Run-On / Run-Off Control

RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

Clover Stage 3 Landfill - SWP#556

Submitted To: Dominion – Clover Power Station
S.R. 92
Clover, VA 24534

Submitted By: Golder Associates Inc.
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Richmond, VA 23227

October 2016 **Project No. 1139-6277**

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1.0 PLAN CERTIFICATION

I certify that the information contained within this Run-On Run-Off Control Plan was prepared by me or under my direct supervision, and meets the requirements of Section §257.81 of the Federal Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals (CCR) from Electric Utilities; Final Rule (40 CFR 257; the CCR rule) and the Virginia Solid Waste Management Regulations.

Daniel McGrath	Senior Consultant
Print Name	Title
Daniel McGrath	10/7/16
Signature	Date

COMMONWEALTH OF VIRGINIA
Daniel McGrath
DANIEL P. McGRATH
Lic. No. 040703
10/7/16
PROFESSIONAL ENGINEER

2.0 INTRODUCTION

This Run-On and Run-Off Control System (ROROCS) Plan was prepared for the Clover Power Station Stage 3 CCR Landfill located in Halifax County, Virginia, in accordance with 40 CFR 257.81 (Run-on and run-off controls for Coal Combustion Residuals (CCR) landfills). This ROROCS plan documents how the facility's run-on and run-off control systems have been designed to meet the requirements of 40 CFR 257.81 and is supported by appropriate engineering calculations.

3.0 REGULATORY REQUIREMENTS

3.1 Federal CCR Rule (40 CFR 257.105(g)(3))

As required by 40 CFR 257.81, the owner or operator of a Coal Combustion Residuals (CCR) landfill must design, construct, operate, and maintain the CCR landfill to convey runoff generated from at least a 25-year, 24-hour storm event. This includes the following:

- A run-on control system to prevent flow onto the active portion of the CCR unit during the peak discharge from the 25-year, 24-hour storm event.
- A run-off control system from the active portion of the CCR unit to collect and control the peak discharge from the 25-year, 24-hour storm event.

In the context of the CCR Rule, "active portion" is not defined but is understood in the context of this *Plan* to refer to all constructed areas of a CCR landfill within the limit of waste on which a final cover system has not been constructed nor has intermediate cover soil been applied. Note that this differs from the definition of "open area" as defined in the landfill's solid waste permit, which is limited to 10 acres. As of June 30, 2016, the Stage 3 landfill consists of the approximate areas and conditions as follows:

- Final Cover: 22.9 acres
- Intermediate Cover Soil: 35.5 acres
- Active Portion: 20.0 acres

The preamble to the federal CCR Rule provides additional description regarding the intent of the requirements. Regarding run-off control, the following quotation from the preamble is relevant.

> *The owner or operator must design, construct, operate, and maintain the CCR landfill in such a way that any runoff generated from at least a 24-hour, 25-year storm must be collected through hydraulic structures, such as drainage ditches, toe drains, swales, or other means, and controlled so as to not adversely affect the condition of the CCR landfill. EPA has promulgated these requirements to minimize the detention time of run-off on the CCR landfill and minimize infiltration into the CCR landfill, to dissipate storm water run-off velocity, and to minimize erosion of CCR landfill slopes. An additional concern with run-off from CCR landfills is the water quality of the run-off, which may collect suspended solids from the landfill slopes.*

3.2 Virginia Solid Waste Management Regulations (9VAC 20-81)

The design of the Stage 3 Landfill conforms to the Virginia Solid Waste Management Regulations (VSWMR), which require run-on and run-off controls sized for the 25-year, 24-hour storm event (9VAC 20-81-130.H). The landfill is permitted to operate as an Industrial Landfill under Virginia Solid Waste Permit # 556.

4.0 DESIGN METHODOLOGY

4.1 Design Storm

Run-on and run-off control systems were designed for hydraulic capacity for at least the 25-year, 24-hour storm event as required by state and federal regulations. Site-specific precipitation estimates were obtained from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 at the landfill location. The 25-year, 24-hour storm event generates 6.02 inches of precipitation at this location. Design calculations are included in Appendices 1 and 2.

4.2 Runoff Curve Numbers

Stormwater calculations were performed using computer software that utilizes the Soil Conservation Service (SCS) Method for estimating runoff. Part of the data input in the SCS method is to select Runoff Curve Numbers (CNs) which represent the soil type and its cover condition. Typical CNs range from 30 to 98, with higher numbers representing soils and/or cover conditions that will produce more runoff; whereas lower CNs will produce lower amounts of runoff. Curve numbers are selected using the Hydrologic Soil Group (HSG - as determined from the Natural Resources Conservation Service Soil Surveys), and cover condition (bare soil, grass, woods, etc.)

CCR material is assumed to perform hydrologically consistent with bare soil conditions for HSG B. The other soils in the area of the landfill were presumed to be predominantly HSG B soils also, as the soil used for cover was excavated on-site. The HSG map for the Stage 3 area is found in Appendix 1.

4.3 Stormwater Calculations

Software from the US Army Corps of Engineers, Hydrologic Engineering Center – Hydrologic Modeling System (HEC-HMS) was used to model the site and calculate runoff rates and volumes. The complete stormwater and runoff control design for the landfill was prepared during the permitting process for the VSWMR; therefore, sample calculations for each critical component are presented in the Appendices to demonstrate compliance with controlling the 25-year, 24-hour storm event.

4.4 Design Drawings

The topography of the site, along with the locations and construction details of the run-on and run-off control system features are presented on permit and record drawings. As-built survey data from June 30, 2016 was used to determine areas of final cover, intermediate cover soil, and the active portion.

5.0 RUN-ON CONTROL

Run-on is defined as stormwater that may flow towards the active portion of the landfill from non-disposal areas. Based on the topography of the Stage 3 Landfill and surrounding areas, run-on potential is limited. The active portion of the landfill is topographically higher than the perimeter road and run-on from outside areas cannot get to the active portion. Run-on to the active portion can only come from higher areas within the landfill perimeter that are under intermediate or final cover. As filling activities progress, run-on from higher areas will decrease.

The primary potential source of run-on water is from the north-facing slope that faces the active portion. A diversion bench has been constructed along the lower portion of this slope to intercept potential run-on and convey it to the perimeter stormwater system. Above the north-facing slope are two additional levels, which also have their runoff diverted away from the active portion by a combination of earthen diversion berms and stormwater conveyance channels leading to the perimeter stormwater system. Figure 2 in Appendix 1 highlights the existing run-on controls. The calculations in Appendix 1 demonstrate the existing channels and diversions are adequate to prevent stormwater run-on into the active portion of the Stage 3 Landfill.

6.0 RUN-OFF CONTROL

6.1 Overview

Run-off management in the Stage 3 Landfill is recognized as two types of run-off:

- Contact water (run-off that has contacted CCR): Contact water run-off for the active ash placement area of the landfill, but not including leachate.
- Non-contact stormwater (run-off that has not contacted CCR): This includes stormwater run-off from intermediate or final cover areas.

Contact water management is addressed in Section 5.2 and non-contact stormwater management is addressed in Section 5.3. Calculations are presented in Appendix 2.

6.2 Contact Water Run-Off

The active portion of the Stage 3 landfill consists of the open disposal area and areas that have been deemed as under intermediate cover by nature of application of a soil, a crusting agent, or other methods allowed in the Landfill's *Operations Plan*. By requirement in the solid waste permit, the landfill's open disposal area is limited to 10 acres. For the purposes of this plan, and as in practice, all run-off water from the 20 +/- acre active portion is treated as contact water. The goal of the contact water run-off plan is to direct the water into leachate basin 2A while minimizing the amount of CCR sediment carried over. Contact water will be managed through a combination of filling practices and active controls.

6.2.1 Filling and Grading

Filling and grading the active portion of the landfill to always drain away from the perimeter is the primary control measure in preventing contact water run-off from leaving the active portion of the landfill. CCR fill plans should be focused on keeping the perimeter of the active portion higher than then run-off collection point. Additionally, placement of a compacted soil berm around the perimeter will contain run-off, provide a surface to compact against, and form the intermediate cover soil surface. Figure 1 shows the recommended fill sequence using the compacted soil berm.

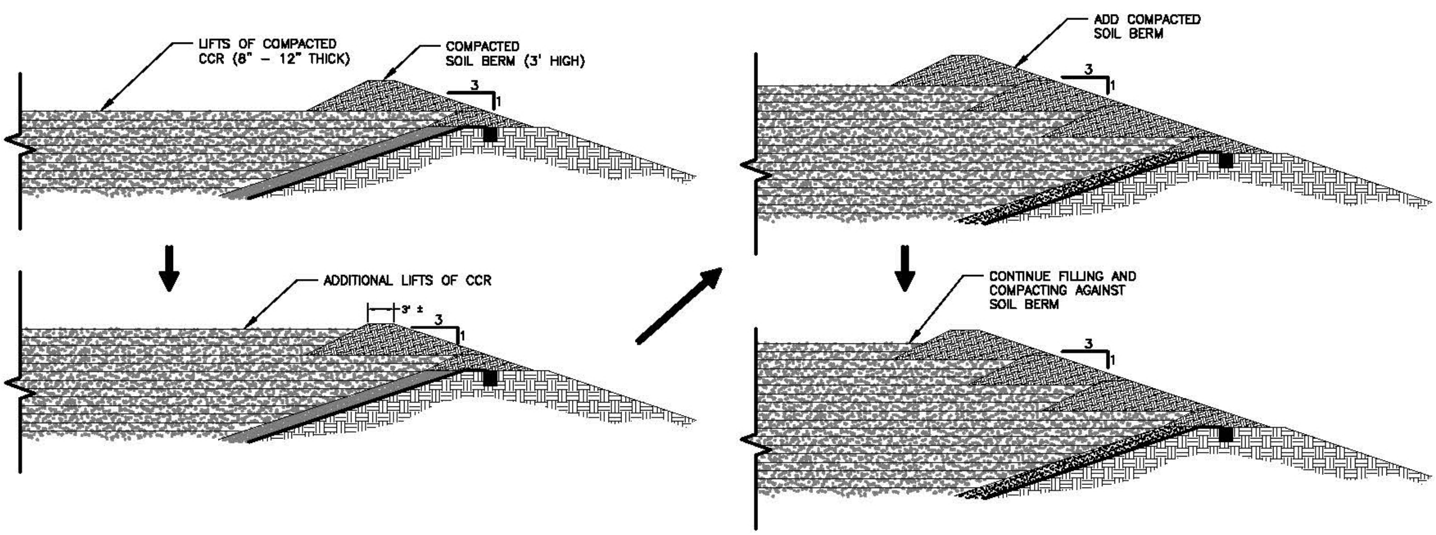


Figure 1 - CCR Fill Placement

6.2.2 Intermediate Cover

Cover consisting of either soil cover or tarps shall be applied to the exterior slopes on the exposed working area on a daily basis. Areas not on the exterior slopes that have not received additional CCR within 30 days will be covered with at least one foot of compacted soil, a soil crusting agent, or other methods allowed in the Landfill's *Operations Plan*. Once final grades are achieved for a section of the exterior CCR slope, the intermediate cover soil will be installed and vegetation established. All areas with intermediate cover exposed shall be inspected as needed but not less than weekly and additional cover material shall be placed on all cracked, eroded, and uneven areas as required to maintain the integrity of the intermediate cover system.

6.2.3 Active Stormwater Controls

Actively controlling the stormwater consists of segmenting the run-off water into smaller drainage areas, each with a controlled outlet and sediment trap. Segmenting the water into smaller areas will prevent long overland flows which have been shown to consolidate into channelized flow and quickly cause erosion in the CCR surface. The smaller drainage areas should be limited to approximately 3-acre sections, with the outlet of each section developed as a sediment trap with a stone outlet in accordance with the Virginia Erosion and Sediment Control Handbook (VESCH) Standard and Specification 3.13. Each trap would have an approximate volume of 134 cubic yards (CY) per acre of contributing drainage.

At the lowest point in the active portion, a final sediment trap is constructed with a pipe outlet to convey the contact stormwater to leachate basin 2A. In order to control runoff from the 25-year storm event from the current active portion, two, 24-inch outlet pipes are recommended. The pipes extend into the basin to ensure the contact water does not run over non-contact areas.

6.3 Non-Contact Water Run-Off

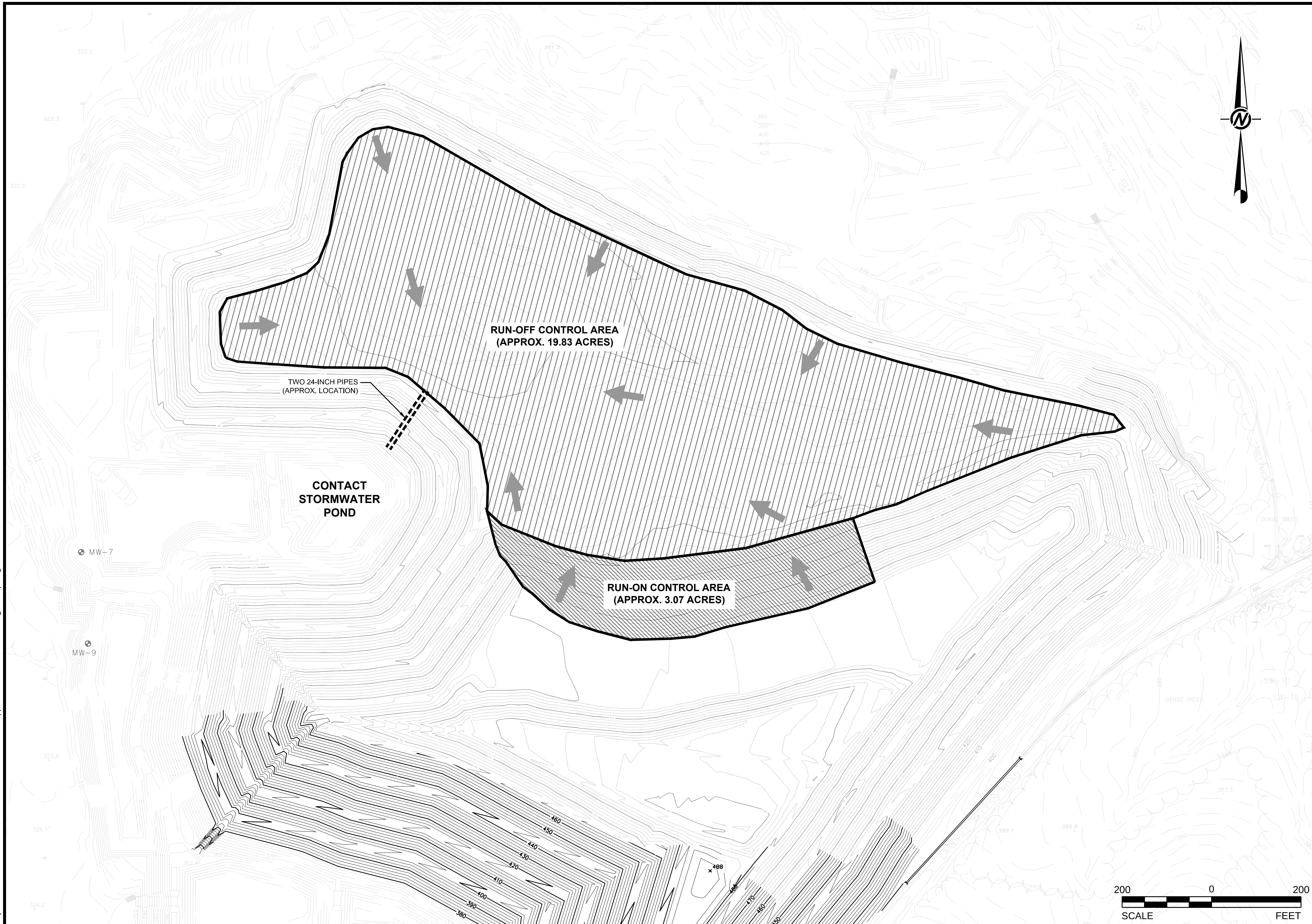
During filling operations, the exterior side slopes of the landfill will be covered with intermediate cover soil as CCR placement progresses. Side-slope benches will be used to interrupt the slope length of the landfill side slopes. The side slope benches are designed to convey stormwater to armored downchutes and into the perimeter channel system. Stormwater run-off devices are capable of conveying flow from the 24-hour, 25-year storm event. The stormwater runoff system was designed to convey at least the 25-year storm event during permitting as a solid waste landfill under the VSWMR.

7.0 CLOSING

As required by 40 CFR 257.81, the Clover Stage 3 Landfill run-on control system is designed to prevent flow onto the active portion of the CCR unit during the peak discharge from a 25-year, 24-hour storm, and the run-off control system is designed to collect and control at least the water volume resulting from a 25-year, 24-hour storm.

Figure 1

Run-On and Run-Off Control Map



Golder Associates
Richmond, Virginia

PROJECT
DOMINION
CLOVER STAGE III B LANDFILL
HALIFAX COUNTY, VA

TITLE
STAGE III B RUN-ON/RUN-OFF CONTROL MAP

PROJECT No.		113-96277
FILE No.		Stage 3 map
REV. 0	SCALE	AS SHOWN
DESIGN	KAL	08/18/2016
CADD	KAL	08/18/2016
CHECK		
REVIEW		

FIGURE 1

G:\Projects\Dominion\Clover Pwr Stn\1139-6277 Clover Landfill Support\RO-RO Control Plan\Stage 3 map.dwg

Appendix 1

Stormwater Run-On Calculations

1.0 OBJECTIVE

These calculations determine the adequacy of the proposed run-on control measures for the active portion of the Clover Stage 3 Landfill. The run-on controls include diversion berms and bench channels to re-direct stormwater from the active landfill area.

2.0 METHOD

The peak stormwater flows were determined for the run-on controls using the methodology described in NRCS technical Release 55 (TR-55) and the Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS). The diversion berms and affected bench channels were analyzed using Manning's Equation:

$$Q = \frac{1.49}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

Precipitation information was collected from the NOAA Atlas 14 database for the site using the Precipitation Frequency Data Server (PFDS) website (http://hdsc.nws.noaa.gov/hdsc/pfds/):

2-year (24-hr)	3.25 in
10-year (24-hr)	4.91 in
25-year (24-hr)	6.02 in

The drainage areas for the analyzed berms and channels are shown in Attachment 1. For these calculations, the drainage area with the highest flow was used to provide a worst-case scenario for the diversion berms and bench channels. According to the NRCS Web Soil Survey, the onsite soils are predominantly Hydrologic Group B soils (Attachment 2). Curve numbers (CNs) of 58 and 85 were used for the covered and active areas respectively.

The standard diversion berms and channels have approximate longitudinal slopes of 2%, have a depth of 18 in, and are assumed to be triangular-shaped and lined with grass (Manning's roughness coefficient of 0.035). The diversion berms are constructed on the lower edge of the drainage area and have effective channel side slopes of 3:1 and 2%. The bench channels have side slopes of 3:1 and approximately 10:1. The peak flows, velocities, and flow depths for typical diversion berms and affected bench channels are summarized in the tables below.

Channel Calculations - Clover Stage 3 Diversion Berm (DB B-1, 4.63 Ac.)

Slope	0.02	Bottom Width		0		
n	0.035	Z1 (:1)		3		
		Z2 (:1)		50	(2% top slope)	
Depth, ft	Area	Pw	r	V	Q	Event
0.18	0.86	9.57	0.09	1.21	1.04	2-Yr
0.33	2.89	17.55	0.16	1.81	5.22	10-Yr
0.40	4.24	21.27	0.20	2.05	8.71	25-Yr
1.50	59.63	79.76	0.75	4.96	295.69	Max Cap

Channel Calculations - Clover Stage 3 Bench Channel (DB A-1, 3.23 Ac.)

Slope	0.02	Bottom Width		0		
n	0.035	Z1 (:1)		3		
		Z2 (:1)		10		
Depth, ft	Area	Pw	r	V	Q	Event
0.32	0.67	4.23	0.16	1.76	1.17	2-Yr
0.55	1.97	7.27	0.27	2.52	4.95	10-Yr
0.66	2.83	8.72	0.32	2.84	8.05	25-Yr
1.50	14.63	19.82	0.74	4.92	71.90	Max Cap

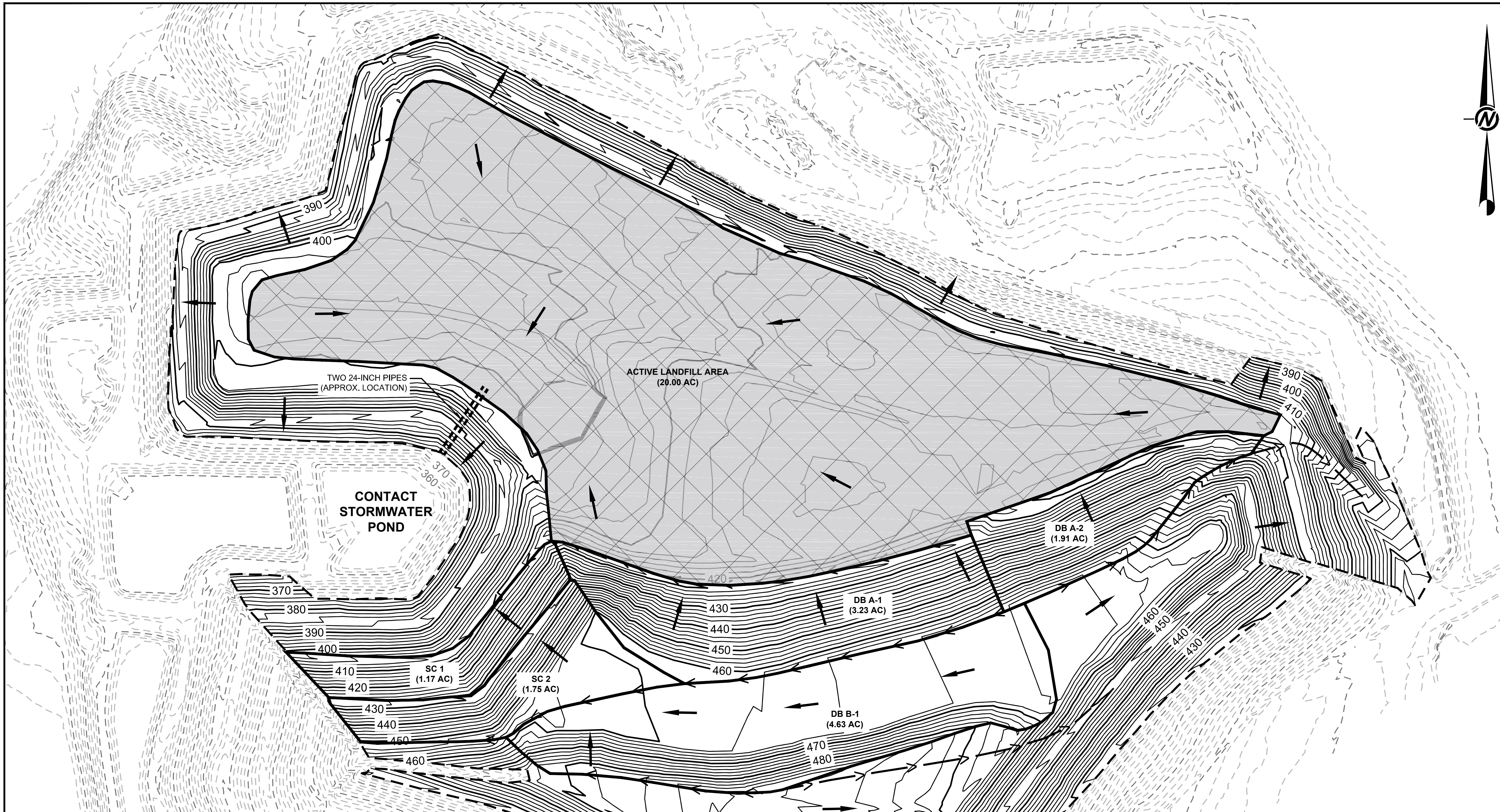
Where:

Slope = Channel longitudinal slope ft/ft
n = Manning's roughness coefficient
Z1, Z2 = Channel sideslope (H:1)
Pw = Channel wetted perimeter, ft
r = Hydraulic radius, ft
V = Flow Velocity, ft/s
Q = Flow Volume, ft^3/s

As shown in the tables, the diversion berm and bench channel maintain non-erosive velocities during the 2-year storm event (< 2 ft/s) and contain the flows from the 25-year storm event.

Attachments

Figure 2	Stage 3 Drainage Area Map
Attachment 2	Hydrologic Soil Group information (Web Soil Survey)
Attachment 3	Precipitation Frequency Data Server (NOAA Atlas 14) information



LEGEND

—> —> —	STORMWATER DIVERSION / CHANNEL
→	SURFACE WATER FLOW DIRECTION
—200—	EXISTING TOPOGRAPHIC CONTOUR (10' INTERVAL)
——	EXISTING TOPOGRAPHIC CONTOUR (2' INTERVAL)
—200—	PROPOSED TOPOGRAPHIC CONTOUR (10' INTERVAL)
——	PROPOSED TOPOGRAPHIC CONTOUR (2' INTERVAL)
▭	LIMITS OF ACTIVE PORTION

SOURCE: TOPOGRAPHY COMPLIED THROUGH MULTIPLE SURVEYS INCLUDING THE 06/30/16 SURVEY BY HEADWATERS PLANT SERVICES (HPS) OF THE ACTIVE PORTION AND IMMEDIATE SURROUNDINGS AREAS.

200 0 200

SCALE FEET

Golder Associates
Richmond, Virginia

PROJECT

DOMINION
CLOVER POWER STATION
HALIFAX COUNTY, VA

TITLE

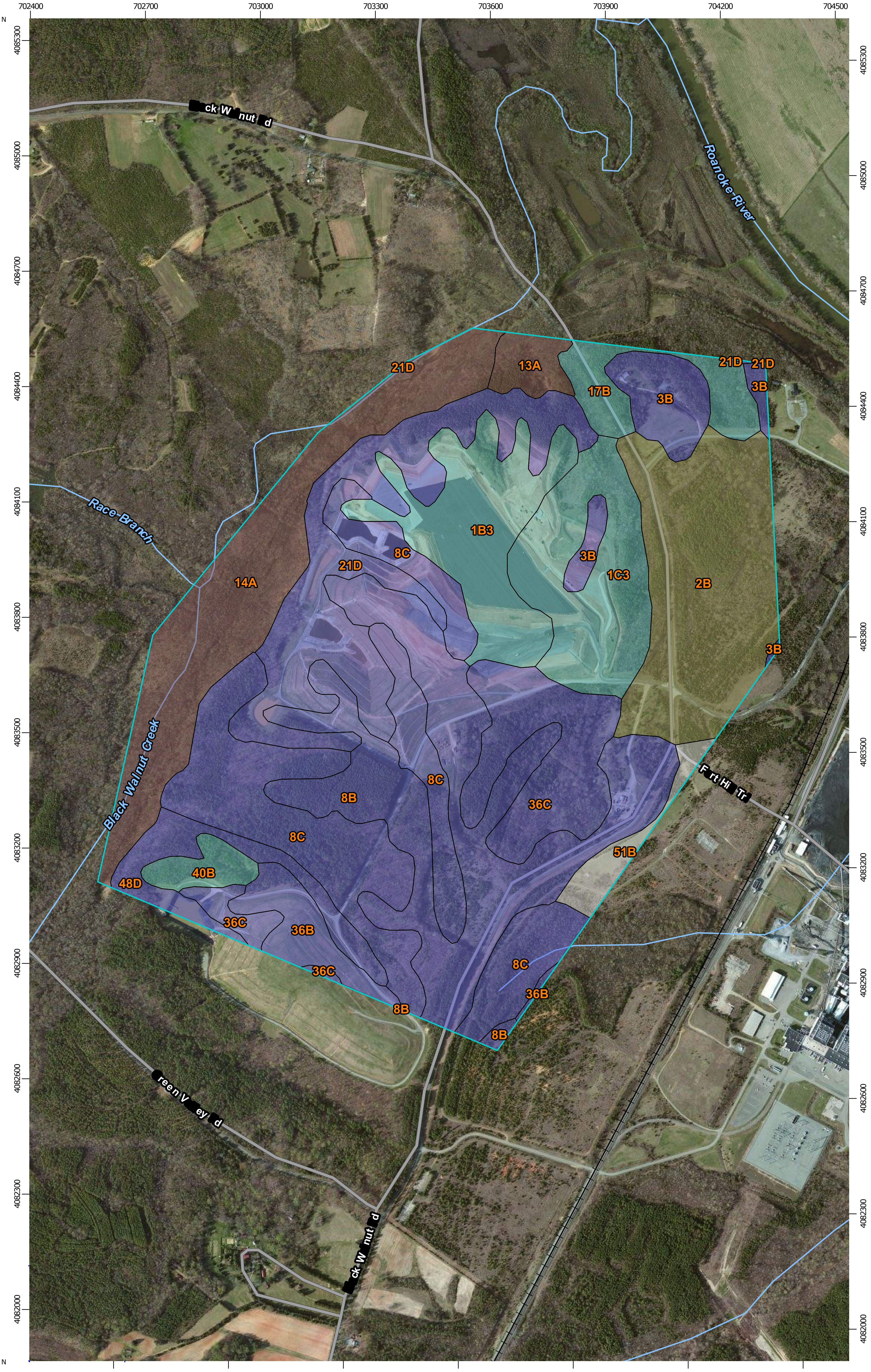
DRAINAGE AREA MAP
STAGE 3 LANDFILL

PROJECT No.		113-96277
FILE No.		RORO PLAN
REV. 0	SCALE	AS SHOWN
DESIGN	DPM	08/16/16
CADD	SIB	08/16/16
CHECK		
REVIEW		

FIGURE 2

Hydrologic Soil Group—Halifax County and the City of South Boston, Virginia
(Clover)

78° 43' 43" W | 78° 42' 16" W
36° 53' 33" N | 36° 51' 39" N



Map Scale: 1:9,780 if printed on B portrait (11" x 17") sheet.

Meters: 0 100 200 400 600

Feet: 0 450 900 1800 2700

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Halifax County and the City of South Boston, Virginia
Survey Area Data: Version 14, Sep 30, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 10, 2010—Apr 4, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Halifax County and the City of South Boston, Virginia (VA083)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1B3	Appomattox clay loam, 2 to 8 percent slopes, severely eroded	C	39.9	7.2%
1C3	Appomattox clay loam, 8 to 15 percent slopes, severely eroded	C	39.2	7.1%
2B	Banister-Kinkora complex, 0 to 4 percent slopes, rarely flooded	C/D	64.5	11.6%
3B	Bentley loamy sand, 2 to 8 percent slopes	B	18.0	3.2%
8B	Clifford sandy loam, 2 to 8 percent slopes	B	87.3	15.8%
8C	Clifford sandy loam, 8 to 15 percent slopes	B	85.4	15.4%
13A	Codorus loam, 0 to 2 percent slopes, occasionally flooded	B/D	7.0	1.3%
14A	Codorus and Hatboro soils, 0 to 2 percent slopes, frequently flooded	B/D	63.0	11.4%
17B	Danripple sandy loam, 2 to 8 percent slopes, very rarely flooded	C	13.9	2.5%
21D	Fairview sandy loam, 15 to 25 percent slopes	B	55.5	10.0%
36B	Nathalie sandy loam, 2 to 8 percent slopes	B	12.9	2.3%
36C	Nathalie sandy loam, 8 to 15 percent slopes	B	37.7	6.8%
40B	Rasalo-Orange complex, 2 to 8 percent slopes	C	6.7	1.2%
48D	Toast sandy loam, 15 to 25 percent slopes	B	15.7	2.8%
51B	Udorthents loamy, 2 to 8 percent slopes		7.3	1.3%
Totals for Area of Interest			**554.0**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher

NOAA Atlas 14, Volume 2, Version 3
Location name: Clover, Virginia, US*
Latitude: 36.8741°, Longitude: -78.7158°
Elevation: 483 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	0.364 (0.324-0.408)	0.430 (0.383-0.482)	0.504 (0.449-0.564)	0.564 (0.502-0.629)	0.632 (0.559-0.703)	0.680 (0.600-0.756)	0.727 (0.638-0.807)	0.767 (0.670-0.853)	0.814 (0.707-0.908)	0.850 (0.733-0.948)
10-min	0.581 (0.518-0.651)	0.688 (0.613-0.770)	0.808 (0.719-0.903)	0.902 (0.803-1.01)	1.01 (0.892-1.12)	1.08 (0.955-1.20)	1.16 (1.01-1.28)	1.22 (1.06-1.35)	1.29 (1.12-1.44)	1.34 (1.16-1.49)
15-min	0.727 (0.647-0.814)	0.864 (0.771-0.968)	1.02 (0.910-1.14)	1.14 (1.01-1.27)	1.28 (1.13-1.42)	1.37 (1.21-1.52)	1.46 (1.28-1.62)	1.53 (1.34-1.71)	1.62 (1.41-1.81)	1.68 (1.45-1.87)
30-min	0.996 (0.887-1.12)	1.19 (1.06-1.34)	1.45 (1.29-1.62)	1.65 (1.47-1.84)	1.89 (1.67-2.10)	2.07 (1.82-2.30)	2.23 (1.96-2.48)	2.39 (2.08-2.66)	2.58 (2.24-2.88)	2.72 (2.35-3.04)
60-min	1.24 (1.11-1.39)	1.50 (1.34-1.68)	1.86 (1.66-2.08)	2.15 (1.92-2.40)	2.52 (2.23-2.80)	2.80 (2.47-3.11)	3.08 (2.70-3.42)	3.35 (2.92-3.73)	3.70 (3.21-4.13)	3.97 (3.43-4.43)
2-hr	1.47 (1.30-1.65)	1.77 (1.57-1.99)	2.21 (1.96-2.49)	2.59 (2.29-2.90)	3.07 (2.70-3.43)	3.47 (3.03-3.86)	3.86 (3.35-4.30)	4.27 (3.68-4.75)	4.81 (4.11-5.36)	5.25 (4.45-5.85)
3-hr	1.57 (1.40-1.77)	1.90 (1.69-2.14)	2.37 (2.10-2.67)	2.77 (2.45-3.11)	3.29 (2.89-3.69)	3.71 (3.25-4.16)	4.15 (3.60-4.63)	4.58 (3.95-5.11)	5.16 (4.41-5.76)	5.63 (4.77-6.29)
6-hr	1.92 (1.70-2.17)	2.31 (2.05-2.61)	2.88 (2.55-3.26)	3.39 (2.99-3.82)	4.06 (3.56-4.57)	4.64 (4.04-5.21)	5.23 (4.52-5.87)	5.86 (5.00-6.55)	6.73 (5.67-7.50)	7.45 (6.21-8.31)
12-hr	2.30 (2.07-2.60)	2.77 (2.49-3.14)	3.48 (3.11-3.92)	4.12 (3.67-4.63)	5.00 (4.42-5.60)	5.77 (5.06-6.43)	6.59 (5.72-7.31)	7.47 (6.41-8.27)	8.74 (7.37-9.65)	9.83 (8.16-10.9)
24-hr	2.68 (2.46-2.96)	3.25 (2.98-3.58)	4.15 (3.79-4.57)	4.91 (4.47-5.40)	6.02 (5.44-6.61)	6.98 (6.27-7.64)	8.02 (7.16-8.78)	9.17 (8.11-10.0)	10.9 (9.48-11.9)	12.3 (10.6-13.5)
2-day	3.15 (2.90-3.45)	3.82 (3.52-4.18)	4.84 (4.45-5.30)	5.69 (5.21-6.21)	6.90 (6.29-7.54)	7.92 (7.19-8.65)	9.01 (8.12-9.84)	10.2 (9.11-11.1)	11.9 (10.5-13.0)	13.3 (11.6-14.6)
3-day	3.33 (3.07-3.65)	4.04 (3.71-4.42)	5.12 (4.70-5.60)	6.00 (5.50-6.57)	7.29 (6.64-7.96)	8.36 (7.58-9.12)	9.51 (8.56-10.4)	10.7 (9.60-11.7)	12.5 (11.1-13.7)	14.0 (12.3-15.4)
4-day	3.52 (3.23-3.85)	4.25 (3.91-4.67)	5.39 (4.95-5.90)	6.33 (5.79-6.92)	7.67 (6.99-8.38)	8.80 (7.97-9.60)	10.0 (9.01-10.9)	11.3 (10.1-12.3)	13.2 (11.6-14.4)	14.7 (12.9-16.2)
7-day	4.05 (3.73-4.43)	4.87 (4.49-5.32)	6.08 (5.58-6.63)	7.06 (6.48-7.71)	8.48 (7.74-9.23)	9.65 (8.77-10.5)	10.9 (9.83-11.9)	12.2 (11.0-13.3)	14.1 (12.5-15.4)	15.7 (13.8-17.2)
10-day	4.60 (4.26-5.00)	5.51 (5.10-5.99)	6.80 (6.28-7.38)	7.84 (7.23-8.51)	9.31 (8.55-10.1)	10.5 (9.61-11.4)	11.8 (10.7-12.7)	13.1 (11.8-14.2)	14.9 (13.4-16.2)	16.4 (14.6-17.9)
20-day	6.23 (5.81-6.71)	7.42 (6.92-7.98)	8.97 (8.34-9.64)	10.2 (9.44-10.9)	11.8 (10.9-12.7)	13.1 (12.1-14.1)	14.4 (13.2-15.5)	15.8 (14.4-16.9)	17.6 (15.9-18.9)	19.0 (17.1-20.4)
30-day	7.70 (7.23-8.20)	9.12 (8.57-9.70)	10.8 (10.1-11.5)	12.0 (11.3-12.8)	13.7 (12.8-14.5)	14.9 (13.9-15.8)	16.1 (15.0-17.1)	17.3 (16.1-18.4)	18.9 (17.4-20.1)	20.0 (18.4-21.4)
45-day	9.71 (9.16-10.3)	11.5 (10.8-12.1)	13.4 (12.6-14.2)	14.8 (13.9-15.7)	16.7 (15.7-17.6)	18.0 (16.9-19.1)	19.4 (18.1-20.5)	20.6 (19.2-21.9)	22.2 (20.6-23.6)	23.4 (21.6-24.9)
60-day	11.6 (10.9-12.2)	13.6 (12.9-14.4)	15.7 (14.8-16.6)	17.3 (16.3-18.2)	19.3 (18.2-20.3)	20.7 (19.5-21.9)	22.1 (20.8-23.4)	23.4 (22.0-24.8)	25.1 (23.4-26.6)	26.3 (24.4-27.9)

[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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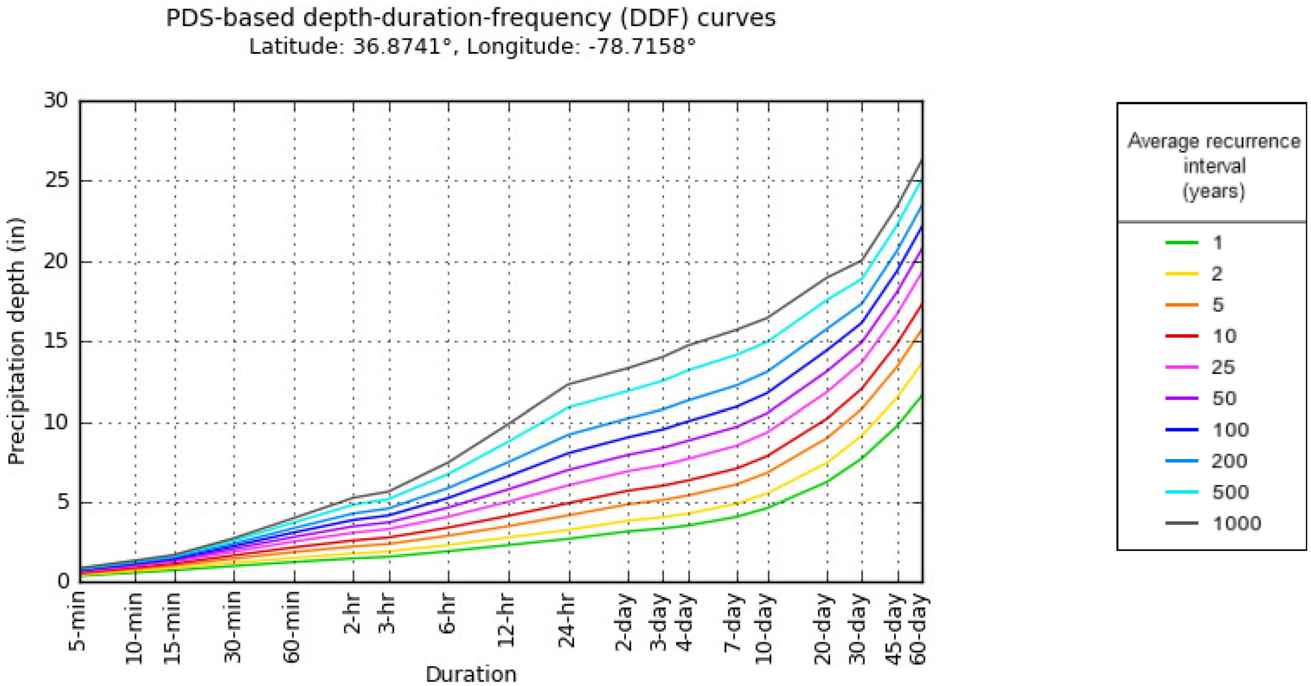
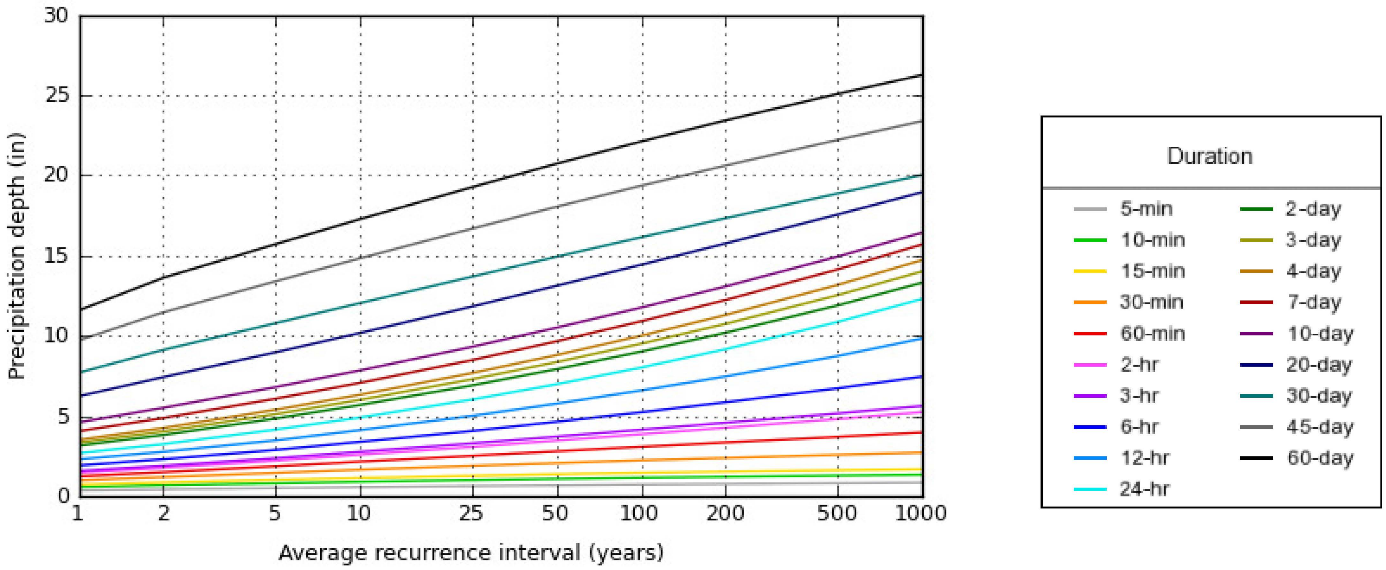
PF graphical





NOAA Atlas 14, Volume 2, Version 3 Created (GMT): Thu Aug 4 18:50:39 2016

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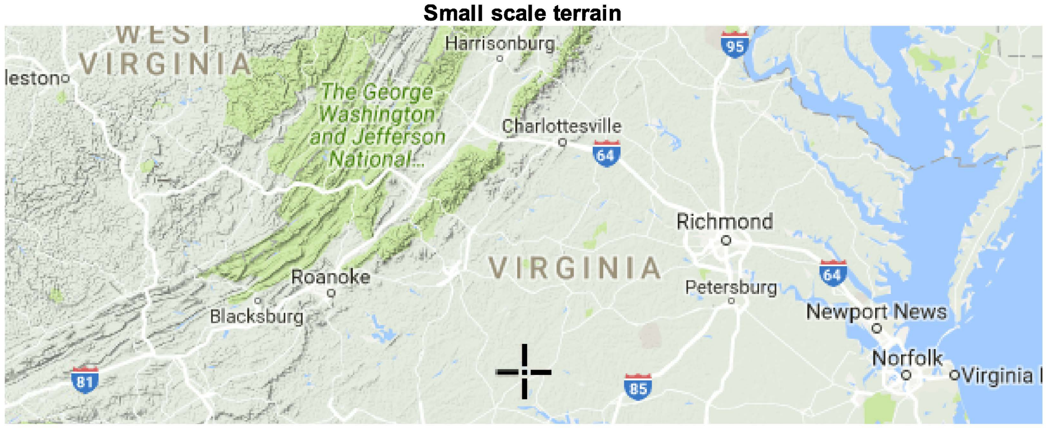
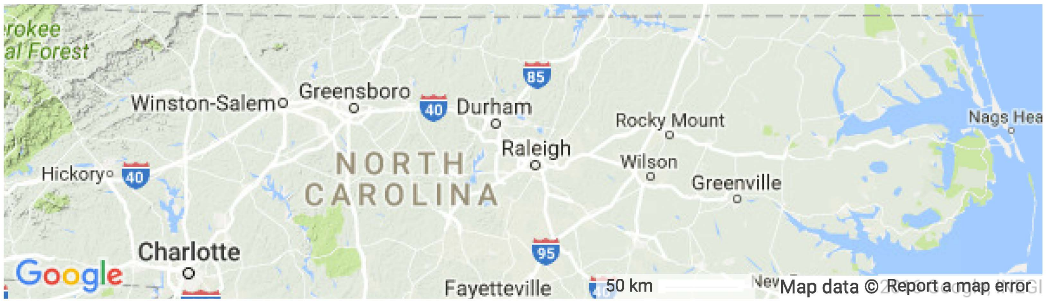
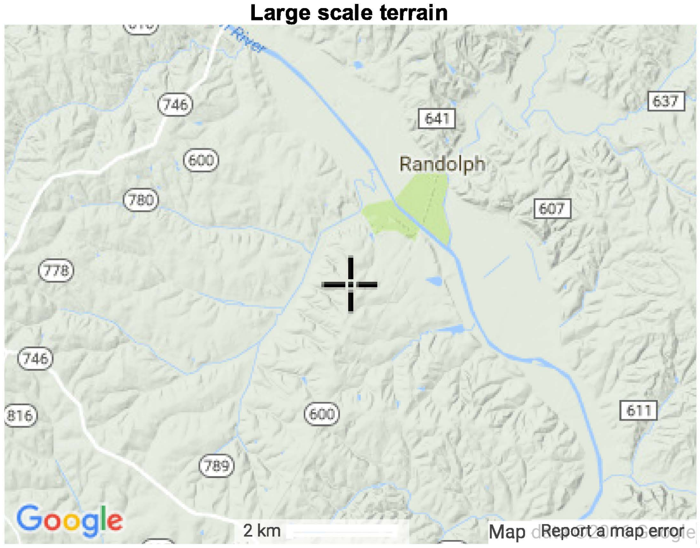
Maps & aerials

Small scale terrain



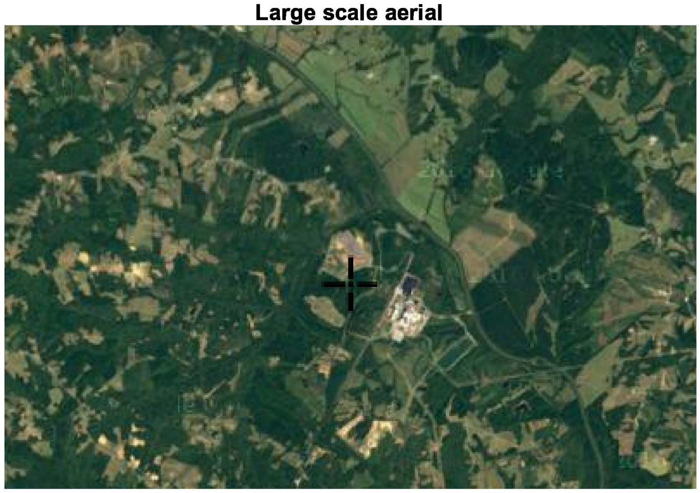


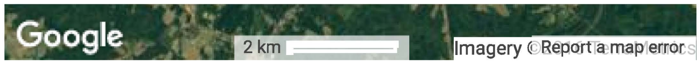
Large scale terrain



Large scale map

Large scale aerial





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National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
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Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

Appendix 2

Stormwater Run-Off Calculations

1.0 OBJECTIVE

These calculations determine the adequacy of the proposed run-off control measures for the active portion of the Clover Stage 3 Landfill. The run-off controls include a series of sediment traps and diversion berms which direct stormwater from the active portion into the leachate basin 2A.

2.0 METHOD

The peak stormwater flows were determined for the run-off controls using the methodology described in NRCS technical Release 55 (TR-55) and the Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS). Precipitation information was collected from the NOAA Atlas 14 database for the site:

2-year (24-hr)	3.25 in
10-year (24-hr)	4.91 in
25-year (24-hr)	6.02 in

The active portion of Stage 3 is continually receiving CCR, which makes specific hydrologic analysis unrealistic. This section describes the conceptual practices that will be used to control run-off from the open area of the Stage 3 landfill.

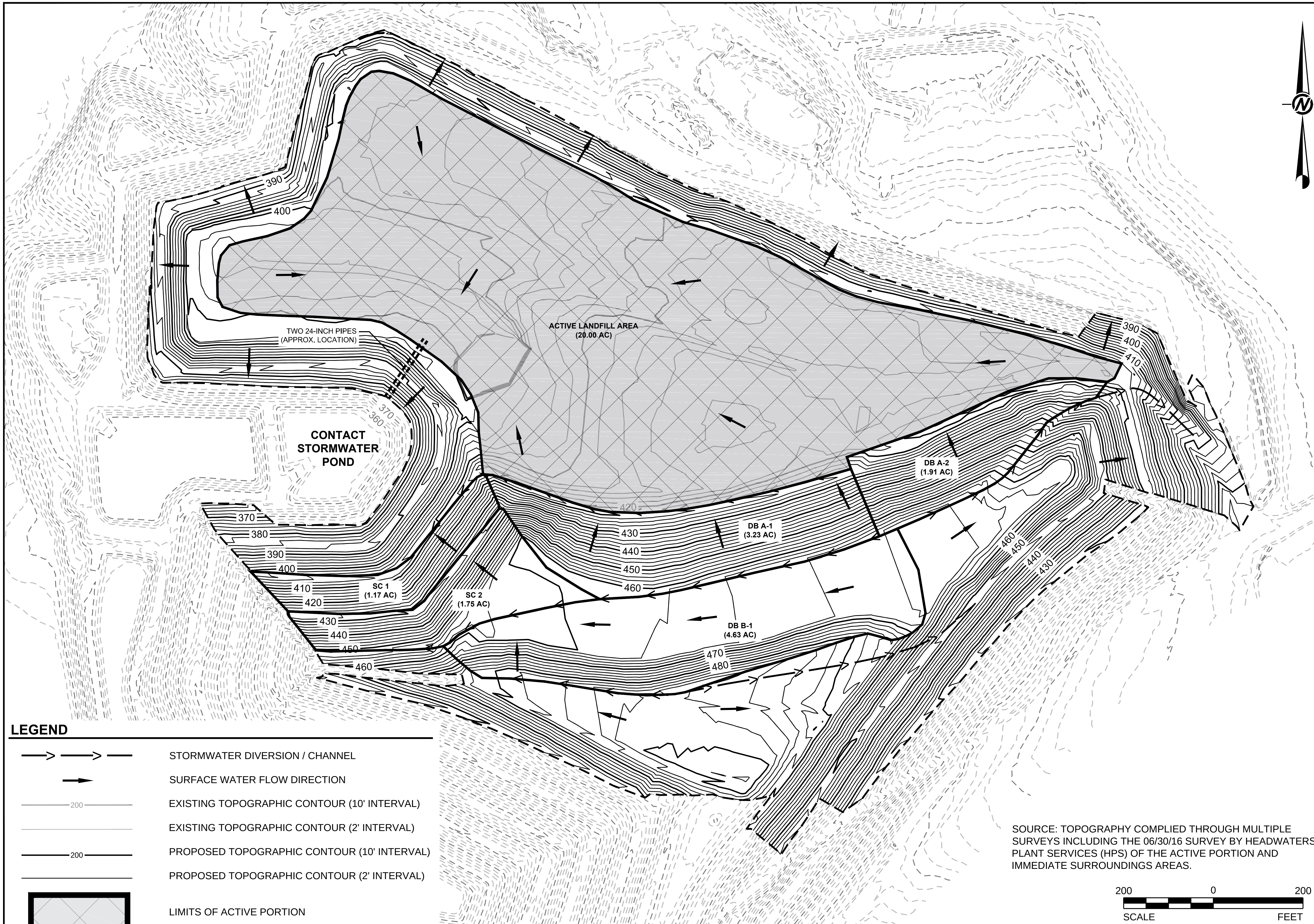
The active portion is approximately 20.0 acres, as shown in Attachment 1, and will be divided into at approximately seven, 3-acre-maximum drainage areas which drain to temporary sediment traps. Diversion dikes will be used, as necessary, to direct run-off to the sediment traps. The sediment traps will direct run-off to two 24-inch pipes that will transport runoff to the contact stormwater pond. As CCR filling continues, the active area will get smaller and consequently the stormwater runoff rate will decrease.

In accordance with the Virginia Erosion and Sediment Control Handbook (VESCH) Standard and Specification 3.13, the sediment traps will receive run-off from areas of 3 acres or smaller. Each sediment trap will be sized so that it has at least 67 yd^3 of wet storage and 67 yd^3 of dry storage for each acre draining to it – approximately 201 yd^3 of wet storage and 201 yd^3 of dry storage for a 3-acre area. Temporary diversion dikes (Standard and Specification 3.09) can be used to direct run-off into the sediment traps as needed.

The peak stormwater flow from the 20-acre area during the 25-year storm event is approximately 50 ft^3/s. This flow results in a headwater depth of approximately 3 feet upstream of the two 24-inch pipes. The compacted soil berm around the inlet of the 24-inch pipes will be raised to an elevation of at least 3.5 feet, and extended around the active portion as needed, to prevent run-off from bypassing the pipes. Construction details of the slope drain are included in Attachment 4 (VESCH Standard and Specification 3.15), with the compacted soil berm height of at least 3.5 feet as noted.

Attachments

Figure 2	Stage 3 Drainage Area Map
Attachment 2	VESCH Standard and Specification 3.09 *Temporary Diversion Dike*
Attachment 3	VESCH Standard and Specification 3.13 *Temporary Sediment Trap*
Attachment 4	VESCH Standard and Specification 3.14 *Temporary Slope Drain*



Golder Associates
Richmond, Virginia

PROJECT

DOMINION
CLOVER POWER STATION
HALIFAX COUNTY, VA

TITLE

DRAINAGE AREA MAP
STAGE 3 LANDFILL

PROJECT No.		113-96277
FILE No.		RORO PLAN
REV. 0	SCALE	AS SHOWN
DESIGN	DPM	08/16/16
CADD	SIB	08/16/16
CHECK		
REVIEW		

FIGURE 2

STD & SPEC 3.09

TEMPORARY DIVERSION DIKE

(DD)

Definition

A temporary ridge of compacted soil constructed at the top or base of a sloping disturbed area.

Purposes

1. To divert storm runoff from upslope drainage areas away from unprotected disturbed areas and slopes to a stabilized outlet.

2. To divert sediment-laden runoff from a disturbed area to a sediment-trapping facility such as a sediment trap or sediment basin.

Conditions Where Practice Applies

Wherever stormwater runoff must be temporarily diverted to protect disturbed areas and slopes or retain sediment on site during construction. These structures generally have a life expectancy of 18 months or less, which can be prolonged with proper maintenance.

Planning Considerations

A temporary diversion dike is intended to divert overland sheet flow to a stabilized outlet or a sediment-trapping facility during establishment of permanent stabilization on sloping disturbed areas. When used a the top of a slope, the structure protects exposed slopes by keeping upland runoff away. When used at the base of a slope, the structure protects adjacent and downstream areas by diverting sediment-laden runoff to a sediment trapping facility.

As per M.S. #5, it is very important that a temporary diversion dike be stabilized immediately following installation with temporary or permanent vegetation to prevent erosion of the dike itself. The gradient of the channel behind the dike is also an important consideration. The dike must have a positive grade to assure drainage, but if the gradient is too great, precautions must be taken to prevent erosion due to high-velocity channel flow behind the dike. The cross-section of the channel which runs behind the dike should be of a parabolic or trapezoidal shape to help inhibit a high velocity of flow which could arise in a vee ditch.

This practice is considered an economical one because it uses material available on the site and can usually be constructed with equipment needed for site grading. The useful life of the practice can be extended by stabilizing the dike with vegetation. Diversion dikes are preferable to silt fence because they are more durable, less expensive, and require much less maintenance when constructed properly. Along with a TEMPORARY SEDIMENT TRAP (Std. & Spec. 3.13), they become a logical choice for a control measure once the control limits of the silt fence or straw bale barrier have been exceeded.

Temporary diversion dikes are often used as a perimeter control in association with a sediment trap or a sediment basin, or a series of sediment-trapping facilities, on moderate to large construction sites. If installed properly and in the first phase of grading, maintenance costs are very low. Often, cleaning of sediment-trapping facilities is the only associated maintenance requirement.

As specified herein, this practice is intended to be temporary. However, with more stringent design criteria, it can be made permanent in accordance with DIVERSIONS (Std. & Spec. 3.12).

Design Criteria

No formal design is required. The following criteria shall be met:

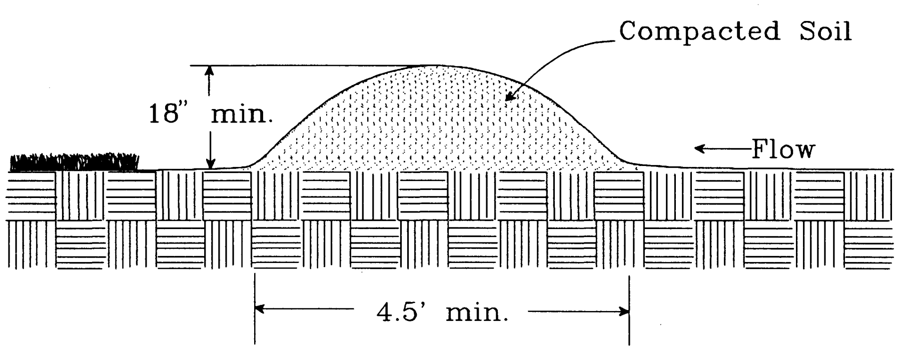
Drainage Area

The maximum allowable drainage area is 5 acres.

Height

The minimum allowable height measured from the upslope side of the dike is 18 inches (see Plate 3.09-1).

TEMPORARY DIVERSION DIKE



Source: Va. DSWC

Plate 3.09-1

Side Slopes

1½:1 or flatter, along with a minimum base width of 4.5 feet (see Plate 3.09-1).

Grade

The channel behind the dike shall have a positive grade to a stabilized outlet. If the channel slope is less than or equal to 2%, no stabilization is required. If the slope is greater than 2%, the channel shall be stabilized in accordance with Std. & Spec. 3.17, STORMWATER CONVEYANCE CHANNEL.

Outlet

1. The diverted runoff, if free of sediment, must be released through a stabilized outlet or channel.

2. Sediment-laden runoff must be diverted and released through a sediment-trapping facility such as a TEMPORARY SEDIMENT TRAP (Std. & Spec. 3.13) or TEMPORARY SEDIMENT BASIN (Std. & Spec. 3.14).

Construction Specifications

1. Temporary diversion dikes must be installed as a first step in the land-disturbing activity and must be functional prior to upslope land disturbance.

2. The dike should be adequately compacted to prevent failure.

3. Temporary or permanent seeding and mulch shall be applied to the dike immediately following its construction.

4. The dike should be located to minimize damages by construction operations and traffic.

Maintenance

The measure shall be inspected after every storm and repairs made to the dike, flow channel, outlet or sediment trapping facility, as necessary. Once every two weeks, whether a storm event has occurred or not, the measure shall be inspected and repairs made if needed. Damages caused by construction traffic or other activity must be repaired before the end of each working day.

STD & SPEC 3.13

TEMPORARY SEDIMENT TRAP

ST

Definition

A temporary ponding area formed by constructing an earthen embankment with a stone outlet.

Purpose

To detain sediment-laden runoff from small disturbed areas long enough to allow the majority of the sediment to settle out.

Conditions Where Practice Applies

1. Below disturbed areas where the total contributing drainage area is less than 3 acres.

2. Where the sediment trap will be used no longer than 18 months (the maximum useful life is 18 months).

3. The sediment trap may be constructed either independently or in conjunction with a TEMPORARY DIVERSION DIKE (Std. & Spec. 3.09).

Planning Considerations

Sediment traps should be used only for small drainage areas. If the contributing drainage area is 3 acres or greater, refer to SEDIMENT BASIN (Std. & Spec. 3.14).

Sediment traps, along with other perimeter controls intended to trap sediment, shall be constructed as a first step in any land-disturbing activity and shall be made functional before upslope land disturbance takes place.

Recent studies have been conducted on the performance of sediment traps (and basins) which were constructed using the design criteria found in previous editions of this handbook. The studies indicate that the control measures only achieved a 46% removal of sediment which flowed into them during storm events which caused measurable outflow. To achieve a more acceptable removal rate (60%), it was necessary to revise the design of these measures in this handbook. The total initial storage volume for both the sediment trap and the TEMPORARY SEDIMENT BASIN (Std. & Spec. 3.14) has been doubled. There are both a "wet" storage volume and a drawdown or "dry" storage volume which help to enhance sediment fall-out and prevent excessive sediment losses during large storm events which occur during the advanced stages of land disturbance (28).

In most cases excavation will be required to attain the necessary storage volume. Also, sediment must be periodically removed from the trap to maintain the required volume. Plans should detail how excavated sediment is to be disposed of, such as by use in fill areas on site or removal to an approved off-site location.

As noted previously in this handbook, there are numerous other acceptable ways to design many of the erosion control practices within. This is certainly true in the case of the sediment trap. However, variations in its design should be considered judiciously by plan reviewers to ensure that the minimum storage requirements and structural integrity noted in this specification are maintained.

Design Criteria

Trap Capacity

The sediment trap must have an initial storage volume of 134 cubic yards per acre of drainage area, half of which shall be in the form of a permanent pool or wet storage to provide a stable settling medium. The remaining half shall be in the form of a drawdown or dry storage which will provide extended settling time during less frequent, larger storm events. The volume of the wet storage shall be measured from the low point of the excavated area to the base of the stone outlet structure. The volume of the dry storage shall be measured from the base of the stone outlet to the crest of the stone outlet (overflow mechanism). Sediment should be removed from the basin when the volume of the wet storage is reduced by one-half.

For a sediment trap, the wet storage volume may be approximated as follows:

$$V_1 = 0.85 \times A_1 \times D_1$$

where,

V_1 = the wet storage volume in cubic feet

A_1 = the surface area of the flooded area at the base of the stone outlet in square feet

D_1 = the maximum depth in feet, measured from the low point in the trap to the base of the stone outlet

The dry storage volume may be approximated as follows:

$$V_2 = \frac{A_1 + A_2}{2} \times D_2$$

where,

V_2 = the dry storage volume in cubic feet

A_1 = the surface area of the flooded area at the base of the stone outlet in square feet

A_2 = the surface area of the flooded area at the crest of the stone outlet (overflow mechanism), in square feet

D_2 = the depth in feet, measured from the base of the stone outlet to the crest of the stone outlet

The designer should seek to provide a storage area which has a minimum 2:1 length to width ratio (measured from point of maximum runoff introduction to outlet).

Note: Conversion between cubic feet and cubic yards is as follows:

number of cubic feet x 0.037 = number of cubic yards

Excavation

Side slopes of excavated areas should be no steeper than 1:1. The maximum depth of excavation within the wet storage area should be 4 feet to facilitate clean-out and for site safety considerations.

Outlet

The outlet for the sediment trap shall consist of a stone section of the embankment located at the low point in the basin. A combination of coarse aggregate and riprap shall be used to provide for filtering/detention as well as outlet stability. The smaller stone shall be VDOT #3, #357, or #5 Coarse Aggregate (smaller stone sizes will enhance filter efficiency) and riprap shall be "Class I." Filter cloth which meets the physical requirements noted in Std. & Spec. 3.19, RIPRAP shall be placed at the stone-soil interface to act as a "separator." The minimum length of the outlet shall be 6 feet times the number of acres comprising the total area draining to the trap. The crest of the stone outlet must be at least 1.0 foot below the top of the embankment to ensure that the flow will travel over the stone and not the embankment. The outlet shall be configured as noted in Plate 3.13-2.

Embankment Cross-Section

The maximum height of the sediment trap embankment shall be 5 feet as measured from the base of the stone outlet. Minimum top widths (W) and outlet heights (Ho) for various embankment heights (H) are shown in Plate 3.13-1. Side slopes of the embankment shall be 2:1 or flatter.

Removal

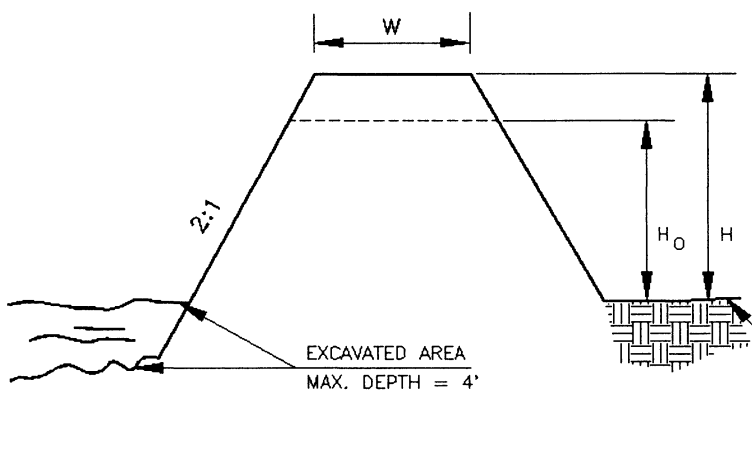
Sediment traps must be removed after the contributing drainage area is stabilized. Plans should show how the site of the sediment trap is to be graded and stabilized after removal.

Construction Specifications

1. The area under the embankment shall be cleared, grubbed, and stripped of any vegetation and root mat.

2. Fill material for the embankment shall be free of roots or other woody vegetation, organic material, large stones, and other objectionable material. The embankment should be compacted in 6-inch layers by traversing with construction equipment.

MINIMUM TOP WIDTH (W) REQUIRED FOR SEDIMENT TRAP EMBANKMENTS ACCORDING TO HEIGHT OF EMBANKMENT (FEET)



H	H_O	W
1.5	0.5	2.0
2.0	1.0	2.0
2.5	1.5	2.5
3.0	2.0	2.5
3.5	2.5	3.0
4.0	3.0	3.0
4.5	3.5	4.0
5.0	4.0	4.5

Source: Va. DSWC

Plate 3.13-1

3. The earthen embankment shall be seeded with temporary or permanent vegetation (see Std. & Spec.'s 3.31 and 3.32) immediately after installation.

4. Construction operations shall be carried out in such a manner that erosion and water pollution are minimized.

5. The structure shall be removed and the area stabilized when the upslope drainage area has been stabilized.

6. All cut and fill slopes shall be 2:1 or flatter (except for excavated, wet storage area which may be at a maximum 1:1 grade).

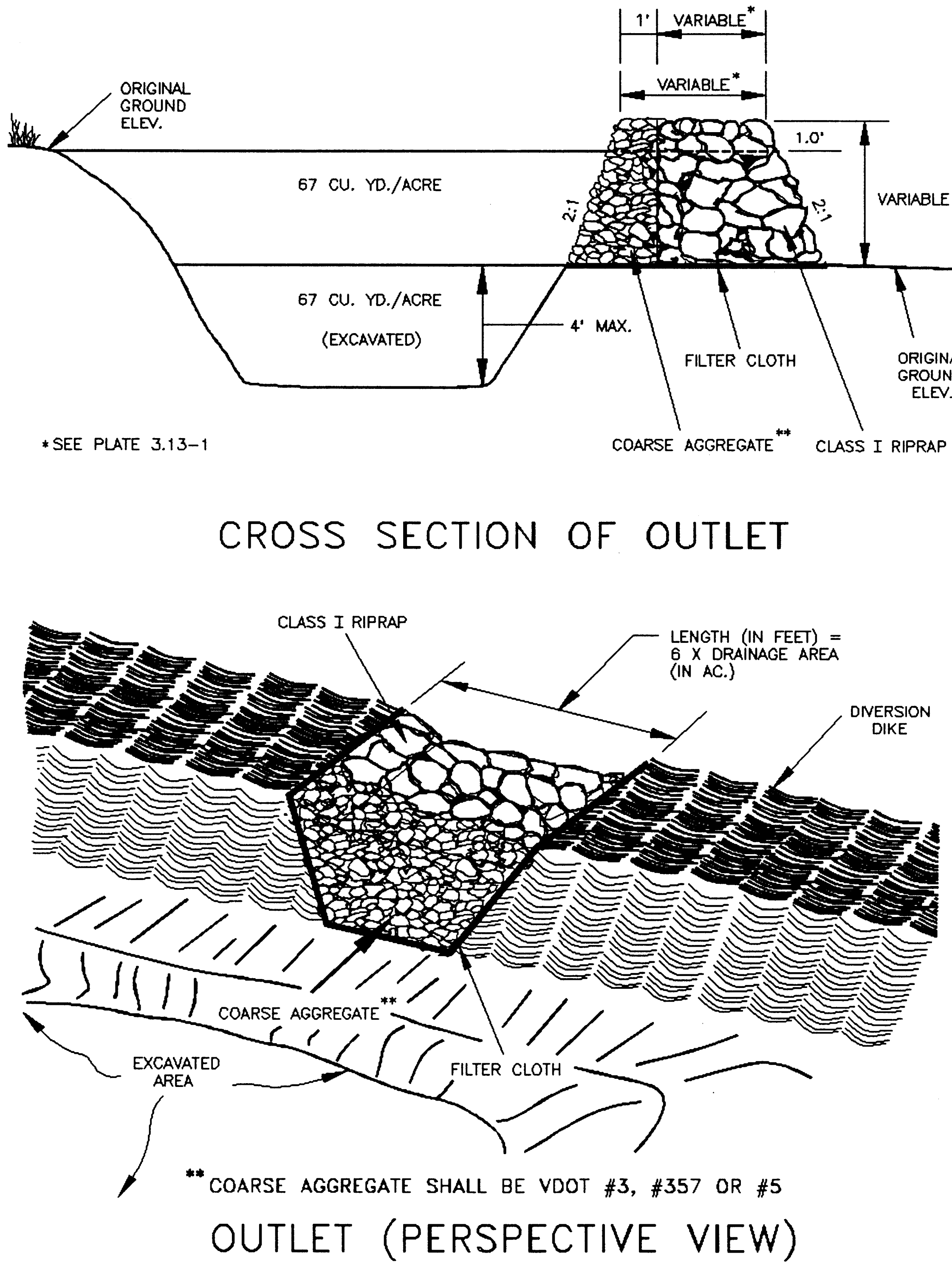
Maintenance

1. Sediment shall be removed and the trap restored to its original dimensions when the sediment has accumulated to one half the design volume of the wet storage. Sediment removal from the basin shall be deposited in a suitable area and in such a manner that it will not erode and cause sedimentation problems.

2. Filter stone shall be regularly checked to ensure that filtration performance is maintained. Stone choked with sediment shall be removed and cleaned or replaced.

3. The structure should be checked regularly to ensure that it is structurally sound and has not been damaged by erosion or construction equipment. The height of the stone outlet should be checked to ensure that its center is at least 1 foot below the top of the embankment.

TEMPORARY SEDIMENT TRAP



Source: Va. DSWC

Plate 3.13-2

STD & SPEC 3.15

TEMPORARY SLOPE DRAIN

Definition

A flexible tubing or conduit extending from the top to the bottom of a cut or fill slope.

Purpose

To temporarily conduct concentrated stormwater runoff safely down the face of a cut or fill slope without causing erosion on or below the slope.

Conditions Where Practice Applies

On cut or fill slopes where there is a potential for upslope flows to move over the face of the slope causing erosion and preventing adequate stabilization.

Planning Considerations

There is often a significant lag between the time a cut or fill slope is completed and the time a permanent drainage system can be installed. During this period, the slope is usually not stabilized and is particularly vulnerable to erosion. This situation also occurs on slope construction which is temporarily delayed before final grade is reached. Temporary slope drains can provide valuable protection of exposed slopes until permanent drainage structures can be installed or vegetation can be established.

Temporary slope drains can be used in conjunction with diversion dikes to convey runoff from the entire drainage area above a slope to the base of the slope without erosion. It is very important that these temporary structures be installed properly, since their failure will often result in severe gully erosion on the site and sedimentation below the slope. The entrance section must be securely entrenched, all connections must be watertight, and the conduit must be staked securely.

Design Criteria

Drainage Area

The maximum allowable drainage area per slope drain is 5 acres.

Flexible Conduit

The slope drain shall consist of heavy-duty, flexible material designed for this purpose. The diameter of the slope drain shall be equal over its entire length. Reinforced hold-down grommets shall be spaced at 10-foot (or less) intervals. Slope drains shall be sized as listed in Table 3.15-A.

Entrance Sections

The entrance to the slope drain shall consist of a standard VDOT flared end-section for metal pipe culverts (see Plates 3.15-2 and 3.15-3) with appropriate inlet protection as set forth in CULVERT INLET PROTECTION, Std. & Spec. 3.08. If ponding will cause a problem at the entrance and make such protection impractical, appropriate sediment-removing measures shall be taken at the outlet of the pipe. Extension collars shall consist of 12-inch long corrugated metal pipe. Watertight fittings shall be provided (see Plate 3.15-1).

Note: End-sections made of heavy-duty, flexible material may be utilized if determined by the Plan-Approving Authority to provide a stable inlet or outlet section.

TABLE 3.15-A

SIZE OF SLOPE DRAIN

Maximum Drainage Area (acres)	Pipe Diameter (inches)
0.5	12
1.5	18
2.5	21
3.5	24
5.0	30

Source: Va. DSWC

Dike Design

An earthen dike shall be used to direct stormwater runoff into the temporary slope drain and shall be constructed as set forth in DIVERSION, Std. & Spec. 3.12. See Plate 3.15-1 for placement of dike in relation to the slope drain.

The height of the dike at the centerline of the inlet shall be equal to the diameter of the pipe plus 6 inches. Where the dike height is greater than 18 inches at the inlet, it shall be sloped at the rate of 3:1 or flatter to connect with the remainder of the dike (see Plate 3.15-1).

Outlet Protection

The outlet of the slope drain must be protected from erosion as set forth in OUTLET PROTECTION, Std. & Spec. 3.18.

Construction Specifications

1. The measure shall be placed on undisturbed soil or well-compacted fill.

2. The entrance section shall slope toward the slope drain at the minimum rate of 1/2-inch per foot.

3. The soil around and under the entrance section shall be hand-tamped in 8-inch lifts to the top of the dike to prevent piping failure around the inlet.

4. The slope drain shall be securely staked to the slope at the grommets provided.

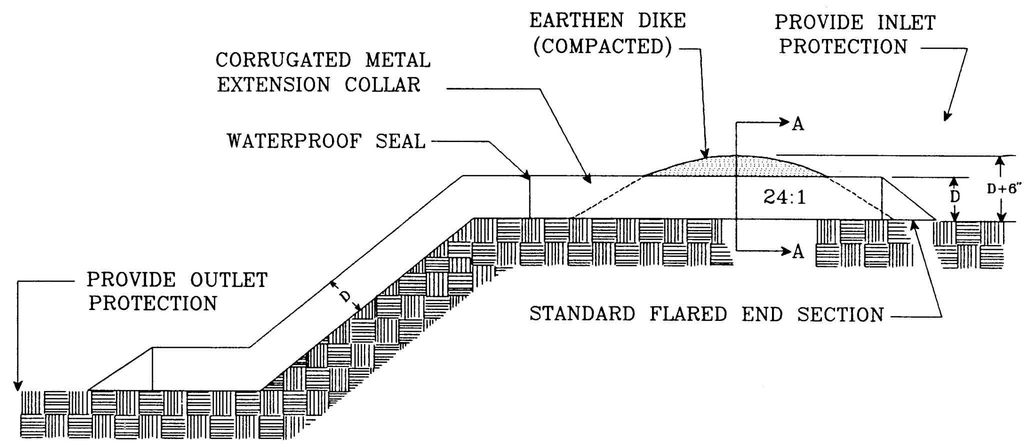
5. The slope drain sections shall be securely fastened together and have watertight fittings.

6. Install CULVERT INLET PROTECTION and OUTLET PROTECTION as per Std. & Spec.'s 3.08 and 3.18, respectively.

Maintenance

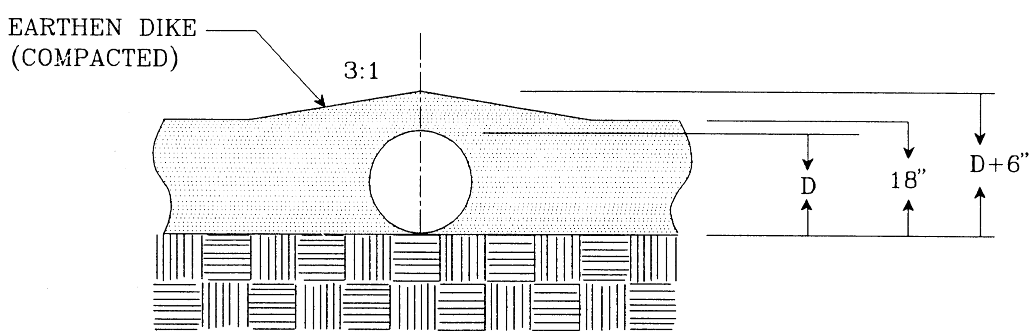
The slope drain structure shall be inspected weekly and after every storm, and repairs made if necessary. The contractor should avoid the placement of any material on and prevent construction traffic across the slope drain.

TEMPORARY SLOPE DRAIN



SECTION VIEW

NOTE: SEDIMENT MAY BE CONTROLLED AT OUTLET IF UPLAND PONDING WILL CREATE PROBLEMS

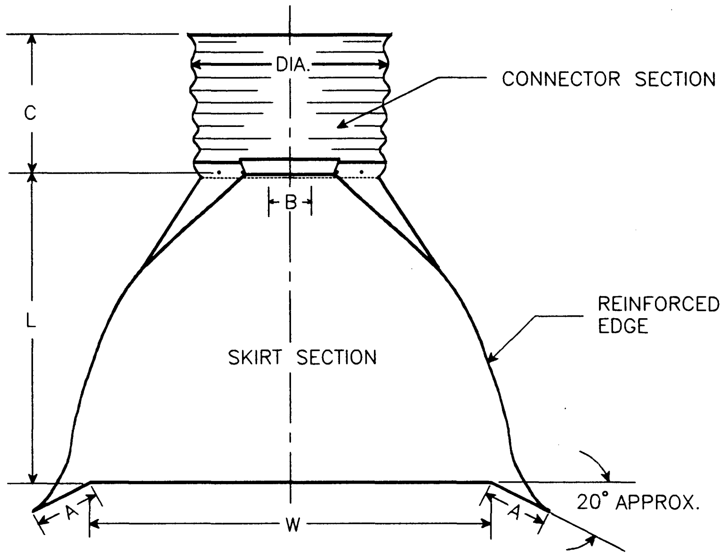


SECTION A – A

Source: Va. DSWC

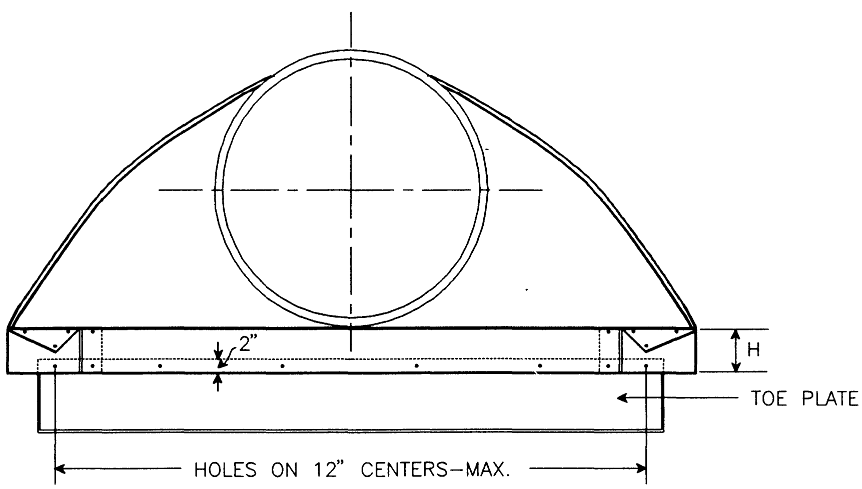
Plate 3.15-1

FLARED END–SECTION



PLAN

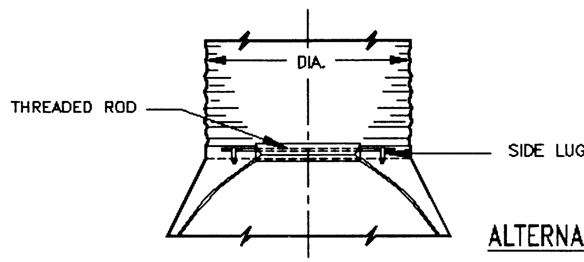
WHERE FLARED END–SECTIONS ARE
TO BE USED WITH BITUMINOUS
COATED AND PAVED METAL PIPE,
THEY ARE TO BE GALVANIZED ONLY.



ELEVATION

Source: VDOT <u>Road and Bridge Standards</u> Plate 3.15-2

FLARED END–SECTION
(CONTINUED)



ALTERNATE CONNECTION

TOE PLATE, WHERE NEEDED, TO BE PUNCHED TO MATCH IN SKIRT LIP. 3/8" GALV. BOLTS TO BE FURNISHED. LENGTH OF TOE PLATE IS W + 10" FOR 12" TO 30" DIA. PIPE AND W + 22" FOR 36" TO 60" DIA. PIPE.

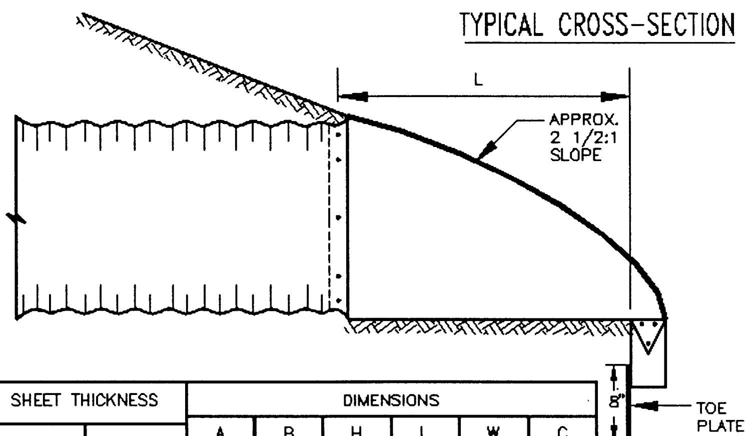
SKIRT SECTION FOR 12" TO 30" DIA. PIPE TO BE MADE IN ONE PIECE.

SKIRT SECTION FOR 36" TO 54" DIA. PIPE MAY BE MADE FROM TWO SHEETS JOINED BY RIVETING OR BOLTING ON CENTER LINE. 60" MAY BE CONSTRUCTED IN 3 PIECES.

CONNECTOR SECTION, CORNER PLATE AND TOE PLATE TO BE SAME SHEET THICKNESS AS SKIRT.

END–SECTIONS AND FITTINGS ARE TO BE GALVANIZED STEEL OR ALUMINUM ALLOY FOR USE WITH LIKE PIPE.

TYPICAL CROSS–SECTION



PIPE DIA.	SHEET THICKNESS		DIMENSIONS					
	STEEL	ALUMINUM	A 1" TOL.	B MAX.	H 1" TOL.	L 1 1/2" TOL.	W 2" TOL.	C
12"	.064"	.060"	6"	6"	6"	21"	24"	24"
15"	.064"	.060"	7"	8"	6"	26"	30"	24"
18"	.064"	.060"	8"	10"	6"	31"	36"	24"
21"	.064"	.060"	10"	12"	6"	36"	42"	24"
24"	.064"	.060"	10"	13"	6"	41"	48"	24"
27"/30"	.064"	.075"	12"	16"	8"	51"	60"	24"
36"	.064"	.075"	14"	19"	9"	60"	72"	36"
42"	.064"	.105"	16"	22"	11"	69"	84"	36"
48"	.064"	.105"	18"	27"	12"	78"	90"	24"
54"	.064"/.079"	.105"	18"	30"	12"	84"	102"	36"
60"	.064"/.109"	.105"/.135"	18"	33"	12"	87"	114"	36"

Source: VDOT Road and Bridge Standards

Plate 3.15-3

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