Prepared for

Dominion
5000 Dominion Boulevard
Glen Allen, Virginia 23060

COAL COMBUSTION RESIDUALS HISTORY OF CONSTRUCTION

for

VIRGINIA ELECTRIC AND POWER COMPANY
CHESTERFIELD POWER STATION
LOWER ASH POND
CHESTERFIELD COUNTY, VIRGINIA

Prepared by

Geosyntec consultants

engineers | scientists | innovators

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MV1373
October 2016

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1. CERTIFICATION/STATEMENT OF PROFESSIONAL OPINION

The History of Construction Report (Report) for the Chesterfield Power Station Lower Ash Pond was prepared by Geosyntec Consultants, Inc. (Geosyntec). The Plan was based on certain information that, other than for information Geosyntec originally prepared, Geosyntec has relied on but not independently verified. This Certification/Statement of Professional Opinion is therefore limited to the information available to Geosyntec at the time the Plan was written. 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 the Assessment 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 Plan was prepared consistent with the requirements of the United States Environmental Protection Agency's "Disposal of Coal Combustion Residuals From Electric Utilities," published in the Federal Register on April 17, 2015 with an effective date of October 19, 2015 (40 CFR 257 Subpart D).

The use of the words "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.

Geosyntec Consultants, Inc.

COMMONWEALTH OF VIRGINIA
SCOTT KENNETH SHERIDAN
Lic. No. 045360
PROFESSIONAL ENGINEER

Scott Sheridan, P.E.
Principal

Date 10/14/2016

2. INTRODUCTION

The Chesterfield Power Station (Station) is owned by Virginia Electric and Power Company d/b/a Dominion Virginia Power (Dominion) and is located in Chesterfield, Virginia. The station includes the Lower Ash Pond (LAP) impoundment, which is a component of the Station's wastewater treatment system utilized to manage and settle solids, including CCRs.

The LAP is located on Dominion property at the Chesterfield Power Station in Chesterfield County, Virginia (coordinates 37.3737° North and 77.3795° West) and is bounded by the Old Channel of the James River and the Upper Pond on the south, Henricus Park Road on the east, Coxendale Road on the north, and the thermal channel to the west.

The LAP is regulated as an existing CCR surface impoundment under the Environmental Protection Agency's "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments" [40 CFR 257 Subpart D] published in the Federal Register on April 17, 2015 with an effective date of October 19, 2015 (CCR Rule).

3. PURPOSE

This History of Construction Report (Report) is prepared pursuant to § 257.73(c)(1) of the CCR Rule [40 CFR § 257.73(c)(1)]. In this document the CCR Unit is identified as the LAP.

4. HISTORY OF CONSTRUCTION

As required by § 257.73(c)(1), this Report includes, to the extent feasible:

a. The name and address of the person(s) owning or operating the CCR Unit; the name associated with the CCR Unit; and the identification number of the CCR Unit if one has been assigned by the state (Section 4.1);

b. The location of the CCR Unit identified on the most recent U.S. Geological Survey (USGS) 7-1/2 minute or 15 minute topographic quadrangle map, or a topographic map of equivalent scale if a USGS map is not available (Section 4.2);

c. A statement of the purpose for which the CCR Unit is being used (Section 4.3);

d. The name and size in acres of the watershed within which the CCR Unit is located (Section 4.4);

e. A description of the physical and engineering properties of the foundation and abutment materials on which the CCR Unit is constructed (Section 4.5);

f. A statement of the type, size, range, and physical and engineering properties of the materials used in constructing each zone or stage of the CCR Unit; the method of site preparation and construction of each zone of the CCR Unit; and the approximate dates of construction of each successive stage of construction of the CCR Unit (Section 4.6);

g. At a scale that details engineering structures and appurtenances relevant to the design, construction, operation, and maintenance of the CCR Unit, detailed dimensional drawings of the CCR Unit, including a plan view and cross sections of the length and width of the CCR Unit, showing all zones, foundation improvements, drainage provisions, spillways, diversion ditches, outlets, instrument locations, and slope protection, in addition to the normal operating pool surface elevation and the maximum pool surface elevation following peak discharge from the inflow design flood, the expected maximum depth of CCR within the CCR surface impoundment, and any identifiable natural or manmade features that could adversely affect operation of the CCR Unit due to malfunction or mis-operation (Section 4.7);

h. A description of the type, purpose, and location of existing instrumentation (Section 4.8);

i. Area-capacity curves for the CCR Unit (Section 4.9);

j. A description of each spillway and diversion design features and capacities and calculations used in their determination (Section 4.10);

k. The construction specifications and provisions for surveillance, maintenance, and repair of the CCR Unit (Section 4.11); and

l. Any record or knowledge of structural instability of the CCR Unit (Section 4.12).

The above requirements are addressed in Sections 4.1 through 4.12 of this Report.

4.1 LAP (CCR Unit)

The LAP, located at the Station, is owned, operated and maintained by Virginia Electric and Power Company d/b/a Dominion Virginia Power.

The Station and the LAP are operated by:

Virginia Electric and Power Company
5000 Dominion Boulevard
Glen Allen, Virginia 23060

The contact information for the Station is:

Mr. David A. Craymer
Vice President, Power Generation System Operations
Virginia Electric and Power Company
5000 Dominion Boulevard
Glen Allen, VA 23060

The LAP (CCR Unit) has been referred to as the "New Ash Pond" (Stone & Webster), 1966), "Old Ash Pond" (Schnabel, 1998), and the "Lower Ash Pond" (Schnabel, 2010).

The LAP is permitted as follows:

- The outfall of the LAP is permitted under Virginia Department of Environmental Quality (DEQ) Virginia Pollutant Discharge Elimination System (VPDES) Permit No. VA0004146;
- The embankment is permitted under Virginia Department of Conservation and Recreation (DCR) Dam Permit, Inventory No. 00823;
- The LAP use is approved under Chesterfield County Conditional Use Permit 90SN0307 (April, 1991) and Chesterfield County Conditional Use Permit 10SN0114 (March 2010); and
- The closure of the LAP will be permitted under a Virginia DEQ Solid Waste Permit (CCR Closure Plan).

4.2 Location Map

The LAP location is shown in Figure 1 – Location Map.

4.3 Purpose of LAP

The LAP is used to manage and settle wastewaters containing solids, including CCRs. In addition, the LAP also serves to manage stormwater from adjacent areas and the coal pile runoff pond.

4.4 Watershed

The LAP is located in the Lower James Watershed (USGS Hydrologic Unit Code 02080206). The watershed area is 1,440 square miles (Montana State University, 2003).

This corresponds to 921,600 acres. The area contributing runoff to the LAP is approximately 117 acres.

4.5 Foundation and Abutment Materials

Alluvial and terrace soils associated with the James River are found below the LAP (Geosyntec, 2016). Boring data show that the material beneath the LAP consists of a range of material types from fine grained soils such as high plasticity and low plasticity clays to sandy soils such as silty sand and clayey sand. Table 1 indicates the properties for the material beneath the LAP.

Table 1
Foundation Soil Properties

Classification	Unit Weight (pounds per cubic foot)	Drained Strength Friction Angle (degrees)	Cohesion (pounds per square inch)
Coarse-grained	120	34	0
Fine-grained	115	28	0

4.6 LAP Properties and Construction Details

The LAP embankment was constructed of fill from soils excavated within the LAP boundaries. The fill materials within the embankment included lean clay, sandy silt and silty sand (Geosyntec, 2016). The physical and engineering properties of the soil used to construct the embankment are listed in Table 2.

Table 2
Impoundment Embankment Fill Properties

Embankment Sample Depth	Classification	Unit Weight (pounds per cubic foot)	Effective Angle of Internal Friction (degrees)	Cohesion (pounds per square inch)
15-17 feet	ML	132.0	36	124
25-27 feet	ML	129.4	40	0

The LAP was constructed in two phases as indicated by O'Brien & Gere, 2010 and illustrated in Stone & Webster, 1966. The first phase of construction occurred in 1964. The LAP embankments were constructed from soils excavated within the LAP footprint and were constructed with a top elevation of 15 feet. The second phase of construction occurred in 1967-1968, increasing the embankment top elevation from 15 to 20 feet.

Stone & Webster, 1966 indicates that fill used to construct the embankments was taken from within the footprint of the LAP. The 1966 Stone & Webster drawing describes the area as a "source of compacted fill", indicating that the embankment soils were compacted in place. There is no other known information directly documenting the specified degree of compaction, specific testing results, etc.

4.7 Detailed Drawing

Drawings included in Appendix A, provide details of engineering structures and appurtenances relevant to the design, construction, operation, and maintenance of the CCR Unit. These items include a plan view and cross sections of the LAP. The plan view provides information related to drainage provisions, the outlet structure, slope protection, normal pool surface elevation, and the maximum pool surface elevation following peak discharge from the 1,000 year flood. The cross sections indicate the expected maximum depth of CCR within the LAP.

4.8 Existing Instrumentation

VPDES Outfall 004 is monitored as a discharge point from the LAP, and a flow meter associated with the discharge structure is used to monitor the discharge flow from the LAP. No other instrumentation is associated with the LAP.

4.9 Area Capacity Curves

The CCR capacity of the LAP is provided in Table 3. The volumes are calculated based on a pond bottom elevation of 0 feet and typical interior embankment side slopes of 4 (horizontal) to 1 (vertical).

Table 3
LAP Capacity

LAP Condition	Incremental Volume (cubic yards)
To minimum top of embankment crest (El. 18.5)	2,870,000
To current operating pool (El. 16)	2,460,000
Current estimated volume	2,350,000

4.10 Spillway and Diversion Features

Discharge from the LAP flows through a concrete outlet structure (primary spillway) and into a concrete and steel discharge pipe. The concrete structure is a two-stage concrete structure. The first stage consists of an adjustable weir with an invert at elevation 15.8 feet. The weir is 3.5 feet wide. The second stage is a square opening on top of the riser at elevation 17.5 feet. The opening is 5.9 feet by 5.4 feet in dimension and is covered with a metal grate. The primary spillway was designed to manage a 100-year, 24-hour storm event (Schnabel, 2015). An emergency spillway was constructed to provide safe passage of at least a 1,000-year flood event. The 40-foot wide emergency spillway has a bottom elevation of 18.0 and a top elevation of 18.5 and is located over the primary spillway discharge pipe.

The LAP embankment crest currently ranges in elevation from 18.5 to 22 feet. Stormwater runon into the LAP comes from two sources, including the coal pile drainage area and stormwater that falls on the LAP itself. Stormwater collected within the coal pile drainage area discharges into a sediment basin which subsequently discharges into the LAP. Stormwater from the coal pile drainage area and stormwater that falls directly on the LAP are discharged through Outfall 004.

The spillway capacity calculations are included as Appendix B.

4.11 Construction Specifications and Provisions for Surveillance, Maintenance, and Repair

A general facility inspection schedule and plan is part of the Operations and Maintenance Certificate (Certificate) approved by DCR. These items are also being incorporated into the DEQ Solid Waste Permit. Provisions in the maintenance and inspection schedule include:

- Conduct maintenance inspection quarterly to include the following items:
  - Slope vegetation;
  - Slope protection;
  - Principal spillway debris accumulation.
  - Principal spillway concrete quality
- Conduct a technical safety inspection by a professional engineer annually.
- Mow the upstream and downstream slopes above the water level at least two times per year.

Maintenance items that are recommended based on the inspection results will be addressed.

4.12 Record or Knowledge of Structural Instability

The following records of structural instability and the corrective actions taken are noted.

- In 1987 Dominion engineers observed erosion and piping around the outfall discharge pipe due to a leak in a joint of the pipe. The issue was corrected by removing and replacing the leaking joint with a steel sleeve pipe encased in concrete, placing the pipe on a concrete bedding, and backfilling with compacted VDOT 21A stone and armoring the outfall pipe area with riprap (MacCrimmon, 1987). After pipe and outfall area slope repairs were completed, a grouting program was completed along either side of the outfall pipe on the downstream slope and perpendicular to the pipe at the crest for a distance of 50 feet north and south of the pipe. Its purpose was to fill any voids that might have been created by the previous pipe leak.

- In 1998 settling was observed along a short section of the western embankment located towards the southwestern corner of the LAP. New pavement had been placed along the embankment and settlement in the order of a few inches was observed on the outside edge of the pavement. Corrective action was taken to remove some of the soils that had settled and replace the soils with rip rap. Subsequent to the repair an additional six inches of settlement was observed in the same area (Schnabel, 1998a). Corrective action included the installation of sheet pile wall along the inside crest of the embankment. Sheet piling was installed August 1998, and construction observation and testing was conducted by Schnabel Engineering (Schnabel, 1998b). As part of the sheet pile wall installation areas of soft soils were excavated and backfilled with crushed stone.

- In 2009 Dominion contracted Schnabel Engineering to "evaluate the subsurface conditions and stability of the Lower Ash Pond dikes, and to provide recommendations regarding the stability of the dike slopes" (Schnabel, 2010a). Schnabel Engineering noted the potential for shallow slope failures along the western embankment. While the shallow failures did not require immediate attention, Dominion implemented corrective actions. Corrective action design included flattening the outer embankment slope to a 2 (horizontal):1(vertical) slope using embankment fill and placement of filter sand and a toe drain collection pipe to control seepage at the toe of the embankment fill (Schnabel, 2010b). Due to extremely wet and soft soil conditions beyond the embankment toe during construction, Schnabel made modifications to the design to abandon the toe drain and flatten the slope using a sand blanket, filter fabric, and riprap section (Schnabel, 2011).

- In 2016 the United States Geological Survey published new seismic hazards maps that included an increased peak ground acceleration (pga) value at the Station. As a result of the increased pga a portion of the LAP embankment did not meet the CCR Rule standards for seismic factor of safety; therefore, Dominion installed 300 feet of sheet pile wall along the outer toe of the embankment in the southwestern corner of the LAP. The increased factor of safety resulting from the sheet pile wall improvement satisfies the CCR Rule standard for seismic stability.

5. REFERENCES

Department of Conservation and Recreation, Operation and Maintenance Certificate Application, Prepared by Michael Winters, P.E. 2014.

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J.K. Timmons & Associates, Inc. Ash Disposal Pond Rehabilitation Details – Existing Oily Waste Pond. 1983.

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Schnabel Engineering. Geotechnical Engineering Study Chesterfield Power Station Stability Evaluation of the Lower Ash Pond Dikes. 2010a.

Schnabel Engineering. Chesterfield Power Station Lower Ash Pond Dike Improvements. 2010b.

Schnabel Engineering. Chesterfield Power Station Lower Ash Pond Dike Improvements – Embankment Modification Typical Section – Figure 1. 2011

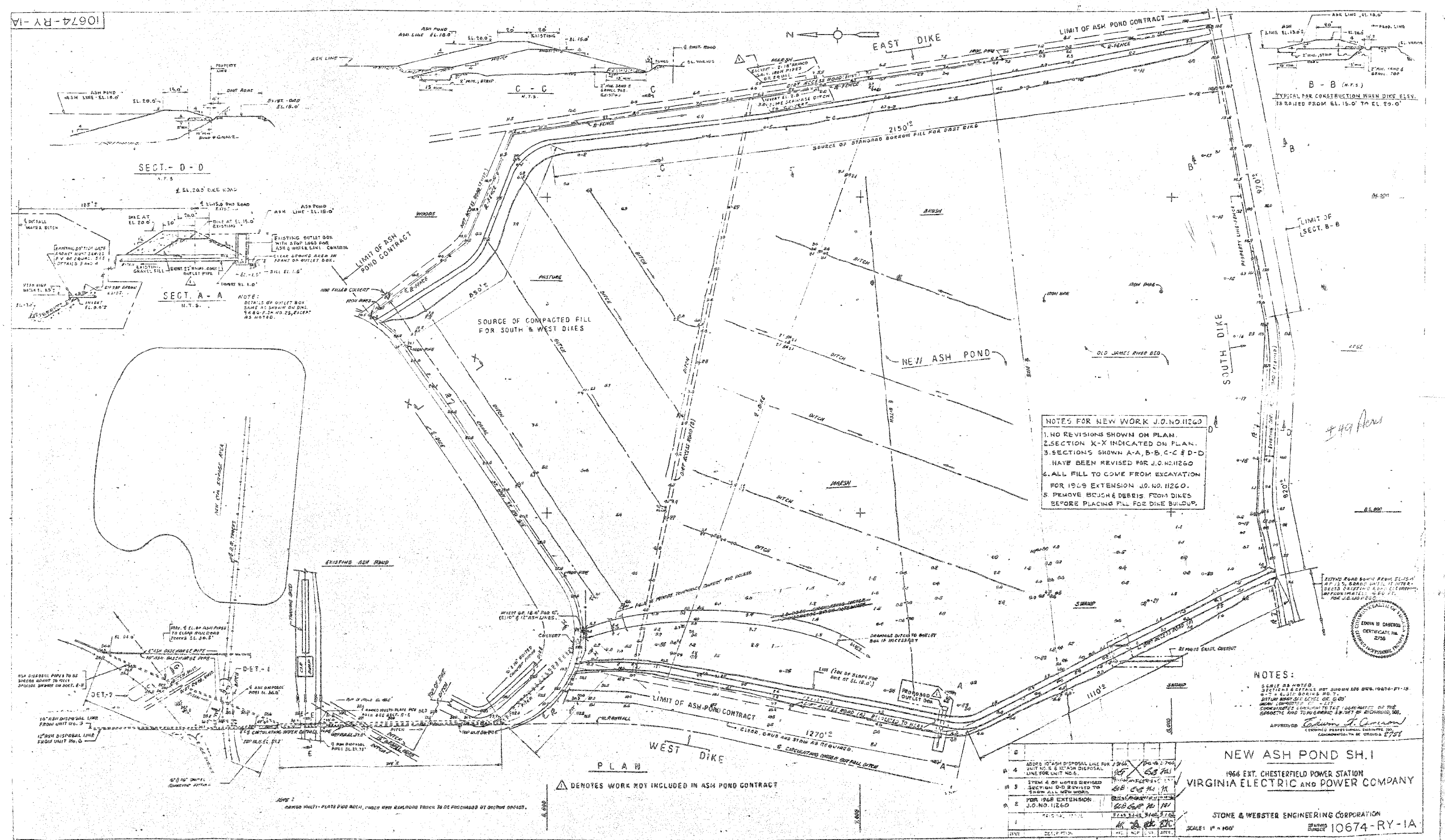
Schnabel Engineering. Dam Breach Analysis Report and Inundation Mapping. 2015.

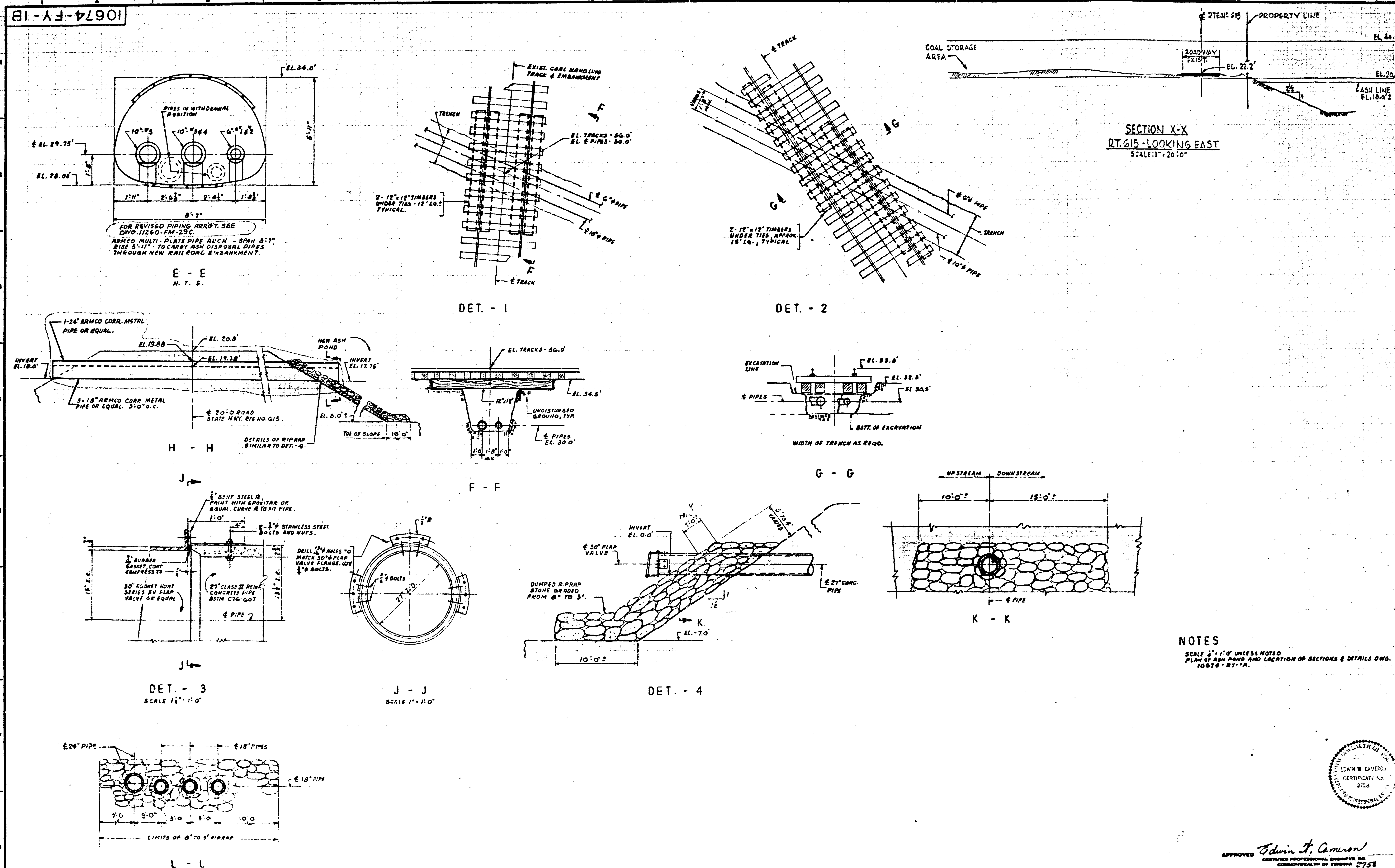
Stone & Webster Engineering Corporation. New Ash Pond Sh. 1 & 2, 1964 Ext. Chesterfield Power Sta. Prepared in 1962, 1969 Extension Revision. 1966.

Virginia Electric & Power Co. NPDES 1977 Master Sump Discharge Pond. 1977.

APPENDIX A

CCR UNIT DRAWINGS


10674-RY-1A
EAST DIKE
LIMIT OF ASH POND CONTRACT
SECT.- D-D
SECT. A - A
C - C
B - B
TYPICAL FOR CONSTRUCTION WHEN DIKE ELEV. IS RAISED FROM EL. 15.0' TO EL. 20.0'
LIMIT OF SECT. B-B
SOURCE OF COMPACTED FILL FOR SOUTH & WEST DIKES
NEW ASH POND
OLD JAMES RIVER BED
SOUTH DIKE
WEST DIKE
PLAN
LIMIT OF ASH POND CONTRACT
DENOTES WORK NOT INCLUDED IN ASH POND CONTRACT
NOTES FOR NEW WORK J.O. NO. 11260
1. NO REVISIONS SHOWN ON PLAN.
2. SECTION X-X INDICATED ON PLAN.
3. SECTIONS SHOWN A-A, B-B, C-C & D-D HAVE BEEN REVISED FOR J.O. NO. 11260
4. ALL FILL TO COME FROM EXCAVATION FOR 1969 EXTENSION J.O. NO. 11260.
5. REMOVE BRUSH & DEBRIS FROM DIKES BEFORE PLACING FILL FOR DIKE BUILDUP.
2150'±
1110'±
1270'±
NOTES:
SCALE AS NOTED.
EDWIN W. CAMERON CERTIFICATE NO. 2758
NEW ASH POND SH. 1
1964 EXT. CHESTERFIELD POWER STATION
VIRGINIA ELECTRIC AND POWER COMPANY
STONE & WEBSTER ENGINEERING CORPORATION
SCALE: 1" = 100'
FOR 1969 EXTENSION J.O. NO. 11260
10674-RY-1A



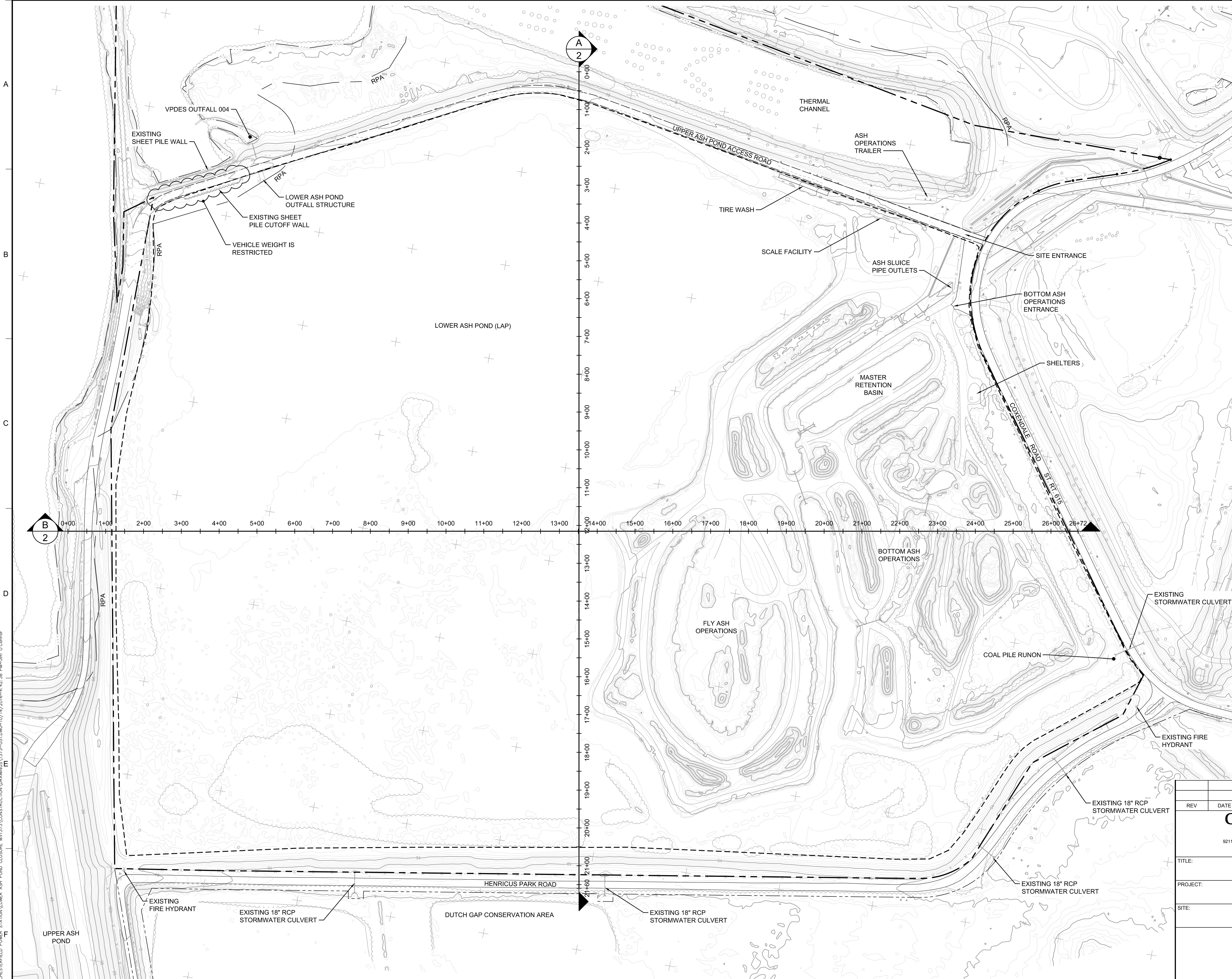
NEW ASH POND SH.2

1964 EXT. - CHESTERFIELD POWER STA.
CHESTER, VA.
VIRGINIA ELECTRIC AND POWER COMPANY
STONE & WEBSTER ENGINEERING CORPORATION
BOSTON, MASS.

DRAWING NUMBER 10674-FY-1B

ISSUE	DESCRIPTION
4	REVISED SECT. E-E, H-H & L-L.
3	REVISED SECTION X-X, AS ADVISED BY FIELD LETTER
2	FOR J.O. NO. 11260, 1965 EXT. ADDED SECTION X-X
1	ORIGINAL ISSUE

Designed by
Dsn. Chk'd by
Drawn by J.N.W.
Chk'd by



LEGEND

- SOLID WASTE MANAGEMENT FACILITY BOUNDARY (SWMFB)
- WASTE MANAGEMENT UNIT BOUNDARY (WMUB)
- 35 EXISTING CONTOUR (FT, MSL)
- EXISTING ROAD
- EXISTING CULVERT PIPE

GENERAL NOTES:

1. TOPOGRAPHY IS FROM LIDAR DATA OBTAINED FROM TUCK MAPPING SOLUTIONS OF BIG STONE GAP, VIRGINIA (https:tuckmapping.com/__, OBTAINED __ APRIL 2016) AND FROM LIDAR DATA OBTAINED FROM U.S. GEOLOGICAL SERVICES (https://nationalmap.gov/viewer.html, OBTAINED 11 NOVEMBER 2016); EXISTING FEATURES FROM AERIAL SURVEY BY TUCK MAPPING SOLUTIONS (FLYOVER DATE 8 OCTOBER 2014). WATER ELEVATION IN LOWER ASH POND AT TIME OF AERIAL SURVEY WAS 16 FT-MSL; CONTOURS SHOWN ON THESE DRAWINGS BELOW ELEVATION 16 WITHIN THE LOWER ASH POND FROM BATHYMETRIC SURVEYS CONDUCTED BY BURGESS & NIPLE OF GLEN ALLEN, VIRGINIA ON 9 JANUARY 2015 AND BY D & M SURVEYORS OF TAPPAHANNOCK, VIRGINIA ON 22 FEBRUARY 2016 (ORIGINAL HORIZONTAL DATUM NAD27, ORIGINAL VERTICAL DATUM NGVD29; VERTICAL DATA CONVERTED TO NAVD88 USING NOAA VDATUM SOFTWARE (-1.0813 VERTICAL DIFFERENCE)).
2. PROPERTY BOUNDARY WAS PREPARED FROM A FIELD SURVEY, DEED DESCRIPTIONS , ADJOINING PLATS, WITHOUT BENEFIT OF A TITLE REPORT, BY D & M SURVEYORS, P.C., 221 QUEEN STREET, P.O. BOX 1828, TAPPAHANNOCK, VA 22560, (804) 443-3080, ON MAY 5, 2015.
3. HORIZONTAL DATUM NAD83; VERTICAL DATUM NAVD 88; STATE PLANE SOUTH ZONE, US FOOT.
4. WETLANDS AND RPA FIELD DELINEATED BY GOLDER ASSOCIATES, MARCH, 2015.

0 120' 240'
SCALE IN FEET

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
9211 ARBORETUM PARKWAY, SUITE 200
RICHMOND, VA 23236 USA
PHONE: 804.767.2206

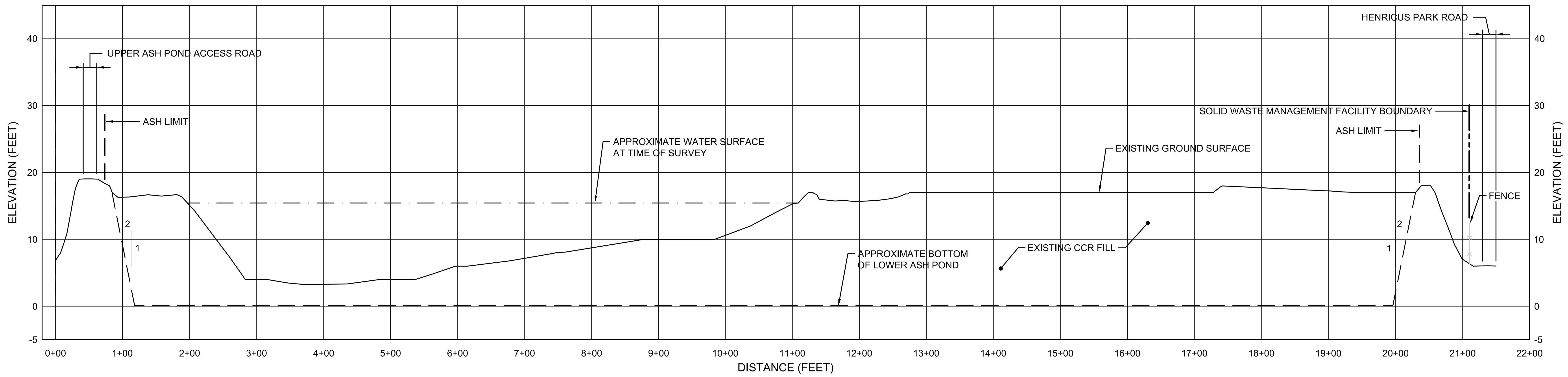
Dominion
5000 DOMINION BOULEVARD
GLEN ALLEN, VA 23060
PHONE: 804.205.0527

TITLE: EXISTING CONDITIONS

PROJECT: HISTORY OF CONSTRUCTION

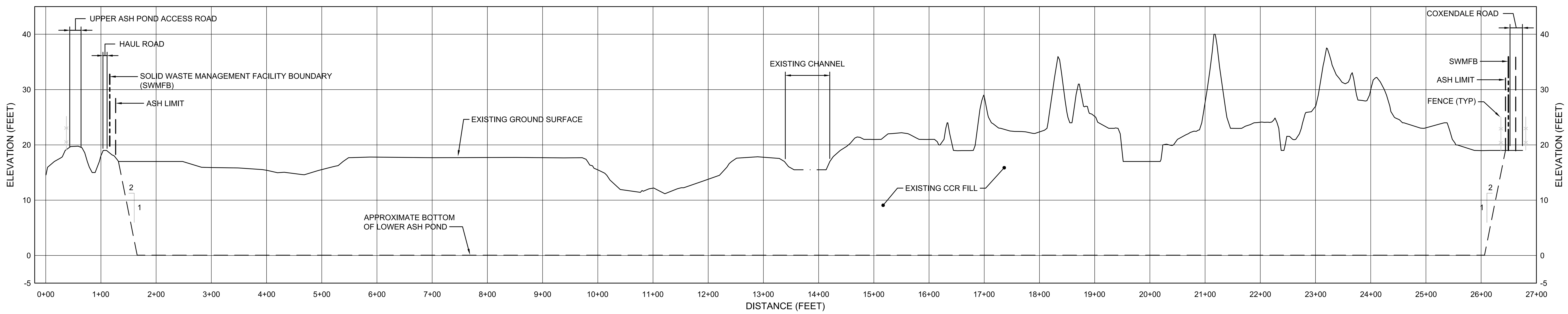
SITE: CHESTERFIELD POWER STATION CHESTER, VIRGINIA

DESIGN BY:	SKS	DATE:	OCTOBER 2016
DRAWN BY:	JOC	PROJECT NO.:	MV1222
CHECKED BY:	SKS	FILE:	1373-051
REVIEWED BY:	KEL	DRAWING NO.:	
APPROVED BY:	SKS	1 OF 2	



A/1 SITE CROSS-SECTION

HORIZONTAL SCALE: 1" = 100'
VERTICAL SCALE: 1" = 10'



B/1 SITE CROSS-SECTION

HORIZONTAL SCALE: 1" = 100'
VERTICAL SCALE: 1" = 10'

0 120' 240'
SCALE IN FEET

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
9211 ARBORETUM PARKWAY, SUITE 200
RICHMOND, VA 23236 USA
PHONE: 804.767.2206

Dominion
5000 DOMINION BOULEVARD
GLEN ALLEN, VA 23060
PHONE: 804.205.0527

TITLE: SITE CROSS-SECTIONS

PROJECT: HISTORY OF CONSTRUCTION

SITE: CHESTERFIELD POWER STATION
CHESTER, VIRGINIA

DESIGN BY:	SKS	DATE:	OCTOBER 2016
DRAWN BY:	JOC	PROJECT NO.:	MV1222
CHECKED BY:	SKS	FILE:	1373-051
REVIEWED BY:	KEL	DRAWING NO.:	
APPROVED BY:	SKS	2 OF 2	

APPENDIX B

SPILLWAY CALCULATIONS

Project	Chesterfield Ash Pond		
Subject	Principal Spillway Rating Curve Calculation		
Date:	9/13/2010		
Filename:	G:\2011-LLC-Jobs\11221002_00-Dominion_Chesterfield_Lower_Ash_Pond_H&H\04_Calcs\Hydrology_&_Hydraulics\Hydraulics\[Pipe& Riser Discharge - v2.xlsx]Pipe	By: MRG	Checked: LES

Data Source: Drawings obtained from the client.

Notes: Drawings obtained from D&M Surveyors
Flied observations done by Schnabel

Pipe Data		
Type:	RCP	
Diameter:	24	inches
Length:	90	feet
# of Barrels:	1	
Upstream Invert	9.4	feet
Downstream Invert	6.8	feet
Normal Pool:	15.8	feet
Model Increment:	0.5	feet
Kentrance:	0.5	
Kexit:	1.0	
Kbend:	0	
Kvalve:	0	
Roughness, ks:	0.004	feet
Tailwater:	0	feet
Trial f:	0.021	

Notes:

1) If tailwater elevation is set to 0, calculation assumes free discharge of flow from the pipe. Otherwise a constant tailwater elevation is used in calculation

2) Friction Factor (f) from Swamee and Jain Equation

3) Velocity from Bernoulli's equation

4) Re = V*D/v

5) Kinematic Viscocity (v) for water at 60° F

6) If check column does not read "OK" replace Trial f with value in column AA

Project Chesterfield Ash Pond

Subject Principal Spillway Rating Curve Calculation

Date: 9/13/2010

Filename: G:\2011-LLC-Jobs\11221002_00-Dominion_Chesterfield_Lower_Ash_Pond_H&H\04_Calcs\Hydrology_&_Hydraulics\Hydraulics\[Pipe& Riser Discharge - v2.xlsx]Pipe

By: MRG Checked: LES

Data Source: Drawings obtained from the client.

Notes: Drawings obtained from D&M Surveyors

Flied observations done by Schnabel

	Initial Values			Trial			Final						
Lake Level	Trial f	Velocity	Re	f	Velocity	Re	f	Velocity	Re	Check	Area	Flow	Total Flow
feet		fps			fps			fps			sqft	cfs	cfs
15.8	0.021	12.23	2.00E+06	0.02356	12.03	1.97E+06	0.02356	12.03	1.97E+06	OK	3.14	37.79	37.79
16.3	0.021	12.61	2.07E+06	0.02356	12.40	2.03E+06	0.02356	12.40	2.03E+06	OK	3.14	38.96	38.96
16.8	0.021	12.97	2.13E+06	0.02356	12.76	2.09E+06	0.02356	12.76	2.09E+06	OK	3.14	40.09	40.09
17.3	0.021	13.33	2.18E+06	0.02355	13.11	2.15E+06	0.02355	13.11	2.15E+06	OK	3.14	41.19	41.19
17.8	0.021	13.67	2.24E+06	0.02355	13.45	2.20E+06	0.02355	13.45	2.20E+06	OK	3.14	42.26	42.26
18.3	0.021	14.01	2.30E+06	0.02355	13.78	2.26E+06	0.02355	13.78	2.26E+06	OK	3.14	43.30	43.30
18.8	0.021	14.34	2.35E+06	0.02354	14.11	2.31E+06	0.02354	14.11	2.31E+06	OK	3.14	44.32	44.32
19.3	0.021	14.66	2.40E+06	0.02354	14.42	2.36E+06	0.02354	14.42	2.36E+06	OK	3.14	45.32	45.32
19.8	0.021	14.98	2.46E+06	0.02354	14.74	2.42E+06	0.02354	14.74	2.42E+06	OK	3.14	46.29	46.29
20.3	0.021	15.29	2.51E+06	0.02354	15.04	2.47E+06	0.02354	15.04	2.47E+06	OK	3.14	47.25	47.25
20.8	0.021	15.59	2.56E+06	0.02353	15.34	2.51E+06	0.02353	15.34	2.51E+06	OK	3.14	48.18	48.18
21.3	0.021	15.89	2.60E+06	0.02353	15.63	2.56E+06	0.02353	15.63	2.56E+06	OK	3.14	49.10	49.10
21.8	0.021	16.18	2.65E+06	0.02353	15.92	2.61E+06	0.02353	15.92	2.61E+06	OK	3.14	50.00	50.00
22.3	0.021	16.46	2.70E+06	0.02353	16.20	2.66E+06	0.02353	16.20	2.66E+06	OK	3.14	50.89	50.89
22.8	0.021	16.75	2.75E+06	0.02353	16.48	2.70E+06	0.02353	16.48	2.70E+06	OK	3.14	51.76	51.76
23.3	0.021	17.02	2.79E+06	0.02353	16.75	2.75E+06	0.02353	16.75	2.75E+06	OK	3.14	52.62	52.62
23.8	0.021	17.29	2.84E+06	0.02352	17.02	2.79E+06	0.02352	17.02	2.79E+06	OK	3.14	53.46	53.46
24.3	0.021	17.56	2.88E+06	0.02352	17.28	2.83E+06	0.02352	17.28	2.83E+06	OK	3.14	54.29	54.29
24.8	0.021	17.83	2.92E+06	0.02352	17.54	2.88E+06	0.02352	17.54	2.88E+06	OK	3.14	55.10	55.10
25.3	0.021	18.09	2.97E+06	0.02352	17.80	2.92E+06	0.02352	17.80	2.92E+06	OK	3.14	55.91	55.91
25.8	0.021	18.34	3.01E+06	0.02352	18.05	2.96E+06	0.02352	18.05	2.96E+06	OK	3.14	56.70	56.70
26.3	0.021	18.60	3.05E+06	0.02352	18.30	3.00E+06	0.02352	18.30	3.00E+06	OK	3.14	57.49	57.49
26.8	0.021	18.85	3.09E+06	0.02352	18.54	3.04E+06	0.02352	18.54	3.04E+06	OK	3.14	58.26	58.26
27.3	0.021	19.09	3.13E+06	0.02352	18.79	3.08E+06	0.02352	18.79	3.08E+06	OK	3.14	59.02	59.02
27.8	0.021	19.34	3.17E+06	0.02351	19.03	3.12E+06	0.02351	19.03	3.12E+06	OK	3.14	59.77	59.77
28.3	0.021	19.58	3.21E+06	0.02351	19.26	3.16E+06	0.02351	19.26	3.16E+06	OK	3.14	60.51	60.51
28.8	0.021	19.81	3.25E+06	0.02351	19.50	3.20E+06	0.02351	19.50	3.20E+06	OK	3.14	61.25	61.25
29.3	0.021	20.05	3.29E+06	0.02351	19.73	3.23E+06	0.02351	19.73	3.23E+06	OK	3.14	61.97	61.97
29.8	0.021	20.28	3.32E+06	0.02351	19.96	3.27E+06	0.02351	19.96	3.27E+06	OK	3.14	62.69	62.69
30.3	0.021	20.51	3.36E+06	0.02351	20.18	3.31E+06	0.02351	20.18	3.31E+06	OK	3.14	63.40	63.40
30.8	0.021	20.74	3.40E+06	0.02351	20.40	3.34E+06	0.02351	20.40	3.34E+06	OK	3.14	64.10	64.10

Project	Chesterfield Ash Pond
Subject	Principal Spillway Rating Curve Calculation
Date:	9/13/2010

Filename: G:\2011-LLC-Jobs\11221002_00-Dominion_Chesterfield_Lower_Ash_Pond_H&H\04_Calcs\Hydrology_&_Hydraulics\Hydraulics\[Pipe& Riser Discharge - v2.xlsx]Total Discharge By: MRG Checked: LES

Data Source: Drawings obtained from the client.
Drawings obtained from D&M Surveyors
Flied observations done by Schnabel

Stage 1

Weir	Length:	3.5
	Coefficient:	3.1
Orifice	Area:	2.63
	Coefficient:	0.61
Invert Elevation:		15.8
Top Elevation:		16.55

Stage 2

Weir	Length:	20.8
	Coefficient:	3.1
Orifice	Area:	36
	Coefficient:	0.61
Invert Elevation:		17.2
Top Elevation:		17.2

Auxiliary Spillway

Width:	0
Left Sideslope:	0 :1
Right Sideslope:	0 :1
Cw:	0
Elevation:	0

Project Chesterfield Ash Pond
Subject Principal Spillway Rating Curve Calculation
Date: 9/13/2010

Schnabel ENGINEERING

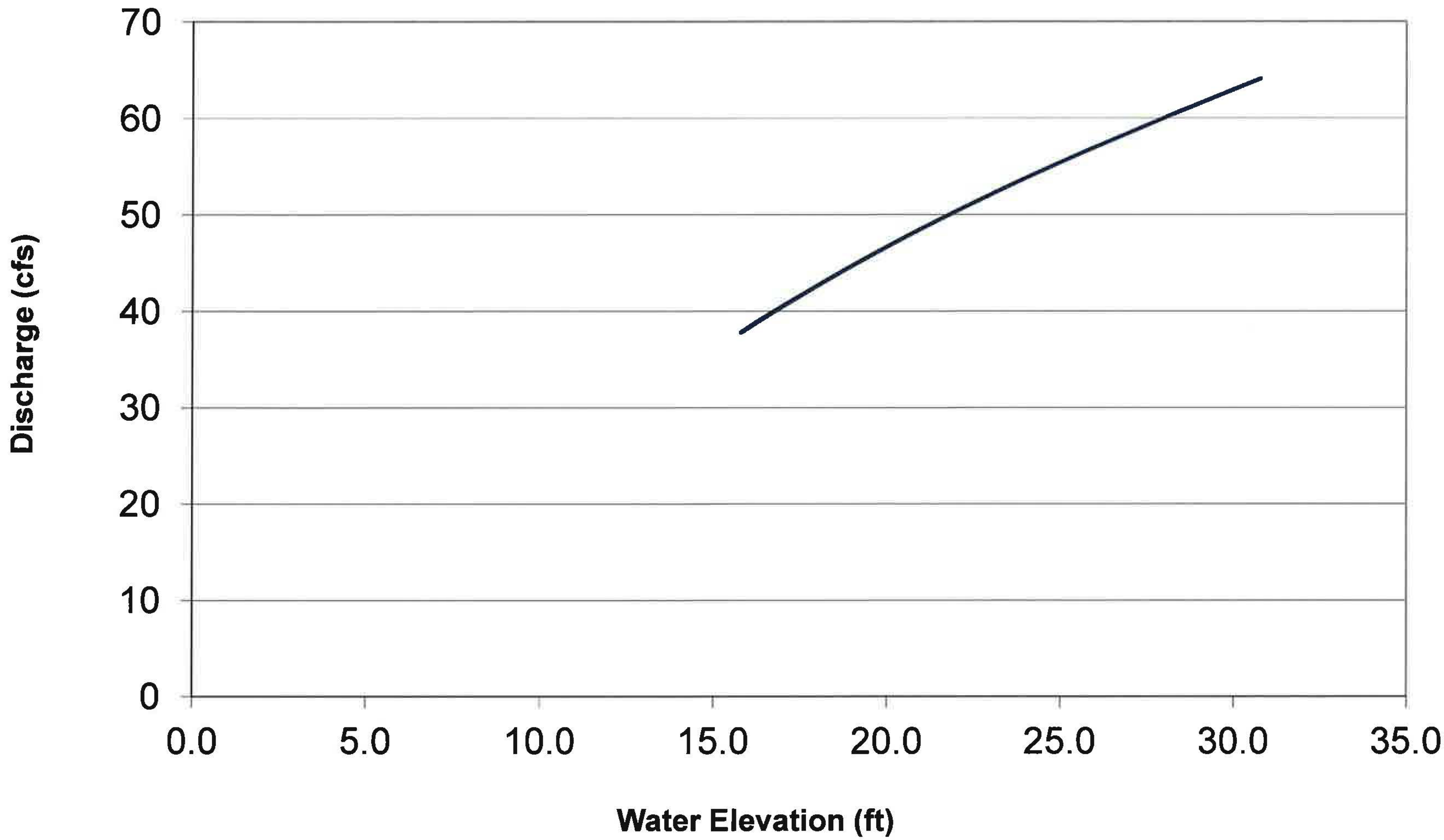
Filename: G:\2011-LLC-Jobs\11221002_00-Dominion_Chesterfield_Lower_Ash_Pond_H&H\04_Calcs\Hydrology_&_Hydraulics\Hydraulics\[Pipe& Riser Discharge - v2.xlsx]Total Discharge By: MRG Checked: LES

Data Source: Drawings obtained from the client.
Drawings obtained from D&M Surveyors
Flied observations done by Schnabel

Lake Level	Stage 1	Discharge	Stage 2	Discharge	Riser Discharge	Pipe Discharge	Pipe / Riser Discharge	Auxiliary Spillway		Total Discharge
	Weir	Orifice	Weir	Orifice				Eff. Width	Discharge	
15.8	0.00		0.00		0.00	37.79	0.00	0.00	0.00	0.00
16.3	3.84		0.00		3.84	38.96	3.84	0.00	0.00	3.84
16.8	10.85	10.18	0.00		10.18	40.09	10.18	0.00	0.00	10.18
17.3	19.93	13.66	2.04	55.73	15.69	41.19	15.69	0.00	0.00	15.69
17.8	30.69	16.41	29.97	136.51	46.38	42.26	42.26	0.00	0.00	42.26
18.3	42.89	18.77	74.39	184.83	93.16	43.30	43.30	0.00	0.00	43.30
18.8	56.38	20.86	130.50	222.91	151.36	44.32	44.32	0.00	0.00	44.32
19.3	71.04	22.76	196.22	255.38	218.98	45.32	45.32	0.00	0.00	45.32
19.8	86.80	24.51	270.32	284.16	294.84	46.29	46.29	0.00	0.00	46.29
20.3	103.57	26.15	351.94	310.28	336.43	47.25	47.25	0.00	0.00	47.25
20.8	121.31	27.69	440.43	334.37	362.06	48.18	48.18	0.00	0.00	48.18
21.3	139.95	29.15	535.30	356.83	385.98	49.10	49.10	0.00	0.00	49.10
21.8	159.46	30.53	636.15	377.97	408.50	50.00	50.00	0.00	0.00	50.00
22.3	179.80	31.86	742.64	397.98	429.84	50.89	50.89	0.00	0.00	50.89
22.8	200.94	33.14	854.49	417.03	450.17	51.76	51.76	0.00	0.00	51.76
23.3	222.85	34.37	971.45	435.25	469.62	52.62	52.62	0.00	0.00	52.62
23.8	245.51	35.55	1093.30	452.74	488.29	53.46	53.46	0.00	0.00	53.46
24.3	268.88	36.70	1219.87	469.57	506.27	54.29	54.29	0.00	0.00	54.29
24.8	292.95	37.81	1350.97	485.83	523.64	55.10	55.10	0.00	0.00	55.10
25.3	317.70	38.89	1486.46	501.55	540.44	55.91	55.91	0.00	0.00	55.91
25.8	343.11	39.94	1626.20	516.80	556.74	56.70	56.70	0.00	0.00	56.70
26.3	369.16	40.97	1770.06	531.61	572.58	57.49	57.49	0.00	0.00	57.49
26.8	395.84	41.97	1917.93	546.02	587.99	58.26	58.26	0.00	0.00	58.26
27.3	423.13	42.94	2069.70	560.06	603.00	59.02	59.02	0.00	0.00	59.02
27.8	451.03	43.90	2225.28	573.76	617.65	59.77	59.77	0.00	0.00	59.77
28.3	479.51	44.83	2384.57	587.13	631.96	60.51	60.51	0.00	0.00	60.51
28.8	508.56	45.75	2547.49	600.21	645.96	61.25	61.25	0.00	0.00	61.25
29.3	538.18	46.64	2713.96	613.01	659.65	61.97	61.97	0.00	0.00	61.97
29.8	568.36	47.52	2883.90	625.55	673.07	62.69	62.69	0.00	0.00	62.69
30.3	599.08	48.39	3057.26	637.84	686.23	63.40	63.40	0.00	0.00	63.40
30.8	630.33	49.24	3233.95	649.90	699.13	64.10	64.10	0.00	0.00	64.10

Pipe Discharge

Schnabel ENGINEERING



Total Discharge