AECOM
1600 Perimeter Park Drive
Suite 400
Morrisville, NC 27560
www.aecom.com

919 461 1100 tel
919 461 1123 fax

October 7, 2016

Tennessee Valley Authority
1101 Market Street
Chattanooga, Tennessee 37402

Initial Inflow Design Flood Control System Plan
Bottom Ash Pond
EPA Final CCR Rule
TVA Gallatin Fossil Plant
Sumner County, Tennessee

1.0 PURPOSE

This letter documents AECOM's certification of the initial inflow design flood control system plan for the TVA Gallatin Fossil (GAF) Plant's Bottom Ash Pond. Based on the assessment, the Bottom Ash Pond complies with the inflow design flood control requirements in the Final CCR Rule 40 CFR 257.82.

2.0 INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN

As described in 40 CFR 257.82(c), an inflow design flood control system plan must be prepared to document how the inflow design flood control system has been designed and constructed to manage the design storm required by the hazard classification. Based on Hazard Potential Classification the Bottom Ash Pond has been assigned a low hazard potential classification rating. Thus, the 100 year storm event was selected from §257.82(a)(3) as the inflow design storm flood event based upon a hazard potential classification.

3.0 SUMMARY OF FINDINGS

The attached plan presents the analysis of the inflow design flood control system for the Bottom Ash Pond. The resulting water surface elevations are shown in the following table. The plan and results show that the impoundment meets the requirements set forth in 40 CFR 257.82(a) and (b).

Plant	Facility	Inflow Design Storm	Water Surface Elevation (feet)	Minimum Embankment Elevation (feet)
GAF	Bottom Ash Pond	100 year	480.3	480.5

AECOM

4.0 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

I, Gabriel W. Lang, PE, being a Professional Engineer in good standing in the State of Tennessee do hereby certify, to the best of my knowledge, information, and belief:

1. that the information contained in this certification is prepared in accordance with the accepted practice of engineering;
2. that the information contained herein is accurate as of the date of my signature below; and
3. that the inflow design flood control system plan for the TVA Gallatin Fossil Plant's Bottom Ash Pond meets the requirements specified in 40 CFR 257.82(a), (b), and (c)(1).

SIGNATURE ____ DATE __10/7/2016____

ADDRESS: AECOM
1600 Perimeter Park Drive
Morrisville, NC 27560

TELEPHONE: (919) 461-1100

ATTACHMENTS: Initial Inflow Design Flood Control System Plan (40 CFR 257.8) For Coal Combustion Residuals (CCR) - Existing Surface Impoundments
TVA - Bottom Ash Pond, Gallatin Fossil Plant, Sumner County, Tennessee

GABRIEL WILLAM LANG
REGISTERED ENGINEER
AGRICULTURE
COMMERCE
No 114323
STATE OF TENNESSEE
10/7/16

COAL COMBUSTION PRODUCT DISPOSAL PROGRAM

TENNESSEE VALLEY AUTHORITY – BOTTOM ASH POND
GALLATIN FOSSIL PLANT
SUMNER COUNTY, TENNESSEE

INFLOW DESIGN FLOOD CONTROL PLAN PER §257.82 OF THE COAL COMBUSTION RESIDUALS RULE

EXISTING SURFACE IMPOUNDMENTS

Prepared for

Tennessee Valley Authority
1101 Market Street
Chattanooga, TN 37402-2801

October 7, 2016 - Rev0

Prepared by

AECOM

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1. INTRODUCTION

This plan outlines compliance to Rule **§ 257.82** of the EPA Final CCR Rule.

The owner or operator of an existing CCR surface impoundment must design, construct, operate, and maintain an inflow design flood control system as specified in Rule **§257.82 (a)**, which is directly stated below for clarity.

Rule **§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.

Rule **§257.82(a)(2)**: 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.

Rule **§257.82(a)(3)**: The inflow design flood is:

> **(i)**: For a high hazard potential CCR surface impoundment, the probable maximum flood;
>
> **(ii)**: For a significant hazard potential CCR surface impoundment, the 1,000-year flood;
>
> **(iii)**: For a low hazard potential CCR surface impoundment, the 100-year flood; or
>
> **(iv)**: For an incised CCR surface impoundment, the 25-year flood.

According to Rule **§257.82(b)**, discharge from the CCR unit must be handled in accordance with the surface water requirements under **§257.3-3**.

Section **§257.82(c)(1)** states that 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). The plans must document how the inflow design flood control system has been designed and constructed to meet the requirements of the 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 operation record.

Section **§257.82(c)(2)** allows amendments to the written inflow design flood control system plan at any time and requires amendments to 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 revised plan must be placed in the facility's operating record.

Section **§257.82(c)(3)** requires that the initial inflow design flood control system plan be completed no later than October 17, 2016.

Section **§257.82(c)(4)** states that the owner or operator must prepare periodic inflow design flood control system plans every five years.

Section **§257.82(c)(5)** requires a certification from a qualified professional engineer stating that the initial and periodic inflow design flood controls system plans meet the requirements of Rule **§257.82**.

According to Rule **§257.82(d)**, the owner or operator must comply with recordkeeping, notification, and internet requirements specified elsewhere in the Rule.

1.1 SITE LOCATION

TVA owns and operates the Gallatin Fossil Plant (GAF) facility. The plant is located at 1499 Steam Plant Road in Sumner County, Tennessee on the north bank of the Cumberland River, approximately four miles southeast of the center of the City of Gallatin.

The property occupies approximately 1,730 acres of land along the Cumberland River (Old Hickory Lake). Plant facilities are located on the south portion of the peninsula. The Ash Pond Complex is located north of the fossil plant facilities. The Ash Pond Complex is comprised of Ash Pond A, Middle Pond A, Bottom Ash Pond, and Ash Pond E. The Stilling Ponds B, C, and D are part of the GAF's stormwater conveyance system. Refer to Figure 1: Site Location Map.

Figure 1: Site Location Map

1.2 SITE HISTORY

Bottom Ash Pond is located to the south of Middle Pond A, to the west of railroad tracks, and to the north of the coal stack. Bottom Ash Pond is hydraulically connected to Middle Pond A via a sluice ditch and attenuated stormwater flows. The sluice ditch alignment starts at Bottom Ash Pond, flows through Middle Pond A and discharges into Ash Pond A. Under normal operating conditions the slice ditch receives continuous process flow.

2. Existing Conditions- § 257.82(a)(1)

Based on the 2015 aerial survey, the Bottom Ash Pond watershed covers an area of approximately 25 acres. Bottom ash is piled highest along the length of the pond separating Bottom Ash Pond into west and east drainage areas. The larger east area (Sub-Basin 2) covers 21 acres and drains to two culverts located in the northeast corner of the dike, while the smaller west drainage area (Sub-Basin 1) covers 4 acres and contains the upstream end of the sluice ditch. The sluice ditch drains through three (3) culvert pipes. Figure 2 depicts the components that make up the drainage area map for Bottom Ash Pond.

Figure 2: Drainage Area Map

The two culverts located in the northeast corner are made up of a 48-inch CMP culvert with an invert elevation of 476.1 ft. (all elevations refer to NAVD88, vertical datum) and a 36-inch RCP with an invert elevation of 477.4 ft. The water surface elevation upstream of these culverts is approximately 478.0 ft. Therefore, both culverts are partially submerged. The three (3) 48-inch RCP culverts in the northwest corner drain the sluice ditch and have invert elevations of approximately 478.5 ft., 478.5 ft., and 478.7 ft. The water surface elevation in the sluice ditch is approximately 478.5 ft.

3. METHODOLOGY/DESIGN CRITERIA

The purpose of the analysis was to examine the adequacy of Bottom Ash Pond to safely store and pass stormwater flows resulting from the Inflow Design Flood (IDF). Based on Hazard Potential Classification Assessment (Reference 3), Bottom Ash Pond is considered a low hazard potential CCR surface impoundment. Therefore the 100-year, 24-hr flood is selected for the IDF.

The 24-hour, 100-year precipitation depth was obtained from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Volume 2, Version 3. Table 1 summarizes the storm events and temporal distributions used for the analysis.

Table 1: IDF Characteristics

Reoccurrence Interval	Storm Duration	Rainfall	Storm Distribution
100 year	24 hours	7.36 inches	SCS Type II

An H&H computer model (SWMM, version 5.1) was developed to examine the hydraulic behavior of Bottom Ash Pond during the IDF. SWMM model with the Dynamic Wave routing option was selected for modeling to include dynamic tailwater calculations between Ash Pond A, Middle Pond A, and Bottom Ash Pond. The model inputs included (1) a stage-storage relationship for Bottom and Middle Ash Ponds, (2) offsite drainage area culverts and outlet structure data, (3) watershed characteristics, (4) inflow hydrographs, (5) tailwater condition, and (6) base flow conditions. These hydrologic inputs are described as follows:

(1) Stage-storage curves used in SWMM are included in Appendix B1. Pond storage capacity was developed based upon:

- Lidar, aerial mapping performed by Tuck Mapping Solutions, Inc. dated July, 2015;
- Bathymetric survey and plans and reports provided by TVA field data dated collected by TVA surveying personnel dated 2016; and
- Observations made during site visits by AECOM personnel.

(2) As-built survey, as well as field observations, were used to gather information on the existing culverts and outlet structures and are summarized in Table 2.

Table 2: Culvert Structure Data

HMS Node	Type	Description
Sub-basin 1	Culvert	3 x 48” RCP
Sub-basin 2	Culvert	48” CMP & 36” RCP

(3) Runoff characteristics for the drainage areas are listed in Table 3 below.

Table 3: Bottom Ash Pond Watershed Characteristics for HMS

Description	HMS node	Area (acres)	Curve Number (CN)	Lag Time (min)
Bottom Ash Pond A (western side)	Sub-basin 1	4	90	12
Bottom Ash Pond (eastern side)	Sub-basin 2	21	80	12

(4) The inflow hydrographs were developed using HEC-HMS (Version 4.1) program. The HEC-HMS model was developed for the IDF analysis of the Ash Pond A (Reference 6). The 100-year, 24-hr storm inflow hydrographs developed with the HEC-HMS model were used in the SWMM model. The HEC-HMS model generated inflow hydrographs for both drainage areas are presented in Appendix B2.

(5) To evaluate effects of backwater, the tailwater condition was set at the Ash Pond A using results from the HEC-HMS model (Reference 6). The tailwater for the 100-year, 24-hour storm was set at 467.5 ft.

(6) Total base process flows entering Bottom Ash Pond from the coal yard runoff ditch and the bottom ash sluice stream were estimated to be 30.21 cfs based on the NPDES permit schematic provided in Appendix B3. The coal yard runoff ditch process flows may also be diverted away from Bottom Ash Pond and discharged instead to Pond E. However, this analysis assumes that these wastewater flows enter Bottom Ash Pond in order to model the most conservative flow scenario.

4. CALCULATION RESULTS - §257.82(a)(2)

The hydrologic modeling results were reviewed to determine the performance of Bottom Ash Pond during the 100-year, 24-hour storm. Table 4 contains the estimated peak inflow and estimated peak water surface elevation for the modeled storm event. The lowest section of the Bottom Ash Pond divider dike is located near the northeast corner along the eastern dike separating Bottom Ash Pond and the Rail Loop Area and is at an approximate elevation of 480.5 ft. The outlet culverts pass the design storm flow with a maximum water surface elevation of 480.3 ft., approximately 0.2-feet below the top of divider dike. The model layout and output results are included in Appendix A.

Table 4: Estimated Peak Inflow and Peak Pool Elevation

Peak Inflow (cfs)	Max. Pool Elevation (NAV83, ft)	Top of Divider Dike (NAV83, ft)	Freeboard to Top of Divider Dike (ft)
125	480.3	480.5	0.2

5. CONCLUSIONS

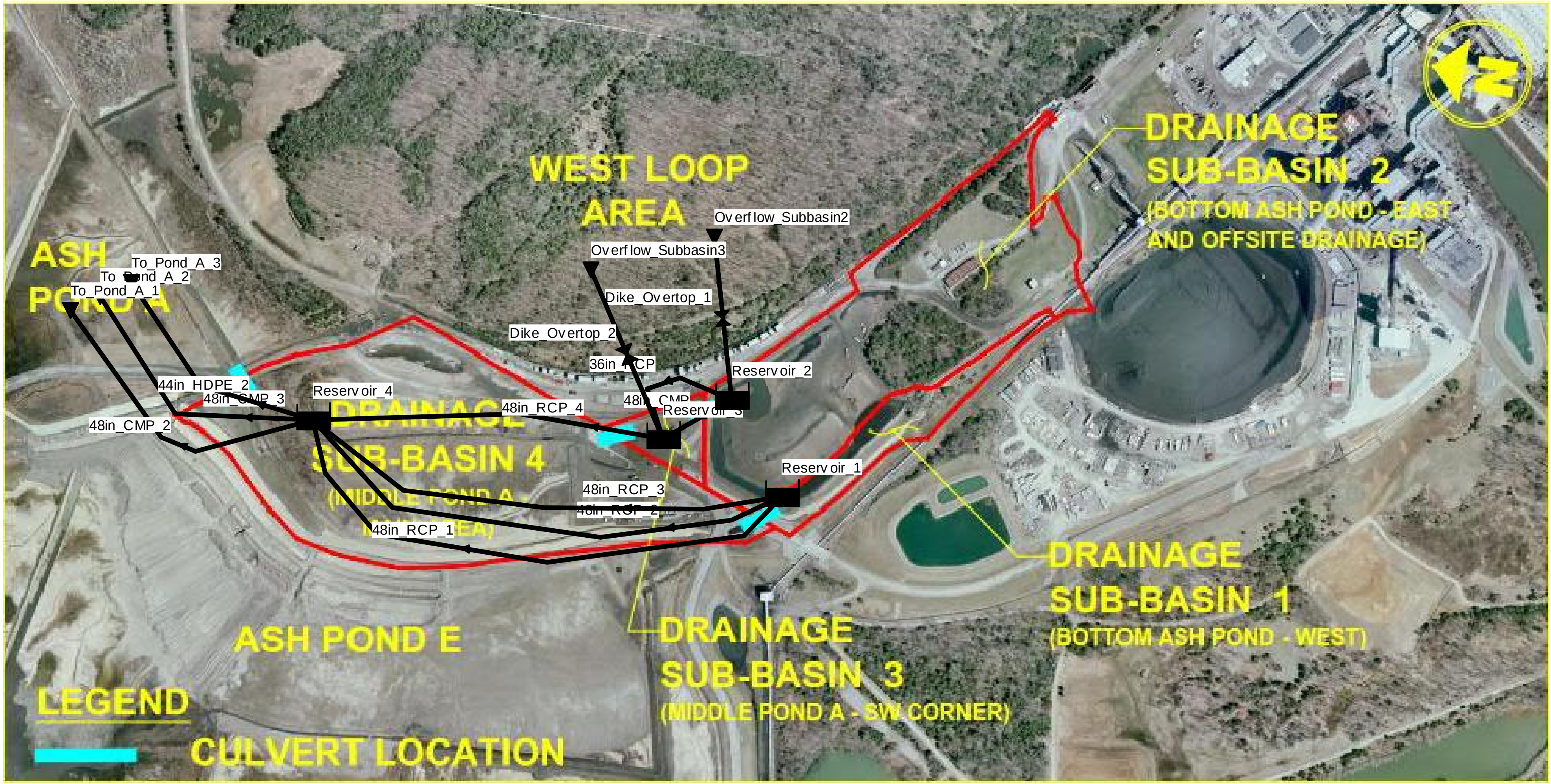
The inflow design flood control system adequately manages flow into the CCR unit during and following the peak discharge of the inflow design flood. Discharge is handled in accordance with the surface water requirements under § 257.82.

6. REFERENCES

1. Environmental Protection Agency, "Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities", Federal Register, April 17, 2015.
2. Bonnin G. M. et all, NOAA Atlas 14, Precipitation Frequency Atlas of the United States, Volume 2, Version 3, 2006.
3. Stantec Consulting Services Inc., "Hazard Potential Classification Assessment, Bottom Ash Pond, Gallatin Fossil Plant, Sumner County, Tennessee", December 15, 2015.
4. United States Army Corps of Engineers, Hydrologic Modeling System (HEC-HMS), Version 4.1, July 31, 2015.
5. U.S. Environmental Protection Agency, Storm Water Management Model (SWMM), Version 5.1, September 30, 2015.
6. AECOM Inc., HEC-HMS Version 4.1 electronic files, "Engineer's Certificate of Inflow Design Flood Control Plan for Ash Pond A", September 23, 2016.
7. OHM Advisors Inc., As-Built Drawings, "Ash Haul Road A, 57 Stone Subgrade, TVA Project ID 604756", September 18, 2015.
8. Tennessee Valley Authority, Gallatin Fossil Plant Flow Schematic Diagram, NPDES Permit No. TN0005428, May 2009 and updated June 2016.

APPENDIX A

SWMM OUTPUT RESULTS


WEST LOOP
AREA
DRAINAGE
SUB-BASIN 2
(BOTTOM ASH POND - EAST
AND OFFSITE DRAINAGE)
ASH
POND A
To_Pond_A_3
To_Pond_A_2
To_Pond_A_1
Overflow_Subbasin2
Overflow_Subbasin3
Dike_Overtop_1
Dike_Overtop_2
36in_RCP
Reservoir_2
44in_HDPE_2
48in_CMP_3
Reservoir_4
48in_RCP_4
48in_CMP
Reservoir_3
48in_CMP_2
DRAINAGE
SUB-BASIN 4
(MIDDLE POND A -
MAIN AREA)
Reservoir_1
48in_RCP_3
48in_RCP_2
48in_RCP_1
DRAINAGE
SUB-BASIN 1
(BOTTOM ASH POND - WEST)
ASH POND E
DRAINAGE
SUB-BASIN 3
(MIDDLE POND A - SW CORNER)
LEGEND
CULVERT LOCATION

Node Depth Summary

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Day of Maximum Depth	Hour of Maximum Depth	Maximum Reported Depth Feet
Overflow_Subbasin2	OUTFALL	0.00	0.00	479.00	0	00:00	0.00
Overflow_Subbasin3	OUTFALL	0.00	0.00	479.00	0	00:00	0.00
To_Pond_A_2	OUTFALL	1.60	2.58	470.14	0	12:15	2.58
To_Pond_A_3	OUTFALL	0.17	1.62	472.32	0	12:15	1.62
To_Pond_A_1	OUTFALL	1.60	2.61	470.04	0	12:15	2.61
Reservoir_3	STORAGE	0.43	1.18	478.97	0	12:21	1.18
Reservoir_2	STORAGE	1.14	2.35	480.35	0	12:19	2.35
Reservoir_4	STORAGE	2.29	4.79	473.05	0	12:15	4.79
Reservoir_1	STORAGE	0.77	0.97	479.47	0	12:08	0.97

BOTTOM ASH POND (EAST) PEAK ELEVATION

BOTTOM ASH POND (WEST) PEAK ELEVATION

Node Inflow Summary

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Day of Maximum Inflow	Hour of Maximum Inflow	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal	Flow Balance Error Percent
Overflow_Subbasin2	OUTFALL	0.00	0.00	0	00:00	0	0	0.000
Overflow_Subbasin3	OUTFALL	0.00	0.00	0	00:00	0	0	0.000
To_Pond_A_2	OUTFALL	0.00	66.84	0	12:15	0	13.5	0.000
To_Pond_A_3	OUTFALL	0.00	62.33	0	12:15	0	0.833	0.000
To_Pond_A_1	OUTFALL	0.00	68.13	0	12:15	0	13.5	0.000
Reservoir_3	STORAGE	17.80	50.05	0	12:19	0.324	2.86	0.005
Reservoir_2	STORAGE	125.49	125.49	0	12:05	3.12	3.12	0.004
Reservoir_4	STORAGE	210.90	289.20	0	12:04	5.08	28	0.018
Reservoir_1	STORAGE	57.41	57.41	0	12:05	20.2	20.2	0.064

BOTTOM ASH POND (WEST) PEAK INFLOW

BOTTOM ASH POND (EAST) PEAK INFLOW

APPENDIX B

REFERENCES

APPENDIX B1:
STAGE/STORAGE DATA

Stage/Storage for Bottom Ash Pond - West

HEC-HMS Model Reservoir 1				
Elevation (msl)	Depth (ft)	Area (ac)	Average Volume (ac-ft)	Cumulative Storage (ac-ft)
478.5	0	0.00		0.00
			0.18	
479	0.5	0.72		0.18
			0.76	
480	1.5	0.80		0.94
			0.41	
480.5	2	0.83		1.35
		Total Volume=	1.35	ac-ft

Notes:
Information based on 2015 aerial survey.

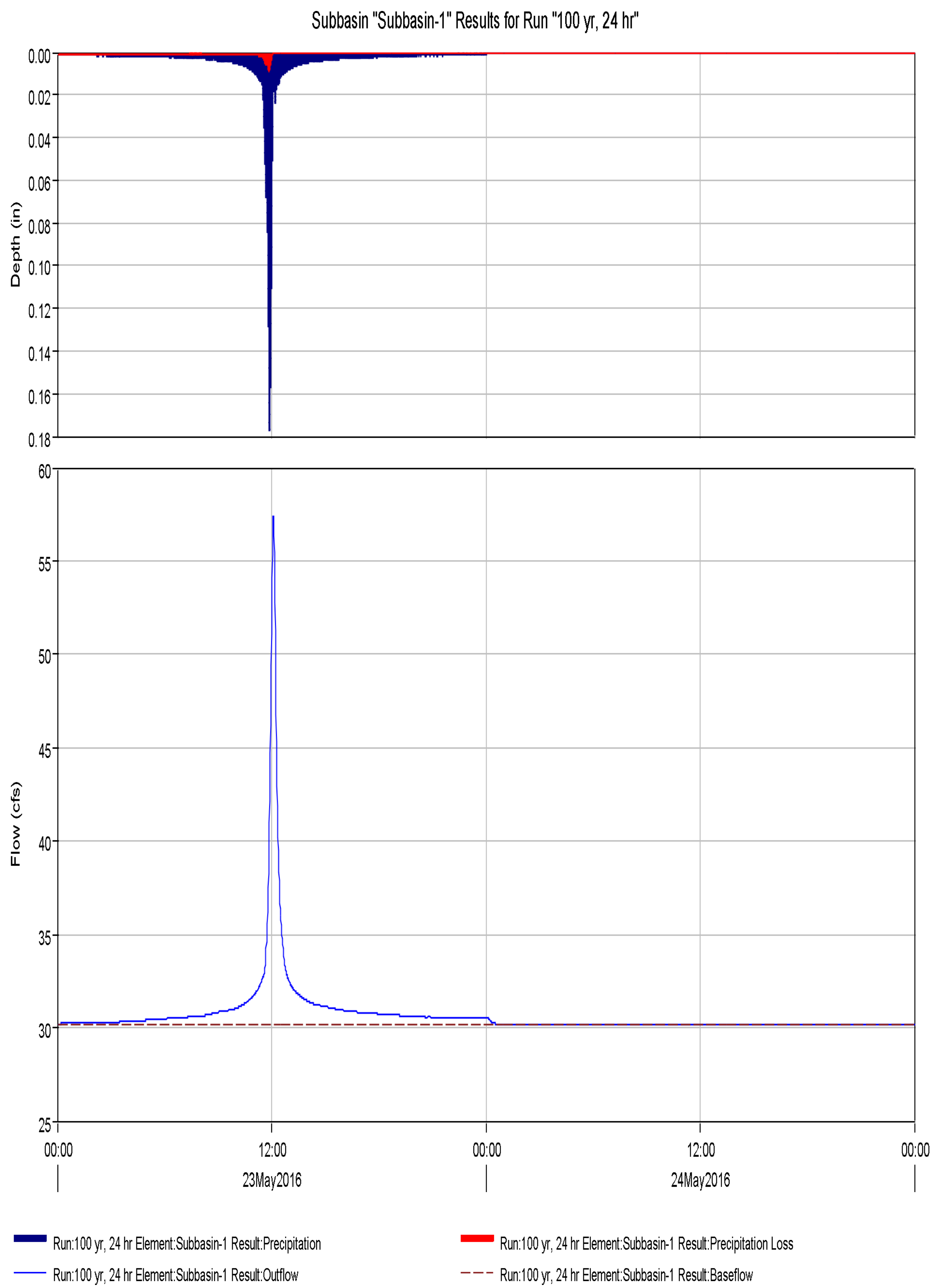
Stage/Storage for Bottom Ash Pond - East

HEC-HMS Model Reservoir 2				
Elevation (msl)	Depth (ft)	Area (ac)	Average Volume (ac-ft)	Cumulative Storage (ac-ft)
478	0	1.21	0.00	0.00
479	1	1.51	1.36	1.36
480	2	1.87	1.69	3.04
481	3	3.48	2.67	5.72
482	4	6.63	5.05	10.77
		Total Volume=	10.77	ac-ft

Notes:
Information based on 2015 aerial survey.

APPENDIX B2:

HEC-HMS INFLOW HYDROGRAPHS


Subbasin "Subbasin-1" Results for Run "100 yr, 24 hr"
Depth (in)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
0.18
Flow (cfs)
60
55
50
45
40
35
30
25
00:00
12:00
00:00
12:00
00:00
23May2016
24May2016
Run:100 yr, 24 hr Element:Subbasin-1 Result:Precipitation
Run:100 yr, 24 hr Element:Subbasin-1 Result:Precipitation Loss
Run:100 yr, 24 hr Element:Subbasin-1 Result:Outflow
Run:100 yr, 24 hr Element:Subbasin-1 Result:Baseflow

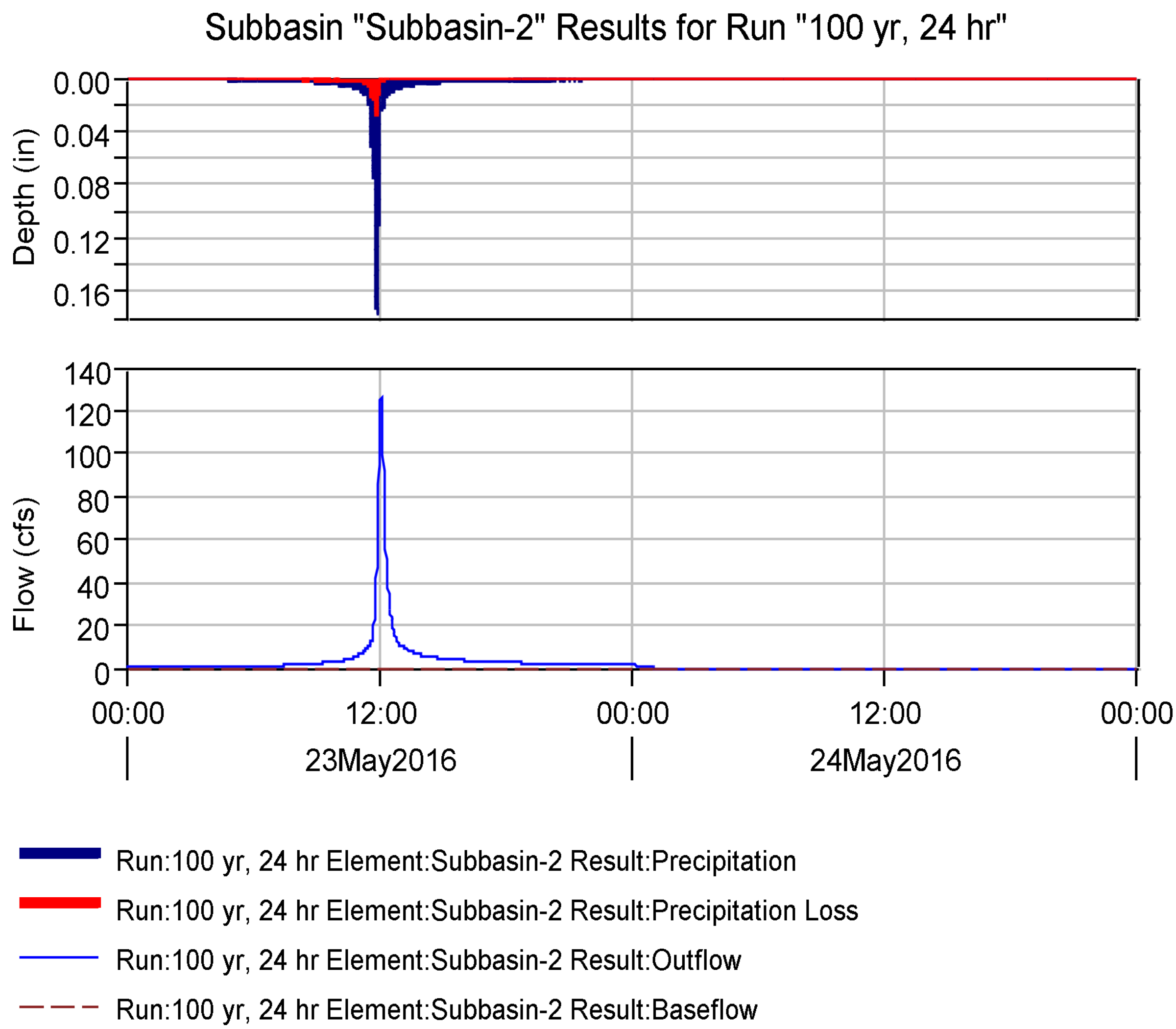
Project: Pond A Simulation Run: 100 yr, 24 hr
Subbasin: Subbasin-1

Start of Run:	23May2016, 00:00	Basin Model:	Pond A watershed
End of Run:	25May2016, 00:00	Meteorologic Model:	100 yr, 24 hr
Compute Time:	29Sep2016, 13:14:17	Control Specifications:	3-day

Volume Units: IN

Computed Results

Peak Discharge:	57.4 (CFS)	Date/Time of Peak Discharge:	23May2016, 12:05
Precipitation Volume:	7.36 (IN)	Direct Runoff Volume:	6.41 (IN)
Loss Volume:	0.95 (IN)	Baseflow Volume:	358.14 (IN)
Excess Volume:	6.41 (IN)	Discharge Volume:	364.56 (IN)


Subbasin "Subbasin-2" Results for Run "100 yr, 24 hr"
Depth (in)
0.00
0.04
0.08
0.12
0.16
Flow (cfs)
140
120
100
80
60
40
20
0
00:00
12:00
00:00
12:00
00:00
23May2016
24May2016
Run:100 yr, 24 hr Element:Subbasin-2 Result:Precipitation
Run:100 yr, 24 hr Element:Subbasin-2 Result:Precipitation Loss
Run:100 yr, 24 hr Element:Subbasin-2 Result:Outflow
Run:100 yr, 24 hr Element:Subbasin-2 Result:Baseflow

Project: Pond A   Simulation Run: 100 yr, 24 hr

Subbasin: Subbasin-2

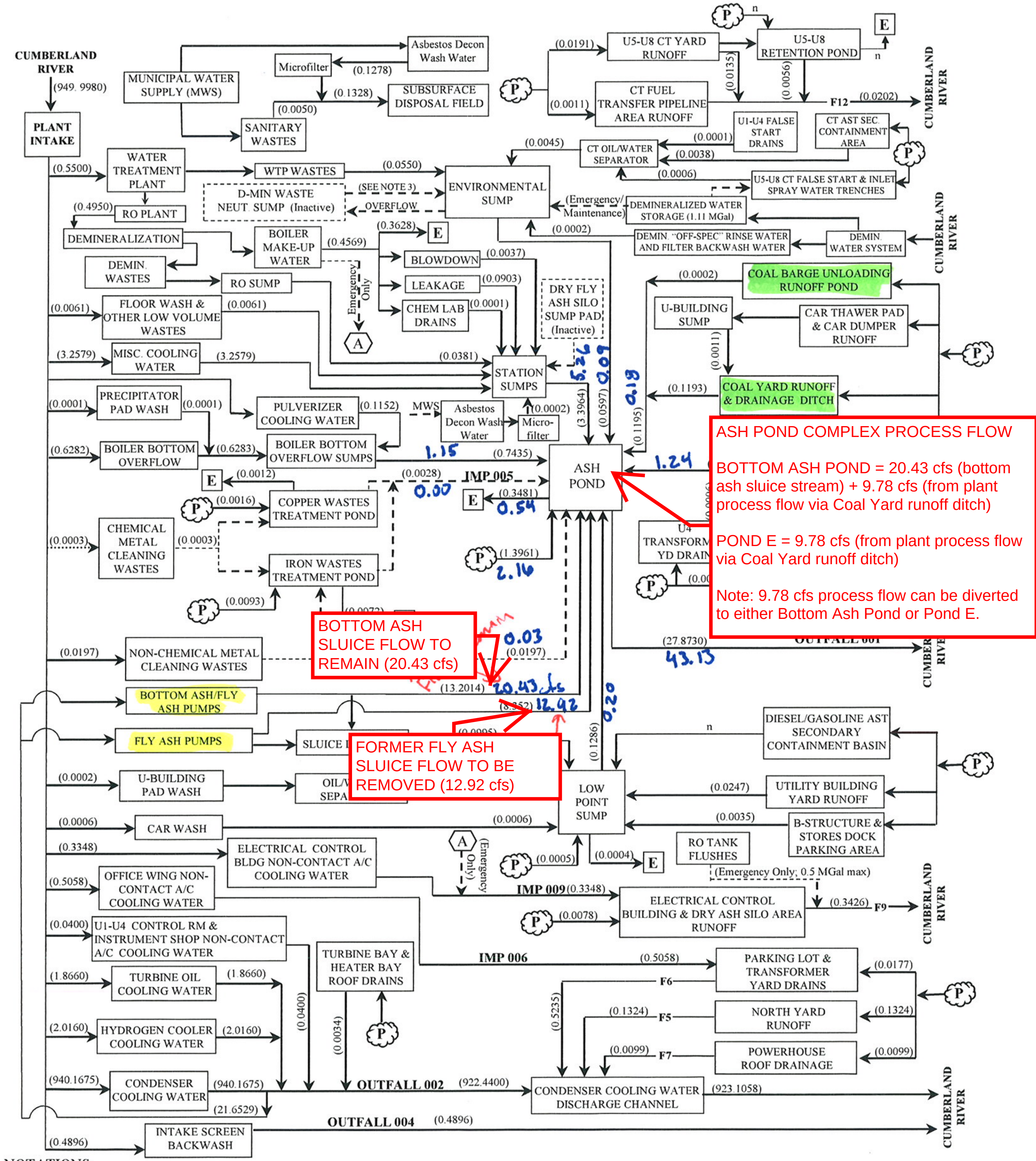
Start of Run:	23May2016, 00:00	Basin Model:	Pond A watershed
End of Run:	25May2016, 00:00	Meteorologic Model:	100 yr, 24 hr
Compute Time:	08Aug2016, 08:49:46	Control Specifications:	3-day

Volume Units: IN

Computed Results

Peak Discharge:	125.5 (CFS)	Date/Time of Peak Discharge	23May2016, 12:05
Precipitation Volume:	7.36 (IN)	Direct Runoff Volume:	5.47 (IN)
Loss Volume:	1.89 (IN)	Baseflow Volume:	0.00 (IN)
Excess Volume:	5.47 (IN)	Discharge Volume:	5.47 (IN)

APPENDIX B3:
GALLATIN FOSSIL PLANT WASTEWATER FLOW SCHEMATIC



NOTATIONS:

1. All flows are annualized & in millions of gallons per day (MGD)
2. The Demineralizer Waste Neutralization Sump has been removed from service. If necessary, accumulated rainwater will be pumped to the Environmental Sump.
3. GAF's 21 fire hydrants receive raw water and are flushed twice each year. Hydrant flushes discharge to F6, F7, F10-F12, the Powerhouse Extension (unwatering) Sump, the Low Point Sump, the Environmental Sump, and/or the Ash Pond.
4. - - ➤ Represents intermittent flows
5. Precipitation (P) Evaporation [E] Ground Water ◇G Municipal Water Supply – MWS n – negligible Internal Monitoring Point - **IMP**

GALLATIN FOSSIL PLANT
FLOW SCHEMATIC DIAGRAM
NPDES Permit No. TN0005428
May 2009

Process flow updated based on year 2016 conditions