INITIAL HAZARD POTENTIAL CLASSIFICATION ASSESSMENT

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Bremo Power Station CCR Surface Impoundment: East Ash Pond

Submitted To: Bremo Power Station
1038 Bremo Bluff Road
Bremo Bluff, VA 23022

Submitted By: Golder Associates Inc.
2108 W. Laburnum Avenue, Suite 200
Richmond, VA 23227

April 2018

Project No. 15-20347

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1.0 CERTIFICATION

This Initial Hazard Potential Classification Assessment for the Bremo Power Station's East Ash Pond was prepared by Golder Associates Inc. (Golder). The document and Certification/Statement of Professional Opinion are based on and limited to information that Golder has relied on from Dominion Energy and others, but not independently verified, as well as work products produced by Golder.

On the basis of and subject to the foregoing, it is my professional opinion as a Professional Engineer licensed in the Commonwealth of Virginia that this document has been prepared in accordance with good and accepted engineering practices as exercised by other engineers practicing in the same discipline(s), under similar circumstances, at the same time, and in the same locale. It is my professional opinion that the document was prepared consistent with the requirements in §257.73(a)(2) of the United States Environmental Protection Agency's "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments," published in the Federal Register on April 17, 2015, with an effective date of October 19, 2015 [40 CFR §257.73(a)(2)], as well as with the requirements in §257.100 resulting from the EPA's "Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals From Electric Utilities; Extension of Compliance Deadlines for Certain Inactive Surface Impoundments; Response to Partial Vacatur" published in the Federal Register on August 5, 2016 with an effective date of October 4, 2016 (40 CFR §257.100).

The use of the word "certification" and/or "certify" in this document shall be interpreted and construed as a Statement of Professional Opinion, and is not and shall not be interpreted or construed as a guarantee, warranty, or legal opinion.

Daniel McGrath	Associate and Senior Consultant
Print Name	Title
Daniel McGrath	4/13/18
Signature	Date

Golder Associates

2.0 INTRODUCTION

This Initial Hazard Potential Classification Assessment was prepared for the Bremo Power Station's (Station) inactive Coal Combustion Residuals (CCR) surface impoundment, the East Ash Pond. This Hazard Potential Classification Assessment was prepared in accordance with 40 CFR Part §257, Subpart D and is consistent with the requirements of 40 CFR §257.73(a)(2) and 40 CFR §257.100(e)(3)(v).

The Station, owned and operated by Virginia Electric and Power Company d/b/a Dominion Energy Virginia (Dominion), is located in Fluvanna County at 1038 Bremo Road, east of Route 15 (James Madison Highway) and north of the James River. The Station includes an inactive CCR surface impoundment, the EAP, as defined by the Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule and Direct Final Rule (40 CFR §257; the CCR rule).

This analysis details the purpose, data sources, method of analysis, and development of a figure showing the inundation level expected downstream given a breach event occurs at the EAP. The potential inundation areas were compared with various map sources to determine what, if any, effect on downstream structures could be expected from a breach of the impoundment. This evaluation is based on the condition of the pond as surveyed in December 2017. All elevations noted in this report are in feet relative to the North American Vertical Datum of 1988 (NAVD-88).

3.0 PURPOSE

This certification is required under 40 CFR §257.100(e)(3)(v) and 40 CFR §257.73(a)(2), *Periodic Hazard Potential Classification Assessments*, regarding the hazard potential classification assessment of the EAP, for the purpose of recommending a hazard potential classification.

Sources of data used in the analysis included:

1) United States Geological Survey (USGS) topographical map (Arvonia quad sheet 2013);
2) Statistical rainfall data from NOAA Atlas 14 (NOAA's Precipitation Frequency Data Server);
3) Maps and aerial photos of area roads and structures from the Google Earth Pro;
4) Aerial survey of the EAP and surrounding areas performed by H&B Surveying and Mapping, LLC, dated December 2017;
5) Flood map information from the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) Community Panel # 51065C0260C dated 5/16/2008. (Accessed through ArcGIS – FEMA's National Flood Hazard Layer mapping system);
6) Web Soil Survey 2.1, Natural Resources Conservation Service (http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm)

4.0 ASSESSMENT

4.1 Description of the Impounding Structure

The 26.5-acre impoundment is located east of the Bremo Power Station and is bounded on the south side by a railroad embankment and the James River, on the north side by the North Ash Pond, and on the east by low-lying undeveloped areas. The EAP was constructed partially by excavation on the north side and embankment construction on the south side. After a series of lateral and vertical expansions over its approximately 50-year operational life, the EAP was mostly closed with a soil cap, with the exception of the easternmost section, which was left as open water. The upstream sideslopes are 4 horizontal to 1 vertical (4H:1V) and the downstream sideslopes vary from 3H:1V to 1.5H:1V around the western and southern areas of the pond. The northern and eastern sides are excavated into natural terrain. The effective embankment height is up to 32 feet.

The existing spillway structure is a square concrete intake tower located in the southeast corner of the pond. The tower structure is approximately 5'-6" in width and has a weir opening at an elevation of approximately 229.0 feet. The outlet pipe is a 24-inch diameter reinforced concrete pipe with an inlet invert elevation of 206.9 feet. The outlet pipe has been temporarily plugged to prevent discharges. Stormwater that enters the pond is pumped to the on-site treatment system.

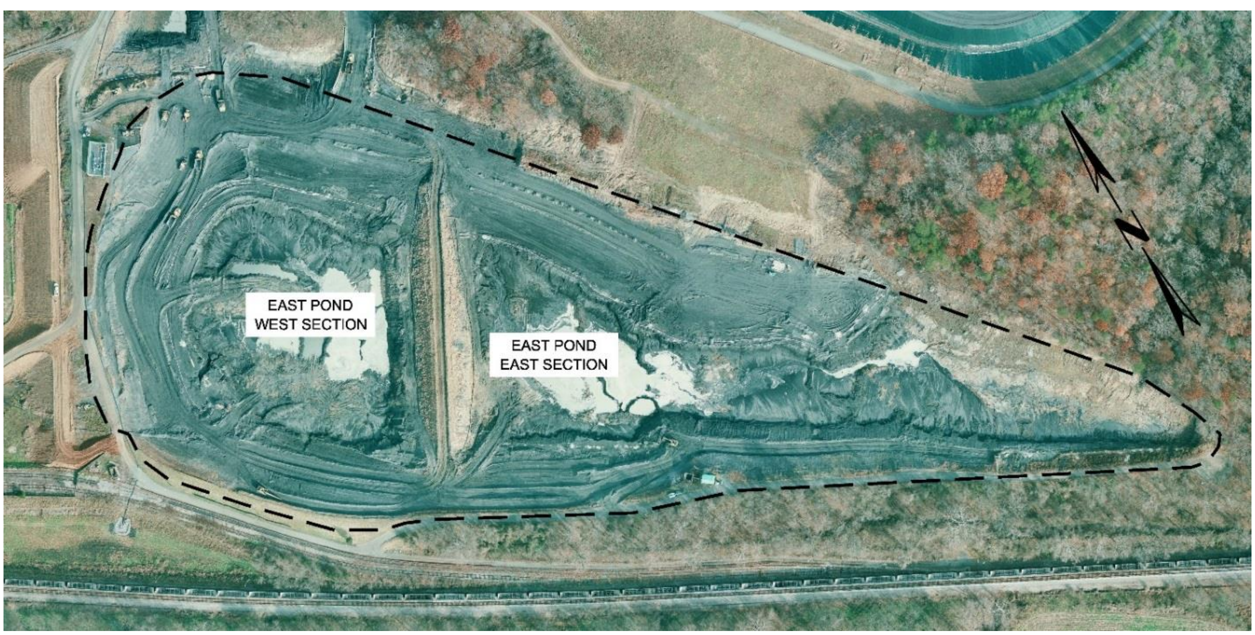


Figure 1 - December 2017 East Ash Pond Aerial Photo

4.2 Drainage Area and Hazard Analysis Area Descriptions

The drainage area for the EAP consists mainly of wooded and grassy areas that are presumed to be in good condition for the purpose of determining a Runoff Curve Number (CN) as defined by the Natural Resource Conservation Service (NRCS). The soils in the drainage area are primarily Hydrologic Soil Group B. The drainage area was divided into areas that drain into the eastern and western sections of the pond. Table 1 below outlines the drainage areas and NRCS curve numbers used in this analysis.

Table 1: East Ash Pond Contributing Drainage Areas

Area Description	**Area (acres)**	**CN**
Eastern - East Woods	9.09	55
Eastern - N Pond Face - E	5.19	61
Eastern - Pond-E	12.79	91
Eastern Section Total	27.07	-
Western - Stump Pond Woods	42.2	55
Western - N Pond Face - W	2.68	61
Western - Pond-W	9.75	91
Western Section Total	54.62	-
East Ash Pond Total Drainage Area	81.69	-

The northern and eastern sections of the EAP are excavated into natural terrain, and the surrounding areas are uphill from the pond. Along the western side is the former coal pile area and the station beyond. The ground elevation west of the pond is approximately 18 feet above the bottom of the pond and 7 feet above the modeled high water level; therefore, a breach event in the western direction is improbable. In the southern direction is a man-made ravine formed by the railroad embankment and the James River beyond. There are no occupied structures downstream of the impoundment.

4.3 Method of Analysis

To model the flows into and out of the impoundment, a numerical model was created using the Hydraulic Engineering Center's Hydrologic Modeling System (HEC-HMS) Version 4.2.1 to generate the anticipated runoff hydrograph from the 24-hour, 1,000-year storm event. Table 2 outlines the resulting inflow and outflow for the non-breach scenario analysis.

Table 2: 1,000-Yr Storm Event and Flows

East Ash Pond-West			**East Ash Pond-East**		
Q_{in} (cubic feet per second, CFS)	Max Hw (Ft El*)	Q_{out} (CFS)	Q_{in} (CFS)	Max Hw (Ft El*)	Q_{out} (CFS)
521.2	210.7	0	326.5	207.3	0

*Top of berm elevation = 230.0 feet

Modeling the existing EAP for the 1,000-year event during a non-breach scenario shows the calculated high water elevations for the east and west pond sections to be 207.3 feet and 210.7 feet, respectively, which indicates the flows do not overtop the embankment. Due to the ongoing excavation, these high water elevations are below the elevation of the outside toe of the embankment, with the exception of a small portion of the man-made ravine near the plugged outlet riser. A breach of the embankment in the western section would have an uphill gradient to escape the pond; therefore, a breach and release from the west section is considered highly improbable and therefore was not modeled.

A breach and water release of the east section of the pond could only occur on the southern embankment, near the riser structure, as all other directions are uphill. The outside toe forms part of a narrow man-made ravine between the pond and the railroad embankment. This narrow ravine receives stormwater flow from approximately 306 acres of undeveloped land to the east, which results in a water level higher in the ravine than the EAP during the 1,000-year event. A breach of the east section would have an uphill hydraulic gradient to escape, and this scenario is also considered highly improbable and therefore was not modeled.

A “sunny day” breach is assumed to occur due to piping of soils through the embankment when the water level in the reservoir is at its normal pool elevation; however, there typically is not a normal pool in the EAP so this evaluation was not performed. A seismic analysis was not performed, nor were other sudden failure type scenarios considered, as this evaluation is for the potential downstream impacts due to an embankment breach during the design storm event (1,000-year event).

4.4 Downstream Consequences

Failure of an embankment during the 1,000-year event could cause some minor water and CCR releases given the right conditions and location along the embankment, that being in the vicinity of the existing riser structure. The effect of the inflow into the James River is anticipated to be minimal due to the short duration of the flow event and the relatively small volume of the breach flow in comparison to the normal volume of flow in the river.

4.5 Spillway Adequacy

If a structural embankment failure does not occur, the existing pond sections are capable of receiving and storing the runoff volume from the 1,000-year event without overtopping the embankment and without a discharge. The east and west sections of the pond would have 22.7 and 19.3 feet of freeboard, respectively.

5.0 HAZARD CLASSIFICATION

Pursuant to 40 CFR §257.73, a CCR unit is classified as a Significant Hazard Potential where failure or mis-operation results in no probable loss of human life, but can cause economic loss, environmental damage, disruption of lifeline facilities, or impact other concerns. Significant Hazard Potential classification impoundments are often located in predominantly rural or agricultural areas, but could be located in areas with population and significant infrastructure. The potential inundation zone downstream of the EAP embankments does not contain occupied structures, nor is it regularly occupied by plant personnel.

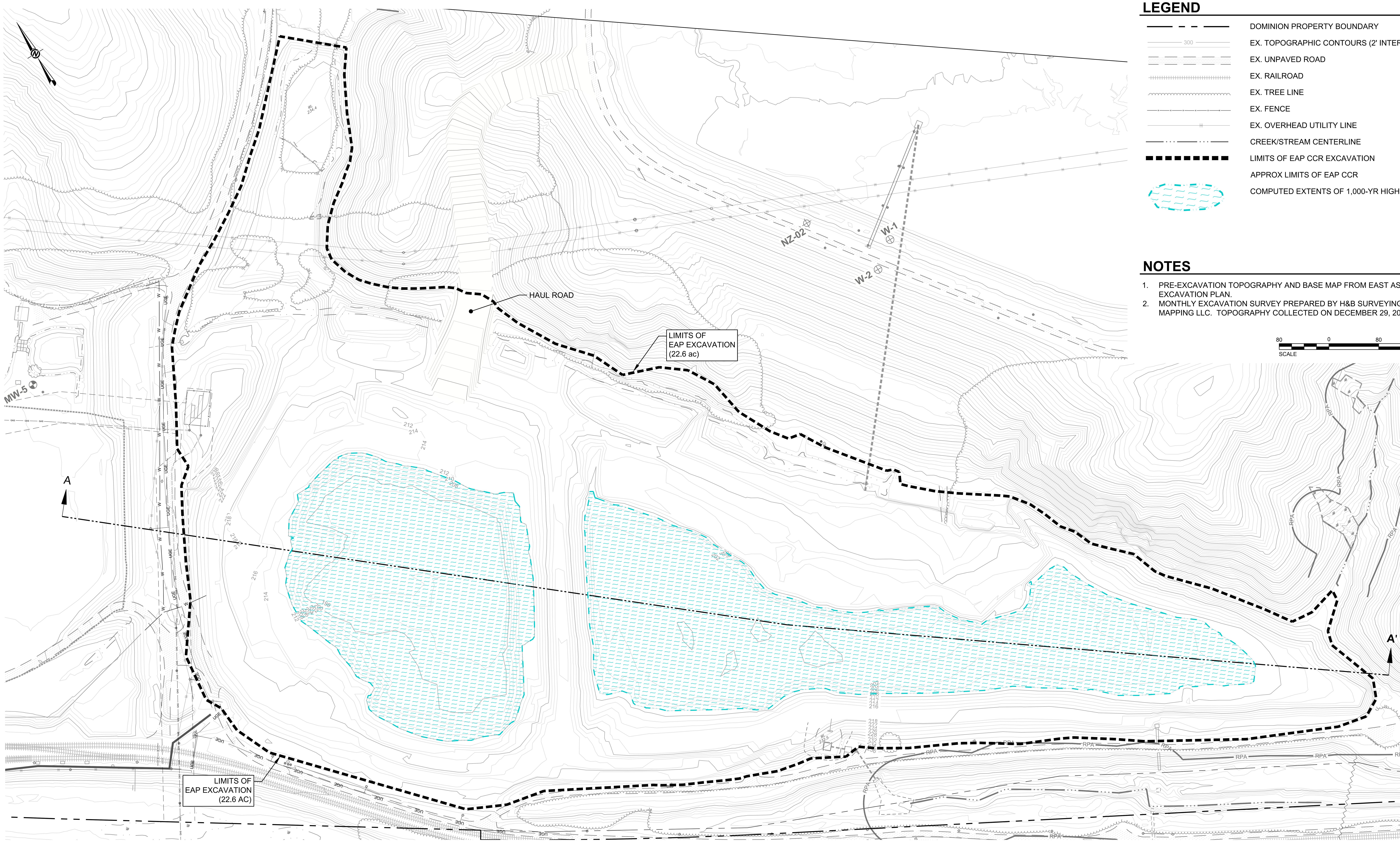
6.0 CONCLUSIONS

The results of this analysis show a breach of this impounding structure during a storm event has no downstream impacts to manmade structures, and failure or mis-operation of the dam would be unlikely to result in loss of human life. Environmental damage from the potential release of CCR would be the likeliest result from a release. Therefore, the EAP in its current condition is assigned a hazard potential rating of “Significant” for this reason under 40 CFR §257.73.

APPENDIX A - Figures

Figure 2 – East Ash Pond 1,000-Yr Event High Water Elevations

Figure 3 – 100-Yr Flood Map (FIRM)



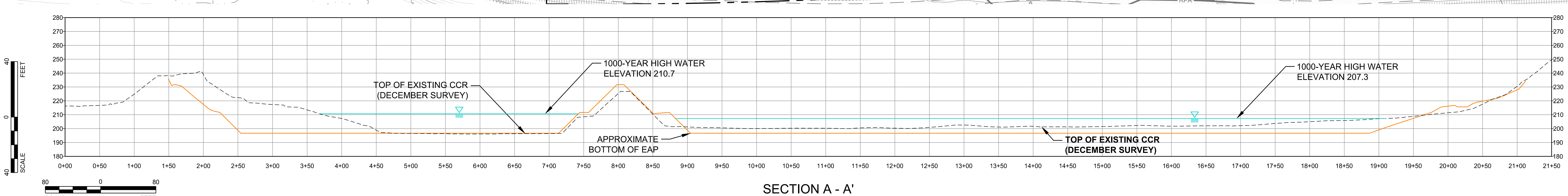
LEGEND

- DOMINION PROPERTY BOUNDARY
- EX. TOPOGRAPHIC CONTOURS (2' INTERVALS)
- EX. UNPAVED ROAD
- EX. RAILROAD
- EX. TREE LINE
- EX. FENCE
- EX. OVERHEAD UTILITY LINE
- CREEK/STREAM CENTERLINE
- LIMITS OF EAP CCR EXCAVATION
- APPROX LIMITS OF EAP CCR
- COMPUTED EXTENTS OF 1,000-YR HIGH WATER

NOTES

1. PRE-EXCAVATION TOPOGRAPHY AND BASE MAP FROM EAST ASH POND EXCAVATION PLAN.
2. MONTHLY EXCAVATION SURVEY PREPARED BY H&B SURVEYING AND MAPPING LLC. TOPOGRAPHY COLLECTED ON DECEMBER 29, 2017.

80 0 80 160
SCALE FEET



SECTION A - A'

REV.	MM/DD/YY	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW
			DPM	ABR	SDRM	DPM

CLIENT
DOMINION ENERGY
BREMO POWER STATION
FLUVANNA COUNTY, VIRGINIA

CONSULTANT
GOLDER ASSOCIATES INC.
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PROJECT
CCR SURFACE IMPOUNDMENT CLOSURE
EAST ASH POND EXCAVATION

TITLE
1000-YEAR EVENT MODELED HIGH WATER ELEVATIONS

PROJECT NO.
15-20347QA

REV.
0

FIGURE
2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

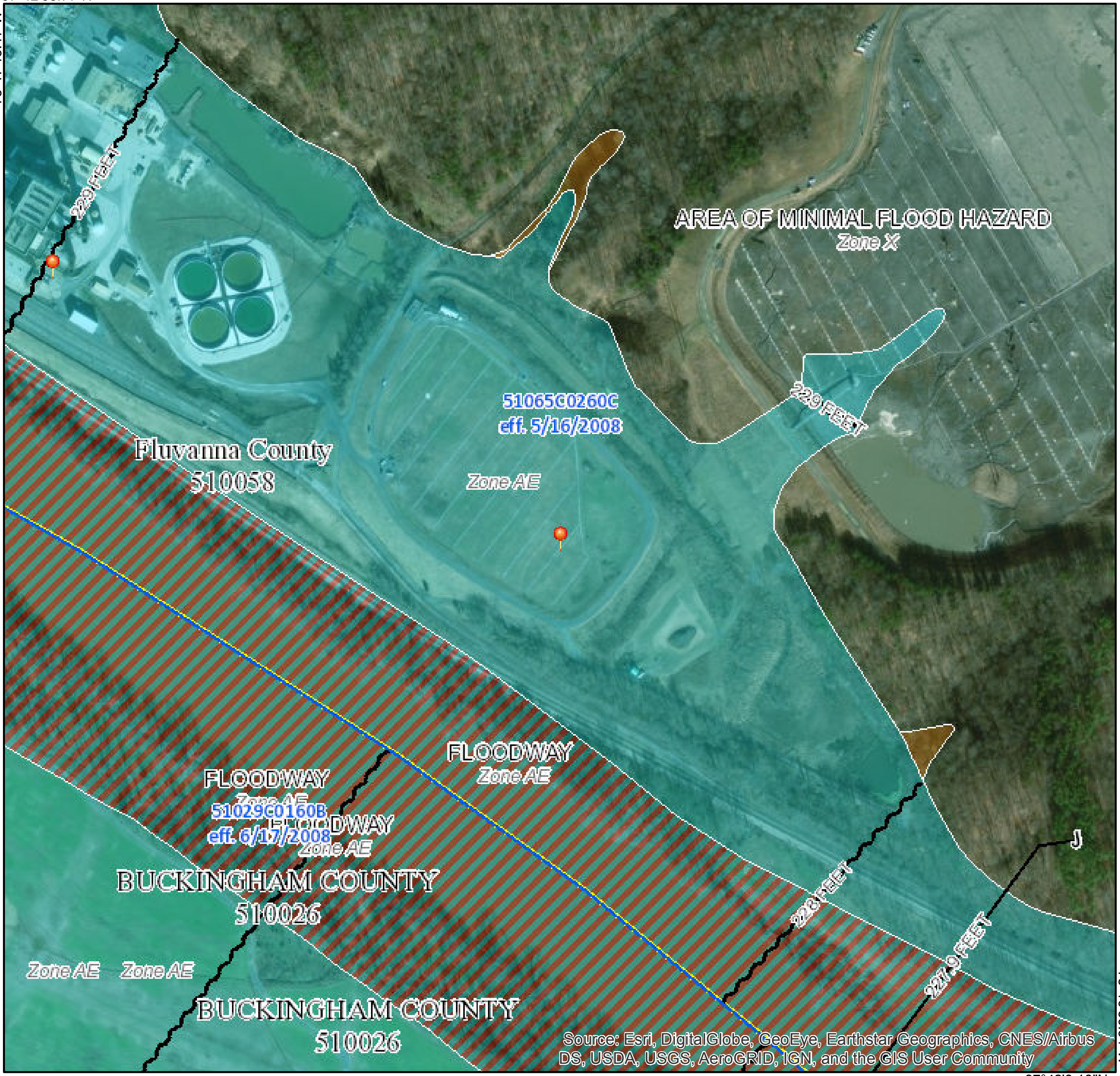
Path: G:\Plan Production Data Files\Drawing Data Files\15-20347QA\E - Misc Drawings\Civil 3d\Working\1,000 Year Event.dwg

National Flood Hazard Layer FIRMette

FEMA

37°42'38.77"N

78°17'15.47"W



78°16'36.51"W

37°42'9.16"N

Feet

0 250 500 1,000 1,500 2,000

1:6,241.13

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) *Zone A, V, A99*
	With BFE or Depth
	Regulatory Floodway *Zone AE, AO, AH, VE, AR*
OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
	Future Conditions 1% Annual Chance Flood Hazard *Zone X*
	Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
	Area with Flood Risk due to Levee *Zone D*
OTHER AREAS	NO SCREEN Area of Minimal Flood Hazard *Zone X*
	Effective LOMRs
	Area of Undetermined Flood Hazard *Zone D*
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer
	Levee, Dike, or Floodwall
OTHER FEATURES	B 20.2 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
	8 Coastal Transect
	513 Base Flood Elevation Line (BFE)
	Limit of Study
	Jurisdiction Boundary
	Coastal Transect Baseline
	Profile Baseline
	Hydrographic Feature
MAP PANELS	Digital Data Available
	No Digital Data Available
	Unmapped

N

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The base map shown complies with FEMA's base map accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 3/7/2018 at 11:16:10 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: base map imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Figure 3

APPENDIX B

East Ash Pond Hydraulic Modeling Analysis

Golder Associates

CALCULATIONS

Date:	April 17, 2018	**Made by:**	KAL
Project No.:	15-20347	**Checked by:**	SDRM
Subject:	East Ash Pond Breach Analysis	**Reviewed by:**	DPM
Project:	**BREMO EAST ASH POND – EXISTING CONDITION**		

The purpose of this evaluation is to determine the hydraulic performance of the existing East Ash Pond CCR impoundment at the Bremo Power Station during the 1,000-year storm event and an associated embankment breach event. This evaluation is in support of the "Significant" hazard potential classification as defined in §257.53 of the *CCR Rule*.

1.0 CALCULATIONS

1.1 Pond Storage Volume

The East Ash Pond storage volume was computed based on the existing conditions, as surveyed in December 2017, being partially excavated. The stored ash was considered a solid, and available water storage was based on the developed surface contours. The maximum available storage in the pond is 347.5 acre-feet at elevation 230.0. Overtopping occurs above elevation 230.0. At elevations below 224.0, a splitter dike effectively creates two separate ponds: 'east pond east' and 'east pond west'. The splitter dike top elevation is 224.0, so above elevation 224.0 the pond acts as a single unit. Attachment 1 contains the stage-storage rating tables used in the HMS model. Typically, the water level in each portion of the pond is kept pumped down to a very low level in support of the excavation activity. For this model, the existing (starting) water level in each section was set at elevation 200.0 feet.

1.2 Outlet Design and Capacity

The existing spillway structure is a square concrete intake tower located in the southeast corner of the pond; therefore, the outlet would only serve the eastern section of the pond. The western section does not have an outlet structure. The tower is 5'-6" in width and has a weir opening at an elevation of approximately 229.0 feet. The outlet pipe is a 24-inch diameter reinforced concrete pipe with an inlet invert elevation of 206.9 feet. Attachment 2 includes the rating table for the existing outlet; however, the outlet pipe has been temporarily plugged to prevent discharges. Stormwater that enters each section of the pond is pumped to the on-site treatment system.

1.3 Storm Routing Calculations

The East Ash Pond stormwater system analysis was performed using the US Army Corps of Engineers Hydrologic Engineering Center's Hydraulic Modeling System (HEC-HMS) software package (ref #1). The direct drainage area to the western section of the pond is 54.6 acres and the direct drainage to the eastern section is 27.1 acres, for a total of 81.7 acres.

The North Ash Pond was evaluated in its existing condition where it does not discharge to the East Ash Pond; therefore, it is not included in this analysis.

Design Storm

Per §257.82(a)(3)(ii), the impoundment is required to adequately manage flow resulting from the 24-hour, 1,000-year storm event. The 24-hour, 1,000-year storm event precipitation quantity was obtained from the Precipitation Frequency Data Server (PFDS, ref #2) for Bremo Bluff, Virginia, and amounts to 12.1 inches.

Breach Event

Modeling the existing East Ash Pond for the 1,000-year event during a non-breach scenario shows the calculated high water elevation for the eastern and western pond sections to be 207.3 feet and 210.7 feet, respectively, which indicates the water does not overtop the embankment. Due to the ongoing excavation, these high water elevations are below the elevation of the outside toe of the embankments with the exception o a small portion of the man-made ravine near the plugged outlet riser. A breach of the western section embankment would have an uphill gradient to escape the pond; therefore, a breach and release from the west section is considered highly improbable and therefore was not modeled.

A breach and water release of the east section of the east pond could only occur on the southern embankment near the riser structure – all other directions are uphill. The outside toe forms part of a narrow man-made ravine between the pond and the railroad embankment. This narrow ravine receives stormwater flow from approximately 306 acres of undeveloped land to the east, which results in a water level higher in the ravine than the east pond during the 1,000-year event. A breach of the east section would have an uphill hydraulic gradient to escape and this scenario is also considered highly improbable and therefore was not modeled.

HMS Model Input

Figure 1 illustrates the connectivity of the stormwater elements and the data inputs as modeled in HEC-HMS. The predominant soil types in the area are Hydrologic Soil Group (HSG) 'B' soils. The acreage, curve number (CN) and lag time for each sub-drainage area are in the attached worksheet.

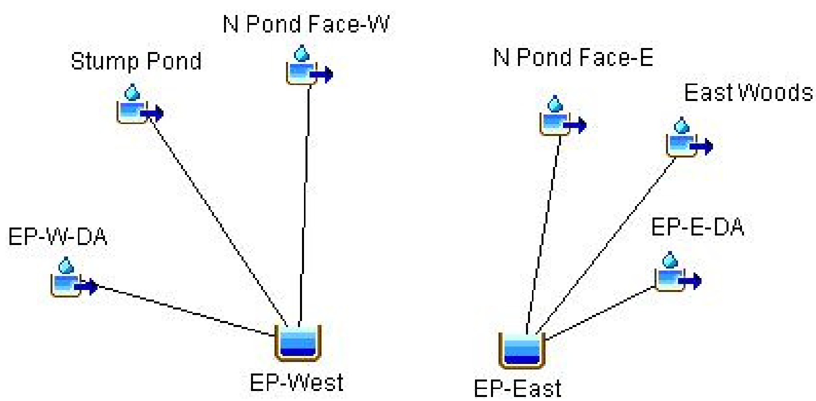


Figure 1 – East Ash Pond HEC-HMS Model

HMS Model Output

The following table summarizes the results of the HEC-HMS analysis for the 1,000-Yr storm event. Note that the computed high water (Max Hw) elevations are below the level of the splitter dike (elevation 224.0).

Table 1: East Ash Pond HEC-HMS Output

East Ash Pond-West			East Ash Pond-East		
Q_{in} (CFS)	Max Hw (Ft El*)	Q_{out} (CFS)	Q_{in} (CFS)	Max Hw (Ft El*)	Q_{out} (CFS)
521.2	210.7	0	326.5	207.3	0

* Top of berm elevation = 230.0 feet

2.0 CONCLUSIONS

Based on the calculations presented herein, the existing East Ash Pond at the Bremo Power Station can accept and store the 1,000-year event without overtopping or causing an unregulated discharge due to a breach event.

3.0 REFERENCES

1) U.S. Army Corps of Engineers Hydrologic Engineering Center – Hydrologic Modeling System (HEC-HMS) release 4.2.1
2) Precipitation Frequency Data Server (NOAA Atlas 14) https://hdsc.nws.noaa.gov/hdsc/pfds/

4.0 ATTACHMENT

1) East Ash Pond Stage-Storage Rating Tables
2) East Ash Pond Existing Riser Outlet Rating

Bremo Power Station - East Ash Pond

Stage-Storage Rating Tables

April 2018

East Ash Pond Grades as of 12/31/17 - West Section

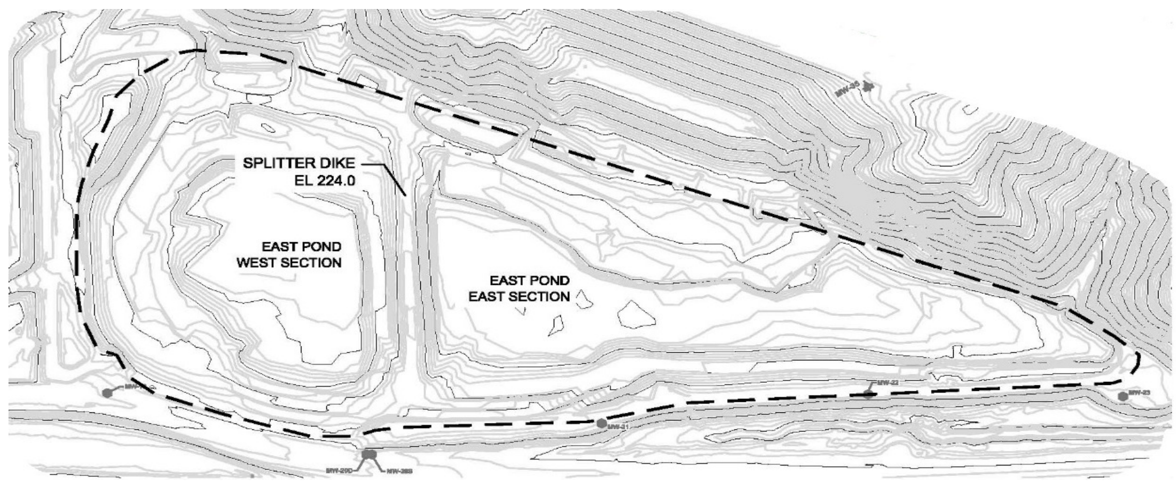
Elevation	Area (SF)	Volume (ft^3)	AC-FT	Total
222	305,694	565,277	12.98	87.62
220	260,194	501,311	11.51	74.64
218	241,237	458,000	10.51	63.14
216	216,978	401,845	9.23	52.62
214	185,284	339,352	7.79	43.40
212	154,533	293,786	6.74	35.61
210	139,384	265,263	6.09	28.86
208	125,992	242,880	5.58	22.77
206	116,944	225,015	5.17	17.20
204	108,129	206,982	4.75	12.03
202	98,921	178,744	4.10	7.28
200	80,152	138,320	3.18	3.18
198	58,723	0	0	0

East Ash Pond Grades as of 12/31/17 - East Section

Elevation	Area (SF)	Volume (ft^3)	AC-FT	Total
222	401,963	755,822	17.35	111.34
220	354,360	680,277	15.62	93.99
218	326,113	615,314	14.13	78.37
216	289,564	544,569	12.50	64.25
214	255,364	480,801	11.04	51.74
212	225,742	431,736	9.91	40.71
210	206,143	390,955	8.98	30.79
208	185,003	344,555	7.91	21.82
206	159,858	293,896	6.75	13.91
204	134,406	230,408	5.29	7.16
202	97,016	81,607	1.87	1.87
200	4,500		0.00	0.00
198		0	0	0

East Ash Pond Grades as of 12/31/17 - Combined Sections (El 224+)

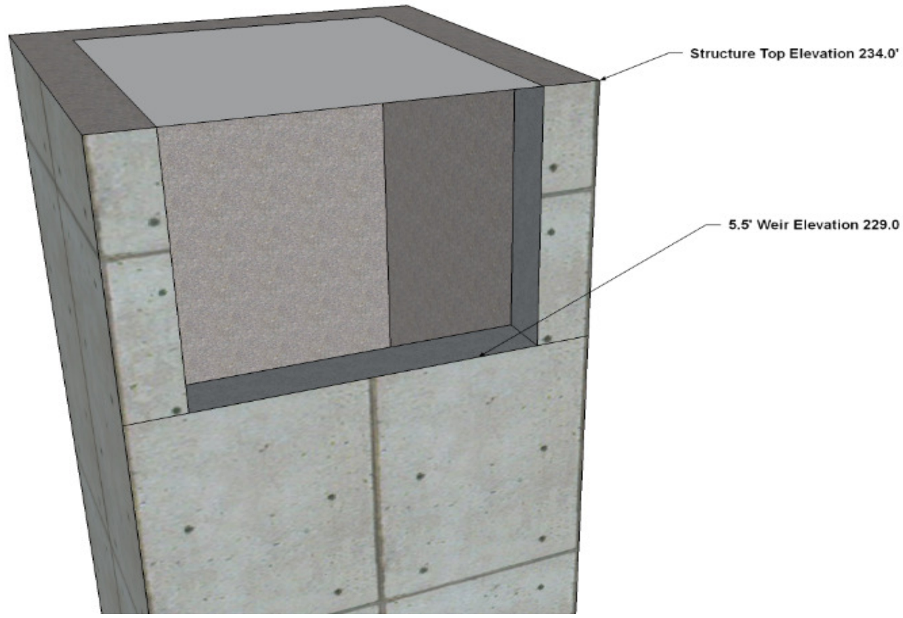
Elevation	Area (SF)	Volume (ft^3)	AC-FT	Total
230	907,784	1,779,883	40.86	347.49
228	872,219	1,687,417	38.74	306.63
226	815,517	1,577,252	36.21	267.89
224	762,039	1,469,359	33.73	231.68



Pond Contours as of 12/31/17

Existing EAP Riser - top stoplog Elevation 229.0

Culvert Outlet from UD Culvert
inv in = 206.9
Slope = 0.036735
L = 98'
Disch HW = free
Dia = 24"



Weir 1 Elevation	229.00
Weir 1 Width	5.5
Weir 2 Elevation	234.00
Weir 2 length	6.00
Weir 2 depth	5.50
Weir 2 perimeter	16.50
Weir 2 Area	30.25
Weir Discharge Coeff.	3.30
Orifice Discharge Coeff.	0.60

Elevation	**Weir 1**	**Weir 2 (O)**	**Weir 2 (W)**	**Combined**	**Culvert Outlet**	**Rating**
229	0.00	0.00	0.00	0.00	70.30	0.00
229.5	6.42	0.00	0.00	6.42	71.10	6.42
230	18.15	0.00	0.00	18.15	72.00	18.15
230.5	33.34	0.00	0.00	33.34	72.80	33.34
231	51.34	0.00	0.00	51.34	73.60	51.34
231.5	71.74	0.00	0.00	71.74	74.40	71.74
232	94.31	0.00	0.00	94.31	75.10	75.10
232.5	118.84	0.00	0.00	118.84	75.90	75.90
233	145.20	0.00	0.00	145.20	76.70	76.70
233.5	173.26	0.00	0.00	173.26	77.40	77.40
234	202.92	0.00	0.00	202.92	78.20	78.20
234.5	234.11	102.99	19.25	253.36	78.90	78.90
235	266.75	145.65	54.45	321.20	79.70	79.70
235.5	300.78	178.39	100.03	400.81	80.40	80.40
236	336.14	205.98	154.01	490.15	81.10	81.10

Established in 1960, Golder Associates is a global, employee-owned organization that helps clients find sustainable solutions to the challenges of finite resources, energy and water supply and management, waste management, urbanization, and climate change. We provide a wide range of independent consulting, design, and construction services in our specialist areas of earth, environment, and energy. By building strong relationships and meeting the needs of clients, our people have created one of the most trusted professional services organizations in the world.

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