Stantec

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

October 12, 2021
File: rpt_026_let_172675014
Revision 0

Tennessee Valley Authority
1101 Market Street
Chattanooga, Tennessee 37402

RE: Periodic Inflow Design Flood Control System Plan
Stilling Pond (including Retention Pond)
EPA CCR Rule
TVA Cumberland Fossil Plant
Cumberland City, Tennessee

1.0 PURPOSE

This letter documents certification that the Stilling Pond (including Retention Pond) at the Tennessee Valley Authority (TVA) Cumberland Fossil Plant is in compliance with the inflow design flood control system plan requirements set forth in 40 CFR 257.82 of the EPA CCR Rule. The EPA CCR Rule requires a certification to be performed on a 5-yr periodic interval. The initial certification of the inflow design flood control system plan was placed in the operating record on October 12, 2016.

2.0 INITIAL INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN

The initial inflow design flood control plan (prepared pursuant to 40 CFR 257.82(c)(1)) is attached. The 1000-year flood event was selected for the design storm based upon a hazard potential classification of “significant.” The result of the initial assessment was that the Stilling Pond (including Retention Pond) complied with 40 CFR 257.82(a)&(b).

3.0 CURRENT INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN

Stantec reviewed the result of the initial inflow design flood control system plan and the changes in site conditions that have occurred in the past five years. The following items summarize changes that have occurred:

1. The Stilling Pond has been dewatered and the perimeter dike has been lowered by about 10 feet. The Stilling Pond ceased receiving CCR and non-CCR waste streams. CCR in the Stilling Pond has been consolidated to a smaller footprint and a temporary lined basin has been constructed to handle non-CCR waste streams.

2. The existing spillways have been modified by lowering the riser structures.

Based on our review, there are no conditions that have changed in the past five years that would cause the result of the initial inflow design flood control system plan to have changed.

Re: **Periodic Inflow Design Flood Control System Plan**
Stilling Pond (including Retention Pond)
EPA CCR Rule
TVA Cumberland Fossil Plant
Cumberland City, Tennessee

4.0 SUMMARY OF ASSESSMENT

Based on a review of the initial inflow design flood control system plan and the current site conditions, the result of this periodic inflow design flood control system plan review is that the Stilling Pond (including Retention Pond) at the Cumberland Fossil Plant meets the requirements of §257.82(a)&(b) of the EPA CCR Final Rule.

5.0 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

I, Stephen H. Bickel, being a Professional Engineer in good standing in the State of Tennessee, do hereby certify, to the best of my knowledge, information, and belief:

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

SIGNATURE ______________________ DATE 10/12/2021

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

TELEPHONE: (502) 212-5075

ATTACHMENTS: Initial Inflow Design Flood Control System Plan

INITIAL INFLOW DESIGN FLOOD CONTROL SYSTEM ASSESSMENT

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

October 6, 2016
File: rpt_003_let_175555021
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

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

TELEPHONE: (502) 212-5075

ATTACHMENTS: Inflow Design Flood Control System Plan

STEPHEN H. BICKEL
REGISTERED ENGINEER
AGRICULTURE
COMMERCE
No. 113134
STATE OF TENNESSEE

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

October 6, 2016
Revision 0

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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.

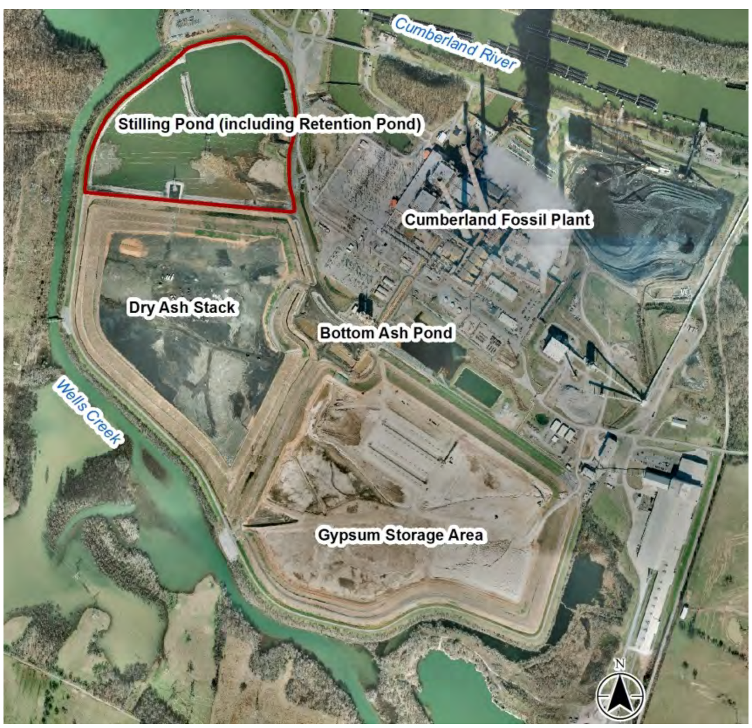


Figure 1 Cumberland Fossil Plant

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-feet 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".

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

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.

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.

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.

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 Typed 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.

- 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 AutaCAD 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:

Riser – Weir flow

Flow just above the riser crest behaves as weir flow and was computed using:

$$Q = C_w L H^{\frac{3}{2}}$$ **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:

$$Q = C_0 A (2gH)^{0.5}$$ **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:

$$Q = C_0 A [2g(H_C)]^{0.5}$$ **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.

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.

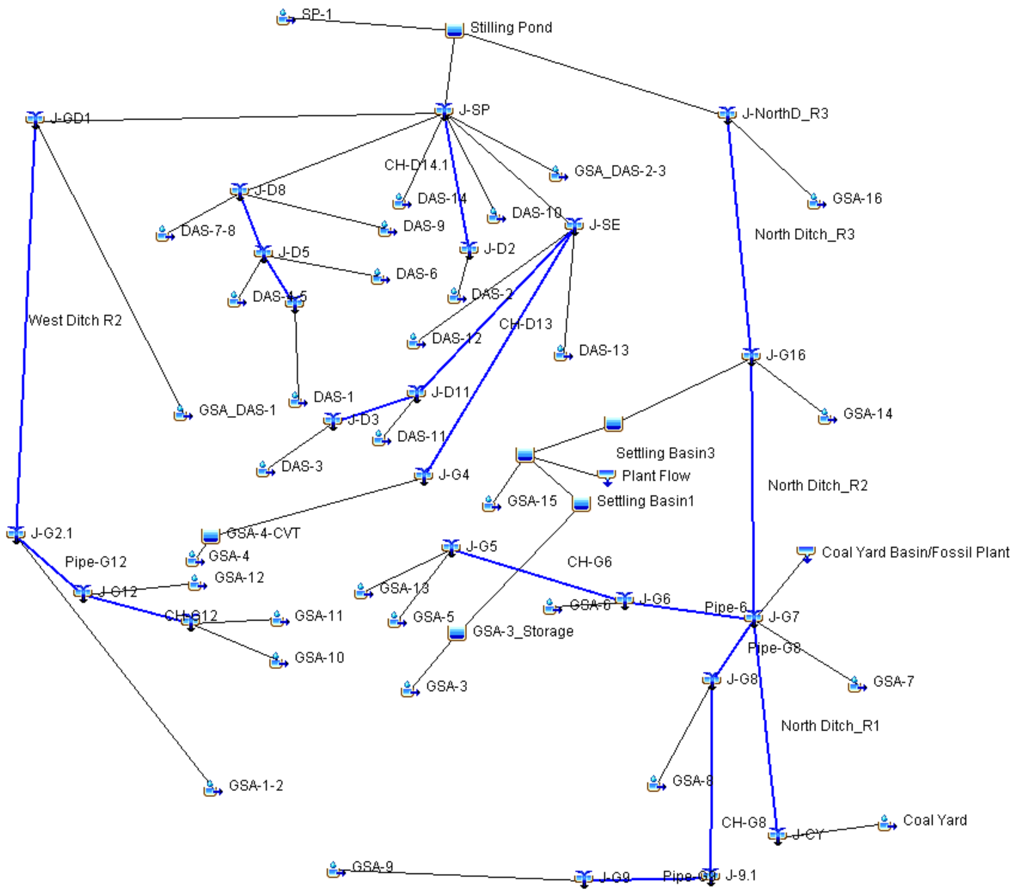


Figure 3 HEC-HMS Model Schematic

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

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.

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.

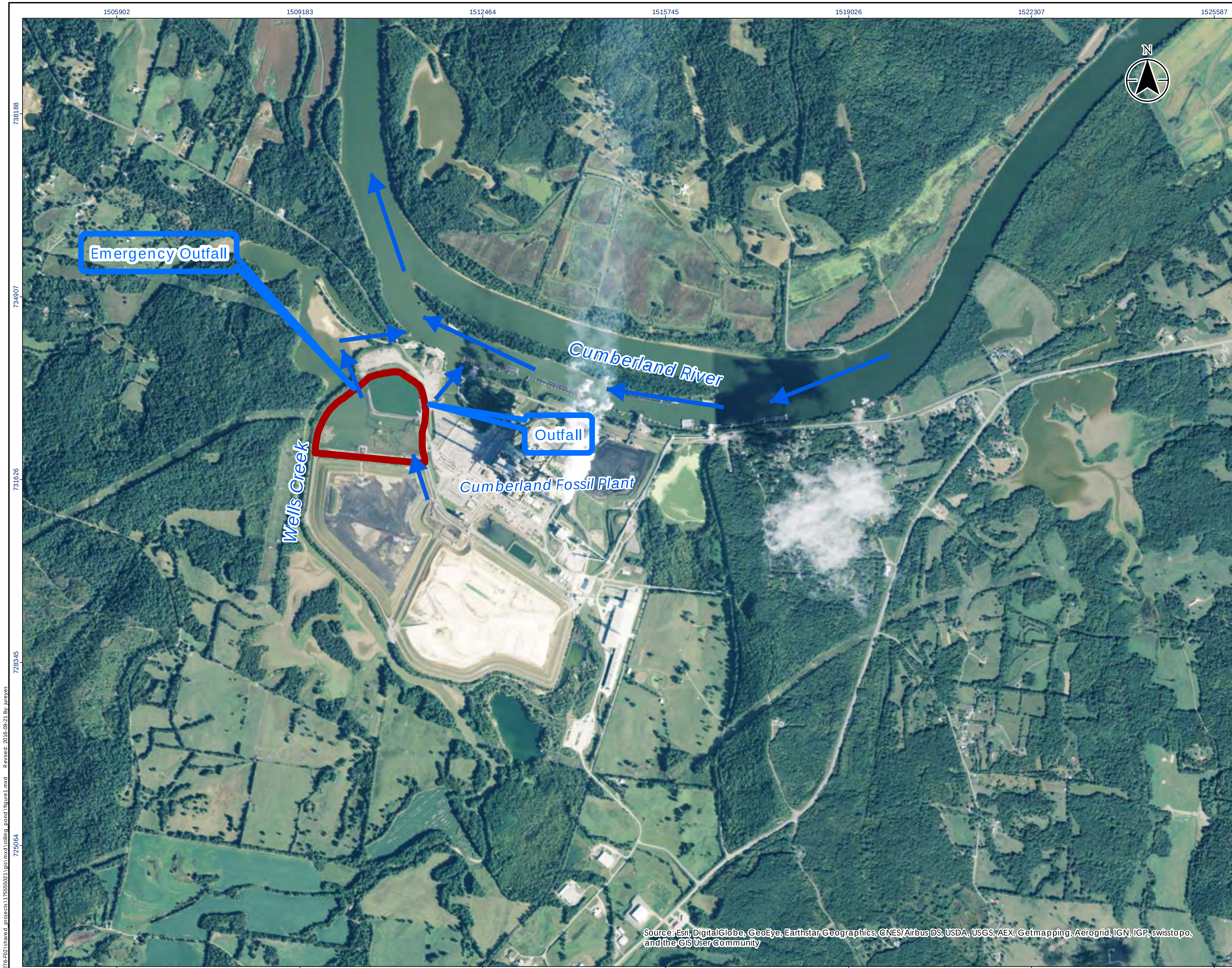
7. Tennessee Valley Authority, Flow Schematic, TVA Cumberland Fossil Plant, NPDES Permit No. TN0005789, January, 2011.

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



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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

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 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

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APPENDIX B
GENERAL DRAINAGE MAP

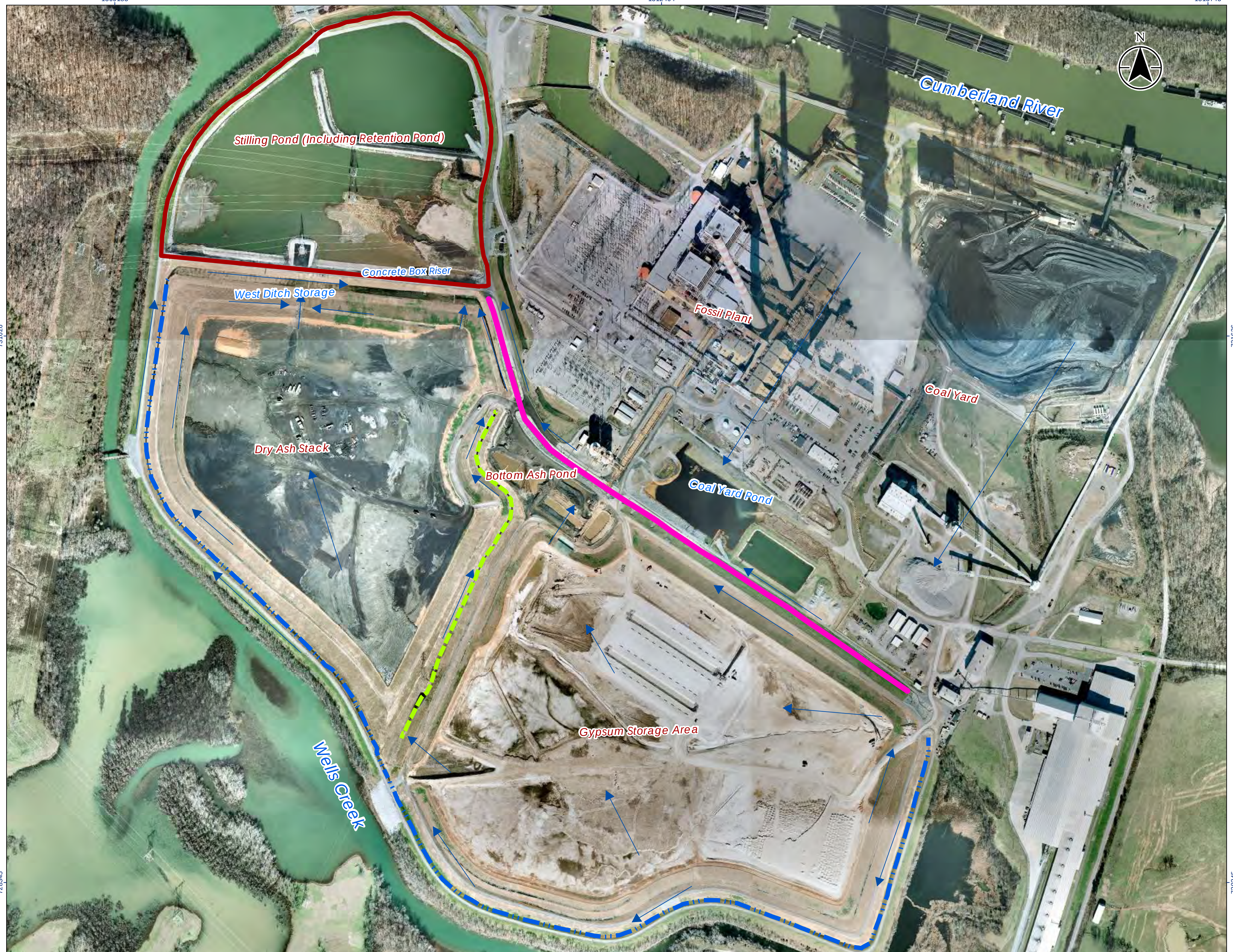

Figure No.
2

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

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

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

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TVA

\\US1276-F02\shared_projects\175555021\gis\mxd\stilling_pond\figure2.mxd Revised: 2016-09-28 By: jureyes

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

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
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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\\US1276-F02\shared_projects\175555021\gis\mxd\stilling_pond\figure3.mxd Revised: 2016-09-28 By: jsreyes

APPENDIX D
CURVE NUMBER MAP AND COMPUTATIONS

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

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

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

Stantec

TVA

\\US1276-F02\shared_projects\175555021\gis\mxd\stilling_pond\figure4.mxd Revised: 2016-09-28 By: jureyes

Curve Numbers - H&H
CCR Rule - Cumberland Fossil Plant
12/15/2015

Notes:
1 Areas retrieved from surface developed from TVA survey and aerial photos
2 Below are CN used in calculating weighed CN:

Gypsum	91	Grass	74
Bottom Ash/Fly Ash	91	TBD	0
TBD (old riprap	0	Water	99
Gravel	91	Capped Type 1 (Poor Veg)	89
Pavement	98	Capped Type 2 (Fair Veg)	84

	Sub basin	CN (2)	Gypsum (sf)(1)	Bottom Ash/Fly Ash (sf)(1)	TBD (old riprap (sf)(1)	Gravel (sf)(1)	Pavement (sf)(1)	Grass (sf)(1)	TBD (sf)(1)	Water (sf)(1)	Capped Type 1 (Poor Veg) (sf)(1)	Capped Type 2 (Fair Veg) (sf)(1)	Overall Area (sf)(1)
	GSA1-2	89				72,711					365,791		438,503
	GSA3	91	4,186,602			11,170							4,197,772
	GSA4	89				3,889					18,300		22,189
	GSA5	89				13,852					132,504		146,356
	GSA6	89				6,406					61,036		67,442
	GSA7	77				38,103		185,659					223,762
	GSA8	89				58,443					277,000		335,443
	GSA9	89				18,115					169,596		187,711
	GSA10	89				28,687					256,844		285,531
	GSA11	89									66,782		66,782
	GSA12	89				4,891					37,804		42,695
	GSA13	89									60,253		60,253
	GSA14	94				92,001							
81,632	GSA15	99				173,633				281,425			281,425
	GSA16	87				39,975		11,027			4,270		55,273
	GSA_DAS1	89									475,140		475,140
	GSA_DAS2-3	89				1,711					297,006		298,717
	DAS1	91				1,229							1,229
	DAS2	91		361,649		297							361,946
	DAS3	91		127,608									127,608
	DAS4_5	90		432,002		779					146,159		578,939
	DAS6	89				1,193					52,310		53,503
	DAS7_8	89				985					369,564		370,549
	DAS9	89				1,717					82,214		83,931
	DAS10	89				968					118,884		119,852
	DAS11	89				3,242							
	DAS12	89				1,452					53,113		54,565
	DAS13	89									356,281		356,281
	DAS14	89				712					13,274		13,986
	SP-1	99											

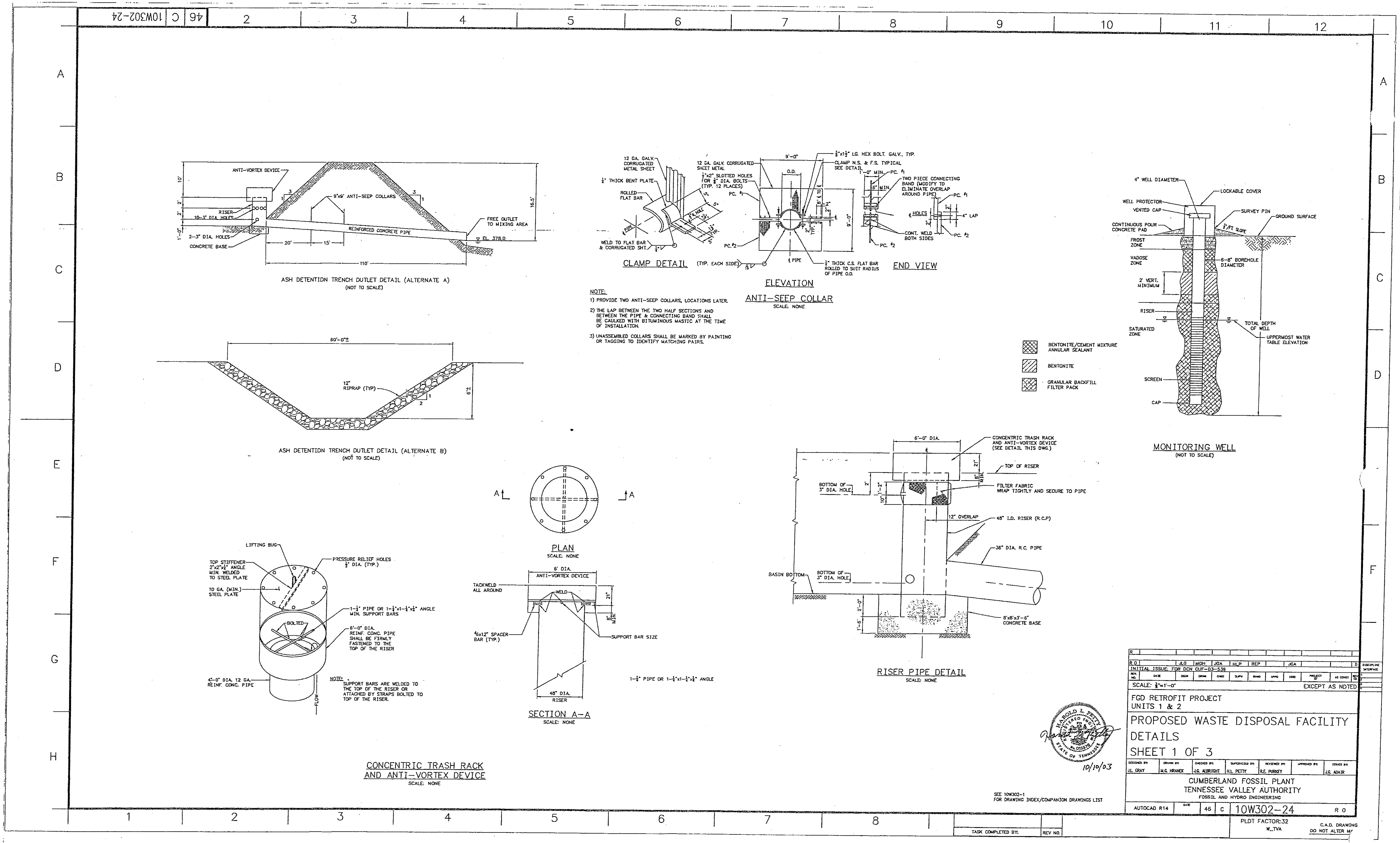
APPENDIX D
LAG TIME COMPUTATIONS

CUF Stilling Pond (including Retention Pond)
Lag Time:

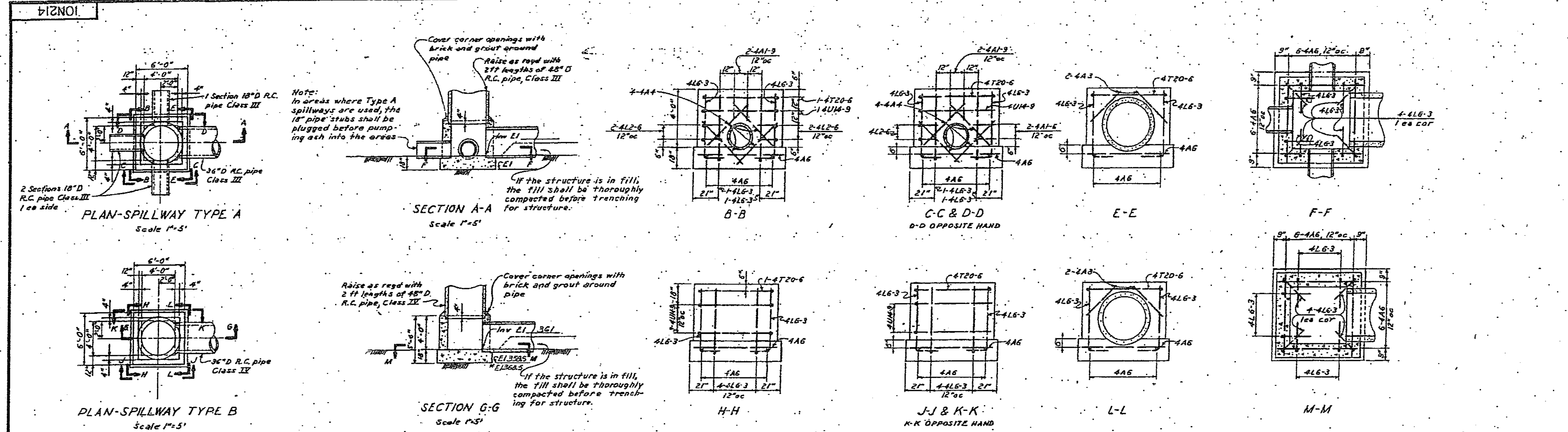
Watershed	Estimated Lag Time (min)
GSA1-2	29.1
GSA3	50.0
GSA4	32.9
GSA5	10.0
GSA6	4.4
GSA7	10.4
GSA8	13.5
GSA9	9.5
GSA10	13.0
GSA11	13.3
GSA12	12.6
GSA13	4.1
GSA14	7.4
GSA15	9.7
GSA16	5.9
GSA_DAS1	14.8
GSA_DAS2-3	7.8
DAS1	29.3
DAS2	25.7
DAS3	45.7
DAS4-5	47.4
DAS6	4.8
DAS7-8	15.0
DAS9	9.4
DAS10	5.1
DAS11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

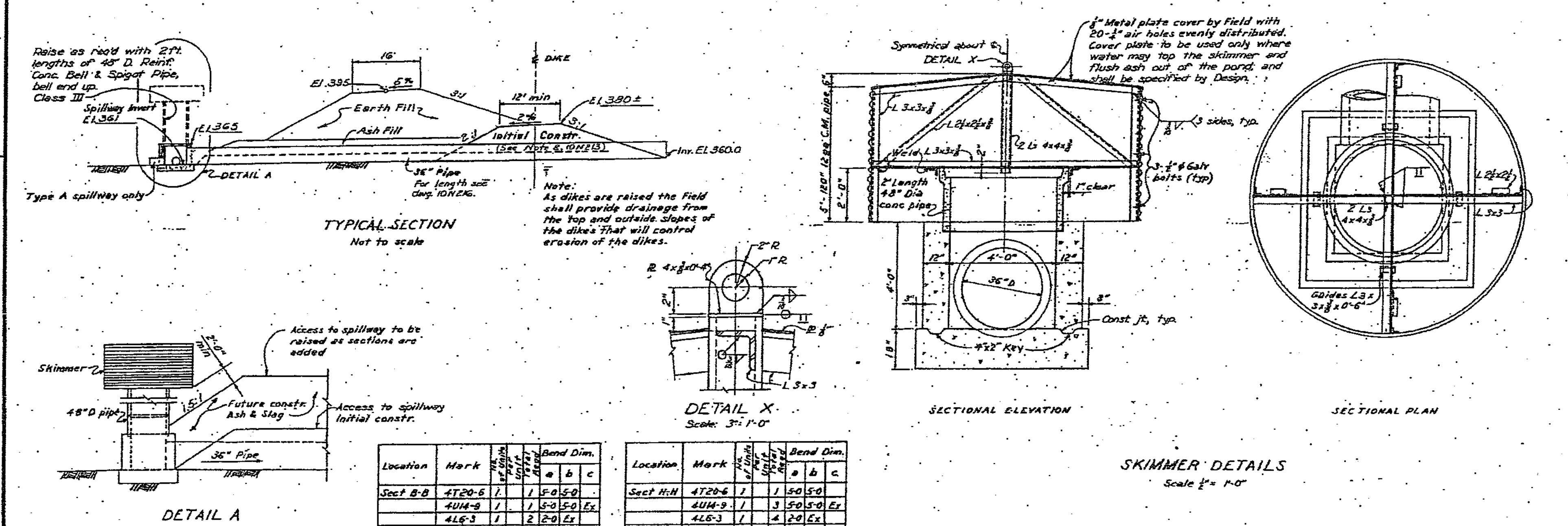
*HEC-HMS model uses minimum lag time of 3.5 minutes. Therefore, any time less than 3.5 minutes will be modified to 3.5 minutes.

APPENDIX F
REFERENCE DRAWINGS



46 C 10W302-24
ANTI-VORTEX DEVICE
RISER
10-3" DIA. HOLES
2-3" DIA. HOLES
CONCRETE BASE
9'x9' ANTI-SEEP COLLARS
REINFORCED CONCRETE PIPE
FREE OUTLET TO MIXING AREA
EL. 378.0
110'
ASH DETENTION TRENCH OUTLET DETAIL (ALTERNATE A)
(NOT TO SCALE)
60'-0"±
12" RIPRAP (TYP)
ASH DETENTION TRENCH OUTLET DETAIL (ALTERNATE B)
(NOT TO SCALE)
12 GA. GALV. CORRUGATED METAL SHEET
1/4" THICK BENT PLATE
ROLLED FLAT BAR
WELD TO FLAT BAR & CORRUGATED SHT.
CLAMP DETAIL
(TYP. EACH SIDE)
12 GA. GALV. CORRUGATED SHEET METAL
1/2"x2" SLOTTED HOLES FOR 3/8" DIA. BOLTS (TYP. 12 PLACES)
9'-0"
O.D.
3/8"x1 1/2" LG. HEX BOLT. GALV., TYP.
CLAMP N.S. & F.S. TYPICAL SEE DETAIL
1/4" THICK C.S. FLAT BAR ROLLED TO SUIT RADIUS OF PIPE O.D.
ELEVATION
ANTI-SEEP COLLAR
SCALE: NONE
TWO PIECE CONNECTING BAND (MODIFY TO ELIMINATE OVERLAP AROUND PIPE)
CONT. WELD BOTH SIDES
4" LAP
END VIEW
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.
BENTONITE/CEMENT MIXTURE ANNULAR SEALANT
BENTONITE
GRANULAR BACKFILL FILTER PACK
4" WELL DIAMETER
LOCKABLE COVER
WELL PROTECTOR
VENTED CAP
SURVEY PIN
GROUND SURFACE
CONTINUOUS POUR CONCRETE PAD
FROST ZONE
VADOSE ZONE
6-8" BOREHOLE DIAMETER
2' VERT. MINIMUM
RISER
SATURATED ZONE
TOTAL DEPTH OF WELL
UPPERMOST WATER TABLE ELEVATION
SCREEN
CAP
MONITORING WELL
(NOT TO SCALE)
6'-0" DIA.
CONCENTRIC TRASH RACK AND ANTI-VORTEX DEVICE (SEE DETAIL THIS DWG.)
TOP OF RISER
BOTTOM OF 3" DIA. HOLE
FILTER FABRIC WRAP TIGHTLY AND SECURE TO PIPE
12" OVERLAP
48" I.D. RISER (R.C.P)
36" DIA. R.C. PIPE
BASIN BOTTOM
8'x8'x3'-6" CONCRETE BASE
RISER PIPE DETAIL
SCALE: NONE
PLAN
SCALE: NONE
6' DIA.
ANTI-VORTEX DEVICE
TACKWELD ALL AROUND
WELD
6x12" SPACER BAR (TYP.)
SUPPORT BAR SIZE
1-1/2" PIPE OR 1-1/2"x1-1/2"x1/4" ANGLE
48" DIA. RISER
SECTION A-A
SCALE: NONE
LIFTING BUG
TOP STIFFENER 2"x2"x1/4" ANGLE MIN. WELDED TO STEEL PLATE
PRESSURE RELIEF HOLES 1/2" DIA. (TYP.)
10 GA. (MIN.) STEEL PLATE
1-1/2" PIPE OR 1-1/2"x1-1/2"x1/4" ANGLE MIN. SUPPORT BARS
BOLTED
6'-0" DIA. REINF. CONC. PIPE SHALL BE FIRMLY FASTENED TO THE TOP OF THE RISER
4'-0" DIA. 12 GA. REINF. CONC. PIPE
NOTE: SUPPORT BARS ARE WELDED TO THE TOP OF THE RISER OR ATTACHED BY STRAPS BOLTED TO TOP OF THE RISER.
FLOW
CONCENTRIC TRASH RACK AND ANTI-VORTEX DEVICE
SCALE: NONE
R0 INITIAL ISSUE FOR DCN CUF-03-536
SCALE: 3/8"=1'-0" EXCEPT AS NOTED
FGD RETROFIT PROJECT UNITS 1 & 2
PROPOSED WASTE DISPOSAL FACILITY DETAILS
SHEET 1 OF 3
J.L. GRAY M.G. HRANEK J.G. ALBRIGHT H.L. PETTY R.E. PURKEY J.G. ADAIR
HAROLD L. PETTY
10/10/03
SEE 10W302-1 FOR DRAWING INDEX/COMPANION DRAWINGS LIST
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING
AUTOCAD R14 46 C 10W302-24 R0
PLOT FACTOR:32 W_TVA
C.A.D. DRAWING DO NOT ALTER MANUALLY
TASK COMPLETED BY: REV NO.





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, inital 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

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 C-C & D-D	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 A 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			

TYPE B SPILLWAY

REINFORCEMENT SCHEDULE

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"Ø 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

Scale ⅛"=1'-0"
Except as noted

COMPANION DRAWING: 10N212,213,216,218

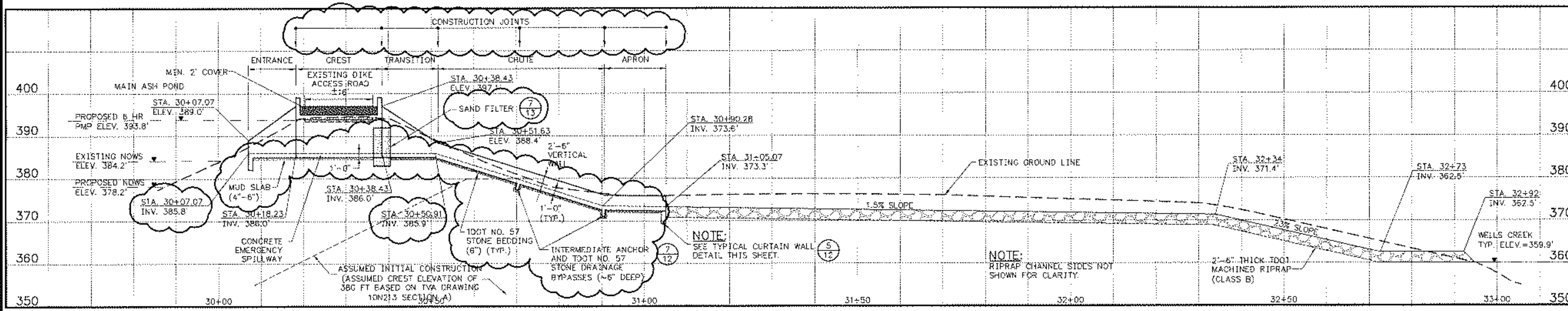
STANDARD DRAWING

ASH DISPOSAL SPILLWAY

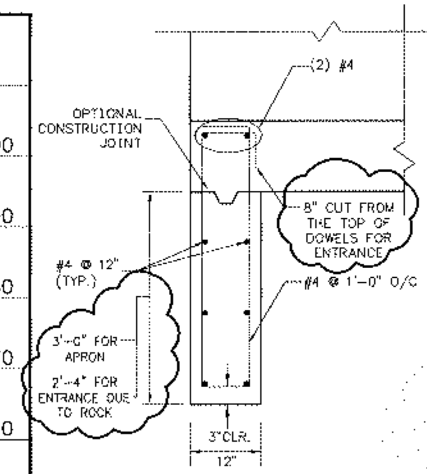
CUMBERLAND STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

SUBMITTED	RECOMMENDED	APPROVED
J. M. [signature]	W. M. Calvert	F. P. Lacy
KNOXVILLE	1-13-69	46 C 4 10N214R2

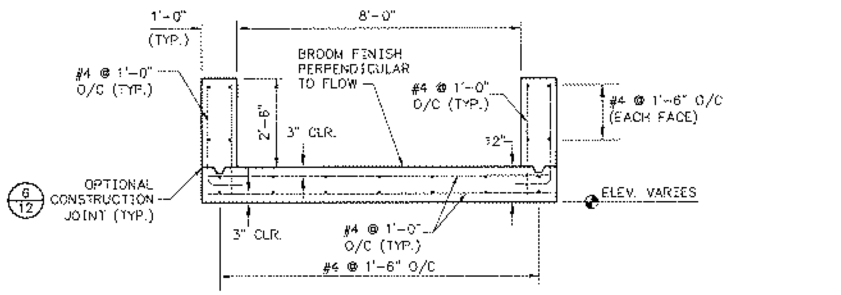
RECORD DRAWING AS CONSTRUCTED R2
Frank Van Meter 9-3-85



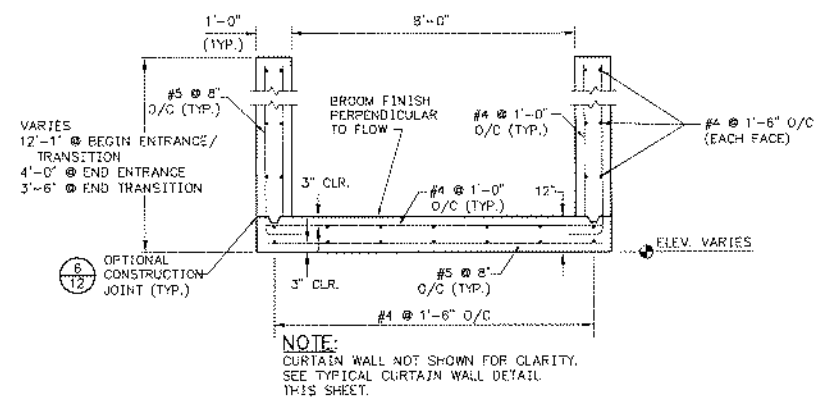
1/12 PROFILE – EMERGENCY SPILLWAY
SCALE: 1"=10'



5/12 DETAIL – CURTAIN WALL (TYP.)
SCALE: 1"=1'-0"

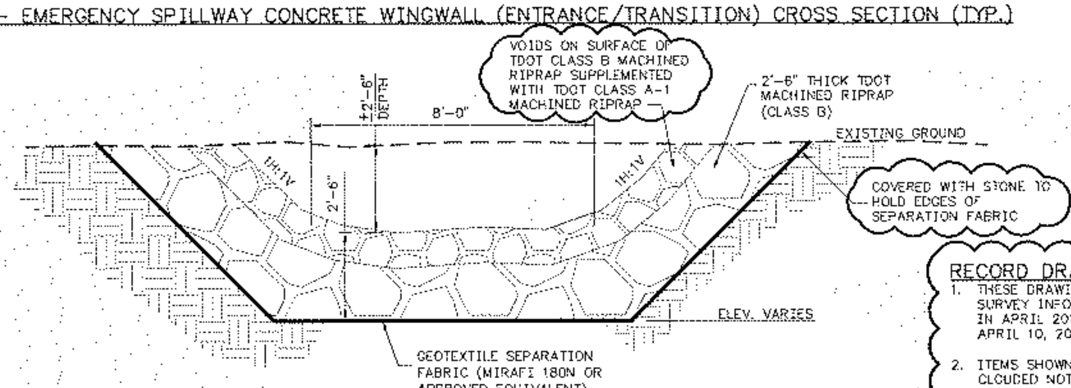


2/12 SECTION – EMERGENCY SPILLWAY CONCRETE CHUTE/APRON CROSS SECTION (TYP.)
SCALE: 1/2"=1'-0"

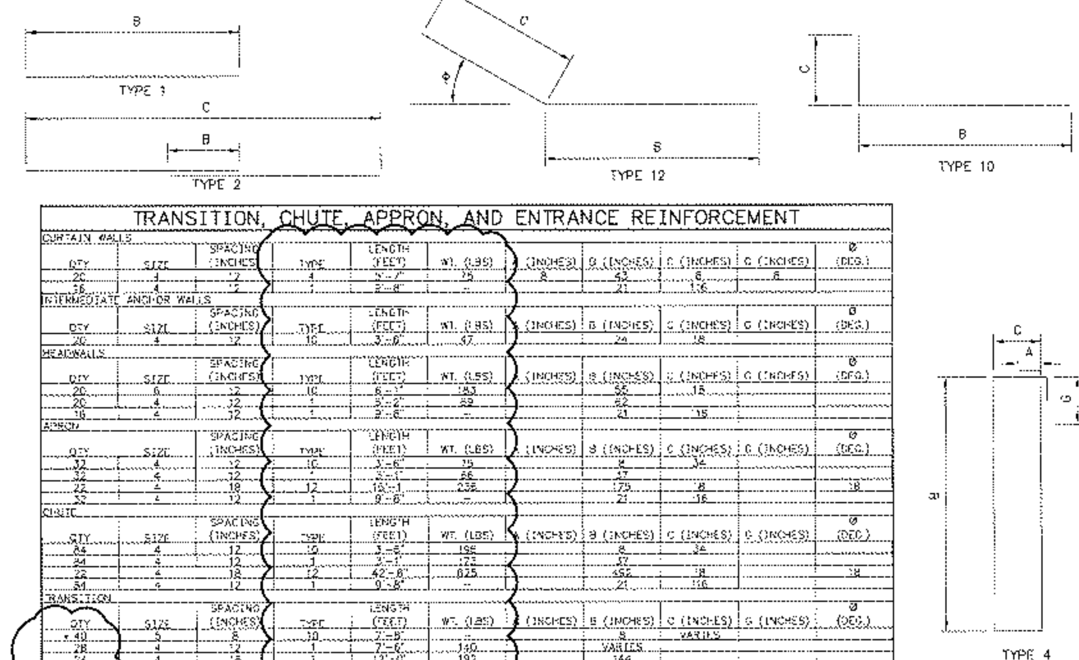


NOTE:
CURTAIN WALL NOT SHOWN FOR CLARITY.
SEE TYPICAL CURTAIN WALL DETAIL THIS SHEET.

3/12 SECTION – EMERGENCY SPILLWAY CONCRETE WINGWALL (ENTRANCE/TRANSITION) CROSS SECTION (TYP.)
SCALE: 1/2"=1'-0"



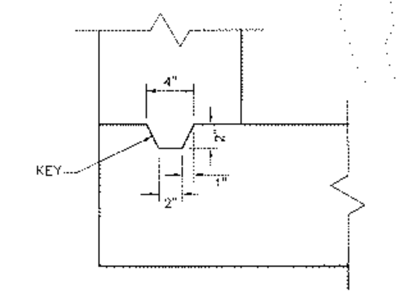
4/12 SECTION – EMERGENCY SPILLWAY RIPRAP CHANNEL (TYP.)
SCALE: 1/2"=1'-0"



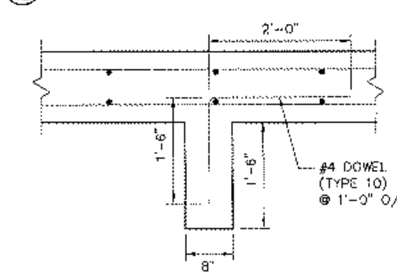
TRANSITION, CHUTE, APPRON, AND ENTRANCE REINFORCEMENT

QTY	SIZE	SPACING (INCHES)	TYPE	LENGTH (FEET)	WT. (LBS)	A (INCHES)	B (INCHES)	C (INCHES)	G (INCHES)	Ø (DEG.)
CURTAIN WALLS										
20	4	12	4	5'-7"	25	8	42	6	6	
36	4	12	1	2'-8"	–		21	116		
INTERMEDIATE ANCHOR WALLS										
20	4	12	10	3'-6"	47		24	18		
HEADWALLS										
20	6	12	10	6'-1"	183		55	15		
20	4	12	1	5'-2"	69		62			
16	4	12	1	2'-8"	–		21	15		
APRON										
32	4	12	10	3'-6"	75		8	34		
32	4	12	1	3'-1"	66		37			
22	4	18	12	19'-1	235		175	18		18
32	4	12	1	9'-6"	–		21	16		
CHUTE										
84	4	12	10	3'-6"	196		8	34		
84	4	12	1	3'-1"	173		37			
22	4	18	12	42'-8"	625		452	18		18
54	4	12	1	9'-8"	–		21	116		
TRANSITION										
* 40	5	8	10	7'-5"	–		8	VARIES		
28	4	12	1	7'-6"	140		VARIES			
24	4	16	1	12'-0"	192		144			
14	4	12	1	9'-8"	–		21	116		
20	5	8	1	9'-8"	–		26	116		
2	4	12	12	3'-0"	4		16	12		45
28	4	12	1	3'-0"	52		36			
ENTRANCE										
* 34	5	8	10	7'-8"	–		8	VARIES		
24	4	12	1	7'-5"	120		VARIES			
24	4	18	1	11'-0"	176		132			
12	4	12	1	9'-0"	–		21	116		
16	5	8	1	9'-8"	–		26	116		
2	4	12	12	3'-0"	4		10	18		26
26	4	12	1	3'-0"	32		36			

* VARYING LENGTHS TO MATCH WINGWALL HEIGHT

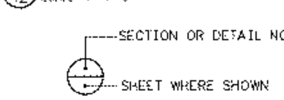


6/12 DETAIL – CONSTRUCTION JOINT (TYP.)
SCALE: 2"=1'-0"



7/12 DETAIL – INTERMEDIATE ANCHOR
SCALE: 1"=1'-0"

LEGEND
NOWS = NORMAL OPERATING WATER SURFACE
O/C = ON CENTER



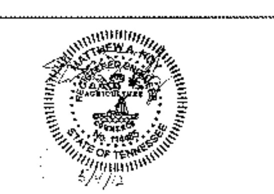
REFERENCE KEY

NOTES:
1. CONCRETE, REINFORCEMENT AND FORMWORK SHALL BE IN ACCORDANCE WITH TECHNICAL SPECIFICATIONS. CONCRETE SHALL BE CLASS A, F'C=4,000 PSI.
2. REINFORCING STEEL SHALL HAVE A MINIMUM YIELD STRENGTH, FY=60,000 PSI
3. 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.).
4. MAINTAIN 2" CLR. UNLESS OTHERWISE SHOWN.
5. ALL EXPOSED CORNERS SHALL HAVE ¾" CHAMFER.
6. TOOLED JOINTS SHALL BE PLACED EVERY 20 FEET ALONG TRANSITION, CHUTE, AND APRON SECTIONS.
7. BROOM FINISH FLOOR SURFACES PERPENDICULAR TO FLOW.

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.

RECORD DRAWING

FOR SUPPORTING DESIGN CALCULATIONS SEE FPGCUFFESCDX00000020100008



Stantec Consulting Services Inc.

REV NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST
R 1	08/25/11	RC	TMM	RV	MAH	SEB	MST	JCK		
ISSUED FOR CONSTRUCTION										
R 2	05/04/12	PRV	TMM	RV	MAH	SEB	MST	JCK	–	–
ISSUED AS-BUILT AS PER WORK PLAN 7 (CUF-110311-WP-7)										
R 0	03/11/11	RC	TMM	RV	MAH	SEB	MST	JCK	–	–
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)

DESIGNED BY	DRAWN BY	CHECKED BY	SUPERVISED BY	REVIEWED BY	APPROVED BY	ISSUED BY
R. CORSA	T.M. MYERS	R. VERRASTRO	M.A. HOY	S.E. BENNETT	M.S. TURNBOW	J.C. KAMMEYER

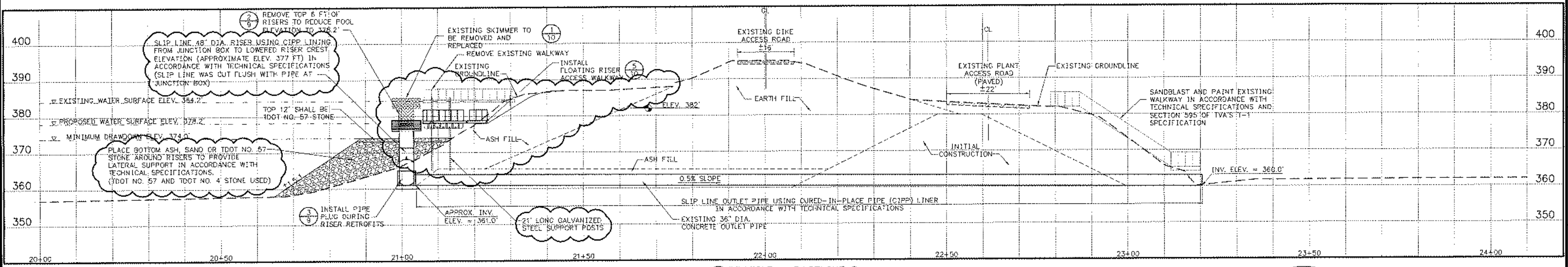
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 | DATE 03/11/11 | 46 | C | 10W286-12 | R 2

PLOT FACTOR:10
W_TVA

C.A.D. DRAWING DO NOT ALTER MANUALLY

STANTEC | 2
TASK COMPLETED BY: | REV NO.

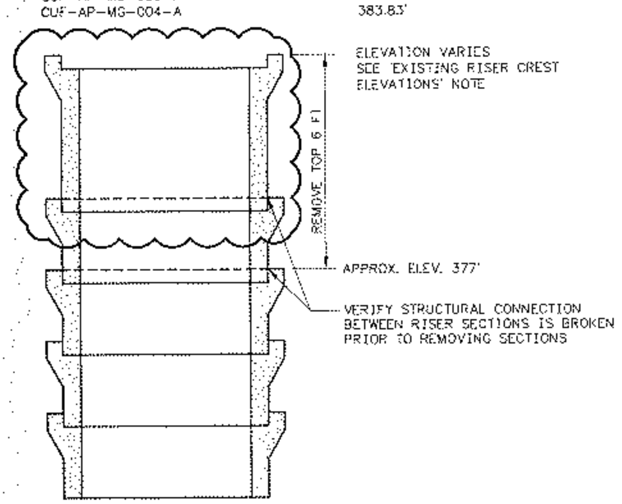


1/9 PROFILE - BASELINE B

SCALE: 1"=10'

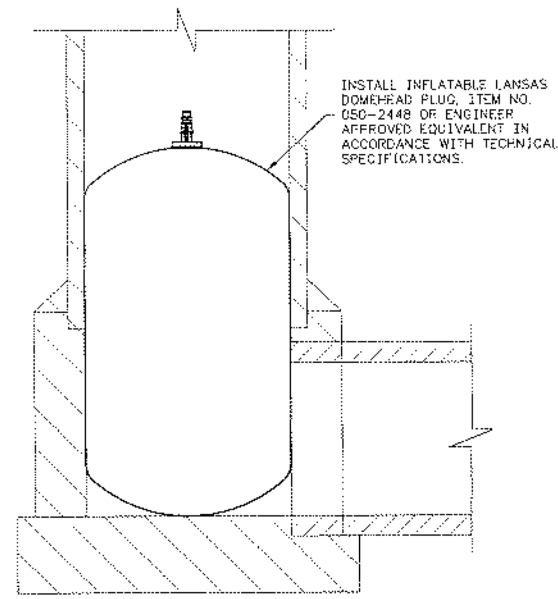
EXISTING RISER CREST ELEVATIONS (STEEL PLATE CREST)

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'



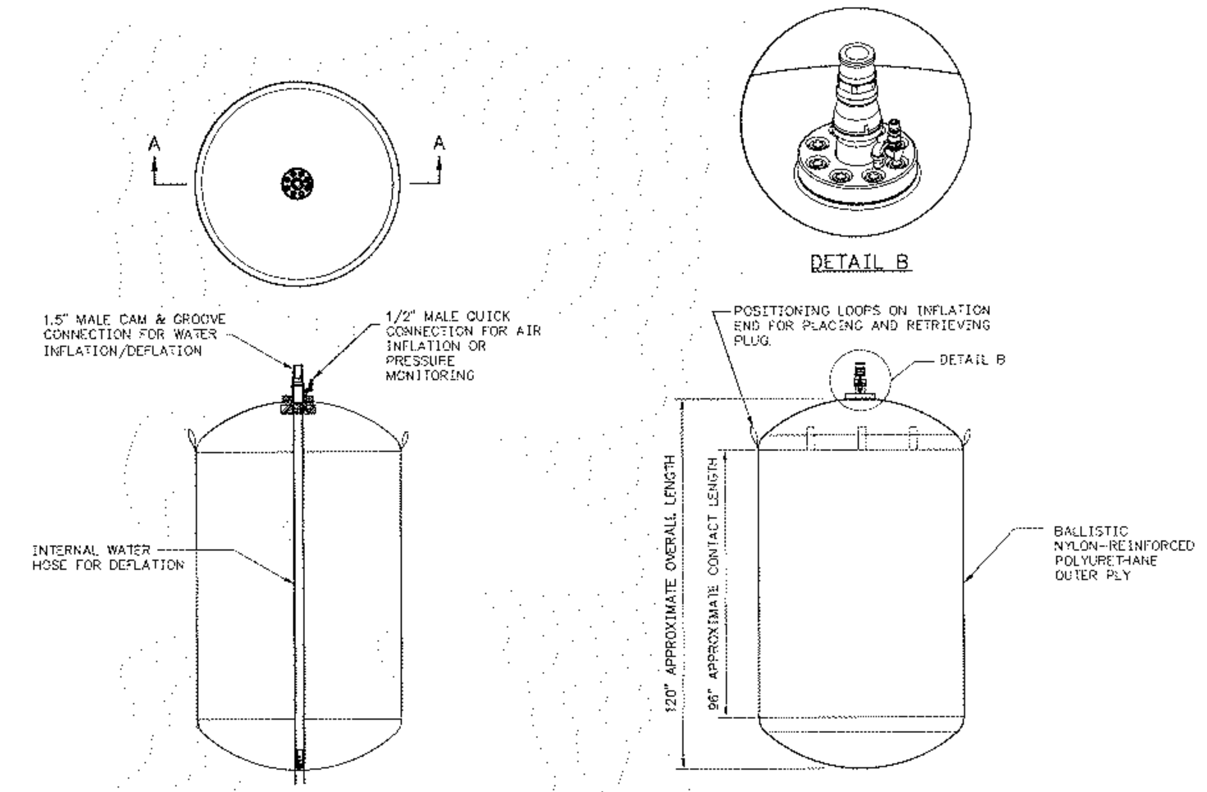
2/9 DETAIL - EXISTING RISER RETROFITS

NOT TO SCALE



3/9 DETAIL - INSTALLATION OF PIPE PLUG

NOT TO SCALE



4/9 DETAIL - INFLATABLE PIPE PLUG

NOT TO SCALE

PHASING AND SEQUENCING:

1. LOWER POOL ELEVATION APPROXIMATELY 1 FT BELOW EXISTING RISER CREST USING SIPHONS.
2. INSTALL TEMPORARY COFFERDAM OR SILT 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 FPGCUFFESCDX00000020100008

REV NO	DATE								
R 1	05/04/12	PRV	TWM	MAH	SHD	SEB	MST	JCK	-
	ISSUED AS-BUILT AS PER WORK PLAN 7 (CUF-110311-WP-7)								
R 0	03/11/11	JJP	TWM	MAH	SHB	SEB	MST	JCK	-
	ISSUED FOR CONSTRUCTION								

SCALE: NONE EXCEPT AS NOTED

YARD
ASH STILLING POND

SPILLWAY IMPROVEMENT PROJECT
DETAILS - SPILLWAY RETROFITS
WORK PLAN 7 (CUF-110311-WP-7)

DESIGNED BY	DRAWN BY	CHECKED BY	SUPERVISED BY	REVIEWED BY	APPROVED BY	ISSUED BY
J.J. PERKINS	T.M. MYERS	M.A. HOY	S.H. BICKEL	S.E. BENNETT	M.S. TURNBOW	J.C. KAMMEYER

Stantec Consulting Services Inc.
1950 Bowles Ave., Ste 250
St. Louis, Missouri
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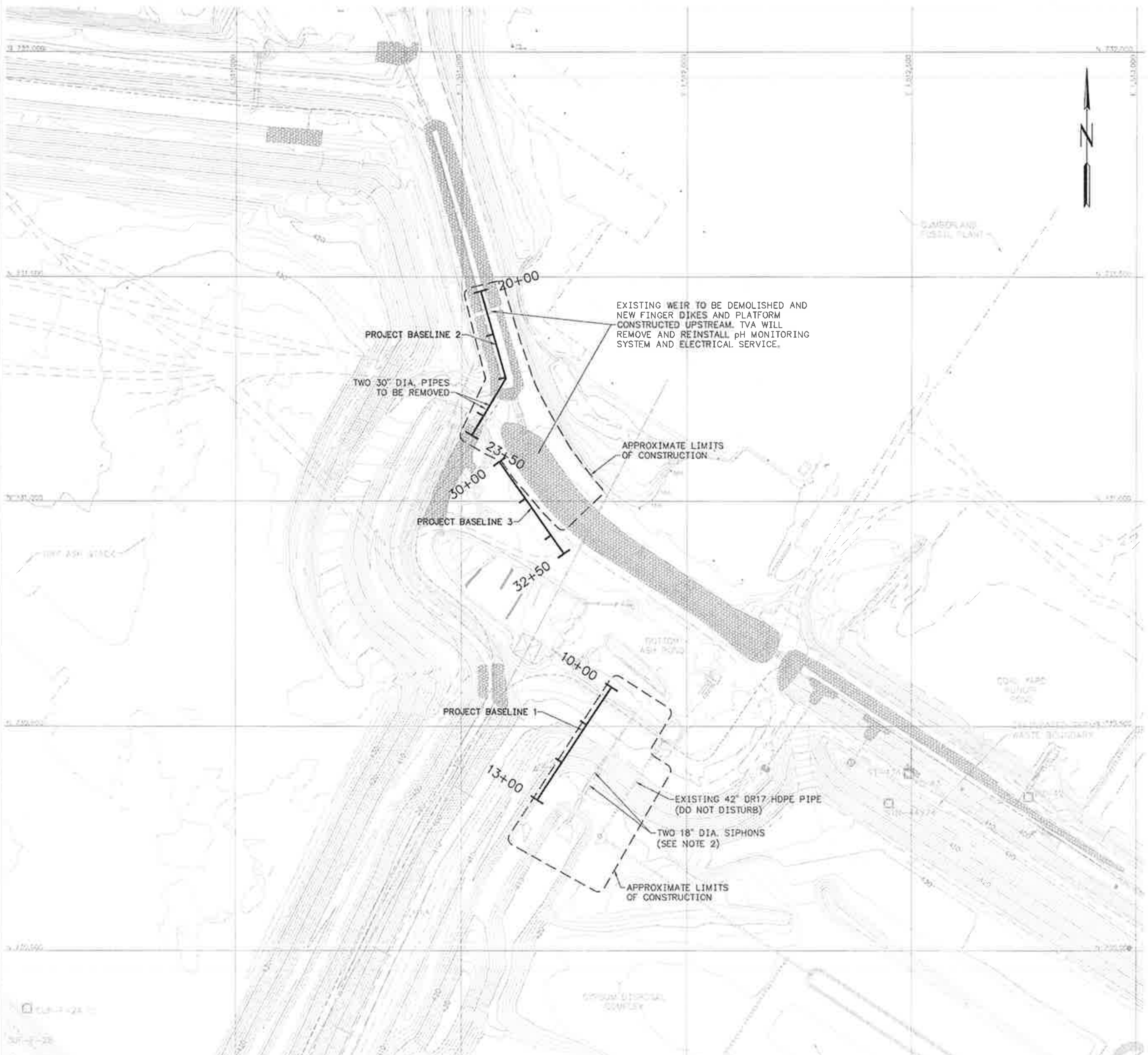
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 | DATE 03/11/11 | 46 | C | 10W286-09 | R 1

STANTEC	1
TASK COMPLETED BY:	REV NO.

PLOT FACTOR:10
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY



1 PLAN – EXISTING CONDITIONS
10W550-03 SCALE: 1"=100'

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 2D12, MARCH 2013 AND OCTOBER 2014.
2. EXISTING 1B" 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 NEEOED.

SURVEY CONTROL NOTE:

A GLOBAL POSITIONING SYSTEM (GPS) BASE STATION HAS BEEN ESTABLISHED ANO TRANSFORMATION PARAMETERS DETERMINED BY TVA USING SELECTED SURVEY CONTROL MONUMENTS. CONTACT WITH TVA SURVEYING DEPARTMENT (423)751–B416 OR (423)751–2571 SHALL BE MADE BEFORE ANY SURVEY OR CONSTRUCTION WORK IS COMMENCEO. 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	73D,336.41	1,511,66B.71
20+D0.DO	BEGIN BASELINE 2	731,46B.22	1,511,541.79
22+02.64	P.I. STA. BASELINE 2	731,273.51	1,511,597.93
23+5D.DD	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,BB3.35	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

GRAPHIC SCALE: 1" = 100'
CONTOUR INTERVAL = 2 FOOT

ISSUED FOR CONSTRUCTION

Stantec

SEE 10W550-01 FOR LIST OF DESIGN, COMPANION, REFERENCE DRAWINGS AND SUPPORTING DESIGN CALCULATIONS NUMBER.

REV	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST
R 0	09/21/15	CLH	RRP	NAB	NAB	DGS	MST	JCK	608929	–

ISSUED FOR CONSTRUCTION

SCALE: 1"=100' EXCEPT AS NOTED

YARD
GYPSUM DISPOSAL COMPLEX

SIPHON IMPROVEMENTS PROJECT EXISTING CONDITIONS

DESIGNED BY	DRAWN BY	CHECKED BY	SUPERVISED BY	REVIEWED BY	APPROVED BY	ISSUED BY
C.L. HAY	R.R. PETTY	N.A. BADER	N.A. BADER	D.G. STEPHENS	M.S. TURNBOW	J.C. KAMMEYER

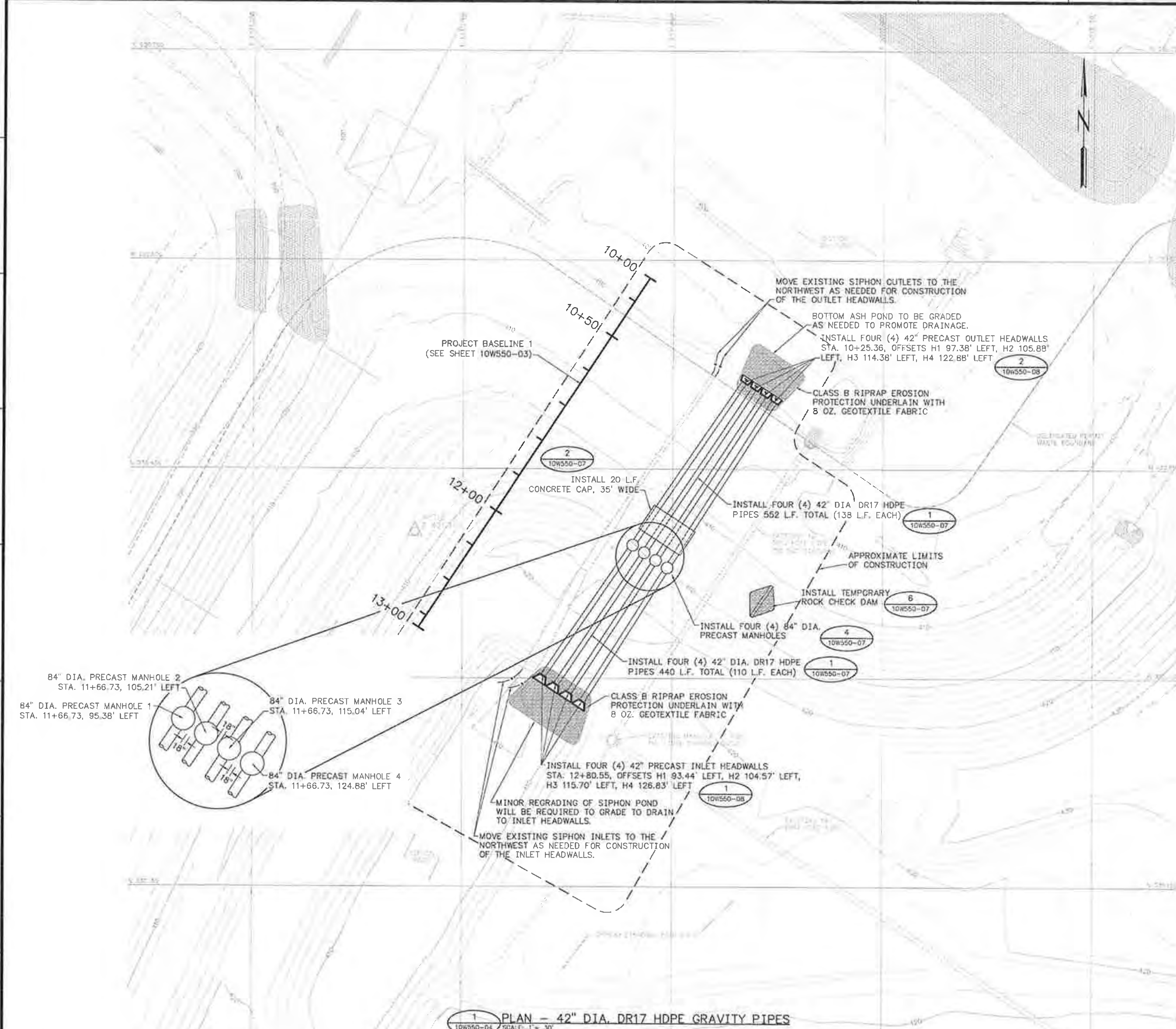
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2010 | 09/21/15 | 46 | C | 10W550–03 | R 0

STANTEC | 0
TASK COMPLETED BY: | REV NO.

PLOT FACTOR:1
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY



1 10W550-04 PLAN – 42" DIA. DR17 HDPE GRAVITY PIPES
SCALE: 1" = 30'

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

SECTION OR DETAIL NO.
DRAWING WHERE SHOWN
REFERENCE KEY

GRAPHIC SCALE: 1" = 30'
CONTOUR INTERVAL = 2 FOOT

ISSUED FOR CONSTRUCTION

Stantec
10509 Timberwood Circle Suite 100
Louisville, Kentucky 40223-5301
www.stantec.com

SEE 10W550-01 FOR LIST OF DESIGN, COMPANION, REFERENCE DRAWINGS AND SUPPORTING DESIGN CALCULATIONS NUMBER.

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST
R 0	09/21/15	CLH	RRP	NAB	NAB	DGS	MST	JCK	608929	–
ISSUED FOR CONSTRUCTION										

SCALE: 1"=30' EXCEPT AS NOTED

YARD
GYPSUM DISPOSAL COMPLEX

SIPHON IMPROVEMENTS PROJECT
42" DIAMETER GRAVITY PIPES
PLAN VIEW

DESIGNED BY	DRAWN BY	CHECKED BY	SUPERVISED BY	REVIEWED BY	APPROVED BY	ISSUED BY
C.L. HAY	R.R. PETTY	N.A. BADER	N.A. BADER	D.G. STEPHENS	M.S. TURNBOW	J.C. KAMMEYER

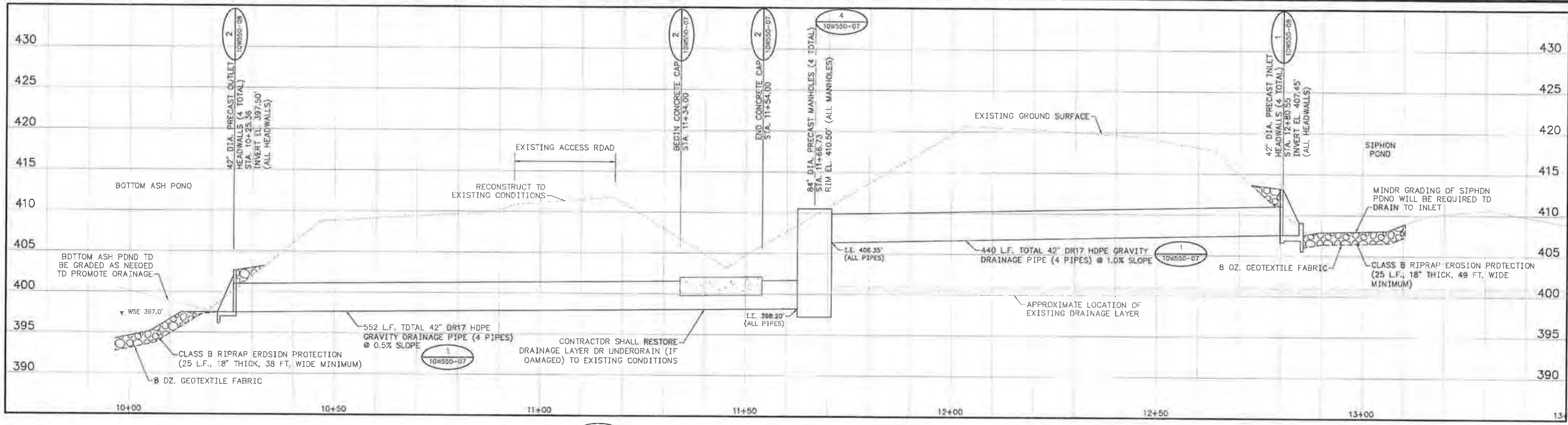
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2010 | DATE 09/21/15 | 46 | C | 10W550–04 | R 0

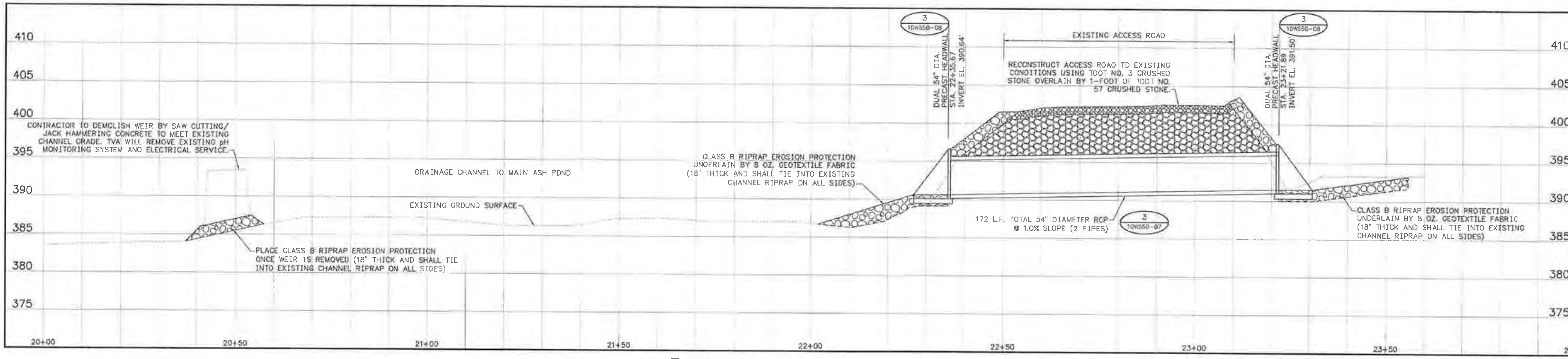
STANTEC | 0
TASK COMPLETED BY: | REV NO.

PLOT FACTOR:1
W_TVA

C.A.D. DRAWING DO NOT ALTER MANUALLY



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



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

SECTION OR DETAIL NO.
DRAWING WHERE SHOWN
REFERENCE KEY

GRAPHIC SCALE: 1" = 10' (HORIZ.) 1" = 5' (VERT.)

ISSUED FOR CONSTRUCTION

Stantec
10509 Timberwood Circle, Suite 100
Louisville, Kentucky 40223-5301
www.stantec.com

SEE 10W550-01 FOR LIST OF DESIGN, COMPANION, REFERENCE DRAWINGS AND SUPPORTING DESIGN CALCULATIONS NUMBER.

REV NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID		AS CONST
R -	-	-	-	-	-	-	-	-	-	-	-
R 0	09/21/15	CLH	RRP	NAB	NAB	DGS	MST	JCK	606929	-	-

ISSUED FOR CONSTRUCTION

SCALE: 1"=10' HORIZONTAL 1"=5' VERTICAL EXCEPT AS NOTED

YARD
GYPSUM DISPOSAL COMPLEX

SIPHON IMPROVEMENTS PROJECT 42" DIA. HDPE & 54" DIA. RCP PIPE PROFILES

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
C.L. HAY	R.R. PETTY	N.A. BADER	N.A. BADER	D.G. STEPHENS	M.S. TURNBOW	J.C. KAMMEYER

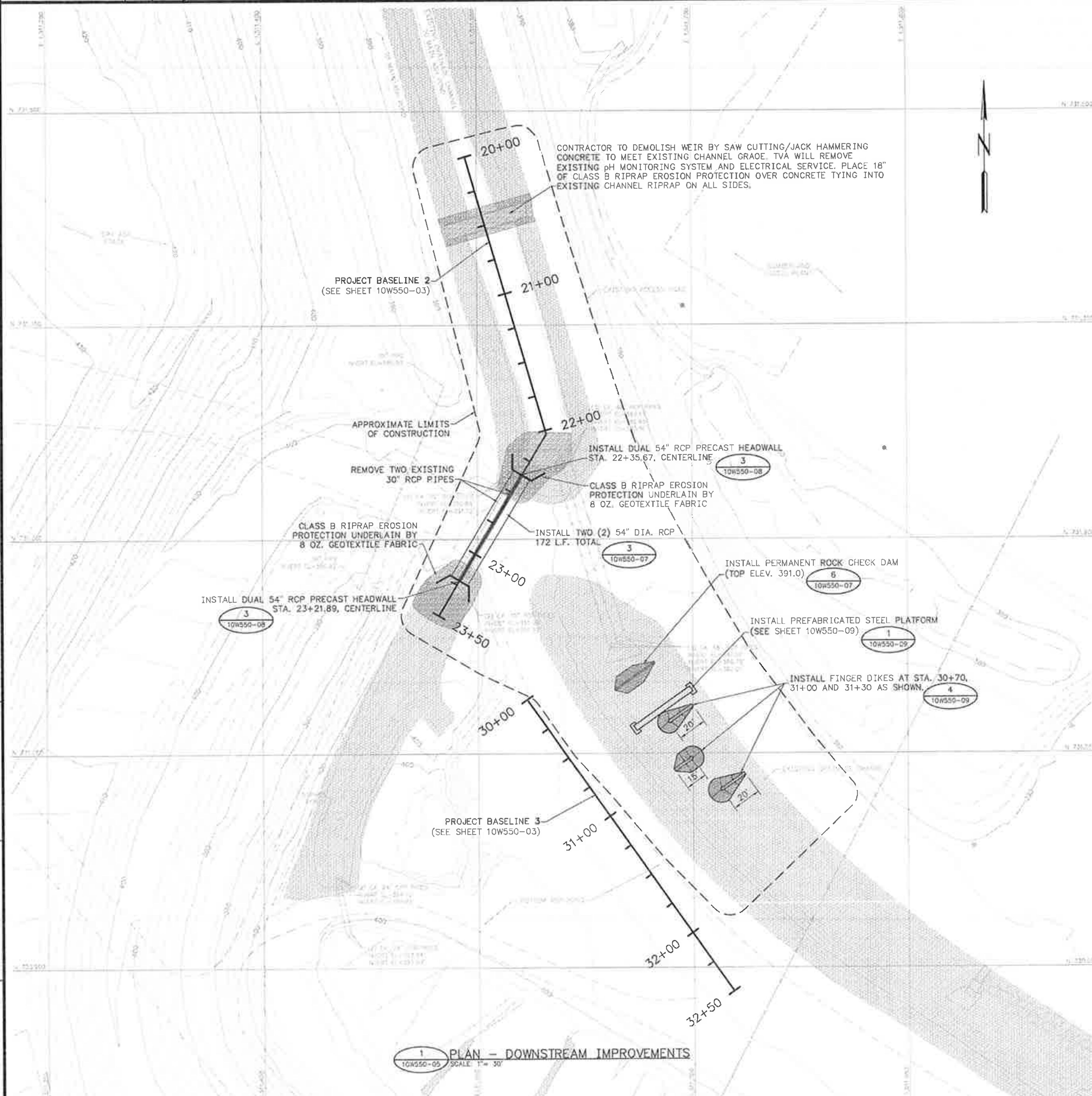
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2010 | 09/21/15 | 46 | C | 10W550-06 | R 0

STANTEC | D
TASK COMPLETED BY: | REV NO.

PLOT FACTOR:1 W_TVA

C.A.D. DRAWING DO NOT ALTER MANUALLY



1 10W550-05 PLAN – DOWNSTREAM IMPROVEMENTS SCALE: 1"= 30'

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 ANO 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

SECTION OR DETAIL NO.
DRAWING WHERE SHOWN
REFERENCE KEY

15 0 30 60 FEET
GRAPHIC SCALE: 1" = 30'
CONTOUR INTERVAL = 2 FOOT

ISSUED FOR CONSTRUCTION

Stantec

SEE 10W550-01 FOR LIST OF DESIGN, COMPANION, REFERENCE DRAWINGS AND SUPPORTING DESIGN CALCULATIONS NUMBER.

REV NO	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST
R 0	09/21/15	CLH	RRP	NAB	NAB	DGS	MST	JCK	509929	–

R 0 ISSUED FOR CONSTRUCTION

SCALE: 1"=30' EXCEPT AS NOTED

YARD
GYPSUM DISPOSAL COMPLEX

SIPHON IMPROVEMENTS PROJECT DOWNSTREAM IMPROVEMENTS PLAN VIEW

DESIGNED BY	DRAWN BY	CHECKED BY	SUPERVISED BY	REVIEWED BY	APPROVED BY	ISSUED BY
C.L. HAY	R.R. PETTY	N.A. BADER	N.A. BADER	D.G. STEPHENS	M.S. TURNBOW	J.C. KAMMEYER

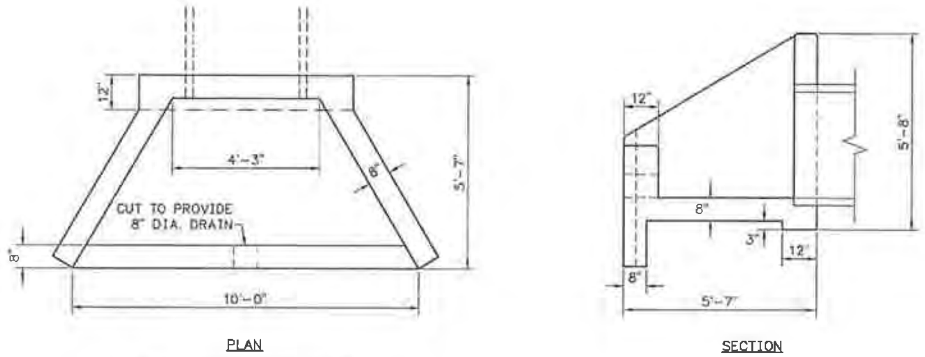
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

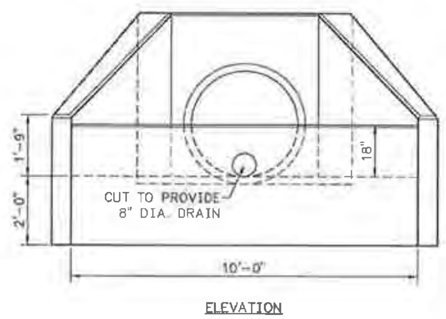
AUTOCAD R 2010 | DATE 09/21/15 | 46 | C | 10W550–05 | R 0

PLOT FACTOR:1
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

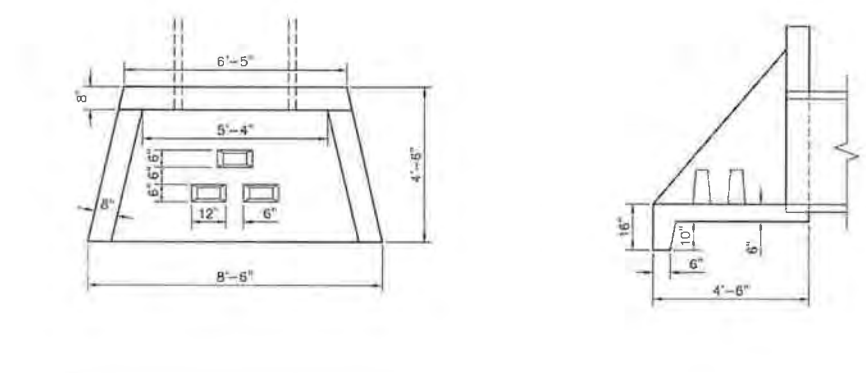
STANTEC | 0
TASK COMPLETED BY: | REV NO.

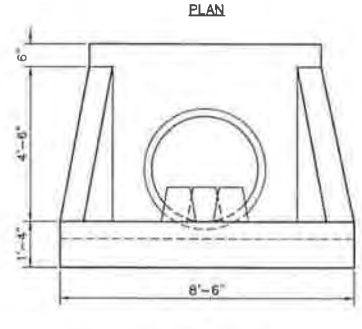




NOTES:
1. THE 42-INCH HDPE PIPE SHALL EXTEND THROUGH THE WALL FOR A SUFFICIENT DISTANCE TO ALLOW FOR CONNECTION TO THE PRECAST HEADWALL. THE SPACE BETWEEN PIPE AND HEADWALL STRUCTURE SHALL BE GROUTED FULL USING NON-SHRINK GROUT (TDOT SPECIFICATION SECTION 918.21 "TYPE 1").
2. INLET HEADWALL SHOWN IS 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.

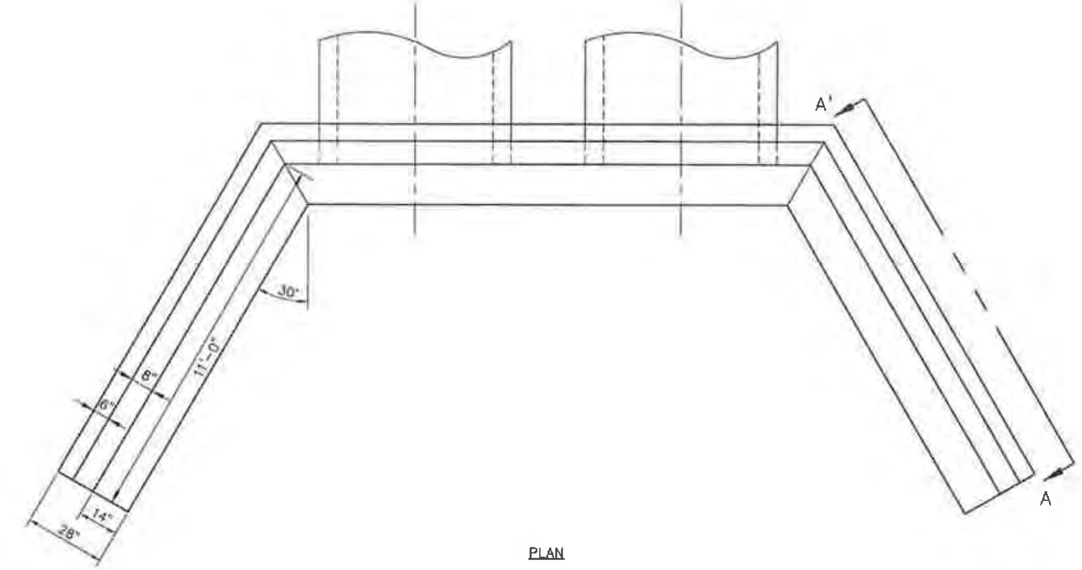
1 / 10W550-08 DETAIL – 42" DIA. PRECAST INLET HEADWALL
SCALE: 1/2"=1'-0"



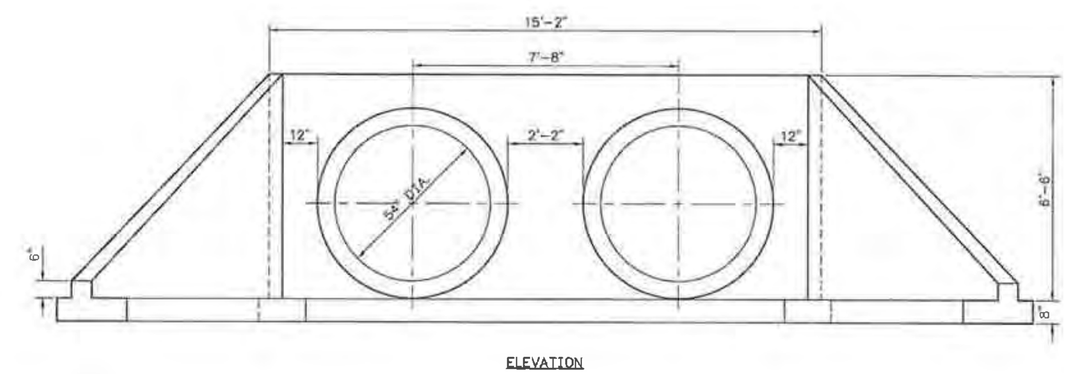


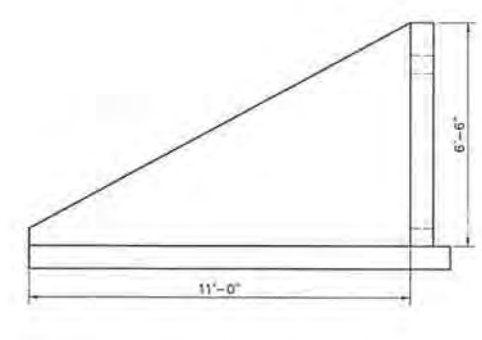
NOTES:
1. THE 42-INCH HDPE PIPE SHALL EXTEND THROUGH THE WALL FOR A SUFFICIENT DISTANCE TO ALLOW FOR CONNECTION TO THE PRECAST HEADWALL. THE SPACE BETWEEN PIPE AND HEADWALL STRUCTURE SHALL BE GROUTED FULL USING NON-SHRINK GROUT (TDOT SPECIFICATION SECTION 918.21 "TYPE 1").
2. OUTLET HEADWALL SHOWN IS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

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

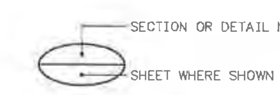


NOTE:
PRECAST DUAL PIPE HEADWALL SHOWN IS A STANDARD ENDWALL FOR MULTIPLE PIPES, EW-7PC MANUFACTURED BY HANSON. AN EQUIVALENT PRODUCT MAY BE USED WITH APPROVAL FROM THE ENGINEER.

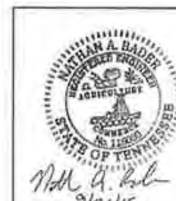




3 / 10W550-08 DETAIL – DUAL 54" DIA. PIPE HEADWALL
SCALE: 1/2"=1'-0"



ISSUED FOR CONSTRUCTION



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10509 Timberwood Circle Suite 100
Louisville, Kentucky 40223-5301
www.stantec.com

SEE 10W550-01 FOR LIST OF DESIGN, COMPANION, REFERENCE DRAWINGS AND SUPPORTING DESIGN CALCULATIONS NUMBER.

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	TSSD	PROJECT ID	AS CONST
R 0	09/21/15	CLH	RRP	NAB	NAB	DGS	MST	JCK	608929	–

ISSUED FOR CONSTRUCTION

SCALE: AS SHOWN EXCEPT AS NOTED

YARD
GYPSUM DISPOSAL COMPLEX

SIPHON IMPROVEMENTS PROJECT
DETAILS

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
C.L. HAY	R.R. PETTY	N.A. BADER	N.A. BADER	D.G. STEPHENS	M.S. TURNBOW	J.C. KAMMEYER

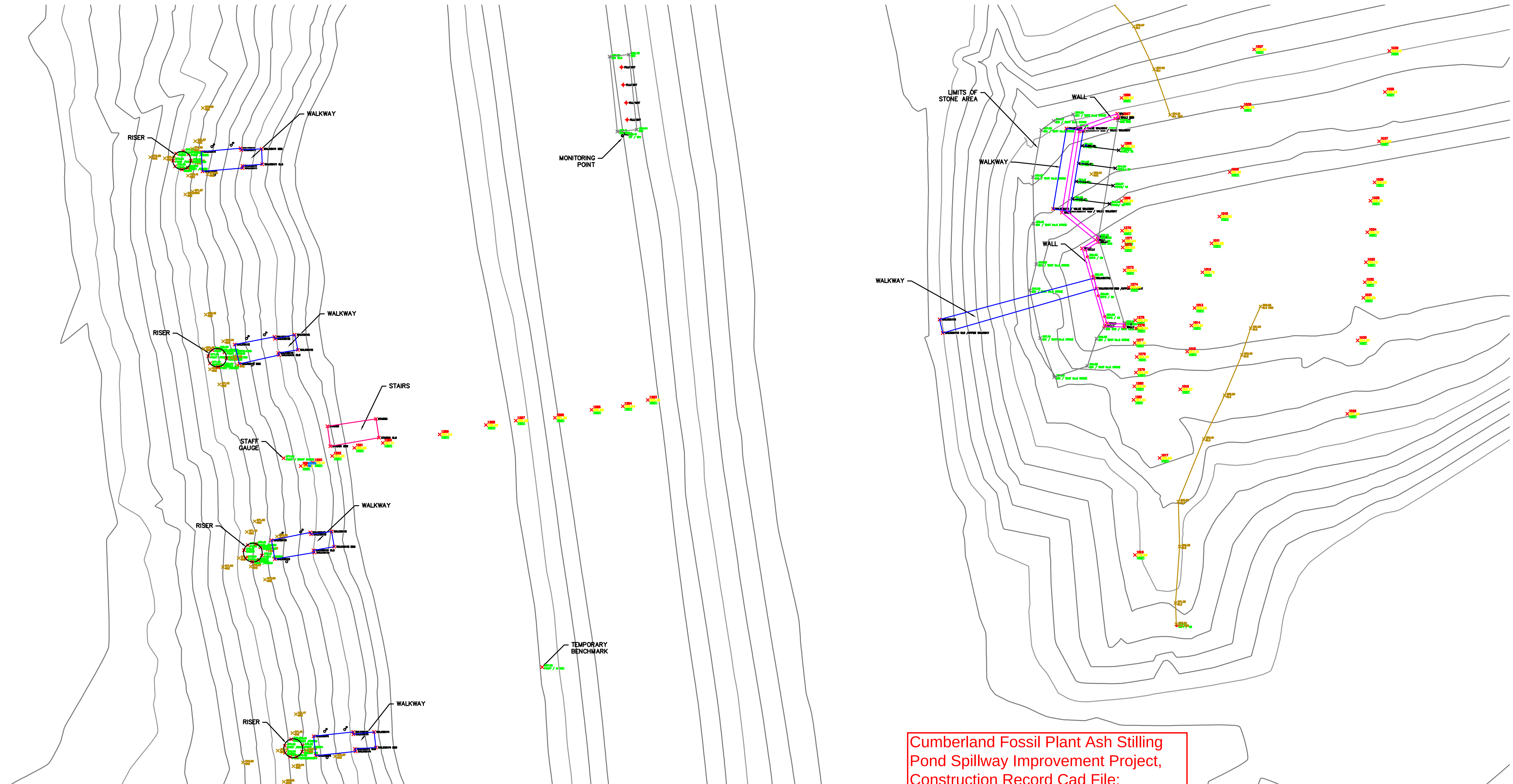
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2010 | DATE 09/21/15 | 46 | C | 10W550-08 | R 0

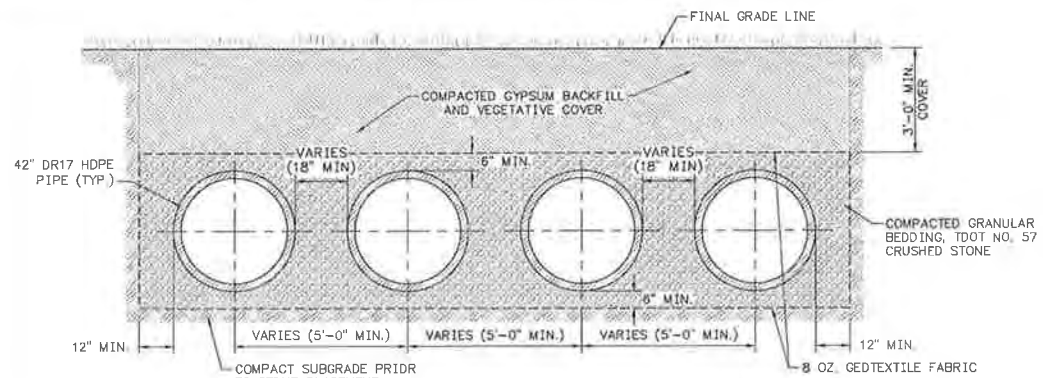
STANTEC | 0
TASK COMPLETED BY: | REV NO.

PLOT FACTOR:1
W_TVA

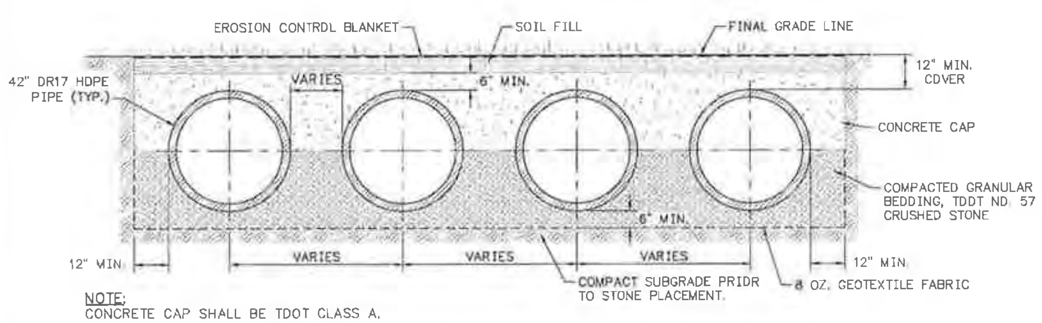
C.A.D. DRAWING
DO NOT ALTER MANUALLY



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

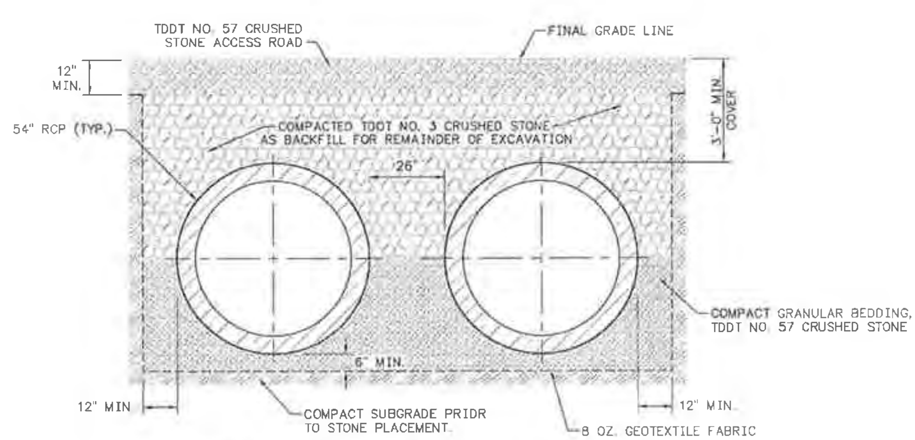


1 / 10W550-07 DETAIL – HDPE PIPE BEDDING/BACKFILL
SCALE: 1/2"=1'-0"

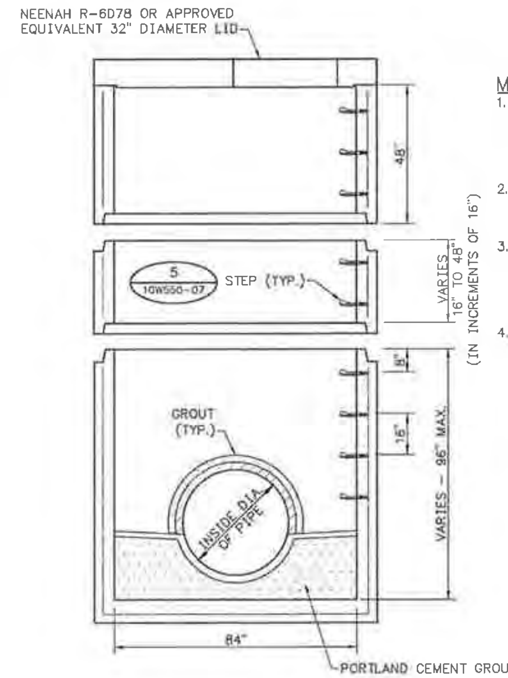


NOTE:
CONCRETE CAP SHALL BE TDOT CLASS A.

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



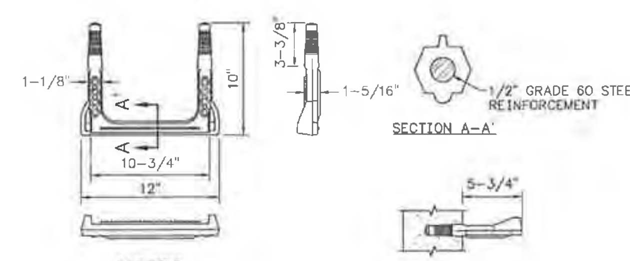
3 / 10W550-07 DETAIL – RCP BEDDING/BACKFILL
SCALE: 1/2"=1'-0"



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 10W550-06 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.

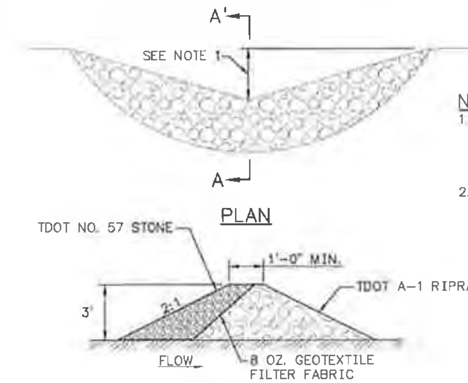
4 / 10W550-07 DETAIL – TDOT STANDARD FLAT TOP 84-INCH I.D. MANHOLE
SCALE: 1/2"=1'-0"



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.

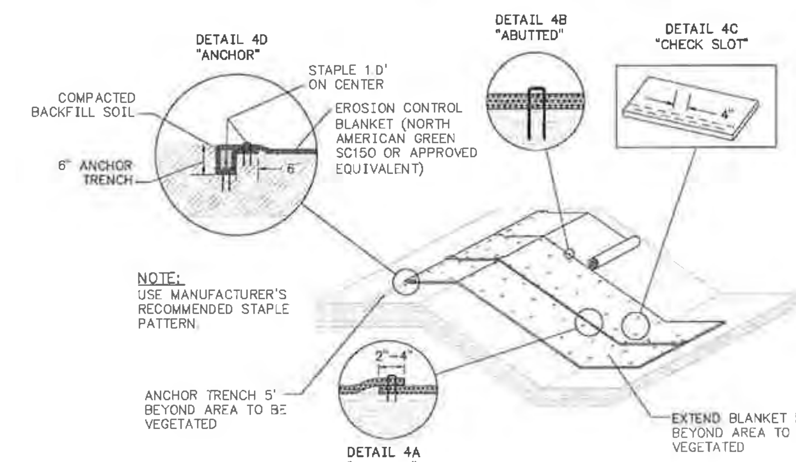
5 / 10W550-07 DETAIL – COPOLYMER POLYPROPYLENE PLASTIC STEP
NOT TO SCALE



NOTES:

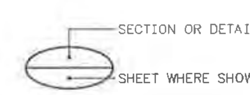
1. MIDDLE OF ROCK CHECK DAM SHALL BE A MINIMUM OF 1'-0" LOWER THAN SIDES SO FLOW WILL NOT BYPASS TRAP OR ERODE BANKS.
2. SPACE ROCK CHECK DAMS AT LOCATIONS AS SHOWN ON THE PLANS OR AS DIRECTED BY THE ENGINEER.

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



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

ISSUED FOR CONSTRUCTION



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Louisville Kentucky 40223-5301
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SEE 10W550-01 FOR LIST OF DESIGN, COMPANION, REFERENCE DRAWINGS AND SUPPORTING DESIGN CALCULATIONS NUMBER.

STATE OF TENNESSEE – NATHAN A. BADER – REGISTERED ENGINEER – AGRICULTURE
9/21/15

R 0 | 09/21/15 | CLH | RRP | NAB | NAB | DOS | MST | JCK | 928129
ISSUED FOR CONSTRUCTION

SCALE: AS SHOWN EXCEPT AS NOTED

YARD
GYPSUM DISPOSAL COMPLEX
SIPHON IMPROVEMENTS PROJECT
DETAILS

DESIGNED BY	DRAWN BY	CHECKED BY	SUPERVISED BY	REVIEWED BY	APPROVED BY	ISSUED BY
C.L. HAY	R.R. PETTY	N.A. BADER	N.A. BADER	D.O. STEPHENS	M.S. TURNBOW	J.C. KAMMEYER

CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2010 | 09/21/15 | 46 | C | 10W550-07 | R D

STANTEC | 0
TASK COMPLETED BY: | REV NO.

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

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

Stilling Pond

	Overflow 1 - Concrete Riser Structure		Overflow 2 - Concrete Riser Structure		Overflow 3 - Concrete Riser Structure		Overflow 4 - Concrete Riser Structure		Data Source
Weir Elev=	378	feet	378	feet	378	feet	378	feet	2
Riser D =	48	in	48	in	48	in	48	in	3
Pipe Inlet=	361	feet	361	feet	361	feet	361	feet	3
Pipe Outlet=	359.82	feet	359.85	feet	359.86	feet	359.89	feet	2
Pipe D=	33	in	33	in	33	in	33	in	Value reflects inside lined pipe diameter(Original Pipe dia. is 36-in per ref. 3
Length=	226	feet	218	feet	218	feet	228	feet	Measured in AutoCAD
C=	3.27		3.27		3.27		3.27		(Assumed to behave as sharp crested weir)
C_0=	0.6		0.6		0.6		0.6		(Based on Brater and King 1976)

Computed Values			Computed Values		Computed Values		Computed Values		Equation
L_{weir}=	12.56637	ft	12.56637	ft	12.56637	ft	12.56637	ft	Circumpherence=PI()*D
A_{riser}=	12.56637	sq. ft.	12.56637	sq. ft.	12.56637	sq. ft.	12.56637	sq. ft.	Area = PI*D^2/4
A_{pipe}=	5.939574	sq. ft.	5.939574	sq. ft.	5.939574	sq. ft.	5.939574	sq. ft.	Area = PI*D^2/4
Elev C=	362.375	feet (NGVD29)	362.375	feet (NGVD29)	362.375	feet (NGVD29)	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)	$Q=C_0A(2gH)^{0.5}$ (cfs)	H_c (ft)	$Q=C_0A(2gH_c)^{0.5}$ (cfs)	Assumed TW (ft)	Q (cfs)	HW Elevation (ft)	Q (cfs)
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)	$Q=C_0A(2gH)^{0.5}$ (cfs)	H_c (ft)	$Q=C_0A(2gH_c)^{0.5}$ (cfs)	Assumed TW (ft)	Q (cfs)	HW Elevation (ft)	Q (cfs)
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)	$Q=C_0A(2gH)^{0.5}$ (cfs)	H_c (ft)	$Q=C_0A(2gH_c)^{0.5}$ (cfs)	Assumed TW (ft)	Q (cfs)	HW Elevation (ft)	Q (cfs)
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)	$Q=C_0A(2gH)^{0.5}$ (cfs)	H_c (ft)	$Q=C_0A(2gH_c)^{0.5}$ (cfs)	Assumed TW (ft)	Q (cfs)	HW Elevation (ft)	Q (cfs)
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_&_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.

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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