Stantec
**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**

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## 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

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

Stantec

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.

October 6, 2016
Revision 0

## Table of Contents



### LIST OF TABLES



### LIST OF FIGURES

## LIST OF APPENDICES

# 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**

## 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.

# 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 is it 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 DSA'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; therefor, there is no run-off flow from surrounding areas.

# 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.

### 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.

### 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.

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:

Riser – Weir flow

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

$$Q = C_w L H^{\frac{3}{2}} \qquad \textbf{Eqn. 1}$$

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:

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

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:

$$Q = C_0 A [2g(H_C)]^{0.5} \qquad \textbf{Eqn. 3}$$

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.

## 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.

# 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.

## 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.

# 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


Figure No.
1

Title
**GENERAL DRAINAGE 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

1755555021
Prepared by MAM on 2015-12-22
Technical Review by JJR on 2015-12-22
Independent Review by MMM on 2015-12-22

0 600 1,200 Feet
1:7,200 (At original document size of 11x17)

**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_&_aerials

## 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

1755555021
Prepared by MAM on 2015-12-22
Technical Review by JJR on 2015-12-22
Independent Review by MMM on 2015-12-22

0 600 1,200 Feet
1:7,200 (At original document size of 11x17)

**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

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TVA

# 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

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

0 600 1,200 Feet
1:7,200 (At original document size of 11x17)

**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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# 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 |

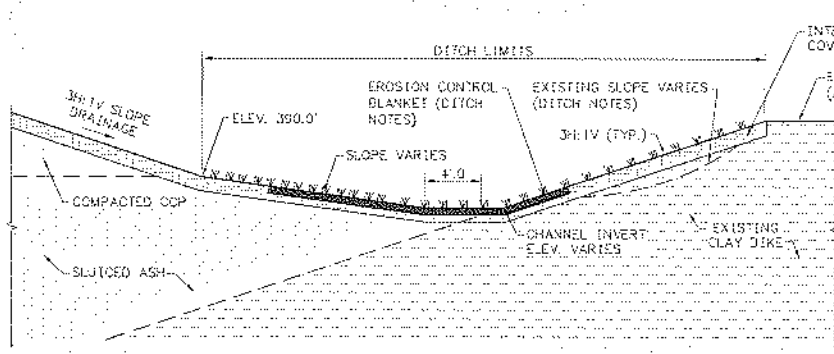
SE Central Ditch

| 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 |

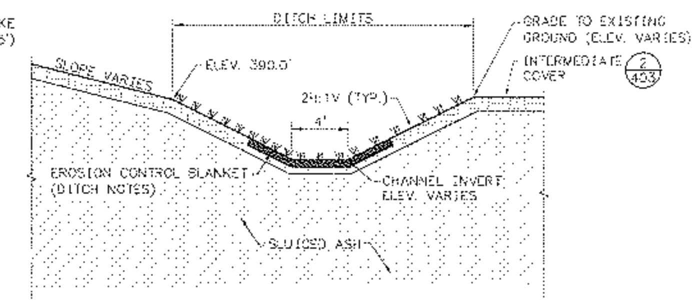
West Ditch R1

| 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 |

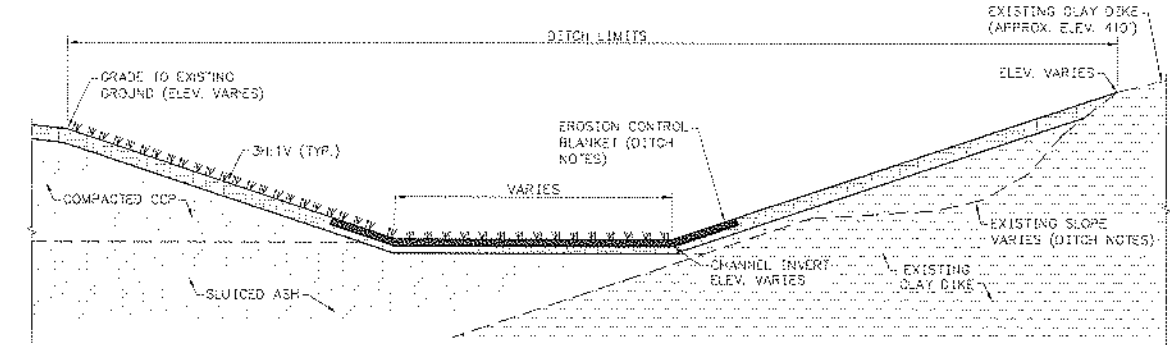
# APPENDIX F
# CONSTRUCTION DRAWINGS



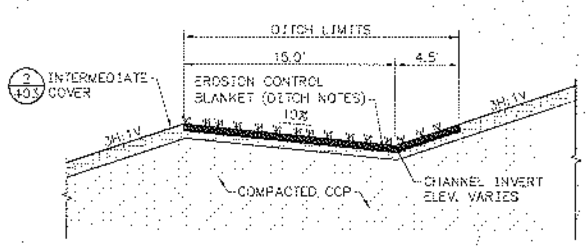

1 / 401 DETAIL – TYPE I DITCH
SCALE: 1"=5'



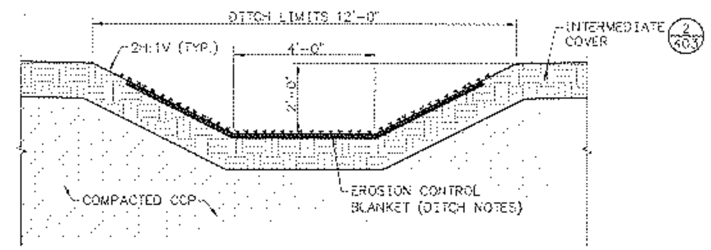

2 / 401 DETAIL – TYPE II DITCH
SCALE: 1"=5'



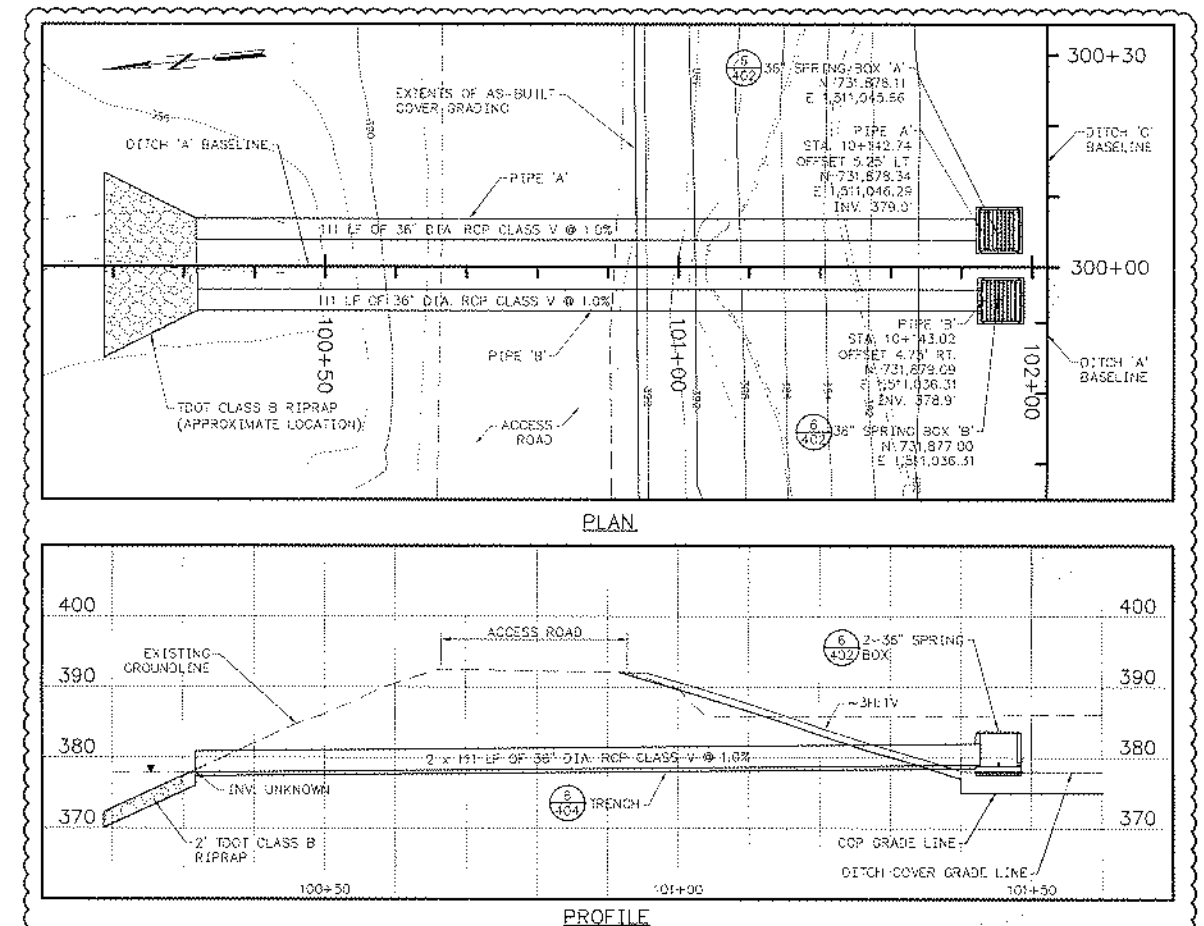

3 / 401 DETAIL – TYPE III DITCH
SCALE: 1"=5'



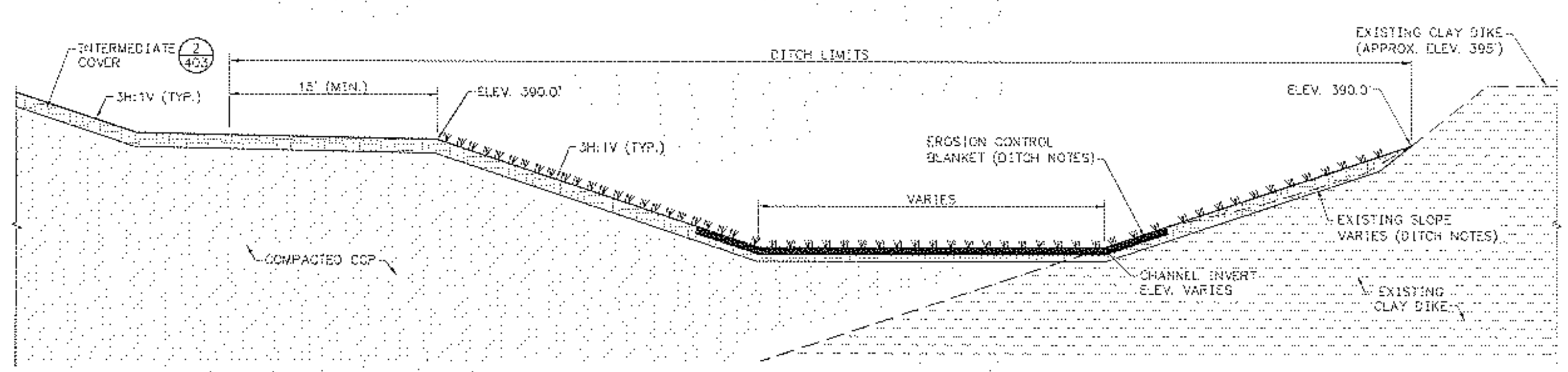

4 / 401 DETAIL – TYPE IV DITCH
SCALE: 1"=5'




5 / 401 DETAIL – TYPE V DITCH
SCALE: 1/2"=1'-0"




6 / 401 DETAIL – DETENTION TRENCH OUTLET
SCALE: 1"=10'




7 / 401 DETAIL – DETENTION TRENCH
SCALE: 1"=5'

## 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 SLUICED 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 OR 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.

SECTION OR DETAIL NO.
SHEET WHERE SHOWN
REFERENCE KEY

**RECORD DRAWING**

SEE DRAWING 10W551-103 FOR LIST OF COMPANION, REFERENCE DRAWINGS AND SUPPORTING DESIGN CALCULATIONS NUMBER.

PROJECT REVISION HISTORY

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| R 1 | 09/26/11 | CJJ | TJ | RCF | SAH | RLS | MST | JCK |
| ISSUED FOR CONSTRUCTION | | | | | | | | |
| R 2 | 12/14/12 | CJJ | TJ | DDR | SAH | RLS | MST | JCK |
| ISSUED AS-BUILT AS PER WORK PLAN 11 (CUF-110310-WP-11) | | | | | | | | |
| R 0 | 03/10/11 | CJJ | DMG | RCF | SAH | RLS | MST | JCK |
| 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.
1409 North Forbes Road
Lexington, Kentucky
40511-2024
Tel. 859.422.3000
Fax. 859.422.3100
www.stantec.com

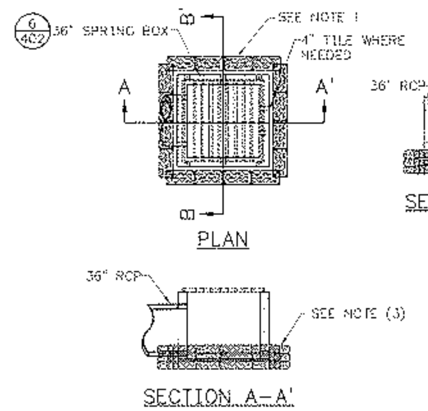
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

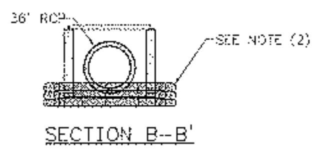
AUTOCAD R 2000 | 46 | C | 10W551-401 | R 2

STANTEC | 2
TASK COMPLETED BY: | REV NO.

PLOT FACTOR: 1
W_TVA

C.A.D. DRAWING DO NOT ALTER MANUALLY



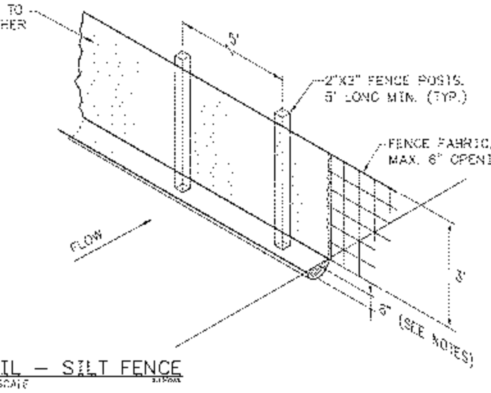




NOTES:
1. TDOT NO. 9 CRUSHED STONE CONTAINED IN PERVIOUS BURLAP BAGS OR IN SYNTHETIC NET BAGS (3 MESH), APPROXIMATELY 24 INCHES LONG, 12 INCHES WIDE AND 6 INCHES HIGH.
2. PLACE BAGS SUCH THAT THERE ARE NO GAPS BETWEEN BAGS. BAGS MAY BE DOUBLE OR TRIPLE LAYERS, AS THE SITUATION DICTATES.
3. ALL CRUSHED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

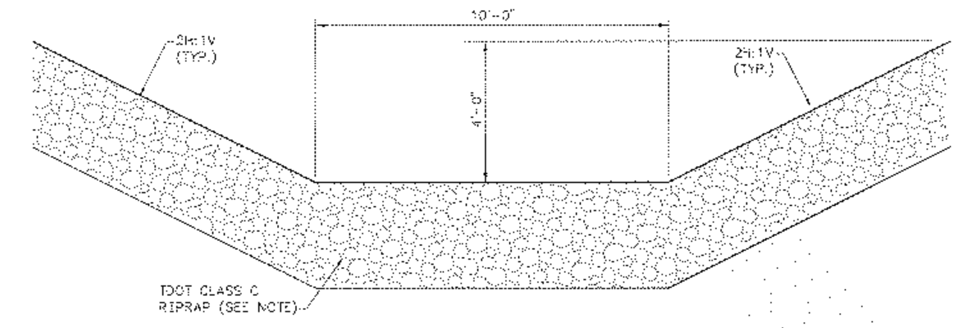
(1/402) DETAIL – SILT CONTROL ROCK BAG
SCALE: 1"=6'

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 EARTH- WORK SHALL BE ON THE UPSTREAM SIDE OF THE FENCE.
2. GEOTEXTILE FABRIC SHALL MEET THE FOLLOWING SPECIFICATIONS: GRAB STRENGTH (ASTM D 4632) – 90 LBS. MIN., WIDTH – 4 FEET MIN., APPARENT OPENING SIZE (ASTM D4751) NO. 20. ULTRAVIOLET DEGRADATION (ASTM D 4355) 70% STRENGTH RETAINED. ELONGATION AT 45LB (ASTM D 4632).

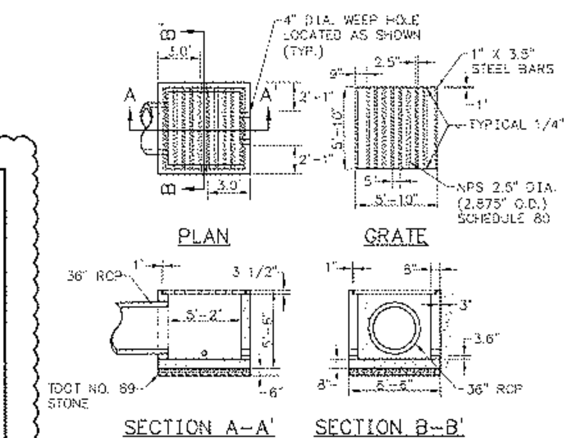



(2/402) DETAIL – SILT FENCE
NOT TO SCALE




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

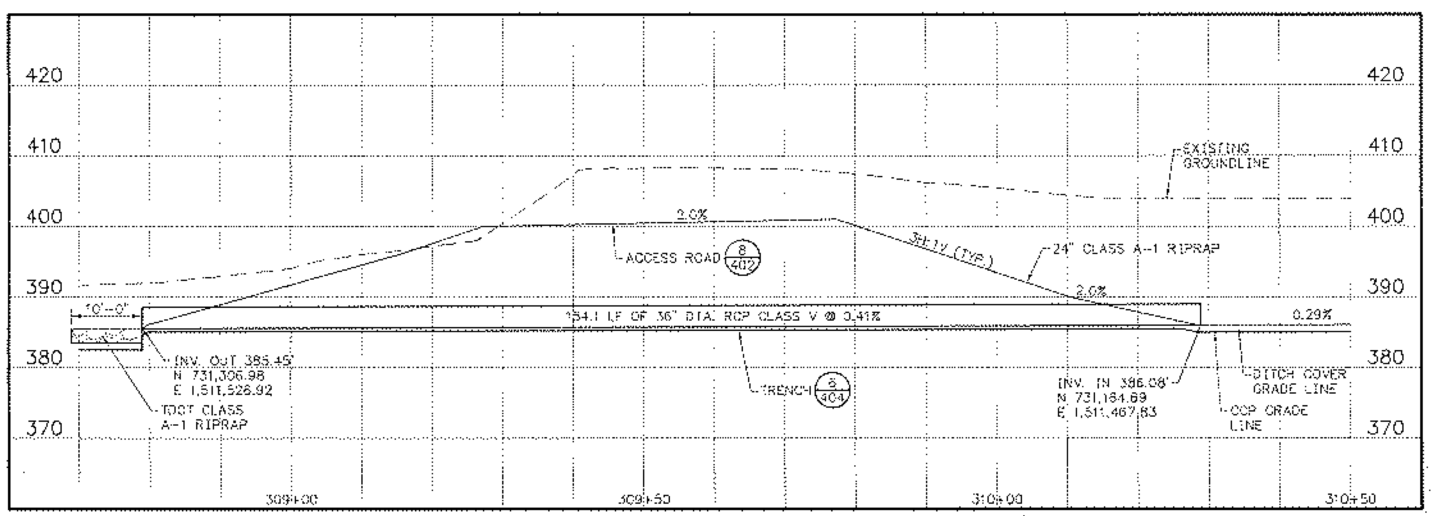
(3/402) DETAIL – RIPRAP FLUME
SCALE: 1/2"=1'-0"




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-38SC.
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-38SC.

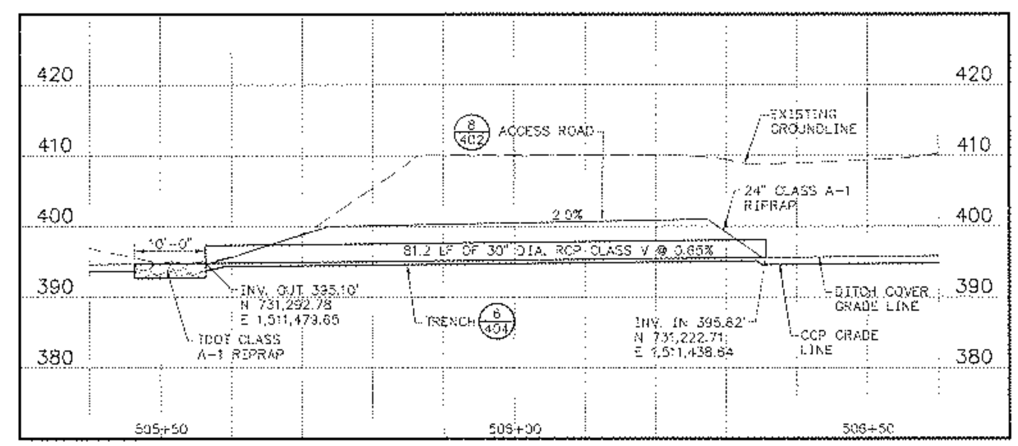
GRATE NOTES:
1. MATERIAL FOR GRATE SPECIFICATIONS FOR STEEL BARS SHALL CONFORM TO ASTM A36. FOR THE PIPE CROSS MEMBERS, ASTM A53 TYPE E OR S GRADE A OR B. THE GRATE UNIT SHALL BE PAINTED BLACK, FEDERAL SPEC. TT-E-489J.
2. ALL WELDS SHALL BE IN ACCORDANCE WITH AWS SPECIFICATIONS D1.1-72 AS MODIFIED BY THE CURRENT AASHTO STD. SPECIFICATIONS FOR WELDING OF HIGHWAY BRIDGES.
3. CONTRACTOR TO SUBMIT SHOP DRAWING OF GRATE FOR ENGINEER'S APPROVAL.

(6/402) DETAIL – 36-INCH SPRING BOX
SCALE: 1"=5'



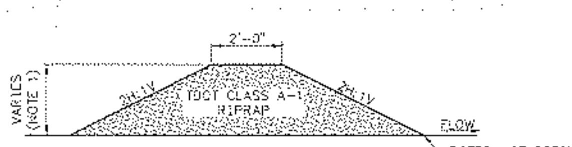

NOTE:
2 FEET DEEP X 19 FEET WIDE X 10 FEET LONG RIPRAP SCOUR PROTECTION BLANKET SHALL BE PLACED IN THE TYPE IV DITCH AT THE OUTLET OF THE 36 INCH DIAMETER RCP PIPE.

(4/402) PROFILE – 36" DIA. RCP CULVERT
SCALE: 1"=10'



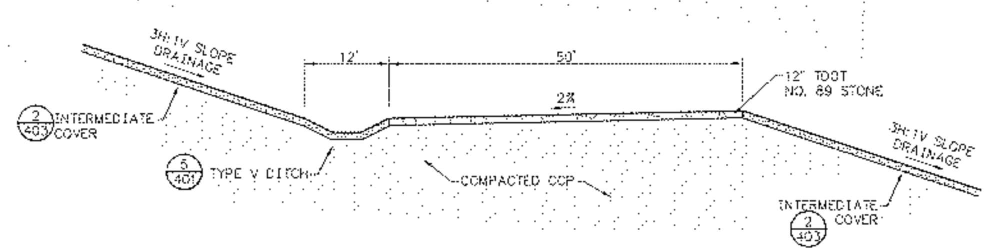

NOTE:
2 FEET DEEP X 19 FEET WIDE X 10 FEET LONG RIPRAP SCOUR PROTECTION BLANKET SHALL BE PLACED IN THE TYPE IV DITCH AT THE OUTLET OF THE 30 INCH DIAMETER RCP PIPE.

(5/402) PROFILE – 30" DIA. RCP CULVERT
SCALE: 1"=10'




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

(7/402) DETAIL – ROCK CHECK
NOT TO SCALE




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

(8/402) DETAIL – ACCESS ROAD
SCALE: 1"=10'

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.

SECTION OR DETAIL NO.
SHEET WHERE SHOWN
REFERENCE KEY

**RECORD DRAWING**

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

PROJECT REVISION HISTORY
R 1 | 09/20/11 | CJJ | TJ | RDF | SAH | RLS | MST | JCK — ISSUED FOR CONSTRUCTION
R 2 | 12/14/12 | CJJ | TJ | RDF | SAH | RLS | MST | JCK — ISSUED AS-BUILT AS PER WORK PLAN 11 (CUF-110310-WP-11)
R 0 | 03/15/11 | CA | TDMC | RDF | SAH | RLS | MST | JCK — 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)

DESIGNED BY C.J. JONES | DRAWN BY J.M. GRAHAM | CHECKED BY R.D. FULLER | SUPERVISED BY S.A. HARRIS | REVIEWED BY R.L. SANCHEZ | APPROVED BY M.S. TURNBOW | ISSUED BY J.C. KAMMEYER

Stantec Consulting Services Inc.
1409 North Forbes Road
Lexington, Kentucky
40511-2024
Tel. 859.422.3000
Fax. 859.422.3100
www.stantec.com

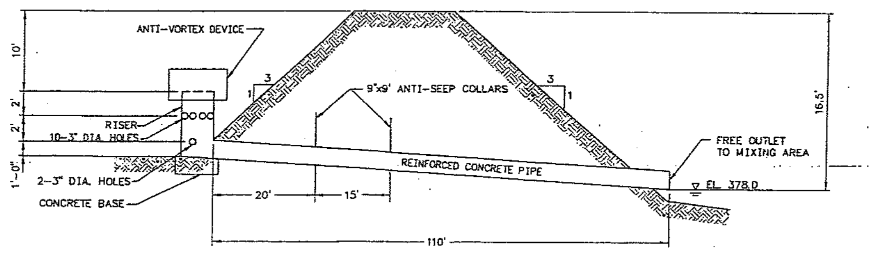
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 | 46 | C | 10W551-402 | R 2

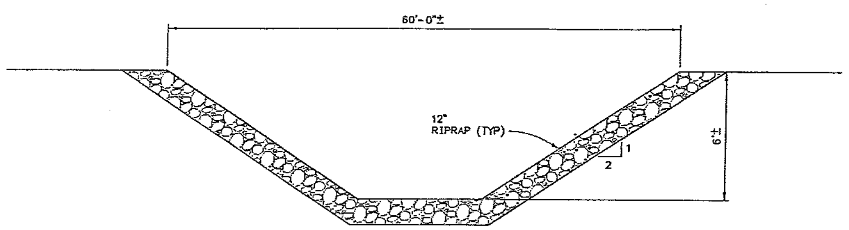
STANTEC | 2
TASK COMPLETED BY: | REV NO.

PLOT FACTOR:1
C.A.D. DRAWING
DO NOT ALTER MANUALLY

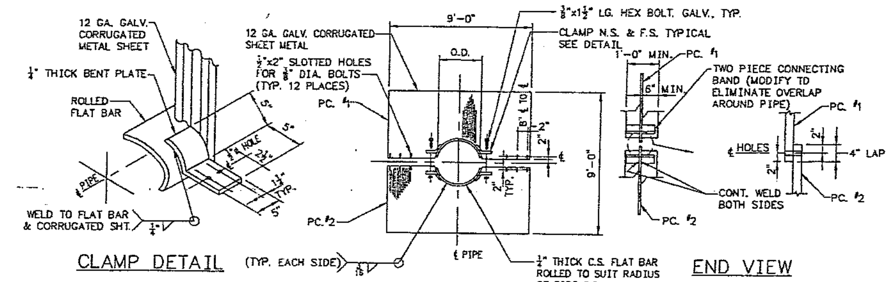
10W302-24 C 46




ASH DETENTION TRENCH OUTLET DETAIL (ALTERNATE A)
(NOT TO SCALE)

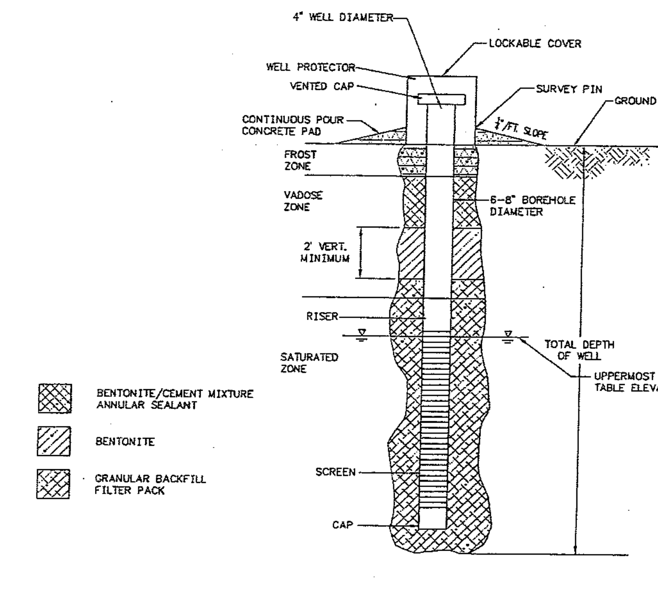



ASH DETENTION TRENCH OUTLET DETAIL (ALTERNATE B)
(NOT TO SCALE)

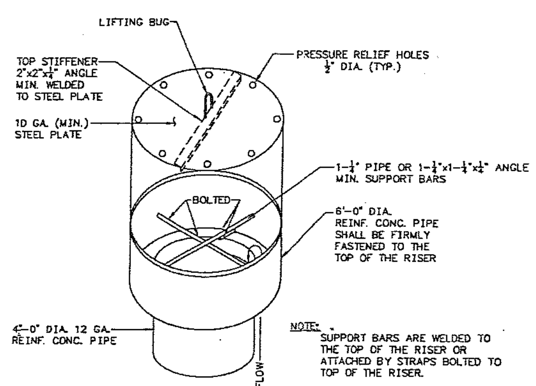



NOTE:
1) PROVIDE TWO ANTI-SEEP COLLARS, LOCATIONS LATER.
2) THE LAP BETWEEN THE TWO HALF SECTIONS AND BETWEEN THE PIPE & CONNECTING BAND SHALL BE CAULKED WITH BITUMINOUS MASTIC AT THE TIME OF INSTALLATION.
3) UNASSEMBLED COLLARS SHALL BE MARKED BY PAINTING OR TAGGING TO IDENTIFY MATCHING PAIRS.

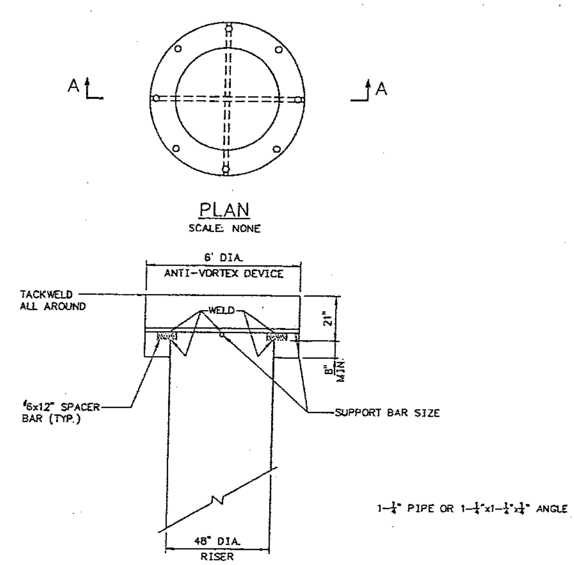
ANTI-SEEP COLLAR
SCALE: NONE




MONITORING WELL
(NOT TO SCALE)



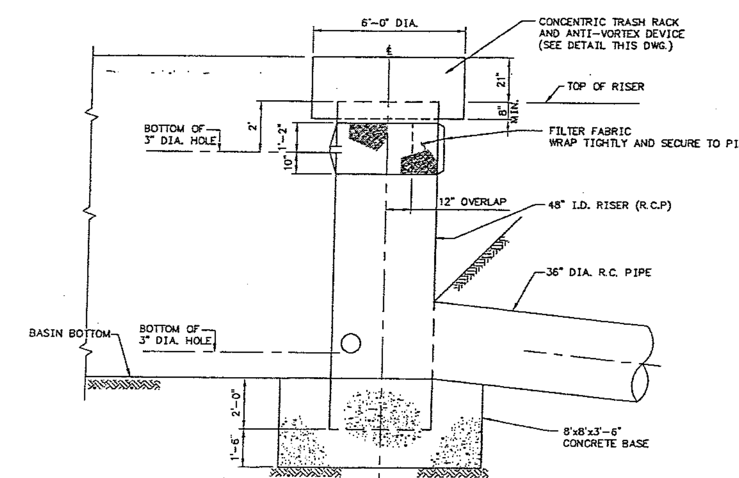

NOTE: SUPPORT BARS ARE WELDED TO THE TOP OF THE RISER OR ATTACHED BY STRAPS BOLTED TO TOP OF THE RISER.




1-1/4" PIPE OR 1-1/4"x1-1/4"x1/4" ANGLE

SECTION A-A
SCALE: NONE

CONCENTRIC TRASH RACK AND ANTI-VORTEX DEVICE
SCALE: NONE




RISER PIPE DETAIL
SCALE: NONE

| R | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| R 0 | | J.G | MGH | JGA | HLP | REP | | JGA |
| INITIAL ISSUE FOR DCN CUF-03-536 | | | | | | | | |
| REV. NO. | DATE | DSGN | DRWN | CHKD | SUPV | RVWD | APPD | ISSD |

SCALE: 3/8"=1'-0" EXCEPT AS NOTED

FGD RETROFIT PROJECT
UNITS 1 & 2

PROPOSED WASTE DISPOSAL FACILITY
DETAILS
SHEET 1 OF 3

| DESIGNED BY: | DRAWN BY: | CHECKED BY: | SUPERVISED BY: | REVIEWED BY: | APPROVED BY: | ISSUED BY: |
|---|---|---|---|---|---|---|
| J.L. GRAY | M.G. HRANEK | J.G. ALBRIGHT | H.L. PETTY | R.E. PURKEY | | J.G. ADAIR |

CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R14 | DATE | 46 | C | 10W302-24 | R 0

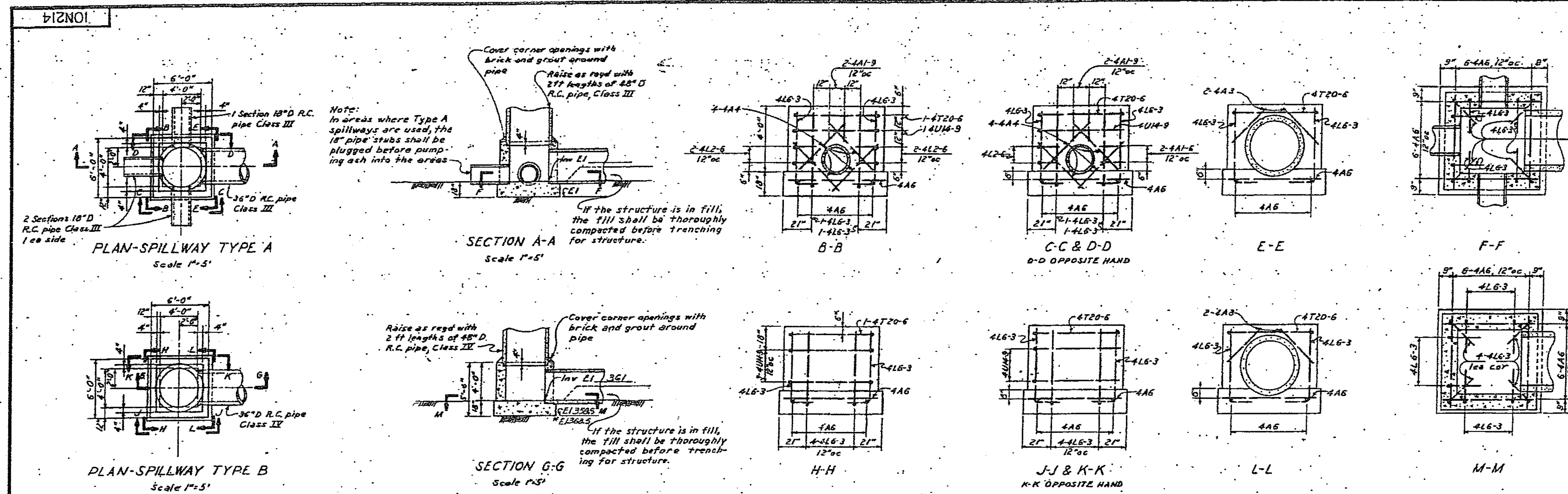
HAROLD L. PETTY REGISTERED ENGINEER STATE OF TENNESSEE
10/10/03

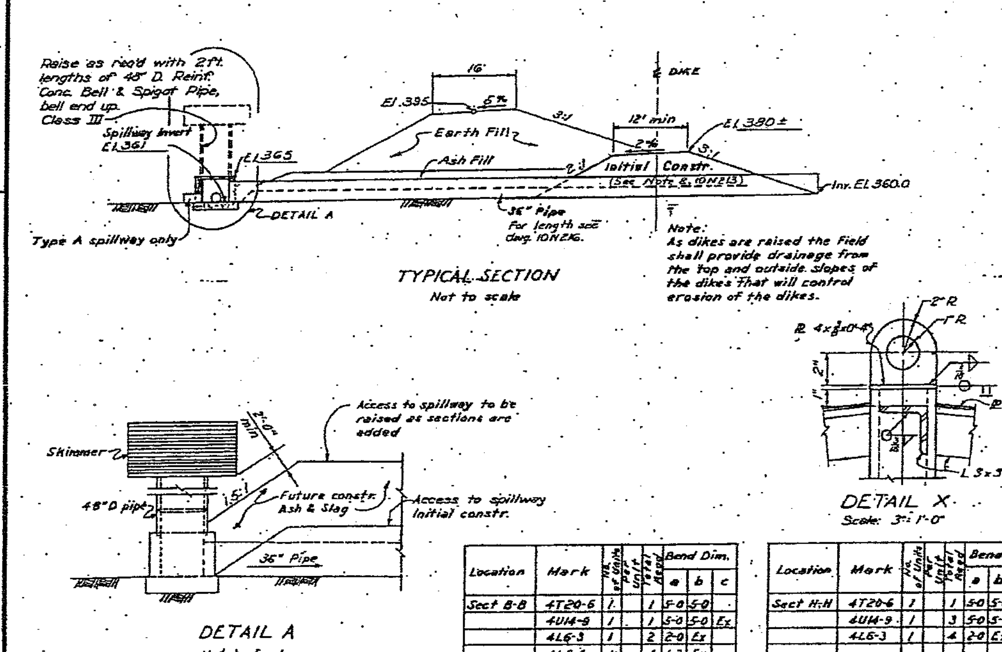
SEE 10W302-1 FOR DRAWING INDEX/COMPANION DRAWINGS LIST

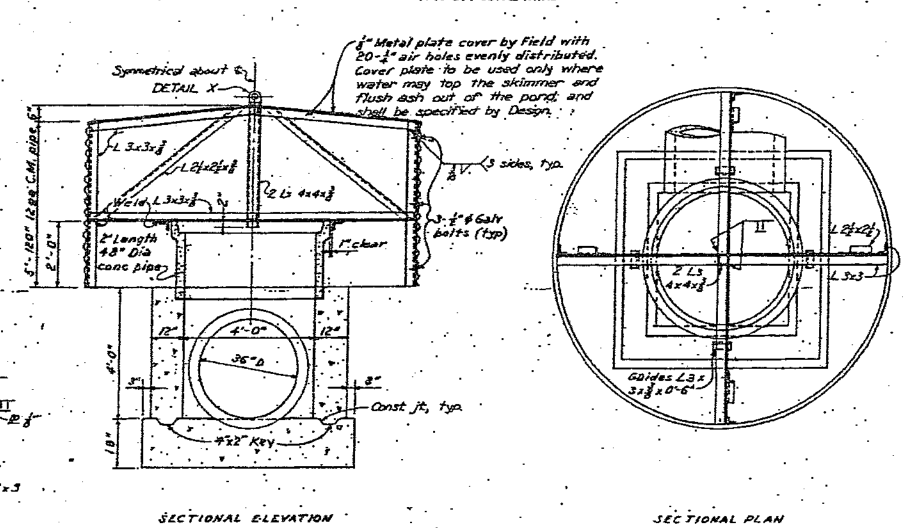
TASK COMPLETED BY: | REV NO.

PLOT FACTOR:32
W_TVA

C.A.D. DRAWING DO NOT ALTER M/




SKIMMER DETAILS
Scale ½"= 1'-0"

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 G, 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 at 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:
30B519 — REINFORCEMENT BENDING DIAGRAMS

## REINFORCEMENT SCHEDULE

TYPE A SPILLWAY

| Location | Mark | No. of Units | Per Unit | Total Reqd | 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 | 1-3 | Ex | |
| | 4A4 | 1 | | 4 | | | |
| | 4A1-9 | 1 | | 2 | | | |
| Sect CC&DD | 4L6-3 | 2 | 2 | 4 | 2-0 | Ex | |
| | 4A4 | 2 | 4 | 8 | | | |
| | 4A1-9 | 2 | 2 | 4 | | | |
| | 4A1-6 | 2 | 2 | 4 | | | |
| Sect E-E | 4A3 | 1 | | 2 | | | |
| Sect F-F | 4L6-3 | 1 | | 4 | 2-0 | Ex | |
| | 4A6 | 1 | | 12 | | | |

TYPE B SPILLWAY

| Location | Mark | No. of Units | Per Unit | Total Reqd | Bend Dim. a | b | c |
|---|---|---|---|---|---|---|---|
| Sect H-H | 4T20-6 | 1 | | 1 | 5-0 | 5-0 | |
| | 4U14-9 | 1 | | 3 | 5-0 | 5-0 | Ex |
| | 4L6-3 | 1 | | 4 | 2-0 | Ex | |
| Sect J-J&K-K | 4L6-3 | 2 | 4 | 8 | 2-0 | Ex | |
| Sect L-L | 4A3 | 1 | | 2 | | | |
| Sect M-M | 4L6-3 | 1 | | 4 | 2-0 | Ex | |
| | 4A6 | 1 | | 12 | | | |

## BILL OF MATERIAL

| ITEM | DESCRIPTION | NO. of Splwys | PER SPLWY | TOTAL REQD |
|---|---|---|---|---|
| 401 | Class A Concrete | 4 | 5 cu yd | 20 cu yd |
| 418 | Reinforcing Steel | 4 | 170 lb | 680 lb |
| 602 | 18"D Reinforced Concrete Pipe-Class III- Type A Only | | | |
| 602 | 36"D Reinforced Concrete Pipe-Class IV | 4 | | 876 ft |
| 602 | 48"D Reinforced Concrete Pipe-Class III (Bell & Spigot) | 4 | 2 ft | 8 ft |
| 660 | 120"-12 Gage Corrugated Metal Pipe | 4 | 5 ft | 20 ft |
| | ½"# Galvanized Bolt | 4 | 12 | 48 |
| | ⅛" Metal cover (By field-see Skimmer Details) | 4 | 1 | 4 |
| | 2½x2½x⅜ Angle | 4 | 23 ft | 92 ft |
| | 3x3x⅜ Angle | 4 | 67 ft | 268 ft |
| | 4x4x⅜ Angle | 4 | 8 ft | 32 ft |

COMPANION DRAWING: 10N212,213,216,218

Scale ⅓"= 1'-0"
Except as noted

STANDARD DRAWING

# ASH DISPOSAL SPILLWAY

CUMBERLAND STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

| SUBMITTED | RECOMMENDED | APPROVED |
|---|---|---|
| [signature] | [signature] | F. P. [signature] |
| KNOXVILLE | 1-13-69 | 46 C 4 10N214 R2 |

RECORD DRAWING AS CONSTRUCTED R2 — [signature] 9-3-85

# 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
End of Run: 02Jan2016, 00:05
Compute Time: 20Jan2016, 15:40:40

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

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

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

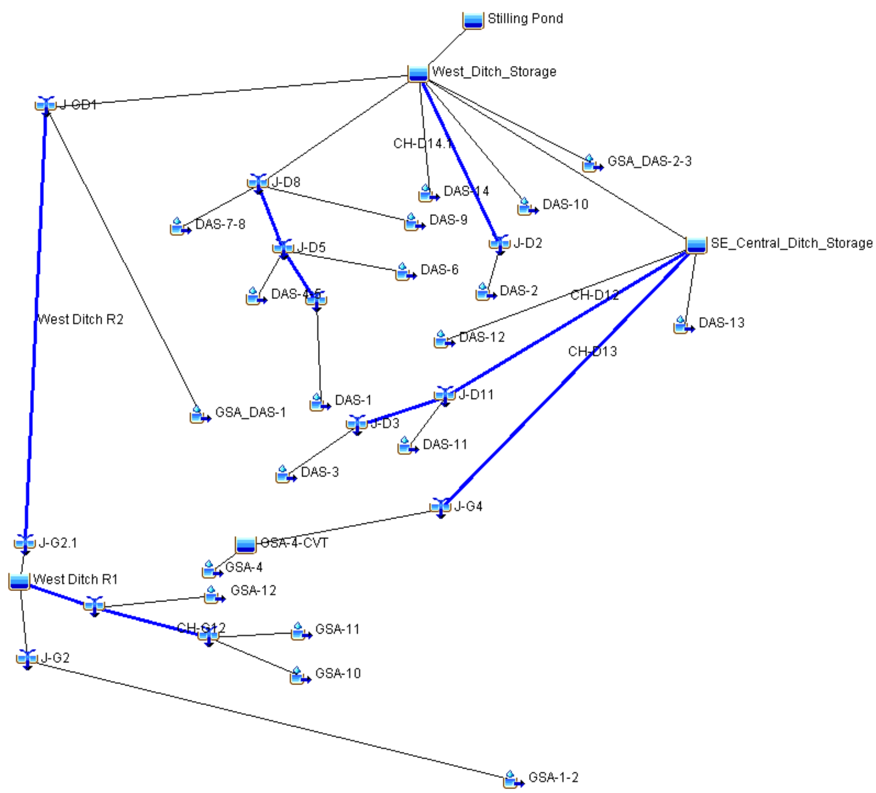
Basin Model: Gypsum_DryAsh_ Storage Area
Meteorologic Model: 25-year, 24-hour
Control Specifications: Control 1

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



Stilling Pond
West_Ditch_Storage
J-GD1
CH-D14.1
GSA_DAS-2-3
J-D8
DAS-14
DAS-10
DAS-7-8
DAS-9
J-D5
J-D2
SE_Central_Ditch_Storage
DAS-6
DAS-4-5
DAS-2
CH-D12
West Ditch R2
DAS-13
DAS-12
CH-D13
DAS-1
J-D11
GSA_DAS-1
J-D3
DAS-11
DAS-3
J-G4
J-G2.1
GSA-4-CVT
GSA-4
West Ditch R1
GSA-12
CH-G12
GSA-11
J-G2
GSA-10
GSA-1-2

# 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 |

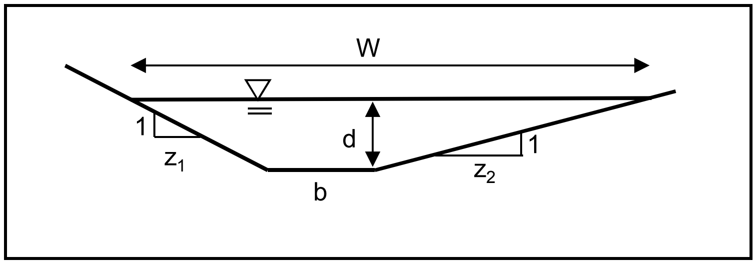
*Side Slope(s)*

| | | |
|---|---|---|
| $z_1$ 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 - Wp | 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 - $\tau_d$ | **0.31** | lb / $ft^2$ |

***Channel Sketch***




***Governing Geometry Equations***

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

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

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

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

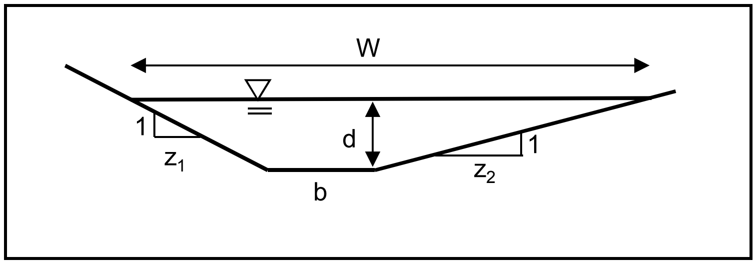
$$\tau_d = \gamma d S \qquad V = \frac{Q}{A}$$

***West Ditch R1***

***Channel Section*** 2

2. Non-symmetrical Trapezoidal Section

***Channel Sketch***




***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 |

***Governing Geometry Equations***

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

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

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

***Output Data:***

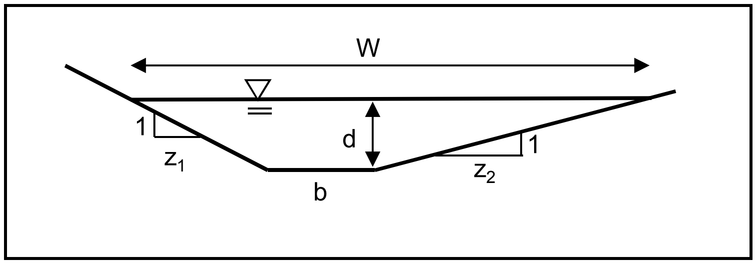
| | | |
|---|---|---|
| Calculated Depth - d | **1.45** | feet |
| Calculated Top Width - W | **25.68** | feet |
| Calculated Area - A | 30.85 | $ft^2$ |
| Calc. Wetted Perimeter - Wp | 26.15 | feet |
| Calc. Hydr. Radius - R | 1.18 | feet |
| Calculated Discharge - Q' | 64.03 | $ft^3/s$ - cfs |
| Convergence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

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

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

***SE Central Ditch***

***Channel Sketch***




| | | |
|---|---|---|
| ***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 - Wp | 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 - $\tau_d$ | **0.23** | lb / $ft^2$ |

***Governing Geometry Equations***

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

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

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

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

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

**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: 175555021
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) | $Q=C_0A(2gH)^{0.5}$ (cfs) | $H_c$ (ft) | $Q=C_0A(2gH_c)^{0.5}$ (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) | $Q=C_0A(2gH)^{0.5}$ (cfs) | $H_c$ (ft) | $Q=C_0A(2gH_c)^{0.5}$ (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**

**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 Cumputed Values is referring to the elevation of centerline of the outlet pipe inlet

| 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 | | | Equation |
| $L_{weir}$= | 12 | ft | Perimeter=Lx4 |
| $A_{riser}$= | 9.6 | sq. ft. | Area = LxL |
| $A_{pipe}$= | 7.068583 | sq. ft. | Area = $PI*D^2/4$ |
| Elev C= | 380.44 | feet | |