HALEY & ALDRICH, INC.
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Suite 200
Cleveland, OH 44131
216.739.0555

MEMORANDUM

16 October 2016
File No. 128064-003

SUBJECT: Inflow Design Flood Control System Plan
Associated Electric Cooperative, Inc.
Thomas Hill Energy Center – Cell 001
Clifton Hill, Missouri

Haley & Aldrich, Inc. (Haley & Aldrich) has developed this Inflow Design Flood (IDF) Control System Plan (Plan) on behalf of Associated Electric Cooperative, Inc. (AECI) for the existing coal combustion residuals (CCR) surface impoundment referred to as Pond 1 - Cell 001 (Cell 001) at the Thomas Hill Energy Center (THEC) in Clifton Hill, Missouri. This has been completed based on requirements of the Environmental Protection Agency (EPA) 40 CFR Parts 257 and 261, "Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities" (CCR Rule), specifically section §257.82. The Cell 001 existing conditions and supporting documentation has been reviewed and associated stormwater modeling and analysis performed to satisfy the Inflow Design Flood Control System Plan requirements of CCR Rule section §257.82 as described below.

§257.82(a): The owner or operator of an existing or new CCR surface impoundment or any lateral expansion of a CCR surface impoundment must design, construct, operate, and maintain an inflow design flood control system as specified in paragraphs (a)(1) and (a)(2) of this section.

§257.82(a)(1): The inflow design flood control system must adequately manage flow into the CCR unit during and following the peak discharge of the inflow design flood specified in paragraph (a)(3) of this section.

Cell 001 is an existing CCR surface impoundment used for settling and temporary wet storage of bottom ash and boiler slag sluiced from Thomas Hill Units 1 and 2. CCR slurry is pumped from the power plant to the impoundment through two approximate 14-in. diameter pipes which discharge into the southwest corner of the impoundment. Decant water from the impoundment discharges via a rectangular concrete decant structure equipped with 60-inch wide concrete stop logs, and principal spillway via a 30-in. diameter concrete outlet pipe to a drainage channel which discharges into Cell 003.

Hydrologic and hydraulic modeling for this Cell 001 Plan was performed using HydroCAD Stormwater Modeling System, version 10.00-12 (HydroCAD) in conjunction with the appropriate IDF as determined per the Hazard Potential Classification Assessment performed under separate cover.

When Cell 001 is maintained at its normal water surface elevation[1] (WSEL) (El. 739.0), the results of the HydroCAD analysis confirm the IDF control system for Cell 001 adequately manage flow into the impoundment during and following the IDF peak discharge. **Table 1** summarizes the effects of the IDF peak discharge during normal operation of the impoundment. The output from the two HydroCAD model simulations is provided as **Appendix 1**. See **Figure 1** for the Cell 001 existing site plan.

Table 1: HydroCAD Output Summary

Peak flood level (ft)	741.3
Minimum Dike Elevation	744.0
Minimum freeboard (ft)	2.7
Peak inflow (cfs)	68.3

<u>§257.82(a)(2)</u>: The inflow design flood control system must adequately manage flow from the CCR unit to collect and control the peak discharge resulting from the inflow design flood specified in paragraph (a)(3) of this section.

The outlet control structure is detailed in the Burns & McDonnell Ash Grading Plan Area No. 1 dated 06 June 1984 and the GEI Specific Site Assessment for Coal Combustion Waste – Impoundments at Thomas Hill Energy Center dated June 2011. The model also analyzes the downstream discharge channel to assess any apparent tail water effects at the discharge point. Pertinent pages providing the required information have been provided as **Appendix 2**. Based on the HydroCAD analysis, the IDF control system for Cell 001 was determined to adequately manage flow from the impoundment by collecting and controlling the IDF peak discharge. The peak level and resulting freeboard in Cell 001 during the 100-year flood is noted in Table 1 (above). The HydroCAD model simulation output is provided as **Appendix 1**.

<u>§257.82(a)(3):</u> The inflow design flood is:

i. *For a high hazard potential CCR surface impoundment, as determined under § 257.73(a)(2) or § 257.74(a)(2), the probable maximum flood;*
ii. *For a significant hazard potential CCR surface impoundment, as determined under § 257.73(a)(2) or § 257.74(a)(2), the 1,000-year flood;*
iii. *For a low hazard potential CCR surface impoundment, as determined under § 257.73(a)(2) or § 257.74(a)(2), the 100-year flood; or*
    a. *For an incised CCR surface impoundment, the 25-year flood.*

Cell 001 was determined to be a low hazard potential classification. Therefore, the IDF is the 100-year storm. The basis of the determination is discussed in Initial Hazard Potential

[1] AECI is capable of lowering the stop logs and the associated normal water surface elevation.

Classification Assessment, Cell 001 dated October 2016. The 100-year storm characteristics were detailed in the NOAA Atlas 14 Point Precipitation Frequency Estimates: MO dated 27 August 2014 and prepared by the National Weather Service. In addition, since plant process water is pumped into this impoundment, conservatively, the maximum process water flows into the pond from the plant NPDES permit along with the inflow storm event were modeled. The model is set up to start at the normal operating water surface elevation. Pertinent pages providing the required information have been provided as **Appendix 3**.

§257.82(b): Discharge from the CCR unit must be handled in accordance with the surface water requirements under § 257.3–3.

§257.3-3(a): For purposed of section 4004(a) of the Act, a facility shall not cause a discharge of pollutants into waters of the United States that is in violation of the requirements of the National Pollutant Discharge Elimination System (NPDES) under section 402 of the Clean Water Act, as amended.

§257.3-3(b): For purposed of section 4004(a) of the Act, a facility shall not cause a discharge of dredged material or fill material to waters of the United States that is in violation of the requirements under section 404 of the Clean Water Act, as amended.

§257.3-3(c): A facility or practice shall not cause non-point source pollution of waters of the United States that violates applicable legal requirements implementing an areawide or Statewide water quality management plan that has been approved by the Administrator under section 208 of the Clean Water Act, as amended.

Discharge from the Cell 001 is managed through plant National Pollution Discharge Elimination System permit which was prepared by the Missouri Department of Natural Resources. Pertinent pages providing the required information have been provided as **Appendix 4**.

§257.82(c)(1): Content of the plan. The owner or operator must prepare initial and periodic inflow design flood control system plans for the CCR unit according to the timeframes specified in paragraphs (c)(3) and (4) of this section. These plans must document how the inflow design flood control system has been designed and constructed to meet the requirements of this section. Each plan must be supported by appropriate engineering calculations. The owner or operator of the CCR unit has completed the inflow design flood control system plan when the plan has been placed in the facility's operating record as required by § 257.105(g)(4).

This document and all attachments serve as the initial IDF Plan. Periodic inflow design flood control system plans will be prepared and placed in the facility operating record at 5-year increments or whenever there is a change in conditions that would affect the Plan.

§257.82(c)(2): Amendment of the plan. The owner or operator of the CCR unit may amend the written inflow design flood control system plan at any time provided the revised plan is placed in the facility's operating record as required by § 257.105(g)(4). The owner or operator must amend the written inflow design flood control system plan whenever there is a change in conditions that would substantially affect the written plan in effect.

The Inflow Design Flood Control System Plan will be amended at least 60 days prior to a planned change in the operation of the facility or the CCR impoundment, or no later than 60 days after an unanticipated event requires the need to revise the IDF Plan. If the Plan needs to be revised after closure activities have commenced, the Plan will be revised no later than 30 days following the triggering event.

Any amendments to the Plan will include written certification from a qualified professional engineer that the initial and any amendments to the flood control plan meet the requirements of the CCR Rule.

A record of amendments to the Plan will be tracked below. The latest version of the IDF Plan will be noted on the front cover of the Plan.

Version	Date	Description of Changes Made
1	16 October 2016	Initial Issuance

§257.82(c)(3): Timeframes for preparing the initial plan

i. *Existing CCR surface impoundments. The owner or operator of the CCR unit must prepare the initial inflow design flood control system plan no later than October 17, 2016.*

This IDF Plan has been prepared within the specified timeframe.

ii. *New CCR surface impoundments and any lateral expansion of a CCR surface impoundment. The owner or operator must prepare the initial inflow design flood control system plan no later than the date of initial receipt of CCR in the CCR unit.*

Not applicable, Cell 001 is an existing impoundment.

§257.82(c)(4): Frequency for revising the plan. The owner or operator must prepare periodic inflow design flood control system plans required by paragraph (c)(1) of this section every five years. The date of completing the initial plan is the basis for establishing the deadline to complete the first periodic plan. The owner or operator may complete any required plan prior to the required deadline provided the owner or operator places the completed plan into the facility's operating record within a reasonable amount of time. In all cases, the deadline for completing a subsequent plan is based on the date of completing the previous plan. For purposes of this paragraph (c)(4), the owner or operator has completed an inflow design flood control system plan when the plan has been placed in the facility's operating record as required by § 257.105(g)(4).

This IDF Plan or any subsequent IDF Plan will be assessed and amended whenever there is a change in operation of the CCR impoundment that would substantially affect the IDF Plan or when unanticipated events necessitate a revision of the Plan, either before or after closure activities have commenced.

§257.82(c)(5): The owner or operator must obtain a certification from a qualified professional engineer stating that the initial and periodic inflow design flood control system plans meet the requirements of this section.

I certify that the Initial Inflow Design Flood Control System Plan addressed in this document for AECI's Cell 001 surface impoundment at the Thomas Hill Energy Center meets the USEPA's CCR Rule requirements of §257.82.

Signed:________________________________
Certifying Engineer

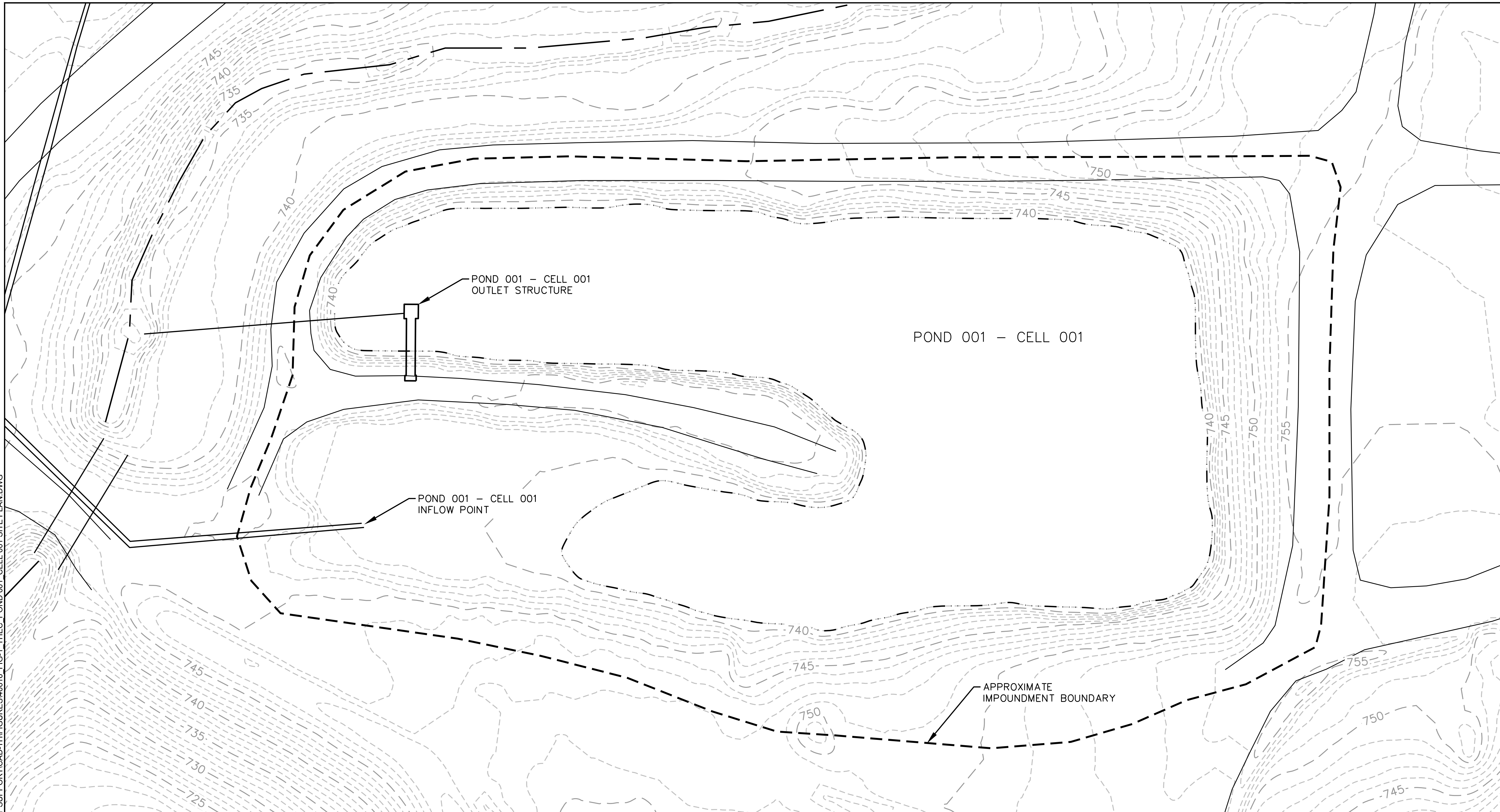
Print Name: Steven F. Putrich
Missouri License No.: 2014035813
Title: Project Principal
Company: Haley & Aldrich, Inc.

Professional Engineer's Seal:

STATE OF MISSOURI
STEVEN F. PUTRICH
NUMBER
PE-2014035813
10-16-16
PROFESSIONAL ENGINEER

Cc: Kim Dickerson-AECI; Jason Pokorny-Haley & Aldrich

HALEY ALDRICH



LEGEND

- - - - -	EXISTING MINOR CONTOUR
—745—	EXISTING MAJOR CONTOUR
— — —	APPROXIMATE IMPOUNDMENT BOUNDARY
———	PIPE
———	DITCH
———	ROAD
- · · -	WATER

NOTES

1. EXISTING TOPOGRAPHY FROM ASSOCIATED ELECTRIC COOPERATIVE, INC. DATED AUGUST 2016. HORIZONTAL IS BASED ON NAD83 ZONE 15N. VERTICAL CONTROL IS BASED ON NAVD88.

N

0 50 100

SCALE IN FEET

HALEY ALDRICH

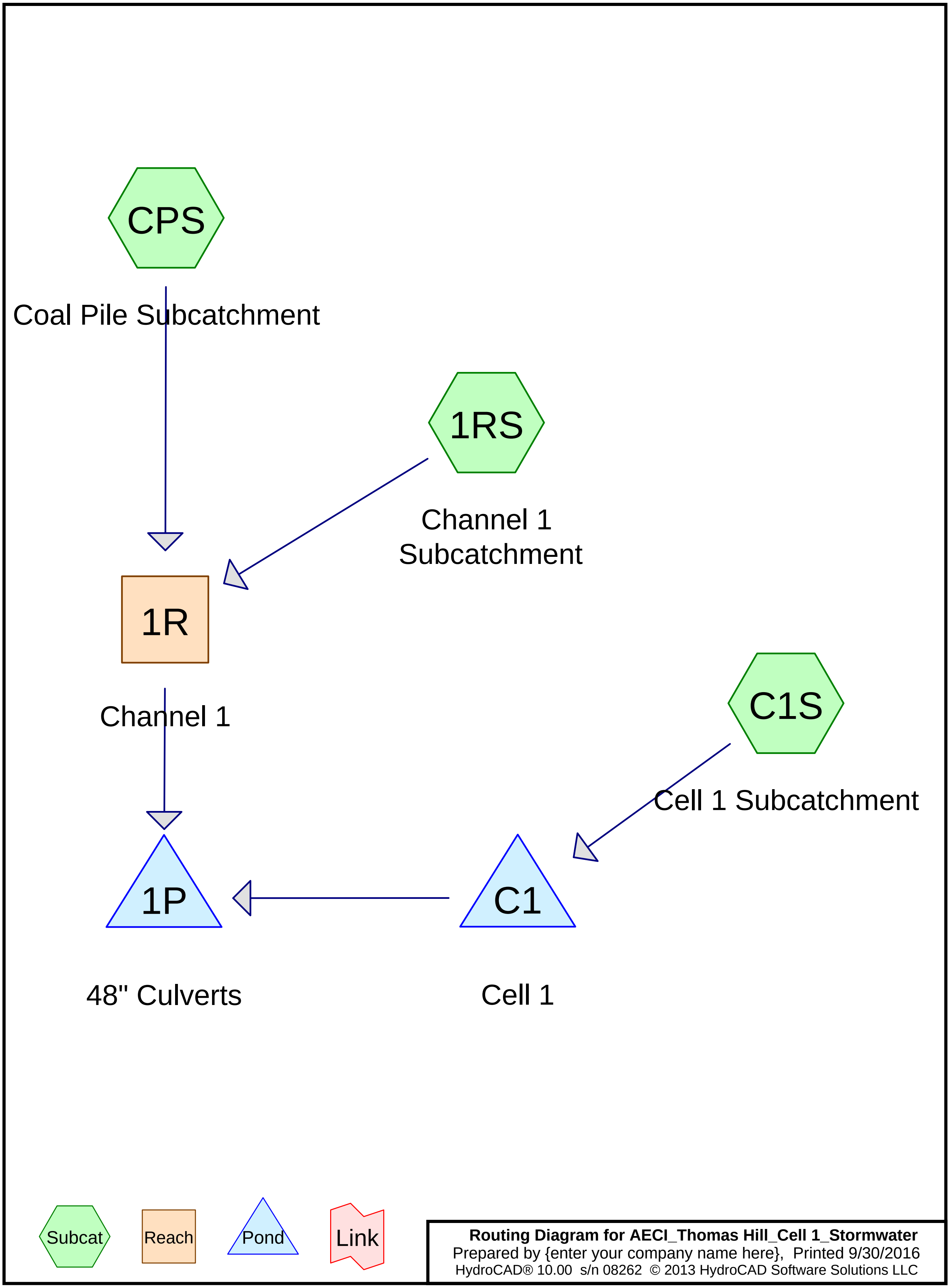
ASSOCIATED ELECTRIC COOPERATIVE, INC.
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

POND 001 - CELL 001
SITE PLAN

SCALE: AS SHOWN
OCTOBER 2016

FIGURE 1

Appendix 1


CPS
Coal Pile Subcatchment
1RS
Channel 1
Subcatchment
1R
Channel 1
C1S
Cell 1 Subcatchment
1P
48" Culverts
C1
Cell 1
Subcat
Reach
Pond
Link
Routing Diagram for AECI_Thomas Hill_Cell 1_Stormwater
Prepared by {enter your company name here}, Printed 9/30/2016
HydroCAD® 10.00 s/n 08262 © 2013 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
6.889	84	50-75% Grass cover, Fair, HSG D (1RS, C1S)
67.122	93	Urban industrial, 72% imp, HSG D (CPS)
1.506	98	Water Surface, HSG A (C1S)
75.517	**92**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
1.506	HSG A	C1S
0.000	HSG B	
0.000	HSG C	
74.011	HSG D	1RS, C1S, CPS
0.000	Other	
75.517		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	6.889	0.000	6.889	50-75% Grass cover, Fair	1RS, C1S
0.000	0.000	0.000	67.122	0.000	67.122	Urban industrial, 72% imp	CPS
1.506	0.000	0.000	0.000	0.000	1.506	Water Surface	C1S
1.506	**0.000**	**0.000**	**74.011**	**0.000**	**75.517**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	1P	734.00	733.00	100.0	0.0100	0.012	48.0	0.0	0.0
2	C1	733.50	732.16	134.0	0.0100	0.011	30.0	0.0	0.0

Time span=0.00-144.00 hrs, dt=0.01 hrs, 14401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Sim-Route method - Pond routing by Sim-Route method

Subcatchment 1RS: Channel 1 Runoff Area=3.169 ac 0.00% Impervious Runoff Depth=6.02"
Flow Length=331' Tc=10.7 min CN=84 Runoff=27.36 cfs 1.589 af

Subcatchment C1S: Cell 1 Subcatchment Runoff Area=5.226 ac 28.82% Impervious Runoff Depth=6.49"
Flow Length=228' Tc=9.5 min CN=88 Runoff=49.31 cfs 2.826 af

Subcatchment CPS: Coal Pile Runoff Area=67.122 ac 72.00% Impervious Runoff Depth=7.08"
Tc=10.0 min CN=93 Runoff=653.22 cfs 39.620 af

Reach 1R: Channel 1 Avg. Flow Depth=5.28' Max Vel=8.10 fps Inflow=680.43 cfs 41.210 af
n=0.025 L=550.0' S=0.0055 '/' Capacity=952.16 cfs Outflow=678.10 cfs 41.210 af

Pond 1P: 48" Culverts Peak Elev=743.73' Storage=6.467 af Inflow=702.10 cfs 553.111 af
48.0" Round Culvert x 2.00 n=0.012 L=100.0' S=0.0100 '/' Outflow=410.80 cfs 552.976 af

Pond C1: Cell 1 Peak Elev=741.27' Storage=4.049 af Inflow=68.25 cfs 228.228 af
Outflow=47.74 cfs 226.297 af

Total Runoff Area = 75.517 ac Runoff Volume = 44.036 af Average Runoff Depth = 7.00"
34.01% Pervious = 25.683 ac 65.99% Impervious = 49.834 ac

Summary for Subcatchment 1RS: Channel 1 Subcatchment

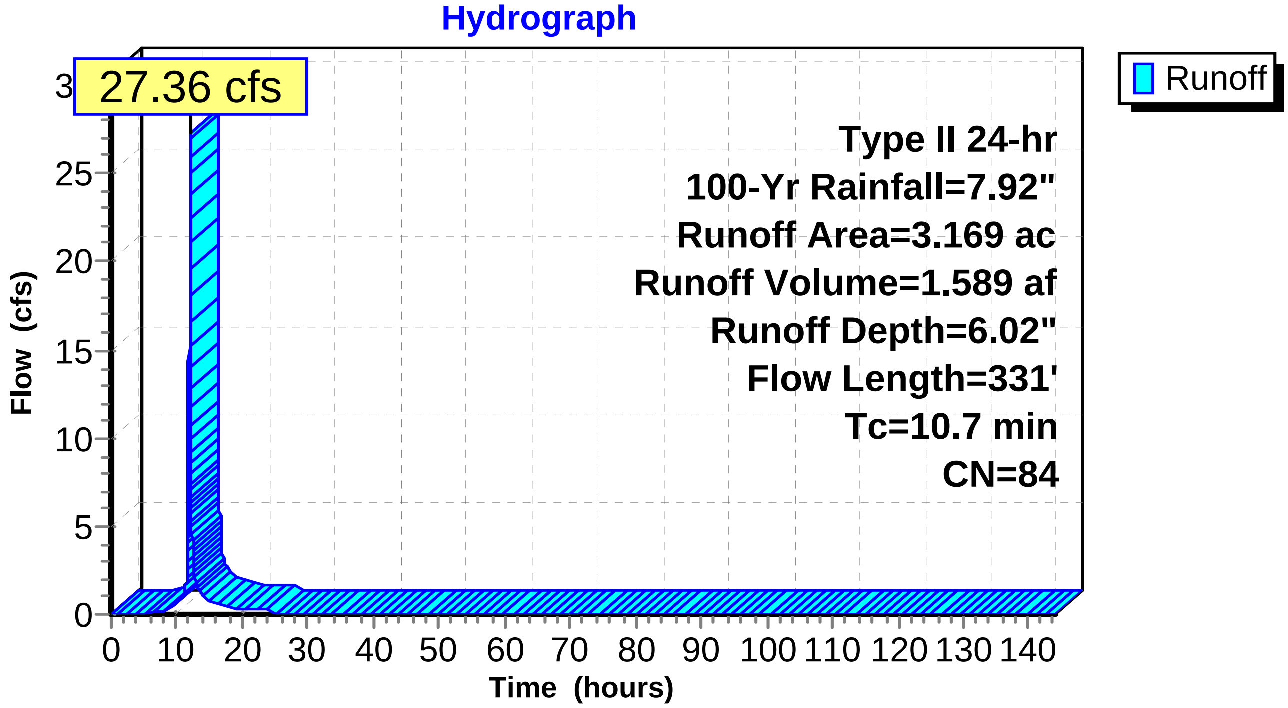
Runoff = 27.36 cfs @ 12.02 hrs, Volume= 1.589 af, Depth= 6.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-144.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Yr Rainfall=7.92"

Area (ac)	CN	Description
3.169	84	50-75% Grass cover, Fair, HSG D
3.169		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.7	100	0.0360	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.56"
2.0	231	0.0753	1.92		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
10.7	331	Total			

Subcatchment 1RS: Channel 1 Subcatchment



Summary for Subcatchment C1S: Cell 1 Subcatchment

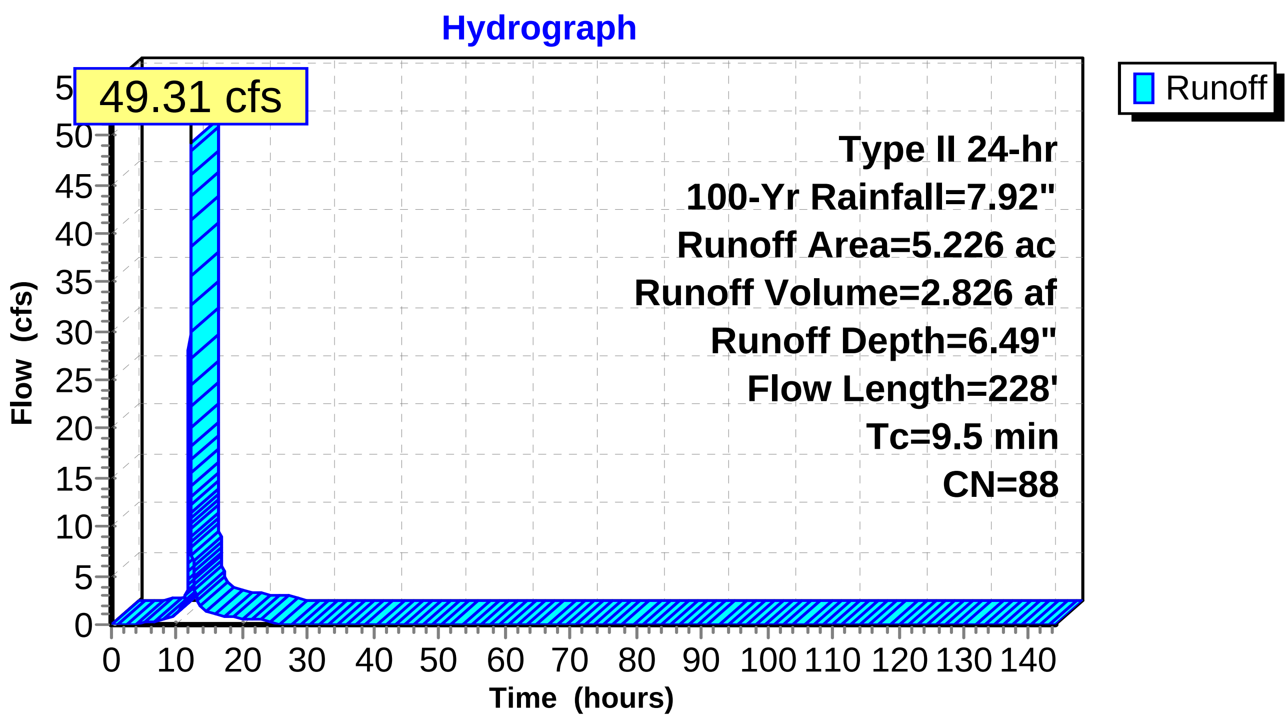
Runoff = 49.31 cfs @ 12.01 hrs, Volume= 2.826 af, Depth= 6.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-144.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Yr Rainfall=7.92"

Area (ac)	CN	Description
1.506	98	Water Surface, HSG A
3.720	84	50-75% Grass cover, Fair, HSG D
5.226	88	Weighted Average
3.720		71.18% Pervious Area
1.506		28.82% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.3	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.56"
1.2	128	0.0625	1.75		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.5	228	Total			

Subcatchment C1S: Cell 1 Subcatchment



Summary for Subcatchment CPS: Coal Pile Subcatchment

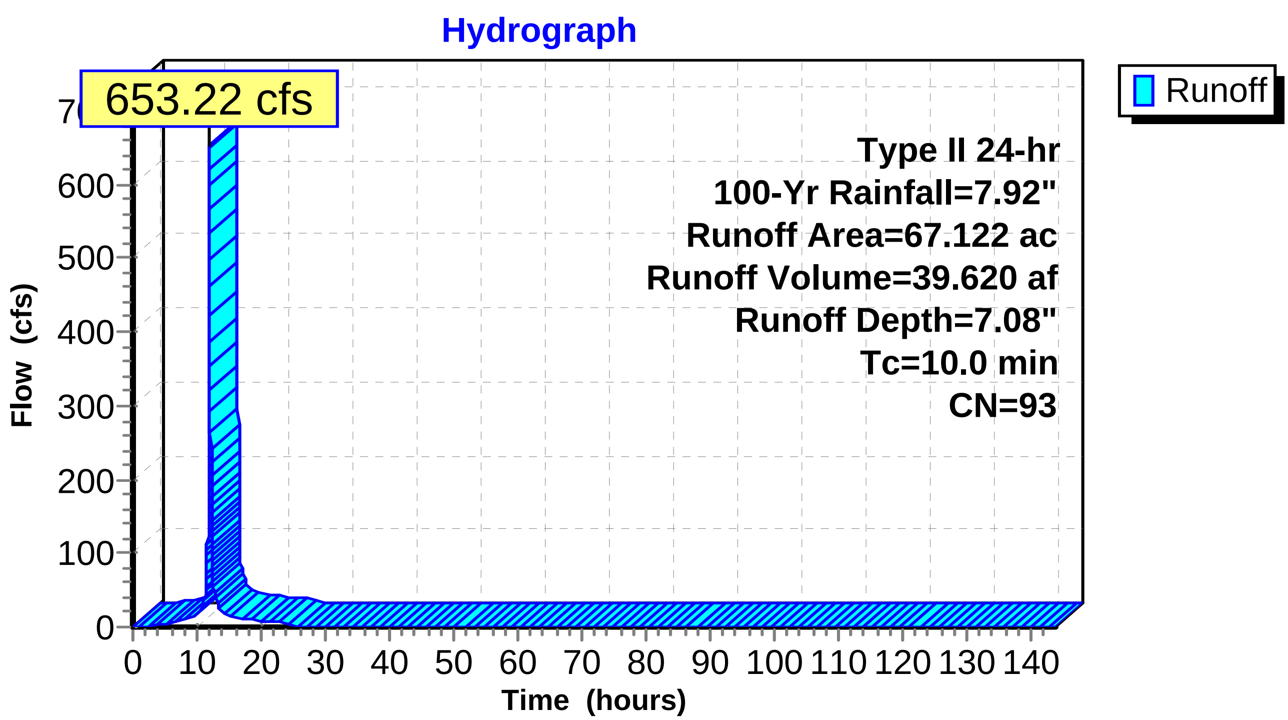
Runoff = 653.22 cfs @ 12.01 hrs, Volume= 39.620 af, Depth= 7.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-144.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Yr Rainfall=7.92"

Area (ac)	CN	Description
67.122	93	Urban industrial, 72% imp, HSG D
18.794		28.00% Pervious Area
48.328		72.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry,**

Subcatchment CPS: Coal Pile Subcatchment



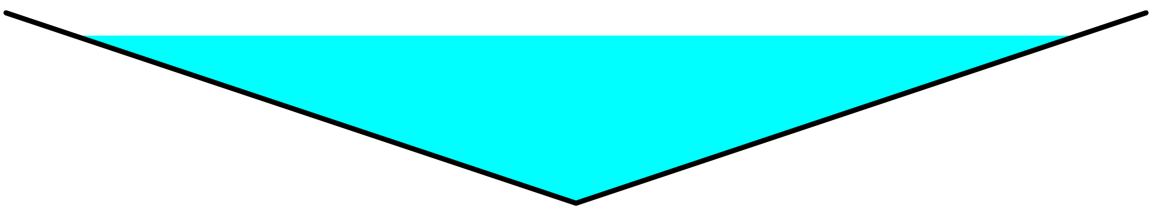
Summary for Reach 1R: Channel 1

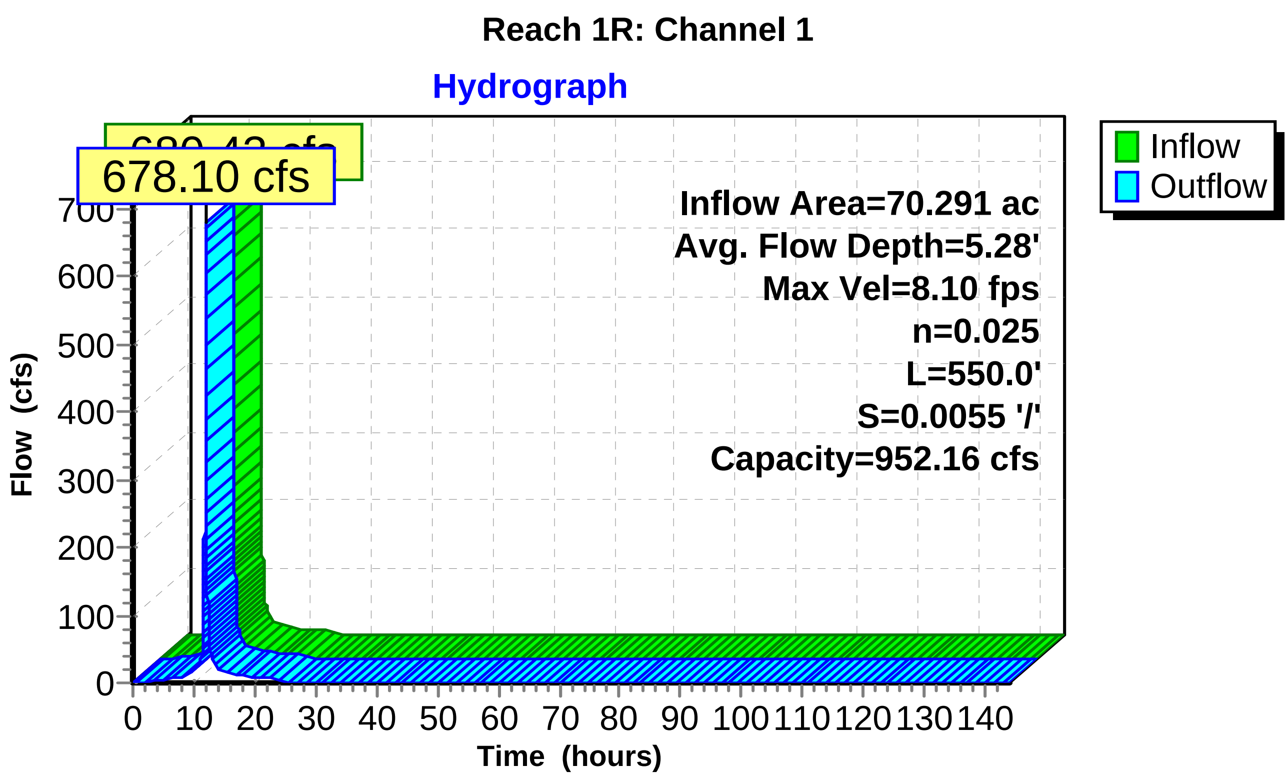
Inflow Area = 70.291 ac, 68.75% Impervious, Inflow Depth = 7.04" for 100-Yr event
Inflow = 680.43 cfs @ 12.01 hrs, Volume= 41.210 af
Outflow = 678.10 cfs @ 12.02 hrs, Volume= 41.210 af, Atten= 0%, Lag= 0.8 min

Routing by Sim-Route method, Time Span= 0.00-144.00 hrs, dt= 0.01 hrs
Max. Velocity= 8.10 fps, Min. Travel Time= 1.1 min
Avg. Velocity = 1.97 fps, Avg. Travel Time= 4.7 min

Peak Storage= 46,049 cf @ 12.02 hrs
Average Depth at Peak Storage= 5.28'
Bank-Full Depth= 6.00' Flow Area= 108.0 sf, Capacity= 952.16 cfs

0.00' x 6.00' deep channel, n= 0.025 Earth, clean & winding
Side Slope Z-value= 3.0 '/' Top Width= 36.00'
Length= 550.0' Slope= 0.0055 '/'
Inlet Invert= 737.00', Outlet Invert= 734.00'





Summary for Pond 1P: 48" Culverts

Dual 48" culverts per Gredell Engineering Cell 2 West Basin drawing (11/2015). Invert elevations per topo.

[63] Warning: Exceeded Reach 1R INLET depth by 2.96' @ 12.20 hrs
[80] Warning: Exceeded Pond C1 by 2.80' @ 12.13 hrs (46.76 cfs 1.199 af)

Inflow Area = 75.517 ac, 65.99% Impervious, Inflow Depth > 87.89" for 100-Yr event
Inflow = 702.10 cfs @ 12.02 hrs, Volume= 553.111 af, Incl. 24.00 cfs Base Flow
Outflow = 410.80 cfs @ 12.14 hrs, Volume= 552.976 af, Atten= 41%, Lag= 6.7 min
Primary = 410.80 cfs @ 12.14 hrs, Volume= 552.976 af

Routing by Sim-Route method, Time Span= 0.00-144.00 hrs, dt= 0.01 hrs
Peak Elev= 743.73' @ 12.14 hrs Surf.Area= 1.426 ac Storage= 6.467 af

Plug-Flow detention time= 3.1 min calculated for 552.976 af (100% of inflow)
Center-of-Mass det. time= 1.9 min (4,054.4 - 4,052.5)

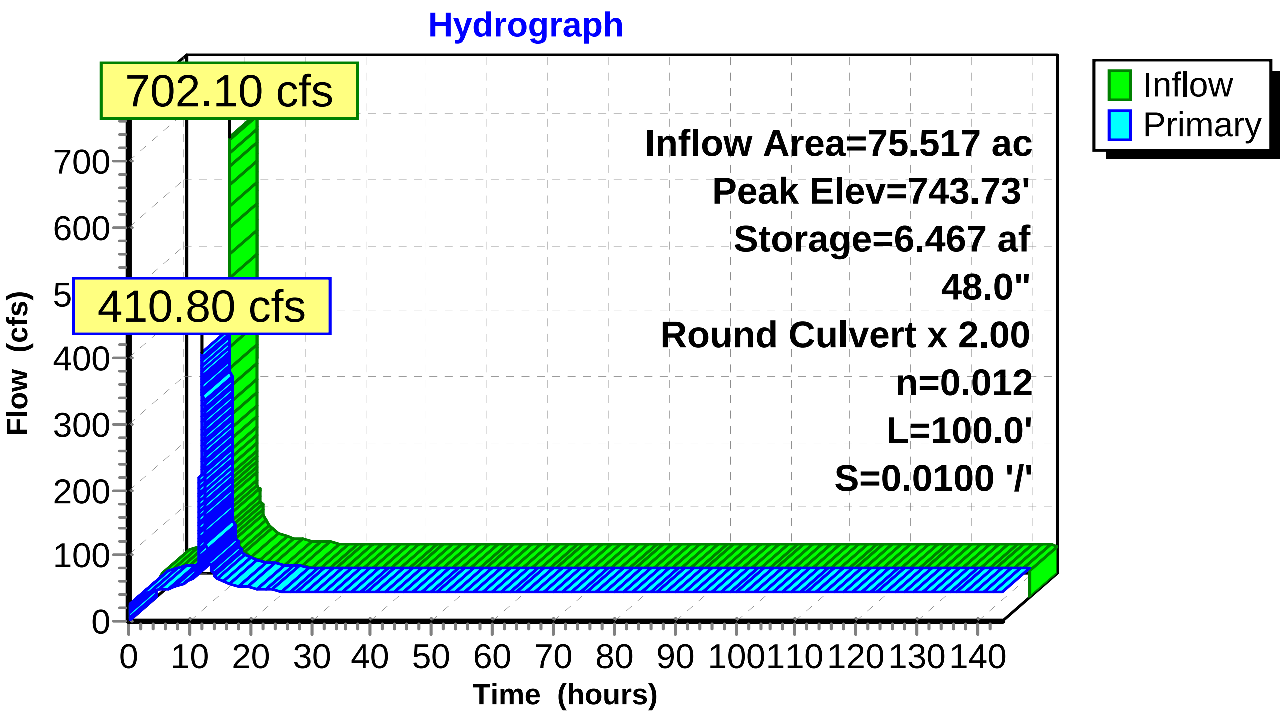
Volume	Invert	Avail.Storage	Storage Description
#1	732.00'	6.861 af	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
732.00	0.002	0.000	0.000
733.00	0.008	0.005	0.005
734.00	0.041	0.024	0.029
735.00	0.098	0.069	0.099
736.00	0.179	0.138	0.237
737.00	0.308	0.244	0.481
738.00	0.427	0.367	0.849
739.00	0.657	0.542	1.390
740.00	0.865	0.761	2.151
741.00	1.037	0.951	3.102
742.00	1.183	1.110	4.212
743.00	1.326	1.255	5.467
744.00	1.463	1.394	6.861

Device	Routing	Invert	Outlet Devices
#1	Primary	734.00'	**48.0" Round Culvert X 2.00** L= 100.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 734.00' / 733.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 12.57 sf

Primary OutFlow Max=410.73 cfs @ 12.14 hrs HW=743.72' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 410.73 cfs @ 16.34 fps)

Pond 1P: 48" Culverts



Summary for Pond C1: Cell 1

Weir length and outlet pipe diameter per GEI Specific Site Assessment for CCW Impoundments at THEC (6/2011).

Weir overflow elevation based on water level at time of survey.

Pipe length, material, downstream invert, and slope per Burns & McDonnell Ash Pond Modifications Drawing Y2 (6/4/1984).

Inflow Area = 5.226 ac, 28.82% Impervious, Inflow Depth >524.06" for 100-Yr event
Inflow = 68.25 cfs @ 12.01 hrs, Volume= 228.228 af, Incl. 18.94 cfs Base Flow
Outflow = 47.74 cfs @ 12.59 hrs, Volume= 226.297 af, Atten= 30%, Lag= 35.2 min
Primary = 47.74 cfs @ 12.59 hrs, Volume= 226.297 af

Routing by Sim-Route method, Time Span= 0.00-144.00 hrs, dt= 0.01 hrs
Peak Elev= 741.27' @ 12.42 hrs Surf.Area= 1.951 ac Storage= 4.049 af

Plug-Flow detention time= 74.5 min calculated for 226.297 af (99% of inflow)
Center-of-Mass det. time= 37.6 min (4,313.5 - 4,275.9)

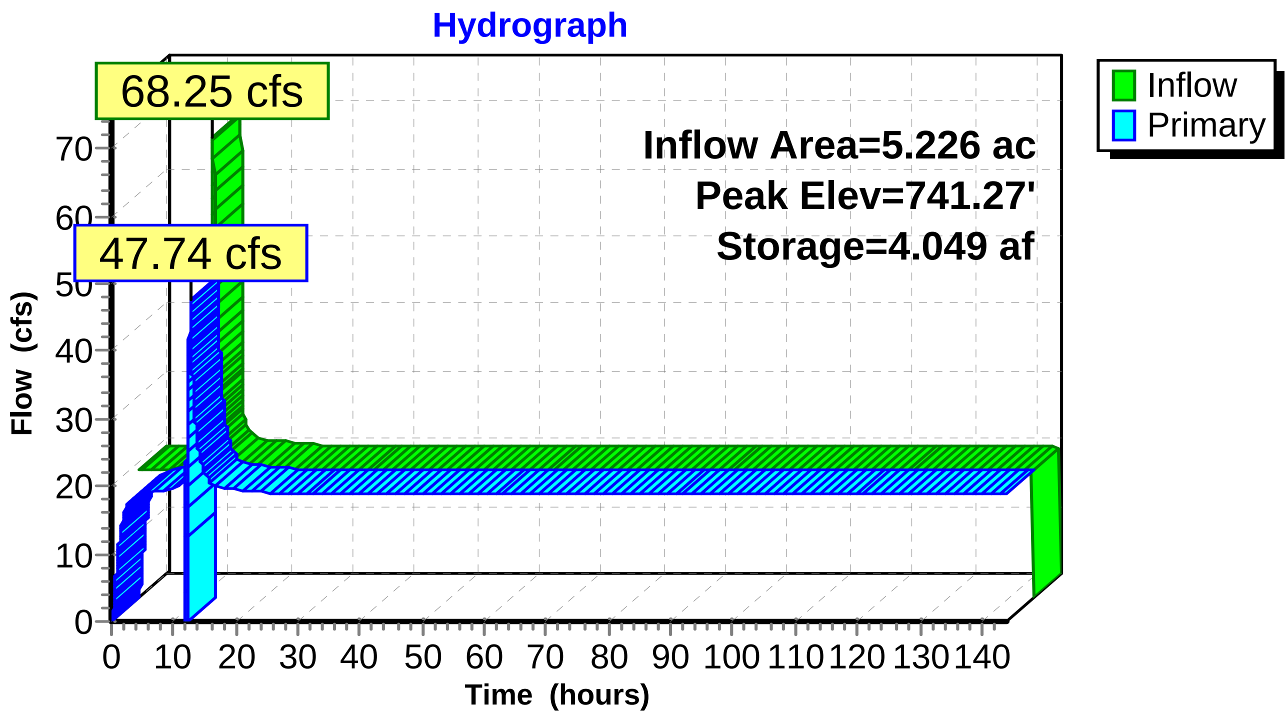
Volume	Invert	Avail.Storage	Storage Description
#1	739.00'	9.760 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
739.00	1.709	0.000	0.000
740.00	1.709	1.709	1.709
741.00	1.926	1.817	3.526
742.00	2.020	1.973	5.499
743.00	2.121	2.070	7.570
744.00	2.259	2.190	9.760

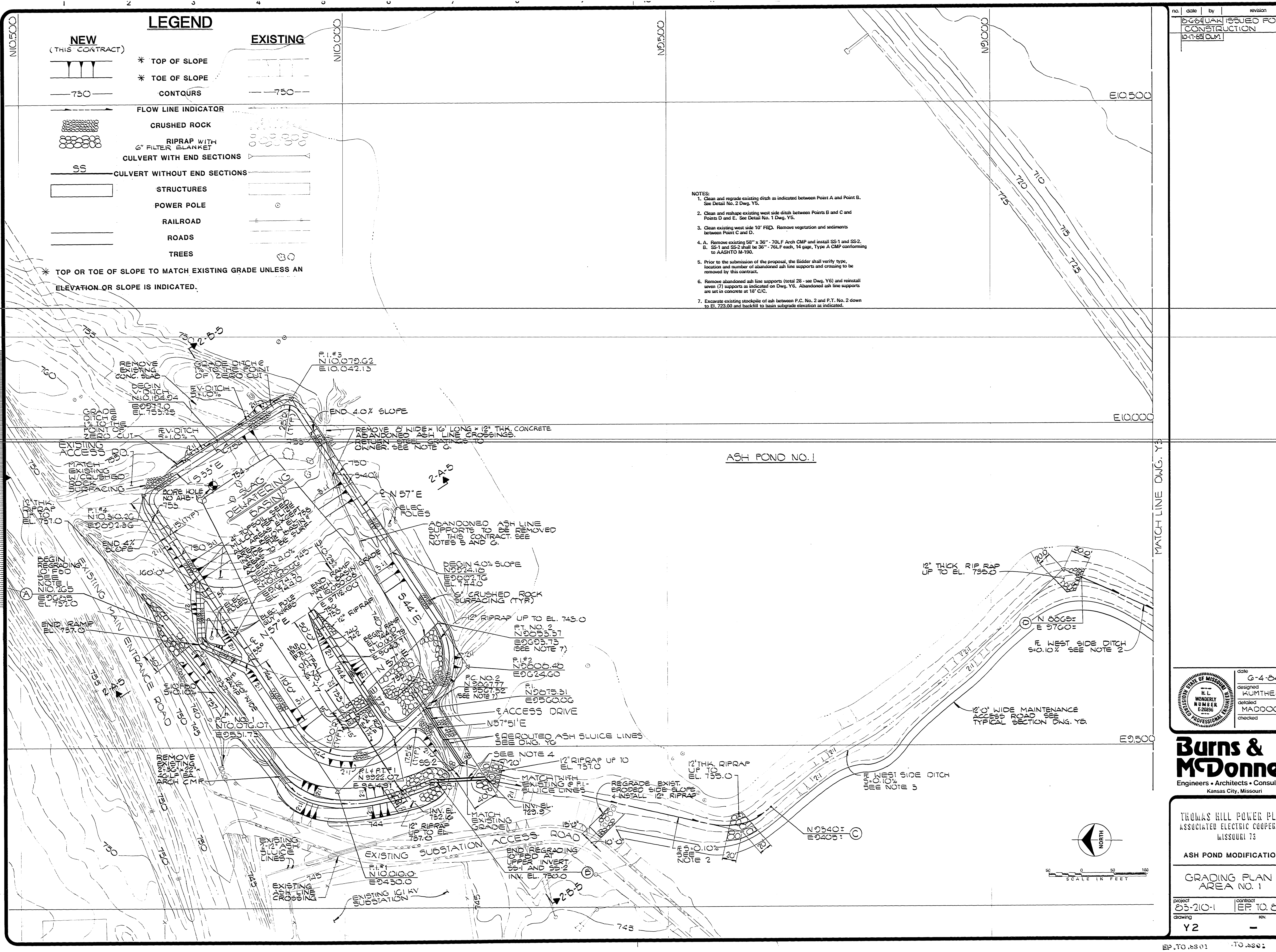
Device	Routing	Invert	Outlet Devices
#1	Primary	733.50'	**30.0" Round Culvert** L= 134.0' RCP, rounded edge headwall, Ke= 0.100 Inlet / Outlet Invert= 733.50' / 732.16' S= 0.0100 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 4.91 sf
#2	Device 1	739.00'	**5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=47.69 cfs @ 12.59 hrs HW=741.17' TW=738.07' (Dynamic Tailwater)
└─**1=Culvert** (Passes 47.69 cfs of 49.17 cfs potential flow)
  └─**2=Sharp-Crested Rectangular Weir** (Weir Controls 47.69 cfs @ 4.82 fps)

Pond C1: Cell 1



Appendix 2



EP.TO.8301 .TO.8301

GEI Consultants

Geotechnical
Environmental
Resources
Ecological

Specific Site Assessment for Coal Combustion Waste Impoundments at Thomas Hill Energy Center

Clifton Hill, Missouri

Submitted to:
U.S. Environmental Protection Agency
Office of Resource Conservation and Recovery
5304P
1200 Pennsylvania Avenue NW
Washington, DC 20460

Submitted by:
GEI Consultants, Inc.
4601 DTC Blvd, Suite 900
Denver, CO 80237

June 2011
Project Number: 092884

Steven R. Townsley, P.E.
Senior Project Engineer

The materials stored in each of the CCW impoundment dikes are summarized below:

- Slag Dewatering Basin – This basin is a wet storage area that is used to contain both bottom ash and boiler slag. The ash and slag is continuously dredged and is sold to a private contractor who uses the material as roofing granules.
- Ash Pond – Cell No. 2 – This cell is a wet storage that is used to contain fly ash, bottom ash, boiler slag, and sediments from the coal pile runoff. The fly ash is collected and used as part of the mine reclamation activities on the power plant property.

Based on our observation and the soil boring information presented in the Global Stability Evaluation report prepared by Geotechnology, Inc. in May of 2010, the CCW impoundment dikes appear to have homogeneous construction using silty clayey fill soils. The dikes were designed without internal drains from the collection of seepage.

The dike for the Slag Dewatering Basin has an approximate crest width of 10 feet and design upstream and downstream side slopes of 3H:1V and 2H:1V, respectively. The perimeter dike for Ash Pond – Cell No. 2 has an approximate crest width of 18 feet and design upstream and downstream side slopes of 3H:1V.

The basic dimensions and geometry of each impoundment is summarized in Table 2-1.

Table 2-1: Summary Information for Impoundment Dike Parameters

Parameter	Value	
Dam	Slag Dewatering Basin	Ash Pond – Cell No. 2
Maximum Height (ft)	Approximately 10	25
Approximate Length (ft)	1,500	830
Approximate Crest Width (ft)	15	18
Lowest Crest Elevation (ft)	735	717
Design Side Slopes (H:V)	3:1 US/2:1 DS	3:1 US/3:1 DS
Estimated Freeboard (ft) at time of site visit	2.7	4
Total Storage Capacity (cubic yards)*	16,000	50,000
Approximate Surface Area (acres)*	3	12

*Storage capacity and area values provided by Associated Electric Cooperative, Inc.

2.3 Spillways

The Ash Pond – Cell No. 2 Impoundment has an emergency spillway (Photo 16) which, if utilized, would flow into Ash Pond – Cell No. 3. The emergency spillway is an Open Channel Spillway, trapezoidal in shape, with a top width of approximately 18 feet, an average bottom width of 12 feet, and a depth of 2 feet below the top of the dike crest. The emergency spillway crest is lined with 3- to 6-inch crushed rock.

The Slag Dewatering Pond does not have a spillway associated with the impoundment.

2.4 Intakes and Outlet Works

2.4.1 Slag Dewatering Basin

The coal ash slurry line at the Slag Dewatering Basin consists of an 18-inch steel pipe from the power plant. Photos 1 and 2 in Appendix B show the inlet structure to the Slag Dewatering Basin.

The outlet structure (Photos 3 and 7) consists of a 30-inch diameter concrete outlet pipe from the concrete decant tower with 60-inch wide, 6-inch square concrete stop logs. The outlet structure releases the decant water into a bypass channel (Photo 4) which bypasses Ash Pond – Cell No. 1 and discharges into the Ash Pond – Cell No. 2 (Photos 8 and 9). At the time of our visit to the site, there was active flow through the outlet structure.

2.4.2 Ash Pond – Cell No. 2

Decant water is received from the Slag Dewatering Basin through a bypass channel (Photos 8 and 9) and from a concrete decant tower with 60-inch wide, 6-inch square concrete stop logs in the Ash Pond – Cell No. 1. This decant water is collected from natural runoff around Ash Pond – Cell No. 1.

The outlet structure (Photo 12) consists of a 36-inch diameter concrete outlet pipe from the concrete decant tower with 72-inch wide, 6-inch square concrete stop logs. At the time of our visit to the site, there was active flow through the outlet structure into Ash Pond – Cell No. 3. Ash Pond – Cell No. 3 contains only decant water prior to its release to the Middle Fork of the Little Chariton River.

2.5 Vicinity Map

Thomas Hill Energy Center is located in the town of Clifton Hill in Randolph County, Missouri, as shown on Figure 1. The specific latitude and longitude of the ponds is provided below:

Longitude: 92 Degrees, 38 Minutes, 17 Seconds
Latitude: 39 Degrees, 32 Minutes, 34 Seconds

2.6 Plan and Sectional Drawings

GEI was provided with two partial sets of design documents for this project and a geotechnical engineering report. These documents included:

- Engineering drawings for the "Ash Pond Facilities" project in 1978-79. These plans were prepared by Burns and McDonnell dated December 1, 1978 and March 23, 1979.

8.0 Field Assessment

8.1 General

A site visit to assess the condition of the Slag Dewatering Basin and Ash Pond – Cell No. 2 impoundments at the Thomas Hill Energy Center was performed on November 9, 2010, by Steven R. Townsley, P.E. and William Butler, P.E., of GEI; and Kim Dickerson, CHMM and David White, R.G. with Associated Electric Cooperative, Inc. who assisted in the assessment.

The weather during the site visit (November 9, 2010) was partly cloudy with temperatures around 50 degrees Fahrenheit and windy. The majority of the ground was dry at the time of the site visit. The last "significant" rainfall event at this site occurred on October 26, 2010 when 0.10 inches of rain was recorded.

At the time of inspection, GEI completed EPA inspection checklists for each impoundment which are provided in Appendix A. Photographs are provided in Appendix B. Field assessment of the impoundments included a site walk to observe the dam crest, upstream slope, downstream slope, intake structures and outlet structures. Both of the impoundments are discussed separately below.

8.2 Slag Dewatering Basin

8.2.1 Impoundment Dike

8.2.1.1 Dike Crest

The crest of the dike at the Slag Dewatering Basin appeared to be in good condition. No signs of cracking, settlement, movement, erosion or deterioration were observed during the assessment. The crest appears to be well-drained and no standing water was observed. The dike crest surface is generally composed of gravel road base material that traverses the length of the dike for vehicle access.

8.2.1.2 Upstream Slope

The upstream slopes of the dike at the Slag Dewatering Basin are generally covered with well established grass and/or CCW waste. The upstream slope protection appeared to be in good condition. No scarps, sloughs, depressions or other indications of slope instability or signs of erosion were observed during the inspection of the impoundment.

8.2.1.3 Downstream Slope

The downstream slope of the dike at the Slag Dewatering Basin generally has well-established grass growth, which provides some erosion protection (Photos 5 and 6). No scarps, sloughs, depressions or other indications of slope instability or signs of erosion were observed during the inspection of the impoundment.

8.2.2 Seepage and Stability

There are no signs of seepage or slope instability along the impoundment dike for the Slag Dewatering Basin.

8.2.3 Appurtenant Structures

8.2.3.1 Outlet Structure

The outlet structure (Photos 3 and 7) consists of a 30-inch diameter concrete outlet pipe and a concrete decant tower with 60-inch wide, 6-inch square concrete stop logs. The outlet structure releases the decant water into a bypass channel which discharges into the Ash Pond – Cell No. 2. At the time of our visit to the site, there was active flow through the outlet structure.

8.2.3.2 Pump Structures

No pumps are present at the Slag Dewatering Basin.

8.2.3.3 Emergency Spillway

No spillways are present at the Slag Dewatering Basin.

8.2.3.4 Drains

No internal or toe drains are present in the dike at the Slag Dewatering Basin.

8.2.3.5 Water Surface Elevations and Reservoir Discharge

At the time of our inspection on November 9, 2010, the Slag Dewatering Basin water level was observed to be at an approximate elevation of 731 feet. The water surface of the Slag Dewatering Basin is controlled by the outlet structure that discharges into the Ash Pond – Cell No. 2.

Appendix 3

NOAA ATLAS 14 POINT PRECIPITATION FREQUENCY ESTIMATES: MO

DATA DESCRIPTION

Data type: precipitation depth **Units:** english **Time series type:** partial duration

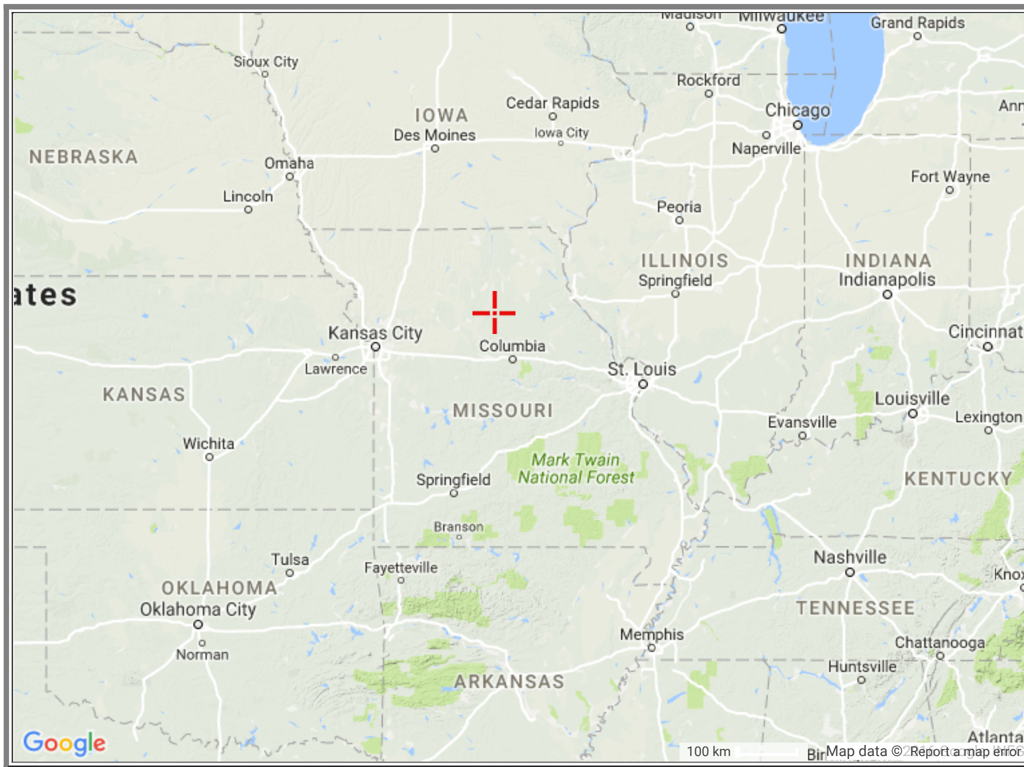
SELECT LOCATION

1. Manually:

a) Enter location (decimal degrees, use "-" for S and W): latitude: 39.544661 longitude: -92.635891 submit

b) Select station (click here for a list of stations used in frequency analysis for MO): select station

2. Use map:



a) Select location
(move crosshair or double click)
b) Click on station icon
(show stations on map)

LOCATION INFORMATION:
Name: Clifton Hill, Missouri, US*
Latitude: 39.5447°
Longitude: -92.6359°
Elevation: 733 ft*

* source: Google Maps

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION
NOAA Atlas 14, Volume 8, Version 2

PF tabular | PF graphical | Supplementary information | Print Page

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

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.405 (0.328-0.498)	0.468 (0.378-0.576)	0.570 (0.459-0.703)	0.654 (0.524-0.810)	0.769 (0.594-0.975)	0.857 (0.647-1.10)	0.944 (0.688-1.24)	1.03 (0.721-1.39)	1.15 (0.770-1.58)	1.23 (0.808-1.72)
10-min	0.593 (0.480-0.729)	0.685 (0.554-0.843)	0.834 (0.673-1.03)	0.958 (0.767-1.19)	1.13 (0.870-1.43)	1.25 (0.947-1.61)	1.38 (1.01-1.81)	1.51 (1.05-2.03)	1.68 (1.13-2.31)	1.80 (1.18-2.52)
15-min	0.723 (0.585-0.890)	0.835 (0.676-1.03)	1.02 (0.820-1.26)	1.17 (0.936-1.45)	1.37 (1.06-1.74)	1.53 (1.16-1.96)	1.69 (1.23-2.21)	1.84 (1.29-2.47)	2.05 (1.38-2.81)	2.20 (1.44-3.08)
30-min	1.02 (0.827-1.26)	1.19 (0.965-1.47)	1.47 (1.19-1.81)	1.70 (1.36-2.10)	2.00 (1.54-2.53)	2.23 (1.68-2.86)	2.45 (1.79-3.21)	2.68 (1.87-3.59)	2.97 (1.99-4.08)	3.18 (2.08-4.44)
60-min	1.29 (1.05-1.59)	1.54 (1.25-1.90)	1.96 (1.58-2.41)	2.30 (1.84-2.85)	2.79 (2.16-3.56)	3.17 (2.40-4.09)	3.56 (2.60-4.68)	3.96 (2.77-5.33)	4.49 (3.02-6.20)	4.91 (3.21-6.85)
2-hr	1.57 (1.28-1.92)	1.89 (1.54-2.31)	2.44 (1.98-2.99)	2.91 (2.35-3.58)	3.58 (2.79-4.55)	4.11 (3.13-5.28)	4.66 (3.43-6.11)	5.24 (3.69-7.02)	6.02 (4.08-8.26)	6.63 (4.38-9.20)
3-hr	1.73 (1.41-2.10)	2.10 (1.72-2.56)	2.75 (2.24-3.36)	3.31 (2.68-4.06)	4.14 (3.25-5.26)	4.81 (3.68-6.17)	5.51 (4.08-7.21)	6.25 (4.43-8.37)	7.28 (4.96-9.97)	8.09 (5.36-11.2)
6-hr	2.06 (1.70-2.49)	2.50 (2.06-3.03)	3.27 (2.68-3.97)	3.96 (3.22-4.82)	4.97 (3.95-6.31)	5.81 (4.49-7.43)	6.71 (5.00-8.74)	7.66 (5.48-10.2)	9.00 (6.19-12.3)	10.1 (6.72-13.8)

12-hr	**2.49** (2.06-2.99)	**2.95** (2.44-3.55)	**3.77** (3.11-4.54)	**4.50** (3.69-5.44)	**5.57** (4.45-7.01)	**6.46** (5.03-8.20)	**7.41** (5.57-9.59)	**8.42** (6.06-11.1)	**9.83** (6.81-13.3)	**11.0** (7.38-14.9)
24-hr	**2.95** (2.46-3.52)	**3.42** (2.85-4.08)	**4.24** (3.52-5.08)	**4.97** (4.11-5.98)	**6.06** (4.88-7.57)	**6.97** (5.46-8.77)	**7.92** (6.00-10.2)	**8.95** (6.50-11.8)	**10.4** (7.25-13.9)	**11.5** (7.82-15.6)
2-day	**3.38** (2.84-4.01)	**3.88** (3.25-4.61)	**4.76** (3.98-5.66)	**5.54** (4.61-6.62)	**6.70** (5.43-8.30)	**7.66** (6.05-9.58)	**8.68** (6.61-11.1)	**9.77** (7.14-12.7)	**11.3** (7.94-15.0)	**12.5** (8.54-16.8)
3-day	**3.67** (3.10-4.34)	**4.22** (3.56-4.99)	**5.17** (4.34-6.13)	**6.02** (5.02-7.16)	**7.26** (5.89-8.94)	**8.28** (6.55-10.3)	**9.35** (7.15-11.9)	**10.5** (7.70-13.6)	**12.1** (8.54-16.0)	**13.4** (9.17-17.9)
4-day	**3.94** (3.33-4.64)	**4.52** (3.81-5.33)	**5.52** (4.65-6.53)	**6.41** (5.37-7.61)	**7.72** (6.28-9.47)	**8.79** (6.97-10.9)	**9.91** (7.60-12.5)	**11.1** (8.17-14.4)	**12.8** (9.04-16.9)	**14.1** (9.70-18.8)
7-day	**4.64** (3.94-5.44)	**5.28** (4.48-6.19)	**6.38** (5.40-7.50)	**7.37** (6.20-8.69)	**8.80** (7.21-10.7)	**9.98** (7.97-12.3)	**11.2** (8.66-14.1)	**12.5** (9.29-16.1)	**14.4** (10.2-18.9)	**15.9** (11.0-21.0)
10-day	**5.28** (4.50-6.16)	**5.97** (5.09-6.98)	**7.17** (6.09-8.40)	**8.23** (6.95-9.68)	**9.79** (8.04-11.9)	**11.1** (8.86-13.6)	**12.4** (9.60-15.5)	**13.8** (10.3-17.7)	**15.8** (11.3-20.7)	**17.4** (12.1-22.9)
20-day	**7.11** (6.10-8.24)	**8.02** (6.88-9.31)	**9.57** (8.18-11.1)	**10.9** (9.27-12.7)	**12.8** (10.6-15.4)	**14.3** (11.6-17.4)	**15.9** (12.4-19.7)	**17.6** (13.1-22.3)	**19.8** (14.3-25.7)	**21.6** (15.1-28.3)
30-day	**8.64** (7.45-9.98)	**9.78** (8.42-11.3)	**11.7** (10.0-13.5)	**13.2** (11.3-15.4)	**15.5** (12.8-18.4)	**17.2** (13.9-20.7)	**18.9** (14.8-23.3)	**20.8** (15.6-26.1)	**23.2** (16.7-29.9)	**25.1** (17.6-32.7)
45-day	**10.6** (9.17-12.2)	**12.0** (10.4-13.8)	**14.3** (12.4-16.5)	**16.2** (13.9-18.8)	**18.8** (15.6-22.3)	**20.8** (16.9-24.9)	**22.8** (17.8-27.9)	**24.8** (18.6-30.9)	**27.3** (19.8-35.0)	**29.3** (20.7-38.0)
60-day	**12.3** (10.6-14.1)	**14.0** (12.1-16.0)	**16.6** (14.4-19.2)	**18.8** (16.2-21.7)	**21.7** (18.0-25.6)	**23.9** (19.4-28.5)	**26.1** (20.4-31.7)	**28.1** (21.2-35.0)	**30.8** (22.4-39.2)	**32.8** (23.2-42.5)

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

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

Please refer to NOAA Atlas 14 document for more information.

Estimates from the table in csv format: precipitation frequency estimates ▼ Submit

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Appendix 4

NOTES:
1. ALL FLOWS INDICATE MILLION GALLONS PER DAY.
2. NUMBERS IN PARENTHESIS () INDICATE INSTANTANEOUS OR DAILY MAXIMUM FLOWS BECAUSE ALL MAXIMUM FLOWS MAY NOT OCCUR SIMULTANEOUSLY. FLOWS WILL NOT BALANCE UNDER MAXIMUM CONDITIONS.
3. ALL OTHER FLOW RATES ARE INTENDED TO REPRESENT THE AVERAGE MONTHLY DAY.

REV	DATE	DESCRIPTION	APP
3	6/08	REV. AS IS	JRE
2	9/99	REV. AS IS	JRE
1	6/97	REV. AS IS	JRE

aeci
associated electric cooperative, inc.

HEADQUARTERS
PROJECT TITLE

DRAWING TITLE
THOMAS HILL POWER PLANT
N. P. D. E. S. FLOW DIAGRAM

CONTRACTOR NAME:

DWG. NO. EOJEBAC
PROJECT NO. — DESIGN BY: JEB
DATE: 21-JAN-1992 — DRAWN BY: DAB
CAD FILE NO. EOJEBAC — APPROVED BY: — REV. 3

LEGEND
——— EXISTING SYSTEM
– – – INTERMITTENT OR ABNORMAL FLOWS

THIS IS A CADD GENERATED DRAWING
MAGNIFICATION FACTOR (1)