



October 6, 2016
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Revision 0

Tennessee Valley Authority
1101 Market Street
Chattanooga, Tennessee 37402

**RE: Initial Inflow Design Flood Control System Plan
Stilling Pond
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 initial inflow design flood control system plan for the TVA Cumberland Fossil Plant's Stilling Pond. Based on the assessment, the Stilling Pond complies with the inflow design flood control requirements in the EPA Final CCR Rule at 40 CFR 257.82.

2.0 INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN

As described in 40 CFR 257.82(c), an inflow design flood control system plan must be prepared to document how the inflow design flood control system has been designed and constructed to manage the design storm required by the hazard classification. Stantec has assigned the Stilling Pond a significant hazard potential classification rating. Thus, the inflow design storm event was selected from §257.82(a)(3) as the 1000-year flood event based upon a hazard potential classification of "significant".

3.0 SUMMARY OF FINDINGS

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

Plant	Facility	Inflow Design Storm	Water Surface Elevation (feet)	Minimum Embankment Elevation (feet)
CUF	Stilling Pond	1000-year storm	385.1	394.7



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Stilling Pond
EPA Final Coal Combustion Residuals (CCR) Rule
TVA Cumberland Fossil Plant
Cumberland City, Tennessee**

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
3. that the inflow design flood control system plan for the TVA Cumberland Fossil Plant's Stilling Pond meets the requirements specified in 40 CFR 257.82(a), (b), and (c)(1).

SIGNATURE

DATE

10/6/2016

ADDRESS:

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Louisville, Kentucky 40223-5308

TELEPHONE:

(502) 212-5075

ATTACHMENTS:

Inflow Design Flood Control System Plan



Initial Inflow Design Flood Control System Plan

Cumberland Fossil Plant – Stilling
Pond (including Retention Pond)
Cumberland City, Tennessee



Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

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INITIAL INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN

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INITIAL INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN

Background
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1.0 BACKGROUND

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 analyze the inflow design flood for Cumberland Fossil Plant's (CUF) Stilling Pond (including Retention Pond) (referred to herein as the "Stilling Pond") CCR surface impoundment (SI) and evaluate compliance with section §257.82 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. A map showing the location of CUF in relation to the surrounding hydrologic features is included as Appendix A. CUF has two SI's, the Stilling Pond and Bottom Ash Pond. CUF also has two CCR Landfills, the Gypsum Storage Area and Dry Ash Stack. A separate inflow design flood control plan has been prepared for the Bottom Ash Pond. In addition, a run-on and run-off control system plan has been prepared for the Gypsum Storage Area and Dry Ash Stack. This inflow design flood control plan addresses the Stilling Pond SI, which is an Existing CCR SI 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 INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN

Existing Conditions
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2.0 EXISTING CONDITIONS

The Stilling Pond conveys stormwater run-off and process water from CUF. CUF stormwater run-off and process water is conveyed through four drop inlet spillway structures during normal conditions and through a spillway box culvert during larger storm events. The Stilling Pond is approximately 56 acres in area (with 17 acres to the north comprising the stilling pond and 38 acres to the south comprising the retention pond). A divider dike and trapezoidal weir divide the stilling pond and retention pond. Under normal operations the Stilling Pond water elevation is approximately 378.0-feet, 12-feet over the bottom elevation of the trapezoidal weir. The Stilling Pond pool elevation is maintained at 378.0-feet by the four drop inlet spillway structures. When the Stilling Pond pool elevation reaches 386.0-feet, water discharges through the emergency spillway box culvert.

The Stilling Pond's perimeter dike is approximately 1.2-miles in length. The perimeter dike average elevation is approximately 394.7-feet. The interior dike that divides the Stilling Pond's stilling and retention ponds has a length and width of approximately 1,300-feet and 30-feet, respectively. The divider dike has an approximate elevation of 395.7-feet. The trapezoidal weir is approximately 40-feet wide with 2H:1V side slopes and an invert elevation of 366.0-feet.

In general, the Stilling Pond surface consists of the following. The Stilling Pond exterior, 3H:1V embankment slopes are typically surfaced with vegetated clay soil. Roads located on the top of the Stilling Pond perimeter are surfaced with gravel. The remaining and majority of the Stilling Pond surface is ponding water.

The existing CUF stormwater system conveys run-off to the Stilling Pond from the Dry Ash Stack (102 acres), Gypsum Storage Area (138 acres), Bottom Ash Pond (5.3 acres), the Fossil Plant (93 acres) and Coal Yard (71 acres). Appendix B illustrates CUF drainage and ditches, and they are described below.

The existing CUF stormwater system includes grass-lined and gravel-lined ditches (North Ditch, West Ditch, and SE Central Ditch), culverts, pumps and detention basins. Run-off from the Dry Ash Stack is conveyed to the Stilling Pond through the West and SE Central Ditch, and a detention basin (West Ditch Storage) before flowing into the Stilling Pond. Run-off from the Gypsum Storage Area is conveyed to the Stilling Pond through the Bottom Ash Pond, West Ditch Storage and the North, West, and SE Central Ditch. Run-off from the Fossil Plant is conveyed to the Coal Yard Pond where it is pumped to the North Ditch before flowing into the Stilling Pond. Run-off from the Bottom Ash Pond is also conveyed by the North Ditch before flowing into the Stilling Pond.

Flow from the Stilling Pond decants through four drop inlet type spillway structures that consist of 4-foot diameter concrete risers with 36-inch diameter lined outflow pipes. The drop inlet type spillway structures were part of the 2012 "Cumberland Fossil Plant Ash Stilling Pond Spillway Improvement Project".

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Under normal conditions, the Stilling Pond discharges to a NPDES permitted outfall (permit number: No. TN0005789) on the Cumberland River through the four drop inlet spillway structures and a discharge channel. When the water level in the Stilling Pond exceeds the approximate elevation of 386-feet, water will discharge through the 8-feet by 8-feet emergency spillway box culvert into Wells Creek.

Note that all elevations included in this document and appendices are referenced to the National Geodetic Vertical Datum of 1929 (NGVD29).

Figure 2 shows the location of the hydraulic structures in the Stilling Pond.



Figure 2 Hydraulic Structures

INITIAL INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN

Methods / Design Criteria
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3.0 METHODS / DESIGN CRITERIA

This Inflow Design Flood Control System Plan has been developed to document how the inflow design flood control system has been designed and constructed to meet the requirements of §257.82. The Stilling Pond was classified as a significant hazard structure in September, 2013 and was confirmed to be a Significant Hazard structure based on the report from Stantec to TVA dated September 30, 2016. This plan has been developed based on that classification and the following EPA Final CCR Rule criteria apply:

1. The inflow design flood control system must adequately manage flow into the CCR unit during and following the peak discharge of the inflow design flood. (Ref. §257.82(a)(1)),
2. The inflow design flood control system must collect and control flow from the CCR unit during and following the peak discharge of the inflow design flood. (Ref. §257.82(a)(2)),
3. The inflow design flood for a significant hazard potential CCR surface impoundment is the 1,000-year flood. (Ref. §257.82(a)(3)(ii)),
4. Discharge from the CCR Unit must be handled in accordance with the surface water requirements under §257.3-3.
5. The owner or operator must prepare an initial inflow design flood control system plan for its existing surface impoundments by October 17, 2016. (Ref. §257.82(c)(3)(i)),
6. The plan must be revised every 5 years, and amendments must be made whenever there is a change in condition(s) that would substantially affect the written plan in effect. (Ref. §257.82)(c)(4) & (2)),
7. This plan will be considered complete upon its placement in the facility's operating record. (Ref. §257.82(c)(1)),
8. The owner or operator must obtain a certification from a qualified professional engineer stating that the initial and periodic inflow design flood control system plans meet the requirements of §257.82.

Hydrological calculations were performed based on Soil Conservation Service Technical Release 55 (TR-55) methods in U.S. Army Corps of Engineers' Hydrologic Engineering Center-Hydrological Modeling System (HEC-HMS) software to analyze the performance of the impoundments for the 1000-year storm. EPA's Final CCR Rule does not specify the storm duration for the inflow design flood; therefore, a 6-hour storm duration was used.

The following sections describe the hydrologic parameter inputs to the HEC-HMS model, including curve number and lag times, in addition to the channel and detention basin hydraulics.

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3.1 MODELING ASSUMPTIONS

1. The model represents existing conditions as of January, 2016, plus new conditions created by the "Siphon Improvement Project" that was completed in March, 2016.
2. For this analysis, the tailwater elevation was assumed to be equal to elevation 381 feet which is approximately the 100-year peak elevation at the Cumberland River near CUF from the "Dam Breach Analysis and Inundation Mapping, Cumberland Fly Ash Pond, Cumberland Fossil Plant" report by Stantec and dated 2010.
3. The Stilling Pond's lined outlet pipe inside diameter for the four drop inlet type spillway structures was assumed to be 33-inches.
4. The Bottom Ash Pond receives a constant plant process flow of 21.7 million gallons per day. The flow was obtained from the Cumberland Fossil Plant Wastewater Flow Schematic, NPDES Permit NO. TN0005789 dated January, 2011.
5. The Fossil Plant area discharges into the Coal Yard Pond. Run-off from the Coal Yard Pond is pumped to the North Ditch at a constant flowrate of 24 cubic feet per second as stated in the "Cumberland Fossil Plant Ash Stilling Pond Spillway Improvement Project" Basis of Design Report developed by Stantec and dated March 21, 2012.
6. The Coal Yard area discharges into the North Ditch. HEC-HMS hydrologic parameter inputs for the Coal Yard, including lag time (8.8 minutes), CN (91) and approximate area are based on the parameters used in the "Cumberland Fossil Plant Ash Stilling Pond Spillway Improvement Project" Basis of Design Report dated 2012.
7. Pipes are assumed to be flowing freely and not clogged or leaking.
8. The storage capacity upstream from culverts was not considered in the analyses.

3.2 HYDROLOGY INPUTS

3.2.1 Watershed Parameters

Subwatersheds were delineated in AutoCAD 2015. The watershed delineations were based on topographic data provided by TVA dated October, 2014. The estimated watershed parameters are summarized in Table 1. A figure showing the watershed delineations is included in Appendix C.

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Table 1 Watershed Parameters

Watershed	Drainage Area (Acres)	Composite Curve Number	Lag Time (minutes)
GSA1-2	10.1	89	29.1
GSA3	96.4	91	50.0
GSA4	0.5	89	32.9
GSA5	3.4	89	10.0
GSA6	1.5	89	4.4
GSA7	5.1	77	10.4
GSA8	7.7	89	13.5
GSA9	4.3	89	9.5
GSA10	6.6	89	13.0
GSA11	1.5	89	13.3
GSA12	1.0	89	12.6
GSA13	1.4	89	4.1
GSA14	4.0	94	7.4
GSA15	6.5	99	9.7
GSA16	1.3	87	5.9
GSA_DAS1	10.9	89	14.8
GSA_DAS2-3	6.9	89	7.8
DAS1	38.4	91	29.3
DAS2	8.3	91	25.7
DAS3	2.9	91	45.7
DAS4-5	13.3	90	47.4
DAS6	1.2	89	4.8
DAS7-8	7.0	89	15.0
DAS9	1.9	89	9.4
DAS10	2.8	89	5.1
DAS11	3.0	89	7.0
DAS12	1.3	89	6.3
DAS13	8.2	89	11.8
DAS14	0.3	89	3.5*
SP-1	55.5	99	3.5*

*Note that HEC-HMS model uses minimum lag time of 3.5 minutes.

3.2.1.1 Curve Number (CN)

The land use cover on the Stilling Pond and contributing watersheds outside the Stilling Pond CCR Unit limits includes water, grass vegetated clay soil, gypsum, bottom and fly ash, pavement, grass, and gravel.

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The Cover Type for vegetated clay soil areas was judged to be best-represented by "Open Space (lawns, parks, etc.)" per NRCS TR-55, Table 2-2a. Grass vegetated clay soil areas with vegetation cover between 50 percent and 75 percent (Capped Type 1) were assumed "Fair" cover type per NRCS TR-55, Table 2-2a. Vegetated clay soil areas with vegetation cover less than 50 percent (Capped Type 2) were assumed "Poor" cover type per NRCS TR-55, Table 2-2a. The clay soil was classified as HSG D. This analysis used a CN of 84 and 89 for Capped Type 1 and Capped Type 2, respectively.

The Cover Type for gypsum and 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 gypsum and bottom and fly ash were classified as HSG C and a CN of 91. The Cover Type for dense grass was judged to be best-represented by "Open Space" per NRCS Table 2-2a, classified as HSG C and assigned a CN of 74.

The Stilling Pond also contains areas surfaced with gravel, and pavement and it contains ponded water. The gravel surface areas were assumed to be compacted and used a CN 91 per NRCS Table 2-2a. Areas with pavement used a CN of 98 per NRCS Table 2-2a. Ponded water surfaced areas were assigned a CN of 99.

A summary of curve number calculations and a map showing the curve numbers for each sub-area is included in Appendix D.

3.2.1.2 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.

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- Open Channel Flow: Open channel flow velocities were calculated based on an assumed depth and channel geometry.

Lag time calculations are included in Appendix E.

3.2.1.3 Reach Routing

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

3.2.2 Spillway Data

Flow from the Stilling Pond is conveyed to Cumberland River. As described in Section 2, there are four drop inlet type spillways within the Stilling Pond.

Dimensions and elevations for the four drop inlet structures were obtained from drawing 10W286-09, "Spillway Improvements Project" by Stantec and AutoCAD construction record drawing, "cu104_cuf12350_20120327.dwg" provided by TVA. These drawings are included in Appendix F.

Riser geometry for the Stilling Pond outflow structures are summarized in Table 2.

Table 2 Stilling Pond Spillway Data

Weir/Riser Structure	Riser Diameter (inches)	Rim Elevation (feet)	Outlet Pipe Diameter (inches)	Pipe Inlet Invert Elevation (feet)	Pipe Outlet Invert Elevation (feet)	Outlet Pipe Length (feet)
Overflow 1	48	378.0	36	361.0	359.82	226
Overflow 2	48	378.0	36	361.0	359.85	218
Overflow 3	48	378.0	36	361.0	359.86	218
Overflow 4	48	378.0	36	361.0	359.89	228

Each drop inlet spillway consist of stacked concrete riser sections and an outlet pipe that penetrates the embankment. Depending on the headwater elevation, these structures are controlled by weir or orifice flow through the riser, or by orifice, open-channel flow, or pipe flow through the outlet pipe. In developing a hydraulic rating curve for these structures, these four flow conditions are computed for a range of headwater elevations and the limiting flow is used. The methods used to estimate the discharge for each of these components are described below:

INITIAL INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN

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Riser – Weir flow

Flow just above the riser crest behaves as weir flow and was 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 (feet); and H = head above the riser crest (feet). The weir was assumed to behave as a sharp-crested weir with a weir coefficient of 3.27 (Chow 1959).

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 was 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. The orifice discharge coefficient is 0.6 (Brater and King 1976).

Outlet Pipe – Orifice flow

Orifice flow in the outlet pipe was 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 outlet pipe springline (at upstream end), A = cross sectional area of the outlet pipe.

Outlet Pipe – Open-channel/submerged inlet flow

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

Computed rating curves for the structures are included in Appendix G.

3.2.3 Precipitation Data

The rainfall depth for the 1,000-yr, 6-hour storm is 7.4 inches based on NOAA Atlas 14 at CUF. "Early", "Middle" and "Late Peak" hyetographs were obtained from HydroCAD for a 6-hr storm duration assuming an SCS Type II shape. The modeled distributions are included in Appendix H.

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3.2.4 Stage-Storage Data

Storage volumes computed at 1-foot increments for the Stilling Pond using AutoCAD Civil3D as included as Appendix I. A surface was created to represent the bottom of the impoundments using existing topographic data (dated October, 2014) provided by TVA.

The elevation of the top of embankment for the Stilling Pond is approximately 394.7-feet based on the existing topographic data.

3.2.5 Plant Process Flow

A flow schematic (dated January 2011 and provided by TVA), shows the average daily process flows into the Stilling Pond is 21.7 million gallons per day and was applied to the system watershed at the Bottom Ash Pond.

3.2.6 Starting Water Surface Elevations

The starting water surface elevation for the Stilling Pond was set to elevation 381-feet, which is approximately the 100-year peak elevation at the Cumberland River near CUF from the "Dam Breach Analysis and Inundation Mapping, Cumberland Fly Ash Pond, Cumberland Fossil Plant" report by Stantec and dated 2010.

3.3 HYDROLOGIC AND HYDRAULIC MODELING

Hydrologic and hydraulic modeling was performed using HEC-HMS 4.0 based on the model inputs summarized in Section 3.2. A model schematic is included in Figure 3. This schematic shows that the Stilling Pond receives flow from watersheds within the Dry Ash Stack, Gypsum Storage Area, Bottom Ash Pond, Fossil Plant and Coal Yard.

INITIAL INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN

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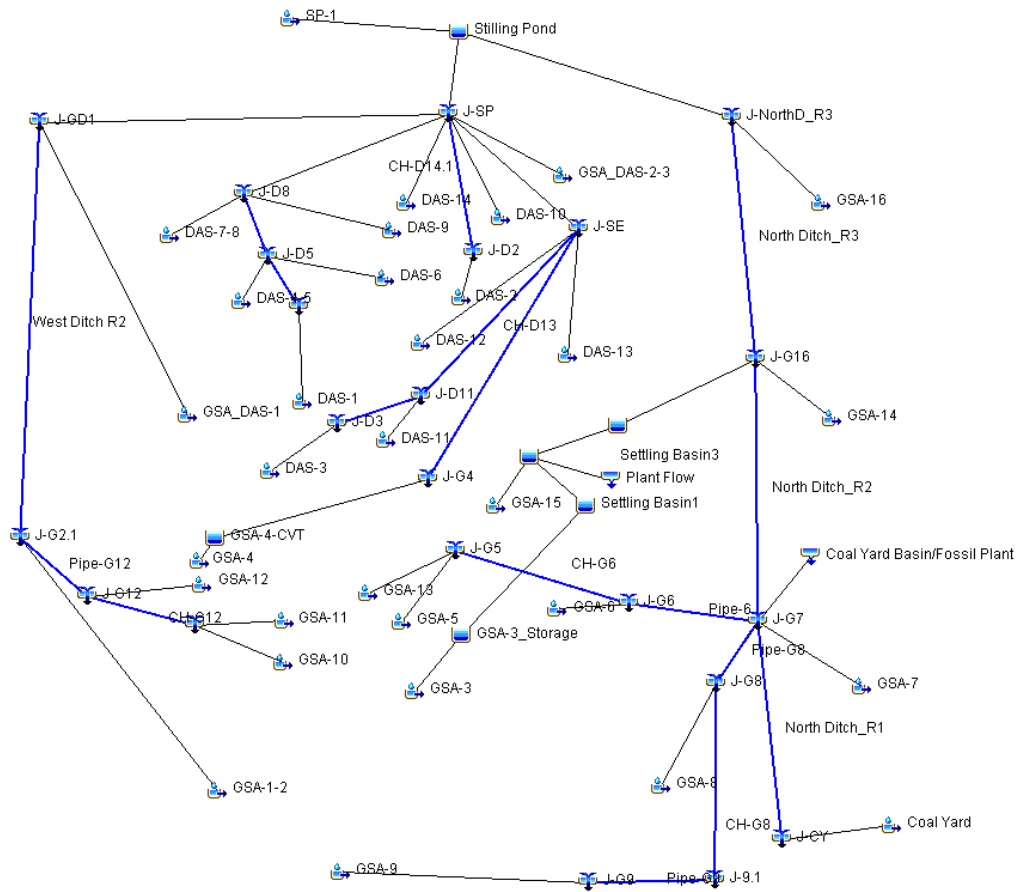


Figure 3 HEC-HMS Model Schematic

INITIAL INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN

Calculation Results
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4.0 CALCULATION RESULTS

The hydrologic modeling results were used to determine the performance of the Stilling Pond for the 1,000-year, 6-hour storm for the three precipitation events described in Section 3.2.3.

4.1 CAPACITY AND FREEBOARD RESULTS

The peak pool elevation, inflow and outflow for each pond is summarized in Table 3. The results showed that the Stilling Pond can safely pass the flow from the 1,000-year 6-hour storm without overtopping.

Table 3 Hydrologic and Hydraulic Modeling Results

Scenario	Storm	Peak Water Surface Elevation (feet)	Peak Inflow (cubic feet per second)	Peak Outflow (cubic feet per second)	Minimum Embankment Crest Elevation (feet)	Freeboard (feet)
1	SCS Type II "Early Peak"	383.6	745.5	213.9	394.7	11.1
2	SCS Type II "Middle Peak"	384.9	1,637.3	216.2	394.7	9.8
3	SCS Type II "Late Peak"	385.1	1,979.5	220.5	394.7	9.6

INITIAL INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN

Conclusions
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5.0 CONCLUSIONS

The calculations included in this report demonstrate that the inflow design flood control system adequately manages flow into and from the CCR Unit during and following the peak discharge of the inflow design flood (1,000-year flood). In addition the CCR Unit discharges through a NPDES permitted outfall, and is therefore handled in accordance with the surface water requirements under §257.3-3. Therefore the Stilling Pond meets the requirements of Section §257.82 of the EPA Final CCR Rule.

INITIAL INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN

References
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6.0 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. Tennessee Valley Authority, Flow Schematic, TVA Cumberland Fossil Plant, NPDES Permit No. TN0005789, January, 2011.
8. Brater, E.F. and H.W. King (1976), Handbook of Hydraulics, McGraw-Hill, New York.
9. Stantec (2010). "Dam Breach Analysis and Inundation Mapping, Cumberland Fly Ash Pond, Cumberland Fossil Plant." Prepared for Tennessee Valley Authority, September, 2010.
10. Stantec Consulting Services Inc. "Initial Hazard Potential Classification Assessment – Stilling Pond (including Retention Pond)", September 30, 2016

APPENDIX A
HYDROLOGIC OVERVIEW MAP

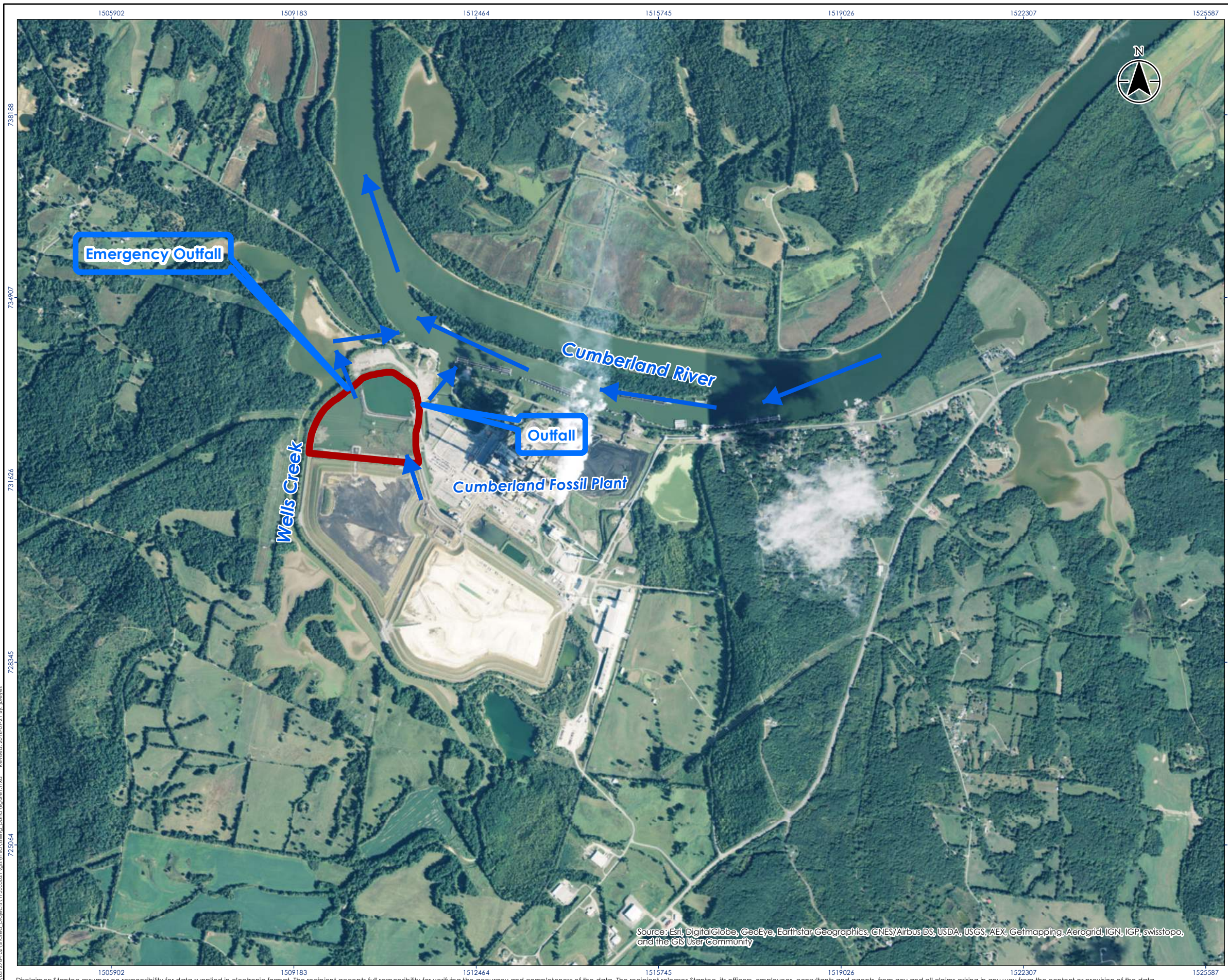


Figure No. **1**
 Title **HYDROLOGIC OVERVIEW MAP
 CUF - STILLING POND(INC. R. POND)**

Client/Project
 Tennessee Valley Authority
 Initial Inflow Design Flood Control System 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

0 1,500 3,000 Feet
 1:21,345 (At original document size of 11x17)

Legend
 Approximate Stilling Pond (inc. Ret. Pond) Boundary
 Flow Arrow

Notes
 1. Coordinate System: NAD 1927 StatePlane Tennessee FIPS 4100

1505902 1509183 1512464 1515745 1519026 1522307 1525587

734907 734907 731426 731426 728345 728345 725064 725064

1505902 1509183 1512464 1515745 1519026 1522307 1525587

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APPENDIX B
GENERAL DRAINAGE MAP

1509183

1512464

1515745

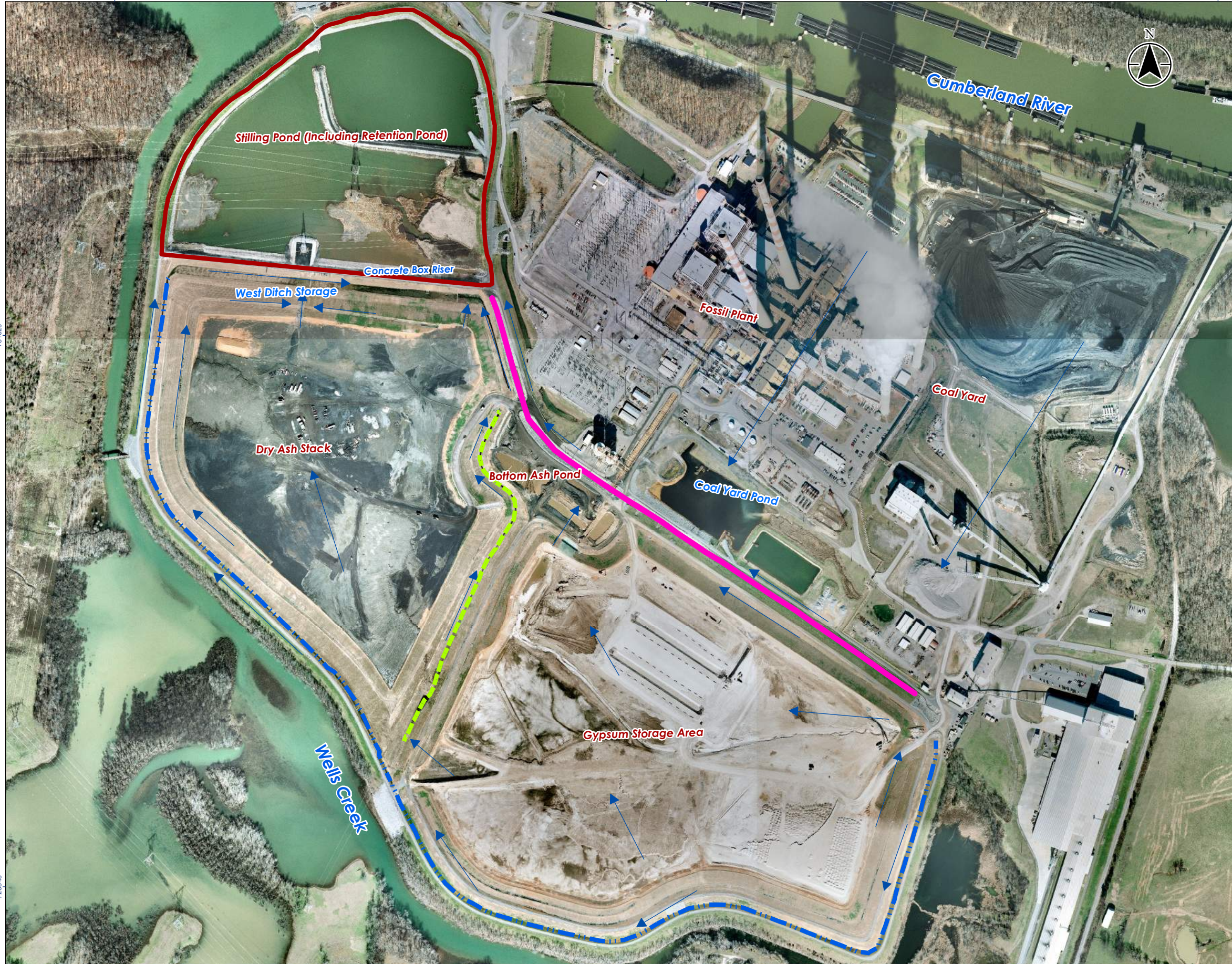


Figure No.

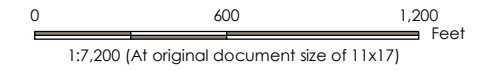
2

Title

GENERAL DRAINAGE MAP CUF - STILLING POND (INC. R. POND)

Client/Project
Tennessee Valley Authority
Inflow Design Flood Control System 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	175555021
---	---	-----------



Legend

Approximate CCR Unit Boundary

Flow Arrows

Ditches

North Ditch

SE Central Ditch

West 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



\\US1276-F22\shared_projects\175555021\gis\mxd\stilling_pond\figure2.mxd Revised: 2014-09-28 By: Levees 728345

1509183

1512464

1515745

APPENDIX C
WATERSHED MAP

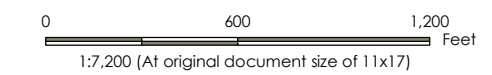


Figure No. **3**
 Title **WATERSHED MAP**
CUF - STILLING POND (INC. R. POND)

Client/Project
 Tennessee Valley Authority
 Inflow Design Flood Control System 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

\\US1276-F02\shared_projects\175555021\gis\mxd\stilling_pond\figure3.mxd
 Revised: 2014-09-28 By: Levees
 728345

**APPENDIX D
CURVE NUMBER MAP AND
COMPUTATIONS**

1509183

1512464

1515745



Figure No.

4

Title

CURVE NUMBER MAP CUF - STILLING POND (INC. R. POND)

Client/Project

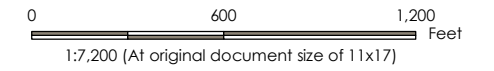
Tennessee Valley Authority
Initial Inflow Design Flood Control System Plan
175555021

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

Curve Number

- Bottom and Fly Ash CN=91
- Capped Type 1 CN=84
- Capped Type 2 CN=89
- Grass CN=74
- Gypsum CN=91
- Pavement CN=98
- Gravel CN=91
- Water CN=99
- Other CN=91 (see Note 4)



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 - See Report Sec. 3.1



\\US1276-F22\shared_projects\175555021\gis\mxd\stilling_pond\figure4.mxd Revised: 2014-09-28 By: Levees 7/28/15

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APPENDIX D
LAG TIME COMPUTATIONS

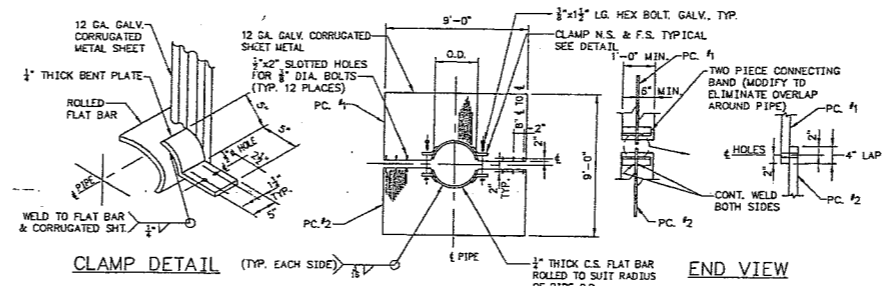
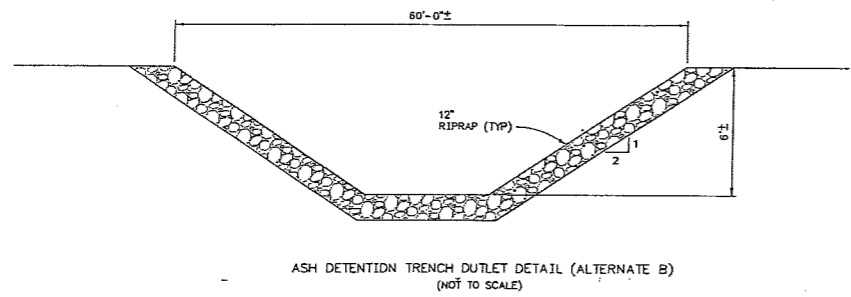
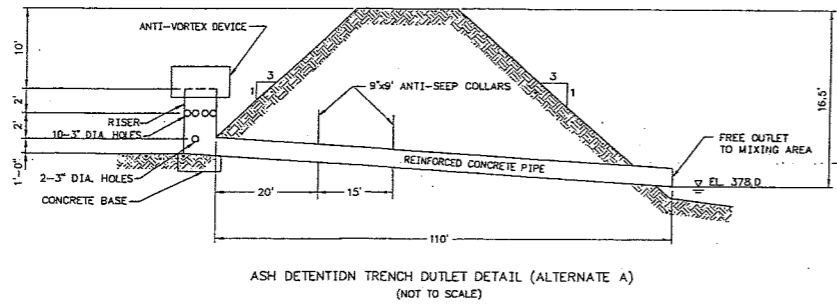
CUF Stilling Pond (including Retention Pond)

Lag Time:

Watershed	Estimated Lag Time (min)
GSA1-2	29.1
GSA3	50.0
GSA4	32.9
GSA5	10.0
GSA6	4.4
GSA7	10.4
GSA8	13.5
GSA9	9.5
GSA10	13.0
GSA11	13.3
GSA12	12.6
GSA13	4.1
GSA14	7.4
GSA15	9.7
GSA16	5.9
GSA_DAS1	14.8
GSA_DAS2-3	7.8
DAS1	29.3
DAS2	25.7
DAS3	45.7
DAS4-5	47.4
DAS6	4.8
DAS7-8	15.0
DAS9	9.4
DAS10	5.1
DAS11	7.0
DAS12	6.3
DAS13	11.8
DAS14	3.5
SP-1	3.5

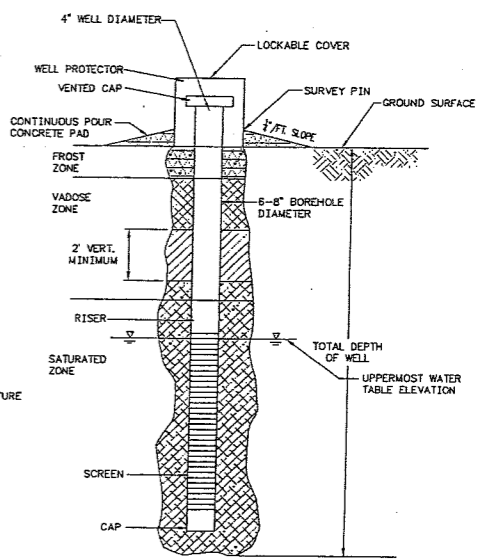
*HEC-HMS model uses minimum lag time of 3.5 minutes. Therefore, any time less than 3.5 minutes will be modified to 3.5 minutes.

APPENDIX F
REFERENCE DRAWINGS

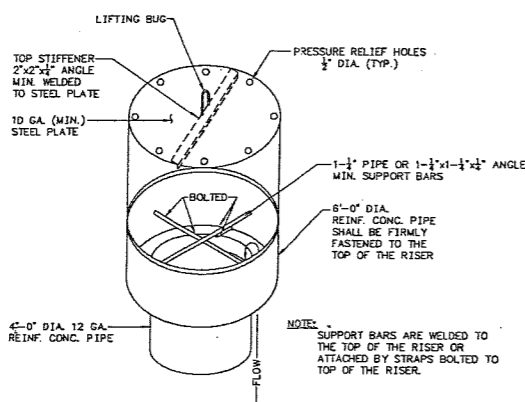


NOTE:
 1) PROVIDE TWO ANTI-SEEP COLLARS, LOCATIONS LATER.
 2) THE LAP BETWEEN THE TWO HALF SECTIONS AND BETWEEN THE PIPE & CONNECTING BAND SHALL BE CAULKED WITH BITUMINOUS MASTIC AT THE TIME OF INSTALLATION.
 3) UNASSEMBLED COLLARS SHALL BE MARKED BY PAINTING OR TAGGING TO IDENTIFY MATCHING PAIRS.

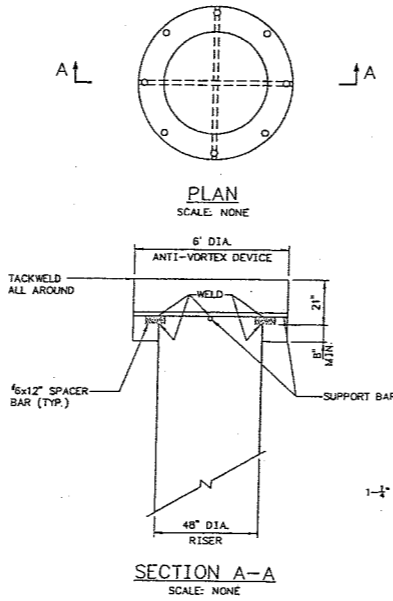
ANTI-SEEP COLLAR
SCALE: NONE



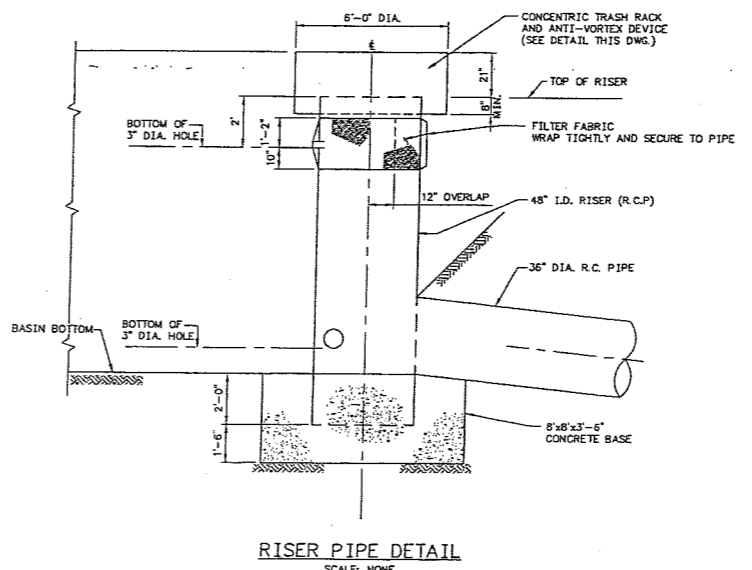
MONITORING WELL
(NOT TO SCALE)



CONCENTRIC TRASH RACK AND ANTI-VORTEX DEVICE
SCALE: NONE

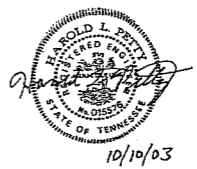


SECTION A-A
SCALE: NONE



RISER PIPE DETAIL
SCALE: NONE

- BENTONITE/CEMENT MIXTURE ANGLAR SEALANT
- BENTONITE
- GRANULAR BACKFILL FILTER PACK

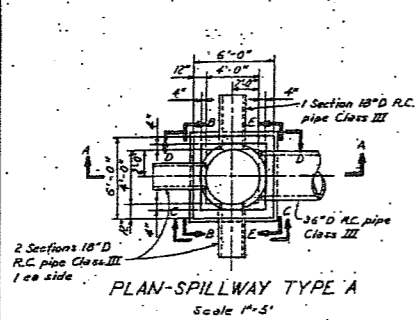


DESIGNED BY	DRAWN BY	CHECKED BY	SUPERVISED BY	REVIEWED BY	APPROVED BY	ISSUED BY
JL GRAY	M.S. HANEX	J.G. ALBRIGHT	H.L. PETTY	R.E. PURSEY		J.L. ADAIR
CUMBERLAND FOSSIL PLANT TENNESSEE VALLEY AUTHORITY FOSSIL AND HYDRO ENGINEERING						
AUTOCAD R14	DATE	46 C	10W302-24	R 0		

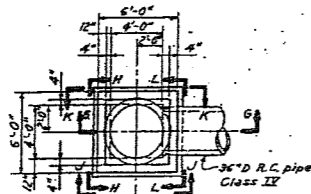
SEE 10W302-1 FOR DRAWING INDEX/COMPANION DRAWINGS LIST

TASK COMPLETED BY: REV NO.

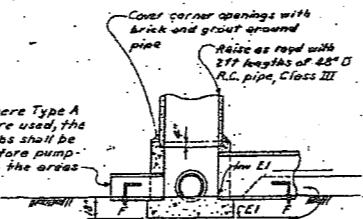
PLDT FACTOR: 32 W.TVA C.A.D. DRAWING DO NOT ALTER M/



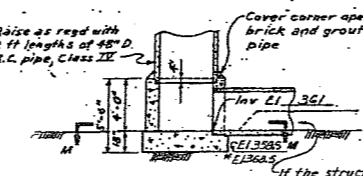
PLAN-SPILLWAY TYPE A
Scale 1"=3'



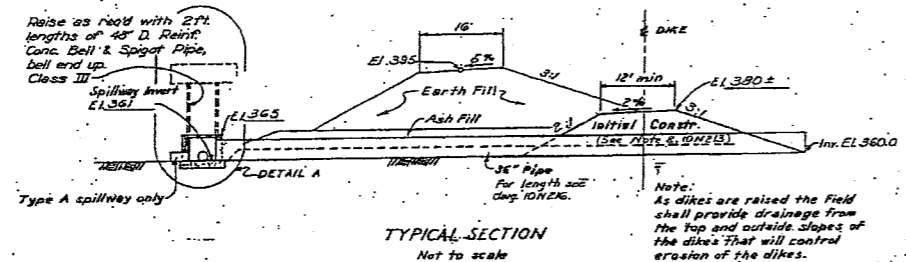
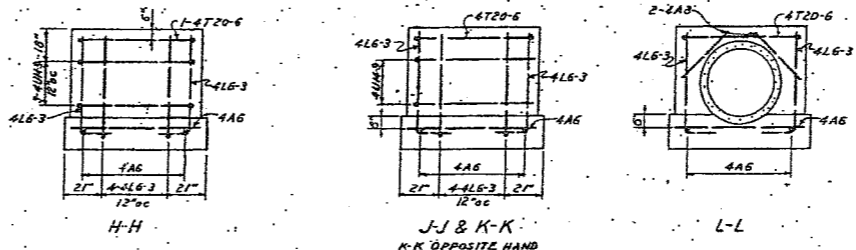
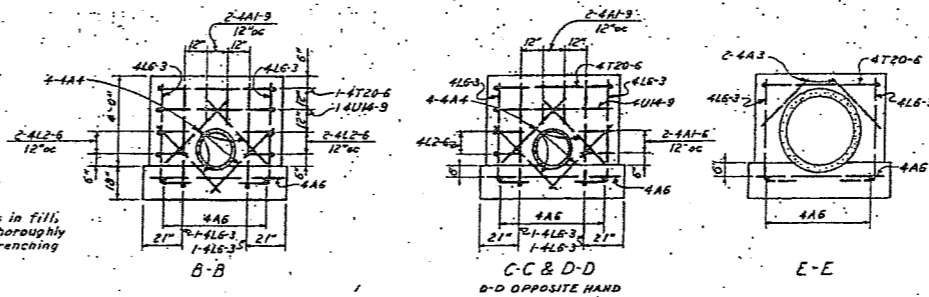
PLAN-SPILLWAY TYPE B
Scale 1"=3'



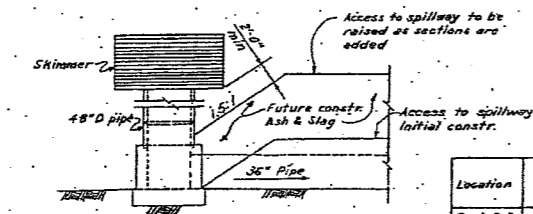
SECTION A-A
Scale 1"=3'



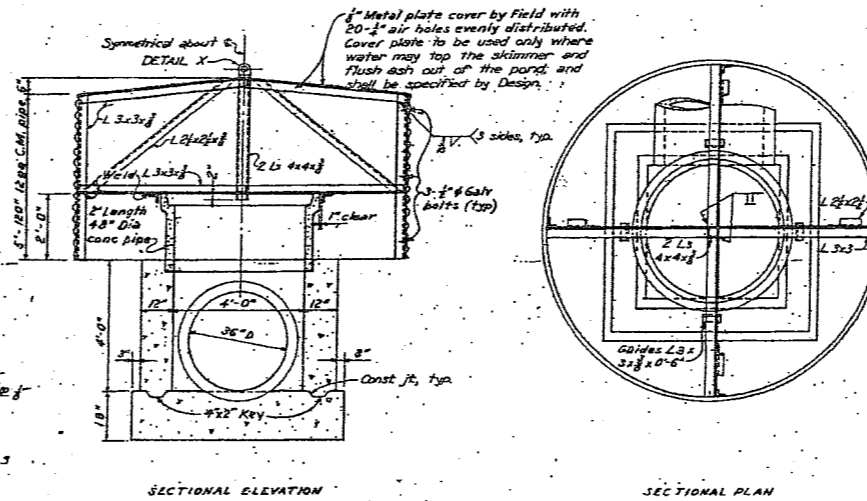
SECTION G-G
Scale 1"=3'



TYPICAL SECTION
Not to scale



DETAIL A
Not to scale



SKIMMER DETAILS
Scale 1/2"=1'-0

Location	Mark	No. of Bars	Bend Dim.		
			a	b	c
Sect B-B	4T20-6	1	1	50	50
	4U14-9	1	1	50	50
	4L6-3	1	2	20	Ex
	4L2-6	1	4	3	Ex
	4A4	1	4		
Sect G-G & D-D	4A4	2	2	4	20
	4A4	2	4	8	
	4A4	2	2	4	
Sect E-E	4A3	1	2		
	4A6	1	2		
Sect F-F	4L6-3	1	4	20	Ex
	4A6	1	2		
Sect H-H	4T20-6	1	1	50	50
	4U14-9	1	1	50	50
	4L6-3	1	4	20	Ex
	4A4	1	4		
	4A4	1	2		
Sect J-J & K-K	4L6-3	2	4	8	20
	4A4	1	2		
Sect L-L	4A3	1	2		
	4A6	1	2		
Sect M-M	4L6-3	1	4	20	Ex
	4A6	1	2		

REINFORCEMENT SCHEDULE

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	200 cu ft
602	36" D Reinforced Concrete Pipe - Class IX	4	60 cu ft
602	48" D Reinforced Concrete Pipe - Class III (Bell & Spigot)	4	27 cu ft
640	120" x 12 Gauge Corrugated Metal Pipe	4	5 ft
	1" Galvanized Bolt	4	4
	2" Metal cover (By field - see Skimmer Details)	4	4
	2" x 2" x 1/2" Angle	4	23 ft
	3" x 3" x 1/2" Angle	4	67 ft
	4" x 4" x 1/2" 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 3"=1'-0"
Except as noted

STANDARD DRAWING

ASH DISPOSAL SPILLWAY

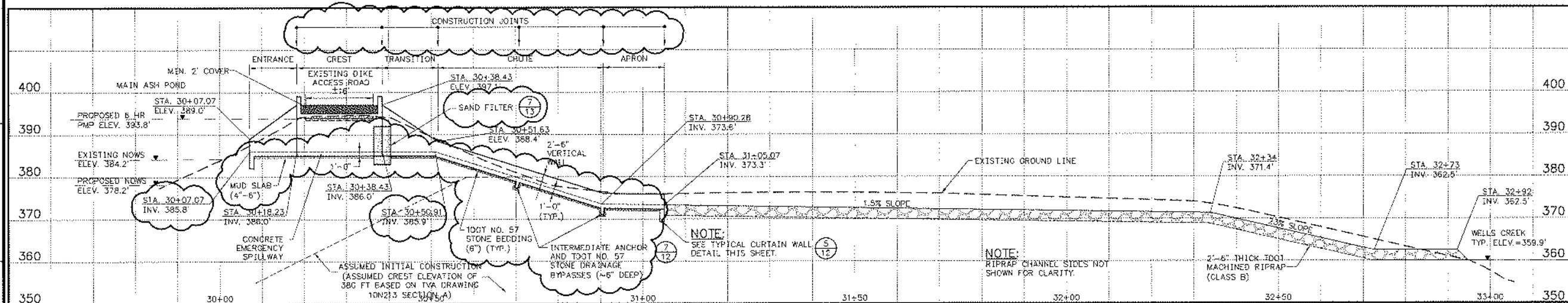
CUMBERLAND STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

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

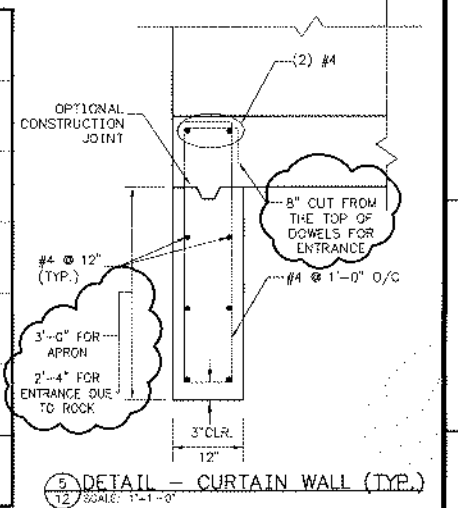
KNOXVILLE 1-13-69 46 C 4 ION214R2
RECORD DRAWING AS CONSTRUCTED
Hand Vn. 1/23/69 9-3-69

COMPANION DRAWING: ION212, 213, 216, 218

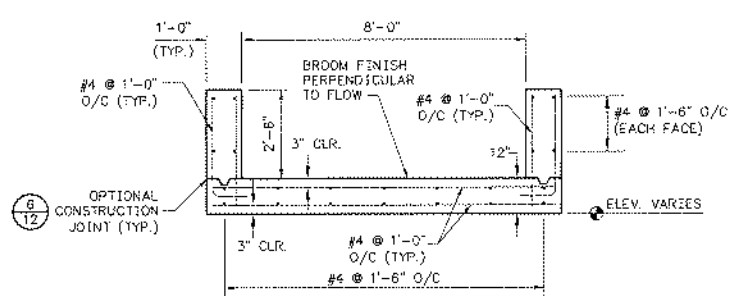
DESIGNED BY	DATE
CHECKED BY	DATE
APPROVED BY	DATE
SCALE	
PROJECT	
NO.	



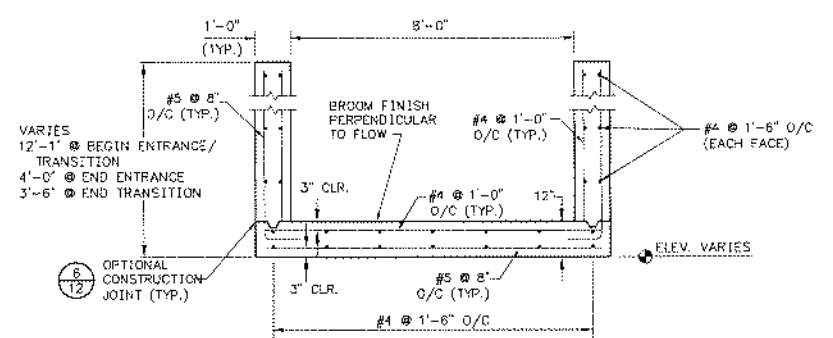
1 PROFILE - EMERGENCY SPILLWAY
SCALE: 1"=10'



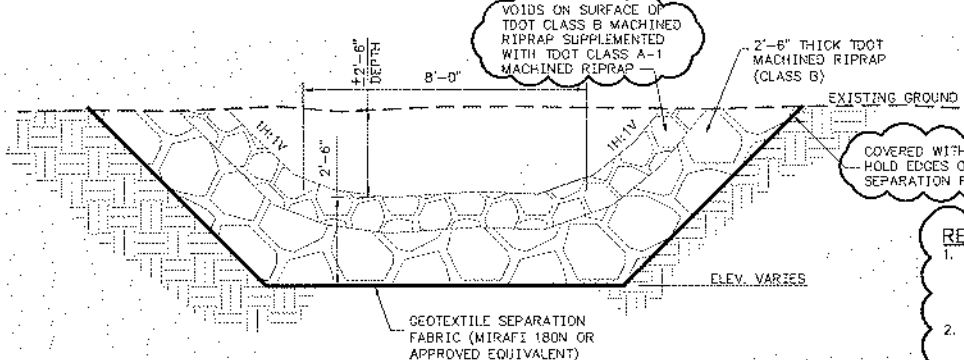
5 DETAIL - CURTAIN WALL (TYP.)
SCALE: 1"=1'-0"



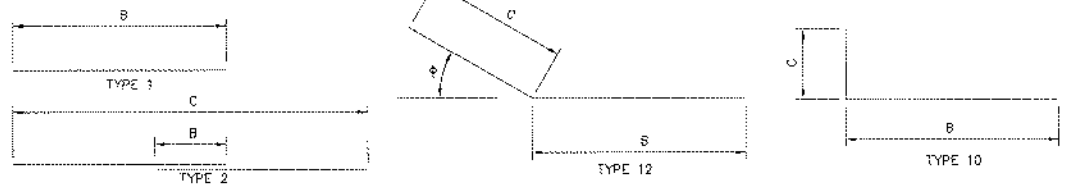
2 SECTION - EMERGENCY SPILLWAY CONCRETE CHUTE/APRON CROSS SECTION (TYP.)
SCALE: 1/2"=1'-0"



3 SECTION - EMERGENCY SPILLWAY CONCRETE WINGWALL (ENTRANCE/TRANSITION) CROSS SECTION (TYP.)
SCALE: 1/2"=1'-0"



4 SECTION - EMERGENCY SPILLWAY RIPRAP CHANNEL (TYP.)
SCALE: 1/2"=1'-0"



TRANSITION, CHUTE, APRON, AND ENTRANCE REINFORCEMENT										
TYPE	SIZE	SPACING (INCHES)	TYPE	LENGTH (FEET)	WT. (LBS)	A (INCHES)	B (INCHES)	C (INCHES)	D (INCHES)	DEG.
CURTAIN WALLS										
20	4	12	1	2-6	32	8	43	6	8	
21	4	12	1	2-6	32	8	43	6	8	
INTERMEDIATE AND/OR WALLS										
20	4	12	10	3-0	40	8	28	32		
21	4	12	1	2-6	32	8	43	6	8	
APRON										
20	4	12	10	3-0	40	8	28	32		
21	4	12	1	2-6	32	8	43	6	8	
CHUTE										
20	4	12	10	3-0	40	8	28	32		
21	4	12	1	2-6	32	8	43	6	8	
TRANSITION										
20	4	12	10	3-0	40	8	28	32		
21	4	12	1	2-6	32	8	43	6	8	
ENTRANCE										
20	4	12	10	3-0	40	8	28	32		
21	4	12	1	2-6	32	8	43	6	8	

- NOTES:**
- CONCRETE, REINFORCEMENT AND FORMWORK SHALL BE IN ACCORDANCE WITH TECHNICAL SPECIFICATIONS. CONCRETE SHALL BE CLASS A, F'C=4,000 PSI.
 - REINFORCING STEEL SHALL HAVE A MINIMUM YIELD STRENGTH, F_y=60,000 PSI
 - ALL #4 BARS SHALL HAVE 1'-9" SPLICE (MIN.). ALL #5 BARS SHALL HAVE 2'-2" SPLICE (MIN.). ALL #6 BARS SHALL HAVE 2'-7" SPLICE (MIN.).
 - MAINTAIN 2" CLR. UNLESS OTHERWISE SHOWN.
 - ALL EXPOSED CORNERS SHALL HAVE 3/4" CHAMFER.
 - TOOLED JOINTS SHALL BE PLACED EVERY 20 FEET ALONG TRANSITION, CHUTE, AND APRON SECTIONS.
 - BROOM FINISH FLOOR SURFACES PERPENDICULAR TO FLOW.

RECORD DRAWING NOTES:

- THESE DRAWINGS HAVE BEEN PREPARED BASED ON SURVEY INFORMATION OBTAINED BY TVA SURVEYING IN APRIL 2012 AND PROVIDED TO STANTEC ON APRIL 10, 2012.
- ITEMS SHOWN ON THE "RECORD DRAWING" WITH CLOUDED NOTATION ARE ITEMS FOR WHICH AS-BUILT INFORMATION WAS AVAILABLE. ALL OTHER ITEMS ARE SHOWN FOR REFERENCE AS THEY WERE IN THE "ISSUED FOR CONSTRUCTION" PLAN SET.

FOR SUPPORTING DESIGN CALCULATIONS SEE FPG04FFES00X0000020100008

Stantec
Stantec Consulting Services Inc.
1959 Bowers Ave., Ste 250
St. Louis, Missouri 63126-1844
Tel: 636.343.3850
Fax: 636.343.3504
www.stantec.com

ISSUED FOR CONSTRUCTION

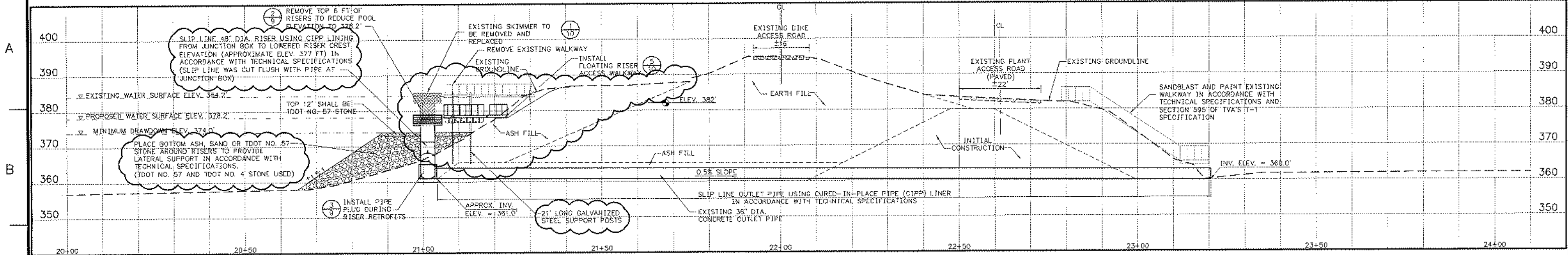
SCALE: AS SHOWN EXCEPT AS NOTED

YARD ASH STILLING POND
SPILLWAY REPLACEMENT PROJECT
DETAILS - EMERGENCY SPILLWAY
WORK PLAN 7 (CUF-110311-WP-7)

CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2010 05/11/11 45 C 10W286-12 R 2

RECORD DRAWING

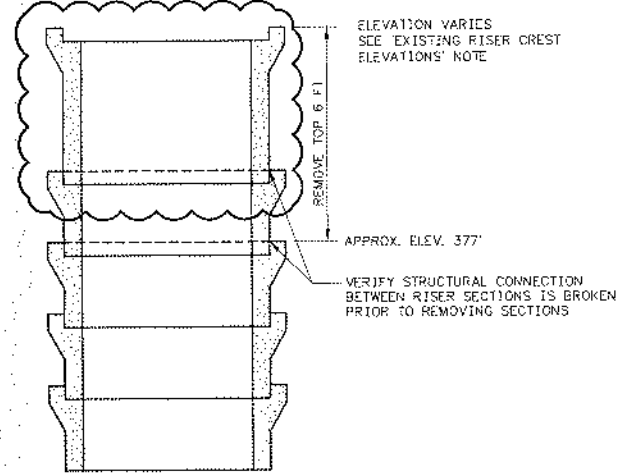


1 PROFILE - BASELINE B
SCALE: 1"=30'

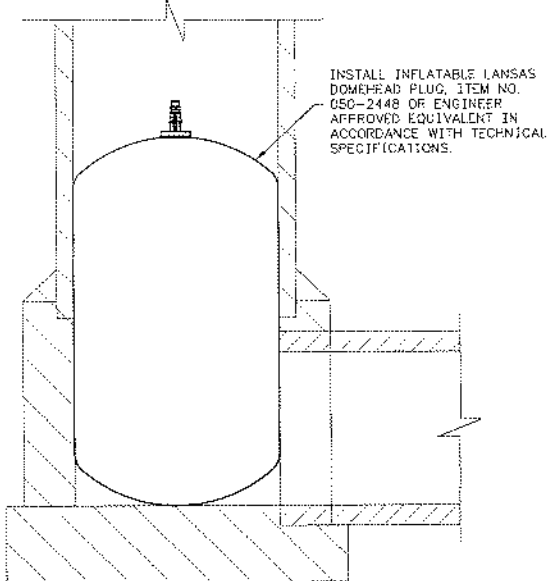
EXISTING RISER CREST ELEVATIONS (STEEL PLATE CREST)

SPILLWAY ID (SEE SHEET 3)	ELEV.
CUF-AP-MG-001-A	383.99'
CUF-AP-MG-002-A	383.92'
CUF-AP-MG-003-A	383.95'
CUF-AP-MG-004-A	383.83'

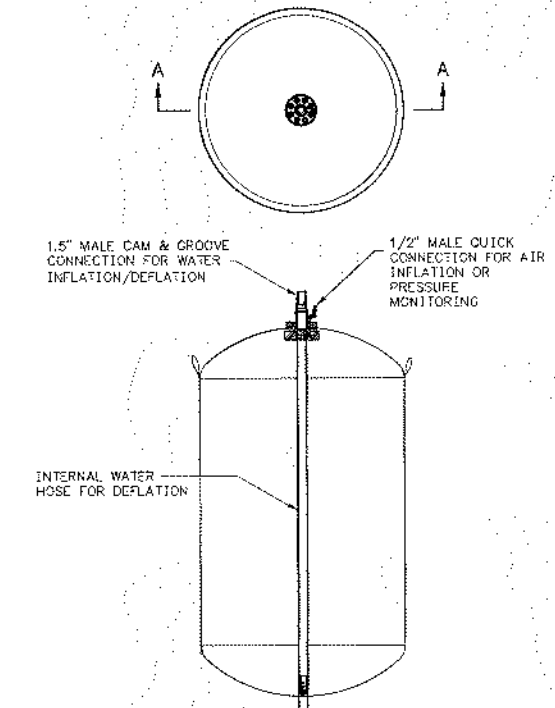
ELEVATION VARIES SEE 'EXISTING RISER CREST ELEVATIONS' NOTE



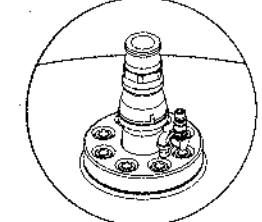
2 DETAIL - EXISTING RISER RETROFITS
SCALE: NOT TO SCALE



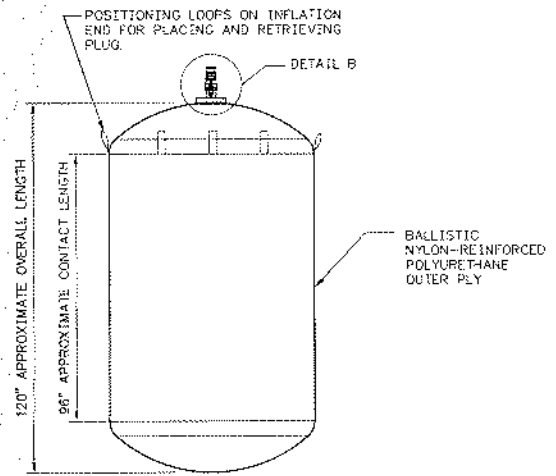
3 DETAIL - INSTALLATION OF PIPE PLUG
SCALE: NOT TO SCALE



SECTION A-A



DETAIL B



4 DETAIL - INFLATABLE PIPE PLUG
SCALE: NOT TO SCALE

PHASING AND SEQUENCING:

1. LOWER POOL ELEVATION APPROXIMATELY 1 FT BELOW EXISTING RISER CREST USING SIPHONS.
2. INSTALL TEMPORARY COFFERDAM OR STILT FENCE DOWNSTREAM OF EXISTING SPILLWAY OUTLETS TO CONTROL SEDIMENT AND WASTE FROM PIPE CLEANING.
3. CLEAN EACH SPILLWAY OUTLET PIPE IN ACCORDANCE WITH TECHNICAL SPECIFICATIONS.
4. INSPECT EACH SPILLWAY OUTLET PIPE AND RISER USING CLOSED-CIRCUIT TELEVISION (CCTV) IN ACCORDANCE WITH THE TECHNICAL SPECIFICATIONS.
5. INSTALL PIPE PLUG IN EACH RISER AND VERIFY TIGHTNESS AND ABILITY TO HOLD PRESSURE.
6. LOWER POOL ELEVATION USING SIPHONS AND REMOVE TOP 6 FT OF EACH RISER. EACH 2 FT RISER SECTION SHALL BE REMOVED INDIVIDUALLY. CONTRACTOR SHALL SUBMIT DETAILED WORKPLAN FOR REMOVING RISER SECTIONS TO ENGINEER FOR APPROVAL PRIOR TO BEGINNING WORK. WORKPLAN SHALL DETAIL POOL DRAWDOWN ELEVATION FOR EACH INCREMENTAL SECTION REMOVAL AS WELL AS MEANS TO ENSURE THAT ONLY THE TOP RISER SECTION WILL BE REMOVED AND NO LOWER JOINTS WILL BE IMPACTED.
7. MAINTAIN POOL LEVEL BELOW NEW RISER CREST ELEVATION USING SIPHONS AND SLIP LINE THE RISERS AND OUTLET PIPES USING CURED-IN-PLACE PIPE (CIPP) LINING IN ACCORDANCE WITH THE TECHNICAL SPECIFICATIONS.
8. INSTALL NEW SKIMMER STRUCTURES IN ACCORDANCE WITH TECHNICAL SPECIFICATIONS.
9. INSTALL NEW FLOATING WALKWAYS.

RECORD DRAWING NOTES:

1. THESE DRAWINGS HAVE BEEN PREPARED BASED ON SURVEY INFORMATION OBTAINED BY TVA SURVEYING IN APRIL 2012 AND PROVIDED TO STANTEC ON APRIL 10, 2012.
2. ITEMS SHOWN ON THE "RECORD DRAWING" WITH CLOUDED NOTATION ARE ITEMS FOR WHICH AS-BUILT INFORMATION WAS AVAILABLE. ALL OTHER ITEMS ARE SHOWN FOR REFERENCE AS THEY WERE IN THE "ISSUED FOR CONSTRUCTION" PLAN SET.

SECTION OR DETAIL NO.
SHEET WHERE SHOWN
REFERENCE KEY

RECORD DRAWING

FOR SUPPORTING DESIGN CALCULATIONS SEE FPGCUFFESC0X00000020100008		R 1 05/04/12 PHV TAM MAH SHD SEB MSF JCK	
ISSUED AS-BUILT AS PER WORK PLAN 7 (CUF-110311-WP-7)		R 0 03/11/11 JCF TAM MAH SHD SEB MSF JCK	
ISSUED FOR CONSTRUCTION		R 0 03/11/11 JCF TAM MAH SHD SEB MSF JCK	
SCALE: NONE		EXCEPT AS NOTED	
YARD ASH STILLING POND SPILLWAY IMPROVEMENT PROJECT DETAILS - SPILLWAY RETROFITS WORK PLAN 7 (CUF-110311-WP-7)			
ISSUED BY: L.J. PERKINS	ISSUED BY: T.M. WATERS	CHANGED BY: A.L.A. HAY	APPROVED BY: S.E. BUCKLE
REVISION BY: S.E. BUCKLE	REVISION BY: S.E. BUCKLE	REVISION BY: S.E. BUCKLE	REVISION BY: S.E. BUCKLE
Stantec Consulting Services Inc. 1850 Bonita Ave., Ste 200 St. Louis, Missouri 63102-4444 Tel: 314.343.2850 Fax: 314.343.2554 www.stantec.com			
CUMBERLAND FOSSIL PLANT TENNESSEE VALLEY AUTHORITY FOSSIL AND HYDRO ENGINEERING			
AS/OCAD R 2000	SHEET NO. 46	PROJECT NO. 10W286-09	SCALE R 1

STANTEC 1
TASK COMPLETED BY: REV NO.

PLOT FACTOR: 10
W_TVA C.A.D. DRAWING DO NOT ALTER MANUALLY

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NOTES:

1. THESE DRAWINGS WERE PREPARED BY STANTEC CONSULTING SERVICES INC. (STANTEC) USING SURVEY INFORMATION-AERIAL AND GROUND SURVEYS PROVIDED BY TVA FROM APRIL AND JUNE 2011, JULY 2012, MARCH 2013 AND OCTOBER 2014.
2. EXISTING 18" DIAMETER SIPHON PIPES TO REMAIN. INLET AND OUTLET OF SIPHONS SHALL BE MOVED TO THE NORTHWEST TO ALLOW FOR CONSTRUCTION OF THE NEW INLET AND OUTLET HEADWALLS, AS NEEDED.

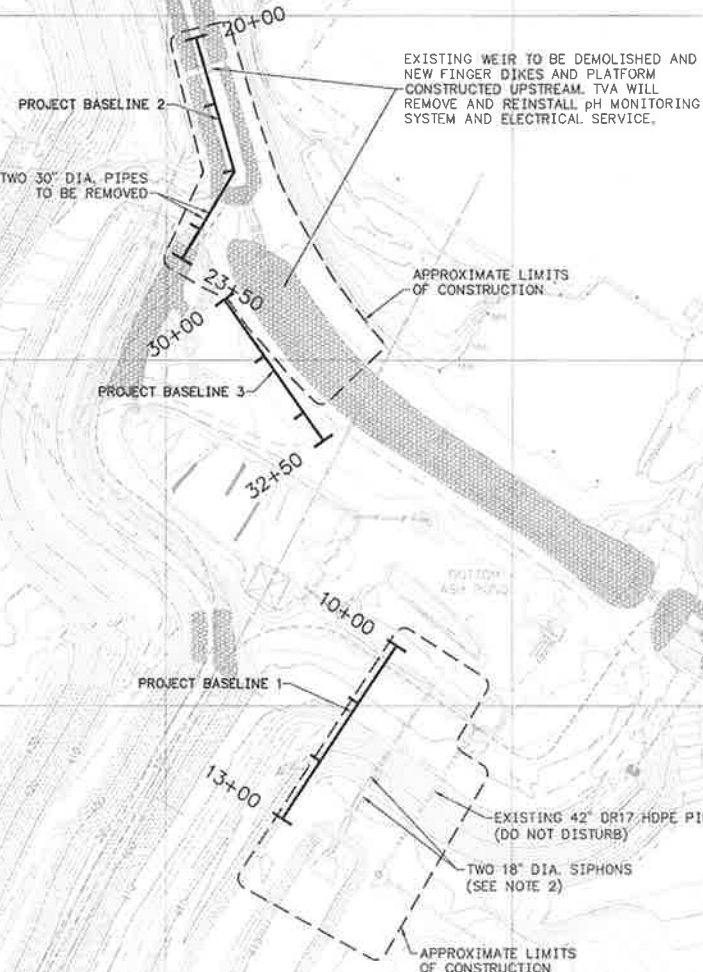
SURVEY CONTROL NOTE:

A GLOBAL POSITIONING SYSTEM (GPS) BASE STATION HAS BEEN ESTABLISHED AND TRANSFORMATION PARAMETERS DETERMINED BY TVA USING SELECTED SURVEY CONTROL MONUMENTS. CONTACT WITH TVA SURVEYING DEPARTMENT (423)751-8416 OR (423)751-2571 SHALL BE MADE BEFORE ANY SURVEY OR CONSTRUCTION WORK IS COMMENCED. BASE STATION FREQUENCIES AND TRANSFORMATION PARAMETERS WILL BE PROVIDED TO THE CONTRACTOR FOR USE IN CONSTRUCTION ACTIVITIES AT THE SITE. PREVIOUSLY USED OR ESTABLISHED CONTROL POINTS AND MONUMENTS SHALL NOT BE USED BY THE CONTRACTOR WITHOUT PRIOR APPROVAL BY TVA SURVEYING DEPARTMENT.

TABLE OF PROJECT BASELINE COORDINATES			
STATION	BASELINE	NORTHING	EASTING
10+00.00	BEGIN BASELINE 1	730,587.21	1,511,833.32
13+00.00	END BASELINE 1	730,336.41	1,511,668.71
20+00.00	BEGIN BASELINE 2	731,468.22	1,511,541.79
22+02.64	P.I. STA. BASELINE 2	731,273.51	1,511,597.93
23+50.00	END BASELINE 2	731,146.79	1,511,522.71
30+00.00	BEGIN BASELINE 3	731,087.87	1,511,583.98
32+50.00	END BASELINE 3	730,883.35	1,511,727.76

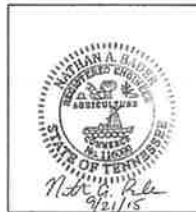
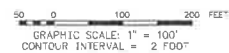
LEGEND

- PROJECT BASELINE
- LIMITS OF CONSTRUCTION
- INDEX CONTOUR
- INTERMEDIATE CONTOUR
- UNDER DRAIN
- DISCHARGE PIPE
- ACCESS ROAD
- EXISTING SIPHONS
- EXISTING DRAINAGE PIPES
- DELINEATED PERMIT WASTE BOUNDARY
- RIPRAP
- PIEZOMETER
- SLOPE INCLINOMETER



1 PLAN - EXISTING CONDITIONS
SCALE: 1" = 100'

ISSUED FOR CONSTRUCTION

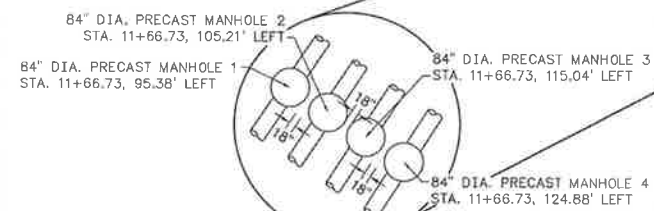
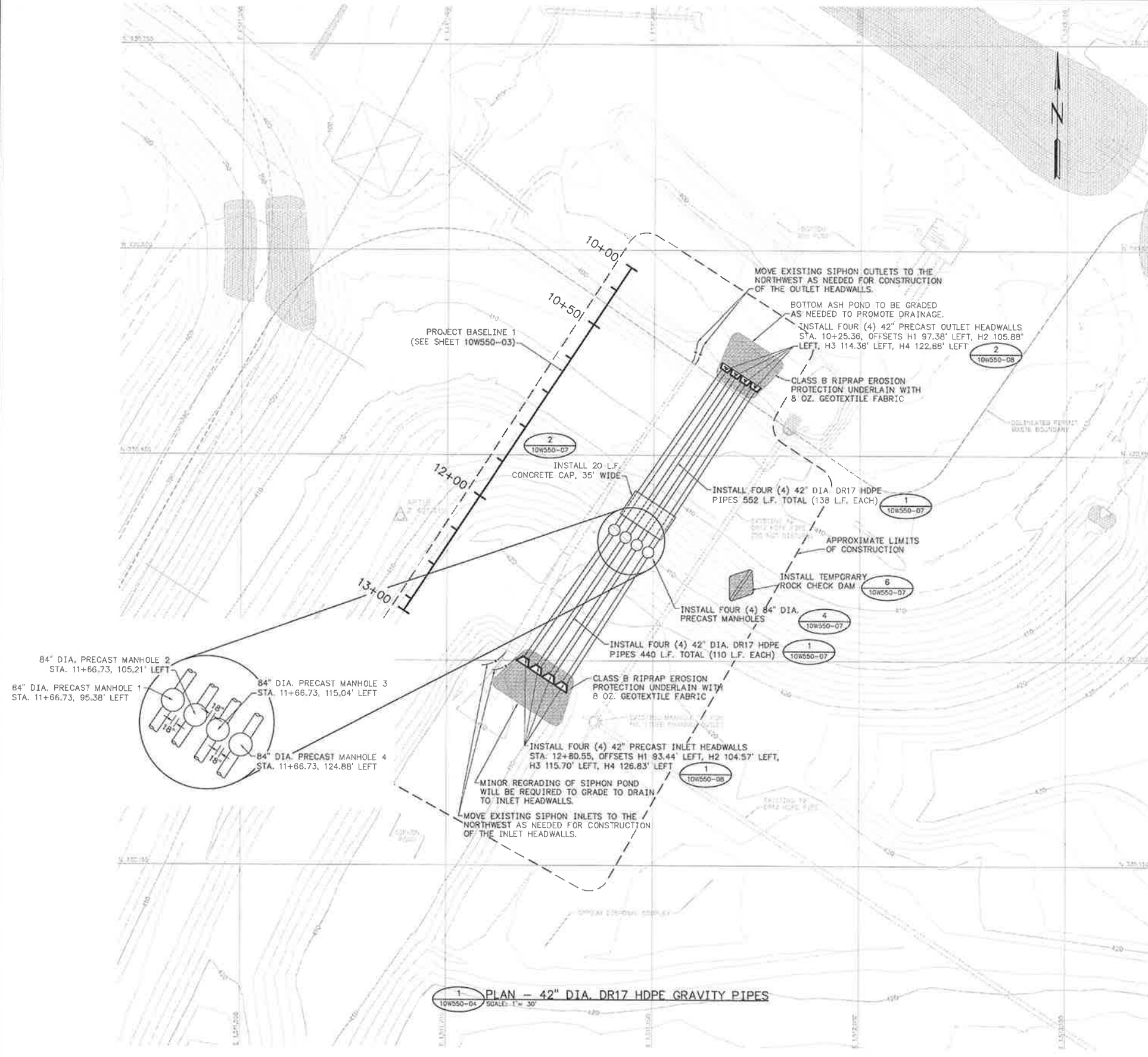


PROJECT NO.	09/21/15	DATE	09/21/15	SCALE	1"=100'
EXCEPT AS NOTED					
YARD GYPSUM DISPOSAL COMPLEX SIPHON IMPROVEMENTS PROJECT EXISTING CONDITIONS					
DESIGNED BY	C.L. HAY	DRAWN BY	R.R. PETTY	CHECKED BY	N.A. BAKER
APPROVED BY	N.A. BAKER	DATE	09/21/15		
CUMBERLAND FOSSIL PLANT TENNESSEE VALLEY AUTHORITY FOSSIL AND HYDRO ENGINEERING					
AUTOCAD R 2010	DATE	09/21/15	46	C	10W550-03

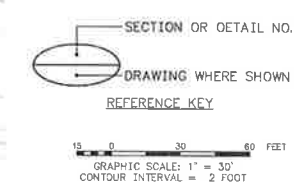
NOTE:
 THESE DRAWINGS WERE PREPARED BY STANTEC CONSULTING SERVICES INC. (STANTEC) USING SURVEY INFORMATION-AERIAL AND GROUND SURVEYS PROVIDED BY TVA FROM APRIL AND JUNE 2011, JULY 2012, MARCH 2013 AND OCTOBER 2014.

SURVEY CONTROL NOTE:
 A GLOBAL POSITIONING SYSTEM (GPS) BASE STATION HAS BEEN ESTABLISHED AND TRANSFORMATION PARAMETERS DETERMINED BY TVA USING SELECTED SURVEY CONTROL MONUMENTS. CONTACT WITH TVA SURVEYING DEPARTMENT (423)751-8416 OR (423)751-2571 SHALL BE MADE BEFORE ANY SURVEY OR CONSTRUCTION WORK IS COMMENCED. BASE STATION FREQUENCIES AND TRANSFORMATION PARAMETERS WILL BE PROVIDED TO THE CONTRACTOR FOR USE IN CONSTRUCTION ACTIVITIES AT THE SITE. PREVIOUSLY USED OR ESTABLISHED CONTROL POINTS AND MONUMENTS SHALL NOT BE USED BY THE CONTRACTOR WITHOUT PRIOR APPROVAL BY TVA SURVEYING DEPARTMENT.

- LEGEND**
- PROJECT BASELINE
 - LIMITS OF CONSTRUCTION
 - PROPOSED RIPRAP
 - DELINEATED PERMIT WASTE BOUNDARY
 - EXISTING INDEX CONTOUR
 - EXISTING INTERMEDIATE CONTOUR
 - EXISTING SIPHONS
 - EXISTING DRAINAGE PIPES
 - EXISTING HDPE DISCHARGE PIPE
 - EXISTING ACCESS ROAD
 - EXISTING RIPRAP

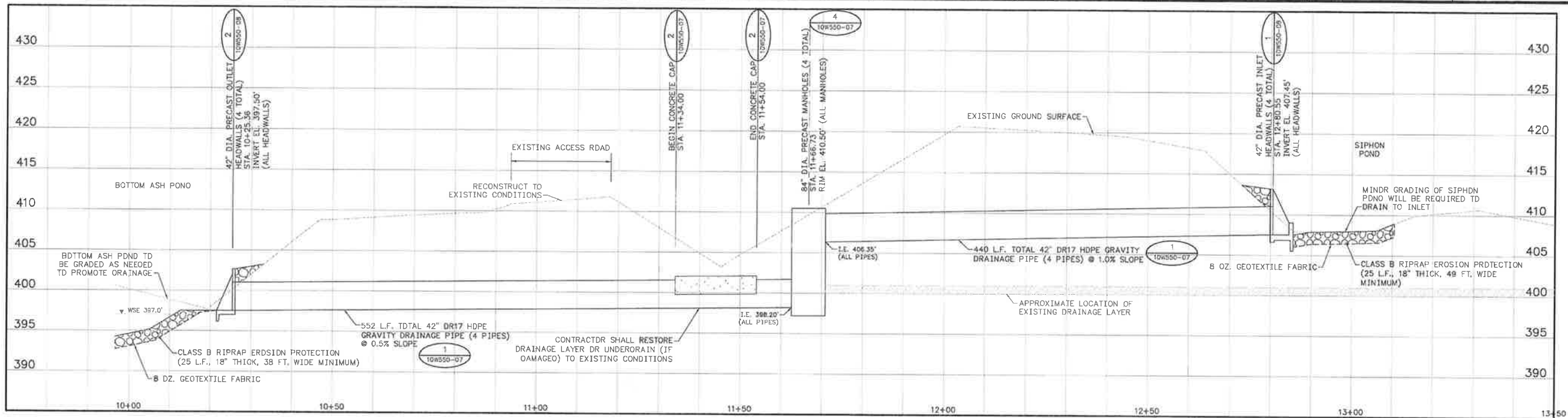


1 PLAN - 42" DIA. DR17 HDPE GRAVITY PIPES
 SCALE: 1" = 30'

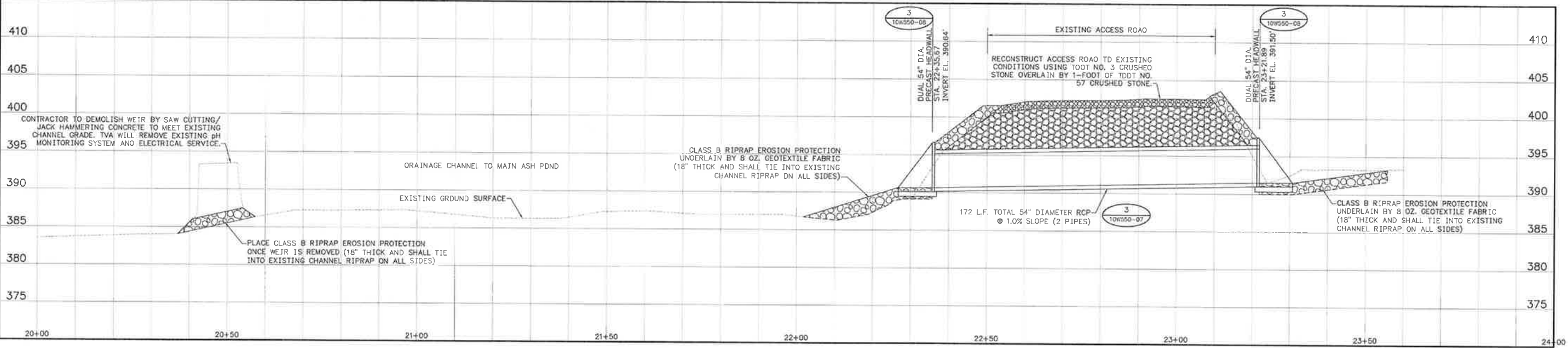


ISSUED FOR CONSTRUCTION

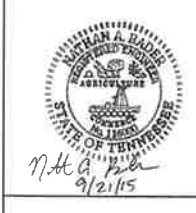
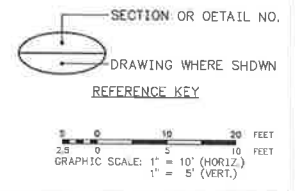
YARD GYPSUM DISPOSAL COMPLEX SIPHON IMPROVEMENTS PROJECT 42" DIAMETER GRAVITY PIPES PLAN VIEW						
DESIGNED BY C. HAY	DRAWN BY R.R. PETTY	CHECKED BY M.A. BADER	SUPERVISED BY N.A. BADER	REVIEWED BY D.G. STEPHENS	APPROVED BY M.S. TURNBOA	ISSUED BY J.C. KAMMAYER
CUMBERLAND FOSSIL PLANT TENNESSEE VALLEY AUTHORITY FOSSIL AND HYDRO ENGINEERING						
AUTOCAD R 2010		DATE 09/21/15		SHEET NO. 46 C		PROJECT NO. 10W550-04



1 PROFILE - 42" DIA. DR17 HDPE GRAVITY PIPES
10W550-06 SCALE: 1"=10' (HORIZONTAL) 1"=5' (VERTICAL)



2 PROFILE - DUAL 54" DIA. RCP
10W550-06 SCALE: 1"=10' (HORIZONTAL) 1"=5' (VERTICAL)



DESIGNED BY	CL HAY	DRAWN BY	R.R. PETTY	CHECKED BY	N.A. BASER	APPROVED BY	N.A. BASER	DATE	09/21/15
YARD GYPSUM DISPOSAL COMPLEX SIPHON IMPROVEMENTS PROJECT 42" DIA. HDPE & 54" DIA. RCP PIPE PROFILES									
CUMBERLAND FOSSIL PLANT TENNESSEE VALLEY AUTHORITY FOSSIL AND HYDRO ENGINEERING									
AUTOCAD R 2010 DATE: 09/21/15 46 C 10W550-06 R 0									

ISSUED FOR CONSTRUCTION

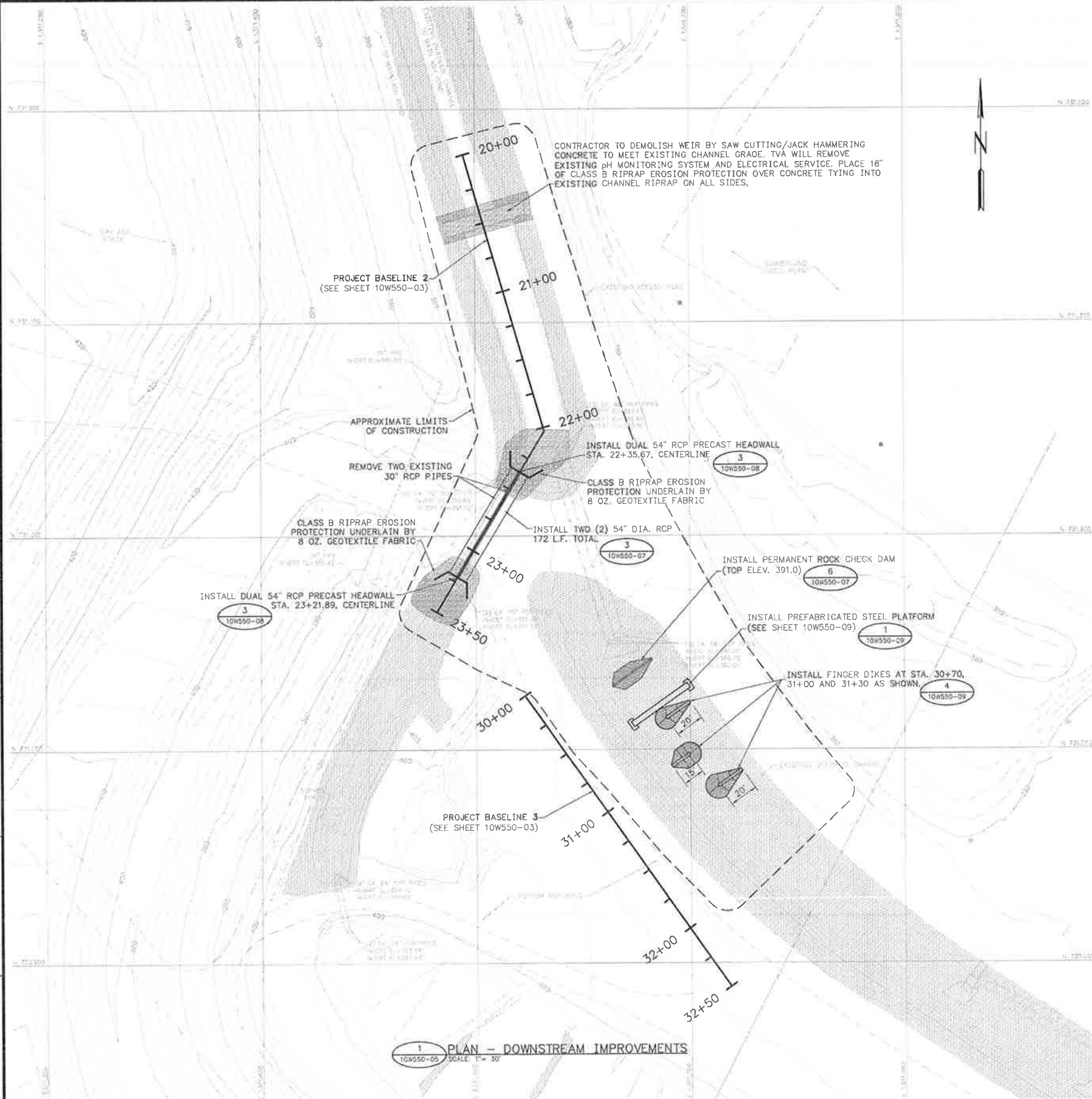
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SURVEY CONTROL NOTE:
 A GLOBAL POSITIONING SYSTEM (GPS) BASE STATION HAS BEEN ESTABLISHED AND TRANSFORMATION PARAMETERS DETERMINED BY TVA USING SELECTED SURVEY CONTROL MONUMENTS. CONTACT WITH TVA SURVEYING DEPARTMENT (423)751-8416 OR (423)751-2571 SHALL BE MADE BEFORE ANY SURVEY OR CONSTRUCTION WORK IS COMMENCED. BASE STATION FREQUENCIES AND TRANSFORMATION PARAMETERS WILL BE PROVIDED TO THE CONTRACTOR FOR USE IN CONSTRUCTION ACTIVITIES AT THE SITE. PREVIOUSLY USED OR ESTABLISHED CONTROL POINTS AND MONUMENTS SHALL NOT BE USED BY THE CONTRACTOR WITHOUT PRIOR APPROVAL BY TVA SURVEYING DEPARTMENT.

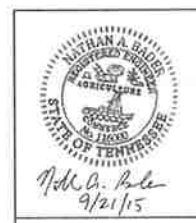
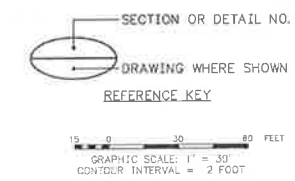
- NOTE:**
1. THESE DRAWINGS WERE PREPARED BY STANTEC CONSULTING SERVICES INC. (STANTEC) USING SURVEY INFORMATION—AERIAL AND GROUND SURVEYS PROVIDED BY TVA FROM APRIL AND JUNE 2011, JULY 2012, MARCH 2013 AND OCTOBER 2014.
 2. MINOR REGRADING OF CHANNEL INLET AND OUTLET WILL BE REQUIRED TO CLEAR SEDIMENTATION.
 3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR DISASSEMBLING THE EXISTING WEIR AND INSTALLING THE FINGER DIKES AND STEEL PLATFORM UPSTREAM. TVA WILL BE RESPONSIBLE FOR DISASSEMBLING pH MONITORING SYSTEM AND INSTALLING THE SYSTEM UPSTREAM. TVA WILL BE RESPONSIBLE FOR REMOVING THE ELECTRICAL SERVICE TO THE EXISTING SYSTEM AND INSTALLING ELECTRICAL SERVICE AT THE NEW LOCATION. PRIOR TO DISASSEMBLY, THE CONTRACTOR SHALL COORDINATE WITH TVA PERSONNEL RESPONSIBLE FOR THE DISASSEMBLY AND INSTALLATION OF THE NEW ELECTRICAL SERVICE AND pH MONITORING SYSTEM.
 4. FINGER DIKE AND PERMANENT ROCK CHECK DAM HEIGHT MAY VARY IN FIELD DUE TO SITE CONDITIONS AT THE TIME OF CONSTRUCTION.

LEGEND

	PROJECT BASELINE
	LIMITS OF CONSTRUCTION
	PROPOSED RIPRAP
	DELINEATED PERMIT WASTE BOUNDARY
	EXISTING INDEX CONTOUR
	EXISTING INTERMEDIATE CONTOUR
	EXISTING SIPHONS
	EXISTING DRAINAGE PIPES
	EXISTING HDPE DISCHARGE PIPE
	EXISTING ACCESS ROAD
	EXISTING RIPRAP



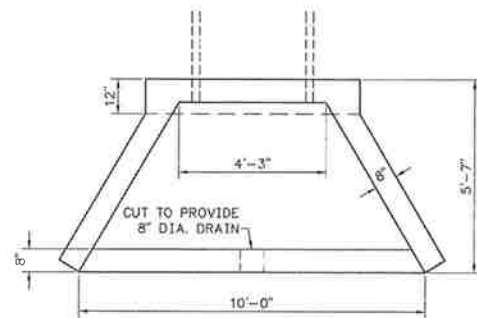
ISSUED FOR CONSTRUCTION



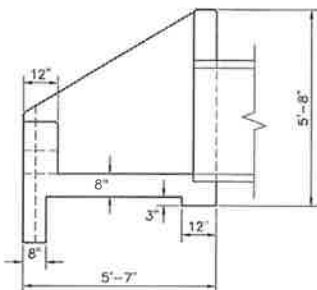
Nathan A. Bader
 9/21/15



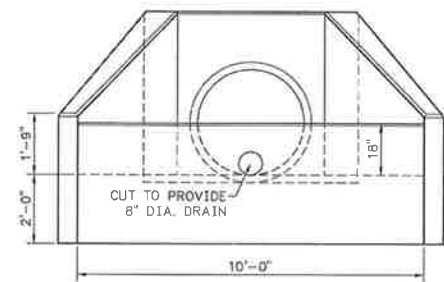
DATE	09/21/15	CL	CLH	RRP	NAB	NAB	DGS	MST	JCK	00929			
ISSUED FOR CONSTRUCTION													
SCALE:	1" = 30'												
EXCEPT AS NOTED													
YARD GYPSUM DISPOSAL COMPLEX													
SIPHON IMPROVEMENTS PROJECT													
DOWNSTREAM IMPROVEMENTS													
PLAN VIEW													
DESIGNED BY	CL. HAY	DRAWN BY	R.P. PETTY	CHECKED BY	N.A. BADER	SUPERVISED BY	N.A. BADER	REVIEWED BY	D.G. STEPHENS	APPROVED BY	M.S. TURNBOK	ISSUED BY	J.C. KAUFNER
CUMBERLAND FOSSIL PLANT													
TENNESSEE VALLEY AUTHORITY													
FOSSIL AND HYDRO ENGINEERING													
AUTOCAD R 2010	DATE	09/21/15	SHEET	46	OF	46	PROJECT NO.	10W550-05		REV.	0		



PLAN



SECTION

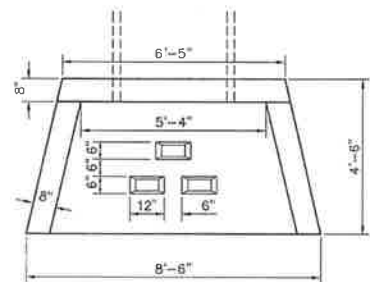


ELEVATION

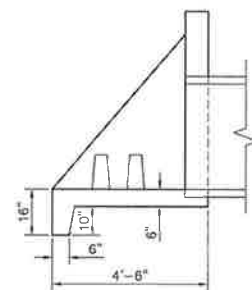
NOTES:

1. THE 42-INCH HDPE PIPE SHALL EXTEND THROUGH THE WALL FOR A SUFFICIENT DISTANCE TO ALLOW FOR CONNECTION TO THE PRECAST HEADWALL. THE SPACE BETWEEN PIPE AND HEADWALL STRUCTURE SHALL BE GROUTED FULL USING NON-SHRINK GRDUT (TDDT SPECIFICATIDN SECTIDN 918.21 "TYPE I").
2. INLET HEADWALL SHOWN IS ET-238 MANUFACTURED BY SHERMAN-DIXIE. AN EQUIVALENT PRODUCT MAY BE USED WITH APPROVAL FROM THE ENGINEER.
3. AN 18-INCH TALL BY 12-INCH WIDE SILL WITH AN 8-INCH DIAMETER WEEP HOLE WILL BE INSTALLED ON EACH INLET HEADWALL DURING PRECAST CONSTRUCTION TO PROVIDE LIMITED PARTICLE SETTLEMENT. THE CONTRACTOR SHALL COORDINATE WITH THE HEADWALL MANUFACTURER FOR INCORPORATION OF THE SILL.

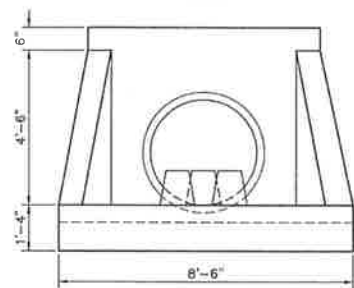
1 DETAIL - 42" DIA. PRECAST INLET HEADWALL
10W550-08 SCALE: 1/2"=1'-0"



PLAN



SECTION

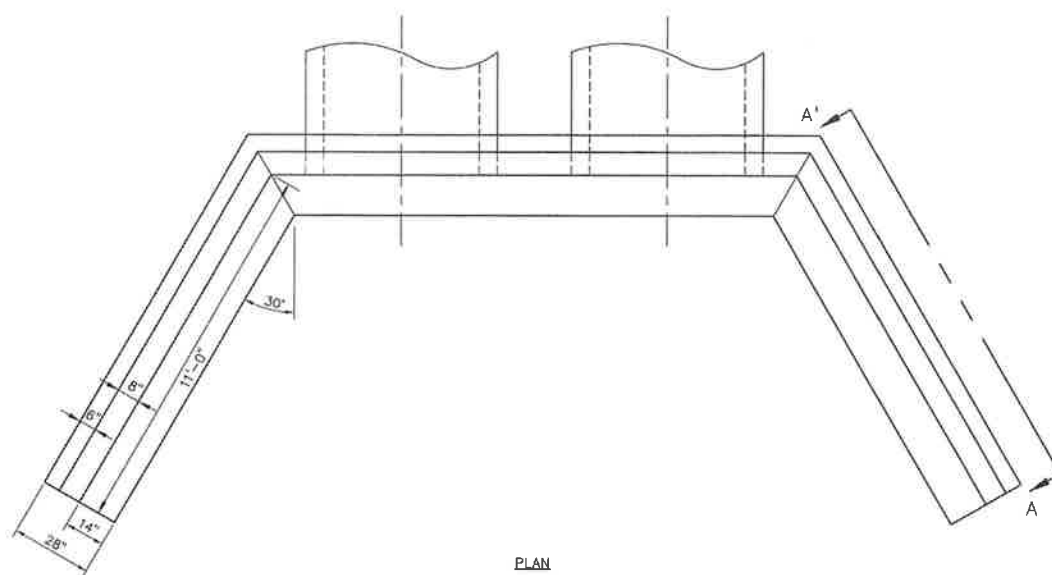


ELEVATION

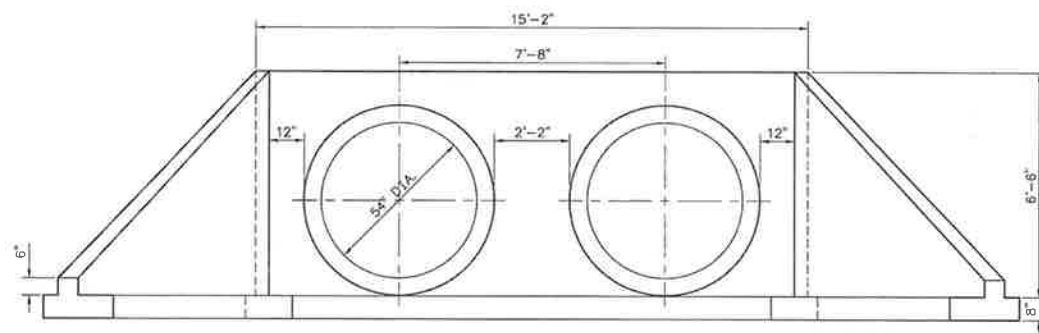
NOTES:

1. THE 42-INCH HDPE PIPE SHALL EXTEND THROUGH THE WALL FOR A SUFFICIENT DISTANCE TO ALLOW FOR CONNECTION TO THE PRECAST HEADWALL. THE SPACE BETWEEN PIPE AND HEADWALL STRUCTURE SHALL BE GROUTED FULL USING NON-SHRINK GRDUT (TDDT SPECIFICATIDN SECTIDN 918.21 "TYPE I").
2. OUTLET HEADWALL SHOWN IS ET-202 MANUFACTURED BY SHERMAN-DIXIE. AN EQUIVALENT PRODUCT MAY BE USED WITH APPROVAL FROM THE ENGINEER.

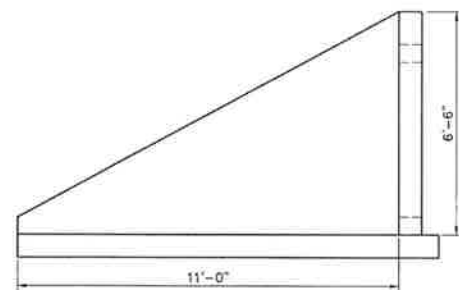
2 DETAIL - 42" DIA. PRECAST OUTLET HEADWALL
10W550-08 SCALE: 1/2"=1'-0"



PLAN



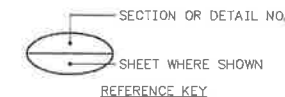
ELEVATION



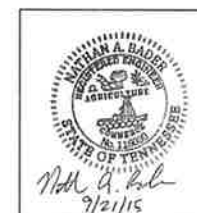
SECTION A-A'

3 DETAIL - DUAL 54" DIA. PIPE HEADWALL
10W550-08 SCALE: 1/2"=1'-0"

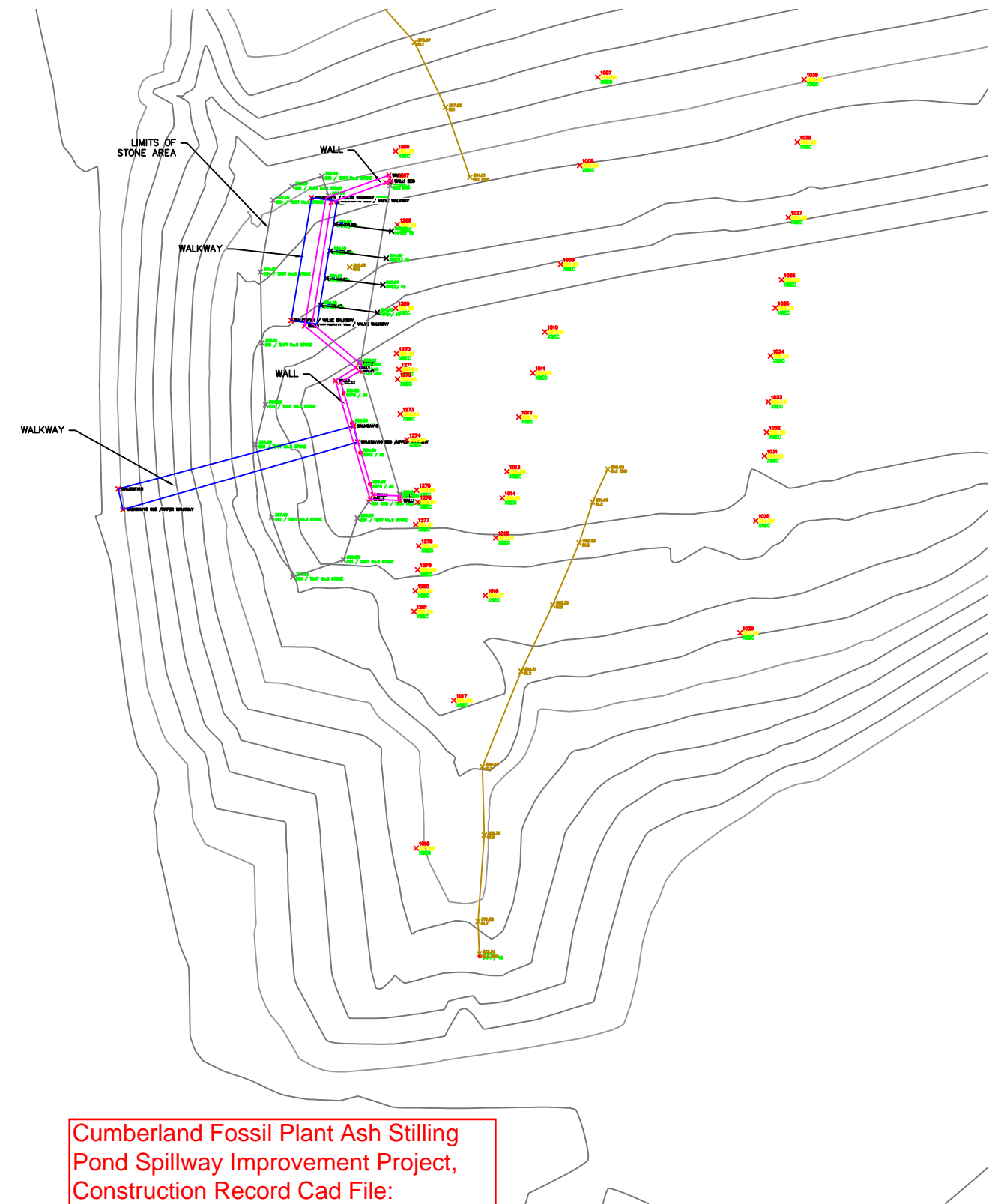
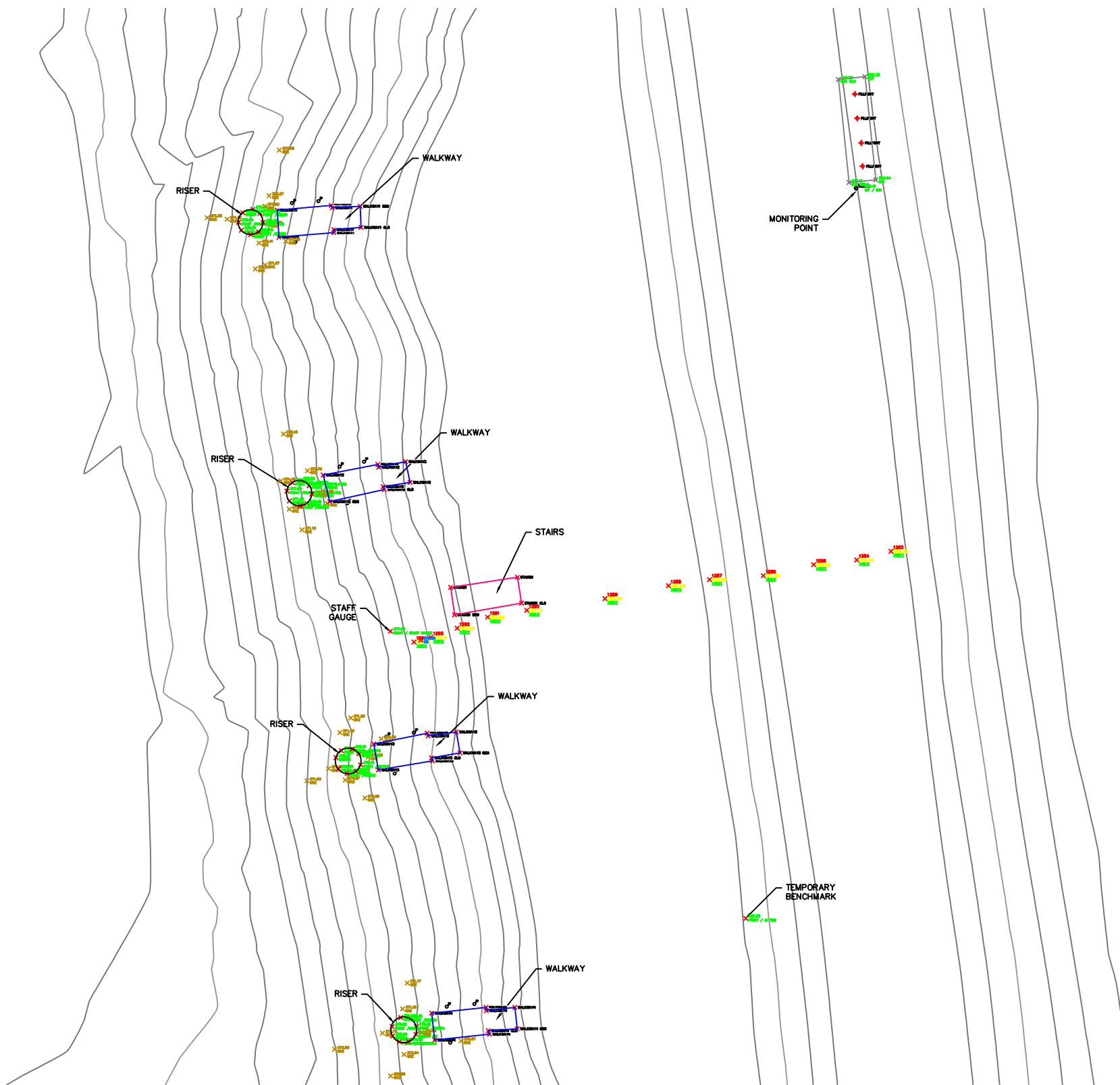
NOTE:
PRECAST DUAL PIPE HEADWALL SHOWN IS A STANDARD ENDWALL FOR MULTIPLE PIPES, EW-7PC MANUFACTURED BY HANSON. AN EQUIVALENT PRODUCT MAY BE USED WITH APPROVAL FROM THE ENGINEER.



ISSUED FOR CONSTRUCTION



REV	NO	DATE	BY	CHKD	APPD	DESC
01	09/21/15	CLM	JENH	NAB	NAB	DGS
SCALE: AS SHOWN EXCEPT AS NOTED						
YARD GYPSUM DISPOSAL COMPLEX						
SIPHON IMPROVEMENTS PROJECT						
DETAILS						
DESIGNED BY:	CLM HAY	DRAWN BY:	R.R. PETTY	CHECKED BY:	N.A. BADER	SUPERVISED BY:
REVIEWED BY:	D.G. STEPHENS	APPROVED BY:	M.E. TURNER	ISSUED BY:	J.C. KAMMEYER	
CUMBERLAND FOSSIL PLANT						
TENNESSEE VALLEY AUTHORITY						
FOSSIL AND HYDRO ENGINEERING						
AUTOCAD R 2010	DATE	09/21/15	46	C	10W550-08	R 0



Cumberland Fossil Plant Ash Stilling
 Pond Spillway Improvement Project,
 Construction Record Cad File:
 "cu104_cuf12350_20120327.dwg"

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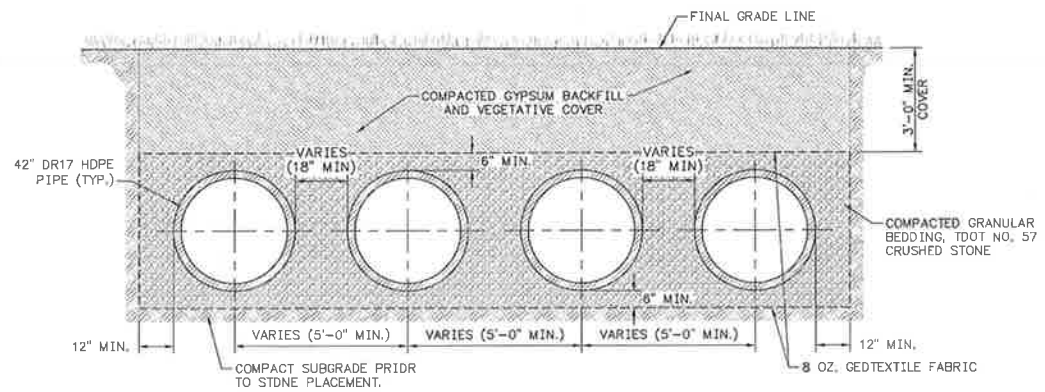
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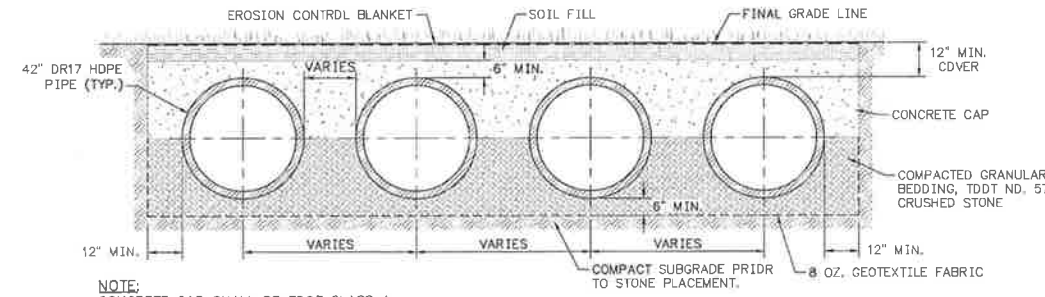
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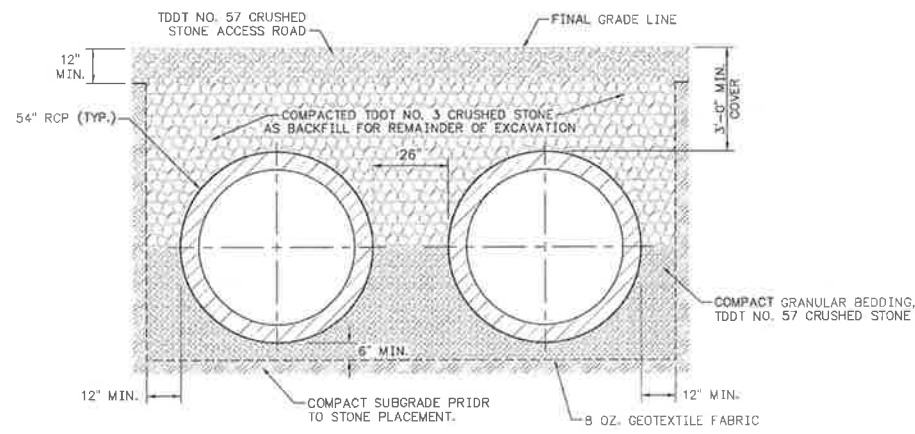
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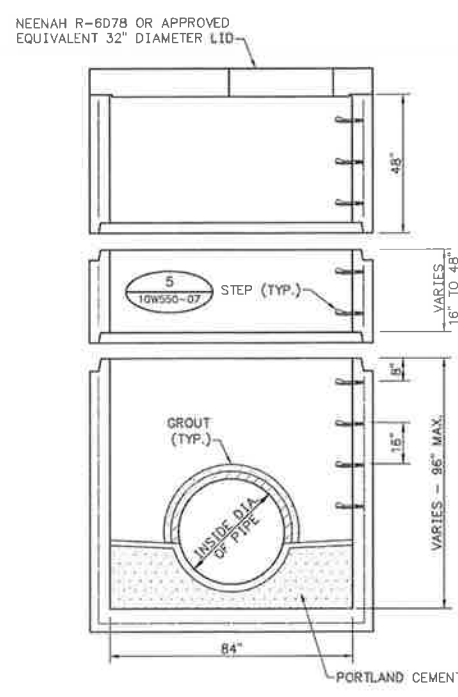
1 DETAIL - HDPE PIPE BEDDING/BACKFILL
10W550-07 SCALE: 1/2"=1'-0"



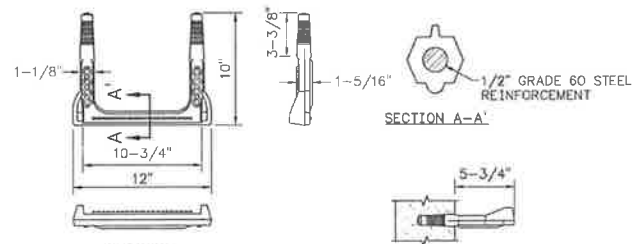
2 DETAIL - HDPE PIPE CONCRETE CAP
10W550-07 SCALE: 1/2"=1'-0"



3 DETAIL - RCP BEDDING/BACKFILL
10W550-07 SCALE: 1/2"=1'-0"



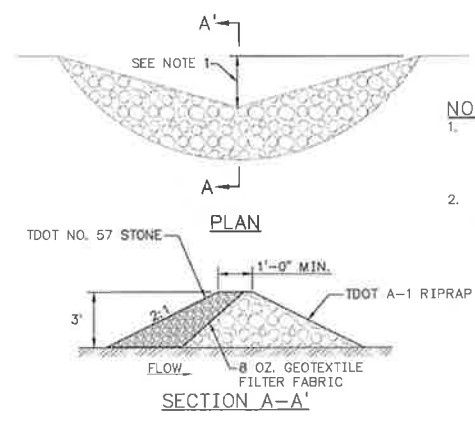
4 DETAIL - TDOT STANDARD FLAT TOP 84-INCH I.D. MANHOLE
10W550-07 SCALE: 1/2"=1'-0"



NOTES:
1. THIS STEP TO BE DRIVEN INTO TAPERED HOLES IN PRECAST MANHOLE SECTIONS. DO NOT USE AS A GROUTED-IN STEP.
2. 1000 LB. PULLOUT TEST REPORT REQUIRED ON EACH STEP.

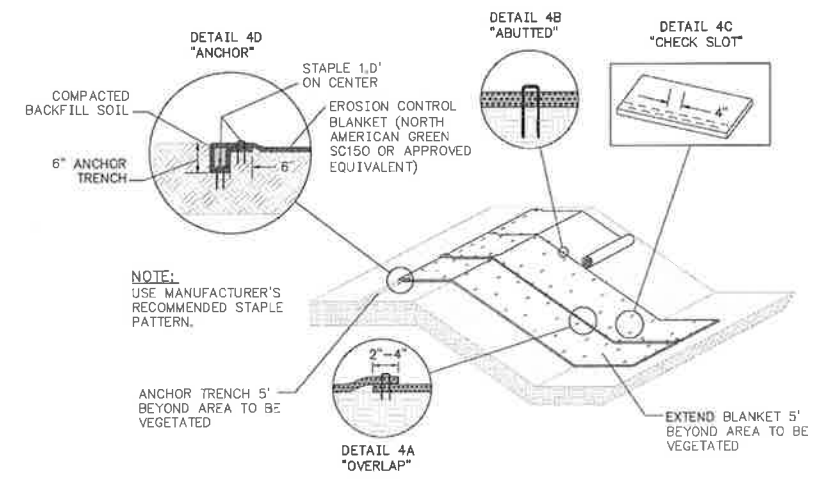
5 DETAIL - COPOLYMER POLYPROPYLENE PLASTIC STEP
10W550-07 NOT TO SCALE

MANHOLE GENERAL NOTES:
1. CONTRACTOR TO REFER TO TDOT DRAWING D-MH-2 FOR COMPLETE DETAIL INFORMATION ON MANHOLE CONSTRUCTION AND REINFORCING STEEL.
2. PRECAST CONCRETE MANHOLE SHALL MEET THE REQUIREMENTS IN THE SPECIFICATIONS.
3. CUT-OUTS FOR PIPE PENETRATIONS AS SHOWN ON SHEET 10W550-D6 SHALL BE CORED OR FORMED IN ORDER TO OBTAIN A SMOOTH EDGED HOLE.
4. PROVIDE A 6-INCH BEDDING LAYER OF COMPACTED TDOT NO. 57 CRUSHED STONE EXTENDING AT LEAST 6-INCHES OUTSIDE OF STRUCTURE FOOTPRINT.



NOTES:
1. MIDDLE OF ROCK CHECK DAM SHALL BE A MINIMUM OF 1'-0" LOWER THAN SIDES SO FLOW WILL NOT BYPASS TRAP OR ERODE BANKS.
2. SPACE ROCK CHECK DAMS AT LOCATIONS AS SHOWN ON THE PLANS OR AS DIRECTED BY THE ENGINEER.

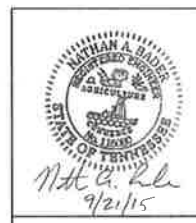
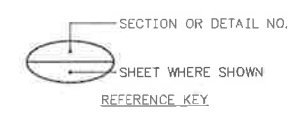
6 DETAIL - ROCK CHECK DAM
10W550-07 NOT TO SCALE



NOTE:
USE MANUFACTURER'S RECOMMENDED STAPLE PATTERN.
ANCHOR TRENCH 5' BEYOND AREA TO BE VEGETATED
EROSION CONTROL BLANKET (NORTH AMERICAN GREEN SC150 OR APPROVED EQUIVALENT)
STAPLE 1.0' ON CENTER
EXTEND BLANKET 5' BEYOND AREA TO BE VEGETATED

7 DETAIL - EROSION CONTROL BLANKET
10W550-07 NOT TO SCALE

ISSUED FOR CONSTRUCTION



DATE	09/21/15	SCALE	AS SHOWN	EXCEPT AS NOTED									
PROJECT	YARD GYPSUM DISPOSAL COMPLEX SIPHON IMPROVEMENTS PROJECT DETAILS												
DESIGNED BY	CL HAY	DRAWN BY	R.R. PETTY	CHECKED BY	N.A. BADER	SUPERVISOR	N.A. BADER	REVIEWED BY	D.S. STEPHENS	APPROVED BY	M.S. TURNER	ISSUED BY	J.C. KAMMAYER
CUMBERLAND FOSSIL PLANT TENNESSEE VALLEY AUTHORITY FOSSIL AND HYDRO ENGINEERING													
AUTOCAD R 2010	DATE	09/21/15	SHEET	46	OF	C 46	DWG NO.	10W550-07	SCALE	R D			

APPENDIX F

RATING CURVES

HEC-HMS Inputs

Elevation (ft)	Discharge (cfs)	Storage (acre-ft)
381.00	0.00	676.22
381.50	75.83	696.34
382.00	108.50	716.47
382.50	133.26	736.95
383.00	154.39	757.44
383.50	172.68	778.29
384.00	189.39	799.14
384.50	204.41	821.24
385.00	218.10	843.35
385.50	231.79	866.29
386.00	244.70	889.23

HY-8 Output

Overflow 1		Overflow 2		Overflow 3		Overflow 4	
Q (cfs)	Headwater (ft)	Q (cfs)	Headwater (ft)	Q (cfs)	Headwater (ft)	Q (cfs)	Headwater (ft)
0	381	0	381	0	381	0	381
7.55	381.08	7.60	381.08	7.60	381.08	7.53	381.08
14.95	381.3	15.09	381.3	15.09	381.3	14.92	381.3
22.42	381.68	22.62	381.68	22.62	381.68	22.37	381.68
29.90	382.2	30.16	382.2	30.16	382.2	29.83	382.2
37.35	382.88	37.69	382.88	37.69	382.88	37.27	382.88
44.82	383.7	45.23	383.7	45.23	383.7	44.72	383.7
49.81	384.34	50.26	384.34	50.26	384.34	49.7	384.34
59.76	385.8	60.31	385.8	60.31	385.8	59.63	385.8
67.23	387.08	67.85	387.08	67.85	387.08	67.08	387.08

Notes:

1. Tailwater elevation was set at the 100-yr water surface elevation of 381 ft per the Dam Breach Analysis and Inundation Mapping, Cumberland Fly Ash Pond, Cumberland Fossil Plant by Stantec and dated 2010.

Rating Curves Inputs

Stilling Pond (Including Retention Pond)

References:

- 1 "175554020_01_gsxxx_eg01_current.dwg, Topographic data." Provided by Tennessee Valley Authority, October 2014
- 2 "cu104_cuf12350_20120327.dwg, Topographic data." Provided by Tennessee Valley Authority, 2012
- 3 Spillway Improvement Project Drawings, Sheet 10W286-09. Developed by Stantec 2012
- 4 "Elev C" under Computed Values is referring to the elevation of centerline of the outlet pipe inlet

Stilling Pond

<u>Overflow 1 - Concrete Riser Structure</u>	<u>Overflow 2 - Concrete Riser Structure</u>	<u>Overflow 3 - Concrete Riser Structure</u>	<u>Overflow 4 - Concrete Riser Structure</u>	<u>Data Source</u>
Weir Elev= 378 feet	Weir Elev= 378 feet	Weir Elev= 378 feet	Weir Elev= 378 feet	2
Riser D = 48 in	Riser D = 48 in	Riser D = 48 in	Riser D = 48 in	3
Pipe Inlet= 361 feet	Pipe Inlet= 361 feet	Pipe Inlet= 361 feet	Pipe Inlet= 361 feet	3
Pipe Outlet= 359.82 feet	Pipe Outlet= 359.85 feet	Pipe Outlet= 359.86 feet	Pipe Outlet= 359.89 feet	2
Pipe D= 33 in	Pipe D= 33 in	Pipe D= 33 in	Pipe D= 33 in	Value reflects inside lined pipe diameter(Original Pipe dia. is 36-in per ref. 3
Length= 226 feet	Length= 218 feet	Length= 218 feet	Length= 228 feet	Measured in AutoCAD
C= 3.27	C= 3.27	C= 3.27	C= 3.27	(Assumed to behave as sharp crested weir)
C ₀ = 0.6	C ₀ = 0.6	C ₀ = 0.6	C ₀ = 0.6	(Based on Brater and King 1976)
<u>Computed Values</u>	<u>Computed Values</u>	<u>Computed Values</u>	<u>Computed Values</u>	<u>Equation</u>
L _{weir} = 12.56637 ft	L _{weir} = 12.56637 ft	L _{weir} = 12.56637 ft	L _{weir} = 12.56637 ft	Circumpherence=PI()*D
A _{riser} = 12.56637 sq. ft.	A _{riser} = 12.56637 sq. ft.	A _{riser} = 12.56637 sq. ft.	A _{riser} = 12.56637 sq. ft.	Area = PI*D ² /4
A _{pipe} = 5.939574 sq. ft.	A _{pipe} = 5.939574 sq. ft.	A _{pipe} = 5.939574 sq. ft.	A _{pipe} = 5.939574 sq. ft.	Area = PI*D ² /4
Elev C= 362.375 feet (NGVD29)	Elev C= 362.375 feet (NGVD29)	Elev C= 362.375 feet (NGVD29)	Elev C= 362.375 feet (NGVD29)	

Rating Curve - Discharge
Stilling Pond (Including Retention Pond)

Overflow 1										
Elevation	Weir Flow		Orifice Flow		Pipe Orifice Flow		Outlet Pipe Flow (from HY-8)		Rating Curve for 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)
381.00	3.00	213.52	3	104.80	18.63	123.42	381	0.00	381.00	0.00
381.50	3.50	269.07	3.5	113.20	19.13	125.07	381	18.88	381.50	18.88
382.00	4.00	328.74	4	121.01	19.63	126.69	381	27.02	382.00	27.02
382.50	4.50	392.26	4.5	128.35	20.13	128.30	381	33.19	382.50	33.19
383.00	5.00	459.42	5	135.30	20.63	129.88	381	38.44	383.00	38.44
383.50	5.50	530.03	5.5	141.90	21.13	131.45	381	43.00	383.50	43.00
384.00	6.00	603.93	6	148.21	21.63	132.99	381	47.16	384.00	47.16
384.50	6.50	680.97	6.5	154.26	22.13	134.52	381	50.90	384.50	50.90
385.00	7.00	761.04	7	160.09	22.63	136.03	381	54.31	385.00	54.31
385.50	7.50	844.01	7.5	165.70	23.13	137.53	381	57.72	385.50	57.72
386.00	8.00	929.81	8	171.14	23.63	139.01	381	60.93	386.00	60.93

Overflow 2										
Elevation	Weir Flow		Orifice Flow		Pipe Orifice Flow		Outlet Pipe Flow (from HY-8)		Rating Curve for 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)
381.00	3.00	213.52	3	104.80	18.63	123.42	381	0.00	381.00	0.00
381.50	3.50	269.07	3.5	113.20	19.13	125.07	381	19.05	381.50	19.05
382.00	4.00	328.74	4	121.01	19.63	126.69	381	27.26	382.00	27.26
382.50	4.50	392.26	4.5	128.35	20.13	128.30	381	33.48	382.50	33.48
383.00	5.00	459.42	5	135.30	20.63	129.88	381	38.79	383.00	38.79
383.50	5.50	530.03	5.5	141.90	21.13	131.45	381	43.39	383.50	43.39
384.00	6.00	603.93	6	148.21	21.63	132.99	381	47.59	384.00	47.59
384.50	6.50	680.97	6.5	154.26	22.13	134.52	381	51.36	384.50	51.36
385.00	7.00	761.04	7	160.09	22.63	136.03	381	54.80	385.00	54.80
385.50	7.50	844.01	7.5	165.70	23.13	137.53	381	58.24	385.50	58.24
386.00	8.00	929.81	8	171.14	23.63	139.01	381	61.49	386.00	61.49

Overflow 3										
Elevation	Weir Flow		Orifice Flow		Pipe Orifice Flow		Outlet Pipe Flow (from HY-8)		Rating Curve for 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)
381.00	3.00	213.52	3	104.80	18.63	123.42	381	0.00	381.00	0.00
381.50	3.50	269.07	3.5	113.20	19.13	125.07	381	19.05	381.50	19.05
382.00	4.00	328.74	4	121.01	19.63	126.69	381	27.26	382.00	27.26
382.50	4.50	392.26	4.5	128.35	20.13	128.30	381	33.48	382.50	33.48
383.00	5.00	459.42	5	135.30	20.63	129.88	381	38.79	383.00	38.79
383.50	5.50	530.03	5.5	141.90	21.13	131.45	381	43.39	383.50	43.39
384.00	6.00	603.93	6	148.21	21.63	132.99	381	47.59	384.00	47.59
384.50	6.50	680.97	6.5	154.26	22.13	134.52	381	51.36	384.50	51.36
385.00	7.00	761.04	7	160.09	22.63	136.03	381	54.80	385.00	54.80
385.50	7.50	844.01	7.5	165.70	23.13	137.53	381	58.24	385.50	58.24
386.00	8.00	929.81	8	171.14	23.63	139.01	381	61.49	386.00	61.49

Overflow 4										
Elevation	Weir Flow		Orifice Flow		Pipe Orifice Flow		Outlet Pipe Flow (from HY-8)		Rating Curve for 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)
381.00	3.00	213.52	3	104.80	18.63	123.42	381	0.00	381.00	0.00
381.50	3.50	269.07	3.5	113.20	19.13	125.07	381	18.84	381.50	18.84
382.00	4.00	328.74	4	121.01	19.63	126.69	381	26.96	382.00	26.96
382.50	4.50	392.26	4.5	128.35	20.13	128.30	381	33.11	382.50	33.11
383.00	5.00	459.42	5	135.30	20.63	129.88	381	38.36	383.00	38.36
383.50	5.50	530.03	5.5	141.90	21.13	131.45	381	42.90	383.50	42.90
384.00	6.00	603.93	6	148.21	21.63	132.99	381	47.05	384.00	47.05
384.50	6.50	680.97	6.5	154.26	22.13	134.52	381	50.79	384.50	50.79
385.00	7.00	761.04	7	160.09	22.63	136.03	381	54.19	385.00	54.19
385.50	7.50	844.01	7.5	165.70	23.13	137.53	381	57.59	385.50	57.59
386.00	8.00	929.81	8	171.14	23.63	139.01	381	60.79	386.00	60.79

Notes:

1. Cells highlighted in yellow indicate selected flow condition.

APPENDIX H PRECIPITATION DATA

1000-year 6-hour SCS Type II "Late Peak" Hydrograph		
Time	Incremental Depth	Cumulative Depth
0	0	0
0.1	0.03256	0.03256
0.2	0.0333	0.06586
0.3	0.0333	0.09916
0.4	0.0333	0.13246
0.5	0.0333	0.16576
0.6	0.0333	0.19906
0.7	0.03404	0.2331
0.8	0.03404	0.26714
0.9	0.03404	0.30118
1	0.03478	0.33596
1.1	0.03478	0.37074
1.2	0.03552	0.40626
1.3	0.03552	0.44178
1.4	0.03552	0.4773
1.5	0.03626	0.51356
1.6	0.03774	0.5513
1.7	0.03774	0.58904
1.8	0.03922	0.62826
1.9	0.03922	0.66748
2	0.03996	0.70744
2.1	0.0407	0.74814
2.2	0.04218	0.79032
2.3	0.04292	0.83324
2.4	0.04366	0.8769
2.5	0.04662	0.92352
2.6	0.04662	0.97014
2.7	0.0481	1.01824
2.8	0.0481	1.06634
2.9	0.05032	1.11666
3	0.05032	1.16698
3.1	0.05328	1.22026
3.2	0.05402	1.27428
3.3	0.05624	1.33052
3.4	0.05698	1.3875
3.5	0.05846	1.44596
3.6	0.06068	1.50664
3.7	0.0629	1.56954
3.8	0.06512	1.63466
3.9	0.0666	1.70126
4	0.06882	1.77008
4.1	0.07178	1.84186
4.2	0.074	1.91586
4.3	0.07696	1.99282
4.4	0.07992	2.07274
4.5	0.08362	2.15636
4.6	0.08806	2.24442
4.7	0.09028	2.3347
4.8	0.10064	2.43534
4.9	0.10286	2.5382
5	0.111	2.6492
5.1	0.12062	2.76982
5.2	0.12802	2.89784
5.3	0.15022	3.04806
5.4	0.1739	3.22196
5.5	0.19906	3.42102
5.6	0.24864	3.66966
5.7	0.49876	4.16842
5.8	0.79994	4.96836
5.9	0.99604	5.9644
6	1.4356	7.4

1000-year 6-hour SCS Type II "Middle Peak" Hydrograph		
Time	Incremental Depth	Cumulative Depth
0	0	0
0.1	0.0333	0.0333
0.2	0.03404	0.06734
0.3	0.0333	0.10064
0.4	0.0333	0.13394
0.5	0.0333	0.16724
0.6	0.03404	0.20128
0.7	0.03404	0.23532
0.8	0.03552	0.27084
0.9	0.03774	0.30858
1	0.03996	0.34854
1.1	0.0407	0.38924
1.2	0.04292	0.43216
1.3	0.04662	0.47878
1.4	0.0481	0.52688
1.5	0.05032	0.5772
1.6	0.05328	0.63048
1.7	0.05624	0.68672
1.8	0.06068	0.7474
1.9	0.06512	0.81252
2	0.06882	0.88134
2.1	0.074	0.95534
2.2	0.07992	1.03526
2.3	0.09028	1.12554
2.4	0.10064	1.22618
2.5	0.111	1.33718
2.6	0.12062	1.4578
2.7	0.24864	1.70644
2.8	0.49876	2.2052
2.9	0.79994	3.00514
3	1.4356	4.44074
3.1	0.99604	5.43678
3.2	0.19906	5.63584
3.3	0.1739	5.80974
3.4	0.15022	5.95996
3.5	0.12802	6.08798
3.6	0.10286	6.19084
3.7	0.08806	6.2789
3.8	0.08362	6.36252
3.9	0.07696	6.43948
4	0.07178	6.51126
4.1	0.0666	6.57786
4.2	0.0629	6.64076
4.3	0.05846	6.69922
4.4	0.05698	6.7562
4.5	0.05402	6.81022
4.6	0.05032	6.86054
4.7	0.0481	6.90864
4.8	0.04662	6.95526
4.9	0.04366	6.99892
5	0.04218	7.0411
5.1	0.03922	7.08032
5.2	0.03922	7.11954
5.3	0.03774	7.15728
5.4	0.03626	7.19354
5.5	0.03552	7.22906
5.6	0.03552	7.26458
5.7	0.03478	7.29936
5.8	0.03478	7.33414
5.9	0.0333	7.36744
6	0.03256	7.4

1000-year 6-hour SCS Type II "Early Peak" Hydrograph		
Time	Incremental Depth	Cumulative Depth
0	1.4356	1.4356
0.1	0.99604	2.43164
0.2	0.79994	3.23158
0.3	0.49876	3.73034
0.4	0.24864	3.97898
0.5	0.19906	4.17804
0.6	0.1739	4.35194
0.7	0.15022	4.50216
0.8	0.12802	4.63018
0.9	0.12062	4.7508
1	0.111	4.8618
1.1	0.10286	4.96466
1.2	0.10064	5.0653
1.3	0.09028	5.15558
1.4	0.08806	5.24364
1.5	0.08362	5.32726
1.6	0.07992	5.40718
1.7	0.07696	5.48414
1.8	0.074	5.55814
1.9	0.07178	5.62992
2	0.06882	5.69874
2.1	0.0666	5.76534
2.2	0.06512	5.83046
2.3	0.0629	5.89336
2.4	0.06068	5.95404
2.5	0.05846	6.0125
2.6	0.05698	6.06948
2.7	0.05624	6.12572
2.8	0.05402	6.17974
2.9	0.05328	6.23302
3	0.05032	6.28334
3.1	0.05032	6.33366
3.2	0.0481	6.38176
3.3	0.0481	6.42986
3.4	0.04662	6.47648
3.5	0.04662	6.5231
3.6	0.04366	6.56676
3.7	0.04292	6.60968
3.8	0.04218	6.65186
3.9	0.0407	6.69256
4	0.03996	6.73252
4.1	0.03922	6.77174
4.2	0.03922	6.81096
4.3	0.03774	6.8487
4.4	0.03774	6.88644
4.5	0.03626	6.9227
4.6	0.03552	6.95822
4.7	0.03552	6.99374
4.8	0.03552	7.02926
4.9	0.03478	7.06404
5	0.03478	7.09882
5.1	0.03404	7.13286
5.2	0.03404	7.1669
5.3	0.03404	7.20094
5.4	0.0333	7.23424
5.5	0.0333	7.26754
5.6	0.0333	7.30084
5.7	0.0333	7.33414
5.8	0.0333	7.36744
5.9	0.03256	7.4
6	0	7.4



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.

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PF graphical

APPENDIX I
STAGE-STORAGE DATA

Stage Storage
 CUF Stilling Pond (including Retention Pond)

Elevation (ft)	Cumulative Volume (cy)	Cumulative Volume (ac-ft)
346	-	0
347	474.20	0.29
348	1,703.06	1.06
349	5,509.35	3.41
350	10,308.73	6.39
351	16,814.05	10.42
352	24,483.39	15.18
353	35,621.79	22.08
354	48,920.54	30.32
355	64,374.49	39.90
356	81,328.33	50.41
357	100,868.36	62.52
358	122,668.65	76.03
359	147,464.56	91.40
360	173,764.30	107.71
361	201,668.15	125.00
362	230,905.77	143.12
363	261,948.92	162.37
364	294,113.29	182.30
365	327,856.93	203.22
366	362,801.29	224.88
367	399,348.77	247.53
368	436,963.27	270.85
369	475,989.14	295.03
370	516,215.80	319.97
371	558,314.50	346.06
372	602,125.55	373.22
373	648,358.78	401.88
374	696,333.63	431.61
375	746,724.51	462.85
376	798,974.92	495.23
377	853,630.74	529.11
378	909,818.85	563.94
379	967,882.72	599.93
380	1,027,514.07	636.89
381	1,090,961.90	676.22
382	1,155,905.63	716.47
383	1,221,998.47	757.44
384	1,289,280.44	799.14
385	1,360,600.85	843.35
386	1,434,618.49	889.23
387	1,510,314.33	936.15
388	1,587,728.49	984.13
389	1,666,745.91	1033.11
390	1,746,845.81	1082.76
391	1,827,915.94	1133.01
392	1,909,946.70	1183.85
393	1,993,404.95	1235.58
394	2,077,789.78	1287.89
395	2,163,192.07	1340.82