



Stantec Consulting Services Inc.
10509 Timberwood Circle, Suite 100, Louisville, Kentucky 40223-5308

October 12, 2021
File: rpt_023_let_175568465
Revision 0

Tennessee Valley Authority
1101 Market Street
Chattanooga, Tennessee 37402

**RE: Periodic Run-on and Run-off Control System Plan
 Dry Ash Stack
 EPA CCR Rule
 TVA Cumberland Fossil Plant
 Cumberland City, Tennessee**

1.0 PURPOSE

This letter documents certification that the Dry Ash Stack at the Tennessee Valley Authority (TVA) Cumberland Fossil Plant is in compliance with the run-on and run-off control system requirements set forth in 40 CFR 257.81 of the EPA CCR Rule. The EPA CCR Rule requires a certification to be performed on a 5-yr periodic interval. The initial certification of the run-on and run-off control system plan was placed in the operating record on October 12, 2016.

2.0 INITIAL RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

The initial run-on and run-off control system plan (prepared in accordance with 40 CFR 257.81(c)(1)) is attached. The result of the initial assessment was that the Dry Ash Stack complied with 40 CFR 257.82(a)&(b).

3.0 CURRENT RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

Stantec reviewed the result of the initial run-on and run-off control system plan and the changes in site conditions that have occurred in the past five years. The following items summarize changes that have occurred:

1. Additional ash material and temporary cover has been placed in some locations.
2. Ditches on the East and West sides of the site were replaced with High Density Polyethylene (HDPE) pipes. These pipes were designed to convey the 25-year, 24-hour storm.

Based on our review, there are no conditions that have changed in the past five years that would cause the result of the initial run-on and run-off assessment to have changed.



October 12, 2021
Page 2 of 2

Re: **Periodic Run-on and Run-off Control System Plan
Dry Ash Stack
EPA CCR Rule
TVA Cumberland Fossil Plant
Cumberland City, Tennessee**

4.0 SUMMARY OF ASSESSMENT

Based on a review of the initial run-on and run-off control system plan and the current site conditions, the result of this periodic run-on and run-off control system plan assessment is that the Dry Ash Stack at the Cumberland Fossil Plant meets the requirements of §257.81 (a)&(b) of the EPA CCR Rule.

5.0 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

I, Stephen H. Bickel, 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 run-on and run-off control system plan for the TVA Cumberland Fossil Plant's Dry Ash Stack meets the requirements specified in 40 CFR 257.81 (a), (b), and (c)(1).

SIGNATURE Stephen H. Bickel

DATE 10/12/2021

ADDRESS: Stantec Consulting Services Inc.
10509 Timberwood Circle, Suite 100
Louisville, Kentucky 40223-5308

TELEPHONE: (502) 212-5075

ATTACHMENTS: Initial Run-on and Run-off Flood Control System Plan



INITIAL RUN-ON AND RUN-OFF CONTROLS ASSESSMENT



Stantec Consulting Services Inc.
10509 Timberwood Circle Ste. 100 Louisville, Kentucky 40223-5308

October 6, 2016
File: rpt_001_let_175555021
Revision 0

Tennessee Valley Authority
1101 Market Street
Chattanooga, Tennessee 37402

**RE: Initial Run-on and Run-off Control System Plan
Dry Ash Stack
EPA Final Coal Combustion Residuals (CCR) Rule
TVA Cumberland Fossil Plant
Cumberland City, Tennessee**

1.0 PURPOSE

This letter documents Stantec's certification of the run-on and run-off control system plan for the TVA Cumberland Fossil Plant's (CUF) Dry Ash Stack. Based on this assessment, the Dry Ash Stack is in compliance with the run-on and run-off control system requirements in the EPA Final CCR Rule at 40 CFR 257.81.

2.0 RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

As described in 40 CFR 257.81(c), a run-on and run-off control system plan must be prepared to document how the run-on and run-off control system has been designed and constructed to manage the 25-year, 24-hour storm.

3.0 SUMMARY OF FINDINGS

The attached plan presents the analysis of the run-on and run-off control system for the Dry Ash Stack. The results show that the landfill meets the requirements set forth in 40 CFR 257.81(a) and (b).

4.0 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

I, Stephen H. Bickel, 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



October 6, 2016
Page 2 of 2

Re: **Initial Run-on and Run-off Control System Plan
Dry Ash Stack
EPA Final Coal Combustion Residuals (CCR) Rule
TVA Cumberland Fossil Plant
Cumberland City, Tennessee**

3. that the run-on and run-off control system plan for the TVA Cumberland Fossil Plant's Dry Ash Stack meets the requirements specified in 40 CFR 257.81(a), (b), and (c)(1).

SIGNATURE

DATE

10/6/2016

ADDRESS:

Stantec Consulting Services Inc.
10509 Timberwood Circle, Suite 100
Louisville, Kentucky 40223-5308

TELEPHONE:

(502) 212-5075

ATTACHMENTS:

Initial Run-on and Run-off Control System Plan



Initial Run-On and Run-Off Control System Plan

Cumberland Fossil Plant – Dry Ash Stack
Cumberland City, Tennessee



Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.

October 6, 2016
Revision 0

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INITIAL RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

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INITIAL RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

Background
October 6, 2016

1.0 BACKGROUND

1.1 INTRODUCTION

On April 17, 2015, the Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities [RIN-2050-AE81; FRL-9149-4] (EPA Final CCR Rule) was published in the Federal Register. Stantec Consulting Services Inc. (Stantec) was contracted by the Tennessee Valley Authority (TVA) to perform a run-on and run-off analysis on the Cumberland Fossil Plant's (CUF) Dry Ash Stack (DAS) CCR Landfill and evaluate compliance relative to §257.81 of the EPA Final CCR Rule.

CUF is a coal-fired, electric generating plant located in Stewart County, Tennessee. CUF is approximately 60 miles northwest from Nashville. The plant is located on the southern bank of the Cumberland River at Cumberland River Mile 103. Wells Creek flows around the southwest perimeter of CUF. CUF has two CCR Landfills, the DAS and the Gypsum Storage Area. CUF also has two CCR Surface Impoundments, the Stilling Pond (including Retention Pond) and Bottom Ash Pond. A separate run-on and run-off control system plan has been prepared for the Gypsum Storage Area. In addition, inflow design flood control plans have been prepared for the Stilling Pond (including Retention Pond) and the Bottom Ash Pond. This run-on and run-off control system plan addresses the DAS Landfill, which is an Existing CCR Landfill as defined by the EPA Final CCR Rule and consists of the approximate boundary area denoted in Figure 1.



Figure 1 Cumberland Fossil Plant

INITIAL RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

Background
October 6, 2016

1.2 OBJECTIVE

This Run-on and Run-off Control System Plan documents the controls for the DAS that are used to meet the requirements of §257.81 of the EPA Final CCR Rule. The objective of the analysis described herein is to evaluate compliance related to §257.81, specifically the following:

1. Run-off: The DAS run-off control system must collect and control the water volume resulting from a 25-year, 24-hour storm event.
2. Run-off (permitted discharge): Run-off point sources that discharge into waters of the United States must discharge through a National Pollutant Discharge Elimination System (NPDES) permitted outfall.
3. Run-on: The run-on control system must prevent flow onto the DAS for all stormwater flows up to the peak discharge from a 25-year, 24-hour storm event.

1.3 PLAN ELEMENTS

Specific Run-on and Run-off Control System Plan elements include:

- A description of stormwater control design and structures,
- Hydrological engineering calculations related to run-on and run-off flows,
- Amendments to the plan whenever there is a change in conditions that would substantially affect the plan,
- A professional engineer's certification stating that the Run-on and Run-off Control System Plan meets the requirements of §257.81 of the EPA Final CCR Rule.

The plan shall be revised every five years, and is considered complete when placed in the facility's operating record.

INITIAL RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

Existing Conditions
October 6, 2016

2.0 EXISTING CONDITIONS

The DAS is located to the west of the electrical generating facility. CUF utilizes coal to generate electricity. Bottom ash, fly ash and gypsum are coal combustion residuals. Bottom ash is sluiced to the Bottom Ash Pond, reclaimed, and then spread and compacted on the DAS. The fly ash is marketed for use in the construction materials industry. The non-marketed fly ash is conditioned in silos and transported by truck to the DAS where it is spread and compacted.

In general, the DAS surface consists of the following. The surface at the top of the DAS is compacted bottom and fly ash. The exterior slope of the DAS is graded to 3H:1V. The slopes have been capped with clay soil and vegetated with grass. Gravel roads are located on the top and on the exterior slopes of the DAS.

Stormwater run-off from the DAS is conveyed to the Stilling Pond through a combination of ditches, culverts, pipes, and a basin. Appendix A illustrates the drainage areas and ditches, and they are described below.

Run-off from the top area of the DAS (Area 1 in Appendix A) and the west side slopes is conveyed through ditches and into a detention basin (West Ditch Storage) before discharging into the Stilling Pond. The grass-lined ditch (West Ditch) located on the west perimeter of the DAS prevents run-off from the DAS and run-off collected upstream from the Gypsum Storage Area (GSA) from leaving the site. There is a culvert within the West Ditch that breaks the ditch into two reaches (West Ditch R1 and West Ditch R2). The culvert between West Ditch R1 and R2 has two, 30-inch diameter pipes. The GSA run-off flows into the upstream West Ditch R1, and the DAS's west side slope run-off discharges into the downstream West Ditch R2 before reaching the West Ditch Storage. Run-off from Area 1 and the GSA that discharges into the West Ditch Storage is discharged into the Stilling Pond through two concrete box riser structures.

Run-off from the DAS south and east side slopes (Area 2) is conveyed to the West Ditch Storage through a ditch (SE Central Ditch) that flows counter clockwise around the eastern half of the DAS, into the West Ditch Storage before discharging into the Stilling Pond. The SE Central Ditch has the potential to act as a detention basin during large storm events due to its large size and flow restriction at the culvert. The culvert has one 36-inch diameter pipe.

The Stilling Pond discharges through a spillway structure into the Cumberland River. Flow through the Stilling Pond spillway is subject to an active NPDES permit (permit number: No. TN0005789).

The DAS is built above adjacent ground; therefore, there is no run-off flow from surrounding areas.

INITIAL RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

Methods and Design Criteria
October 6, 2016

3.0 METHODS AND DESIGN CRITERIA

Criteria listed in the EPA Final CCR Rule were used to evaluate the performance of the DAS run-on and run-off control system. The following methods were used to evaluate requirements for the existing stormwater conveyance system and methods used to address them:

1. Run-off: Collect and control the run-off water volume of a 25-year, 24-hour design storm event.
 - **Area 1:** Calculations were completed to demonstrate that the conveyance system (West Ditch R1, West Ditch R2 and West Ditch Storage) is sufficiently sized to contain the flows that are intended to reach the Stilling Pond. A hydrologic analysis was conducted to estimate the 25-year, 24-hour peak water surface elevation for the West Ditch Storage and West Ditch R1 (acts as a detention basin) and also the run-off peak flow rates to conduct a hydraulic analysis and evaluate the capacity of West Ditch R1 and R2 during the 25-year, 24-hour storm.
 - **Area 2:** Calculations were completed to demonstrate that the conveyance system (SE Central Ditch) is sufficiently sized to contain the flows that are intended to reach the Stilling Pond. A hydrologic analysis was conducted to estimate the 25-year, 24-hour peak water surface elevation for the SE Central Ditch (acts as a detention basin) and also the run-off peak flow rates to conduct a hydraulic analysis and evaluate the capacity of the SE Central Ditch during the 25-year, 24-hour storm.
2. Run-off (permitted discharge): Run-off discharging into waters of the United States must flow through a permitted outfall.
 - Run-off from the DAS flows to the Stilling Pond, which flows through active NPDES permit (No. TN0005789)
3. Run-on: A run-on control system must be in place to prevent the peak discharge from the 25-year, 24-hour storm event onto the CCR Landfill.
 - No run-on discharges onto the DAS. Therefore, no analysis was performed.

Details of the run-off hydrology and hydraulics are provided in the following sections.

3.1 HYDROLOGY

The Soil Conservation Services (SCS) Technical Release 55 (TR-55) method was used within U.S. Army Corps of Engineers' Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS) Version 4.0 software to estimate the peak flows for the 25-year, 24-hour storm event.

INITIAL RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

Methods and Design Criteria
October 6, 2016

3.1.1 Rainfall Runoff and Distribution

The precipitation depth for the 25-year, 24-hour storm event is 6.20 inches and was obtained from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14. Appendix B displays the NOAA precipitation data. The SCS Type II storm distribution was applied to develop a rainfall hyetograph.

3.1.2 Curve Number (CN)

The land use cover on the DAS and contributing watersheds outside the DAS CCR Unit limits that discharge into the West and SE Central Ditches includes bottom and fly ash, vegetated clay soil (bottom and fly ash capping), and gravel surfaces.

The Cover Type for vegetated clay soils was judged to be best-represented by "Cover Type: Open Space (lawns, parks, etc.)" per NRCS TR-55, Table 2-2a. Vegetated cover less than 50 percent were assumed "Poor" cover type per NRCS-TR55, Table 2-2a. The clay soil layer was classified as HSG D. This analysis used a CN of 89 for vegetated clay soil areas (Capped).

The Cover Type for bottom and fly ash was judged to be best-represented by "Fallow: Bare soil" per NRCS TR-55, Table 2-2b. Based on the soil conductivity from the "Report of Geotechnical Exploration, Dry Fly Ash Stack and Gypsum Disposal Complex Cumberland Fossil Plant" (Geotechnical Report) developed by Stantec and dated June, 2010, the bottom and fly ash was classified as HSG C and a CN of 91.

The DAS also contains areas surfaced with gravel. The gravel surface areas were assumed to be compacted and used a CN of 91 per NRCS Table 2-2a.

Table 1 below summarizes the CN used for specific soil and land use combinations. Also, Appendix C depicts the CN boundaries.

Table 1 CN Summary

Soil and Land Use	NRCS TR-55 Tables 2-2a and 2-2b Cover Type	HSG	CN
Capped	Open Space (lawns, parks, etc.), assume "poor" grass cover	D	89
Bottom and Fly Ash	Fallow, "Bare Soil"	C	91
Gravel	Street and Roads, "Gravel"	D	91

3.1.3 Subwatershed Delineation

Subwatersheds were delineated in AutoCAD 2015. The watershed delineations were performed using topographic data provided by TVA dated October, 2014. Appendix D depicts the watersheds.

INITIAL RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

Methods and Design Criteria
October 6, 2016

3.1.4 Lag Time

The time of concentration for each subwatershed was calculated using the NRCS segmental approach described in TR-55. The longest hydraulic flow path in each subwatershed was delineated using topographic data and aerial imagery data (dated October 2014 and September 2013, respectively). The flowpaths were subdivided into sheet, shallow-concentrated and open-channel flow components. The following methods were used to calculate flow velocities (time of concentration was then found by dividing flow length by velocity) for each flow component:

- Sheet Flow: Sheet flow velocity was computed based on methodology presented in TR-55. This equation calculates time of concentration based on Manning's roughness coefficient for sheet flow, flow length (up to a maximum distance of 100 feet) slope, and the 2-year, 24-hour rainfall depth.
- Shallow Concentrated Flow: Shallow concentrated flow velocity was calculated based on methodology presented in TR-55. This equation calculates average velocity based on the slope and surface of the watercourse.
- Open Channel Flow: Open channel flow velocities were calculated by an iterative process. An initial velocity was assumed and compared to the predicted velocities calculated by HEC-HMS. Successive iterations were calculated until velocities converged.

The time of concentration was multiplied by 0.6 to calculate lag time based on the SCS Lag Time equation.

3.1.5 Reach Routing

Reach routings of subwatersheds through the ditches were analyzed using the Muskingum-Cunge reach routing method.

3.2 HYDRAULIC ANALYSIS

Hydraulic calculations were performed to evaluate whether the West Ditch R1, West Ditch R2 and SE Central Ditches are able to convey run-off from the 25-year, 24-hour storm to the Stilling Pond without leaving the site. In instances where the ditch outlets are controlled by a pipe/culvert, the ditch was also analyzed as a storage basin within HEC-HMS.

3.2.1 Ditch Capacity

The capacity of the ditches was analyzed using Manning's equations for open channel flow. The ditch geometry was retrieved from a cross section of each ditch generated in AutoCAD using the topographic data provided by TVA, dated October 2014. The ditches used to convey run-off are grass-lined. A Manning's "n" value of 0.03 was used in the grass-lined ditch analysis.

INITIAL RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

Methods and Design Criteria
October 6, 2016

The peak flows for the 25-year 24-hour storm event were retrieved from the HEC-HMS model. Table 2 shows the ditch dimensions.

Table 2 Ditch Geometry

Ditch Identification	Ditch Type	Bottom Width (ft)	Side Slope 1 (H:V)	Side Slope 2 (H:V)	Longitudinal Slope(ft/ft)	Depth (ft)
West Ditch R1	Trapezoidal – Grass-Lined	17	3	3	0.0014	4
West Ditch R2	Triangular – Grass-Lined	0	3	5	0.002	9.5
SE Central	Trapezoidal – Grass-Lined	8.6	3	3	0.002	20

3.2.2 Ditch Stage Storage

To compute storage volumes for the ditches modeled as basins within the HEC-HMS model, areas for each respective contour were computed in AutoCAD based on the October 2014 topographic data. HEC-HMS detention basin input data is displayed in Appendix E.

3.2.3 Culvert Pipes Rating Curves

Rating curves for the culvert pipes at the downstream end of West Ditch R1 and SE Central Ditch were computed using the HY-8 Culvert Hydraulic Analysis Program developed by the US Department of Transportation Federal Highway Administration (FHWA).

3.2.4 Drop Inlet Structure

Flow is conveyed to the Stilling Pond from the West Ditch Storage through two similar drop inlet structures. The drop inlet structures consist of a concrete riser box with a metal grate located in the West Ditch Storage, and a 36-inch concrete outlet pipe that penetrates the embankment and discharges into the Stilling Pond. These structures are controlled by weir or orifice flow through the riser, or by orifice or pipe flow through the outlet pipe. In developing a hydraulic rating curve for these structures, these four potential limiting flows are computed for a range of headwater elevations and the limiting flow is applied to develop a comprehensive rating curve for the structure. The methods used to estimate the discharge for each of these components are described below:

INITIAL RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

Methods and Design Criteria
October 6, 2016

Riser – Weir flow

Flow just above the riser crest or stoplogs behaves as weir flow and can be computed using:

$$Q = C_w LH^{\frac{3}{2}} \quad \text{Eqn. 1}$$

Where: Q = discharge (cubic feet per second); C_w = weir coefficient; L = weir length (ft); and H = head above the riser crest (ft). The weir is assumed to behave as a sharp-crested weir and therefore a weir coefficient of 3.27 (Chow 1959) will be selected.

Riser – Orifice flow

As head develops above the riser crest, orifice flow in the riser may limit flow through the spillway system. Orifice flow in the riser can be computed as:

$$Q = C_0 A(2gH)^{0.5} \quad \text{Eqn. 2}$$

Where C_0 = orifice discharge coefficient, A = cross sectional area of the riser, g = gravitational constant, and H = head above the riser crest. An orifice discharge coefficient of 0.6 (Brater and King 1976) will be selected.

Outlet Pipe – Orifice flow

Orifice flow in the outlet pipe will also be computed for the range of hydraulic conditions using:

$$Q = C_0 A[2g(H_c)]^{0.5} \quad \text{Eqn. 3}$$

Where H_c = head above the centroid of the outlet pipe, A = cross sectional area of the outlet pipe. This equation reflects that the head acts on the centroid of flow in the outlet pipe.

Outlet Pipe – Open-channel/submerged inlet flow

Open-channel flow in the outlet pipe will also be computed using the HY-8 Culvert Hydraulic Analysis Program developed by the US Department of Transportation Federal Highway Administration (FHWA).

Rating curves for the structures are included in Appendix F.

INITIAL RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

Methods and Design Criteria
October 6, 2016

3.3 MODELING ASSUMPTIONS

Assumptions related to the hydrologic and hydraulic calculations were as follows:

- The model represents existing conditions as of January, 2016.
- A portion of the West Ditch becomes part of the West Ditch Storage when run-off backs up.
- The elevation in the Stilling Pond used in this analysis was 379.8 feet. The Stilling Pond water elevation was based on the 100-year, 24-hour elevation as stated in the "Cumberland Fossil Plant Ash Stilling Pond Spillway Improvement Project" Basis of Design Report dated March 2012.
- Ditches were modeled as basins, and the storage capacity upstream from culverts was considered in the analyses.

INITIAL RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

Calculation Results
October 6, 2016

4.0 CALCULATION RESULTS

The calculation results were used to evaluate performance relative to the requirements of §257.81 of the EPA Final CCR Rule for Run-on and Run-off Controls.

4.1 RUN-OFF

Table 3 displays the peak run-off and ditch capacity in cubic feet per second (cfs) for sub-reaches along the West and SE Central Ditches. Appendices E, H and I show the location of the ditches, the HMS model output, and the hydraulic calculations, respectively.

Table 3 Ditch Capacity

Ditch Identification	Discharge (25-year, 24-hour) (cfs)	Ditch Capacity (cfs)
West Ditch R1	64	425
West Ditch R2	60	2,200
SE Central	66	12,000

In addition, the HEC-HMS model was used to calculate the peak water elevation as run-off backs up in the ditches. Table 4 below displays the peak water elevation in the ditches and also the West Ditch Storage and their respective over-flow elevation. Please note, the West Ditch Storage has the potential to backflow into the West Ditch R2; hence "See "West Ditch Storage" " comment in Table 4 below.

Table 4 Ditch Storage-Elevation

Ditch Identification	Elevation (25-year, 24-hour) (feet)	Ditch Overflow Elevation (feet)
West Ditch R1	393.1	395
West Ditch R2	See "West Ditch Storage"	See "West Ditch Storage"
West Ditch Storage	386.3	394
SE Central	390.3	394

Table 3 and Table 4 illustrates that the ditches are able to convey discharge from the 25-year, 24-hour storm event.

INITIAL RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

Calculation Results
October 6, 2016

4.2 CONCLUSION

Based on the calculations included in this report, CUF DAS meets the requirements of §257.81 of the EPA Final CCR Rule for Run-on and Run-off Controls. The following summarizes compliance with EPA Final CCR Rule criteria:

1. Run-off: Area 1's West Ditch R1 and West Ditch R2 and West Ditch Storage and Area 2's SE Central Ditch are capable of conveying run-off for the 25-year, 24 hour storm event before discharging into the Stilling Pond. Based on the "Cumberland Fossil Plant Ash Stilling Pond Spillway Improvement Project" Basis of Design Report, the Stilling Pond and its outlets safely pass the 6-hour, Probable Maximum Precipitation (PMP) storm without overtopping the dikes. The 6-hour PMP is significantly larger than the 25-year, 24-hour storm event. Therefore, the run-off control system collects and controls the water volume resulting from a 25-year, 24-hour storm.
2. Run-off (permitted discharge): Run-off from the DAS flows to the Stilling Pond. The Stilling Pond discharges through an active NPDES permitted outfall, and is therefore handled in accordance with surface water requirements under §257.3-3.
3. Run-on: The DAS is built above adjacent ground; therefore, there is no run-on. Therefore the run-on control system prevents flow onto the active portion of the CCR Unit during the peak discharge from a 25-year, 24-hour storm.

INITIAL RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

References
October 6, 2016

5.0 REFERENCES

1. Stantec (2012). "Cumberland Fossil Plant Ash Stilling Pond Spillway Improvements Project, Basis of Design Report." Prepared for Tennessee Valley Authority, March, 2012.
2. Stantec (2010). "Report of Geotechnical Exploration, Dry Fly Ash Stack and Gypsum Disposal Complex Cumberland Fossil Plant" Basis of Design Report." Prepared for Tennessee Valley Authority, June, 2010.
3. "175554020_01_gsxxx_eg01_current.dwg, Topographic data." Provided by Tennessee Valley Authority, October, 2014.
4. Site aerial imagery prepared for Tennessee Valley Authority, September, 2013.
5. Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities [RIN-2050-AE81; FRL-9149-4] (EPA Final CCR Rule) April 2015.
6. United States Department of Agriculture (1986). "Urban Hydrology for Small Watersheds, TR-55." June, 1986.
7. Brater, E.F. and H.W. King (1976), Handbook of Hydraulics, McGraw-Hill, New York.

**APPENDIX A
GENERAL DRAINAGE MAP**

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Figure No.

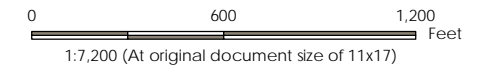
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Title

GENERAL DRAINAGE MAP CUF - DRY ASH STACK

Client/Project
Tennessee Valley Authority
Run-On/Run-Off Control Plan
175555021

Project Location	175555021
815 Cumberland City Rd	Prepared by MAM on 2015-12-22
Cumberland City,	Technical Review by JJR on 2015-12-22
Stewart County, Tennessee	Independent Review by MMM on 2015-12-22



Legend

Approximate CCR Unit Boundary

Flow Arrows

Watersheds

Area 1

Area 2

Ditches

West Ditch R1

West Ditch R2

SE Central Ditch



Notes

1. Coordinate System: NAD 1927 StatePlane Tennessee FIPS 4100
2. Topographic Survey Data dated October 27, 2014
3. Aerial Imagery dated September 2013



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APPENDIX B
NOAA RAINFALL DEPTHS



NOAA Atlas 14, Volume 2, Version 3
 Location name: Cumberland City, Tennessee, US*
 Latitude: 36.3843°, Longitude: -87.6554°
 Elevation: 386 ft*
 * source: Google Maps



POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aerals](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.393 (0.361-0.431)	0.462 (0.424-0.507)	0.532 (0.488-0.583)	0.588 (0.538-0.642)	0.657 (0.598-0.718)	0.709 (0.644-0.775)	0.761 (0.686-0.832)	0.810 (0.727-0.887)	0.873 (0.776-0.959)	0.923 (0.812-1.01)
10-min	0.629 (0.577-0.689)	0.739 (0.679-0.811)	0.852 (0.781-0.933)	0.940 (0.861-1.03)	1.05 (0.954-1.14)	1.13 (1.02-1.23)	1.21 (1.09-1.32)	1.28 (1.15-1.41)	1.38 (1.23-1.52)	1.45 (1.28-1.60)
15-min	0.786 (0.721-0.861)	0.929 (0.853-1.02)	1.08 (0.988-1.18)	1.19 (1.09-1.30)	1.33 (1.21-1.45)	1.43 (1.30-1.56)	1.53 (1.38-1.67)	1.62 (1.45-1.77)	1.74 (1.54-1.91)	1.82 (1.60-2.01)
30-min	1.08 (0.988-1.18)	1.28 (1.18-1.41)	1.53 (1.40-1.68)	1.72 (1.58-1.88)	1.97 (1.79-2.15)	2.15 (1.96-2.35)	2.34 (2.11-2.56)	2.52 (2.26-2.76)	2.77 (2.46-3.04)	2.95 (2.60-3.25)
60-min	1.34 (1.23-1.47)	1.61 (1.48-1.77)	1.96 (1.80-2.15)	2.24 (2.06-2.45)	2.62 (2.38-2.86)	2.92 (2.65-3.19)	3.22 (2.91-3.53)	3.54 (3.17-3.87)	3.97 (3.53-4.36)	4.31 (3.79-4.74)
2-hr	1.56 (1.43-1.71)	1.87 (1.71-2.04)	2.28 (2.08-2.48)	2.61 (2.39-2.85)	3.07 (2.79-3.34)	3.44 (3.11-3.75)	3.83 (3.44-4.17)	4.23 (3.78-4.62)	4.79 (4.22-5.24)	5.23 (4.58-5.75)
3-hr	1.70 (1.56-1.85)	2.03 (1.87-2.21)	2.47 (2.27-2.69)	2.84 (2.60-3.09)	3.35 (3.05-3.63)	3.76 (3.42-4.09)	4.19 (3.78-4.56)	4.65 (4.17-5.07)	5.29 (4.68-5.78)	5.80 (5.08-6.36)
6-hr	2.09 (1.92-2.28)	2.49 (2.29-2.72)	3.04 (2.79-3.32)	3.50 (3.20-3.81)	4.14 (3.77-4.51)	4.68 (4.23-5.09)	5.25 (4.71-5.72)	5.85 (5.21-6.39)	6.71 (5.89-7.34)	7.40 (6.43-8.13)
12-hr	2.54 (2.33-2.80)	3.04 (2.78-3.34)	3.72 (3.40-4.09)	4.28 (3.90-4.70)	5.08 (4.60-5.57)	5.74 (5.17-6.29)	6.44 (5.74-7.06)	7.18 (6.36-7.89)	8.24 (7.19-9.07)	9.10 (7.87-10.1)
24-hr	3.09 (2.88-3.33)	3.69 (3.44-3.98)	4.53 (4.22-4.89)	5.22 (4.85-5.63)	6.20 (5.73-6.66)	6.99 (6.44-7.52)	7.83 (7.17-8.42)	8.71 (7.92-9.38)	9.95 (8.96-10.7)	11.0 (9.79-11.8)
2-day	3.68 (3.44-3.96)	4.40 (4.12-4.74)	5.41 (5.06-5.83)	6.24 (5.83-6.71)	7.42 (6.89-7.96)	8.38 (7.75-8.99)	9.39 (8.63-10.1)	10.5 (9.55-11.3)	12.0 (10.8-12.9)	13.2 (11.8-14.3)
3-day	3.91 (3.65-4.20)	4.67 (4.37-5.03)	5.74 (5.36-6.17)	6.60 (6.16-7.09)	7.81 (7.26-8.39)	8.80 (8.14-9.45)	9.84 (9.04-10.6)	10.9 (9.98-11.8)	12.4 (11.3-13.4)	13.7 (12.2-14.8)
4-day	4.14 (3.87-4.45)	4.95 (4.63-5.32)	6.06 (5.67-6.52)	6.96 (6.50-7.47)	8.21 (7.63-8.81)	9.23 (8.54-9.91)	10.3 (9.46-11.1)	11.4 (10.4-12.3)	12.9 (11.7-13.9)	14.1 (12.7-15.3)
7-day	4.91 (4.57-5.29)	5.87 (5.47-6.32)	7.20 (6.70-7.76)	8.29 (7.69-8.93)	9.84 (9.09-10.6)	11.1 (10.2-12.0)	12.5 (11.4-13.4)	13.9 (12.6-15.0)	15.9 (14.3-17.2)	17.6 (15.7-19.1)
10-day	5.57 (5.21-5.97)	6.64 (6.21-7.13)	8.07 (7.55-8.66)	9.22 (8.60-9.88)	10.8 (10.0-11.6)	12.1 (11.2-13.0)	13.4 (12.3-14.4)	14.8 (13.5-15.9)	16.7 (15.1-18.0)	18.2 (16.3-19.7)
20-day	7.56 (7.13-8.03)	8.97 (8.45-9.53)	10.7 (10.0-11.3)	11.9 (11.2-12.7)	13.7 (12.8-14.5)	15.0 (14.0-15.9)	16.3 (15.2-17.3)	17.6 (16.3-18.7)	19.3 (17.8-20.6)	20.6 (18.8-22.0)
30-day	9.20 (8.68-9.75)	10.9 (10.3-11.5)	12.8 (12.0-13.5)	14.2 (13.4-15.1)	16.2 (15.2-17.1)	17.6 (16.5-18.7)	19.1 (17.8-20.3)	20.5 (19.1-21.8)	22.4 (20.7-23.9)	23.8 (21.9-25.4)
45-day	11.5 (10.9-12.2)	13.6 (12.9-14.3)	15.8 (14.9-16.6)	17.4 (16.5-18.3)	19.5 (18.4-20.6)	21.1 (19.9-22.2)	22.6 (21.3-23.9)	24.1 (22.6-25.5)	26.0 (24.3-27.5)	27.3 (25.4-29.0)
60-day	13.8 (13.1-14.6)	16.2 (15.4-17.1)	18.7 (17.8-19.7)	20.6 (19.5-21.7)	22.8 (21.6-24.1)	24.5 (23.1-25.9)	26.1 (24.6-27.6)	27.6 (25.9-29.1)	29.4 (27.5-31.1)	30.7 (28.6-32.5)

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.

[Back to Top](#)

PF graphical

APPENDIX C
CURVE NUMBER BOUNDARIES MAP

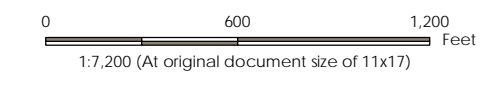


Figure No.
2
Title
CURVE NUMBER BOUNDARIES MAP
CUF - DRY ASH STACK

Client/Project
Tennessee Valley Authority
Run-On/Run-Off Control Plan
175555021

Project Location
815 Cumberland City Rd
Cumberland City,
Stewart County, Tennessee

175555021
Prepared by MAM on 2015-12-22
Technical Review by JJR on 2015-12-22
Independent Review by MMM on 2015-12-22



- Legend**
- Approximate CCR Unit Boundary
 - Curve Number**
 - Capped CN=89
 - Bottom/Fly Ash CN=91
 - Gravel CN=91



- Notes**
1. Coordinate System: NAD 1927 StatePlane Tennessee FIPS 4100
 2. Topographic Survey Data dated October 27, 2014
 3. Aerial Imagery dated September 2013
 4. Coal Yard CN=91 and no CN for Fossil Plant - Please see Report

\\US1276-f02\shared_projects\175555021\gis\mxd\cuf_ash_stack\figure2.mxd Revised: 2016-09-21 By: jgreys
 728345

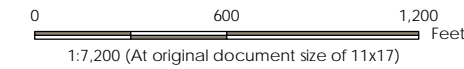
APPENDIX D
WATERSHED BOUNDARIES MAP



Figure No. 3
 Title: WATERSHED BOUNDARIES MAP
 CUF - DRY ASH STACK

Client/Project: Tennessee Valley Authority
 Run-On/Run-Off Control Plan
 175555021

Project Location: 815 Cumberland City Rd, Cumberland City, Stewart County, Tennessee
 Prepared by MAM on 2015-12-22
 Technical Review by JJR on 2015-12-22
 Independent Review by MMM on 2015-12-22



- Legend
- Approximate CCR Unit Boundary
 - Watershed (Within CCR Unit Limits)
 - Watershed (Outside CCR Unit Limits)



- Notes
1. Coordinate System: NAD 1927 StatePlane Tennessee FIPS 4100
 2. Topographic Survey Data dated October 27, 2014
 3. Aerial Imagery dated September 2013

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 728345

APPENDIX E
DITCH STAGE STORAGE

West Ditch Storage

Item No.	Basin Elevation (ft) (1)	Height (ft)	Surface Area (sf) (1)	Surface Area (ac)	Storage per Elevation Interval (ac-ft) (2)	Cumulative Storage (ac-ft)	Item No.
1	378		196	0.005	0.00	0.00	1
2	379	1.0	20,885	0.479	0.24	0.24	2
3	380	2.0	46,026	1.057	0.77	1.01	3
4	381	3.0	77,106	1.770	1.41	2.42	4
5	382	4.0	105,593	2.424	2.10	4.52	5
6	383	5.0	125,700	2.886	2.65	7.18	6
7	384	6.0	150,550	3.456	3.17	10.35	7
8	385	7.0	179,460	4.120	3.79	14.13	8
9	386	8.0	217,032	4.982	4.55	18.69	9
10	387	9.0	260,296	5.976	5.48	24.16	10
11	388	10.0	326,583	7.497	6.74	30.90	11
12	389	11.0	406,871	9.340	8.42	39.32	12
13	390	12.0	475,114	10.907	10.12	49.44	13

SE Central Ditch

Item No.	Basin Elevation (ft) (1)	Height (ft)	Surface Area (sf) (1)	Surface Area (ac)	Storage per Elevation Interval (ac-ft) (2)	Cumulative Storage (ac-ft)	Item No.
1	386.43		1	0.000	0.00	0.00	1
1	387	0.6	30	0.001	0.00	0.00	1
2	388	1.6	5,574	0.128	0.06	0.00	2
3	389	2.6	10,932	0.251	0.19	0.06	3
4	390	3.6	24,973	0.573	0.41	0.25	4
5	391	4.6	39,699	0.911	0.74	0.67	5
6	392	5.6	62,327	1.431	1.17	1.41	6
7	393	6.6	81,713	1.876	1.65	2.58	7
8	394	7.6	98,087	2.252	2.06	4.23	8

West Ditch R1

Item No.	Basin Elevation (ft) (1)	Height (ft)	Surface Area (sf) (1)	Surface Area (ac)	Storage per Elevation Interval (ac-ft) (2)	Cumulative Storage (ac-ft)	Item No.
1	390		867	0.020	0.00	0.00	1
2	391	1.0	1,193	0.027	0.02	0.00	2
3	392	2.0	1,569	0.036	0.03	0.02	3
4	393	3.0	30,519	0.701	0.37	0.06	4
5	394	4.0	84,231	1.934	1.32	0.42	5
6	395	5.0	138,792	3.186	2.56	1.74	6

APPENDIX F
CONSTRUCTION DRAWINGS

A

B

C

D

E

F

G

H

A

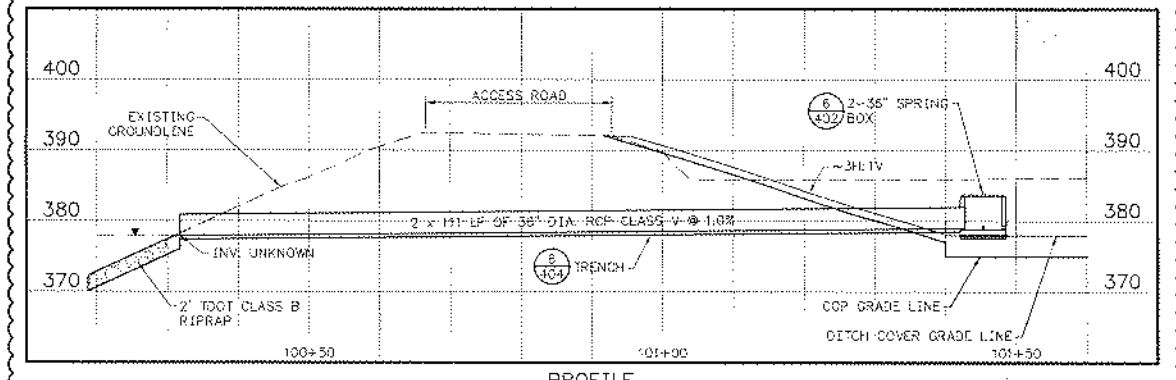
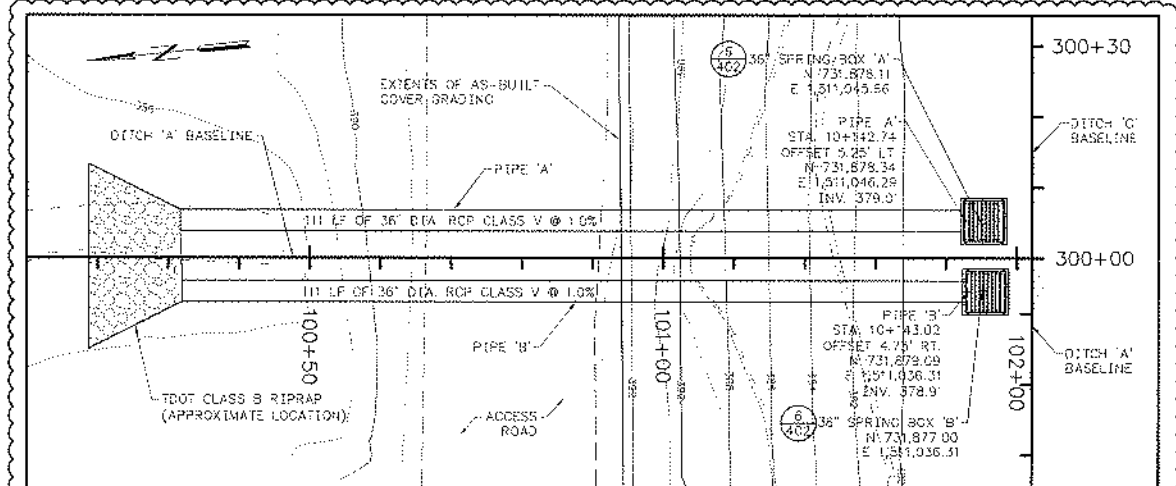
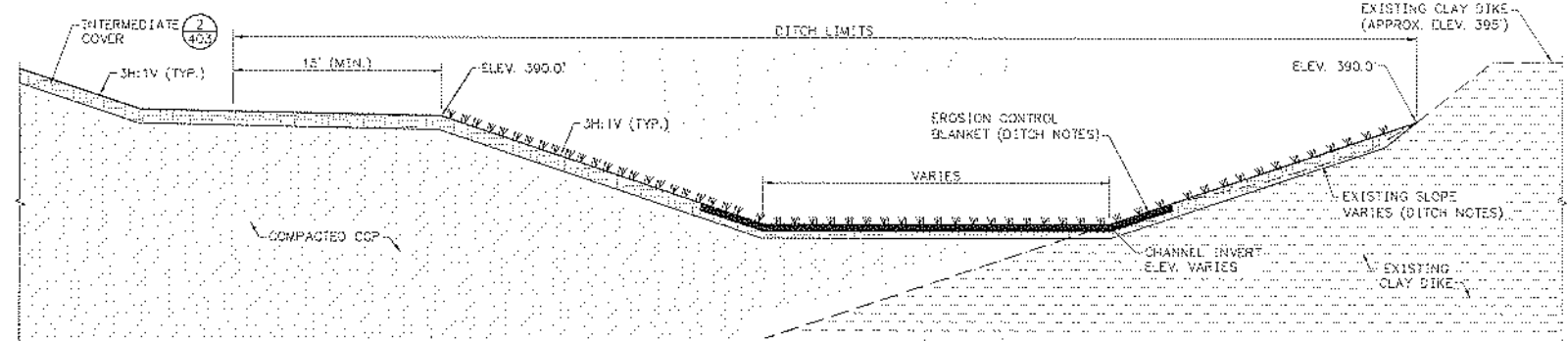
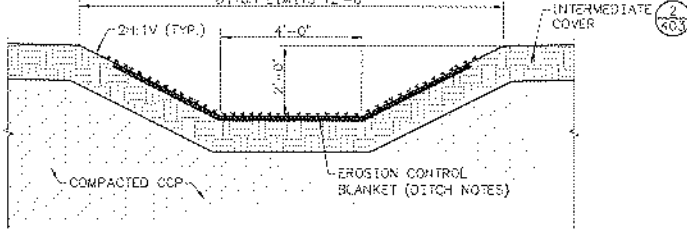
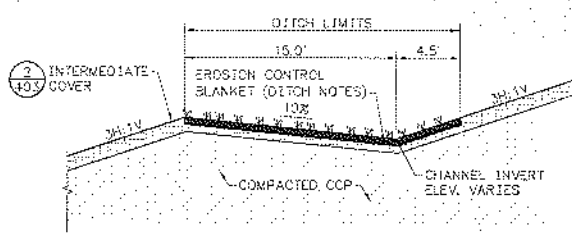
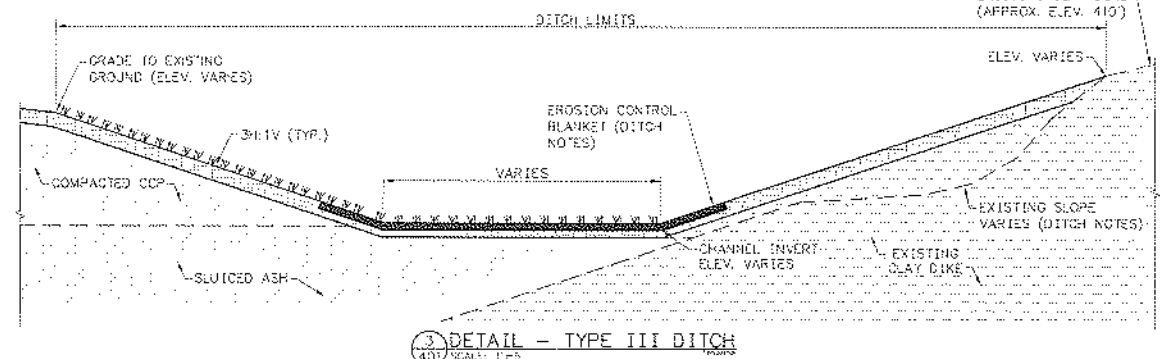
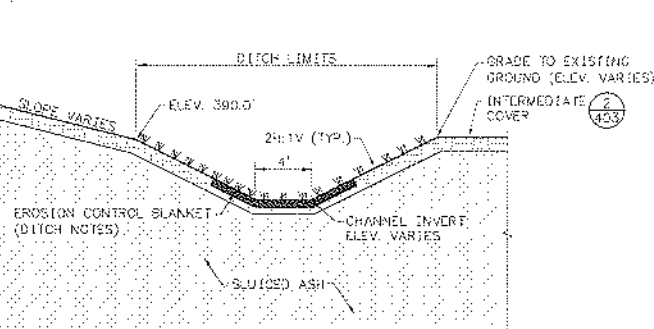
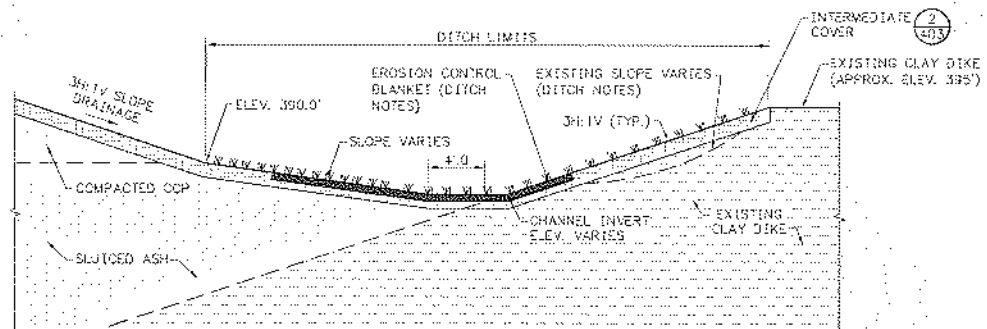
B

C

D

F

F



- DITCH NOTES:**
1. VEGETATION AND DEBRIS SHALL BE REMOVED AND DISPOSED OFFSITE AT THE DIRECTION OF THE TVA.
 2. CLAY SHALL BE PLACED AND COMPACTED ALONG THE INTERIOR SLOPE OF THE CLAY DIKES TO ACHIEVE THE 3H:1V INTERIOR SLOPE AS SHOWN.
 3. CONSTRUCTION WORK BELOW ELEVATION 401 FEET MAY ENCOUNTER SOFT SLUDGED ASH POND MATERIALS, SEEPAGE AND ACCUMULATING WATER. DEWATERING PLANS SHALL BE IMPLEMENTED BY THE CONTRACTOR AS FIELD AND WEATHER CONDITIONS DICTATE.

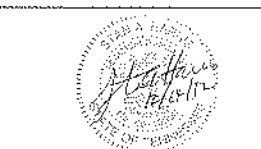
4. WHEN DITCH SUBGRADE IS REACHED BY EXCAVATING TO THE LINES SHOWN, STABILIZATION OF THE DITCH FOUNDATION SURFACE SHALL BE REQUIRED AS NECESSARY TO PRODUCE NON-YIELDING SURFACE AS DETERMINED BY PROOF ROLL TEST. A COMBINED STABILIZATION METHOD OF OVEREXCAVATION, PLACEMENT AND COMPACTION OF CRUSHED STONE ON BOTTOM ASH SHALL BE USED AS CONDITIONS DICTATE. PROOF ROLL TEST SHALL BE PERFORMED UNDER THE SUPERVISION OF THE QC MANAGER OR HIS/HER DESIGNEE.
5. EROSION CONTROL BLANKET SHALL BE INSTALLED IN THE BOTTOM OF DITCH TO A DEPTH OF 18 INCHES.

RECORD DRAWING NOTES:

1. THESE DRAWINGS HAVE BEEN PREPARED BASED ON SURVEY INFORMATION OBTAINED BY TVA SURVEYING THROUGHOUT THE DURATION OF THE CONSTRUCTION AND RED LINE DRAWINGS PREPARED BY TRANS ASH.
2. ITEMS SHOWN ON THE "RECORD DRAWING" WITH CLOUDED NOTATION ARE ITEMS FOR WHICH SUFFICIENT AS-BUILT INFORMATION WAS AVAILABLE. ALL OTHER ITEMS ARE SHOWN FOR REFERENCES AS THEY WERE IN THE "ISSUED FOR CONSTRUCTION" PLAN SET.

RECORD DRAWING

SEE DRAWING 10W551-102 FOR LIST OF COMPANION, REFERENCE DRAWINGS AND SUPPORTING DESIGN CALCULATIONS NUMBER.



Stantec
Stantec Consulting Services Inc.
1624 North Foothill Road
Littleton, CO 80120
303.441.8831
Tel: 482.422.5000
Fax: 482.422.5100
www.stantec.com

PROJECT REVISION HISTORY

REV	DATE	BY	DESCRIPTION
1	09/22/11	SM	ISSUED FOR CONSTRUCTION

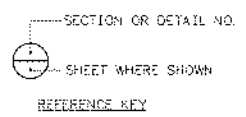
REV	DATE	BY	DESCRIPTION
1	12/14/11	SM	ISSUED FOR CONSTRUCTION
2	01/16/12	SM	ISSUED FOR CONSTRUCTION

SCALE: AS SHOWN EXCEPT AS NOTED

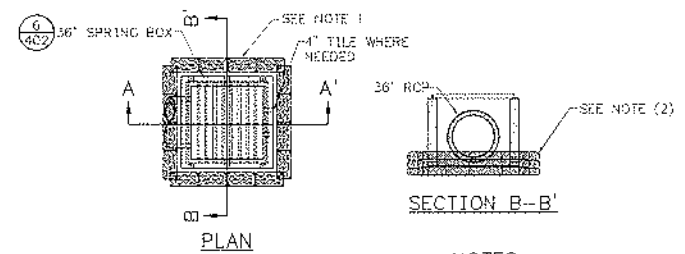
YARD
DRY FLY ASH STACK AND GYPSUM DISPOSAL COMPLEX
GRADING/DRAINAGE IMPROVEMENTS
DETAILS
WORK PLAN 11 (CUF-110310-WP-11)

CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 DWG 02/29/11 46 C 10W551-401 R 2



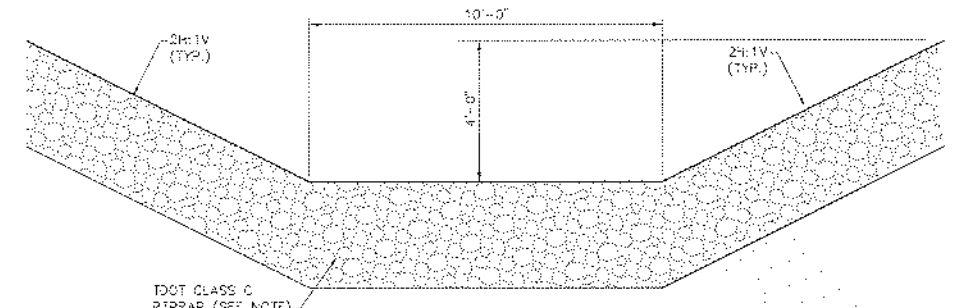
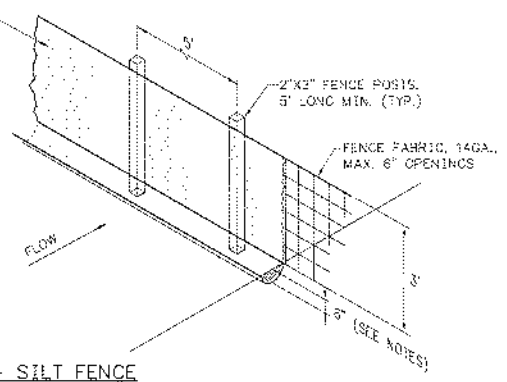
STANTEC	2
TASK COMPLETED BY:	REV NO.



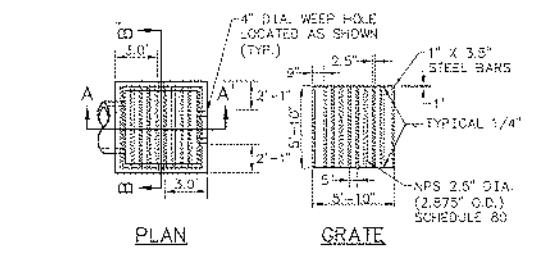
- NOTES:**
1. TDOT NO. 9 CRUSHED STONE CONTAINED IN PERVIOUS RIPRAP BAGS OR IN SYNTHETIC NET BAGS (3 MESH), APPROXIMATELY 24 INCHES LONG, 12 INCHES WIDE AND 6 INCHES HIGH.
 2. PLACE BAGS SUCH THAT THERE ARE NO GAPS BETWEEN BAGS. BAGS MAY BE DOUBLE OR TRIPLE LAYERS, AS THE SITUATION DICTATES.
 3. ALL CRUSHED LIMESTONE SHALL BE IN ACCORDANCE WITH THE TENNESSEE DEPARTMENT OF TRANSPORTATION.

GEOTEXTILE FABRIC SHALL BE ATTACHED TO FENCE USING STAPLES, HOORINGS OR OTHER METHODS APPROVED BY THE OWNER (SEE NOTES).

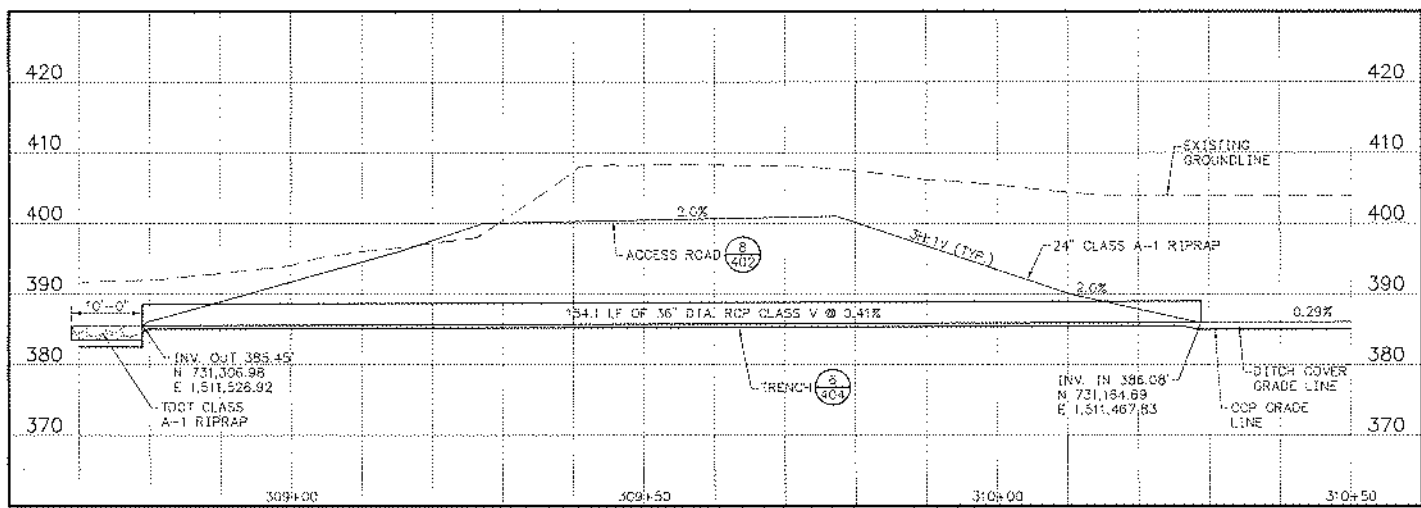
- NOTES:**
1. THE BOTTOM 12 INCHES OF THE FABRIC SHALL BE BURIED IN A 6-INCH TRENCH CUT INTO THE GROUND OR COVERED BY 6 INCHES OF FILL MATERIAL TO PREVENT SEDIMENT FROM ESCAPING UNDER THE FENCE. ALL EARTHWORK SHALL BE ON THE UPSTREAM SIDE OF THE FENCE.
 2. GEOTEXTILE FABRIC SHALL MEET THE FOLLOWING SPECIFICATIONS: GRAB STRENGTH (ASTM D 4632) - 30 LBS. MIN., WIDTH - 4 FEET MIN., APPARENT OPENING SIZE (ASTM D4751) NO. 20, ULTRAVIOLET DEGRADATION (ASTM D 4365) 70% STRENGTH RETAINED, ELONGATION AT 45LB (ASTM D 4832).



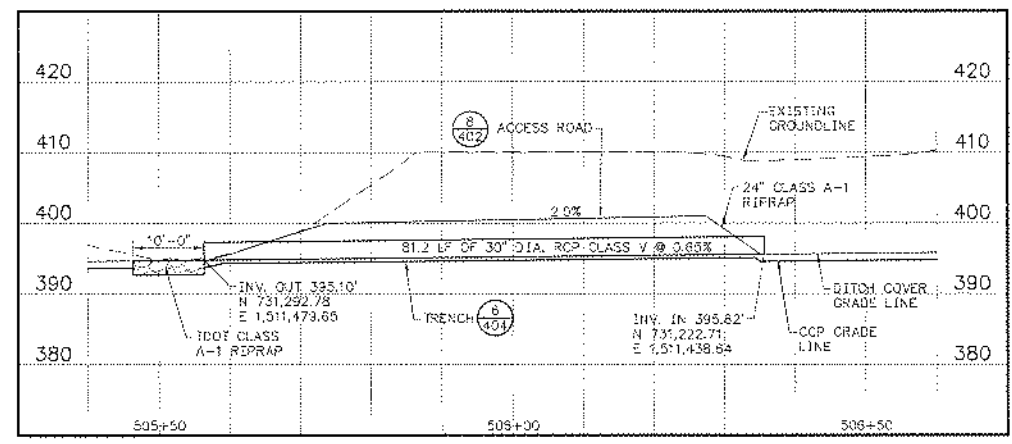
NOTE: TDOT CLASS C RIPRAP SHALL BE PLACED TO A DEPTH OF 3 FEET IN THE RIPRAP FLUME.



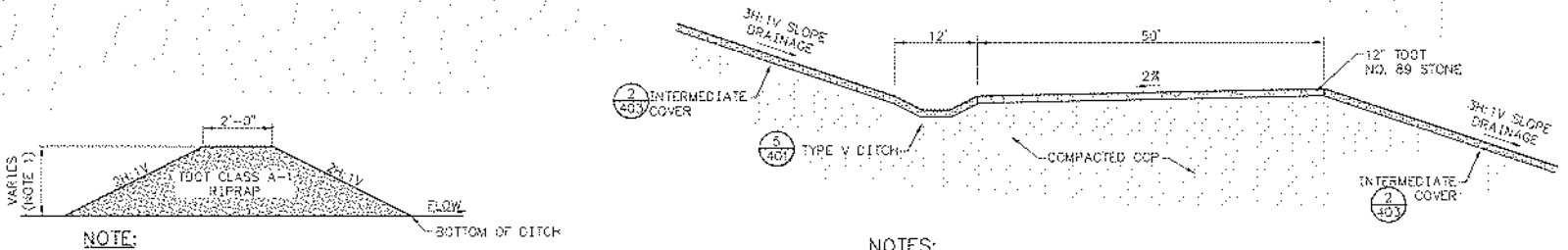
- NOTES:**
1. ALL STEEL SHALL HAVE A 2 INCH MINIMUM CLEARANCE TO ANY CONCRETE FACE.
 2. ALL STEEL SHALL BE INSTALLED ACCORDING TO TDOT DWG. D-CB-385C.
 3. CONCRETE JOINT MATERIAL TO BE 0.5" PREMOLDED FIBER IN ACCORDANCE WITH SECTION 905 OF STANDARD SPECIFICATIONS.
 4. TO BE USED IN CONJUNCTION WITH TDOT DWG. D-CB-385C.
- GRATE NOTES:**
1. MATERIAL FOR GRATE SPECIFICATIONS FOR STEEL BARS SHALL CONFORM TO ASTM A36 FOR THE PIPE CROSS MEMBERS, ASTM A53 TYPE E OR S GRADE A OR B. THE GRATE UNIT SHALL BE PAINTED BLACK, FEDERAL SPEC. TT-E-489A.
 2. ALL WELDS SHALL BE IN ACCORDANCE WITH AWS SPECIFICATIONS D11-72 AS MODIFIED BY THE CURRENT AASHTO STD. SPECIFICATIONS FOR WELDING OF HIGHWAY BRIDGES.
 3. CONTRACTOR TO SUBMIT SHOP DRAWING OF GRATE FOR ENGINEER'S APPROVAL.



NOTE: 2 FEET DEEP X 19 FEET WIDE X 10 FEET LONG RIPRAP SCOUR PROTECTION BLANKET SHALL BE PLACED IN THE TYPE IV DITCH AT THE OUTLET OF THE 36 INCH DIAMETER RCP PIPE.



NOTE: 2 FEET DEEP X 19 FEET WIDE X 10 FEET LONG RIPRAP SCOUR PROTECTION BLANKET SHALL BE PLACED IN THE TYPE IV DITCH AT THE OUTLET OF THE 30 INCH DIAMETER RCP PIPE.



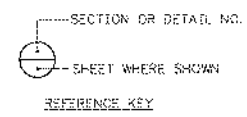
NOTE: THE HEIGHT OF THE ROCK CHECK DAM SHALL NOT EXCEED THE DEPTH OF THE DITCH.

- NOTES:**
1. VEGETATION TO BE ESTABLISHED IN ACCORDANCE WITH THE TECHNICAL SPECIFICATIONS.
 2. CCP DESIGNATES ALL PERMITTED COAL COMBUSTION PRODUCTS.

DETAIL - ACCESS ROAD
SCALE: 1"=10'

RECORD DRAWING NOTES:

1. THESE DRAWINGS HAVE BEEN PREPARED BASED ON SURVEY INFORMATION OBTAINED BY TMA SURVEYING THROUGHOUT THE DURATION OF THE CONSTRUCTION AND RED LINE DRAWINGS PREPARED BY TRANS ASH.
2. ITEMS SHOWN ON THE "RECORD DRAWING" WITH CLOUDED NOTATION ARE ITEMS FOR WHICH SUFFICIENT AS-BUILT INFORMATION WAS AVAILABLE. ALL OTHER ITEMS ARE SHOWN FOR REFERENCES AS THEY WERE IN THE "ISSUED FOR CONSTRUCTION" PLAN SET.



RECORD DRAWING

PROJECT REVISION HISTORY									
NO.	DATE	BY	DESCRIPTION	CHKD.	APP'D.	REV.	DATE	BY	DESCRIPTION
1	09/20/11	CU	ISSUED FOR CONSTRUCTION						

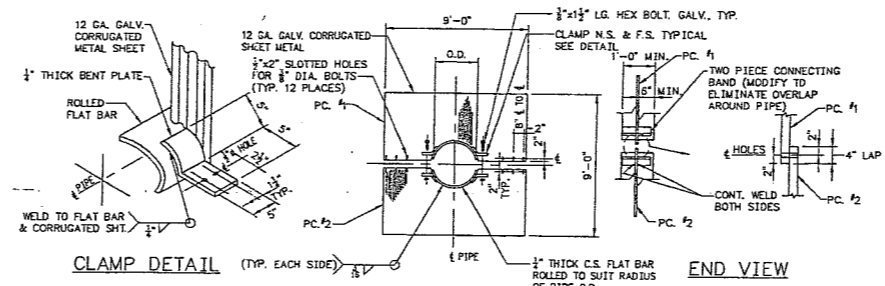
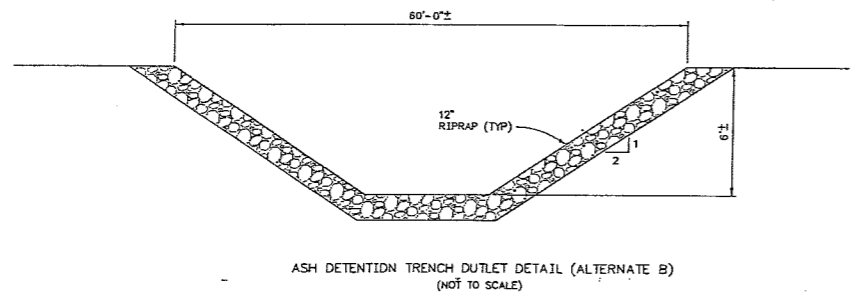
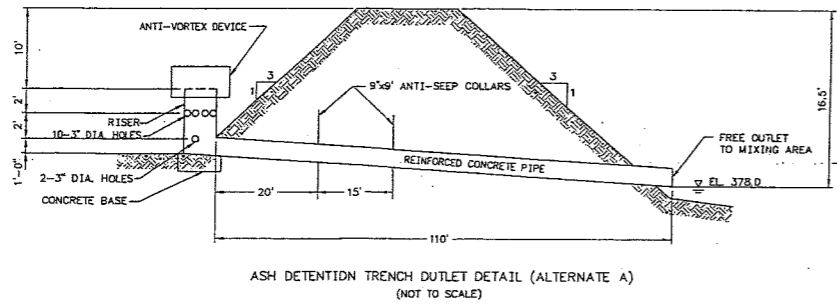
SCALE: AS SHOWN EXCEPT AS NOTED

YARD DRY FLY ASH STACK AND GYPSUM DISPOSAL COMPLEX GRADING/DRAINAGE IMPROVEMENTS DETAILS WORK PLAN 11 (CUF-110310-WP-11)

Stantec Consulting Services Inc.
1600 North Forbes Road
Lebanon, Kentucky 40531-2204
Tel: 858-422-3300
Fax: 858-422-3150
www.stantec.com

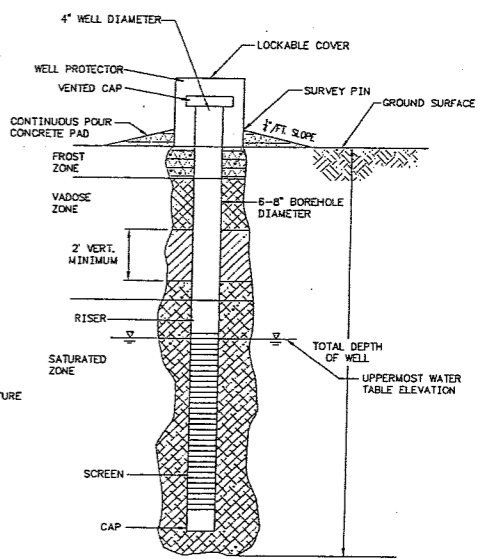
CUMBERLAND FOSSIL PLANT TENNESSEE VALLEY AUTHORITY FOSSIL AND HYDRO ENGINEERING

AUTOMATIC # 2000 SHEET 45 OF 45 C 10W551-402 R 2



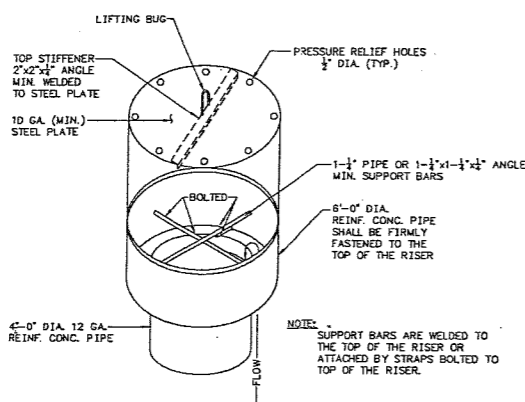
NOTE:
 1) PROVIDE TWO ANTI-SEEP COLLARS, LOCATIONS LATER.
 2) THE LAP BETWEEN THE TWO HALF SECTIONS AND BETWEEN THE PIPE & CONNECTING BAND SHALL BE CAULKED WITH BITUMINOUS MASTIC AT THE TIME OF INSTALLATION.
 3) UNASSEMBLED COLLARS SHALL BE MARKED BY PAINTING OR TAGGING TO IDENTIFY MATCHING PAIRS.

ANTI-SEEP COLLAR
SCALE: NONE

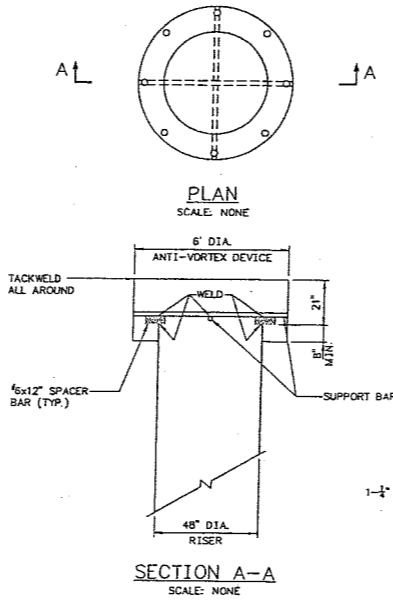


BENTONITE/CEMENT MIXTURE ANGULAR SEALANT
 BENTONITE
 GRANULAR BACKFILL FILTER PACK

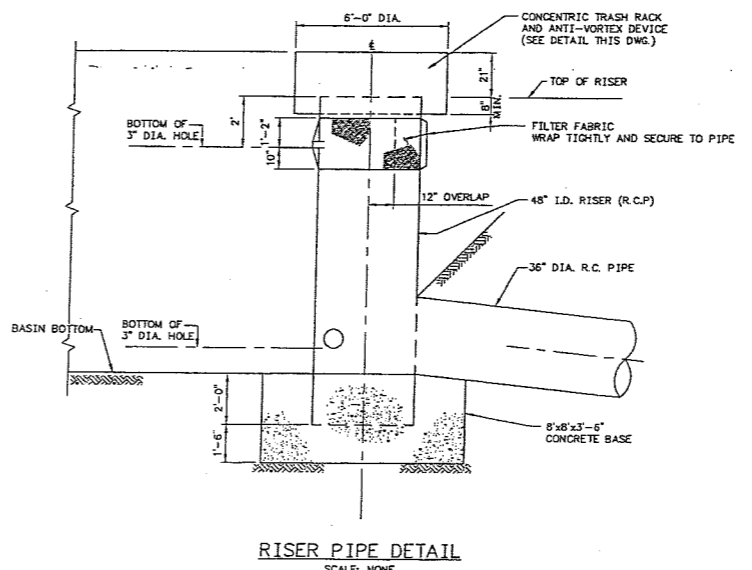
MONITORING WELL
SCALE: NONE



CONCENTRIC TRASH RACK AND ANTI-VORTEX DEVICE
SCALE: NONE



SECTION A-A
SCALE: NONE



RISER PIPE DETAIL
SCALE: NONE

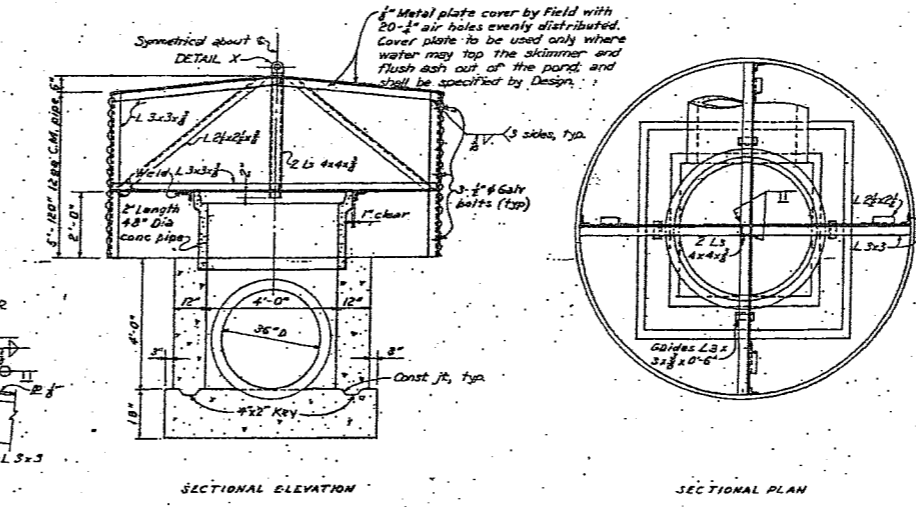
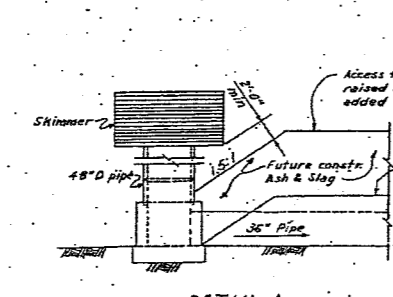
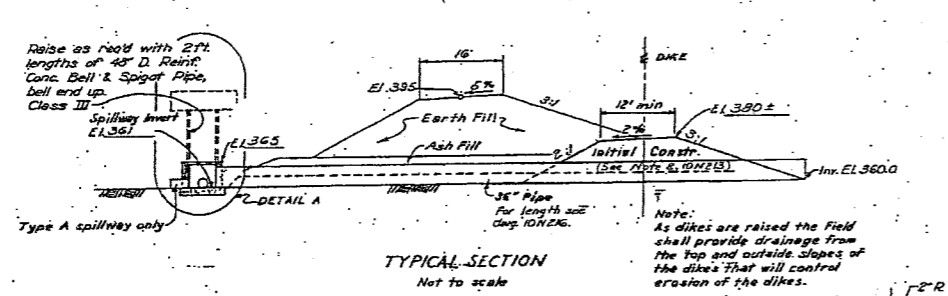
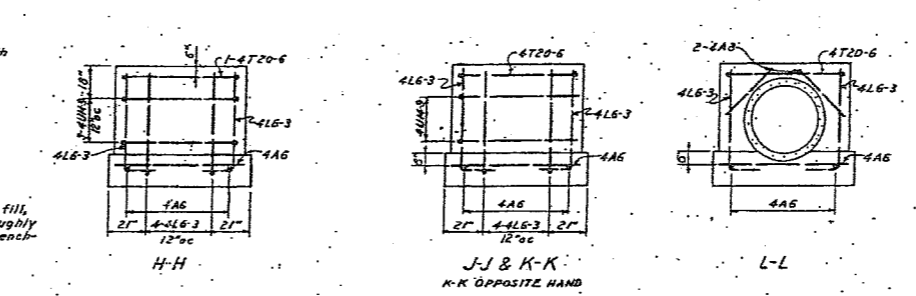
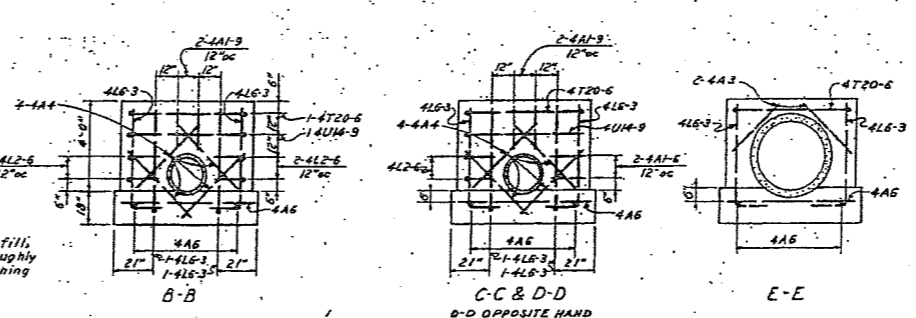
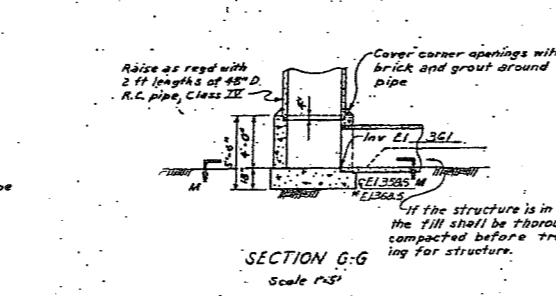
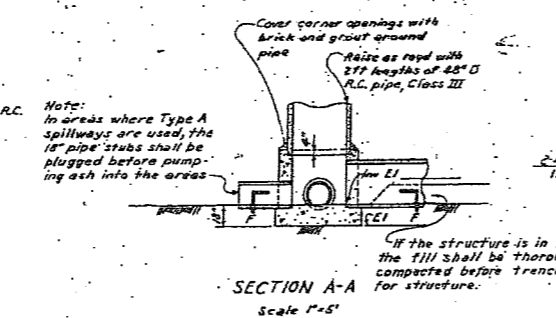
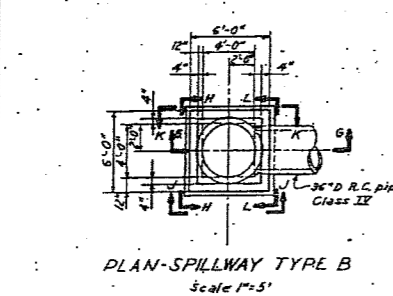
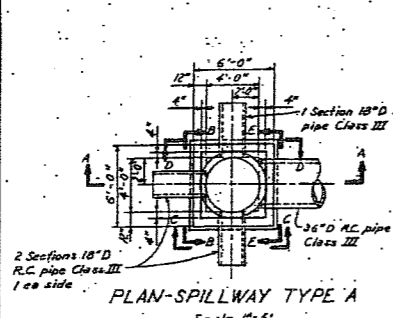


DESIGNED BY	DRAWN BY	CHECKED BY	SUPERVISED BY	REVIEWED BY	APPROVED BY	ISSUED BY
JL GRAY	M.S. HRANEK	J.G. ALBRIGHT	K.L. PETTY	R.E. PURSEY		J.L. ADAIR
CUMBERLAND FOSSIL PLANT TENNESSEE VALLEY AUTHORITY FOSSIL AND HYDRO ENGINEERING						
AUTOCAD R14	DATE	46 C	10W302-24	R 0		

SEE 10W302-1 FOR DRAWING INDEX/COMPANION DRAWINGS LIST

TASK COMPLETED BY: REV NO.

PLDT FACTOR: 32 W.TVA C.A.D. DRAWING DO NOT ALTER M/



Location	Mark	No. of Bars	Bend Dim.		
			a	b	c
Sect B-B	4T20-6	1	1	5.0	5.0
	4U14-9	1	1	5.0	5.0 Ex
	4L6-3	1	2	2.0	Ex
	4L2-6	1	4	3	Ex
	4A4	1	4		
Sect G-G	4A4	2	2	4	2.0 Ex
	4A4	2	4	8	
	4A4-B	2	2	4	
Sect E-E	4A3	1	2		
	4A6	1	2		
	4A6	1	2		
Sect F-F	4L6-3	1	4	2.0	Ex
	4A6	1	2		
Sect H-H	4T20-6	1	1	5.0	5.0
	4U14-9	1	1	5.0	5.0 Ex
	4L6-3	1	2	2.0	Ex
	4L2-6	1	4	3	Ex
	4A4	1	4		
Sect J-J & K-K	4L6-3	2	4	3	2.0 Ex
	4A3	1	2		
	4A6	1	2		
Sect L-L	4L6-3	1	4	2.0	Ex
	4A6	1	2		

BILL OF MATERIAL			
ITEM	DESCRIPTION	No. of Spillway	TOTAL REBAR
401	Class A Concrete	4	5 cu yd
410	Reinforcing Steel	4	170 lb
602	18" D Reinforced Concrete Pipe - Class III - Type A Only	4	2000 ft
602	36" D Reinforced Concrete Pipe - Class III	4	5 ft
602	48" D Reinforced Concrete Pipe - Class III (Bell & Spigot)	4	27 ft
640	120" x 12 Gauge Corrugated Metal Pipe	4	12 ft
	1" Galvanized Bolt	4	4
	1" Metal cover (By field - see Skimmer Details)	4	4
	2" x 2" x 1/2 Angle	4	23 ft
	3x3x1/2 Angle	4	67 ft
	4x4x1/2 Angle	4	8 ft

NOTES:

- ① SPECIFICATIONS: All work shall be done in accordance with the T-1 Specifications.
- ② All concrete shall be Class A in accordance with Section 400.
- ③ Where earth borrow can be obtained economically, for example, from disposal area, it may be used to raise dikes.
- ④ Vegetation shall be established on all earth slopes, initial and future construction. Seeding specifications to be furnished with drawings for each project. In general, Type C Mixture E, Section 180 of T-1 Specifications is recommended.
- ⑤ Location and elevation of the spillways shall be selected so as to maintain the depth of water in the ash pond at an absolute minimum.
- ⑥ Use Type A spillways for ash areas not scheduled for immediate use.
- ⑦ A section of 120" corrugated metal pipe is recommended for skimmer device. If structural plates or other metal shapes are used for fabrication of the plant, special care shall be taken to seal all joints by welding or with asphalt paint.
- ⑧ One 2" section of 48" Dia pipe shall be installed during initial construction.
- ⑨ As additional sections of 48" pipe are added, grout the joint to form a stable and water-tight connection.

REFERENCE DRAWINGS:
308519 REINFORCEMENT BENDING DIAGRAMS

Scale 1/4" = 1'-0"
Except as noted

STANDARD DRAWING

ASH DISPOSAL SPILLWAY

CUMBERLAND STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

SUBMITTED: [Signature]
RECOMMENDED: [Signature]
APPROVED: [Signature]

KNOXVILLE 1-13-69 46 C 4 ION214R2

RECORD DRAWING AS CONSTRUCTED
Hand V. [Signature] 9-3-82

REVISION	DATE	BY	DESCRIPTION
1	1-13-69	[Signature]	ISSUED FOR CONSTRUCTION

REINFORCEMENT SCHEDULE

COMPANION DRAWING: ION212, 213, 216, 218

APPENDIX G

HYDROLOGY RESULTS

For Reservoir elements, Peak Inflow values were used as the peak discharge values in the hydraulic calculations.

Summary Results for Reservoir "West Ditch R1"

Project: mdl_das_cuf_rev1 Simulation Run: Run 1
Reservoir: West Ditch R1

Start of Run: 01Jan2016, 00:00 Basin Model: Gypsum_DryAsh_ Storage Area
End of Run: 02Jan2016, 00:05 Meteorologic Model: 25-year, 24-hour
Compute Time:20Jan2016, 15:40:40 Control Specifications:Control 1

Volume Units: IN AC-FT

Computed Results

Peak Inflow:	63.1 (CFS)	Date/Time of Peak Inflow:	01Jan2016, 12:15
Peak Discharge:	52.8 (CFS)	Date/Time of Peak Discharge:	01Jan2016, 12:30
Inflow Volume:	7.8 (AC-FT)	Peak Storage:	0.5 (AC-FT)
Discharge Volume:	7.8 (AC-FT)	Peak Elevation:	393.1 (FT)

Summary Results for Reservoir "West_Ditch_Storage"

Project: mdl_das_cuf_rev1 Simulation Run: Run 1
Reservoir: West_Ditch_Storage

Start of Run: 01Jan2016, 00:00 Basin Model: Gypsum_DryAsh_ Storage Area
End of Run: 02Jan2016, 00:05 Meteorologic Model: 25-year, 24-hour
Compute Time:20Jan2016, 15:40:40 Control Specifications:Control 1

Volume Units: IN AC-FT

Computed Results

Peak Inflow:	304.7 (CFS)	Date/Time of Peak Inflow:	01Jan2016, 12:10
Peak Discharge:	163.8 (CFS)	Date/Time of Peak Discharge:	01Jan2016, 13:00
Inflow Volume:	52.4 (AC-FT)	Peak Storage:	12.8 (AC-FT)
Discharge Volume:	51.9 (AC-FT)	Peak Elevation:	386.3 (FT)

Summary Results for Reservoir "SE_Ditch_Storage"

Project: mdl_das_cuf_rev1 Simulation Run: Run 1
Reservoir: SE_Ditch_Storage

Start of Run: 01Jan2016, 00:00 Basin Model: Gypsum_DryAsh_ Storage Area
End of Run: 02Jan2016, 00:05 Meteorologic Model: 25-year, 24-hour
Compute Time:20Jan2016, 15:40:40 Control Specifications:Control 1

Volume Units: IN AC-FT

Computed Results

Peak Inflow:	65.7 (CFS)	Date/Time of Peak Inflow:	01Jan2016, 12:05
Peak Discharge:	40.9 (CFS)	Date/Time of Peak Discharge:	01Jan2016, 12:15
Inflow Volume:	4.95 (IN)	Peak Storage:	0.9 (AC-FT)
Discharge Volume:	4.95 (IN)	Peak Elevation:	390.3 (FT)

Summary Results for Junction "J-GD1"

Project: mdl_das_cuf_rev1 Simulation Run: Run 1
Junction: J-GD1

Start of Run: 01Jan2016, 00:00 Basin Model: Gypsum_DryAsh_ Storage Area
End of Run: 02Jan2016, 00:05 Meteorologic Model: 25-year, 24-hour
Compute Time:20Jan2016, 15:40:40 Control Specifications:Control 1

Volume Units: IN AC-FT

Computed Results

Peak Discharge:	59.7 (CFS)	Date/Time of Peak Discharge:	01Jan2016, 12:45
Volume:	12.1 (AC-FT)		

*West Ditch R2 Peak Discharge

APPENDIX H

HYDRAULIC CALCULATIONS

West Ditch R2

Channel Section 2

2. Non-symmetrical Trapezoidal Section

Input Data:

Manning's "n" value	0.03
Longitudinal Slope - S_o	0.002 ft/ft
Design Discharge - Q	60.0 ft ³ /s - cfs

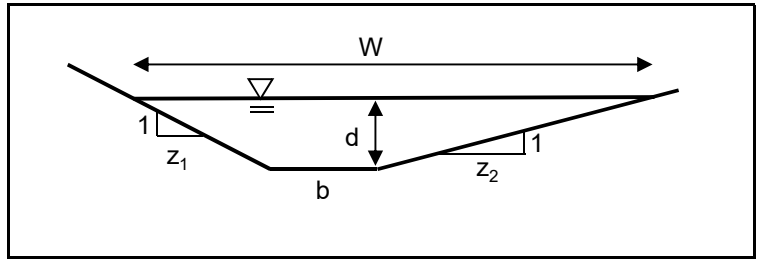
Channel Geometry Data:

Bottom Width(s) b_1 or b	0 feet
Side Slope(s) z_1 or z	3.0 z H:1V
z_2	5.0 z H:1V

Output Data:

Calculated Depth - d	2.45 feet
Calculated Top Width - W	19.63 feet
Calculated Area - A	24.09 ft ²
Calc. Wetted Perimeter - W_p	20.27 feet
Calc. Hydr. Radius - R	1.19 feet
Calculated Discharge - Q'	60.02 ft ³ /s - cfs
Convergence	0.02 ft ³ /s - cfs
Calculated Velocity	2.49 ft / s
Calculated Shear Stress - τ_d	0.31 lb / ft ²

Channel Sketch



Governing Geometry Equations

$$W = b + d(z_1 + z_2)$$

$$A = bd + \frac{d^2}{2}(z_1 + z_2)$$

$$W_p = b + d(\sqrt{z_1^2 + 1} + \sqrt{z_2^2 + 1})$$

$$Q = \frac{1.49}{n} AR^{\frac{2}{3}} S_o^{\frac{1}{2}} \quad R = \frac{A}{W_p}$$

$$\tau_d = \gamma dS \quad V = \frac{Q}{A}$$

West Ditch R1

Channel Section 2

2. Non-symmetrical Trapezoidal Section

Input Data:

Manning's "n" value	0.03
Longitudinal Slope - S_o	0.001 ft/ft
Design Discharge - Q	64.0 ft ³ /s - cfs

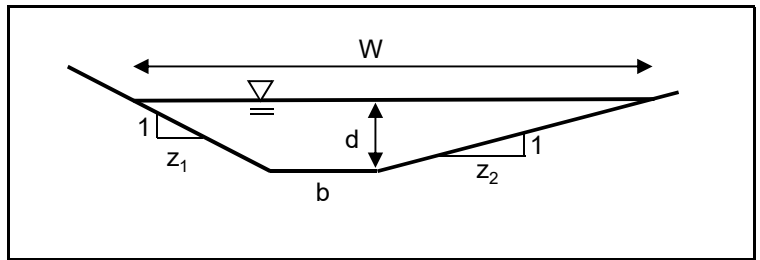
Channel Geometry Data:

Bottom Width(s)	
b_1 or b	17 feet
Side Slope(s)	
z_1 or z	3.0 z H:1V
z_2	3.0 z H:1V

Output Data:

Calculated Depth - d	1.45 feet
Calculated Top Width - W	25.68 feet
Calculated Area - A	30.85 ft ²
Calc. Wetted Perimeter - W_p	26.15 feet
Calc. Hydr. Radius - R	1.18 feet
Calculated Discharge - Q'	64.03 ft ³ /s - cfs
Convergence	0.03 ft ³ /s - cfs
Calculated Velocity	2.08 ft / s
Calculated Shear Stress - τ_d	0.13 lb / ft ²

Channel Sketch



Governing Geometry Equations

$$W = b + d(z_1 + z_2)$$

$$A = bd + \frac{d^2}{2}(z_1 + z_2)$$

$$W_p = b + d(\sqrt{z_1^2 + 1} + \sqrt{z_2^2 + 1})$$

$$Q = \frac{1.49}{n} AR^{\frac{2}{3}} S_o^{\frac{1}{2}} \quad R = \frac{A}{W_p}$$

$$\tau_d = \gamma d S \quad V = \frac{Q}{A}$$

SE Central Ditch

Channel Section 2

2. Non-symmetrical Trapezoidal Section

Input Data:

Manning's "n" value	0.03
Longitudinal Slope - S_o	0.002 ft/ft
Design Discharge - Q	66.0 ft ³ /s - cfs

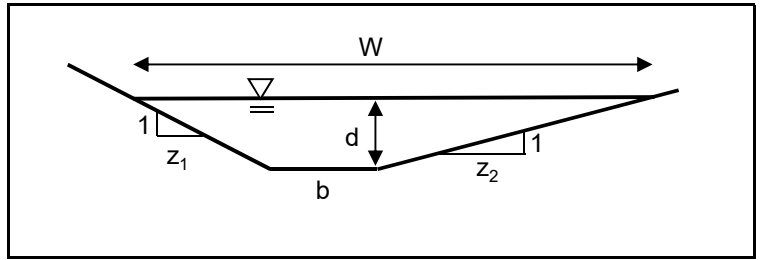
Channel Geometry Data:

Bottom Width(s)	
b_1 or b	8.6 feet
Side Slope(s)	
z_1 or z	3.0 z H:1V
z_2	3.0 z H:1V

Output Data:

Calculated Depth - d	1.81 feet
Calculated Top Width - W	19.46 feet
Calculated Area - A	25.39 ft ²
Calc. Wetted Perimeter - W_p	20.05 feet
Calc. Hydr. Radius - R	1.27 feet
Calculated Discharge - Q'	66.03 ft ³ /s - cfs
Convergence	0.03 ft ³ /s - cfs
Calculated Velocity	2.60 ft / s
Calculated Shear Stress - τ_d	0.23 lb / ft ²

Channel Sketch



Governing Geometry Equations

$$W = b + d(z_1 + z_2)$$

$$A = bd + \frac{d^2}{2}(z_1 + z_2)$$

$$W_p = b + d(\sqrt{z_1^2 + 1} + \sqrt{z_2^2 + 1})$$

$$Q = \frac{1.49}{n} AR^{\frac{2}{3}} S_o^{\frac{1}{2}} \quad R = \frac{A}{W_p}$$

$$\tau_d = \gamma d S \quad V = \frac{Q}{A}$$



Input Rating Curve, HEC-HMS - West Ditch Storage, CUF

CCR Rule Run-on and Run-off

Dry Ash Stack, Cumberland Fossil Plant

Project Number: 175555021

Calculation Performed by: JJR Calculation Date: 12/14/2015 Checked

by: Checked By Date:

Rating Curve-HEC-HMS Input	
HW Elevation (ft)	Q (cfs)
383.00	0.00
383.50	27.75
384.00	78.48
384.50	113.22
385.00	130.74
385.50	146.17
386.00	160.12
386.50	167.57
387.00	174.34
387.50	180.87
388.00	187.16
388.50	193.25
390.00	199.16



Rating Curve Development: West Ditch Storage - CUF

CCR Rule Run-on and Run-off

Dry Ash Stack, Cumberland Fossil Plant

Project Number: 17555021

Calculation Performed by: JJR Calculation Date: 12/14/2015

Checked by: Checked By Date:

Overflow 1										
Elevation	Weir Flow		Orifice Flow		Pipe Orifice Flow		Outlet Pipe Flow (from HY-8)		Rating Curve used in HEC-HMS	
	H (ft)	$Q=CLH^{1.5}$ (cfs)	H (ft)	$Q=C_oA(2gH)^{0.5}$ (cfs)	H_c (ft)	$Q=C_oA(2gH_c)^{0.5}$ (cfs)	Assumed TW (ft)	Q (cfs)	HW Elevation (ft)	Q (cfs)
383.00	0.00	0.00	0	0.00	2.56	54.46	379.80	58.50	383.00	0.00
383.50	0.50	13.87	0.5	32.69	3.06	59.54	379.80	64.75	383.50	13.87
384.00	1.00	39.24	1	46.22	3.56	64.22	379.80	70.67	384.00	39.24
384.50	1.50	72.09	1.5	56.61	4.06	68.58	379.80	75.90	384.50	56.61
385.00	2.00	110.99	2	65.37	4.56	72.68	379.80	81.04	385.00	65.37
385.50	2.50	155.11	2.5	73.09	5.06	76.56	379.80	85.57	385.50	73.09
386.00	3.00	203.90	3	80.06	5.56	80.25	379.80	90.08	386.00	80.06
386.50	3.50	256.94	3.5	86.48	6.06	83.78	379.80	94.12	386.50	83.78
387.00	4.00	313.92	4	92.45	6.56	87.17	379.80	98.16	387.00	87.17
387.50	4.50	374.58	4.5	98.06	7.06	90.43	379.80	102.21	387.50	90.43
388.00	5.00	438.72	5	103.36	7.56	93.58	379.80	105.76	388.00	93.58
388.50	5.50	506.14	5.5	108.40	8.06	96.63	379.80	109.08	388.50	96.63
389.00	6.00	576.71	6	113.22	8.56	99.58	379.80	112.41	389.00	99.58

Overflow 2										
Elevation	Weir Flow		Orifice Flow		Pipe Orifice Flow		Outlet Pipe Flow (from HY-8)		Rating Curve used in HEC-HMS	
	H (ft)	$Q=CLH^{1.5}$ (cfs)	H (ft)	$Q=C_oA(2gH)^{0.5}$ (cfs)	H_c (ft)	$Q=C_oA(2gH_c)^{0.5}$ (cfs)	Assumed TW (ft)	Q (cfs)	HW Elevation (ft)	Q (cfs)
383.00	0.00	0.00	0	0.00	2.56	54.46	379.80	58.50	383.00	0.00
383.50	0.50	13.87	0.5	32.69	3.06	59.54	379.80	64.75	383.50	13.87
384.00	1.00	39.24	1	46.22	3.56	64.22	379.80	70.67	384.00	39.24
384.50	1.50	72.09	1.5	56.61	4.06	68.58	379.80	75.90	384.50	56.61
385.00	2.00	110.99	2	65.37	4.56	72.68	379.80	81.04	385.00	65.37
385.50	2.50	155.11	2.5	73.09	5.06	76.56	379.80	85.57	385.50	73.09
386.00	3.00	203.90	3	80.06	5.56	80.25	379.80	90.08	386.00	80.06
386.50	3.50	256.94	3.5	86.48	6.06	83.78	379.80	94.12	386.50	83.78
387.00	4.00	313.92	4	92.45	6.56	87.17	379.80	98.16	387.00	87.17
387.50	4.50	374.58	4.5	98.06	7.06	90.43	379.80	102.21	387.50	90.43
388.00	5.00	438.72	5	103.36	7.56	93.58	379.80	105.76	388.00	93.58
388.50	5.50	506.14	5.5	108.40	8.06	96.63	379.80	109.08	388.50	96.63
389.00	6.00	576.71	6	113.22	8.56	99.58	379.80	112.41	389.00	99.58

Notes:

1. Cells highlighted in yellow are selected limiting flow and are to be used in HEC-HMS Input.



Rating Curve - HY-8, West Ditch Storage, CUF

CCR Rule Run-on and Run-off

Dry Ash Stack, Cumberland Fossil Plant

Project Number: 175555021

Calculation Performed by: JJR Calculation Date: 12/14/2015 Checked by:

Checked By Date:

HY-8 Output

ALF Overflow 1	
Q (cfs)	Headwater (ft)
57.5	382.92
69.0	383.84
80.5	384.94
90.0	385.99
103.5	387.66
115.0	389.39
118.8	390.00



Rating Curve Inputs - West Ditch Storage, CUF

CCR Rule Run-on and Run-off

Dry Ash Stack, Cumberland Fossil Plant

Project Number: 175555021

Calculation Performed by: JJR Calculation Date: 12/14/2015

Checked by: Checked By Date:

West Ditch Outlet Structures

Overflow 1 and 2 - Concrete Riser Structure	
Weir Elev=	383 feet
Square Riser L=	36 in
Pipe Inlet=	378.94 feet
Pipe Outlet=	377.68 feet
Pipe D=	36 in
Length=	110 feet
C=	3.27
C ₀ =	0.6
Computed Values	
L _{weir} =	12 ft
A _{riser} =	9.6 sq. ft.
A _{pipe} =	7.068583 sq. ft.
Elev C=	380.44 feet

Equation

Perimeter=Lx4

Area = LxL

Area = PI*D²/4

Notes:

1. Elevation from October 2014 topography provided by TVA
2. Grate assumed to reduce area to 80% (FHWA grate used as reference)
3. Riser box top elevation is assumed to be approximately 4ft above pipe invert
4. Overflow riser 1 and 2 are assumed to have the same elevations and dimensions
5. "Elev C" under Computed Values is referring to the elevation of centerline of the outlet pipe inlet