PERIODIC INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN
PLANT GASTON ASH POND
ALABAMA POWER COMPANY

EPA's "Disposal of Coal Combustion Residuals from Electric Utilities" Final Rule (40 C.F.R. Part 257 and Part 261) and the State of Alabama's ADEM Admin. Code Chapter 335-13-15, establish certain hydrologic and hydraulic capacity requirements for CCR surface impoundments. Per §257.82 and ADEM Admin. Code r. 335-13-15-.05(3), the owner or operator of an existing or new CCR surface impoundment or any lateral expansion of a CCR surface impoundment is required to design, construct, operate and maintain an inflow design flood control system capable of safely managing flow during and following the peak discharge of the specified inflow design flood. The owner or operator also must prepare a written plan documenting how the inflow flood control system has been designed and constructed to meet the requirements of the referenced sections of the rules. In addition, §257.82(c)(4) and ADEM Admin. Code r. 335-13-15-.05(3)(c)4. require a subsequent revision to the inflow design flood control system plan be prepared every 5 years.

The existing CCR surface impoundment referred to as the Plant Gaston Ash Pond is located at Alabama Power Company's Plant Gaston. The inflow design flood consists of the rainfall that falls within the limits of the surface impoundment and runoff from approximately 40 acres of adjoining watershed. As the impoundment is now undergoing closure, water levels within the pond have been lowered and there is only a limited amount of free water present, existing mainly after rain events. Under current normal conditions, stormwater runoff from the site is collected in a clear pool at the southwest corner of the Ash Pond and is pumped to a temporary water treatment system (Evoqua) at the plant. Supporting calculations for the design storm (see attached summary document) analyze the current closure conditions at the Ash Pond. Under the current construction work phase, the site provides stormwater detention at both the north/northeast and southwest areas where CCR has been (or is currently being) removed and consolidated into the central area of the pond footprint for final closure configuration. These low areas will be utilized for detention storage for the final closure conditions. Construction operations are using wells and other pumping arrangements to maintain dry conditions in the lower areas to facilitate removal and consolidation efforts.

Basin precipitation for this site has been calculated for the PMP, 24-hour duration storm using Hydrometeorological Report No. 51 (HMR-51) and HMR-52 to generate a 24-hour rainfall distribution.

Precipitation-Duration values were taken from HMR-51 rainfall maps along with additional site-specific data for input into the HMR-52 software. Stormwater runoff was calculated using the National Resources Conservation Service - SCS Method.

Soils data from the USDA/NRCS Web Soil Survey was used to determine the soil characteristics and hydrological soil groups for areas outside of the limits of the ash pond which contribute runoff to the south canal. These values were used to determine the appropriate curve numbers (CN's). The soils in these areas are primarily noted as gravelly silt loam underlain by gravelly silty clay loam - hydrologic soil group B. An antecedent runoff condition III (ARC III) was used for runoff calculations. Drainage basins were delineated, and time of concentration values (Tc) were calculated using a topographic survey (current as of 7/30/21) along with additional field run surveys. This data was input into Hydraflow Hydrographs software to generate runoff hydrographs along with water surface elevations and other hydraulic values.

Calculations show the impoundment has sufficient capacity to adequately manage flow during and following the peak discharge from the design storm event.

The facility is operated subject to and in accordance with § 257.3-3 and ADEM Admin. Code r. 335-13-4-.01(2)(a) and (b).

I hereby certify that the inflow design flood control system plan meets the requirements of 40 C.F.R. §257.82 and ADEM Admin. Code r. 335-13-15-.05(3).

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ALABAMA LICENSED No. 16516 PROFESSIONAL ENGINEER JAMES C. PEGUES, JR.

Inflow Design Control System Plan:
Hydrologic and Hydraulic Calculation Summary

for

Plant Gaston Ash Pond

Prepared by:

Southern Company Services
T&PS Environmental Solutions

Originator: Curtis R. Upchurch 9/30/21
Curtis R. Upchurch Date

Reviewer: Clay M. Campbell 10-7-21
Clay M. Campbell Date

Approval: James C. Pegues 10/8/21
James C. Pegues Date

1.0 Purpose of Calculation

The purpose of this report is to demonstrate the hydraulic capacity of the subject CCR impoundment in order to prepare an inflow design flood control plan as required by the United States Environmental Protection Agency's (EPA) final rule for Disposal of CCR from Electric Utilities (EPA 40 CFR 257) and the State of Alabama's ADEM Admin. Code Ch. 335-13-15 (r. 335-13-15-.05(3)).

2.0 Summary of Conclusions

A hydrologic and hydraulic model was developed for the Plant Gaston Ash Pond to determine the hydraulic capacity of the impoundment. The design storm for the Plant Gaston Ash Pond is the PMP (Probable Maximum Precipitation) rainfall event. Southern Company has selected a storm length of 24-hours for all inflow design flood control plans. The results of routing a PMP, 24-hour rainfall event through the impoundment's current configuration are presented in Table 1 below. Closure operations (as of the date of this report) have resulted in two separate non-connected drainage areas/basins noted in the following summary as the Northeast and Southwest Areas. As initially designed and analyzed in the 2016 H&H study, both areas were connected and drained to the discharge channel. The 2016 H&H Study determined that overtopping during a PMP event was probable. As a result, in the fall of 2017 a hardened auxiliary spillway was constructed to control release from the discharge channel to the Coosa River. Under current conditions, stormwater runoff from a PMP rainfall event would result in water being contained in both basins with some limited discharge through the auxiliary spillway at the Southwest Basin. See table 1 below. The overall closure design for the ash pond is to consolidate ash from the northeast, southwest and eastern areas and place on the existing stack. This will create detention areas which provide storage and attenuate the PMP event.

Table 1-Flood Routing Results for Plant Gaston Ash Pond (Current Conditions)

Ash Pond Area/ Basin	Normal Pool El (ft)	Top of embankment El (ft)	Auxiliary Spillway Crest El (ft)	Peak Water Surface Elevation (ft)	Free-board (ft)*	Peak Inflow (cfs)	Peak Outflow (cfs)
Northeast	None-Dry	Varies – low point @ 445.0	N/A	444.8 (8/31/21) 443.2 (9/30/21)	0.2 1.8	2764	N/A
Southwest	426-427**	444.0	439.0	439.3	4.7	4170	78

*Freeboard is measured from the top of embankment to the peak water surface elevation

**Assumed the higher normal pool elevation of 427.0 in calculations for conservative approach.

3.0 Methodology

3.1 Hydrologic Analysis

The Plant Gaston Ash Pond is classified as a high hazard structure. The design storm for a high hazard structure is the PMP rainfall event. A summary of the design storm parameters and rainfall distribution methodology for these calculations is summarized below in Table 2.

Table 2 - Plant Gaston Ash Pond Storm Precipitation

Hazard Classification	Return Frequency (years)	Storm Duration (hours)	Rainfall Total (Inches)	Rainfall Source	Storm Distribution
High	PMP	24	42.9	HMR - 51	HMR - 52

The drainage basin for the Plant Gaston Ash Pond was delineated based on a July 30, 2021 topographic survey for areas within the ash pond and borrow pit along with LiDAR data acquired for the Plant in 2013 for areas external to the ash pond. Run-off characteristics were developed based on the Soil Conservation Service (SCS) methodologies as outlined in TR-55. An overall SCS curve number for the drainage area was developed based on the National Engineering Handbook Part 630, Chapter 9 which provides a breakdown of curve numbers for each soil type and land use combination. Soil types were obtained from the USGS online soils database. Land use areas were delineated based on aerial photography. Time of Concentration calculations were developed based on the overland flow method as described in the National Engineering Handbook Part 630, Chapter 15.

A table of the pertinent basin characteristics of the Ash Pond is provided below in Table 3.

Table 3— Plant Gaston Ash Pond Hydrologic Information

Northeast Drainage Basin

Drainage Basin Area (acres)	136.57
Hydrologic Curve Number, CN	94
Hydrologic Methodology	SCS Method
Time of Concentration (minutes)	21.2
Hydrologic Software	Autodesk Hydraflow Hydrographs

Southwest Drainage Basin (Includes Drainage Areas A, B, & C)

Drainage Basin Area (acres)	197.0
Hydrologic Curve Number, CN	93
Hydrologic Methodology	SCS Method
Time of Concentration (minutes)	13.30
Hydrologic Software	Autodesk Hydraflow Hydrographs

Rainfall distribution was derived by HMR-52 software using precipitation depth-area-duration values from HMR-51 maps as noted in Table 2(b). Run-off values were determined by importing the characteristics developed above into a hydrologic model with the Autodesk Hydraflow Hydrographs program. ARC III curve numbers have been assigned.

Process flows from Plant Gaston are no longer discharging into the ash pond and are not included in this analysis.

Storage values for the Ash Pond were determined by developing a stage-storage relationship utilizing contour data for the ash pond and outlet canal. An arrangement of the ash pond and outlet canal is shown in the attached ash pond map in Section 4.5.

A summary of spillway information is presented below in Table 4.

Table 4— Plant Gaston Ash Pond Spillway Attribute Table

Spillway Component	US Invert El (feet)	DS Invert El (feet)	Dimension	Slope (ft/ft)	Length (ft)	Spillway Capacity (cfs)
Primary* (Concrete stop log riser 8 foot square)	N/A	N/A	N/A	N/A	N/A	N/A
Auxiliary Spillway	439.0	438.7	Trapezoidal Weir L=120ft., 10:1s.s.	1.0%	33.3	3200±

*Primary spillway has been grouted closed and has no discharge.

Based on the spillway attributes listed above, a rating curve was developed and inserted into Hydraflow Hydrographs software to analyze pond performance during the design storm. Results are shown in Tables 1 and 2.

4.0 Supporting Information

4.1 Curve Numbers

4.1.1 Soil Types/Curve Numbers

Curve Number Data

Cover Type	NRCS Soil	ARC II Curve Number, CN	Arc III Curve Number, CN*
CCR	N/A	86	94
Roads (aggregate)	B	85	94
Exposed earth/dirt	B	82	92
Pond (water)	B	100	100
Residential	B	68	84
Wooded	B	65	82

*Assume Ia = 0.2s, Chapter 10, Part 630, NRCS, Ref. 8.

4.1.2 Drainage Area/Basin CN's

Drainage Basin Composite Curve Numbers, CN's

<u>Northeast Area</u>
Basin Area = 5,948,861 sf/43,560 sf/Ac = 136.57 Ac

Area of ponded water (CN = 100):
Area = 0 Ac

Area of aggregate roads (CN = 94):
Area = 126,200 sf/43,560 sf/Ac = 2.90 Ac

Area of CCR (CN = 94)
Area = 136.57 – 2.90 = 133.67 Ac

$CN_{composite}$ = 94

Southwest Area

Basin Area = 6,035,139 sf/43,560sf/Ac = 138.55 Ac

Area of aggregate roads (CN = 94)

Area = 111,660 sf/43,560 sf/Ac = 2.56 Ac

Area of ponded water (CN=100):

Area = 975,542 sf/43,560 sf/Ac = 22.30 Ac

Area of CCR (CN = 94)

Area = 138.55 – 2.56 – 22.30 = 113.69 Ac

$CN_{composite}$ = ((2.56)(94) + (22.30)(100)) + (113.69)(94))/138.55
= 12,224.94/138.55 = 95.0 = 95

Area A

Basin Area = 1,012,914 sf/43,560sf/Ac = 23.25 Ac

CN = 84 (Residential Approx. 1 Ac. Lots)

Area B

Basin Area = 224,437 sf/43,560sf/Ac = 5.15 Ac

CN = 82 (Wooded, Thin Stand)

Area C

Basin Area = 1,308,402 sf/43,560sf/Ac = 30.03 Ac

CN = 92 (Disturbed earth/dirt) Borrow Pit

4.2 Stage-Storage Tables (Autodesk Civil3D

4.2.1 Northeast Area

Northeast Area (7/31/21 LIDAR with Excavation through 8/31/21)*

Depth	Elevation	Volume (c.f.)
0	423	0
1	424	2,496,030
2	425	2,625,047
3	426	2,794,839
4	427	3,013,456
5	428	3,296,312
6	429	3,724,501
7	430	4,273,457
8	431	5,024,064
9	432	5,862,622
10	433	6,741,430
11	434	7,651,704
12	435	8,593,183
13	436	9,560,574
14	437	10,552,818
15	438	11,576,819
16	439	12,636,443
17	440	13,742,125
18	441	14,969,914
19	442	16,278,718
20	443	17,640,348
21	444	19,093,514
22	445	20,684,118
23	446	22,382,276

*Note that all excavation is in lower area of pond and has been added to lower area for calculations. Excavation for August through 8/31/21 is 69,000 cy per Saiia plus 21,000 cy projected = 90,000 cy.

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Northeast Area (7/31/21 LIDAR with Excavation through 9/30/21)*

Depth	Elevation	Volume (c.f.)
0	423	0
1	424	4,926,030
2	425	5,055,407
3	426	5,224,839
4	427	5,443,456
5	428	5,726.312
6	429	6,154,501
7	430	6,703,457
8	431	7,454,064
9	432	8,292,622
10	433	9,171,430
11	434	10,081,704
12	435	11,023,183
13	436	11,990,574
14	437	12,982,818
15	438	14,006,819
16	439	15,066,443
17	440	16,172,125
18	441	17,399,914
19	442	18,708,718
20	443	20,070,348
21	444	21,523,514
22	445	23,114,118
23	446	24,812,276

*Note that all excavation is in lower area of pond and has been added to lower area for calculations. Excavation for August projected through 8/31/21 = 90,000 cy plus September projected through 9/30/21 = 90,000 cy = 180,000 cy total.

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4.2.2 Southwest Area

Depth	Elevation	Volume (c.f.)
0	409	0
1	410	1389
2	411	4534
3	412	66,495
4	413	332,118
5	414	690.546
6	415	1,100,519
7	416	1,545,324
8	417	2,015,655
9	418	2,506,244
10	419	3,021,484
11	420	3,573,073
12	421	4,197,337
13	422	4,867,861
14	423	5,559,695
15	424	6,268,038
16	425	6,991,733
17	426	7,732,321
18	427	8,572,771
19	428	9,580,612
20	429	10,665,943
21	430	11,816,013
22	431	13,055,287
23	432	14,403,571
24	433	15,869,129
25	434	17,516,931
26	435	19,264,018
27	436	21,093,296
28	437	23,045,874
29	438	25,107,202
30	439	27,238,566
31	440	29,436,303
32	441	31,709,640
33	442	34,070,674
34	443	36,530,424
35	444	39,110,242
36	445	41,800,270

4.3 Time of Concentration

Formulas for sheet flow, shallow concentrated flow, channel flow, and flow thru water:

SCS TR-55 Time of Concentration Computations Report	
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Sheet Flow Equation	Channel Flow Equation
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Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))	V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
	R = Aq / Wp
Where:	Tc = (Lf / V) / (3600 sec/hr)
Tc = Time of Concentration (hrs)	
n = Manning's Roughness	Where:
Lf = Flow Length (ft)	Tc = Time of Concentration (hrs)
P = 2 yr, 24 hr Rainfall (inches)	Lf = Flow Length (ft)
Sf = Slope (ft/ft)	R = Hydraulic Radius (ft)
	Aq = Flow Area (ft^2)
Shallow Concentrated Flow Equation	Wp = Wetted Perimeter (ft)
----------------------------------	V = Velocity (ft/sec)
V = 16.1345 * (Sf^0.5) (unpaved surface)	Sf = Slope (ft/ft)
V = 20.3282 * (Sf^0.5) (paved surface)	n = Manning's Roughness
V = 15.0 * (Sf^0.5) (grassed waterway surface)	
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)	Water Travel Velocity Equation
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)	---------------------
V = 7.0 * (Sf^0.5) (short grass pasture surface)	V = (g*D)^0.5
V = 5.0 * (Sf^0.5) (woodland surface)	Tc = ((Lf / V) /60sec/min)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)	
Tc = (Lf / V) / (3600 sec/hr)	Where:
	Tc = Time of Concentration (hrs)
Where:	D = Mean Depth (ft)
Tc = Time of Concentration (hrs)	g = Gravitational Constant (32.2 ft/sec)
Lf = Flow Length (ft)	Lf = Flow Length (ft)
V = Velocity (ft/sec)	R = Hydraulic Radius (ft)
Sf = Slope (ft/ft)	V = Velocity (ft/sec)

4.3.1 Basin Tc Calculated

Northeast Area

TR55 Tc Worksheet

Hyd. No. 1

Northeast Area

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.011		0.011		0.011		
Flow length (ft)	= 200.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 4.11		0.00		0.00		
Land slope (%)	= 0.50		0.00		0.00		
Travel Time (min)	**= 3.24**	**+**	**0.00**	**+**	**0.00**	**=**	**3.24**
Shallow Concentrated Flow							
Flow length (ft)	= 315.00		465.00		308.00		
Watercourse slope (%)	= 0.50		0.90		50.00		
Surface description	= Unpaved		Unpaved		Unpaved		
Average velocity (ft/s)	= 1.14		1.53		11.41		
Travel Time (min)	**= 4.60**	**+**	**5.06**	**+**	**0.45**	**=**	**10.11**
Channel Flow							
X sectional flow area (sqft)	= 19.64		13.30		0.00		
Wetted perimeter (ft)	= 22.69		33.03		0.00		
Channel slope (%)	= 0.20		1.20		0.00		
Manning's n-value	= 0.020		0.020		0.015		
Velocity (ft/s)	= 3.02		4.44		0.00		
Flow length (ft)	({0})1194.0		325.0		0.0		
Travel Time (min)	**= 6.58**	**+**	**1.22**	**+**	**0.00**	**=**	**7.80**
Total Travel Time, Tc							**21.16 min**

Southwest Area

TR55 Tc Worksheet

Hyd. No. 2

Southwest Area

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.011		0.011		0.011		
Flow length (ft)	= 90.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 4.11		0.00		0.00		
Land slope (%)	= 1.10		0.00		0.00		
Travel Time (min)	**= 1.25**	**+**	**0.00**	**+**	**0.00**	**=**	**1.25**
Shallow Concentrated Flow							
Flow length (ft)	= 72.00		226.00		475.00		
Watercourse slope (%)	= 1.90		4.90		21.00		
Surface description	= Unpaved		Unpaved		Unpaved		
Average velocity (ft/s)	= 2.22		3.57		7.39		
Travel Time (min)	**= 0.54**	**+**	**1.05**	**+**	**1.07**	**=**	**2.66**
Channel Flow							
X sectional flow area (sqft)	= 10.07		0.00		0.00		
Wetted perimeter (ft)	= 17.77		0.00		0.00		
Channel slope (%)	= 0.50		0.00		0.00		
Manning's n-value	= 0.020		0.015		0.015		
Velocity (ft/s)	= 3.60		0.00		0.00		
Flow length (ft)	({0})929.0		0.0		0.0		
Travel Time (min)	**= 4.30**	**+**	**0.00**	**+**	**0.00**	**=**	**4.30**
Total Travel Time, Tc							**8.20 min**
Add Tc through water body							5.1 min
							13.30 min.

Area A

TR55 Tc Worksheet

Hyd. No. 4

Area A

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.150		0.011		0.011		
Flow length (ft)	= 120.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 4.11		0.00		0.00		
Land slope (%)	= 5.80		0.00		0.00		
Travel Time (min)	**= 6.53**	**+**	**0.00**	**+**	**0.00**	**=**	**6.53**
Shallow Concentrated Flow							
Flow length (ft)	= 1160.00		0.00		0.00		
Watercourse slope (%)	= 5.80		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	= 3.89		0.00		0.00		
Travel Time (min)	**= 4.98**	**+**	**0.00**	**+**	**0.00**	**=**	**4.98**
Channel Flow							
X sectional flow area (sqft)	= 0.00		0.00		0.00		
Wetted perimeter (ft)	= 0.00		0.00		0.00		
Channel slope (%)	= 0.00		0.00		0.00		
Manning's n-value	= 0.018		0.015		0.015		
Velocity (ft/s)	= 0.00		0.00		0.00		
Flow length (ft)	({0})0.0		0.0		0.0		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**
Total Travel Time, Tc							**11.50 min**

Area B

TR55 Tc Worksheet

Hyd. No. 6

Area B

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.011		0.011		0.011		
Flow length (ft)	= 18.0		140.0		0.0		
Two-year 24-hr precip. (in)	= 4.11		4.11		0.00		
Land slope (%)	= 5.60		2.10		0.00		
Travel Time (min)	**= 0.18**	**+**	**1.37**	**+**	**0.00**	**=**	**1.55**
Shallow Concentrated Flow							
Flow length (ft)	= 0.00		0.00		0.00		
Watercourse slope (%)	= 0.00		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	= 0.00		0.00		0.00		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**
Channel Flow							
X sectional flow area (sqft)	= 2.43		4.23		0.00		
Wetted perimeter (ft)	= 6.37		21.41		0.00		
Channel slope (%)	= 1.70		1.30		0.00		
Manning's n-value	= 0.020		0.020		0.015		
Velocity (ft/s)	= 5.09		2.87		0.00		
Flow length (ft)	({0})352.0		225.0		0.0		
Travel Time (min)	**= 1.15**	**+**	**1.31**	**+**	**0.00**	**=**	**2.46**

Total Travel Time, Tc .... 6.00 min

Area C

TR55 Tc Worksheet

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v12

Hyd. No. 10

Area C

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.011		0.011		0.011		
Flow length (ft)	= 0.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 0.00		0.00		0.00		
Land slope (%)	= 0.00		0.00		0.00		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**
Shallow Concentrated Flow							
Flow length (ft)	= 100.00		208.00		137.00		
Watercourse slope (%)	= 6.50		2.20		17.50		
Surface description	= Unpaved		Unpaved		Unpaved		
Average velocity (ft/s)	=4.11		2.39		6.75		
Travel Time (min)	**= 0.41**	**+**	**1.45**	**+**	**0.34**	**=**	**2.19**
Channel Flow							
X sectional flow area (sqft)	= 8.07		11.37		9.69		
Wetted perimeter (ft)	= 18.12		31.65		15.07		
Channel slope (%)	= 1.40		1.00		0.60		
Manning's n-value	= 0.020		0.020		0.020		
Velocity (ft/s)	=5.13		3.75		4.29		
Flow length (ft)	({0})601.0		611.0		511.0		
Travel Time (min)	**= 1.95**	**+**	**2.71**	**+**	**1.98**	**=**	**6.65**

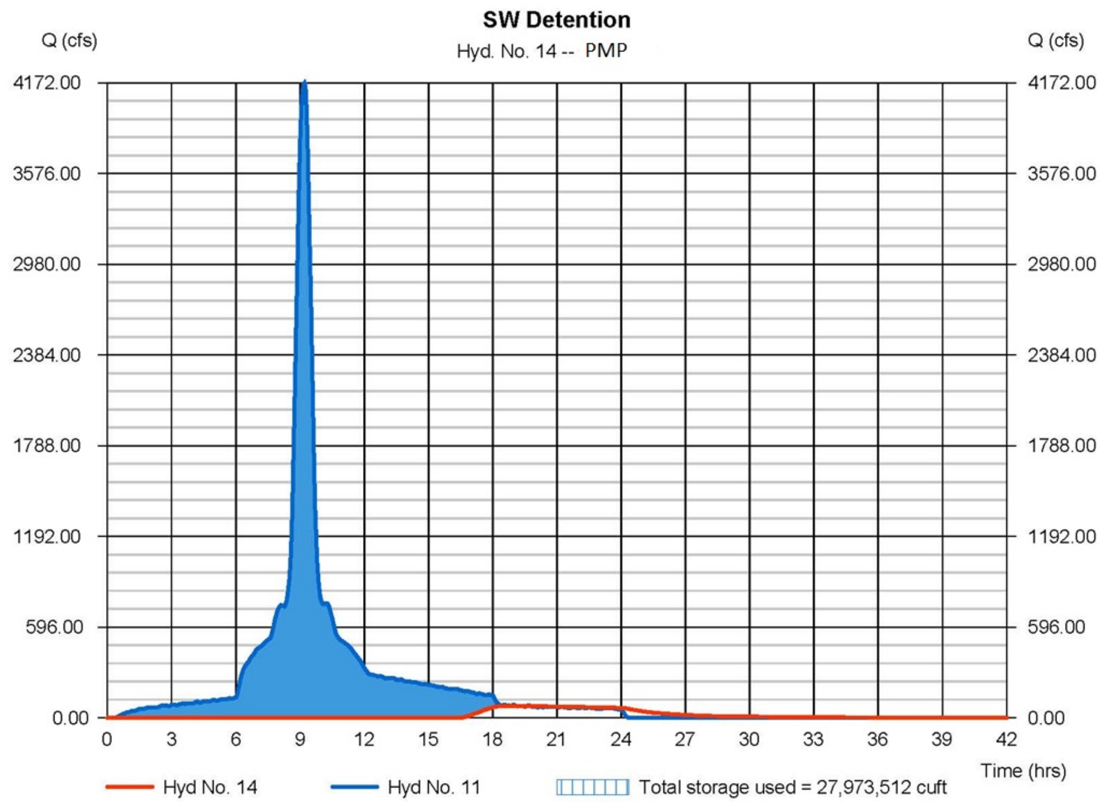
Total Travel Time, Tc .... **8.80 min**

4.4 Plant Process Flows to Ash Pond

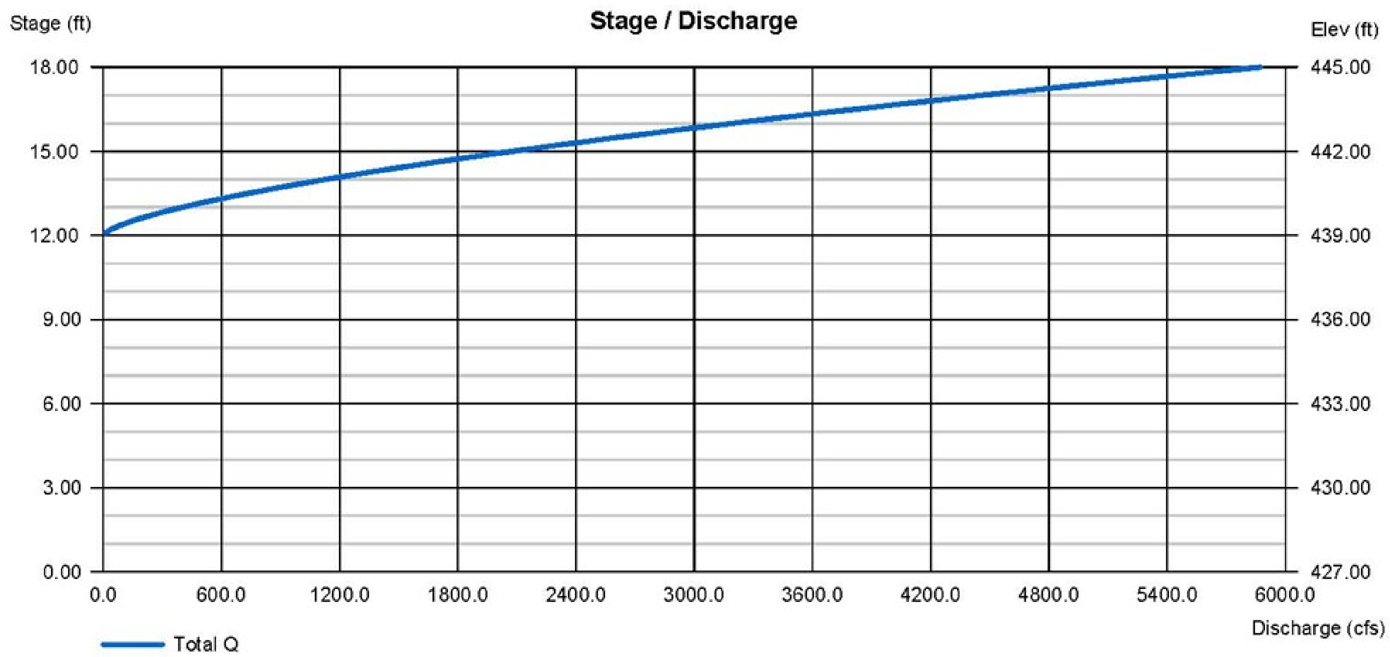
None - All plant flows removed from ash pond.

4.5 Hydrographs and Rating Curves

4.5.1 Discharge Hydrograph – Southwest Drainage Area



4.5.2 Auxiliary Spillway Rating Curve – Southwest Drainage Area



4.6 Drainage Map