412.1
	08/20/2013				409.1
	11/25/2013	0.3300	0.007100	7.000	404.6
	02/26/2014				403.5

Wood River
Groundwater Monitoring Data for the West Ash Pond System: 2010 - 2015

Date Range: 01/01/2010 to 12/31/2015

		Boron, dissolved, mg/L	Manganese, dissolved, mg/L	pH (field), SU	Water level, relative to, ft
21	05/22/2014	0.3430	0.01370	6.940	407.5
	09/03/2014				407.5
	11/18/2014	0.2250	<0.003000	7.040	407.7
	03/11/2015				405.3
	05/21/2015	0.3640	0.05250	6.900	406.7
	09/04/2015				410.3
	11/04/2015	0.3680	<0.005000	6.820	405.7
22	03/02/2010				408.8
	06/14/2010	0.2900	<0.005000	6.530	413.4
	09/27/2010				411.7
	11/09/2010	0.2700	<0.005000	6.820	409.6
	03/03/2011				406.8
	06/23/2011	0.3000	<0.005000	6.850	415.9
	09/27/2011				409.7
	11/01/2011	0.3200	<0.005000	6.940	407.3
	03/27/2012				406.5
	06/26/2012	0.2900	<0.005000	6.770	406.8
	08/21/2012				404.8
	11/14/2012	0.2700	<0.005000	7.080	403.5
	02/27/2013				403.7
	05/02/2013	0.3200	0.1500	6.970	411.0
	08/20/2013				409.6
	11/25/2013	0.2600	<0.005000	7.050	405.1
	02/26/2014				403.9
	05/22/2014	0.3310	0.01630	7.020	407.5
	09/03/2014				407.8
	11/18/2014	0.2860	<0.003000	7.030	408.2
	03/11/2015				405.7
	05/21/2015	0.3270	<0.005000	6.890	407.0
	09/04/2015				410.9
	11/05/2015	0.2630	<0.005000	6.970	406.2
23	03/02/2010				407.9
	06/14/2010	0.3500	0.01200	6.210	413.5
	09/27/2010				411.9
	11/09/2010	0.3000	0.03700	6.070	408.5
	03/03/2011				408.2
	06/23/2011	0.3900	0.005600	6.300	416.6

Wood River
Groundwater Monitoring Data for the West Ash Pond System: 2010 - 2015

Date Range: 01/01/2010 to 12/31/2015

		Boron, dissolved, mg/L	Manganese, dissolved, mg/L	pH (field), SU	Water level, relative to, ft
23	09/27/2011				408.3
	11/01/2011	0.4000	0.07700	6.000	405.9
	03/27/2012				406.5
	06/26/2012	0.3600	0.03800	6.360	405.9
	08/21/2012				401.6
	11/14/2012	0.4000	0.4500	6.410	402.4
	02/27/2013				402.8
	05/02/2013	0.4500	0.4700	6.840	414.0
	08/20/2013				408.0
	11/25/2013	0.3500	0.3300	6.330	403.9
	02/26/2014				403.3
	05/22/2014	0.5530	1.010	6.940	408.0
	09/03/2014				404.1
	11/18/2014	0.4360	0.5100	6.320	406.8
	03/11/2015				404.6
	05/21/2015	0.3590	0.01300	6.260	406.8
	09/04/2015				409.2
	11/05/2015	0.3430	0.1190	6.030	404.8
25	03/02/2010				408.9
	06/14/2010	0.7600	0.04300	6.880	412.9
	09/27/2010				411.6
	11/09/2010	0.6100	0.1300	6.640	409.6
	03/03/2011				407.8
	06/23/2011	0.8300	0.7600	6.690	415.0
	09/27/2011				409.2
	11/01/2011	0.6800	0.05900	6.540	407.2
	03/27/2012				407.3
	06/26/2012	0.5600	0.007700	6.740	407.1
	08/21/2012				404.9
	11/14/2012	0.3900	0.1100	6.770	404.2
	02/27/2013				404.3
	05/02/2013	0.5800	0.8100	7.010	403.8
	08/20/2013				409.3
	11/25/2013	0.6200	0.001000	7.460	405.4
	02/26/2014				405.0
	05/22/2014	0.5010	0.07760	7.100	408.4
	09/03/2014				408.2

Wood River
Groundwater Monitoring Data for the West Ash Pond System: 2010 - 2015

Date Range: 01/01/2010 to 12/31/2015

		Boron, dissolved, mg/L	Manganese, dissolved, mg/L	pH (field), SU	Water level, relative to, ft
25	11/18/2014	0.6480	0.09080	6.870	407.9
	03/11/2015				405.9
	05/21/2015	0.5030	0.07110	6.920	407.7
	09/04/2015				410.4
	11/04/2015	0.5220	0.02020	6.730	406.5
28	03/02/2010				408.0
	06/14/2010	1.900	0.4500	6.390	413.1
	09/27/2010				411.5
	11/09/2010	1.200	0.4800	6.640	408.7
	03/03/2011				407.8
	06/23/2011	2.300	1.100	6.530	415.8
	09/27/2011				408.5
	11/01/2011	0.7900	0.2600	6.720	406.0
	03/27/2012				406.5
	06/26/2012	0.9500	0.8100	6.820	406.3
	08/21/2012				403.7
	11/14/2012	1.040	2.200	6.960	402.8
	02/27/2013				403.2
	05/02/2013	2.090	1.740	6.960	413.1
	08/20/2013				408.4
	11/25/2013	0.7600	0.5300	6.940	404.3
	02/26/2014				403.6
	05/22/2014	1.200	1.400	6.990	408.0
	09/03/2014				407.3
	11/18/2014	0.9130	3.540	6.930	407.1
	03/11/2015				405.1
	05/21/2015	1.020	1.540	6.860	406.8
	09/04/2015				409.6
	11/05/2015	0.9080	1.820	6.800	405.1
31	03/02/2010				408.2
	06/14/2010	1.100	0.4100	6.210	412.6
	09/27/2010				411.6
	11/09/2010	1.100	0.09600	6.510	408.8
	03/03/2011				408.5
	06/23/2011	1.200	0.1500	6.360	415.0
	09/27/2011				408.1
	11/01/2011	1.200	0.03100	6.390	405.8

Wood River
Groundwater Monitoring Data for the West Ash Pond System: 2010 - 2015

Date Range: 01/01/2010 to 12/31/2015

		Boron, dissolved, mg/L	Manganese, dissolved, mg/L	pH (field), SU	Water level, relative to, ft
31	03/27/2012				407.4
	06/26/2012	1.000	0.03400	6.100	406.6
	08/21/2012				404.2
	11/14/2012	0.9800	0.06000	7.020	403.7
	02/27/2013				397.6
	05/02/2013	1.190	0.001000	7.270	413.1
	08/29/2013	0.9900	0.05000	6.860	407.4
	11/25/2013	0.9000	0.07000	7.390	404.8
	02/26/2014				405.3
	05/22/2014	0.9270	0.04300	6.600	408.6
	09/03/2014				408.0
	11/18/2014	0.9360	0.05150	7.030	407.3
	03/11/2015				405.5
	05/21/2015	0.9020	0.04150	7.020	407.6
	09/04/2015				409.3
	11/04/2015	0.7970	0.04550	6.980	405.4
34	03/02/2010				406.0
	06/14/2010	1.300	6.100	6.740	413.7
	09/27/2010				413.2
	11/09/2010	0.9500	3.200	6.700	406.8
	03/03/2011				412.7
	06/23/2011	0.8000	6.200	6.630	416.8
	09/27/2011				405.4
	11/01/2011	0.9500	4.000	6.600	402.7
	03/28/2012				408.5
	06/26/2012	1.300	4.500	6.480	404.5
	08/21/2012				401.0
	11/14/2012	1.430	6.100	6.890	401.3
	02/27/2013				402.5
	05/06/2013	0.9000	6.050	6.820	416.5
	08/20/2013				404.6
	11/25/2013	7.390	4.450	7.030	402.6
	02/26/2014				429.1
	05/22/2014	2.090	7.750	6.890	410.4
	09/03/2014				408.3
	11/18/2014	5.890	5.250	6.860	404.3
	03/11/2015				404.2

Wood River
Groundwater Monitoring Data for the West Ash Pond System: 2010 - 2015

Date Range: 01/01/2010 to 12/31/2015

		Boron, dissolved, mg/L	Manganese, dissolved, mg/L	pH (field), SU	Water level, relative to, ft
34	05/21/2015	5.950	6.700	6.820	408.5
	09/04/2015				406.6
	11/03/2015	7.490	4.960	7.050	402.5
36	03/02/2010				407.8
	06/14/2010	0.07900	2.600	6.960	412.6
	09/27/2010				412.3
	11/09/2010	0.08900	2.200	6.810	408.3
	03/03/2011				411.2
	09/27/2011				406.7
	11/01/2011	0.09200	3.200	6.870	404.7
	03/28/2012				408.6
	06/26/2012	0.08500	2.600	7.090	406.9
	08/21/2012				404.4
	11/14/2012	0.1600	3.340	6.650	404.3
	02/27/2013				404.8
	08/20/2013				406.9
	11/25/2013	0.1300	2.520	7.320	405.7
	02/26/2014				406.6
	05/22/2014	0.1240	2.520	6.880	410.3
	09/03/2014				406.5
	11/18/2014	0.1220	2.630	7.010	406.4
	03/11/2015				406.1
	05/21/2015	0.1400	3.190	6.930	409.6
	09/04/2015				407.6
	11/03/2015	0.1190	2.520	7.140	405.2

Wood River
Groundwater Monitoring Data for the West Ash Pond System: 2010 - 2015

Date Range: 01/01/2010 to 12/31/2015

Well Id	Date Sampled	Lab Id	Residue, total filtrable, mg/L	Sulfate, total, mg/L
02	06/14/2010		930.0	180.0
	11/09/2010		940.0	140.0
	06/23/2011		880.0	160.0
	11/01/2011		930.0	210.0
	06/26/2012		1000.	220.0
	05/06/2013		1020.	288.0
	11/25/2013		936.0	298.0
	05/22/2014		964.0	222.0
	11/18/2014		872.0	185.0
	05/21/2015		862.0	213.0
	11/03/2015		948.0	228.0
04	06/14/2010		1000.	10.00
	11/09/2010		970.0	11.00
	06/23/2011		940.0	<5.000
	11/01/2011		930.0	47.00
	06/26/2012		1000.	<5.000
	11/14/2012		908.0	<10.00
	05/06/2013		894.0	10.00
	11/25/2013		928.0	<10.00
	05/22/2014		740.0	<10.00
	11/18/2014		820.0	<20.00
	05/21/2015		758.0	<10.00
	11/03/2015		884.0	<10.00
12	06/14/2010		520.0	37.00
	11/09/2010		460.0	18.00
	06/23/2011		530.0	50.00
	11/01/2011		460.0	16.00
	06/26/2012		570.0	30.00
	11/14/2012		490.0	71.00
	05/02/2013		500.0	74.00
	11/25/2013		436.0	33.00
	05/22/2014		498.0	68.00
	11/18/2014		454.0	33.00
	05/21/2015		496.0	39.00
	11/05/2015		502.0	48.00
20	03/02/2010		380.0	64.00
	06/14/2010		310.0	62.00

Wood River
Groundwater Monitoring Data for the West Ash Pond System: 2010 - 2015

Date Range: 01/01/2010 to 12/31/2015

		Residue, total filtrable, mg/L	Sulfate, total, mg/L
20	09/27/2010	490.0	150.0
	11/09/2010	360.0	110.0
	03/02/2011	450.0	100.0
	06/23/2011	380.0	100.0
	09/27/2011	450.0	140.0
	11/02/2011	400.0	97.00
	03/28/2012	530.0	140.0
	06/26/2012	700.0	150.0
	08/21/2012	730.0	180.0
	11/14/2012	652.0	152.0
	02/27/2013	600.0	162.0
	05/02/2013	590.0	157.0
	08/20/2013	548.0	87.00
	11/25/2013	546.0	93.00
	02/26/2014	528.0	91.00
	05/22/2014	468.0	74.00
	09/03/2014	518.0	111.0
	11/18/2014	440.0	56.00
	03/11/2015	420.0	83.00
	05/21/2015	424.0	61.00
	09/04/2015	422.0	72.00
	11/05/2015	430.0	70.00
21	06/14/2010	540.0	130.0
	11/09/2010	490.0	110.0
	06/23/2011	550.0	140.0
	11/01/2011	600.0	170.0
	06/26/2012	600.0	110.0
	11/14/2012	508.0	129.0
	05/02/2013	630.0	236.0
	11/25/2013	490.0	118.0
	05/22/2014	574.0	109.0
	11/18/2014	438.0	74.00
	05/21/2015	526.0	96.00
	11/04/2015	554.0	116.0
22	06/14/2010	570.0	78.00
	11/09/2010	500.0	91.00
	06/23/2011	520.0	75.00

Wood River
Groundwater Monitoring Data for the West Ash Pond System: 2010 - 2015

Date Range: 01/01/2010 to 12/31/2015

		Residue, total filtrable, mg/L	**Sulfate, total, mg/L**
22	11/01/2011	490.0	67.00
	06/26/2012	560.0	62.00
	11/14/2012	408.0	76.00
	05/02/2013	480.0	79.00
	11/25/2013	454.0	59.00
	05/22/2014	628.0	99.00
	11/18/2014	530.0	77.00
	05/21/2015	536.0	62.00
	11/05/2015	444.0	46.00
23	06/14/2010	640.0	180.0
	11/09/2010	610.0	130.0
	06/23/2011	670.0	150.0
	11/01/2011	670.0	140.0
	06/26/2012	720.0	150.0
	11/14/2012	626.0	158.0
	05/02/2013	552.0	183.0
	11/25/2013	604.0	132.0
	05/22/2014	760.0	219.0
	11/18/2014	644.0	180.0
	05/21/2015	668.0	182.0
	11/05/2015	670.0	123.0
25	06/14/2010	1500.	260.0
	11/09/2010	1600.	290.0
	06/23/2011	1200.	180.0
	11/01/2011	1700.	300.0
	06/26/2012	1600.	270.0
	11/14/2012	1140.	192.0
	05/02/2013	690.0	104.0
	11/25/2013	1710.	307.0
	05/22/2014	742.0	89.00
	11/18/2014	1410.	283.0
	05/21/2015	974.0	124.0
	11/04/2015	1320.	219.0
28	06/14/2010	800.0	180.0
	11/09/2010	730.0	130.0
	06/23/2011	800.0	180.0
	11/01/2011	490.0	68.00

Wood River
Groundwater Monitoring Data for the West Ash Pond System: 2010 - 2015

Date Range: 01/01/2010 to 12/31/2015

		Residue, total filtrable, mg/L	Sulfate, total, mg/L
28	06/26/2012	800.0	180.0
	11/14/2012	626.0	118.0
	05/02/2013	858.0	285.0
	11/25/2013	678.0	178.0
	05/22/2014	790.0	235.0
	11/18/2014	784.0	252.0
	05/21/2015	644.0	173.0
	11/05/2015	596.0	154.0
31	06/14/2010	2800.	270.0
	11/09/2010	4800.	250.0
	06/23/2011	6000.	230.0
	11/01/2011	5100.	230.0
	06/26/2012	3700.	240.0
	11/14/2012	2490.	206.0
	05/02/2013	1720.	164.0
	08/29/2013	2040.	169.0
	11/25/2013	1860.	149.0
	05/22/2014	1620.	129.0
	11/18/2014	2020.	161.0
	05/21/2015	2240.	118.0
	11/04/2015	2170.	149.0
34	06/14/2010	860.0	<5.000
	11/09/2010	670.0	7.400
	06/23/2011	860.0	<5.000
	11/01/2011	680.0	10.00
	06/26/2012	740.0	6.800
	11/14/2012	896.0	15.00
	05/06/2013	900.0	30.00
	11/25/2013	720.0	10.00
	05/22/2014	1050.	47.00
	11/18/2014	770.0	<10.00
	05/21/2015	902.0	<10.00
	11/03/2015	758.0	<10.00
36	06/14/2010	620.0	11.00
	11/09/2010	600.0	11.00
	11/01/2011	620.0	33.00
	06/26/2012	530.0	11.00

Wood River
Groundwater Monitoring Data for the West Ash Pond System: 2010 - 2015

Date Range: 01/01/2010 to 12/31/2015

		Residue, total filtrable, mg/L	Sulfate, total, mg/L
36	11/14/2012	768.0	<10.00
	11/25/2013	474.0	<10.00
	05/22/2014	468.0	<10.00
	11/18/2014	474.0	<10.00
	05/21/2015	556.0	<10.00
	11/03/2015	430.0	<10.00

APPENDIX D

GROUNDWATER SAMPLING PROTOCOL

Groundwater Sampling Protocol

The following procedures shall be used in sampling groundwater at the site. This sampling protocol shall apply to the routine quarterly (or modified semi-annual or annual) sampling events. A sample collector's worksheet, comparable to the one located in Exhibit 1, may be used for noting relevant information in regard to each well.

Water Levels

Water levels shall be taken in each well prior to purging and/or sampling. Water levels should be taken as close together as practical, to prevent any time distortion of the water surface data. The following steps shall be followed to obtain accurate water level readings:

1. Note the general condition of the monitoring well on the worksheet. This shall include, but is not limited to the condition of the casing, the lock, evidence of tampering, condition of the pad, and any standing water.
2. Remove the lock and open the monitoring well. Note the condition of the interior of the casing and the condition of the well cap and riser. Open the cap, taking care not to allow dirt or foreign material into the monitoring well.
3. The technician shall rinse the probe and cable of the water level meter with decon water.
4. Slowly lower the probe into the monitoring well until the meter indicates the water surface has been reached.
5. Note the depth to water (to the nearest 0.01 ft) and the time on the worksheet.
6. Lower the probe to the bottom of well. (If a dedicated pump is installed in the well, skip this step). Note the well depth on the worksheet. The depth of the well will be measured on an annual basis, at wells that do not contain dedicated pumps. The depth of wells with dedicated pumps will be measured at least once every 5 years, or whenever the pump is removed.
7. Slowly remove the probe from the well. Rinse the probe and line with decon water.
8. Replace cap. Close and lock the well. Proceed to the next well, and repeat.

Purging of Monitoring Well – Pump Method

After all water level measurements have been taken, the monitoring wells shall be purged to provide a representative sample. Each groundwater monitoring well shall be purged by using a dedicated pump. The pump construction shall consist of inert materials consistent with the monitoring well construction (e.g., stainless steel pump bodies installed in stainless steel wells).

Purging shall be conducted utilizing a "low-flow" or minimal drawdown technique. Flow rates for this technique will typically fall below 0.5 liters/minutes, with an overall goal of not reducing the water level in the monitoring well by more than 0.3 ft during purging. Water levels should be checked frequently to ensure that the drawdown in the well does not exceed the 0.3-ft limits. Every 3 minutes to 5 minutes, readings shall be taken on the following water quality indicators to determine if a representative water sample is available.

- pH (in SU),
- Specific Conductance (in µmhos/cm or µS/cm),
- Temperature (in ºF),
- And, it is suggested, at least one of the following:
  - Redox Potential (in mV);
  - Dissolved Oxygen (in mg/L); and/or
  - Turbidity (in NTU).

The water quality indicators will be considered stabilized when the following tolerances are reached after three consecutive readings:

- pH.................................... ±0.05 SU
- Specific Conductance ...... ±5 percent
- Temperature.................... ±0.5ºF
- Redox Potential .... ±10 percent
- Dissolved Oxygen........... ±10 percent
- Turbidity......................... ±10 percent

Slow recovering wells require special consideration. If a well is dry, or is purged below the bottom of the pump intake, the well will be allowed to recharge for at least 12 hours. Samples shall be collected until all sample containers have been filled or the well becomes dry. Notes shall be kept on the worksheet with regard to water levels, times, volume of water removed, and any other parameters considered to be relevant.

Purging of Monitoring Well – Bailer Method

Purging and sample collection with a bailer shall be performed in the event of a non-functioning pump or from a well that does not have a dedicated pump installed. A sample shall be collected utilizing a factory packaged, clean, disposable bailer with an appropriate length of new, clean rope attached.

Calculate the number of bailer volumes of water needed to remove one (1) well volume of water.

Well Volume Calculations (2-inch well):

Schedule 40 PVC has an inside diameter of 2.067 inches.

$\therefore$ ((2.067 inches/12 inches/ft)/2)^2 • π • 1 ft of water = 0.0233 ft^3/ft of water.

0.0233 ft^3/ft • 7.48 gallons/ft^3 = 0.174 gallon/ft

Schedule 5 Stainless Steel (304 or 316) has an inside diameter of 2.245 inches.

$\therefore$ ((2.245 inches/12 inches/ft)/2)^2 • π • 1 ft of water = 0.0275 ft^3/ft of water.

0.0275 ft^3/ft • 7.48 gallons/ft^3 = 0.206 gallon/ft

Volume of well (in gallons) = well type gallon/ft • (DTB - DTW); where,
DTB $\equiv$ depth to bottom of well (from measuring point), and
DTW $\equiv$ depth to water (from measuring point)

Bailer Volumes:

Disposable bailer volumes will vary by type and manufacturer. Volume information should be obtained before going to the site. For comparison, a 3 ft stainless steel bailer has a volume of approximately 1220 cc or 0.322 gallon and a 5 ft PVC bailer of approximately 1085 cc or 0.287 gallon.

Open monitoring well, being careful that no potential contaminant enters the well.

Remove one (1) bailer volume of water from the monitoring well. Test pH, specific conductance and temperature. Note values on worksheet. (Turbidity, redox potential and dissolved oxygen will vary considerably due to the agitation a bailer will cause in the well. Testing for these parameters is not recommended with this method.)

Remove one-half (½) gallon of water from the monitoring well. Test pH, specific conductance and temperature. Note values on worksheet.

Remove ½ to 1 gallon of water. Test pH, specific conductance and temperature. Record data on worksheet.

Repeat until pH, specific conductance and temperature stabilize or three (3) well volumes of water have been removed.

If the monitoring well becomes dry, or there is insufficient water to obtain all necessary samples, the monitoring well will be allowed to recharge for 24 hours. Samples shall be collected until all sample containers are filled or the well becomes dry. Notes shall be kept on the worksheet regarding water levels, times, volume of water removed, and any other parameters considered by the technician to be relevant.

If there is sufficient water volume in the monitoring well to obtain all samples, sample collection shall begin at this time.

Sample Collection Order

Samples shall be collected starting at the monitoring well with the least likelihood for contamination. Sampling shall proceed from the well with the lowest potential for contamination to the well with the highest potential for contamination.

Field Measurements

General

Upon arrival at each groundwater monitoring well, the technician shall note on the sampler's worksheet or in a field notebook the date, time, ambient air temperature, general weather conditions, and individuals present, including sample team members and any observers. (Note: Any observers shall need at a minimum, the same personal protective gear as the members of the sample team.)

Establish a "clean area" near the monitoring well where the sample containers and equipment can be stored while not in use. Every effort should be made to keep the sampling equipment and containers from contacting the ground surface. If necessary, a disposable, plastic tarp can be used as a ground cover to prevent potential contamination of the sample containers and equipment. Typically, the back of the field vehicle will be used as the "clean area".

Any non-dedicated sampling equipment (meter probes, thermometers, etc.) shall be washed in a commercial, laboratory cleaner (Alconox®, Liquinox®, or equivalent), and thoroughly rinsed in decon water before each use. Calibration shall be performed at each new monitoring location after the initial decontamination. After use, each device shall be powered down (if necessary) decontaminated, and stored in its manufacturer-approved container.

Temperature

Obtain a water sample from the well. Place the sample aliquot in a disposable container, insert the thermometer (or electronic probe), wait until the readings have stabilized, and record the temperature on the worksheet. Temperature for a glass thermometer should be noted to the nearest degree Fahrenheit (1ºF). For electronic thermometers (thermocouples), temperature should be noted to the nearest tenth degree Fahrenheit (0.1ºF). The thermometer or probe shall be cleaned and rinsed with decon water after use.

pH

Confirm calibration of the instrument by comparing with an appropriate buffer solution. Adjust for temperature compensation (if meter is not self-compensating). Rinse probe with decon water. Obtain a sample from the well and place the probe in sample aliquot. Note the pH and record on the sample worksheet. Note pH readings to the nearest tenth unit (0.1).

Specific Conductance

Confirm calibration of the instrument by comparing against an appropriate buffer solution. Adjust for temperature compensation (if meter is not self-compensating). Rinse the probe with decon water. Obtain a sample from the well and place the probe in sample aliquot. Note the specific conductance and record on the sample worksheet. Specific conductance should be noted to the nearest micromhos per centimeter (µmhos/cm) or microSiemens per centimeter (µS/cm).

Sample Collection Procedures

Jars and vials may ship pre-labeled from the laboratory, identifying the analysis and preservative for each type of sample. Dependent upon circumstances, sample containers may be prepared by non-laboratory personnel. If so, this should be noted on the sample worksheet or in the field notebook.

A technician shall remove a sample container from the cooler, affix a label, and in indelible, waterproof ink write the well number and/or sample I.D., the facility name, the sample collection date and time, the type of sample in the container, and the sample collector's name. A technician shall organize the containers in the following sampling order:

- Metals and Minerals (dissolved)
- Anions (dissolved)
- Total Dissolved Solids (TDS)
- Cyanides (total)

Dissolved parameters include dissolved metals and minerals, total dissolved solids (TDS), and nitrogen should be field filtered. Samples should be filtered using a 0.45-micron filter attached to the sample pump line. Other filter apparatus may be utilized as long as Illinois EPA guidelines are followed. Filters should be replaced no less frequently than at each new well, and may need to be replaced more often if flow is restricted due to particulate matter in the sample water.

Transportation of Monitoring Samples

Sample Preservation Techniques

The preservation techniques utilized in the groundwater samples will typically adhere to those listed in *Handbook for Sampling and Sample Preservation of Water and Wastewater*, U.S. EPA, EPA-600/4-82-029, September 1982 and/or *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods*, EPA/530/SW-846, 3rd. Edition, Final Update IV (January 2008).

Transportation of Samples

Samples shall be transported to the laboratory in sealed, insulated shipping containers, ice chests, or coolers. The shipping containers should be sturdy, and if samples are contained in glass bottles, dividers and/or bubble wrap should be used to restrict potential breakage. All samples will be packed in ice or a packaged refrigerant as necessary for proper preservation. Samples should be packed to maintain sample temperatures as close to 4ºC (degrees Celsius) or 39ºF as possible from the time the samples are collected to the time the samples are received by the laboratory. The samples should be shipped/delivered to the laboratory as soon as practical, preferably within 24 hours of sample collection.

All samples shall be accompanied by a chain-of-custody record. The sampler shall retain a copy of the record and forward the original with the samples to the analytical laboratory. Once the laboratory has received the samples, a representative from the laboratory is to complete the record, retain the original and return a copy with the chemical analysis reports to the sampler. The chain-of-custody shall contain the facility name, the wells sampled, time and date of sampling, members of the sampling party, type of samples (i.e. water, soil, leachate, etc.), number of sample bottles, requested analysis, overnight courier, etc. A sample chain-of-custody record is provided in Exhibit 2.

Attachments
Exhibit 1: Groundwater Sampling Worksheet
Exhibit 2: Example Chain-of-Custody Record

Appendix C.
Hydrostatic Modeling Report

SMARTER SOLUTIONS

EXCEPTIONAL SERVICE

VALUE

HYDROSTATIC MODELING REPORT

West Ash Pond Complex
Wood River Power Station
Alton, Illinois

FINAL

October 19, 2016

NATURAL
RESOURCE
TECHNOLOGY

ENVIRONMENTAL CONSULTANTS

Natural Resource Technology
Environmental Consultants

234 W. Florida Street, Fifth Floor
Milwaukee, Wisconsin 53204
(P) 414.837.3607
(F) 414.837.3608

HYDROSTATIC MODELING REPORT

WEST ASH POND COMPLEX
WOOD RIVER POWER STATION
ALTON, ILLINOIS

Project No. 2376

Prepared For:

Dynegy Operating Company
1500 Eastport Plaza Drive
Collinsville, IL 62234

Prepared By:

Natural Resource Technology, Inc.
234 W. Florida Street, Fifth Floor
Milwaukee, Wisconsin 53204

FINAL
October 19, 2016

Stuart J. Cravens, PG
Principal Hydrogeologist

Meng Wang, PhD, PE
Environmental Engineer

TABLE OF CONTENTS

1 BACKGROUND 1-1
  1.1 Introduction 1-1
  1.2 Ash Pond Scenarios 1-1
    1.2.1 Baseline Conditions 1-1
    1.2.2 Closure Scenarios 1-1
  1.3 Objective 1-2
2 HELP MODEL SET-UP 2-1
  2.1 Model Description 2-1
  2.2 Input Data 2-1
  2.3 Types of Analysis 2-2
3 HELP MODEL RESULTS 3-1
  3.1 Percolation Calculation 3-1
  3.2 Prediction Analysis 3-1
  3.3 Sensitivity Analysis 3-2
4 SUMMARY 4-1
5 REFERENCES 5-1

FIGURES

Figure 1a Hydraulic Head and Percolation Rate for Capped WAP 1
Figure 1b Hydraulic Head and Percolation Rate for Capped WAP 2W
Figure 1c Hydraulic Head and Percolation Rate for Capped WAP 2E
Figure 2 Sensitivity Analysis - Initial Saturation Thickness for Capped WAP 1
Figure 3a Sensitivity Analysis - Foundation Soil Hydraulic Conductivity for Capped WAP 1
Figure 3b Sensitivity Analysis - Foundation Soil Hydraulic Conductivity for Capped WAP 2E
Figure 4a Sensitivity Analysis - Geomembrane Placement Quality for Capped WAP 1
Figure 4b Sensitivity Analysis - Geomembrane Placement Quality for Capped WAP 2E
Figure 5a Sensitivity Analysis - Geomembrane Installation Defects for Capped WAP 1
Figure 5b Sensitivity Analysis - Geomembrane Installation Defects for Capped WAP 2E

TABLES

Table 1 HELP Input Parameters - West Ash Ponds 1 and 2W Baseline Conditions
Table 2 HELP Input Parameters - West Ash Pond 2E Baseline Condition
Table 3 HELP Input Parameters - West Ash Ponds 1 and 2W Closure Conditions
Table 4 HELP Input Parameters - West Ash Pond 2E Closure Condition
Table 5 Foundation Soil Percolation Rate Summary
Table 6 HELP Sensitivity Analyses

APPENDICES

Appendix A HELP Model Files (included on CD)

1 BACKGROUND

1.1 Introduction

This Hydrostatic Modeling Report has been prepared by Natural Resource Technology (NRT) on behalf of Dynegy Midwest Generation, LLC (DMG) to estimate percolation from the Wood River West Ash Complex (Site) and to evaluate hydrostatic equilibrium of groundwater beneath the proposed pond cap systems at the Wood River Power Station, Alton, Madison County, Illinois. The cap systems, as described in the draft Closure and Post-Closure Care Plan for Dynegy Wood River Ash Complex (AECOM, 2016), are proposed to be implemented on West Ash Pond 1 (WAP 1), West Ash Pond 2W (WAP 2W), and West Ash Pond 2E (WAP 2E). The Hydrologic Evaluation of Landfill Performance (HELP) model was used to predict percolation and to evaluate hydrostatic conditions of each ash pond in response to the proposed cap system.

1.2 Ash Pond Scenarios

For each ash pond, two HELP model scenarios were established to represent the pond condition in different stages: the baseline conditions for the pre-construction stage, prior to the implementation of the proposed cap system, and the closure conditions for the post-construction stage, when the cap system is in-place.

1.2.1 Baseline Conditions

WAP 1, WAP 2W and WAP 2E were categorized into two groups to represent baseline conditions:

- Unlined Ash Ponds (WAP 1 and WAP 2W) – represents the condition when coal ash, primarily composed of fly ash in WAP 1 and WAP 2W, is deposited directly on the silty clay foundation soil. It is assumed for ground surface condition that there is no stormwater runoff and vegetation consists of a poor stand of grass.
- Lined Ash Pond (WAP 2E) – represents the condition when a composite clay/synthetic liner system was constructed at the bottom of the ash pond. The basal liner is comprised of (from bottom up) a 12-inch compacted clay layer and a 45-mil polypropylene liner. WAP 2E was primarily used for bottom ash storage. It is assumed for ground surface condition that there is no stormwater runoff and the ground is bare (i.e., no vegetation).

1.2.2 Closure Scenarios

Closure scenarios were modeled to represent the draft Closure and Post-Closure Care Plan cap configurations (AECOM, 2016). The preferred cap system is comprised of a geomembrane cover with a drainage layer, consisting of (from bottom up) a 40-mil LLDPE geomembrane, a geocomposite (to drain infiltrated surface water), and a 2-foot thick protective layer. The protective layer consists of an 18-inch rooting zone soil layer and a 6-inch topsoil layer.

HELP model input assumes the proposed cover systems are properly constructed and maintained to allow 100% stormwater runoff, i.e., the covers have positive drainage to prevent standing water and vegetation consists of a fair stand of grass.

1.3 Objective

The purpose of this report is to estimate percolation from the ponds and to evaluate the design of the cap systems on the hydrostatic conditions within the system. The time for the Wood River West Ash Complex ponds to reach hydrostatic equilibrium is also assessed. This modeling report addresses the following:

- Estimate the percolation rates from WAP 1, WAP 2W and WAP 2E. The percolation rates serve as input data for recharge rates in the groundwater flow model (MODFLOW model) to simulate Site hydraulics and leachate transport when no caps are implemented.
- Predict the percolation rates through the basal component of the pond when the designed caps are implemented for WAP 1, WAP 2W and WAP 2E. The percolation rates serve as input data for recharge rates in the MODFLOW model to predict Site hydraulics and leachate transport when caps are in-place.
- Assess whether the capped West Ash Complex ponds could reach hydrostatic equilibrium conditions for the proposed design of the cap system, when applied with Site-specific parameters, which means minimal water head fluctuation beneath the cap system on the foundation soil following the completion of cap construction (i.e., flow rate in equals flow rate out). If modeling indicates hydrostatic equilibrium is achievable, then the time it will take the West Ash Complex ponds to reach hydrostatic equilibrium status is estimated.

2 HELP MODEL SET-UP

2.1 Model Description

The Hydrologic Evaluation of Landfill Performance (HELP) model was developed by the U.S. Environmental Protection Agency (Schroeder et al., 1994). HELP is a one-dimensional hydrologic model of water movement across, into, through and out of a landfill or soil column based on precipitation, evapotranspiration, runoff, and the geometry and hydrogeologic properties of a layered soil and waste profile.

For this investigation, HELP Version 3.07 (Schroeder et al., 1994) was selected to estimate the hydraulic conditions beneath caps implemented on the Wood River West Ash Complex as prescribed by AECOM (2016). The hydrologic data entered into HELP are listed in Tables 1 through 4 and described in the following paragraphs.

2.2 Input Data

Tables 1 and 2 present input data used to configure the baseline HELP models for unlined ash ponds (WAP 1 and WAP 2W) and the lined ash pond (WAP 2E), respectively. Tables 3 and 4 present input data used to configure the cap HELP models for the capped unlined ash ponds (WAP 1 and WAP 2W) and capped lined ash pond (WAP 2E), respectively. Climatic input variables were synthetically generated by the HELP model using default values for St. Louis, MO, and a latitude of 38.87° N for the Wood River Power Station. Rainfall frequency and temperature patterns for more than 100 cities are programmed into HELP. St. Louis, MO was the closest city to the Site. The model used St. Louis, MO default precipitation and temperature coefficients to generate daily precipitation and temperature data. A 30-year simulation period was selected for baseline models of WAP 1 and WAP 2W, which provided a sufficient duration to review the impact of precipitation variance on outputs for models. The baseline model for WAP 2E used a 16-year simulation period to simulate only the time period following placement of the polypropylene liner. The closure was modeled for a 100-year simulation period after completion of cap construction. The 100-year simulation duration was required to indicate the trend for the designed cap to reach equilibrium.

Physical input data were based on the actual and proposed configurations of the ponds, measured soil properties, and in the absence of site specific measurements, assumed soil properties (NRT, 2016; AECOM, 2016). The coal ash was subdivided into several 18-inch thick (WAP 1 and WAP 2W) or 12-inch thick (WAP 2E) sublayers in the models. Coal ash thickness was obtained from the record of soil borings conducted in the pond (NRT, 2016).

The initial moisture content of the uncapped coal ash in the baseline scenarios was set equal to porosity for saturated coal ash or field capacity for unsaturated coal ash to simulate specific saturated conditions in each pond. The thickness of saturated coal ash was determined from soil boring records (NRT, 2016). The initial surface water of the WAP 2E baseline model was set as 60 inches to represent the standing water in the pond. Any excess water above 60 inches is removed as it flows through a weir into the adjacent Pond 3.

For closure scenarios of WAP 1 and WAP 2W, the initial moisture contents of existing layers were set to the steady-state conditions as in the baseline models. The initial moisture content of existing layers for the closure scenario of WAP 2E were set equal to the moisture content calculated by HELP at Year 16 from the baseline model under the assumption that the cap would be implemented in Year 2016. The initial moisture content for the cap/liner materials was set equal to field capacity. The cap was assumed to allow 100% surface water runoff provided the cap drainage is properly maintained.

Individual material layers were assumed to be homogenous; that is, the material layers have uniform texture and hydraulic properties. Hydraulic properties of materials, including hydraulic conductivity, porosity, field capacity, and wilting point, were either the default HELP database values or as provided by the geosynthetic manufacturer, such as the hydraulic conductivity (1×10^{-11} cm/s) of the basal polypropylene liner at WAP 2E. The hydraulic conductivity of fly ash in WAP 1 and WAP 2W was set equal to the calibrated value in the previous 2000 HELP Model (NRT, 2000). The hydraulic conductivity of bottom ash in WAP 2E was set as the default HELP database value.

Field measurement of horizontal hydraulic conductivity of the foundation layer silty clay has a geometric mean value of 2.4×10^{-5} cm/s (Hampton and O'Hearn, 1984). Laboratory measurement of vertical hydraulic conductivity of the silty clay has a geometric mean value of 1.1×10^{-7} cm/s (Hampton and O'Hearn, 1984; Kelron Environmental, 2004; NRT, 2016). A value of 3.0×10^{-7} cm/s (near the geometric mean vertical conductivity) was selected for modeling. The baseline scenarios for the West Ash Pond Complex resulted in saturated ash thicknesses that correlate well with observed conditions indicating the model was calibrated for prediction runs.

2.3 Types of Analysis

Two types of HELP simulations were performed: prediction analysis and sensitivity analysis.

The prediction analysis was conducted to estimate percolation rates for each capped pond, which were later input to the groundwater flow model. The prediction analysis was also performed to estimate the hydraulic head on the foundation soil, which was used to evaluate the hydrostatic status over time for the Wood River West Ash Complex and to estimate the time for the hydraulic head to reach equilibrium.

Sensitivity analysis was used to determine the significance of input parameters for the Wood River West Ash Complex to reach hydrostatic equilibrium. Sensitivity analysis was performed for parameters potentially influencing the capped West Ash Complex hydrostatic conditions, including:

- Initial thickness of saturated fly ash zone (applied only for capped unlined ash pond)
- Hydraulic conductivity of foundation soil
- Geomembrane placement
- Geomembrane installation defects

3 HELP MODEL RESULTS

3.1 Percolation Calculation

HELP input and output files are included as Appendix A on the attached CD. Calculated percolation rates through the foundation soil fluctuated with changes in precipitation and evaporation conditions. Average foundation soil percolation rates calculated from the HELP simulations are summarized in Table 5, and were used in the groundwater flow models. The baseline condition percolation rates though the foundation soil estimated for WAP 1, WAP 2W and WAP 2E are 8.67 inch/yr, 8.52 inch/yr and 0.71 inch/yr, respectively.

3.2 Prediction Analysis

The HELP model was run for 100 years after cap construction completion, applying the input parameters listed in Section 2.2.

Figures 1a, 1b and 1c exhibit the predicted hydraulic heads in the system and the predicted percolation rates through the basal component of the pond. Due to the different magnitudes of percolation rate decreases for capped unlined ash ponds (Figures 1a and 1b), the post closure period was divided into three stages: the initial one with dramatically decreasing percolation rate, the intermediate one with slowly decreasing percolation rate, and the last one with approaching-zero percolation rate. Mean values of the percolation rates for each period were calculated and shown in Table 5, which were 5.28 inch/yr (Year 1-10), 0.28 inch/yr (Year 11-31) and 0.002 inch/yr (Year 32-100) for capped WAP 1; and 5.24 inch/yr (Year 1-9), 0.28 inch/yr (Year 10-28) and 0.001 inch/yr (Year 29-100) for capped WAP 2W, respectively. The closure condition percolation rate though the foundation soil for WAP 2E was estimated as a mean value of 0.33 inch/yr throughout the 100-year period due to its relatively constant decreasing trend (Figure 1c).

As shown on Figures 1a and 1b, the hydraulic head on the foundation soil and percolation rate through the system behave in a similar manner for the two unlined ash ponds, WAP 1 and WAP 2W. The hydraulic heads on the foundation soil continuously decrease until approximately Year 10-11 from cap construction completion when equilibrium is reached and the head on the foundation soil is minimized.

Figure 1c shows the predicted hydraulic head on the basal liner and the predicted percolation rate through the basal liner and foundation soil for capped WAP 2E. The predicted hydraulic head starts to decrease from the beginning of the cap completion until the end of the 100-Year simulation duration. Correspondingly, the percolation rate follows a decreasing trend along with the hydraulic head. The capped pond does not reach equilibrium within the 100-year model simulation, which is largely because the hydraulic conductivity of the basal liner limits pond dewatering. Although this prediction model does not indicate the year when the cap scenario reaches equilibrium, the continuously decreasing trends in hydraulic head and percolation rate indicate the system is gradually approaching equilibrium.

3.3 Sensitivity Analysis

Sensitivity analyses were performed on select layer parameters as summarized in Table 6 and as described in the following paragraphs. The closure scenario of WAP 1 was chosen to represent capped unlined ash pond for sensitivity analyses. The changes in hydraulic heads under sensitivity analyses are shown on Figures 2 through 5.

Initial Thickness of Saturated Ash Zone

The hydraulic heads on the WAP 1 foundation soil were predicted under different initial thicknesses of saturated fly ash (from 90 inches to 210 inches) for the chosen cap scenario, as shown on Figure 2. The plot shows the hydraulic heads were sensitive to the initial thickness of saturated fly ash in the early years. At approximately Year 10, the different hydraulic heads converged to a minimum level approaching zero. The result implies hydrostatic equilibrium can be attained under all tested initial thickness of saturated ash zone in approximately 10 years.

Hydraulic Conductivity of Foundation Soil

The hydraulic heads within the ponds were predicted under a range of foundation soil hydraulic conductivities (1.0×10^{-8} to 1.0×10^{-5} cm/s), and plotted on Figures 3a (capped unlined ash pond) and 3b (capped lined ash pond), respectively.

For capped unlined ash pond WAP 1 (Figure 3a), the hydraulic head does not build up when the hydraulic conductivity of foundation soil is 3.0×10^{-7} cm/s or above. Additionally, in the extreme condition of 1.0×10^{-8} cm/s, the hydraulic head does not accumulate but decreases with time. Although this prediction model does not indicate the year when the 1.0×10^{-8} cm/s scenario reaches equilibrium, the continuously decreasing trends in hydraulic head indicate the system is gradually approaching equilibrium. It is not believed that the foundation soil behaves as a unit with a hydraulic conductivity as low as 1.0×10^{-8} cm/s because the ponds have been uncapped without any runoff for over 10 years, and water levels have not approached the top of the berms. Therefore, the result shows that hydrostatic equilibrium can be attained under a wide range of foundation soil hydraulic conductivity.

For WAP 2E (Figure 3b), the hydraulic heads in all scenarios remain consistent throughout the simulation period. The hydrostatic equilibrium of capped WAP 2E is not sensitive to the chosen range of hydraulic conductivity of the foundation soil.

Geomembrane Placement Quality

The hydraulic heads on the capped unlined ash pond foundation soil (Figure 4a) and the capped lined ash pond basal liner (Figure 4b) were predicted under a range of the cap geomembrane placement quality (from poor to excellent). The consistent hydraulic heads predicted for all scenarios reveal the hydrostatic conditions for both capped ponds are minimally sensitive to the placement quality of the geomembrane.

Geomembrane Installation Defects

The hydraulic heads on the capped unlined ash pond foundation soil (Figure 5a) and the capped lined ash pond basal liner (Figure 5b) were predicted under a range of installation defects for the cap geomembrane (from poor to excellent). According to Figure 5a, the hydrostatic equilibrium of capped unlined ash pond is not sensitive to the chosen range of installation defects. Figure 5b reveals that, for capped lined ash pond, with high geomembrane installation defects, the hydraulic head decreases more slowly than the scenario with low geomembrane installation defects. However, all scenarios show a decreasing trend in hydraulic head, suggesting hydrostatic equilibrium could be reached under the simulated range of geomembrane installation defects.

4 SUMMARY

The HELP model was used to estimate percolation rate within the Wood River West Ash Complex, and to evaluate the hydrostatic conditions with implementation of proposed cap systems. Input parameters were chosen based on Site specific configurations and a range of parameters were tested for sensitivity to the hydraulic head accumulated beneath the cap system in the 100 years following closure completion. The results of the modeling indicate:

- Hydrostatic equilibrium can be obtained for the proposed Wood River West Ash Complex under the current hydrogeological conditions for WAP 1, WAP 2W, and WAP 2E with the proposed cap system for each pond.
- Hydraulic head in the proposed cap system for WAP 1 and WAP 2W is expected to decrease to near-zero level for equilibrium at Year 10-11 after completion of cap construction (Figures 1a and 1b).
- Hydraulic head in WAP 2E with the proposed cap system is expected to keep decreasing beyond the 100-year simulation duration after the cap completion (Figure 1c). Although the system does not reach hydraulic equilibrium during the simulation timeframe, the continuously decreasing hydraulic head indicates a trend toward hydrostatic equilibrium.
- The hydrostatic condition of capped unlined ash ponds (WAP 1 and WAP 2) is sensitive to the foundation soil hydraulic conductivity as shown on Figure 3a. The higher foundation soil hydraulic conductivities of 1.0×10^{-6} and 1.0×10^{-5} cm/s indicate the hydraulic head is minimized within 3 years. Hydrostatic equilibrium is reached in approximately 10 to 11 years with a foundation soil hydraulic conductivity of 3.0×10^{-7} cm/s. Where the foundation soil hydraulic conductivity is unrealistically low, as with the 1.0×10^{-8} cm/s case, the calculated hydraulic head still demonstrates a decreasing trend, although equilibrium is not realized in the modeled 100 years following cap completion.
- The proposed cap with a permeability of 1.0×10^{-11} cm/s is lower than both the lab measured vertical permeability and the field measured horizontal hydraulic conductivity and meets the criteria of 40 CFR Part 257.102 (U.S. EPA, 2015).

The proposed capping system - a geomembrane cover with a drainage layer, consisting of (from bottom up) a 40-mil LLDPE geomembrane, a geocomposite (to drain infiltrated surface water), and a 2-foot thick protective layer - is feasible for all three ponds. The hydraulic heads within the ash ponds will continue to decrease following cap construction and hydrostatic equilibrium will be attained.

5 REFERENCES

AECOM. 2016. *Draft Closure and Post-Closure Care Plan for the Wood River West Ash Complex*. Dynegy Midwest Generation, LLC. Wood River Power Station #1 Chessen Lane Alton, IL 62002. May 2016.

Hampton, M.W. and M. O’Hearn, 1984. *Groundwater Monitoring at the Wood River Power Station’s Ash Disposal Ponds and Renovated Ash Disposal Area*, Illinois State Water Survey unpublished report to Illinois Power Company.

Kelron Environmental. 2004. *Hydrogeologic Investigation for the Proposed New East Ash Pond, Wood River Power Station, Illinois*

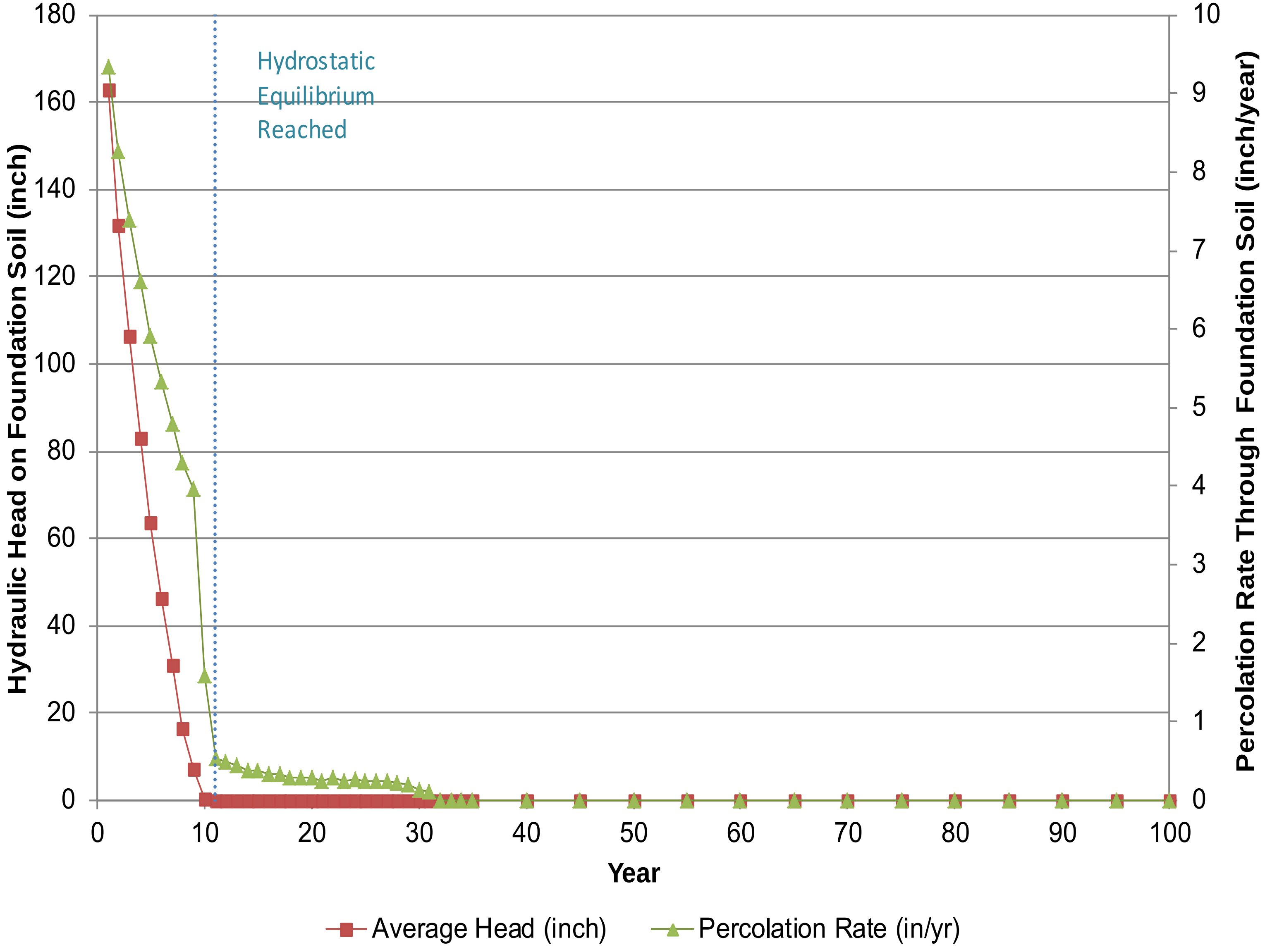
Natural Resource Technology, Inc. August, 2000. *Wood River Closure Report*. Prepared for Dynegy Midwest Generation, LLC.

Natural Resource Technology, Inc. 2016. Hydrogeologic Site Characterization Report, West Ash Pond Complex, Wood River Power Station, Alton, Illinois. Prepared for Dynegy Midwest Generation, LLC.

Schroeder, P.R., T.S. Dozier, P.A. Zappi, B.M. McEnroe, J.W. Sjostrom, and R.L. Peyton. 1994. *The Hydrologic Evaluation of Landfill Performance (HELP) Model: Engineering Documentation for Version 3.* EPA/600/R-94/168b. U.S. Environmental Protection Agency Office of Research and Development, Washington, D.C.

U.S. EPA, 2015. 40 CFR Parts 257 and 261 – *Hazardous and Solid Waste Management System; Disposal of Coal Ash Residuals from Electric Utilities*. Federal Register vol. 80, no. 74, April 17, 2015. 21467-21501.

FIGURES



PREPARED BY/DATE
M_W 08/18/2016
REVIEWED BY/DATE
BGH 08/22/2016

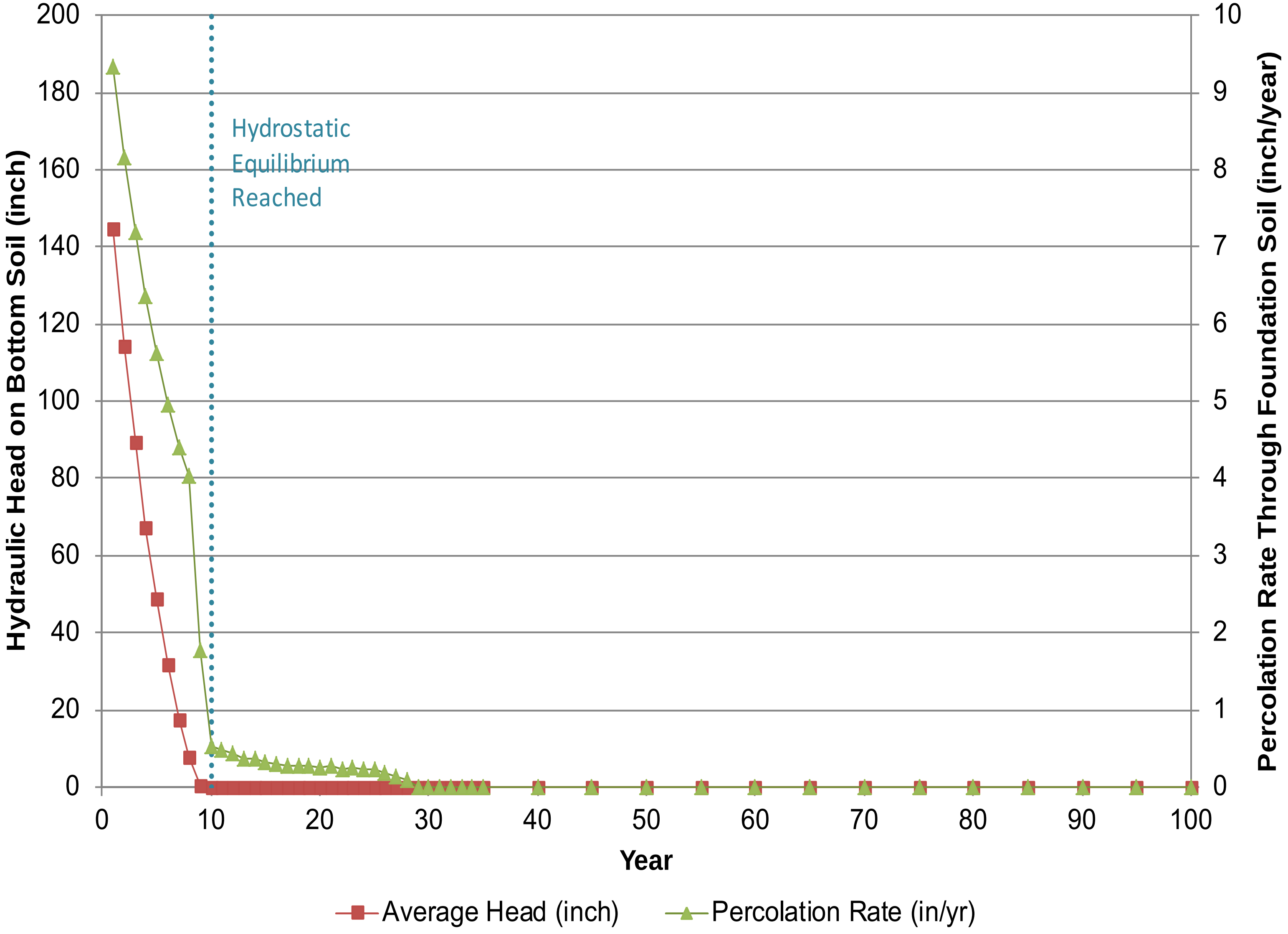
Hydraulic Head and Percolation Rate for Capped WAP 1

HYDROSTATIC MODELING REPORT
WOOD RIVER ASH IMPOUNDMENT SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2376

FIGURE NO: 1a

NATURAL
RESOURCE
TECHNOLOGY



PREPARED BY/DATE
M_W 08/18/2016
REVIEWED BY/DATE
BGH 08/22/2016

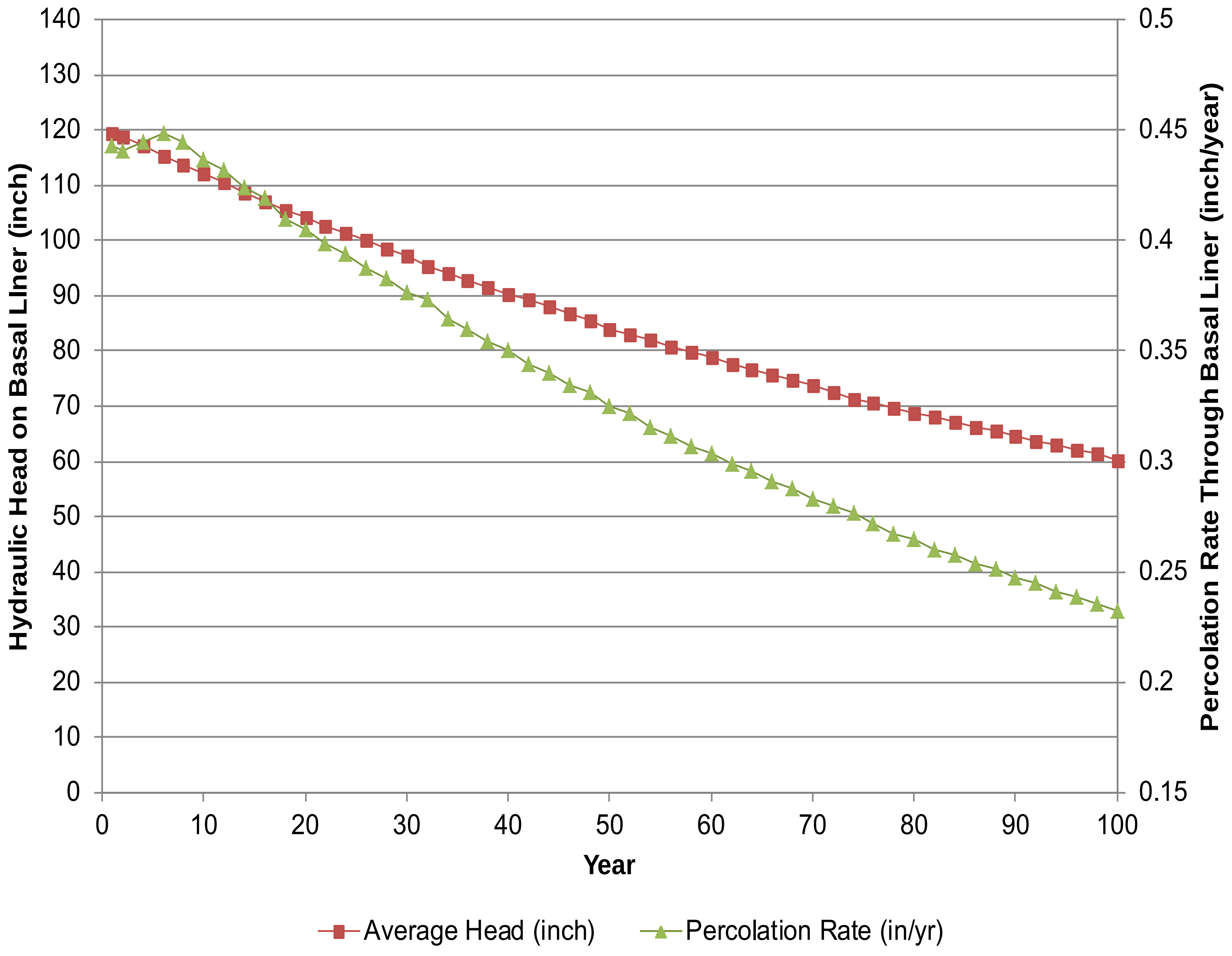
Hydraulic Head and Percolation Rate for Capped WAP 2W

HYDROSTATIC MODELING REPORT
WOOD RIVER ASH IMPOUNDMENT SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2376

FIGURE NO: 1b

Natural
Resource
Technology



PREPARED BY/DATE
M_W 08/18/2016
REVIEWED BY/DATE
BGH 08/22/2016

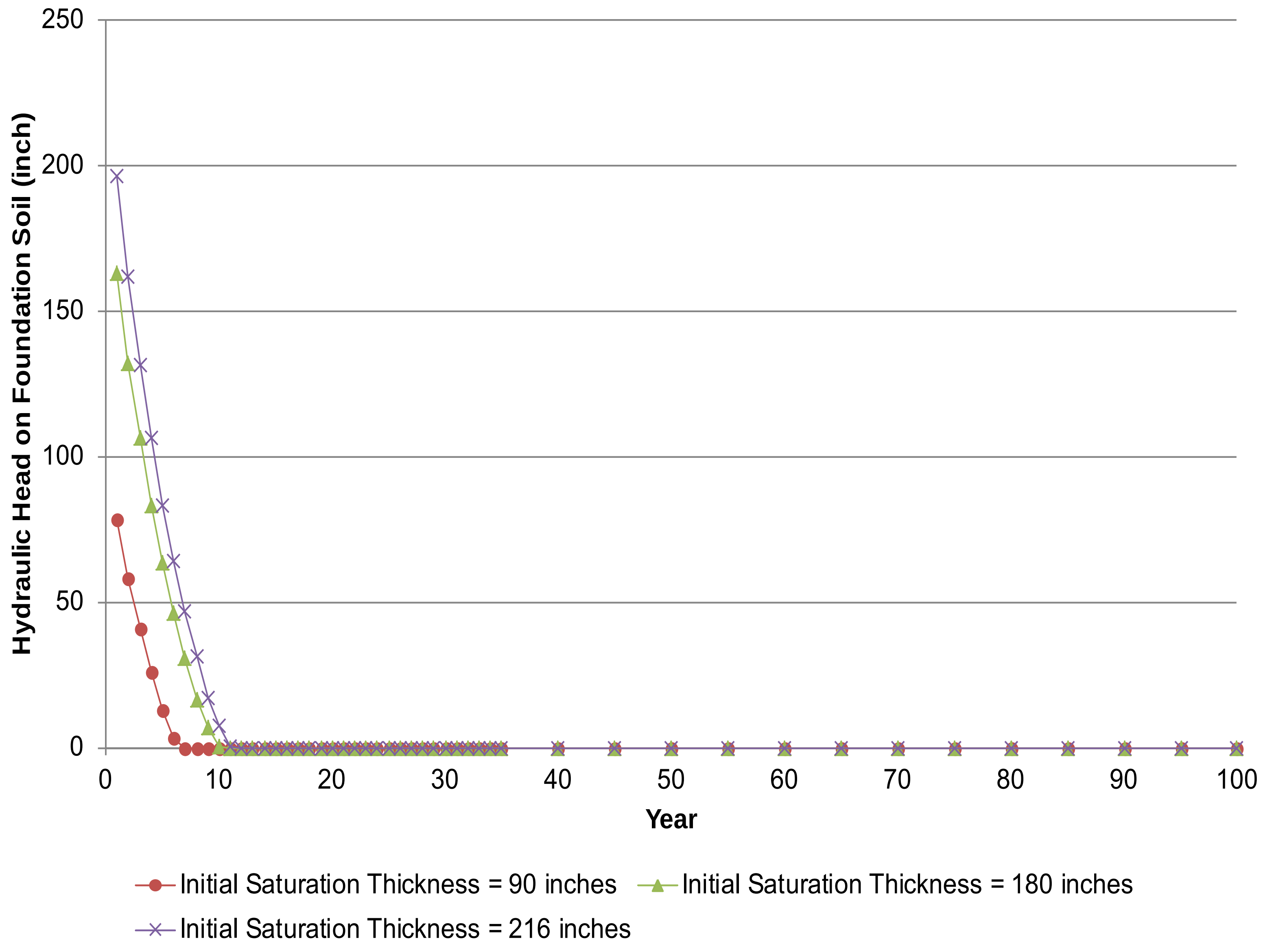
Hydraulic Head and Percolation Rate for Capped WAP 2E

HYDROSTATIC MODELING REPORT
WOOD RIVER ASH IMPOUNDMENT SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2376

FIGURE NO: 1c

NATURAL
RESOURCE
TECHNOLOGY



Sensitivity Explanation
Negligible - Hydraulic head changes within 1 inch and hydrostatic equilibrium can be attained.
Low - Hydraulic head changes within 10 inch and hydrostatic equilibrium can be attained.
Moderate - Hydraulic head changes higher than 10 inch and hydrostatic equilibrium can be attained.
High - Hydrostatic equilibrium cannot be attained.

PREPARED BY/DATE
M_W 08/18/2016
REVIEWED BY/DATE
BGH 08/22/2016

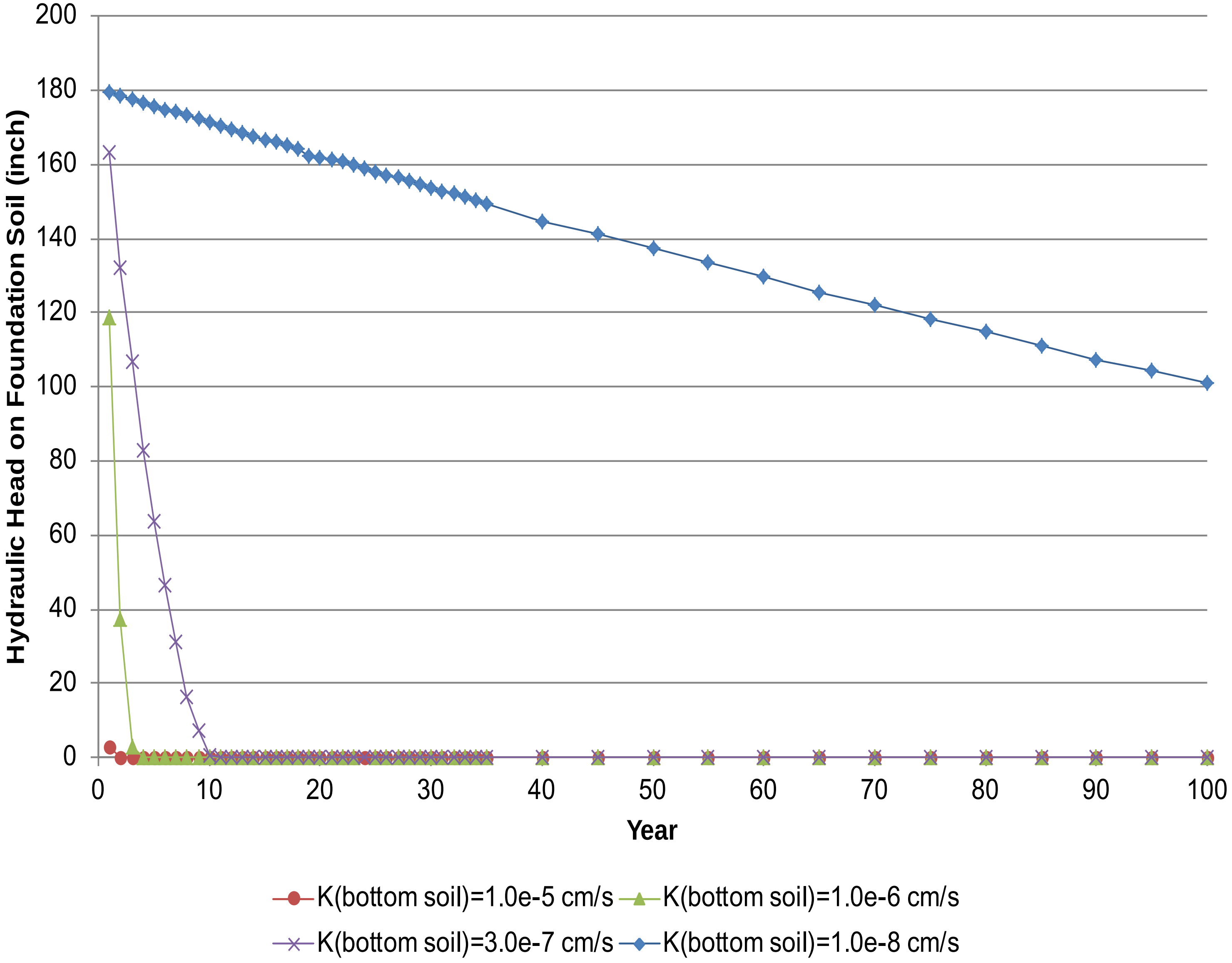
Sensitivity Analysis - Initial Saturation Thickness for Capped WAP 1

HYDROSTATIC MODELING REPORT
WOOD RIVER ASH IMPOUNDMENT SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2376

FIGURE NO: 2

NATURAL
RESOURCE
TECHNOLOGY



Sensitivity Explanation
Negligible - Hydraulic head changes within 1 inch and hydrostatic equilibrium can be attained.
Low - Hydraulic head changes within 10 inch and hydrostatic equilibrium can be attained.
Moderate - Hydraulic head changes higher than 10 inch and hydrostatic equilibrium can be attained.
High - Hydrostatic equilibrium cannot be attained.

PREPARED BY/DATE
M_W 08/18/2016
REVIEWED BY/DATE
BGH 08/22/2016

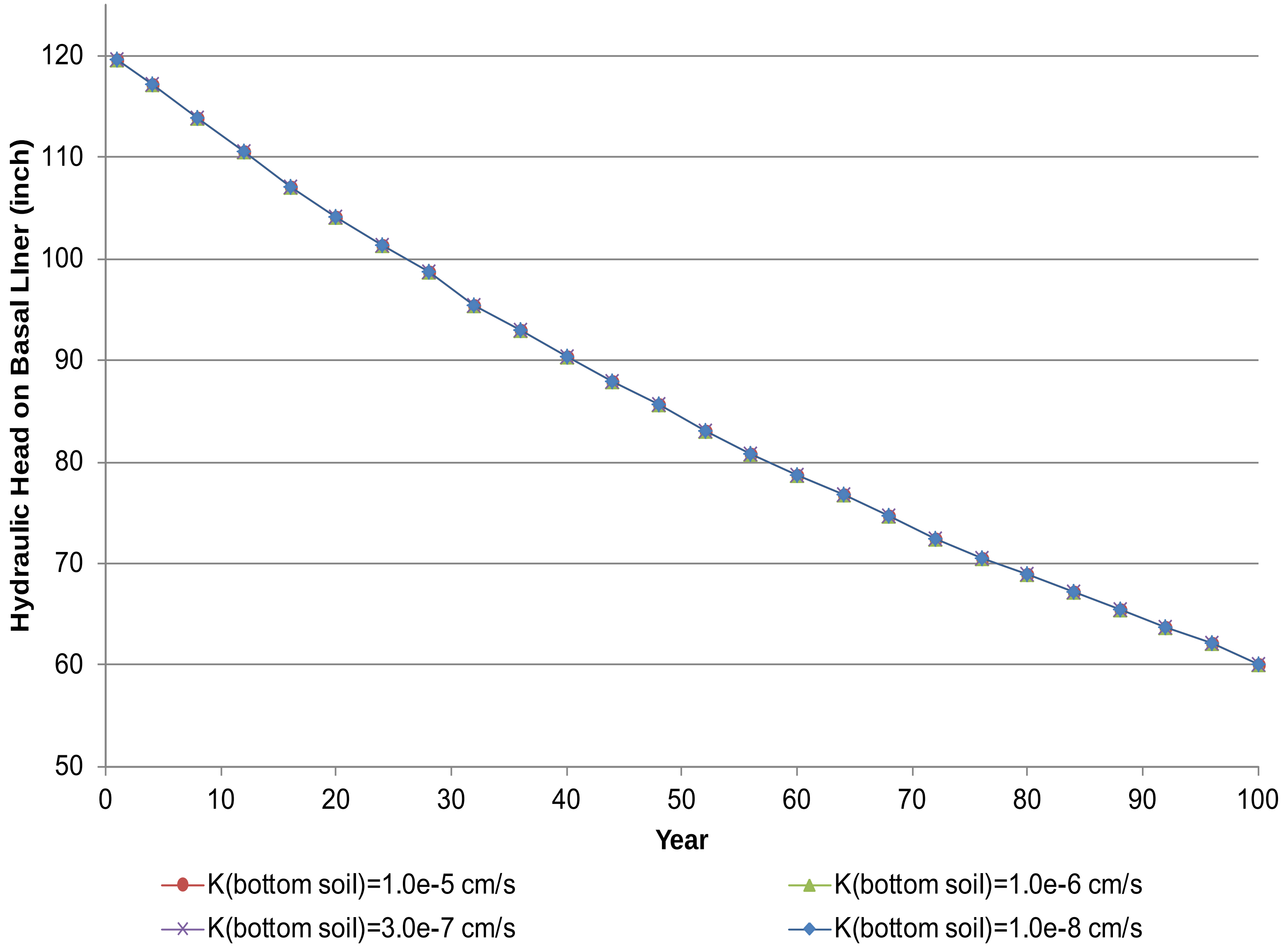
Sensitivity Analysis - Foundation Soil Hydraulic Conductivity for Capped WAP 1

HYDROSTATIC MODELING REPORT
WOOD RIVER ASH IMPOUNDMENT SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2376

FIGURE NO: 3a

NATURAL
RESOURCE
TECHNOLOGY



Sensitivity Explanation

Negligible - Hydraulic head changes within 1 inch and hydrostatic equilibrium can be attained.

Low - Hydraulic head changes within 10 inch and hydrostatic equilibrium can be attained.

Moderate - Hydraulic head changes higher than 10 inch and hydrostatic equilibrium can be attained.

High - Hydrostatic equilibrium cannot be attained.

PREPARED BY/DATE
M_W 08/18/2016
REVIEWED BY/DATE
BGH 08/22/2016

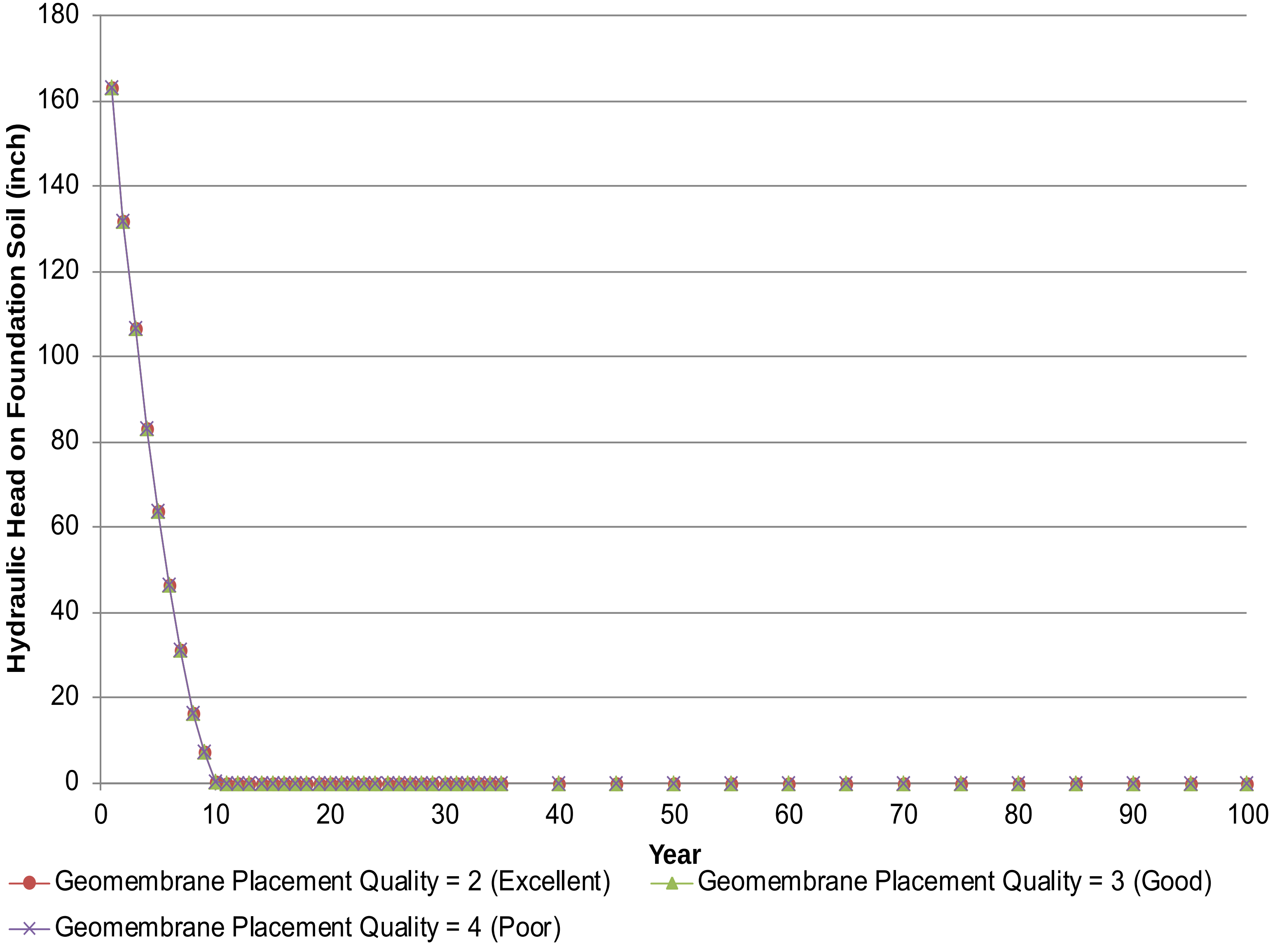
Sensitivity Analysis - Foundation Soil Hydraulic Conductivity for Capped WAP 2E

HYDROSTATIC MODELING REPORT
WOOD RIVER ASH IMPOUNDMENT SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2376

FIGURE NO: 3b

NATURAL RESOURCE TECHNOLOGY



Sensitivity Explanation
Negligible - Hydraulic head changes within 1 inch and hydrostatic equilibrium can be attained.
Low - Hydraulic head changes within 10 inch and hydrostatic equilibrium can be attained.
Moderate - Hydraulic head changes higher than 10 inch and hydrostatic equilibrium can be attained.
High - Hydrostatic equilibrium cannot be attained.

PREPARED BY/DATE
M_W 08/18/2016
REVIEWED BY/DATE
BGH 08/22/2016

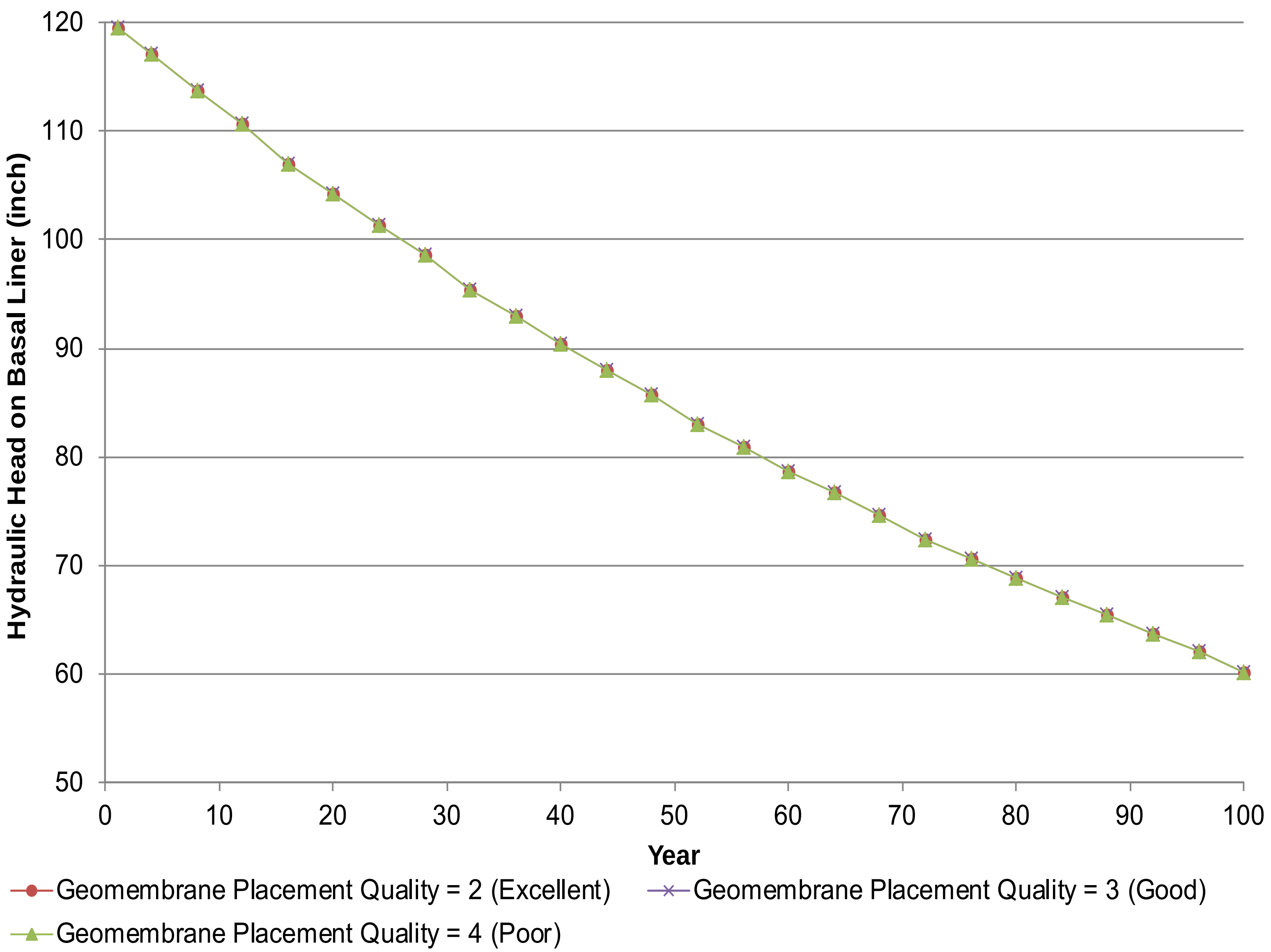
Sensitivity Analysis - Geomembrane Placement Quality for Capped WAP 1

HYDROSTATIC MODELING REPORT
WOOD RIVER ASH IMPOUNDMENT SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2376

FIGURE NO: 4a

NATURAL
RESOURCE
TECHNOLOGY



Sensitivity Explanation
Negligible - Hydraulic head changes within 1 inch and hydrostatic equilibrium can be attained.
Low - Hydraulic head changes within 10 inch and hydrostatic equilibrium can be attained.
Moderate - Hydraulic head changes higher than 10 inch and hydrostatic equilibrium can be attained.
High - Hydrostatic equilibrium cannot be attained.

PREPARED BY/DATE
M_W 08/18/2016
REVIEWED BY/DATE
BGH 08/22/2016

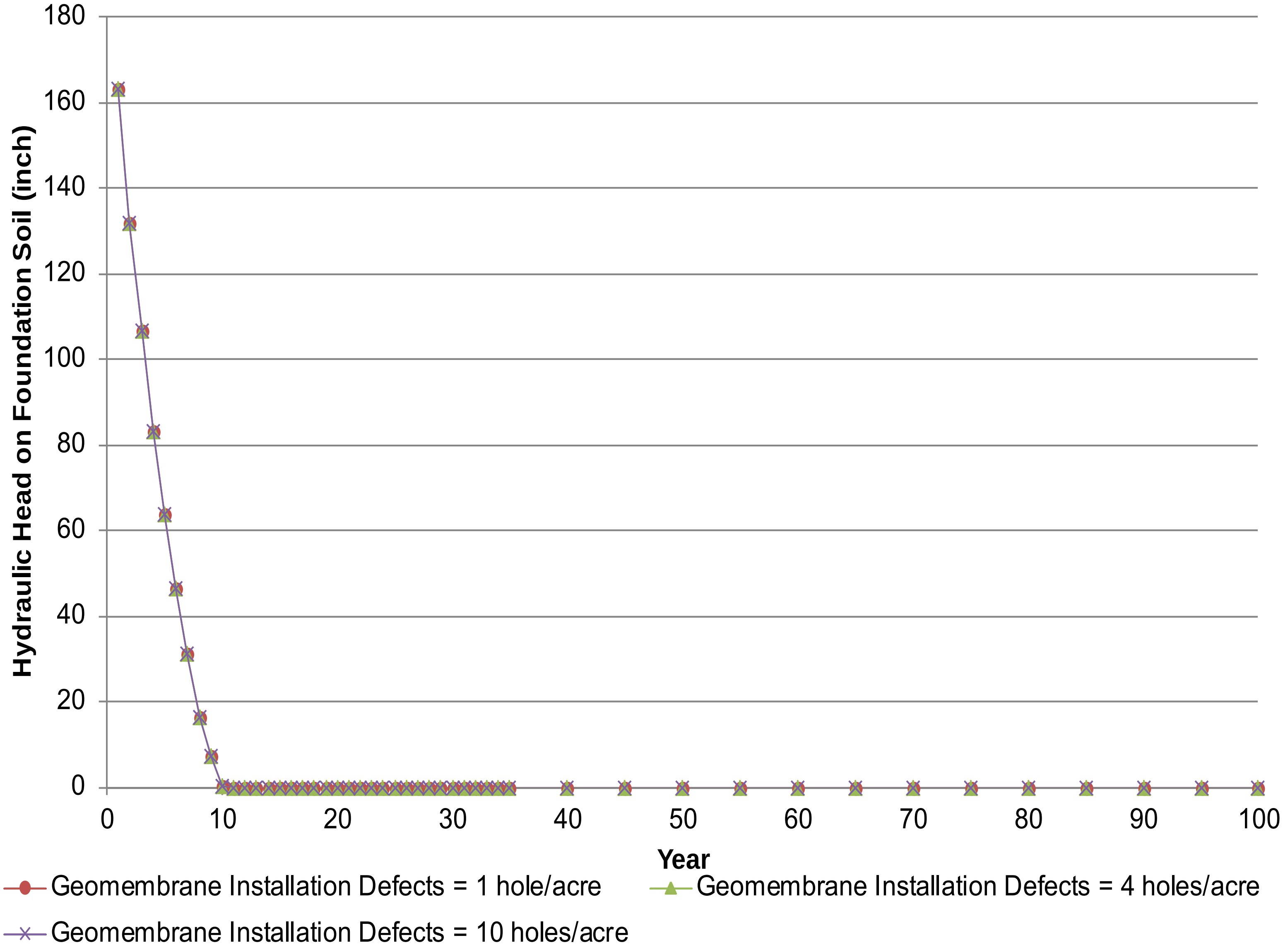
Sensitivity Analysis - Geomembrane Placement Quality for Capped WAP 2E

HYDROSTATIC MODELING REPORT
WOOD RIVER ASH IMPOUNDMENT SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2376

FIGURE NO: 4b

NATURAL RESOURCE TECHNOLOGY



Sensitivity Explanation
Negligible - Hydraulic head changes within 1 inch and hydrostatic equilibrium can be attained.
Low - Hydraulic head changes within 10 inch and hydrostatic equilibrium can be attained.
Moderate - Hydraulic head changes higher than 10 inch and hydrostatic equilibrium can be attained.
High - Hydrostatic equilibrium cannot be attained.

PREPARED BY/DATE
M_W 08/18/2016
REVIEWED BY/DATE
BGH 08/22/2016

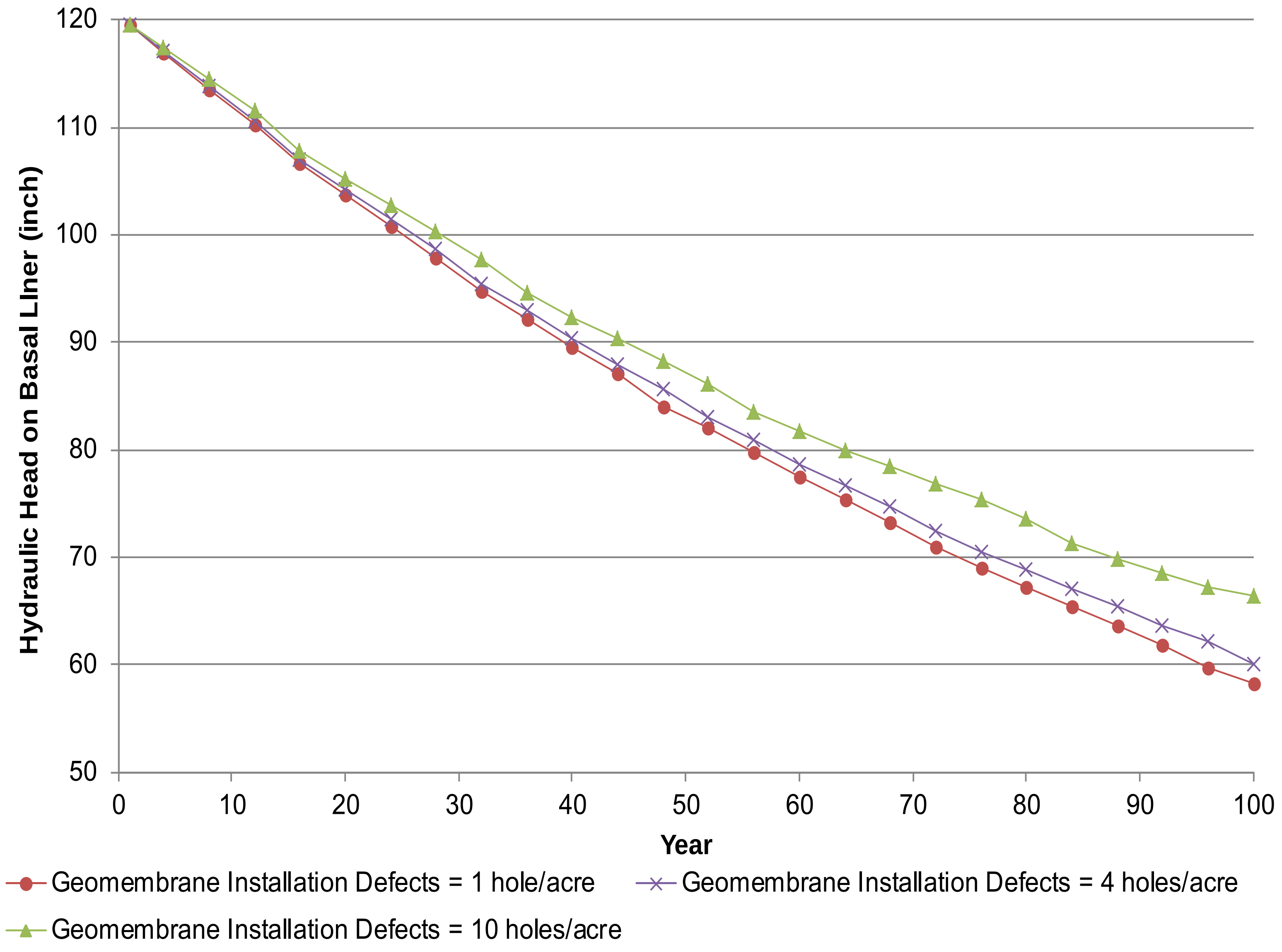
Sensitivity Analysis - Geomembrane Installation Defects for Capped WAP 1

HYDROSTATIC MODELING REPORT
WOOD RIVER ASH IMPOUNDMENT SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2376

FIGURE NO: 5a

NATURAL RESOURCE TECHNOLOGY



Sensitivity Explanation
Negligible - Hydraulic head changes within 1 inch and hydrostatic equilibrium can be attained.
Low - Hydraulic head changes within 10 inch and hydrostatic equilibrium can be attained.
Moderate - Hydraulic head changes higher than 10 inch and hydrostatic equilibrium can be attained.
High - Hydrostatic equilibrium cannot be attained.

PREPARED BY/DATE
M_W 08/18/2016
REVIEWED BY/DATE
BGH 08/22/2016

Sensitivity Analysis - Geomembrane Installation Defects for Capped WAP 2E

HYDROSTATIC MODELING REPORT
WOOD RIVER ASH IMPOUNDMENT SYSTEM
DYNEGY MIDWEST GENERATION, LLC

PROJECT NO: 2376

FIGURE NO: 5b

NATURAL RESOURCE TECHNOLOGY

TABLES

Table 1. HELP Input Parameters - West Ash Ponds 1 and 2W Baseline Conditions
Wood River Ash Impoundment System
Hydrostatic Modeling Report
Dynegy Midwest Generation, LLC

NRT PROJECT NO.: 2376
BY: M_W CHKD BY: BGH
DATE: 8/23/16

Parameter				**Notes**
Climate Data				
City	St. Louis, MO			Nearby city to the Site within HELP database
Latitude	38.87° N			Plant latitude
Evaporation Zone Depth (in)	20			8 - bare ground, 20 - fair grass
Leaf Index	1			1 - poor stand of grass (Schroeder, 1994)
Growing Season Period, Average Wind Speed, and Quarterly Relative Humidity.	HELP model defaults			See HELP output in Appendix A
Number of Years for Synthetic Data Generation	30			30-year period is applied to look for equilibrium.
Temperature, Evapotranspiration, and Precipitation	synthetically generated using St. Louis, MO defaults.			-
Soil Layer Data				
Soil-general				
% Where Runoff Possible	0			-
Area (acres)	1			Unit area
Specify Initial moisture content	Y			-
Initial Surface Water/Snow (in)	0			-
Soil Layers	**West Ash Pond 1**	**West Ash Pond 2W**		
1	Unsaturated Fly Ash	Unsaturated Fly Ash		-
2		Saturated Fly Ash		
3	Saturated Fly Ash			
4				
5				
6				
7				
8				
9				
10				
11		Silty Clay		
12		--		
13	Silty Clay			
Layer Parameter				
Layer # (West Ash Pond 1)	**1-2**	**3-12**	**13**	
Layer # (West Ash Pond 2W)	**1**	**2-10**	**11**	
Type	1	1	3	1 = vertical percolation layer, 3=barrier soil liner
Thickness Per Layer (in)	18	18	108 (Pond 1)/ 96 (Pond 2W)	Based on field measurement
Material Texture Number	30	30	14	14 = silty clay; 30 = fly ash
Porosity (vol/vol)	0.541	0.541	0.479	Default value for selected soil texture
Field Capacity (vol/vol)	0.187	0.187	0.371	Default value for selected soil texture
Wilting Point (vol/vol)	0.047	0.047	0.251	Default value for selected soil texture
Initial Moisture Content (vol/vol)	F	P	P	P = porosity, F = field capacity
Hydraulic Conductivity (cm/s)	1.00E-05	1.00E-05	3.00E-07	Fly ash value calibrated (2000 HELP Model); silty clay unit K value chosen based on the range of field/laboratory measurements
Soils-runoff				
SCS Runoff Curve Number	--			No runoff is assumed in this scenario
Slope				
Length (ft)				
Texture				
Vegetation				

Table 2. HELP Input Parameters - West Ash Pond 2E Baseline Condition
Wood River Ash Impoundment System
Hydrostatic Modeling Report
Dynegy Midwest Generation, LLC

NRT PROJECT NO.: 2376
BY: M_W CHKD BY: BGH
DATE: 8/23/16

Parameter					**Notes**
Climate Data					
City	St. Louis, MO				Nearby city to the Site within HELP database
Latitude	38.87° N				Plant latitude
Evaporation Zone Depth (in)	8				8 - bare ground, 20 - fair grass
Leaf Index	0				0 - bareground (Schroeder, 1994)
Growing Season Period, Average Wind Speed, and Quarterly Relative Humidity.	HELP model defaults				See HELP output in Appendix A
Number of Years for Synthetic Data Generation	16				Year 2000 - Year 2016
Temperature, Evapotranspiration, and	synthetically generated using St. Louis, MO defaults.				-
Soil Layer Data					
Soil-general					
% Where Runoff Possible	0				-
Area (acres)	1				Unit area
Specify Initial moisture content	Y				-
Initial Surface Water/Snow (in)	60				-
Soil Layers					
1-10	Saturated Bottom Ash				-
11	45-mil polypropylene liner				
12	clay liner				
13	Silty Clay				
Layer Parameter					
Layer #	**1-10**	**11**	**12**	**13**	
Type	1	4	3	1	1 = vertical percolation layer, 3 = barrier soil liner, 4 = flexible membrane liner
Thickness Per Layer (in)	12	0.045	12	90	Based on field measurement
Material Texture Number	31	--	16	14	14 = silty clay; 16 = barrier soil, 31= bottom ash
Porosity (vol/vol)	0.578	--	0.427	0.479	Default value for selected soil texture
Field Capacity (vol/vol)	0.076	--	0.418	0.371	Default value for selected soil texture
Wilting Point (vol/vol)	0.025	--	0.367	0.251	Default value for selected soil texture
Initial Moisture Content (vol/vol)	P	P	P	P	P = porosity, F = field capacity
Hydraulic Conductivity (cm/s)	4.1E-03*	1.00E-11	1.0E-7*	3.0E-7	* - default value; silty clay unit K value chosen based on the range of field/laboratory measurements; Polypropylene K value supplied by vendor
Pinhole Density (holes/acre)	--	1	--	--	1 = Excellent
Installation Defects (holes/acre)	--	4	--	--	4 = Good
Placement Quality	--	3	--	--	3 = Good
Soils-runoff					
SCS Runoff Curve Number	--				No runoff is assumed in this scenario
Slope					
Length (ft)					
Texture					
Vegetation					

Table 3. HELP Input Parameters - West Ash Ponds 1 and 2W Closure Conditions
Wood River Ash Impoundment System
Hydrostatic Modeling Report
Dynegy Midwest Generation, LLC

NRT PROJECT NO.: 2376
BY: M_W CHKD BY: BGH
DATE: 8/23/16

Parameter			**Notes**
Climate Data			
City	St. Louis, MO		Nearby city to the Site within HELP
Latitude	38.87° N		Plant latitude
Evaporation Zone Depth (in)	20		8 - bare ground, 20 - fair grass
Leaf Index	2		1 - poor stand of grass, 2 - fair stand of grass (Schroeder, 1994)
Growing Season Period, Average Wind Speed, and Quarterly Relative Humidity.	HELP model defaults		See HELP output in Appendix A
Number of Years for Synthetic Data Generation	100		-
Temperature, Evapotranspiration, and	synthetically generated using St. Louis, MO defaults.		-
Soil Layer Data			
Soil-general			
% Where Runoff Possible	100		The landfill cap does not have areas of ponding water
Area (acres)	1		Unit area
Specify Initial moisture content	Y		-
Initial Surface Water/Snow (in)	0		-
Soil Layers	**West Ash Pond 1 CAP**	**West Ash Pond 2W CAP**	-
1	Vegetative Cover	Vegetative Cover	
2	Soil Rooting Zone	Soil Rooting Zone	
3	Geocomposite Drainage Layer	Geocomposite Drainage Layer	
4	40-mil LLDPE geomembrane	40-mil LLDPE geomembrane	
5	Unsaturated Fly Ash	Unsaturated Fly Ash	
6		Saturated Fly Ash	
7	Saturated Fly Ash		
8			
9			
10			
11			
12			
13			
14			
15		Silty Clay	
16		--	
17	Silty Clay		

Table 3. HELP Input Parameters - West Ash Ponds 1 and 2W Closure Conditions
Wood River Ash Impoundment System
Hydrostatic Modeling Report
Dynegy Midwest Generation, LLC

NRT PROJECT NO.: 2376
BY: M_W CHKD BY: BGH
DATE: 8/23/16

Parameter								Notes
Layer Parameter								
Layer # (West Ash Pond 1)	**1**	**2**	**3**	**4**	**5-6**	**7-16**	**17**	
Layer # (West Ash Pond 2W)	**1**	**2**	**3**	**4**	**5**	**6-14**	**15**	
Type	1	1	2	4	1	1	3	1 = vertical percolation layer; 3=barrier soil liner
Thickness Per Layer (in)	6	18	0.33	0.04	18	18	108 (Pond 1)/ 96 (Pond 2W)	-
Material Texture Number	9	9	20	36	30	30	14	9 = silt loam, 14 = silty clay, 16 = barrier soil, 20 = drainage net, 30 = fly ash, 36 = LDPE
Porosity (vol/vol)	0.501	0.501	0.85	--	0.541	0.541	0.479	Default value for selected soil texture
Field Capacity (vol/vol)	0.284	0.284	0.01	--	0.187	0.187	0.371	Default value for selected soil texture
Wilting Point (vol/vol)	0.135	0.135	0.005	--	0.047	0.047	0.251	Default value for selected soil texture
Initial Moisture Content (vol/vol)	F	F	F	--	F	P	P	P = porosity, F = field capacity
Hydraulic Conductivity (cm/s)	1.90E-04*	1.90E-04*	10*	4.0E-13*	1.00E-05	1.00E-05	3.00E-07	*Default values. fly ash value calibrated (2000 HELP Model); silty clay unit K value chosen based on the range of field/laboratory measurements
Pinhole Density	--	--	--	1	--	--	--	
Installation Defects	--	--	--	4	--	--	--	
Placement Quality	--	--	--	3	--	--	--	
Soils-runoff								
SCS Runoff Curve Number	80.3							HELP Calculated
Slope	1% (Pond 1)/1.3% (Pond 2W)							AECOM 30% Design
Length (ft)	800 (Pond 1)/890 (Pond 2W)							Estimated values
Texture	9							Based on uppermost soil type (silt loam)
Vegetation	3							3 - fair stand of grass

Table 4. HELP Input Parameters - West Ash Pond 2E Closure Condition
Wood River Ash Impoundment System
Hydrostatic Modeling Report
Dynegy Midwest Generation, LLC

NRT PROJECT NO.: 2376
BY: M_W CHKD BY: BGH
DATE: 8/23/16

Parameter		**Notes**
Climate Data		
City	St. Louis, MO	Nearby city to the Site within HELP
Latitude	38.87° N	Plant latitude
Evaporation Zone Depth (in)	20	8 - bare ground, 20 - fair grass
Leaf Index	2	1 - poor stand of grass, 2 - fair stand of grass (Schroeder, 1994)
Growing Season Period, Average Wind Speed, and Quarterly Relative Humidity.	HELP model defaults	See HELP output in Appendix A
Number of Years for Synthetic Data Generation	100	-
Temperature, Evapotranspiration, and	synthetically generated using St. Louis, MO defaults.	-
Soil Layer Data		
Soil-general		
% Where Runoff Possible	100	The landfill cap does not have areas of ponding water
Area (acres)	1	Unit area
Specify Initial moisture content	Y	-
Initial Surface Water/Snow (in)	0	-
Soil Layers		
1	Vegetative Cover	-
2	Soil Rooting Zone	
3	Geocomposite Drainage Layer	
4	40-mil LLDPE geomembrane	
5	Saturated Bottom Ash	
6		
7		
8		
9		
10		
11		
12		
13		
14		
15	45-mil polypropylene liner	
16	clay liner	
17	Silty Clay	

Table 4. HELP Input Parameters - West Ash Pond 2E Closure Condition
Wood River Ash Impoundment System
Hydrostatic Modeling Report
Dynegy Midwest Generation, LLC

NRT PROJECT NO.: 2376
BY: M_W CHKD BY: BGH
DATE: 8/23/16

Parameter									**Notes**
Layer Parameter									
Layer #	**1**	**2**	**3**	**4**	**5-14**	**15**	**16**	**17**	
Type	1	1	2	4	1	4	3	1	1 = vertical percolation layer, 2 = lateral drainage layer, 3 = barrier soil liner, 4 = flexible membrane liner
Thickness Per Layer (in)	6	18	0.33	0.04	12	0.045	12	90	-
Material Texture Number	9	9	20	36	31	--	16	14	9 = silt loam, 14 = silty clay, 16 = barrier soil, 20 = drainage net, 31= bottom ash, 36 = LDPE
Porosity (vol/vol)	0.501	0.501	0.85	--	0.578	--	0.427	0.479	Default value for selected soil texture
Field Capacity (vol/vol)	0.284	0.284	0.01	--	0.076	--	0.418	0.371	Default value for selected soil texture
Wilting Point (vol/vol)	0.135	0.135	0.005	--	0.025	--	0.367	0.251	Default value for selected soil texture
Initial Moisture Content (vol/vol)	F	F	F	F	B	B	P	B	P = porosity, F = field capacity, B = estimated value from baseline
Hydraulic Conductivity (cm/s)	1.90E-04*	1.90E-04*	10*	4.0E-13*	4.1E-03*	1.00E-11	1.0E-7*	3.00E-07	* - default value; silty clay unit K value chosen based on the range of field/laboratory measurements; Polypropylene K value supplied by vendor
Pinhole Density	--	--	--	1	--	1	--	--	1 = Excellent
Installation Defects	--	--	--	4	--	4	--	--	4 = Good
Placement Quality	--	--	--	3	--	3	--	--	3 = Good
Soils-runoff									
SCS Runoff Curve Number	80.9								HELP Calculated
Slope	1.5%								AECOM 30% Design
Length (ft)	560								Estimated values
Texture	9								Based on uppermost soil type (silt
Vegetation	3								3 - fair stand of grass

Table 5. Foundation Soil Percolation Rate Summary
Wood River Ash Impoundment System
Hydrostatic Modeling Report
Dynegy Midwest Generation, LLC

NRT PROJECT NO.: 2376
BY: M_W CHKD BY: BGH
DATE: 8/23/16

	Percolation Rate through Foundation Soil (inches/year)	Simulation Year
West Ash Pond 1 Baseline	8.67	1-30
West Ash Pond 2W Baseline	8.52	1-30
West Ash Pond 2E Baseline	0.71	1-16
West Ash Pond 1 with CAP	5.28	1-10
	0.28	11-31
	0.002	32-100
West Ash Pond 2W with CAP	5.24	1-9
	0.28	10-28
	0.001	29-100
West Ash Pond 2E with CAP	0.33	1-100

Table 6. HELP Sensitivity Analysis
Wood River Ash Impoundment System
Hydrostatic Modeling Report
Dynegy Midwest Generation, LLC

NRT PROJECT NO.: 2376
BY: M_W CHKD BY: BGH
DATE: 8/23/16

Parameter			Sensitivity to Hydrostatic Equilibrium[1]	
	Model Value	Tested Range	Synthetic Cap for Unlined Pond[2]	Synthetic Cap for Lined Pond
Soil Layers				
Initial Saturation Thickness (in)	180	90, 180, 216	Moderate	NA
Soil Parameters--foundation soil				
Hyraulic conductivity (cm/s)	3.00E-07	1.0E-05, 1.0E-06, 3.0E-7, 1.0E-08	Moderate	Negligible
Soil Parameters - membrane layer				
Placement Quality	3	2, 3, 4	Negligible	Negligible
Installation Defects	4	1, 4, 10	Negligible	Low

Notes:

1. Sensitivity Explanation
    - Negligible - Hydraulic head changes within 1 inch and hydrostatic equilibrium can be attained.
    - Low - Hydraulic head changes within 10 inch and hydrostatic equilibrium can be attained.
    - Moderate - Hydraulic head changes higher than 10 inch and hydrostatic equilibrium can be attained.
    - High - Hydrostatic equilibrium cannot be attained.
2. West Ash Pond 1 Soil Cap was used to perform the sensitivity analyses.

APPENDIX A

HELP MODEL FILES

(PROVIDED SEPARATELY)

Appendix D. Groundwater Model Report

SMARTER SOLUTIONS

EXCEPTIONAL SERVICE

VALUE

GROUNDWATER MODEL REPORT

West Ash Pond Complex
Wood River Power Station
Alton, Illinois

FINAL

October 19, 2016

Natural
Resource
Technology

Environmental Consultants

NATURAL
RESOURCE
TECHNOLOGY
ENVIRONMENTAL CONSULTANTS

234 W. FLORIDA STREET, FIFTH FLOOR
MILWAUKEE, WISCONSIN 53204
(P) 414.837.3607
(F) 414.837.3608

GROUNDWATER MODEL REPORT

WEST ASH POND COMPLEX
WOOD RIVER POWER STATION
ALTON, ILLINOIS

Project No. 2376

Prepared For:

Dynegy Operating Company
1500 Eastport Plaza Drive
Collinsville, IL 62234

Prepared By:

Natural Resource Technology, Inc.
234 W. Florida Street, Fifth Floor
Milwaukee, Wisconsin 53204

FINAL
October 19, 2016

Stuart J. Cravens, PG
Principal Hydrogeologist

Jacob J. Walczak, PG
Hydrogeologist

TABLE OF CONTENTS

1 BACKGROUND 1-1
  1.1 Introduction 1-1
  1.2 Site Location and History 1-1
  1.3 Site Hydrogeology 1-2
  1.4 Groundwater Quality 1-4
2 GROUNDWATER MODEL 2-1
  2.1 Overview 2-1
  2.2 Conceptual Model 2-1
  2.3 Model Approach 2-2
3 MODEL SET-UP AND CALIBRATION 3-1
  3.1 Model Descriptions 3-1
  3.2 Flow and Transport Model Setup 3-2
    3.2.1 Grid and Boundary Conditions 3-2
    3.2.2 Flow Model Input Values and Sensitivity 3-2
    3.2.3 Transport Model Input Values and Sensitivity 3-5
  3.3 Flow and Transport Model Assumptions and Limitations 3-6
  3.4 Calibration Flow and Transport Model Results 3-7
4 SIMULATION OF CAPPING SCENARIO 4-1
  4.1 Overview 4-1
  4.2 Simulation of the Capping Scenario 4-1
    4.2.1 Predicted Hydraulic Heads and Boron Concentrations 4-2
5 SUMMARY 5-1
6 REFERENCES 6-1

FIGURES

Figure 1-1 Site Location Map
Figure 1-2 Overview of Ash Pond System
Figure 1-3 Potentiometric Surface November 18, 2014
Figure 3-1 MODFLOW and MT3DMS Grid and Boundary Conditions Array
Figure 3-2 Bottom Elevation (feet) Array for Layer 1 through Layer 8
Figure 3-3 Hydraulic Conductivity (ft/day) Array
Figure 3-4 Recharge (ft/day) Arrays for Calibrated Model
Figure 3-5 Reaction K_d (cm^3/g) Arrays
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) – Wells 02, 12, 34 (1995-2075) and 20, 23, 28, 04 (1995-2035)
Figure 4-1 Predicted and Observed Boron Concentrations – Well 02 (1995-2515)
Figure 4-2 Predicted Maximum Extent of Boron Plume (2 mg/L) with Capping Scenario

TABLES

Table 3-1 Flow Model Input Values (calibration and sensitivity)
Table 3-2 Transport Model Recharge and Concentration Input Values (calibration)
Table 3-3 Mean Monthly Mississippi River Stage from 1990-2014
Table 3-4 Transport Input Values (calibration and sensitivity)
Table 4-1 West Ash Ponds Transport Model Recharge Input Values (baseline and capping scenario prediction)

APPENDICES

Appendix A: MODFLOW/MT3DMS Model Files (on CD)

ACRONYMS AND ABBREVIATIONS

CCR	coal combustion residual
WAP	West Ash Pond
WRPS	Wood River Power Station
cm/sec	centimeters per second
DMG	Dynegy Midwest Generation, Inc.
g/cm^3	grams per cubic centimeter
in/yr	inches per year
ft	Feet
bgs	below ground surface
mg/L	milligram per liter
HELP	Hydrologic Evaluation of Landfill Performance
IAC	Illinois Administrative Code
mg/L	milligrams per liter
NRT	Natural Resource Technology
TDS	total dissolved solids
OEAP	Old East Ash Pond
NEAP	New East Ash Pond
USACE	United States Army Corps of Engineers
LLDPE	Linear low density polyethylene
K_d	distribution coefficient
NAVD88	North American Vertical Datum of 1988

1 BACKGROUND

1.1 Introduction

This Groundwater Model Report has been prepared by Natural Resource Technology (NRT) on behalf of Dynegy Midwest Generation, LLC (DMG). A groundwater flow and transport model was developed for the Wood River West Ash Complex (Site) at the Wood River Power Station (WRPS), Alton, Madison County, Illinois with the objective of evaluating the effect constructing a cover system as part of a closure plan will have on surrounding groundwater quality. The cover system, as described in the draft Closure and Post-Closure Care Plan for Dynegy Wood River Ash Complex (AECOM, 2016), are proposed to be implemented on West Ash Pond (WAP 1), West Ash Pond 2W (WAP 2W), and West Ash Pond 2E (WAP 2E). This Groundwater Model Report was used to predict changes in groundwater quality in response to the proposed capping system.

In conjunction with this report, a Hydrogeologic Characterization Report (NRT, 2016d) was completed, which summarizes data collected to comply with Federal Coal Combustion Residual (CCR) Rule (40 CFR Part 257) as well as comprehensive data collection and evaluations from prior hydrogeologic investigation reports completed at the Site (1984 - present). A Groundwater Monitoring Plan (NRT, 2016c) and a Groundwater Management Zone Application (NRT, 2016b) are also being prepared to support the closure of the West Ash Pond Complex. In addition, Hydrologic Evaluation of Landfill Performance (HELP) modeling has also been conducted to enable estimation of the time required for hydrostatic equilibrium of groundwater to be achieved beneath the West Ash Pond Complex. The HELP modeling also provided percolation rates for existing conditions and predicted cap scenario that were used as inputs in the groundwater flow and transport model. A description of the HELP model inputs and modeling results are found in the Hydrostatic Modeling Report (NRT, 2016e).

1.2 Site Location and History

The WRPS includes a power plant and the West and East Ash Pond Complexes situated on the east bank of the Mississippi River, about six river miles upstream from the confluence of the Mississippi and Missouri Rivers. For the purposes of this groundwater model report, the Site is comprised of WAP 1, WAP 2E and WAP 2W at the WRPS. The Wood River, a perennial stream that discharges into the Mississippi River, lies on eastern edge of the site. The Site is located within Section 19 Township 5 North and Range 9 West. The cities of Alton, East Alton, and Wood River are within 2 miles of the West and East Ash Pond Complexes. The WRPS is located in an area of heavy industrial activity. Metal refining, vinegar production, cardboard manufacturing, and sewage treatment occur within ½ mile of the plant. The site location and an overview of the ash ponds system is shown on Figures 1-1 and 1-2. The WRPS property is bordered on the south by the State Route 143 and the Mississippi River, the east by the Wood River, the north by vacant/abandoned industrial property and railroad tracks, and the west by vacant land/water retention ponds of the Mississippi River levee system operated by the Army Corps of Engineers.

WRPS began operation in 1949 and ash from the first coal fired unit was disposed of in the Old East Ash Pond (OEAP). The OEAP was located on the eastern edge of the site along the Wood River and was utilized for approximately 30 years until the West Ash Pond Complex was constructed in 1978. Several modifications to the Site and its operation have been made following construction. The Hydrogeologic Characterization Report (NRT, 2016d) describes the operational history in detail, significant changes that are important to the development of the groundwater models are included below:

- During a plant shutdown in 1997, DMG began reconstruction of the ponds. All ash was removed from the West Ash Pond impoundment areas now known as Pond 3 and a new double-lined pond with leachate collection was constructed.
- In 1998 DMG began mining ash from West Ash Pond impoundments now known as WAP 2W and WAP 2E. After removing all ash from WAP 2E a composite clay/synthetic liner was constructed.
- Beginning in 1999 all fly ash was managed through a dry handling system. The dry ash was sold as cement additive and bottom ash was sluiced to the lined ponds (WAP 2E and Pond 3) where the ash settled and the sluice water discharged via the NPDES permitted outfall.
- Ash was handled through the west pond complex until 2006-2007, at which time it was redirected to the New East Ash Pond (also called the Primary East Ash Pond) following its construction.
- Ash from WAP 1 and WAP 2W has been mined periodically since closure in 2006.

1.3 Site Hydrogeology

According to the site investigations performed from 1984 to 2015, four principal hydrogeologic units were identified beneath the Site and the surrounding area. The details are described in the Hydrogeologic Characterization Report (NRT, 2016d). These units are, from top down:

- **Fill & Coal Combustion Residual (CCR) Unit**

  The Fill and CCR Unit consists of fly ash and bottom ash. The thickest accumulations of coal ash at the Site occur in WAP 1 with a maximum depth of approximately 26 feet. Ash thickness in WAP 2W ranged from 11 to 18.5 feet. No borings were advanced in WAP 2E because it is a lined unit; however, it is estimated that the maximum bottom ash thickness is less than 25 feet.

- **Silty Clay Units**

  The silty clay units are composed of layers and lenses of clay, silty clay and silt with varying amounts of sand, but is predominantly clay and silty clay. Across most of the site the silty clay unit is split into an upper and lower unit. The units are separated by the inter-sand unit, described below. The upper silty clay unit and portions of the inter-sand were removed during impoundment construction in the vicinity of the Site, such that the CCR is in contact with the inter-sand unit or the lower silty clay. In areas where both the upper silty clay unit and the inter-sand were removed, the lower silty clay unit separates the CCR of the Site impoundments from the primary sand unit and acts as a barrier to downward migrating leachate from WAP 1 and WAP 2W. In addition to the silty clay unit, WAP 2E and Pond 3 have designed liners consisting of polyethylene membrane and compacted clay which further limit the vertical migration of leachate.

  The total thickness of the silty clay unit beneath the Site ranges from less than 5 feet in the southeast corner of WAP 1 and the northwest section of WAP 2W (where the inter-sand layer was removed during filling), to greater than 20 feet beneath WAP 2E. The thickness of the silty clay unit decreases north and south of the ash pond complex as the base of the unit approaches the ground surface.

  Field testing of former Monitoring Wells 10 and 11, which were screened entirely within the silty clay unit, indicated a geometric mean horizontal hydraulic conductivity of 2.4 x 10^{-5} cm/s (NRT, 2000). Laboratory tests of vertical hydraulic conductivity on clay samples ranged from 1.7 x 10^{-8} cm/s (Kelron, 2004) to 1.2 x 10^{-6} cm/s (AECOM, 2015). These low values are indicative of a confining layer.

- **Inter-sand Unit**

  The inter-sand unit occurs between the upper and lower silty clay units beneath portions of the site and can intersect the primary sand unit, described below, as identified in a portion of the East Ash Pond Complex. The inter-sand unit is composed of heterogeneous fine to medium-grained sand and silty sand that ranges from well to poorly sorted and is generally 5 feet thick or less. The top of the inter-sand unit is deepest where the silty clay units are the thickest and shallows to the south and to the north where the silty clay units thin. There are no monitoring wells present onsite that are screened exclusively in the inter-sand unit, and no field hydraulic conductivities have been measured.

- **Primary Sand Unit**

  The primary sand unit is comprised of permeable valley fill that contains the uppermost aquifer known in the area as the American Bottoms. The estimated thickness of the permeable valley fill at WRPS is approximately 120 feet to 140 feet and the sand and gravel constitutes 80 to 100 feet of this thickness. The top of the primary sand unit reflects a former river channel which trends east-west across the site. The top of the sand unit is near the surface (<5 feet below ground surface [bgs]) in the northern portion of the WRPS property and is up to 60 feet deep in the center of the historical channel. The primary sand unit overlies silt, sandy silt and silty clay diamicton and limestone bedrock which are the lower limits of the uppermost aquifer in the vicinity of the Site. Field testing of monitoring wells screened entirely within the primary sand unit indicate high horizontal hydraulic conductivities of 10^{-1} to 10^{-3} cm/sec (NRT, 2000 & Kelron, 2004), the geometric mean of all wells tested is 5.7 x 10^{-2} cm/sec (Kelron, 2004).

Groundwater flow directions are variable and significantly influenced by the Mississippi River stage. During base stage or low river levels, groundwater flow occurs in both a southerly direction toward the

Mississippi River and southeasterly toward the Wood River (Figure 1-3). During spring flooding and high Mississippi River stages, groundwater flow is easterly away from the Mississippi River. After flood levels subside, the flow direction reverts to normal conditions and groundwater again discharges to the rivers. The flooding and high river stages only occur periodically and the dominant flow direction during any given year is toward the rivers. Vertical groundwater gradients indicate general downward flow of water from the silty clay into the primary sand. Near the groundwater discharge areas along the rivers gradients are flat to upward.

In the vicinity of the Site, surface water and groundwater flow is further altered by levee drainage improvements at the Mel Price Lock and Dam segment of the Wood River Upper Levee System implemented by the U.S. Army Corps of Engineers (USACE), Mississippi Valley Division, St. Louis District, the Wood River Drainage and Levee District, and the Southwestern Illinois Flood Prevention District Council. The seepage control systems alter landside ponding adjacent to the Mel Price Lock and Dam on the north bank of the Mississippi River. The controlled ponding is adjacent to and west-northwest of the Site and likely influences groundwater flow in the immediate area.

1.4 Groundwater Quality

Groundwater sampling at the West Ash Pond Complex was initiated in 1984; however, consistent data collection began in 1996. Currently, groundwater monitoring is completed in accordance with the Closure Work Plan (CWP) (NRT, 2000) approved by the Illinois EPA on December 13, 2000. As called for by the 2000 CWP, DMG is required to sample groundwater quarterly, submit the results quarterly to the Illinois EPA, and provide an annual data assessment (NRT, 2016a). Modifications to the 2000 CWP proposed in the “2005 Closure Work Plan Annual Report” and cover letter were approved by the Illinois EPA in a letter to DMG dated June 15, 2006. Modifications approved by the Illinois EPA include reduction of monitoring frequency from quarterly to semiannually and semiannual submittals of data discs to Illinois EPA.

Parameters that have been detected in groundwater at concentrations exceeding the Class I groundwater quality standards include the following: boron, manganese, pH, and total dissolved solids (total filterable residue). A detailed summary of the analytical results and statistical analysis of the results are found in the Hydrogeologic Characterization Report (NRT, 2016d) and the 2015 Closure Work Plan Annual Report (NRT, 2016a). Boron is the primary indicator of coal ash leachate among the parameters detected in exceedance of the Class I groundwater quality standards at the Site.

Boron exceeded the 2 mg/L standard at three of the 12 monitoring wells from 2013 through 2015. Well 02 had boron concentrations of 2.50 and 3.45 mg/L, and Well 34 had boron concentrations of 5.95 and 7.49 mg/L. Wells 02 and 34 are located to the south and downgradient of the Site and screened in the primary sand. Well 12 had boron concentrations of 2.21 and 2.05 mg/L. Well 12 is located east of the

West Ash Pond Complex adjacent to Pond 3 and screened in the top 6 feet of the primary sand just below the Silty Clay Unit.

Annual median boron concentrations have decreased since the unlined ponds were removed from service (prior to 1998) in eight of the eleven downgradient monitoring wells currently monitored, while concentrations have increased only in wells 02, 12, and 34. The recent increases in boron at these wells may be attributed to several natural and anthropogenic factors, including, but not limited to the following; unusually stable southerly groundwater flow directions in recent years, disrupted groundwater flow direction due to recently installed levee drainage improvements, ash mining/removal for beneficial reuse at WAP 1 potentially increasing infiltration and mobilization of boron. Additional information regarding groundwater quality can be found in the 2015 Closure Work Plan Annual Report dated January 20, 2016 (NRT, 2016a).

2 GROUNDWATER MODEL

2.1 Overview

This section presents the conceptual model and the overall modeling methodology. Specifically, the model was established to address the following points:

- The model's capability to simulate current Site hydrology and the extent of CCR leachate impacts on groundwater
- The effect of pond closure on nearby groundwater quality

2.2 Conceptual Model

The Site overlays unlithified deposits (e.g., silty clay and the sand and gravel units) and bedrock. The hydrostratigraphy consists of a confining silty clay unit over a thick, highly permeable sand and gravel aquifer. Groundwater flow is transient and flow reversals are regularly observed as a function of Mississippi River stage. Groundwater discharges to the Mississippi River or Wood River, which border the WRPS property to the south and east, respectively, during periods of base river stage. Groundwater flow is away from the rivers during periods of flood stage. Flood river stage is estimated to occur annually; however, base river stage and the associated groundwater flow direction toward the rivers is predominant. In addition, there are large cones of depression east and northwest of the WRPS, although regional water table information indicates that the Site is not within either cone of depression. Groundwater originates from five sources within the model domain:

1. Natural recharge outside of the East and West Ash Pond Complexes
2. Recharge (percolation) within the Ash Pond Complexes that varies over time with changes in use
3. Natural flow within the American Bottoms aquifer from upgradient (north) areas during base river stage
4. Flow from the landside ponding adjacent to the Mel Price Lock and Dam
5. Flow from the Mississippi River during periods of flood river stage.

Boron was modeled to simulate migration of CCR leachate because: (1) boron is the only monitored primary indicator parameter for CCR impacts on groundwater with concentrations exceeding Class I standards in some on-site and downgradient wells; (2) boron is relatively conservative in the subsurface; and (3) boron is more representative of CCR leachate than sulfate, which may originate from anthropogenic and natural sources other than CCR leachate.

The conceptual model for transport assumes boron leaching to recharge water during percolation through CCRs above the water table. The model also includes flow and transport percolation rates for the East Ash Pond Complex taken from the Transport Model Investigation for the New East Ash Pond (NRT, 2006).

2.3 Model Approach

Three model codes were used to simulate groundwater flow and boron transport:

- Groundwater flow was modeled in three dimensions using MODFLOW
- Boron transport was modeled in three dimensions using MT3DMS (MODFLOW calculated the flow field that MT3DMS used in the transport calculations)
- Leachate percolation after pond closure was modeled using the HELP model, details of HELP modeling are found in the Hydrostatic Model Report (NRT, 2016e) and the leachate percolation rates were applied in MODFLOW to simulate recharge beneath pond caps.

The approach used to calibrate the groundwater flow model and transport model was:

- A steady-state flow model was calibrated to approximate observed head distributions, based on the range of heads measured in November 2014 (Figure 1-3) (a period that overlapped with available river stage data).
- The transport model calibration simulated boron transport over a period of 67 years (1949-2015). The model was calibrated to concentrations measured in 2015 and concentration time series trends from 1995-2015 (NRT, 2016a).

The transport model calibration required iterative changes to and recalibration of the steady-state flow model. The results provided a representative simulation of groundwater flow and transport conditions in the proximity of the Site.

The calibrated model was then used to predict changes in groundwater quality over a period of 500 years (2016-2515). A cover system that meets the requirements of 35 IAC 840.126 consisting of a vegetated soil layer, geocomposite drainage layer and 40-mil LLDPE geomembrane was chosen as the closure solution. A baseline (no action) and a capping scenario were modeled and described below:

- Baseline (no action): assumes no action is undertaken.
- Cap Scenario: Capping of the WAP 1, WAP 2W and WAP 2E with a cover system consisting of a vegetative soil layer, geocomposite drainage layer and 40-mil LLDPE geomembrane.

3 MODEL SET-UP AND CALIBRATION

3.1 Model Descriptions

MODFLOW uses a finite difference approximation to solve a three-dimensional head distribution in a transient, multi-layer, heterogeneous, anisotropic, variable-gradient, variable-thickness, confined or unconfined flow system—given user-supplied inputs of hydraulic conductivity, aquifer/layer thickness, recharge, wells, and boundary conditions. The program also calculates water balance at wells, rivers, and drains.

MODFLOW was developed by the United States Geological Survey (McDonald and Harbaugh, 1988) and has been updated several times since. Major assumptions of the code are: (1) groundwater flow is governed by Darcy's law; (2) the formation behaves as a continuous porous medium; (3) flow is not affected by chemical, temperature, or density gradients; and (4) hydraulic properties are constant within a grid cell. Other assumptions concerning the finite difference equation can be found in McDonald and Harbaugh (1988).

MT3DMS (Zheng and Wang, 1998) is an update of MT3D. It calculates concentration distribution for a single dissolved solute as a function of time and space. Concentration is distributed over a three-dimensional, non-uniform, transient flow field. Solute mass may be input at discrete points (wells, drains, river nodes, constant head cells), or a really distributed evenly or unevenly over the land surface (recharge).

MT3DMS accounts for advection, dispersion, diffusion, first-order decay, and sorption. Sorption can be calculated using linear, Freundlich, or Langmuir isotherms. First-order decay terms may be differentiated for the adsorbed and dissolved phases.

The program uses the standard finite difference method, the particle-tracking-based Eulerian-Lagrangian methods and the higher-order finite-volume TVD method for the solution schemes. The finite difference solution has numerical dispersion for low-dispersivity transport scenarios but conserves good mass-balance. The particle-tracking method avoids numerical dispersion but was not accurate in conserving mass. The TVD solution is not subject to significant numerical distribution and adequately conserves mass, but is numerically intensive, particularly for long-term models such as developed for the APS. The finite difference solution was used for this simulation.

Major assumptions of MT3DMS are: (1) changes in the concentration field do not affect the flow field; (2) changes in the concentration of one solute do not affect the concentration of another solute;

(3) chemical and hydraulic properties are constant within a grid cell; and (4) sorption is instantaneous and fully reversible, while decay is not reversible.

3.2 Flow and Transport Model Setup

3.2.1 Grid and Boundary Conditions

An eight layer, 100 by 54 node grid was established with consistent 100 foot grid spacing (Figure 3-1). Flow and transport boundaries remain constant for all scenarios as shown in Figure 3-1. The upgradient edge of the model was a general head (Dirichlet) boundary, set at a close distance, which caused it to act as a constant head boundary. The general head boundary was used in this case, rather than a constant head boundary, because it was simpler to implement for transient constant head conditions. The lower and lateral boundaries were no-flow (Neumann) boundaries. The downgradient boundaries were either MODFLOW river (Mixed) boundaries (layer 2) or no flow (layers 1, 3-8). The upper boundary was a time-dependent specified flux (Neumann) boundary, with specified flux rates equal to the recharge rate or the rate of percolation from the ash pond complexes. A specified mass flux (Cauchy condition) boundary was used to simulate downward percolation of solute mass from the impoundment. This boundary condition assigns a specified concentration to recharge water entering the node, and the resulting concentration in the node is a function of the relative rate and concentration of recharge water (water percolating from the impoundments) compared to the rate and concentration of other water entering the node.

3.2.2 Flow Model Input Values and Sensitivity

Flow model input values and sensitivity analyses results are presented in Table 3-1 and described below.

Layer Top/Bottom. The top of layer 1 approximated the water table. This elevation was set at 430 feet, a value higher than the estimated maximum elevation of the top of the silty clay units across most of the WRPS property and the maximum water table elevation. This top elevation setting assures unconfined conditions in layer 1. The top of layers 2-8 was the base of the overlying layer.

The base of the upper confining layer (layer 1) was determined by contouring the top of the primary sand unit (i.e. base of the silty clay), as determined from site borings on the Hydrogeologic Characterization Report (NRT, 2016d), and importing the contour data into MODFLOW (Figure 3-2). The resulting base elevations for layer 1 were between 376 and 420 feet. Layers 2-8 represented the sand and gravel unit, and base elevations were 376-380, 368-370, 360, 354, 348, 342 and 336 feet, respectively (Figure 3-2). The base of layer 8 represents the contact between the primary sand unit and either: bedrock, the silt and sandy silt unit, or the silty clay diamicton (i.e., the basal confining unit of the American Bottoms aquifer).

Hydraulic Conductivity. Hydraulic conductivity values (Figure 3-3) were derived from field and laboratory measured values (NRT, 2016d). Vertical anisotropy ratios were set at 5.0 for the sand units and 100 for the silty clay unit. The Kx/Kz ratios represent expected stratification within the formations.

The model was sensitive to most hydraulic conductivity values. Calibrated heads were highly sensitive to horizontal and vertical hydraulic conductivity of zone 1 (layer 1, silty clay units). Calibrated heads had a low sensitivity to horizontal conductivity of zone 3 (layers 1-3, shallow primary sand unit) and moderately sensitive to vertical conductivity of zone 3. The sensitivity of the horizontal conductivity of zone 8 (layers 4-8, deep primary sand unit) was moderate to moderately high; however, the vertical conductivity of this zone was negligible.

Storage. No field data were available defining these terms, so representative values for similar materials were obtained from Smith and Wheatcraft (1993). Sensitivity analysis was not performed on this parameter. Values used in the model are listed below.

Silty Clay Units

- Specific Storage Ss: 3X10-4 ft-1
- Specific Yield Sy: 0.1

Sand Units

- Specific Storage Ss: 3X10-6 ft-1
- Specific Yield Sy: 0.2

Recharge. Recharge rates for the impoundments were determined from a combination of values attained from 2016 HELP modeling and values used in previous model calibrations (NRT, 2006 and NRT, 2000).

Recharge zones are illustrated in Figure 3-4. The extent of each recharge zone was constant. The infiltration rates for each zone varied with time with respect to changes in use and construction of the Site, the Old East Ash Pond (OEAP), and the New East Ash Pond (NEAP) (Table 3-2). For stress periods 1-58 (1949-1978) only the Old East Ash Ponds were active. For stress periods 59-98 (1978-1998) the Site became active while the OEAP infiltration rates were reduced. Also during this time period a recharge zone (i.e. zone 12) was included along the northern edge of WAP 2E and Pond 3 to simulate a possible inter-sand window and/or an area where the silty clay unit is thin allowing leachate to enter the model and match concentrations observed upgradient of the Site. For stress periods 99-114 (1999-2006) the infiltration rates of the Site were reduced due to removal of ponds from service and the installation of pond liners (installed liners cut off infiltration through zone 12), while the OEAP rates were unchanged. During stress periods 114-134 (2006-2015) the infiltration rates of the Site were unchanged, while a portion of the OEAP was covered with a zone of reduced infiltration in the footprint of the NEAP, which was constructed with a lower liner. Further, during stress periods 123-134 the infiltration at zone 8 (the zone representing infiltration in the inter-sand window) was reduced to simulate dewatering approximately 4 years after installation of the NEAP.

River Parameters. The Mississippi River and Wood River were represented by head-dependent flux nodes (Figure 3-1) that required inputs for river stage, width, bed thickness, and bed hydraulic conductivity. The latter three parameters are used to calculate a conductance term for the boundary node. This conductance term was determined by starting with calibrated values from the NRT (2000) model and adjusting during the 2016 model calibration.

Mississippi River stage fluctuates significantly over the course of a year and has a strong effect on groundwater flow (NRT, 2000). Therefore, stage could not be approximated as steady state; rather it was approximated as a transient event. Because river stage is too variable and unpredictable to model on a day by day or month by month basis, a simplification was performed where two stage conditions (base stage and flood stage) were modeled. Base stage was set at about 403 feet, the average mean monthly river stage observed at Mel Price Lock and Dam tailwater gauging station from 1990 to 2014 for months where groundwater flow is typically southeast, toward the river (Table 3-3). Flood stage was set at the average mean monthly river stage elevation for months where groundwater flow reversals, away from the river, were regularly observed, about 411 feet based on the same gauging station data.

In the NRT 2000 model, in order to estimate the period over which to model each stage, it was necessary to select an elevation at which all higher elevations were grouped with flood stage, and all lower values were grouped with base stage. An elevation of 407.5 feet was selected as the dividing point in the NRT 2000 model. River stage was below 407.5 feet 62 percent of the time, or 226 out of every 365 days, and the remaining period was modeled as flood stage (NRT, 2000). The time period estimated in the NRT 2000 model was maintained in the 2016 model.

Mississippi River stage downriver of the Mel Price Lock and Dam decreased at a gradient of about 1.3 feet/mile. Stage on the upriver side of the Mel Price Lock and Dam was set at a constant 418.5 feet, the approximate mean pool elevation (NRT, 2000). During low Mississippi River stage, Wood River was set at approximately 407 feet (same stage as the general head boundary) at the upstream (north) end and graded down to 401 feet to match the elevation of the Mississippi River at the confluence. During Mississippi River flood stage, Wood River was assigned a constant elevation equal to Mississippi River stage at the confluence with Wood River (approximately 409 feet). The riverbed thickness and river width values from the NRT (2000) report were used in this model. The riverbed conductivities from the NRT (2000) report were maintained initially for this model, final values were determined during calibration.

Calibrated heads were highly sensitive to river stage at reach 1 (Mississippi River stage downstream of the Mel Price Lock and Dam), while the model displayed negligible sensitivity to stage at reaches

0 (Mel Price Lock and Dam pool water) and 3 (Wood River). The model was insensitive to the conductance values for reach 0, 1 and 3.

General Head Boundary Parameters. General head boundary elevation and conductance were established during calibration. General head elevations were highest at about 409 feet on the west end of the model and graded approximately 1.5 ft/mile towards Wood River at approximately 407 feet. Calibrated heads were highly sensitive to general head boundary elevation, and displayed negligible sensitivity to the conductance values.

Constant Head Boundary Parameters. Constant head boundary elevations were determined by starting with approximated target ponding elevation at Alton Pump Station as part of the seepage control systems, then adjusted during calibration. The estimated elevation at the east side of the boundary at Alton Pump station was 408 feet, while the elevation at the west end of the model was maintained at approximately 409 feet. An approximate gradient of 1.2 ft/mile from the west end of the model toward Alton Pump Station was applied to the model. Calibrated heads were moderately sensitive to constant head boundary elevation.

3.2.3 Transport Model Input Values and Sensitivity

Transport model input values are listed in Table 3-2 and Table 3-4, and described below. The results of sensitivity analyses are presented in Table 3-4.

Initial Concentration. Initial concentration for the calibration model was set at zero, implicitly implying a background concentration of zero, which is reasonable for boron. Initial concentration for the prediction model was the final calibration model concentration.

Source Concentration. Boron concentrations were set during model calibration with the constraint that they must be equal to or less than the maximum observed leachate concentration of 80 mg/L. Source concentrations were varied with respect to changes in use and construction of the Site. For stress periods 1-58 (1949-1978) only the Old East Ash Ponds were active and source concentrations at the Site were set to 0 mg/L. For stress periods 59-98 (1978-1998) the Site became active and concentrations were set to a value of 80 mg/L or less to match observed concentrations in surrounding monitoring wells. For stress periods 99-134 (1999-2015) the source concentrations were reduced due to removal from service, construction of basal liners at WAP 2E and Pond 3, changes in ash handling operations, and periodic mining of ash from the impoundments to match observed concentrations.

Effective Porosity. Effective porosity values were based on ranges provided by Mercer and Waddel (1993). For sensitivity analysis the effective porosity input was varied by ±0.05. Predicted concentrations were highly sensitive to the increased and decreased porosity applied to the sand and gravel zone, and the model runs failed to converge with these changes. A test model was run with the MT3MS convergence criteria relaxed to allow the model to converge while maintaining mass balance. Results of the test model run indicated the predicted concentrations were still highly sensitive to changes in the effective porosity.

Dispersivity. Dispersivity was set as 10 ft for the sand and gravel unit and 1 ft for the silty clay units during calibration of the NRT 2000 model and retained for the 2016 model. Transverse and vertical dispersion were estimated according to ratios developed by Gelhar et al. (1985). The final calibrated value for dispersivity was towards the lower end of acceptable values; therefore, for sensitivity analysis the longitudinal, transverse and vertical dispersivities were increased by factors of 3 (rather than decreased) and 10. Predicted concentrations were highly sensitive to both increased values of longitudinal and vertical dispersivity. Predicted boron concentrations were less sensitive to transverse dispersivity. When transverse dispersivity was increased by a factor of 3, predicted boron concentrations had a low sensitivity, but when increased by a factor of 10, sensitivity was high.

Retardation. Retardation was calculated by the model based on the distribution coefficient (K_d) (Figure 3-5). The parameter simulated a reversible adsorption and desorption process, which would slow down the contaminant migration without reducing the total mass. The calibrated values for K_d were set to 0.7 g/cm^3 for silty clay units and 0 g/cm^3 for the sand and gravel units

The silty clay unit K_d value was varied by ±0.4 g/cm^3, predicted boron concentrations were highly sensitive to both the increased and decreased K_d values Sand and gravel K_d was only increased by 0.4 g/cm^3 for sensitivity as the calibrated value was 0 g/cm^3. The predicted boron concentrations were highly sensitive to the increased Kd value for the sand and gravel unit.

Diffusion. Diffusion was assumed to be zero for the entire model domain.

3.3 Flow and Transport Model Assumptions and Limitations

Simplifying assumptions are necessary when numerically representing the natural environment in a groundwater flow model. Assumptions specific to this model are listed below. The reader is referred to McDonald and Harbaugh (1988), Zheng and Wang (1998), and Schroeder et al., (1994) for assumptions inherent with the codes used to develop the model.

- Natural recharge is constant over the long term.
- Hydraulic conductivity is consistent within hydrostratigraphic units.
- River stage has regular and constant variability.
- Liners are constructed instantaneously.

- Source concentrations change instantaneously due to changes in operations
- Leachate instantaneously migrates to groundwater (e.g., rapid migration through the unsaturated zone).
- Boron undergoes a reversible adsorption and desorption process and does not decay. Dispersion and retardation are the primary attenuation mechanisms.
- Cap construction has an instantaneous effect on recharge and percolation through the underlying ash fill deposit, relative to the 500 year period of the prediction model.

The model is limited by the data used for calibration, which adequately describe groundwater flow and quality near the Site as of 2015. Model predictions of flow and concentration are less reliable with increasing distance from the Site. Furthermore, the reliability of model predictions decreases with increasing time since changes may occur that were not accounted for in the model. Groundwater flow and concentration data used for calibration were collected during November 2014 (overlaps with available river stage data) and November 2015, respectively.

3.4 Calibration Flow and Transport Model Results

Results of the MODFLOW/MT3DMS modeling are presented below. A disk containing the model files is attached to this report (Appendix A).

In Figure 3-6, the simulated hydraulic heads are compared with the observed range of the heads measured in 24 monitoring points at or surrounding the Site. Leachate well L1R (screened within the West Ash Pond complex above the watertable) was not included in flow calibration. The simulated values successfully fall within the observed range from 403 to 409 ft NAVD88 (excluding perched porewater level at leachate well L1R). The model captured the approximate 4 ft of head decrease from north of the impoundments (Wells 22, 30, 25 and 21) to the southeast (Wells 40S, 41 and 02) approaching the confluence of the Mississippi River and Wood River. The relative standard deviation, given as a percentage of standard deviation to data mean, was 2.3%, within the customary goal of less than 10% for this value. The observed heads are plotted versus the simulated heads in Figure 3-7. The near-linear relationship between observed and simulated values and the evenly distributed residuals indicate that the model adequately represents the calibration dataset. Further, all calibrated heads were within 1 foot of the observed values and were well distributed as illustrated in the plotted observed heads verse residuals in Figure 3-7, therefore, discrepancies between observed and predicted heads were not considered significant.

Simulated boron concentrations are compared to observed data in Figure 3-8. A subset of 7 of the available 25 wells were selected for calibration based on wells used in the previous modeling report (NRT, 2000), proximity to the Site and upgradient/downgradient position relative to the Site. The calibrated monitoring points were categorized into two groups: (1) wells with current observed boron concentrations over the Class I standard (2 mg/L) (i.e. 02, 12 and 34); and (2) wells with current observed boron concentrations equal to or below the standard (i.e. 04, 20, 23 and 28). The simulated boron concentrations reasonably matched the concentration trends over time observed between 1996 and 2015, and the most recent observed concentrations met the calibration criterion that simulated results for category (1) were all higher than 2 mg/L while the simulated results for category (2) were all equal to or below 2 mg/L. The model also successfully simulated the limited migration of boron from the ash sources to the surrounding groundwater (low boron concentrations in the category [2] wells). The agreement between modeled and predicted concentrations demonstrated that the transport model adequately simulates contaminant transport in groundwater in the proximity of the Site.

4 SIMULATION OF CAPPING SCENARIO

4.1 Overview

The baseline and capping scenario described in Section 2 were modeled for a time frame of 500 years. Capping of the ponds was simulated by applying the HELP-calculated percolation rates based on cap design documented in the draft Closure and Post-Closure Care Plan for Dynegy Wood River Ash Complex (AECOM, 2016) and found in the Hydrostatic Model Report (NRT, 2016) The changes in hydraulic head and boron concentrations were compared to a baseline condition when no cap was simulated. The following simplifying assumptions were made during the simulation:

- In the baseline scenario, HELP-calculated no cap percolation rates were assumed to remain constant where there was little change in predicted percolation rate.
- In the capping scenario, HELP-calculated with cap percolation rates were averaged over three periods to simulate the following: an initial high percolation rate occurring during initial dewatering of the pond leachate water (approximately 1-10 years following closure); a reduced percolation rate as the system moves toward equilibrium (approximately 10-30 years following closure); and a low percolation rate that remains relatively constant under hydrostatic equilibrium (approximately 30-500 years) (Table 4-1).
- Boron concentrations in leachate at WAP 1, WAP 2W and WAP 2E were assumed to remain constant as a function of time following the end of the calibration simulation. Boron concentration in Pond 3 was assumed to be 0 mg/L in the capping scenario following cap construction to simulate discontinuation of leachate and surface water inputs from WAP 2E.
- Caps were assumed to be constructed instantaneously at the start of the prediction simulation.
- Final grade of the capping system was at or above current top of berms. Proper storm water control system was assumed to remove excess water from the surface of the capped areas.

4.2 Simulation of the Capping Scenario

The calibrated model was used to evaluate the effect of the capping scenario by changing recharge rates to simulate capping of selected ponds in the Site. The extent of the recharge zones stayed constant as in Figure 3-4. The capping scenario represents a condition when all Site ash ponds are capped (i.e. WAP 1, WAP 2E and WAP 2W). The changes in recharge rate in the capping scenario in the predicted models are listed in Table 4-1. Discontinuation of leachate inputs from the Site at Pond 3 was simulated by reducing the boron concentration in Zone 5 to 0 mg/L.

4.2.1 Predicted Hydraulic Heads and Boron Concentrations

Predicted hydraulic heads do not vary significantly from the calibrated transport and flow models. As the upgradient General Head Boundary is the primary source of water during base river stage and the Mississippi River is the primary source of water during flood river stage; therefore, there is no significant change in hydraulic heads as a result of reduced recharge inputs at the Site during the capping scenario. Figure 3-8 compares predicted boron concentrations between baseline and capping scenarios at downgradient wells 02, 12, and 34. These wells were selected for presentation because they have observed boron concentrations higher than the Class I groundwater quality standard of 2 mg/L.

Concentrations are predicted to increase under the baseline scenario due to the continued infiltration of ash leachate. Concentrations continue to increase until a period approximately greater than 300 years when the concentration at the well asymptotically reaches equilibrium with concentrations released from the source. An example of this trend at downgradient well 02 is shown in Figure 4-1.

The prediction model indicates rapid response to the capping scenario and resulting reduced infiltration rates. The greatest extent of the boron plume exceeding the Class I standard of 2 mg/L occurs at the end of the first base river stage stress period (approximately 365 days), as shown on Figure 4-2. Following the first year of the prediction model, capping scenario concentrations begin to decrease (Figure 3-8). Approximately 28 years following cap construction boron concentrations at downgradient well 34 are predicted to be below the Class I standard. Similarly, approximately 33 years following cap construction boron concentrations at downgradient well 02 are predicted to be below the Class I standard.

Well 12 is predicted to take approximately 53 years following cap construction to meet the Class I standard for boron. The well construction log indicates the well was constructed through some of the thickest deposits of silty clay at the Site. The well is screened just below the silty clay unit in the top 6-feet of the sand and gravel unit and a portion of the filter pack is placed within the overlying silty clay unit, which likely contributes to slow infiltration of boron into the well screen. For these reasons, the well takes longer to achieve concentrations below the standard.

5 SUMMARY

A groundwater flow and transport model was calibrated to match hydraulic head and boron concentrations observed near the Site at the WRPS in November 2014 and November 2015, respectively. The calibrated model was then used to evaluate a baseline (no action) scenario and a capping scenario over a future time frame of 500 years. The capping scenario assumed cap construction with a geosynthetic barrier layer that complies with 40 CFR Part 257, Subpart D (CCR Rule). The results of the modeling indicated:

- The baseline (no action) scenario prediction model indicated boron concentrations at downgradient monitoring wells that currently exceed the Class I standard would slowly increase for a period of about 300 years before reaching an equilibrium concentration above the standard. There was no indication within the 500 year model run that boron concentrations would significantly decrease.
- The capping scenario prediction model indicated boron concentrations in all calibrated monitoring wells are predicted to start decreasing one year following cap construction. Predicted concentration distributions demonstrated reduced contaminant plumes relative to the calibrated transport model. The capping scenario model predicted all calibrated monitoring well concentrations to be below the Class I standard of 2 mg/L for boron within 53.5 years following cap construction. Similarly, the capping scenario model predicted two of the three calibrated monitoring well concentrations downgradient of the Site (wells 02 and 34) would decrease below the Class I standard for boron within 33 years following cap construction.

These model results suggest that the geosynthetic cover system will control recharge and subsequent leachate generation within the limits of the Site and sufficiently reduce concentrations of boron below Class I standards. Concentration reductions should begin approximately one year after completion of the cover system. Alternatively, the model results demonstrate that the base line scenario of no action will not significantly decrease concentrations of boron at downgradient wells, and boron concentrations will not be reduced below the standard within the modeled timeframe of 500 years.

6 REFERENCES

AECOM, 2015. 30% Design Data Package for Dynegy Wood River Energy Complex, West Ash Pond and East Pond CCR Units. Prepared for Dynegy Midwest Generation, LLC. December 2015.

AECOM. 2016. Draft Closure and Post-Closure Care Plan for the Wood River West Ash Complex. Dynegy Midwest Generation, LLC. Wood River Power Station #1 Chessen Lane Alton, IL 62002. May 2016.

Gelhar, L.W., A. Mantoglou, C. Welty, and K.R. Rehfeldt, 1985, *A Review of Field-Scale Physical Solute Transport Processes in Saturated and Unsaturated Porous Media*, Electric Power Research Institute, EA-4190, Palo Alto, CA.

Kelron Environmental. 2004. Hydrogeologic Investigation for the Proposed New East Ash Pond, Wood River Power Station, Illinois

McDonald, M.G., and A.W. Harbaugh, 1988, *A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model: Techniques of Water-Resources Investigations*, Techniques of Water-Resources of the United States Geological Survey, Book 6, Chapter A1.

Mercer, J.W., and R.K. Waddell, 1993, *Contaminant Transport in Groundwater*, in Handbook of Hydrology, D.R. Maidment (ed.), McGraw-Hill Inc., pp. 16.1-16.41, New York, NY.

Natural Resource Technology, Inc., 2000. Wood River Closure Report. Prepared for Dynegy Midwest Generation, LLC. August 2000.

Natural Resource Technology, Inc., 2006. Transport Model Investigation for the New East Ash Pond. Wood River Power Station. Prepared for Dynegy Midwest Generation, LLC. May 2006.

Natural Resource Technology, Inc., 2016a. 2015 Closure Work Plan Annual Report, West Ash Pond System, Cell Numbers 1 and 2W, Wood River Power Station, Prepared for Dynegy Midwest Generation, LLC. January 2016.

Natural Resource Technology, Inc., 2016b, Groundwater Management Zone Application, West Ash Pond Complex, Wood River Power Station, Alton, Illinois.

Natural Resource Technology, Inc., 2016c, Groundwater Monitoring Plan. West Ash Pond Complex, Wood River Power Station, Alton, Illinois.

Natural Resource Technology, Inc., 2016d, Hydrogeologic Characterization Report. West Ash Pond Complex, Wood River Power Station, Alton, Illinois.

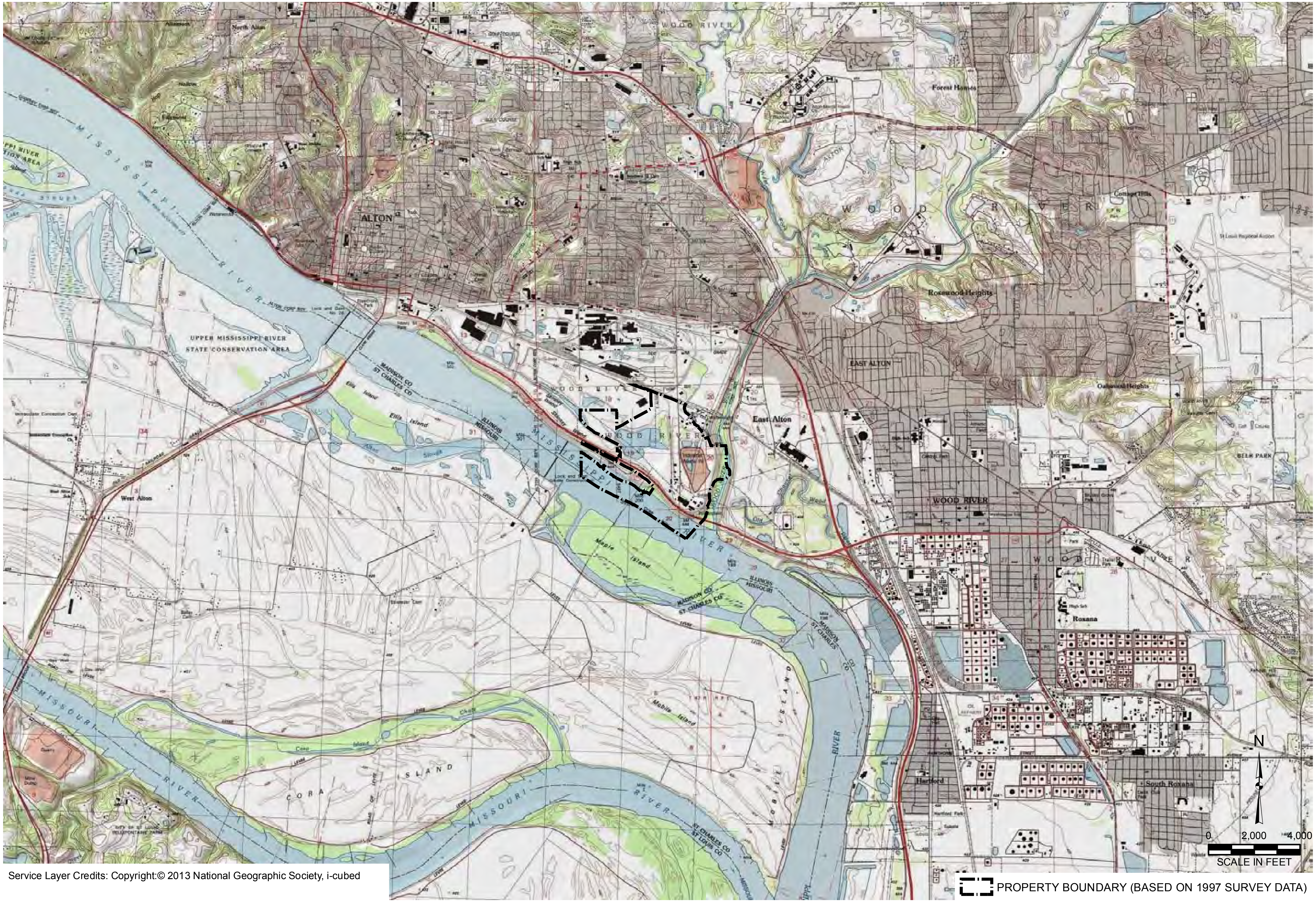
Natural Resource Technology, Inc., 2016e, Hydrostatic Modeling Report. West Ash Pond Complex, Wood River Power Station, Alton, Illinois.

Schroeder, P.R., T.S. Dozier, P.A. Zappi, B.M. McEnroe, J.W. Sjostrom, and R.L. Peyton, 1994, *The Hydrologic Evaluation of Landfill Performance (HELP) Model: Engineering Documentation for Version 3*, EPA/600/R-94/168b, U.S. Environmental Protection Agency Office of Research and Development, Washington, D.C.

Smith, L, and S.W. Wheatcraft, 1993, *Groundwater Flow*, in Handbook of Hydrogeology, D.R. Maidment (ed.), McGraw-Hill inc., pp. 6.1-6.58, New York, NY.

Zheng, Z., and P.P. Wang, 1998, *MT3DMS, a Modular Three-Dimensional Multispecies Transport Model*, Model documentation and user's guide prepared by the University of Alabama Hydrogeology Group for the US Army Corps of Engineers.

FIGURES



Service Layer Credits: Copyright:© 2013 National Geographic Society, i-cubed

▭ PROPERTY BOUNDARY (BASED ON 1997 SURVEY DATA)

Y:\Mapping\Projects\23\2376\MXD\GW_Model\Figure 1-1_Site Location Map.mxd Author: sstolz; Date/Time: 8/18/2016, 4:33:02 PM

DRAWN BY/DATE:
SDS 7/15/16
REVIEWED BY/DATE:
NRK 7/15/16
APPROVED BY/DATE:
SJC 7/28/16

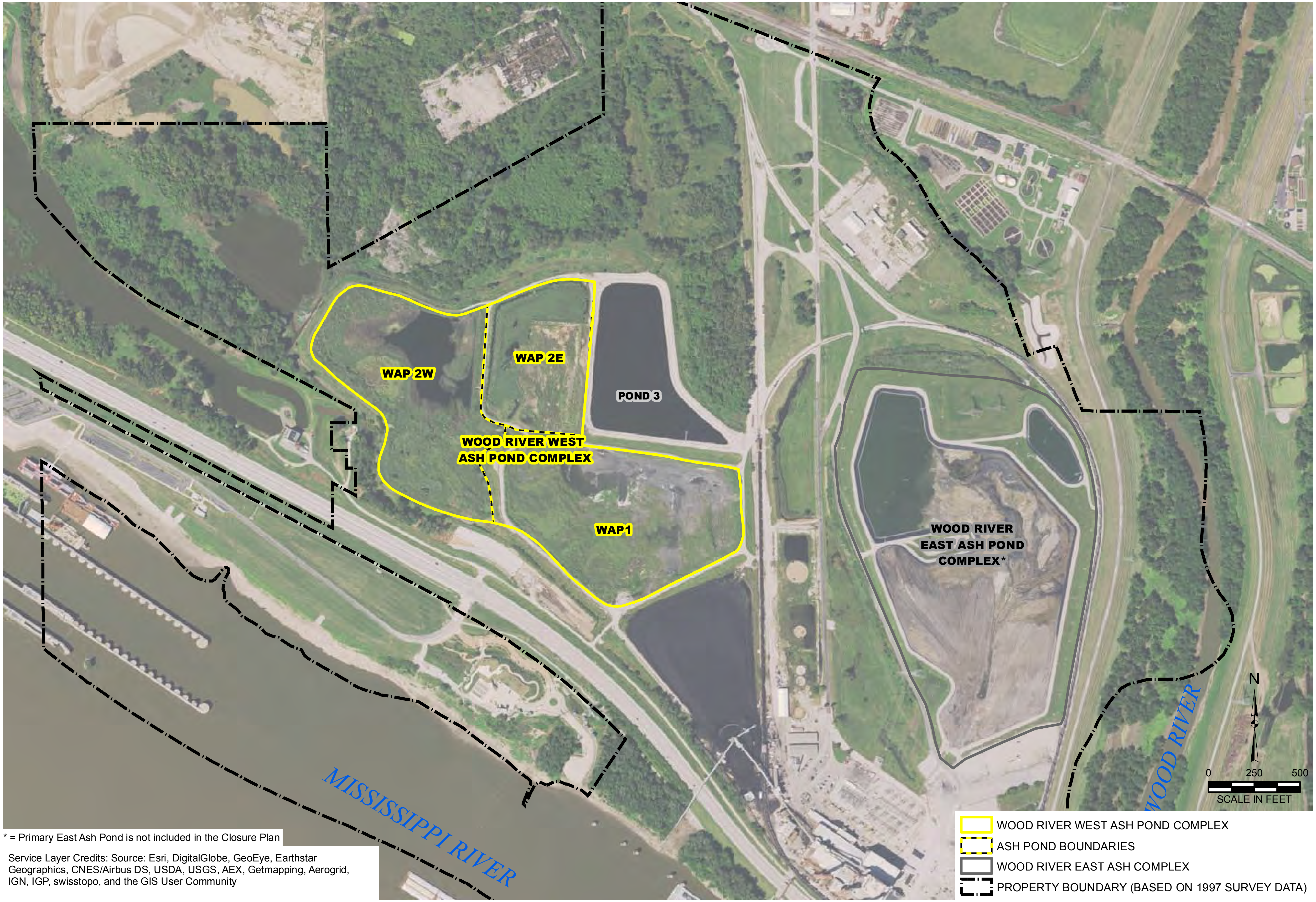
SITE LOCATION MAP

GROUNDWATER MODEL REPORT
WEST ASH POND COMPLEX
WOOD RIVER POWER STATION
ALTON, ILLINOIS

PROJECT NO: 2376

FIGURE NO: 1-1

NATURAL RESOURCE TECHNOLOGY



* = Primary East Ash Pond is not included in the Closure Plan

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

🟨	WOOD RIVER WEST ASH POND COMPLEX
▨	ASH POND BOUNDARIES
▭	WOOD RIVER EAST ASH COMPLEX
▭	PROPERTY BOUNDARY (BASED ON 1997 SURVEY DATA)

DRAWN BY/DATE:
SDS 7/15/16
REVIEWED BY/DATE:
NRK 7/15/16
APPROVED BY/DATE:
SJC 7/28/16

OVERVIEW OF ASH POND SYSTEM

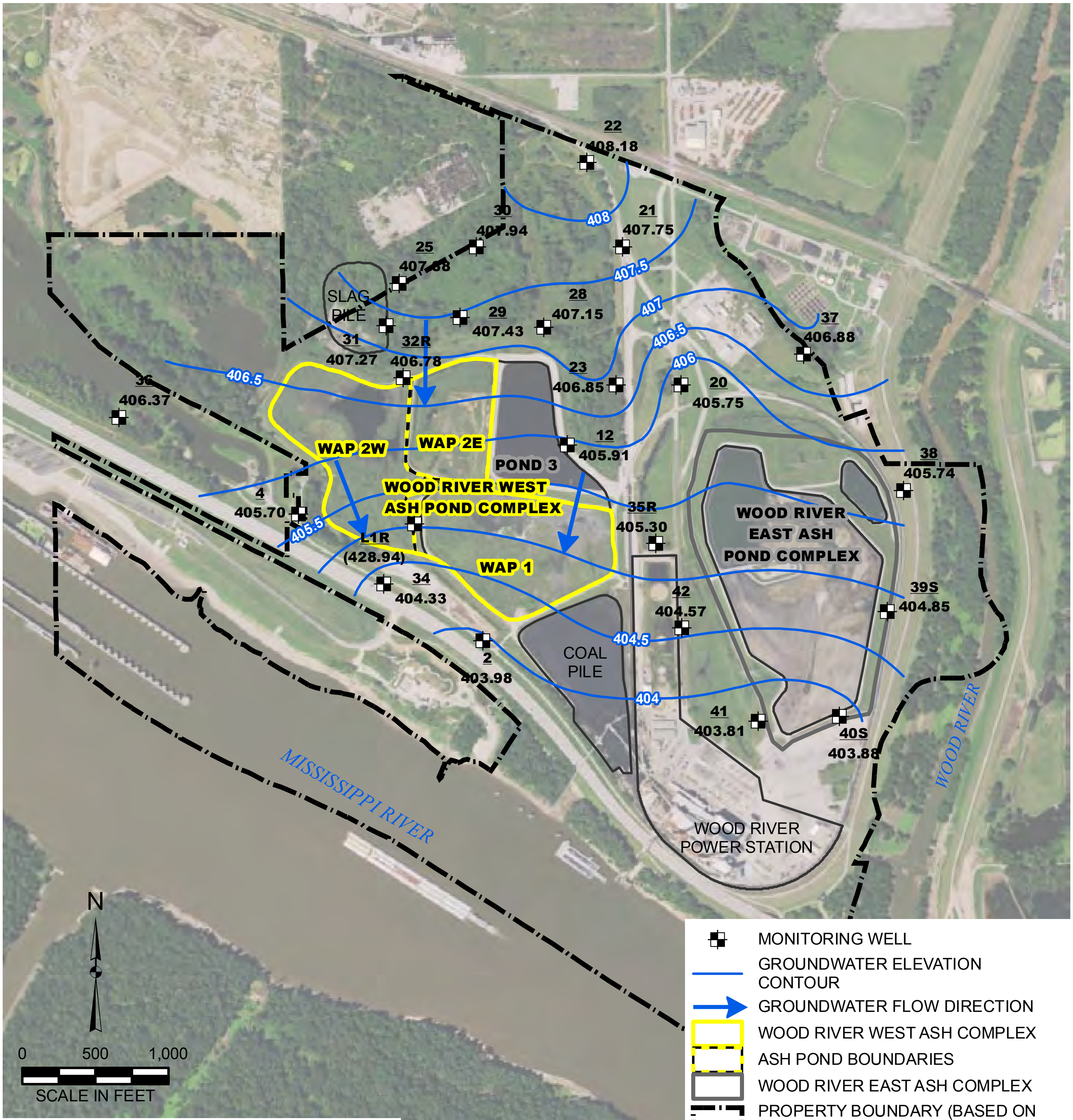
GROUNDWATER MODEL REPORT
WEST ASH POND COMPLEX
WOOD RIVER POWER STATION
ALTON, ILLINOIS

PROJECT NO: 2376

FIGURE NO: 1-2

NATURAL RESOURCE TECHNOLOGY

Y:\Mapping\Projects\23\2376\MXD\GW_Model\Figure 1-2_Site Location Map - Wood River West Ash Pond.mxd Author: sstolz; Date/Time: 8/18/2016, 4:32:48 PM



NOTE: POTENTIOMETRIC SURFACE ELEVATIONS IN PARENTHESES WERE NOT UTILIZED FOR CONTOURING.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

NOTES:
GROUNDWATER ELEVATIONS ARE IN FEET.
WELL L1R NOT USED FOR CONTOURING.

Y:\Mapping\Projects\23\2376\MXD\GW_Model\Figure 1-3_Potentiometric_Surface_November2014_Letter.mxd Author: sstolz; Date/Time: 8/18/2016, 4:32:26 PM

DRAWN BY/DATE:
MDM 1/5/15
REVIEWED BY/DATE:
SJC 1/6/15
APPROVED BY/DATE:
SJC 1/6/15

POTENTIOMETRIC SURFACE
NOVEMBER 18, 2014

GROUNDWATER MODEL REPORT
DYNEGY MIDWEST GENERATION, LLC
WOOD RIVER POWER STATION

PROJECT NO: 2376

FIGURE NO: 1-3

NATURAL RESOURCE TECHNOLOGY

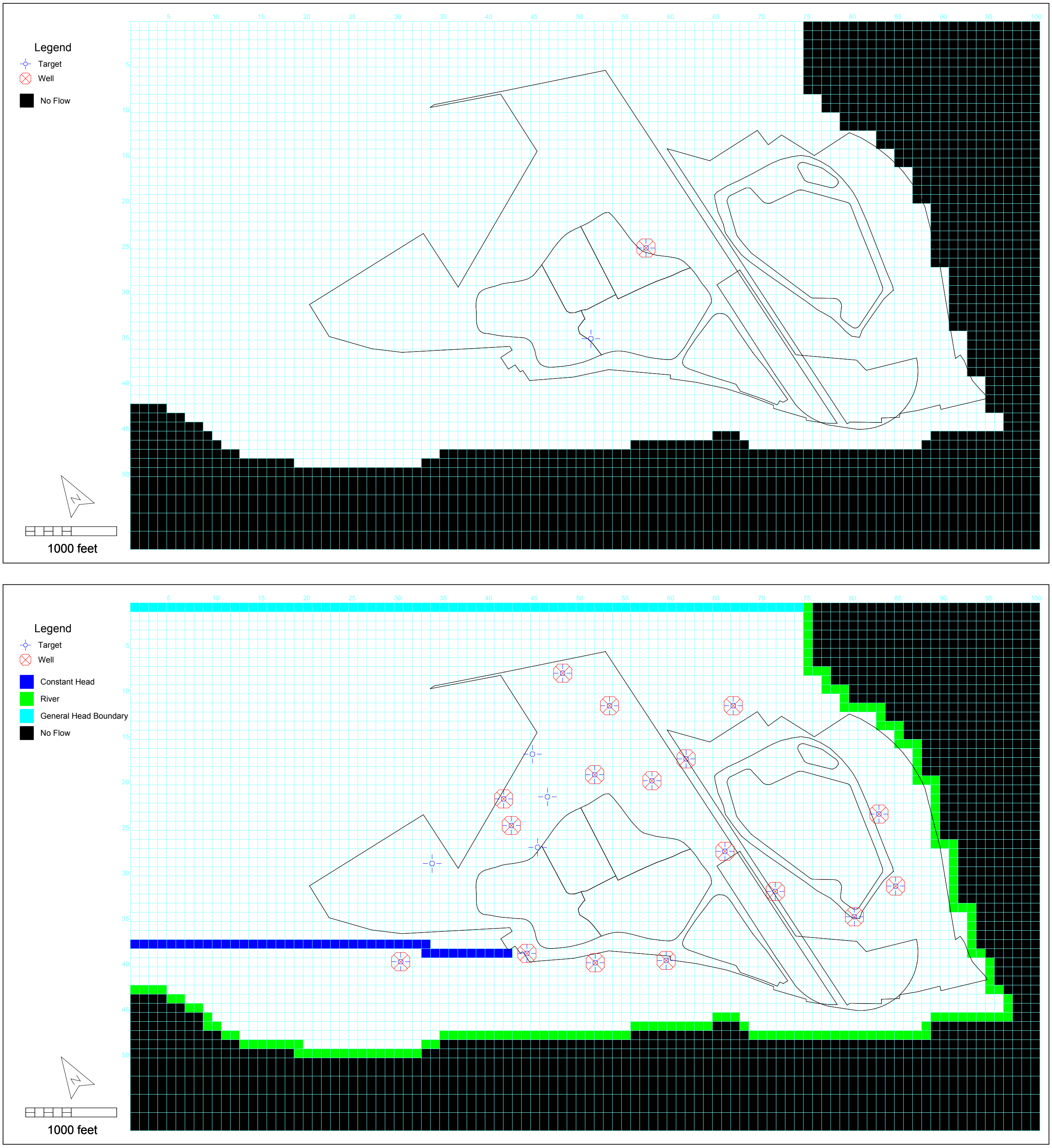


Figure 3-1. MODFLOW and MT3DMS Grid and Boundary Conditions for Layer 1 (top) and Layer 2 (bottom).

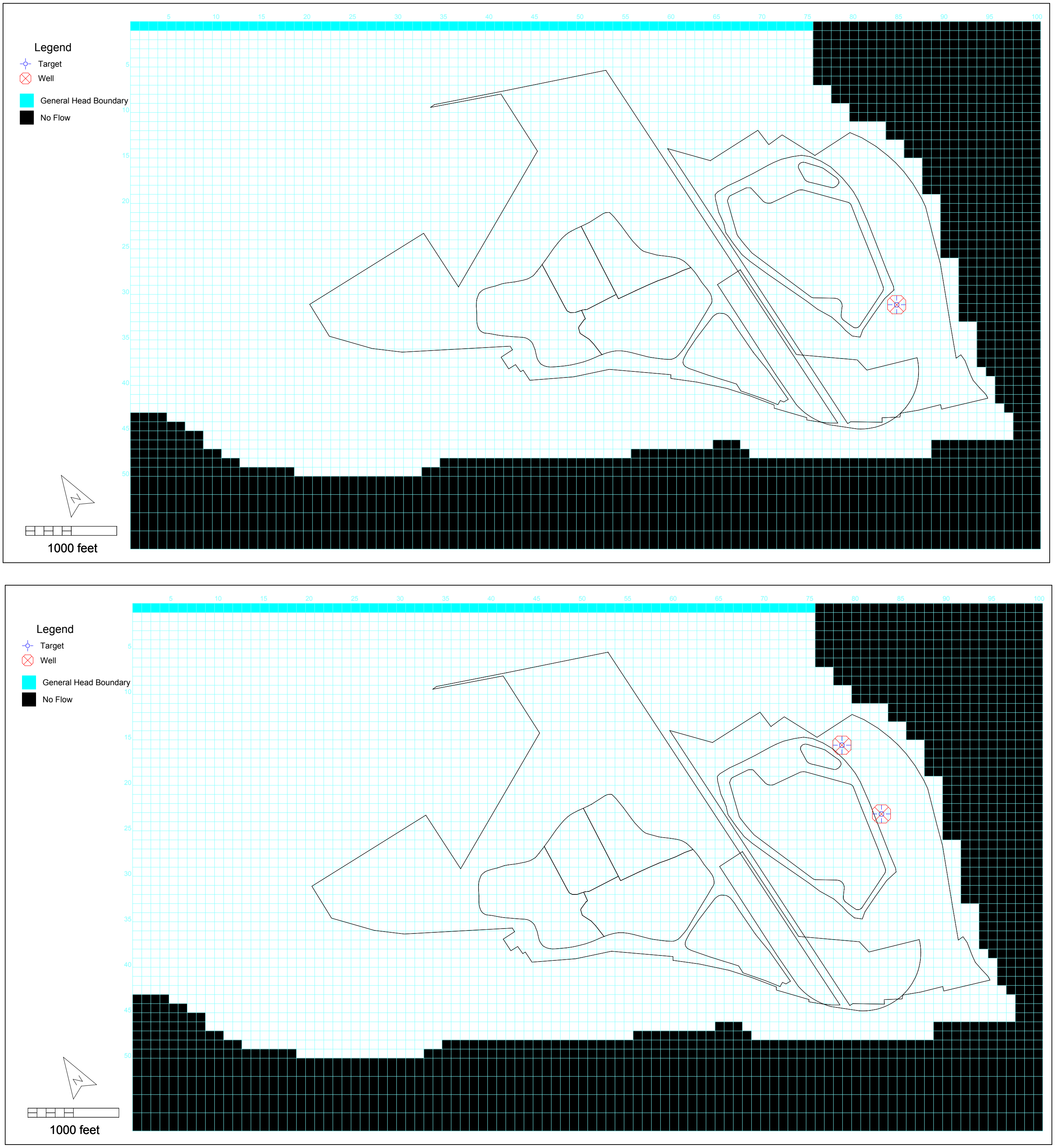


Figure 3-1 (cont'd). MODFLOW and MT3DMS Grid and Boundary Conditions for Layer 3 (top) and Layer 4 (bottom).

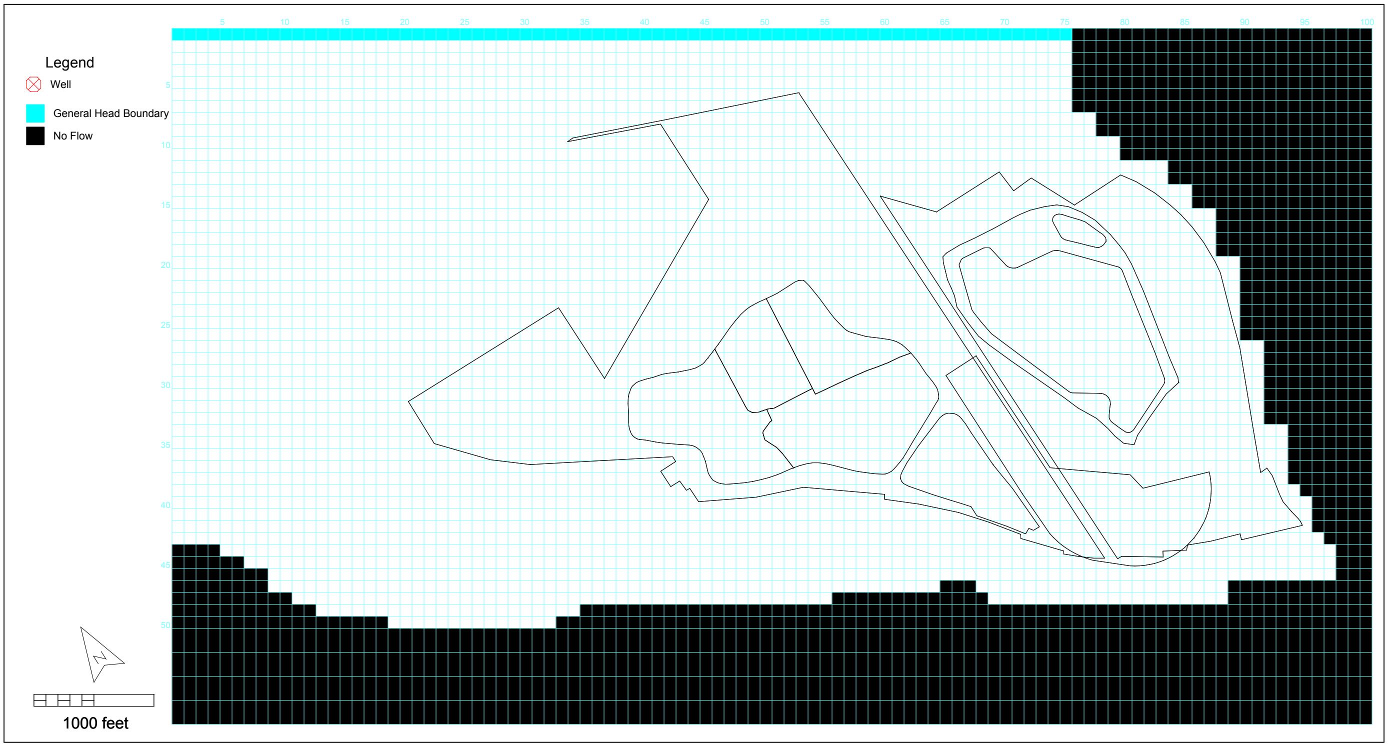


Figure 3-1 (cont'd). MODFLOW and MT3DMS Grid and Boundary Conditions for Layer 5 through Layer 8.

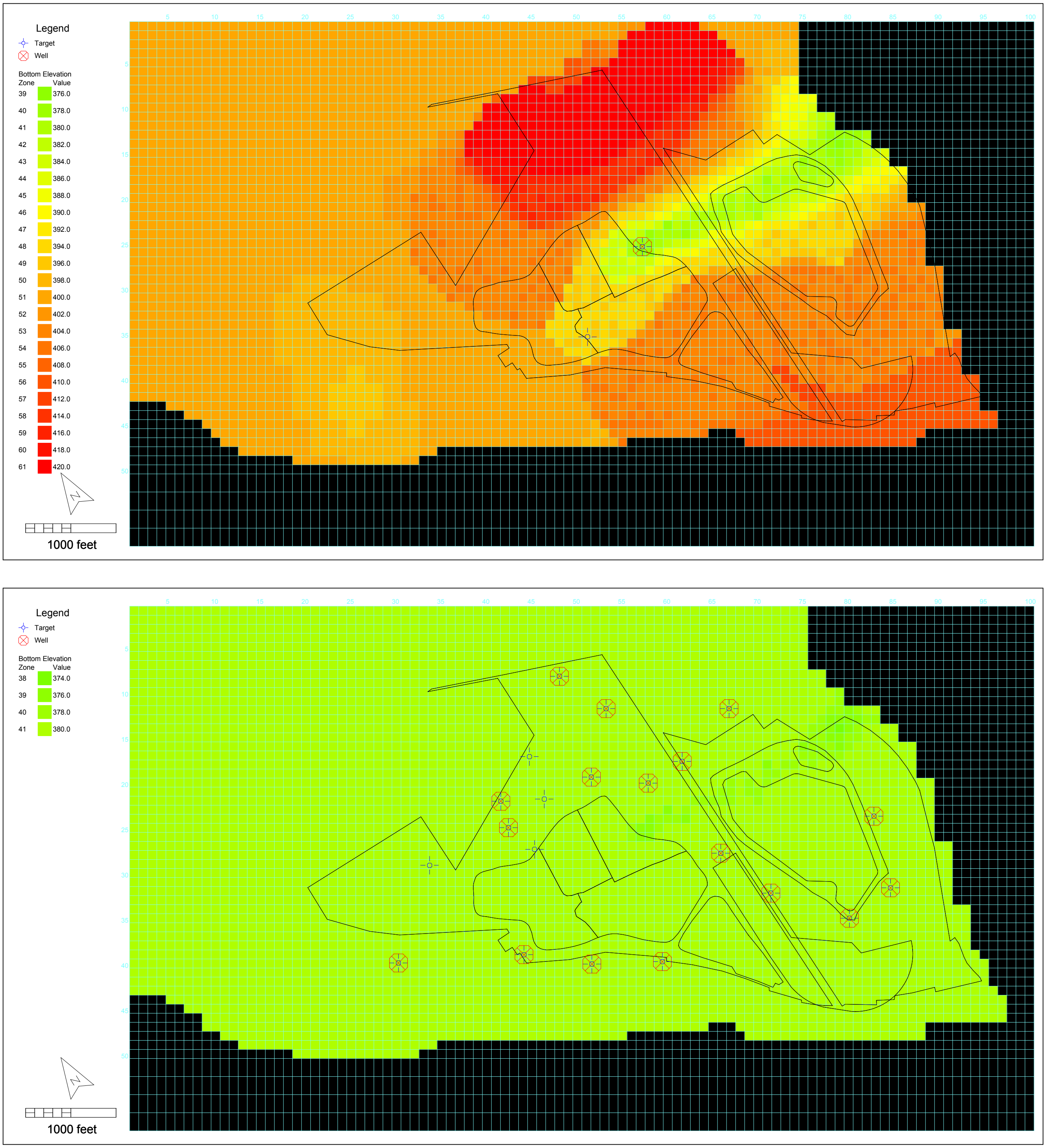


Figure 3-2. Bottom Elevation (feet) Array for Layer 1 (top) and Layer 2 (bottom).

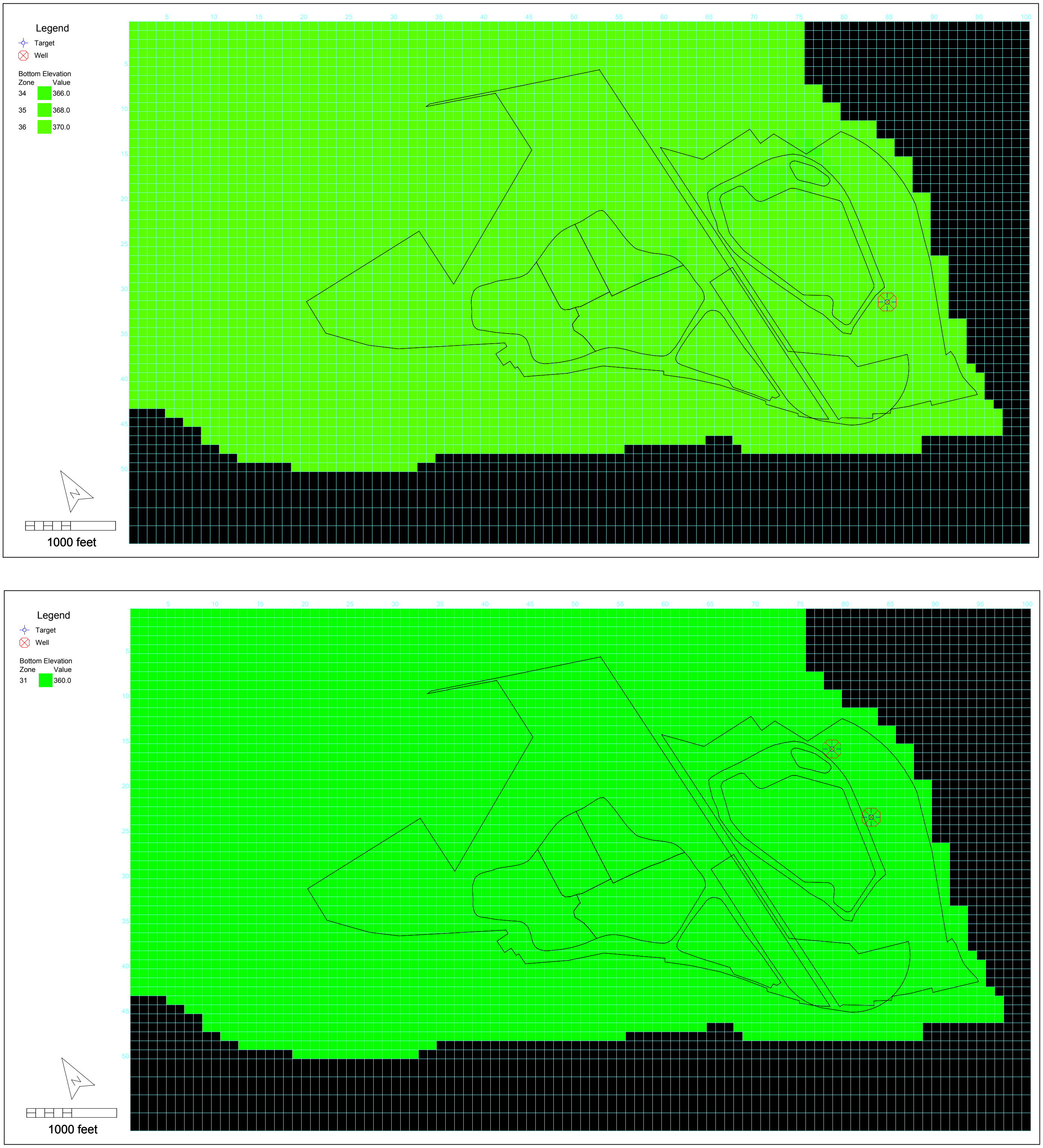


Figure 3-2 (cont'd). Bottom Elevation (feet) Array for Layer 3 (top) and Layer 4 (bottom).

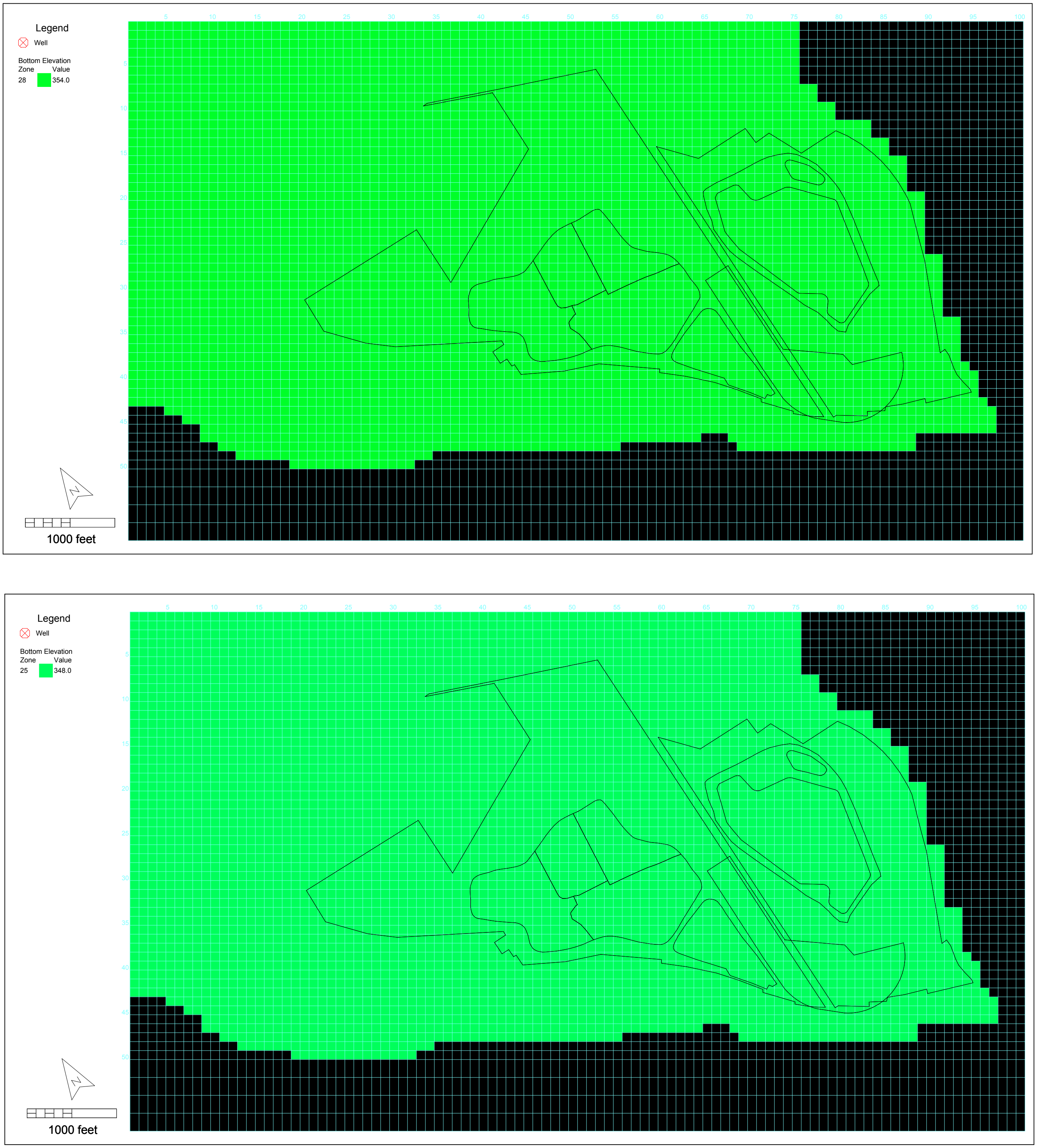
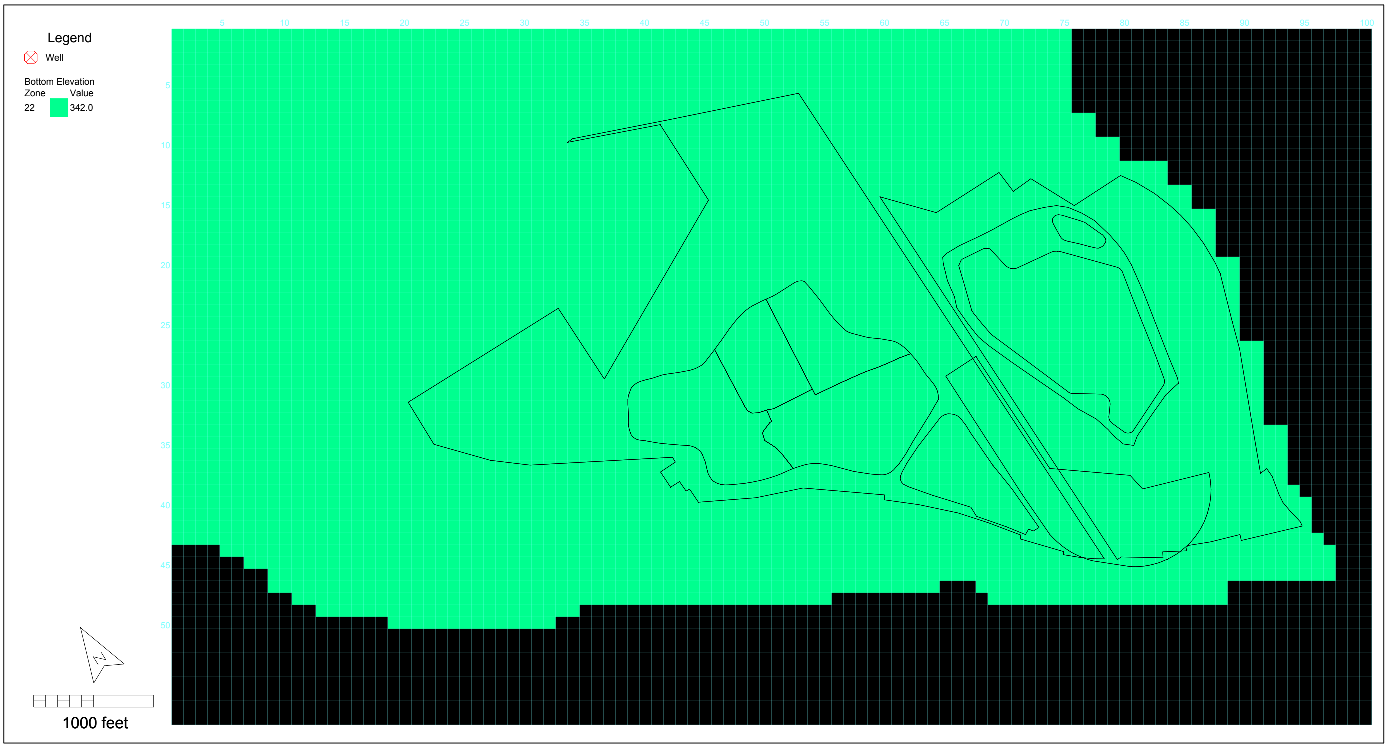


Figure 3-2 (cont'd). Bottom Elevation (feet) Array for Layer 5 (top) and Layer 6 (bottom).



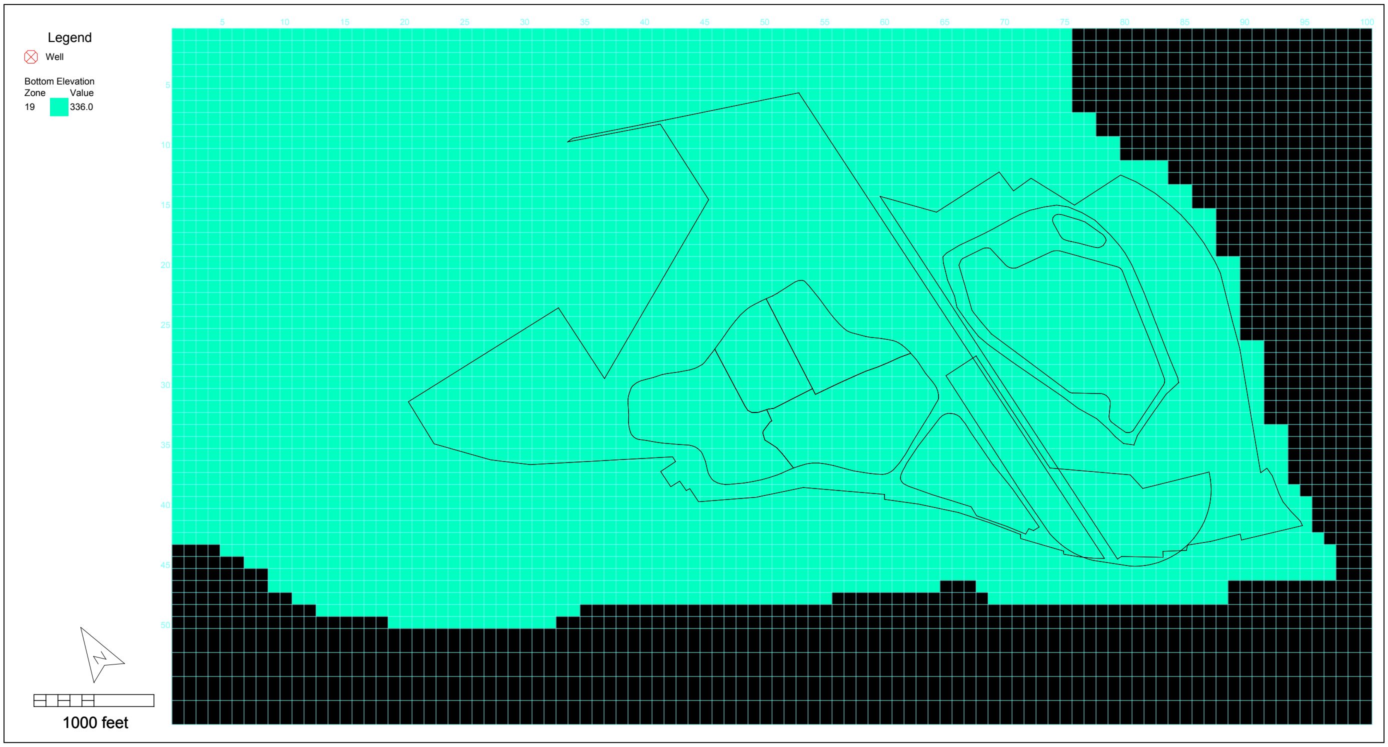


Figure 3-2 (cont'd). Bottom Elevation (feet) Array for Layer 7 (top) and Layer 8 (bottom).

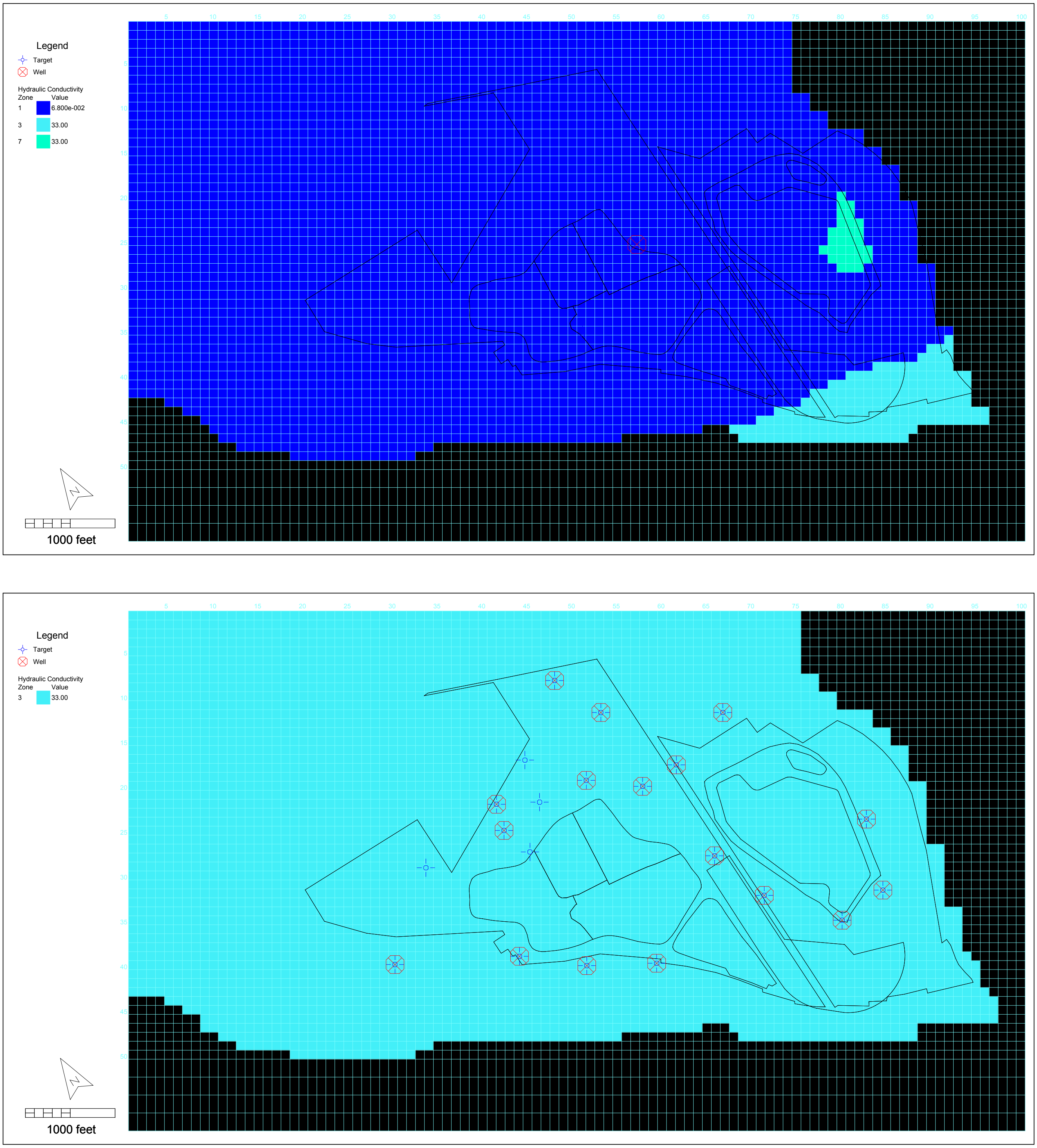


Figure 3-3. Hydraulic Conductivity (ft/day) for Layer 1 (top) and Layer 2 through Layer 3 (bottom).

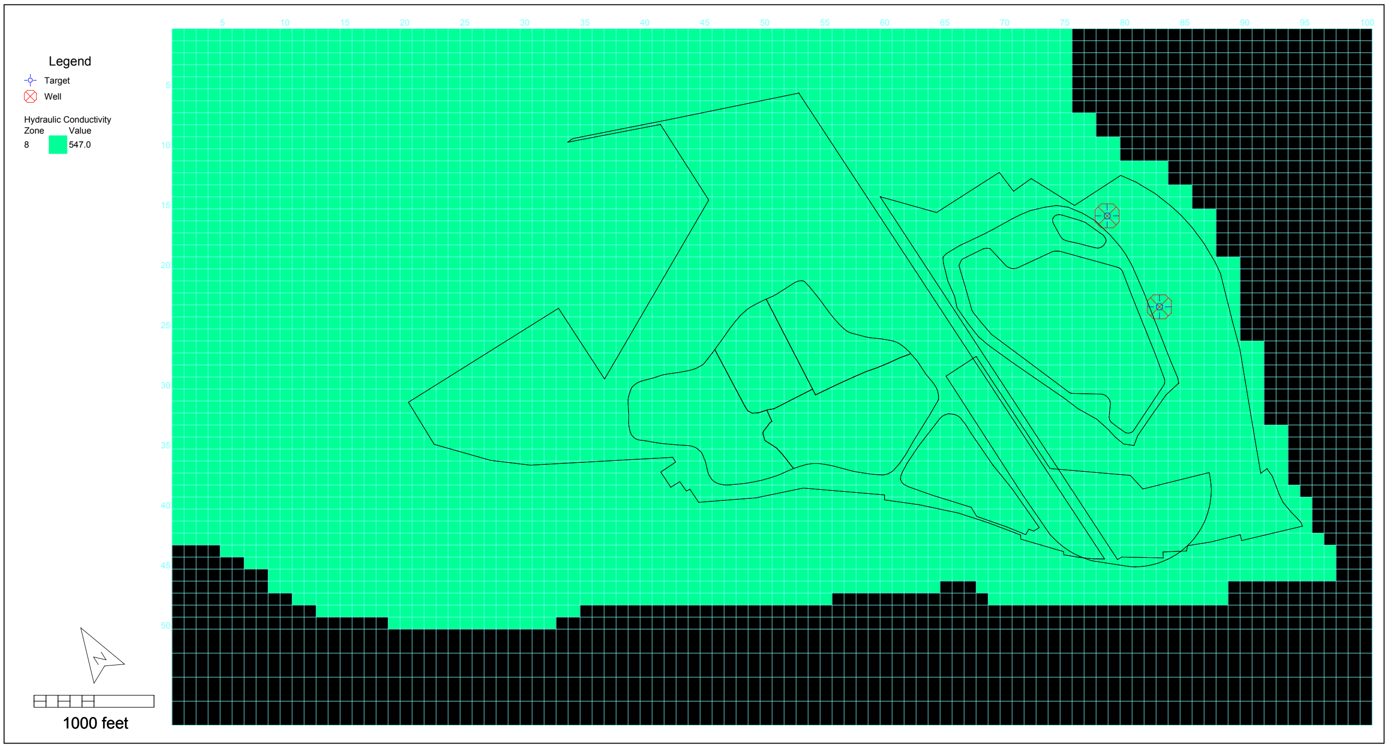


Figure 3-3 (cont'd). Hydraulic Conductivity (ft/day) for Layer 4 through Layer 8.

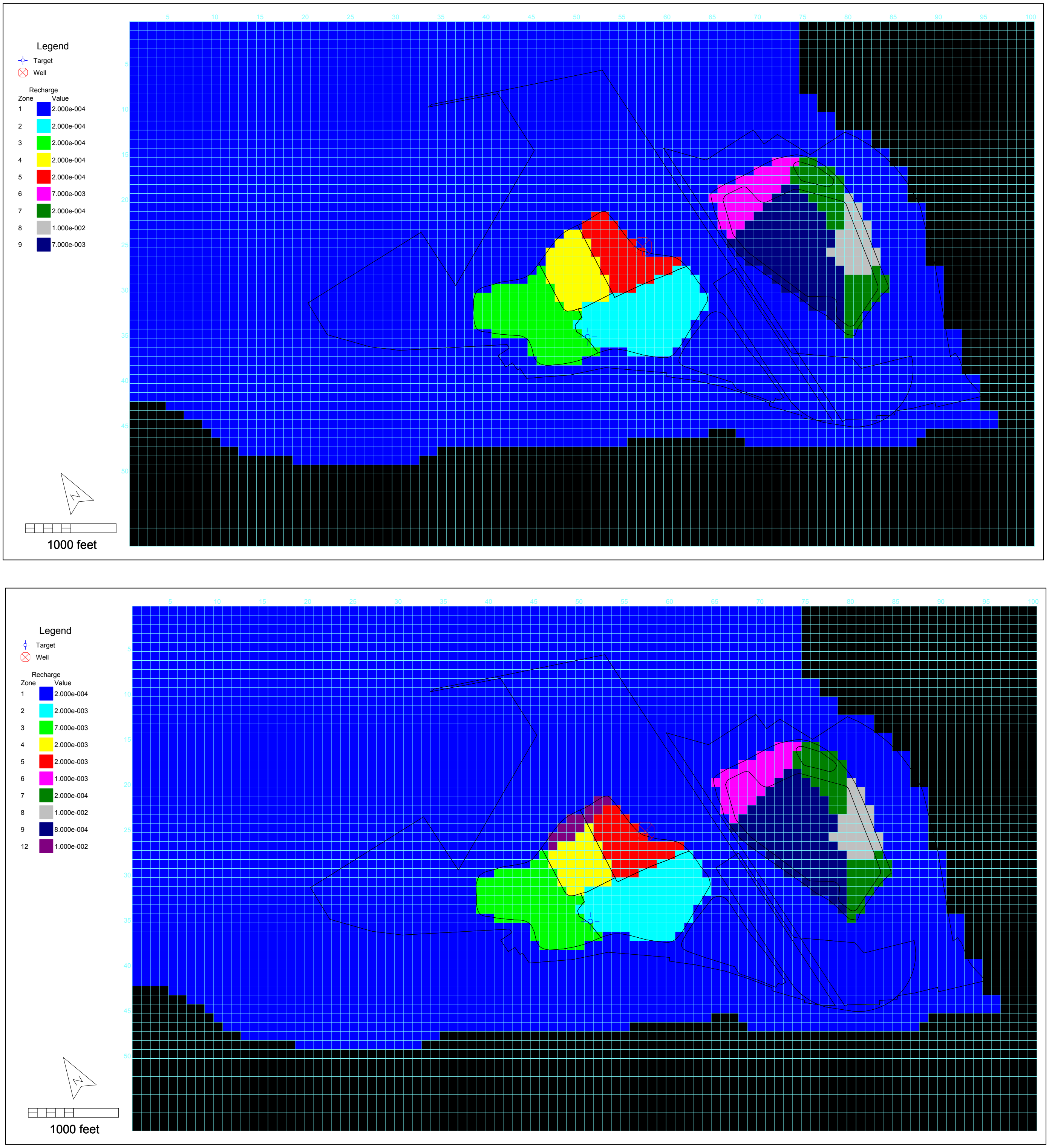


Figure 3-4. Recharge (ft/day) for Layer 1 Calibration Model Stress Periods 1 - 58 (top) and 59 - 98 (bottom).

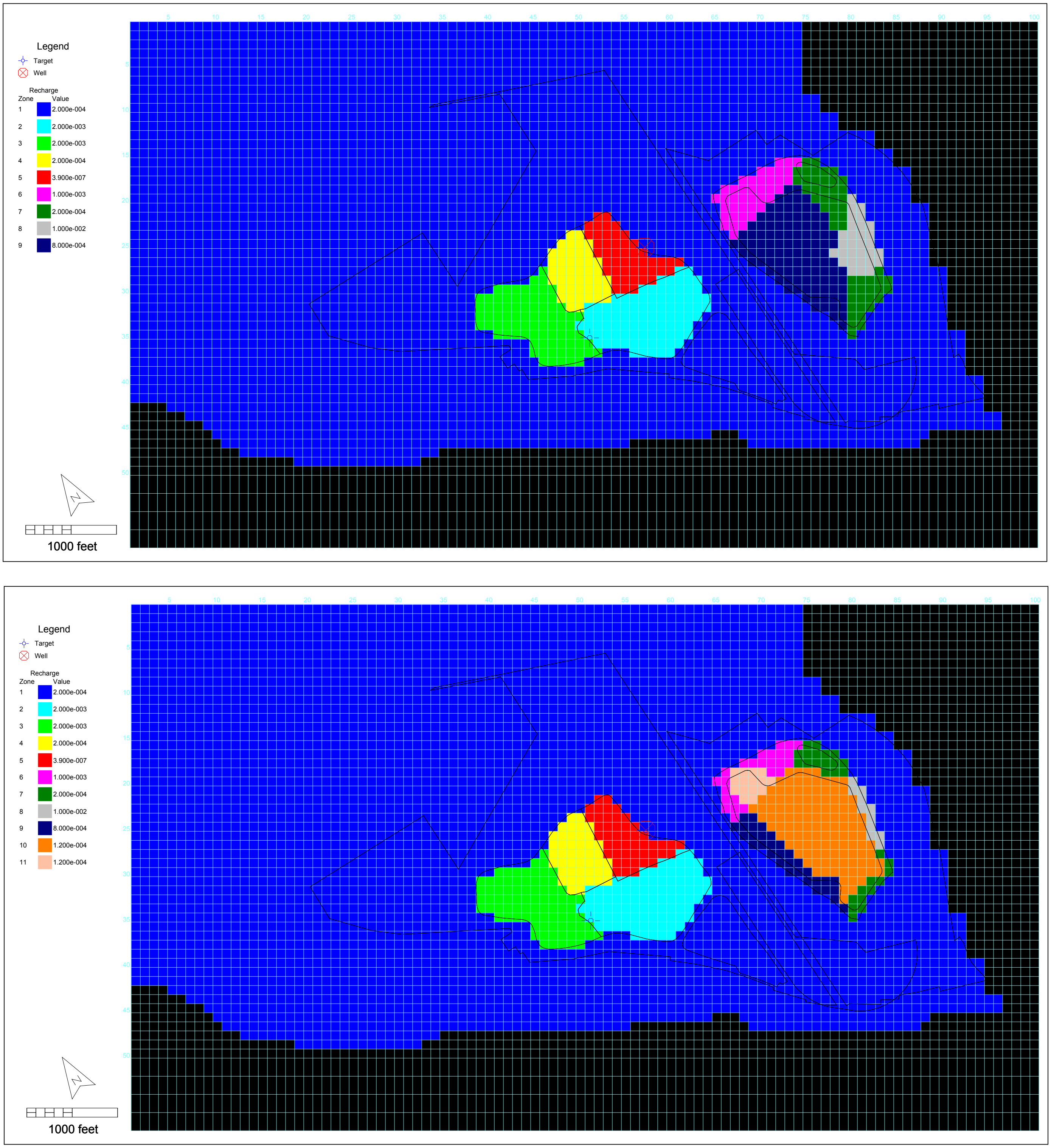


Figure 3-4 (cont'd). Recharge (ft/day) for Layer 1 Calibration Model Stress Periods 99 - 114 (top) and 115 - 122 (bottom).

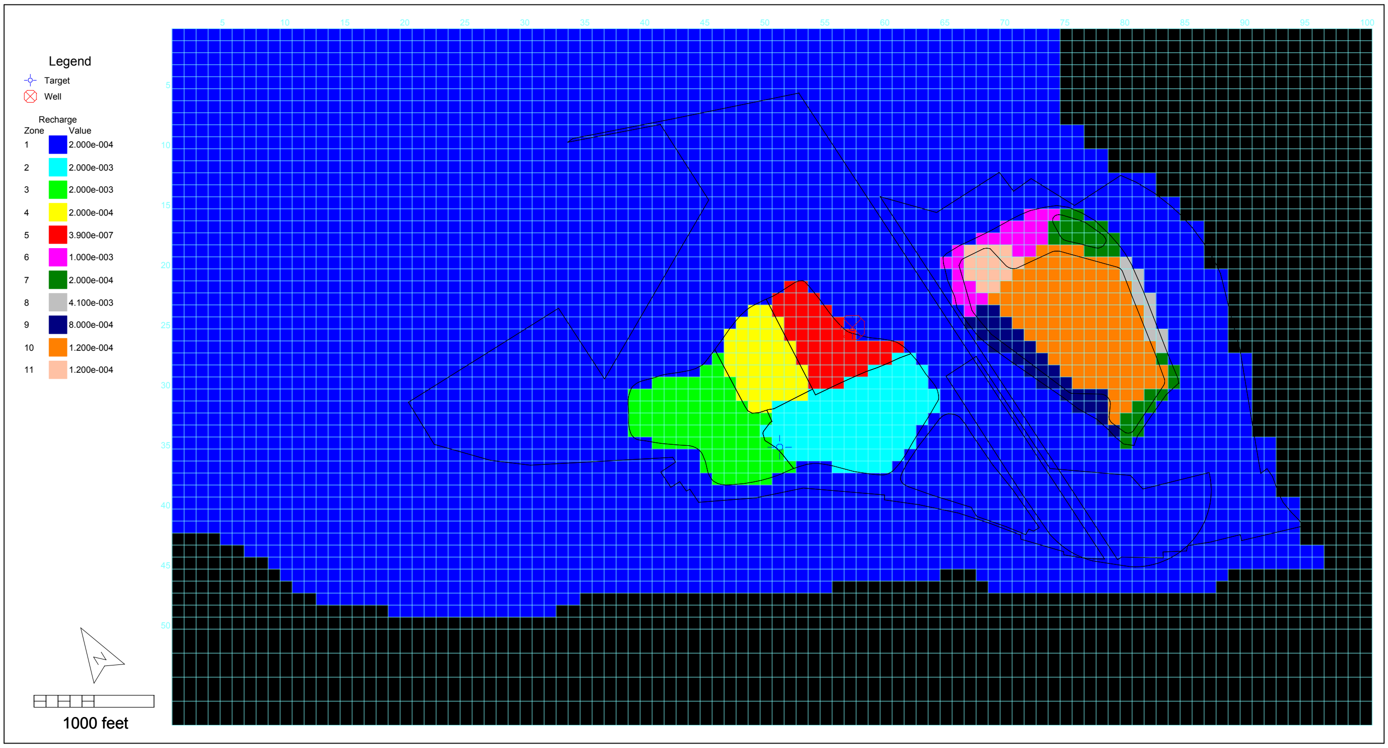


Figure 3-4 (cont'd). Recharge (ft/day) for Layer 1 Calibration Model Stress Periods 123 - 134.