OBJECTIVE

The objective of this analysis is to evaluate the stormwater components of the closure cap system for capacity to adequately convey the 25-year storm event. The components designed under this set of engineering calculations include sideslope berms, downslope pipes, perimeter channels and an evaluation of the modified stormwater basin's performance. The design is to:

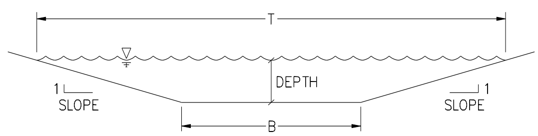
- Adequately convey the 25-year, 24-hour storm to the stormwater basin without overbank conditions in the sidelslope berms and perimeter channels; and,
- Be non-erosive for the 2-year stormwater flow.

METHOD

Evaluation of stormwater runoff will be made using hydraulic modeling software HEC-HMS (ref #1). Determining hydraulic grade line in channels is determined by the Manning equation (by spreadsheet analysis) at various cross sections. Each section evaluates the freeboard to determine adequate conveyance.

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

Where: Q= flow in cubic feet per second (cfs)
R = hydraulic radius, feet
A = cross sectional area of flow, ft^2
S = channel slope, ft/ft
n = Manning's coefficient of roughness



- Sideslope berms - the berms were designed to ensure at least one-half foot of freeboard during a 25-yr storm event and to ensure sufficient capacity during a 100-yr storm event.
- Perimeter channels- the perimeter channels were checked to provide freeboard for a 25-yr storm event.
- The stormwater basin will lined with a geomembrane liner and a new riser structure. Verify performance of the riser and that adequate freeboard remains in the basin under the evaluated design storms.

ASSUMPTIONS

1. The surface Runoff Curve Numbers (CN) used in this evaluation were 74 for the finished landfill cover area (HSG-C, grass, good condition) and 85 for the other areas of the landfill (combination of open water, roads, and other non-landfill grassed surfaces). Most, if not all, of the cover soil will be imported to the site from a yet-to-be-determined borrow area.
2. The perimeter channels and the sideslope berms have one surface type with a Manning's "n" value of 0.035 (grass-lined);

3. The annual 2, 10, 25, and 100-year storm rainfall depths were identified in the Precipitation Frequency Data Server (PFDS - Reference 2) for Chesapeake, Virginia:

Year Storm	(in) / 24hrs
2	3.64
10	5.60
25	6.93
100	9.33

CALCULATIONS

HMS Model Input

Sub-area delineations/flow path to point of interest are illustrated on Drawing 1 (attachment 2). Figure 1 illustrates the connectivity of the stormwater elements as modeled in HEC-HMS:

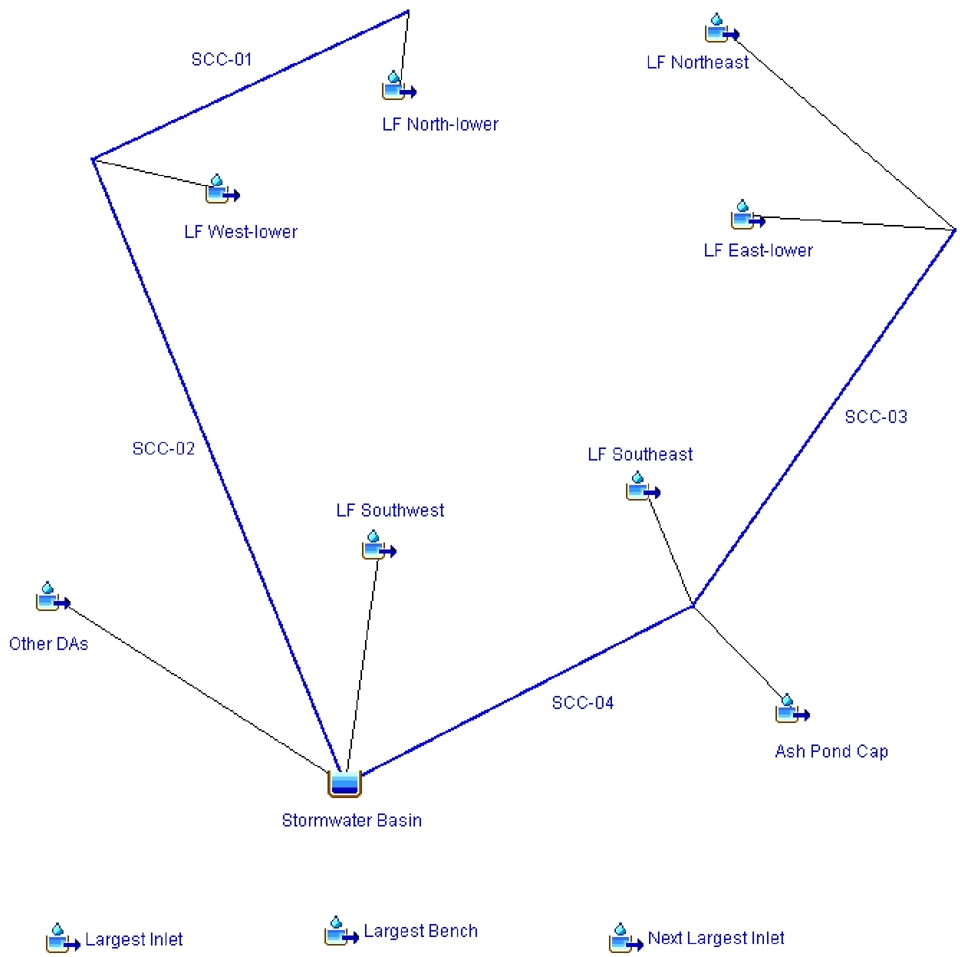


Figure 1 - HEC-HMS Model

Table 1: HEC-HMS Input Data

Element	DA (Ac)	CN	Lag Time (min)
LF Northeast	7.87	74	6.0
LF East-lower	3.90	74	6.0
SCC-03	11.78	74	6.0
Ash Pond Cap	5.12	74	6.0
LF Southeast	3.39	74	6.0
SCC-04	20.29	74	6.0
Other DAs	8.38	85	6.0
LF Southwest	4.86	74	6.0
LF West-lower	2.82	74	6.0
LF North-lower	1.47	74	6.0
SCC-01	1.47	74	6.0
SCC-02	4.29	74	6.0
Stormwater Basin in	37.85		

Individual Areas for Component Evaluation:

Largest Inlet	4.55	74	6.0
Largest Bench	3.64	74	6.0
Next Largest Inlet	2.99	74	6.0

In addition to evaluating the stormwater system as a whole, individual, unconnected components were established in the model to evaluate specific inlets or sideslope berms. The modeled flows for the individual components were used in further spreadsheet analysis to determine capacities and freeboard.

HMS Model Output

The following table summarizes the results of the HEC-HMS analysis for given storms through the system.

Table 2: HEC-HMS Output

Element	DA (Ac)	Q_2 (CFS)	Q_{10} (CFS)	Q_{25} (CFS)	Q_{100} (CFS)
LF Northeast	7.87	15.4	33.1	45.9	69.9
LF East-lower	3.90	7.6	16.4	22.8	34.7
SCC-03	11.78	22.6	48.8	68.5	104.3
Ash Pond Cap	5.12	10.0	21.5	29.9	45.5
LF Southeast	3.39	6.6	14.3	19.8	30.1
SCC-04	20.29	33.5	76.8	109.4	168.7
Other DAs	8.38	26.2	47.2	61.6	87.2
LF Southwest	4.86	9.5	20.4	28.4	43.2
LF West-lower	2.82	5.5	11.8	16.4	25.0
LF North-lower	1.47	2.9	6.2	8.6	13.1
SCC-01	1.47	2.8	6.2	8.6	13.0
SCC-02	4.29	7.5	16.7	23.6	36.3
Stormwater Basin in	37.85	61.6	144.9	203.9	314.6
Stormwater Basin out	37.85	2.2	5.8	9.1	38.1
Basin HW Elevation		14.3	15.0	15.5	16.1

Top of Basin embankment = 19.0'

Largest Inlet	4.55	8.9	19.1	26.2	36.7
Largest Bench	3.64	7.1	15.3	21.3	32.4
Next Largest Inlet	2.99	5.9	12.6	16.0	20.2

Calculations for the HEC-HMS input and output are attached.

Sideslope Bench Capacity Hydraulics

For the largest sideslope bench drainage area of 3.64 acres, the capacity of the berm to convey water to the downslope pipe inlet was evaluated. Stormwater runoff calculations for the bench capacity were made using the Manning's equation.

The landfill sideslope berm forms a V-ditch cross sectional shape with side slopes of 6:1 and 3:1. The constructed depth is 2.5 feet. At the 25-year storm event, the bench with the largest individual drainage area is capable of conveying the flow with a freeboard of 1.25 feet. Flow velocity at the 2-year event is calculated at 2.33 ft/sec, and a non-biodegradable erosion control matting (EC-3 equivalent) is specified.

Calculations for the sideslope bench (and other perimeter channels) are attached. The constructed depth of the berms is driven by the downslope pipe inlets rather than the capacity of the berm, as explained in the next section.

Downslope Pipe and Inlet Capacity

At the low point of each of the diversion berms, a 24-inch diameter drop inlet will receive the flow into a 24-inch diameter HDPE downslope pipe. The inlets were evaluated to verify sufficient capacity exists at each inlet to accept flow and provide at least one-half foot of freeboard. For the inlet point with the largest drainage area, a twin, 24" inlet is specified. For all other inlet locations, a single 24" inlet is sufficient to convey the 25-year storm event. To provide for at least one-half foot of freeboard at the inlet during the 25-year event, the sideslope berms will be constructed with an effective depth of 2.5 feet.

The downslope pipe conveying flow from the largest contributing drainage area is SD-A on the northeastern corner of the landfill. The computed 25-year storm flow in SD-A is 45.9 CFS. The capacity of the downslope pipes is approximately 81.7 CFS. Calculation spreadsheets are attached.

At the terminal end of SD-A and SD-B, a stilling basin box will be constructed to attenuate the concentrated flow from the pipe and let it into the perimeter channel in a non-erosive manner. Capacity calculations are attached.

Perimeter Channel Capacity

The capacity and lining requirements for the proposed perimeter channels were evaluated for the 25-year event. The channels as designed have adequate capacity based on a minimum three-foot constructed depth. Channel lining of non-biodegradable erosion control matting (EC-3 equivalent) is specified based on the 2-year velocity. Calculation spreadsheets are attached.

Culvert Capacity

One culvert is proposed where the final cover access road crosses the perimeter channel at the northwest corner of the landfill. This culvert, RC-1, will be a 24-inch diameter culvert and will convey the flow from the northern lower section of the landfill. A calculation spreadsheet is attached.

Stormwater Basin Evaluation

The modified stormwater basin at the landfill was evaluated to provide function for erosion and sediment control capacity as well as attenuation for the 25-year storm event. The outfall structure will be replaced with a new structure, maintaining the existing outfall pipe. This new structure will set the wet storage and dry storage elevation and allow the liner system to be installed.

At the 25-year storm event, the basin has a freeboard of 3.5 feet, based on a top of berm elevation of 19.0 feet. The basin is adequately sized for the 25-year event. Please see the attached calculation spreadsheets.

ATTACHMENTS

Attachment 1: Drainage Area Map (Drawing 1)

Attachment 2: Individual component calculation spreadsheets or packages:

- Slope Drain Drop Inlet Rating;
- Slope drain pipe capacity and stilling basin
- Diversion Berm and Perimeter channel capacity worksheet;
- Culvert (RC-1) Rating worksheet;
- Sediment Basin revision calculation package

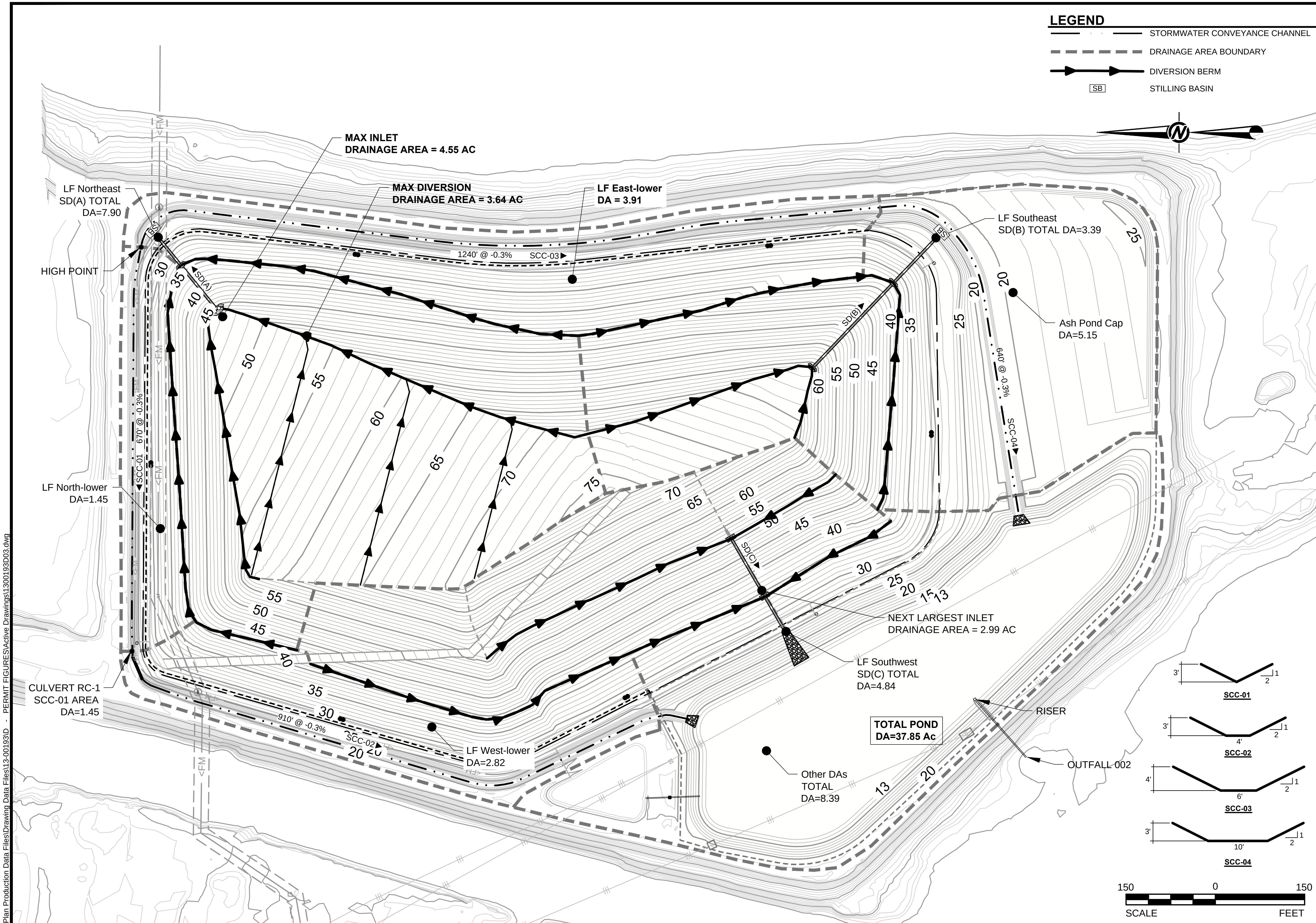
References

1) U.S. Army Corps of Engineers Hydrologic Engineering Center – Hydrologic Modeling System (HEC-HMS) release 3.5

2) National Oceanic and Atmospheric Administration(NOAA), Point Precipitation Frequency Estimates for NOAA Atlas 14, http://hdsc.nws.noaa.gov/hdsc/pfds/index.html

3) Brater, Ernest; King, Horace; Handbook of Hydraulics 7th Ed, 1996

4) Natural Resources Conservation Service (NRCS), “Web Soil Survey”, http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx



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Golder Associates
Richmond, Virginia

PROJECT

DOMINION
CHESAPEAKE ENERGY CENTER
SWP #440 CLOSURE PLAN
CITY OF CHESAPEAKE, VIRGINIA

TITLE

DRAINAGE AREA MAP

PROJECT No.		130-0193
FILE No.		1300193D03
REV. 0	SCALE	AS SHOWN
DESIGN	ATN	12/6/13
CADD	AWL	12/6/13
CHECK		
REVIEW		

DWG 1

Given Data

Pipe Inside Dia, ft	2
Cd (Orifice)	0.6
Cw (Weir)	3.33
reduced pipe area, A	2.670352
reduced pipe opening, L	5.340703

Nominal Pipe Area	3.14159	
% open area	85%	(if covered or obstructed, otherwise use 100%)
Inlet Crest Elevation	0	

Orifice Equation Q = A*Cd*sqrt (2 *g * H)

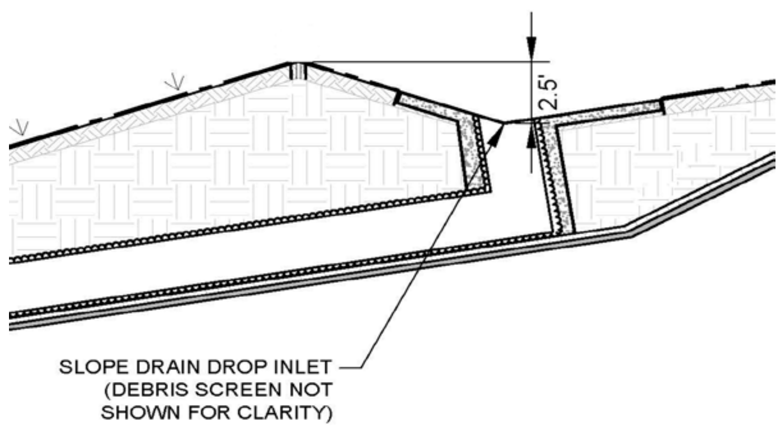
Weir Equation Q = Cw * L * H^1.5

Use:

A vertical pipe used as an inlet will act first as a weir, then at a certain depth, will transition to an orifice flow. This depth depends on the diameter of the pipe. Use the lower of the two values for the actual expected flow from the riser.

Rated Capacity of one Slope Drain Drop Inlet

Head, ft	CFS Orifice	CFS Weir	Minimum Value, CFS	Controlling Flow
0	0	0	0.00	N/A
0.25	6.43	2.22	2.22	WEIR
0.5	9.09	6.29	6.29	WEIR
0.75	11.14	11.55	11.14	ORIFICE
1	12.86	17.78	12.86	ORIFICE
1.25	14.38	24.85	14.38	ORIFICE
1.5	15.75	32.67	15.75	ORIFICE
1.75	17.01	41.17	17.01	ORIFICE
2	18.18	50.30	18.18	ORIFICE
2.25	19.29	60.02	19.29	ORIFICE
2.5	20.33	70.30	20.33	ORIFICE
3	22.27	92.41	22.27	ORIFICE

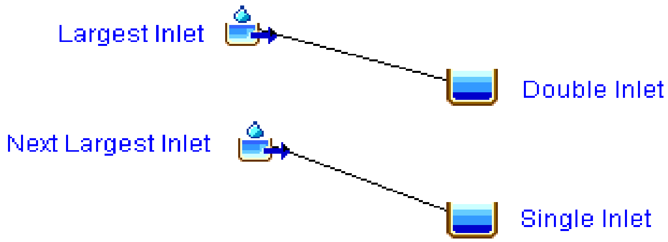


HEC-HMS Modeled Results for inlet analysis

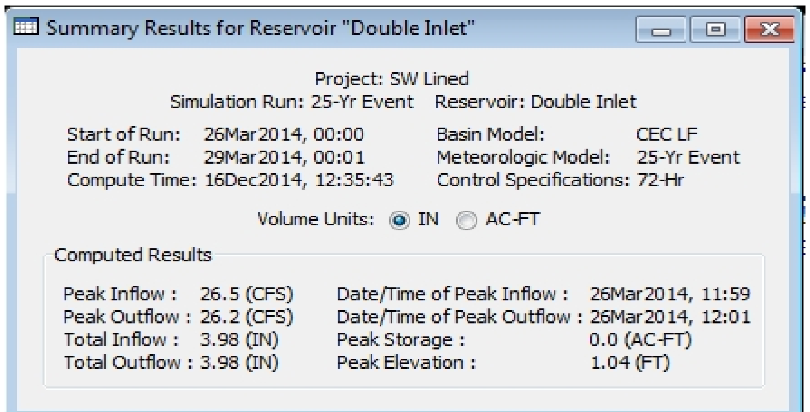
		25-Yr Event			100-Yr Event			
	Area, Ac.	Flow, CFS	Head, ft	Freeboard	Flow, CFS	Head, ft	Freeboard	
Largest Drop Inlet	4.55	26.2	1.04	1.96	36.7	2.04	0.96	(double inlet)
Next-Largest	2.99	16.0	1.54	0.96	20.2	2.46	0.04	(single inlet)

Made By:
Checked:
Reviewed:

Golder Associates Inc.



Each inlet was modeled in HEC-HMS as a small reservoir to account for the stage storage volume that temporarily develops at the inlet during large storm events. The inlets as designed with 85% open function for both the 25-yr and 100-yr events.



Summary Results for Reservoir "Double Inlet"

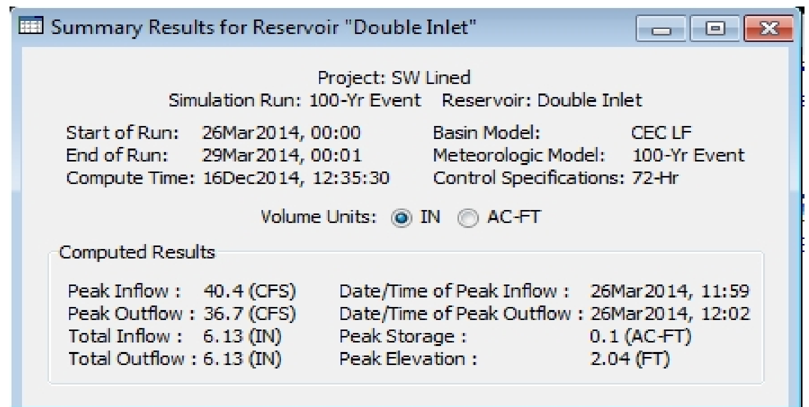
Project: SW Lined
Simulation Run: 25-Yr Event Reservoir: Double Inlet

Start of Run: 26Mar2014, 00:00 Basin Model: CEC LF
End of Run: 29Mar2014, 00:01 Meteorologic Model: 25-Yr Event
Compute Time: 16Dec2014, 12:35:43 Control Specifications: 72-Hr

Volume Units: IN AC-FT

Computed Results

Peak Inflow : 26.5 (CFS) Date/Time of Peak Inflow : 26Mar2014, 11:59
Peak Outflow : 26.2 (CFS) Date/Time of Peak Outflow : 26Mar2014, 12:01
Total Inflow : 3.98 (IN) Peak Storage : 0.0 (AC-FT)
Total Outflow : 3.98 (IN) Peak Elevation : 1.04 (FT)



Summary Results for Reservoir "Double Inlet"

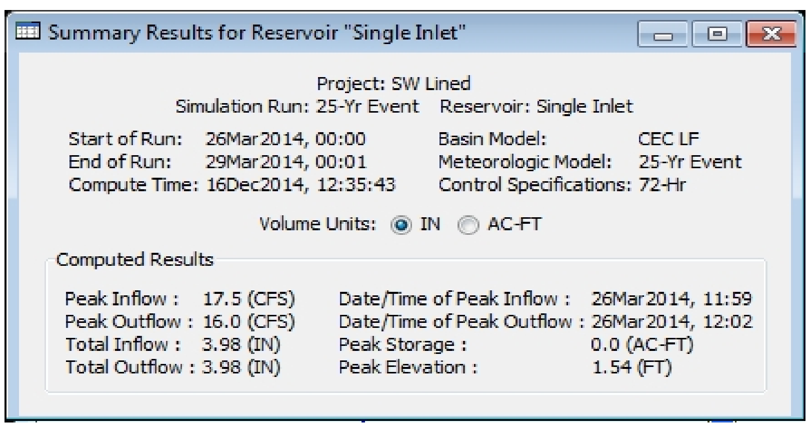
Project: SW Lined
Simulation Run: 100-Yr Event Reservoir: Double Inlet

Start of Run: 26Mar2014, 00:00 Basin Model: CEC LF
End of Run: 29Mar2014, 00:01 Meteorologic Model: 100-Yr Event
Compute Time: 16Dec2014, 12:35:30 Control Specifications: 72-Hr

Volume Units: IN AC-FT

Computed Results

Peak Inflow : 40.4 (CFS) Date/Time of Peak Inflow : 26Mar2014, 11:59
Peak Outflow : 36.7 (CFS) Date/Time of Peak Outflow : 26Mar2014, 12:02
Total Inflow : 6.13 (IN) Peak Storage : 0.1 (AC-FT)
Total Outflow : 6.13 (IN) Peak Elevation : 2.04 (FT)



Summary Results for Reservoir "Single Inlet"

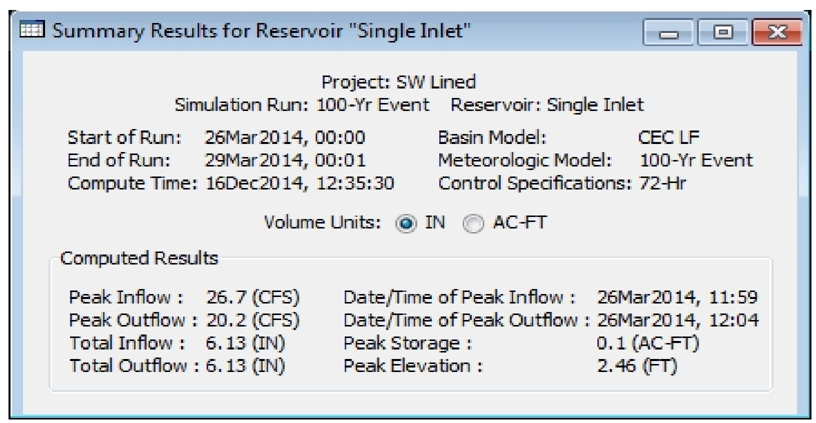
Project: SW Lined
Simulation Run: 25-Yr Event Reservoir: Single Inlet

Start of Run: 26Mar2014, 00:00 Basin Model: CEC LF
End of Run: 29Mar2014, 00:01 Meteorologic Model: 25-Yr Event
Compute Time: 16Dec2014, 12:35:43 Control Specifications: 72-Hr

Volume Units: IN AC-FT

Computed Results

Peak Inflow : 17.5 (CFS) Date/Time of Peak Inflow : 26Mar2014, 11:59
Peak Outflow : 16.0 (CFS) Date/Time of Peak Outflow : 26Mar2014, 12:02
Total Inflow : 3.98 (IN) Peak Storage : 0.0 (AC-FT)
Total Outflow : 3.98 (IN) Peak Elevation : 1.54 (FT)



Summary Results for Reservoir "Single Inlet"

Project: SW Lined
Simulation Run: 100-Yr Event Reservoir: Single Inlet

Start of Run: 26Mar2014, 00:00 Basin Model: CEC LF
End of Run: 29Mar2014, 00:01 Meteorologic Model: 100-Yr Event
Compute Time: 16Dec2014, 12:35:30 Control Specifications: 72-Hr

Volume Units: IN AC-FT

Computed Results

Peak Inflow : 26.7 (CFS) Date/Time of Peak Inflow : 26Mar2014, 11:59
Peak Outflow : 20.2 (CFS) Date/Time of Peak Outflow : 26Mar2014, 12:04
Total Inflow : 6.13 (IN) Peak Storage : 0.1 (AC-FT)
Total Outflow : 6.13 (IN) Peak Elevation : 2.46 (FT)

Made By:
Checked:
Reviewed:

Objective Determine the capacity of the slope drain and the stilling basins that will be located at the base of the slope drain

Calculation

Slope Drain

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

Where: Q = flowrate, cfs

A= cross-sectional area, sq ft = π/4 * dia^2

R= hyrdaulic radis, ft = dia/4 (assuming full)

S= downchute slope, ft/ft = 9:1 = .111 ft/ft (on corner slopes)

n = Manning number = 0.012 smooth

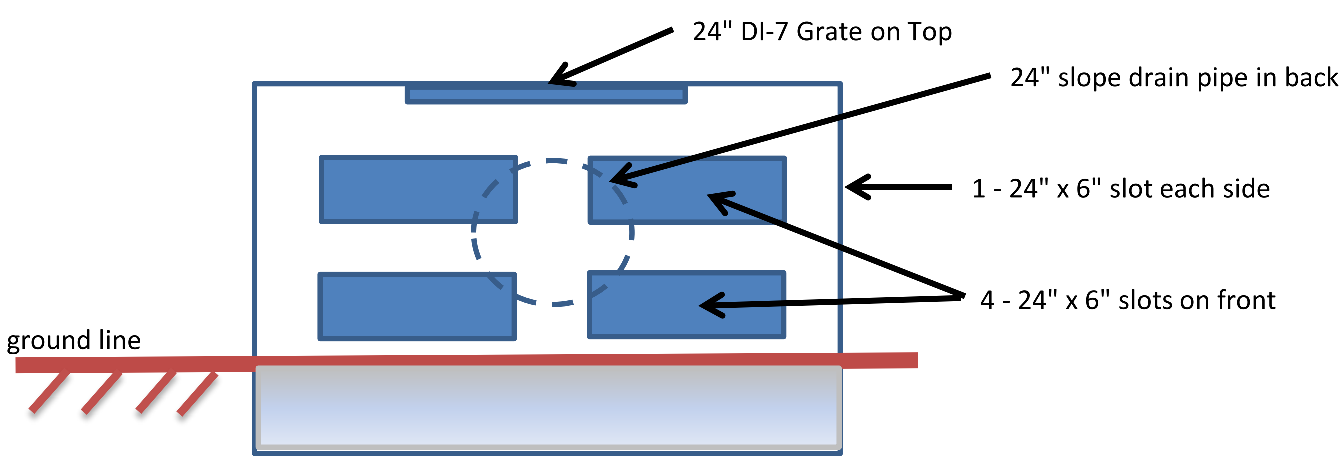
With diameter = 24"

Qfull = 81.7 cfs

Slope drain Pipe ID	Drainage area (Ac.)	Q_{25} (cfs)	Flow depth (ft)	Flow velocity (ft/s)	% Full	
A	7.90	45.9	1.07	26.81	56%	* LF Northeast
B	3.39	19.8	0.67	21.48	24%	* LF Southeast
C	4.84	28.4	0.82	23.81	35%	* LF Southwest

Note: Slope Drain SD-C does not have a stilling basin

Stilling Basin



Golder Associates Richmond, Virginia	Subject:	Slope drain and stilling basins at the CEC Ash Landfill facility in Chesapeake, Virginia - SWP #440		
	Job No:	130-0193	Made by: DPM	Date: 12/16/14
		Rev 1	Checked:	
	Ref:		Reviewed:	Sheet 2 of 2

Slot height	6	inches
slot width	24	
Hole area	1	ft^2
holes/row 1	2	
holes/row 2	4	
row 1 crest	3	inches from bottom
row 2 crest	18	inches from bottom

Depth in Box	H1	H2	Q/hole1	Q/row1	Q/hole2	Q/row2	Total	
0	0	0	0				0	
3	0	0	0	0			0	
6	0.25	0	1.04	2.08	0.00	0.00	2.08	cfs
9	0.5	0	2.94	5.89	0.00	0.00	5.89	cfs
12	0.75	0	4.17	8.34	0.00	0.00	8.34	cfs
15	1	0	4.81	9.63	0.00	0.00	9.63	cfs
18	1.25	0	5.38	10.77	0.00	0.00	10.77	cfs
21	1.5	0.25	5.90	11.79	1.04	4.16	15.96	cfs
24	1.75	0.5	6.37	12.74	2.94	11.77	24.51	cfs
27	2	0.75	6.81	13.62	4.17	16.68	30.30	cfs
30	2.25	1	7.22	14.44	4.81	19.26	33.70	cfs
33	2.5	1.25	7.61	15.23	5.38	21.53	36.76	cfs
36	2.75	1.5	7.98	15.97	5.90	23.59	39.56	cfs
39	3	1.75	8.34	16.68	6.37	25.48	42.16	cfs
42	3.25	2	8.68	17.36	6.81	27.24	44.60	cfs

** Flows in excess of 44.6 CFS will convey out the top DI-7 grate

Conclusion Based on the results of this model, the downslope pipes and the stilling basins with 6-24"x6" holes adequately convey the 25-year, 24 hour storm event.

References

1) Brater, Ernest; King, Horace; Handbook of Hydraulics 7th Ed, 1996

Chesapeake Energy Center Ash Landfill
Permit #440

Largest CEC Sideslope Bench - Design Depth = 3.0', Area = 3.64 Ac.

Slope	0.01	Bottom Width	0
n	0.035	Z1 (:1)	6
		Z2 (:1)	3

Depth, ft	X-Area	Pw	r	V	Q	Shear Stress	Event
0.83	3.10	7.67	0.40	2.33	7.21	0.25	2
1.10	5.45	10.17	0.54	2.81	15.28	0.33	10
1.25	7.03	11.56	0.61	3.06	21.49	0.38	25
1.46	9.59	13.50	0.71	3.39	32.52	0.44	100

CEC Perimeter Channel SCC-01 - Design Depth = 3.0'

Slope	0.003	Bottom Width	0
n	0.035	Z1 (:1)	2
		Z2 (:1)	2

Depth, ft	X-Area	Pw	r	V	Q	Shear Stress	Event
1.01	2.04	4.52	0.45	1.37	2.80	0.08	2
1.36	3.70	6.08	0.61	1.67	6.19	0.11	10
1.54	4.74	6.89	0.69	1.82	8.63	0.13	25
1.80	6.48	8.05	0.80	2.02	13.08	0.15	100

CEC Perimeter Channel SCC-02 - Design Depth = 3.0'

Slope	0.003	Bottom Width	4
n	0.035	Z1 (:1)	6
		Z2 (:1)	3

Depth, ft	X-Area	Pw	r	V	Q	Shear Stress	Event
0.81	4.55	7.62	0.60	1.65	7.53	0.11	2
1.24	8.04	9.55	0.84	2.08	16.70	0.16	10
1.49	10.40	10.66	0.98	2.29	23.85	0.18	25
1.85	14.25	12.27	1.16	2.58	36.68	0.22	100

CEC Perimeter Channel SCC-03 - Design Depth = 4.0'

Slope	0.003	Bottom Width	6
n	0.035	Z1 (:1)	2
		Z2 (:1)	2

Depth, ft	X-Area	Pw	r	V	Q	Shear Stress	Event
1.23	10.41	11.50	0.90	2.18	22.70	0.17	2
1.86	18.08	14.32	1.26	2.72	49.25	0.24	10
2.21	23.03	15.88	1.45	2.99	68.78	0.27	25
2.73	31.29	18.21	1.72	3.34	104.65	0.32	100

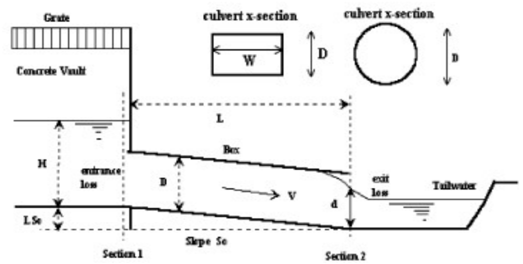
CEC Perimeter Channel SCC-04 - Design Depth = 3.0'

Slope	0.003	Bottom Width	10
n	0.035	Z1 (:1)	2
		Z2 (:1)	2

Depth, ft	X-Area	Pw	r	V	Q	Shear Stress	Event
1.20	14.88	15.37	0.97	2.28	33.96	0.18	2
1.90	26.22	18.50	1.42	2.94	77.15	0.27	10
2.30	33.58	20.29	1.66	3.26	109.57	0.31	25
2.90	45.82	22.97	1.99	3.70	169.31	0.37	100

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Chesapeake Energy Center - Culvert RC-1
Basin ID: Green cells are calculated values
Status:



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =	24	inches
	Inlet Edge Type (choose from pull-down list)		Grooved End Projection	
OR:				
Box Culvert:	Barrel Height (Rise) in Feet	Height (Rise) =		ft.
	Barrel Width (Span) in Feet	Width (Span) =		ft.
	Inlet Edge Type (choose from pull-down list)		Square Edge w/ 90-15 Deg. Headwall	
	Number of Barrels	No =	1	
	Inlet Elevation at Culvert Invert	Inlet Elev =	19.1	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Slope =	0.003	ft vert. / ft horiz.
	Culvert Length in Feet	L =	30	ft.
	Manning's Roughness	n =	0.013	
	Bend Loss Coefficient	K_b =	0	
	Exit Loss Coefficient	K_x =	1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.20
Friction Loss Coefficient	K_f =	0.37
Sum of All Loss Coefficients	K_s =	1.57
Orifice Inlet Condition Coefficient	C_d =	0.95
Minimum Energy Condition Coefficient	KE_{low} =	-0.0342

Drainage Area for RC-1 is LF North-Lower
Q25 = 8.6 CFS
Q100 = 13.1 CFS

Calculations of Culvert Capacity (output):

Water Surface Elevation (ft., linked)	Tailwater Surface Elevation ft	Culvert Inlet-Control Flowrate cfs	Culvert Outlet-Control Flowrate cfs	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used:	Flow Control Used
19.10		0.00	0.00	**0.00**	No Flow (WS < inlet)	N/A
19.35		0.30	1.43	**0.30**	Min. Energy. Eqn.	INLET
19.60		1.20	3.04	**1.20**	Min. Energy. Eqn.	INLET
19.85		2.60	4.65	**2.60**	Min. Energy. Eqn.	INLET
20.10		4.50	6.13	**4.50**	Min. Energy. Eqn.	INLET
20.35		6.30	7.56	**6.30**	Regression Eqn.	INLET
20.60		8.70	7.99	**7.99**	Regression Eqn.	OUTLET
20.85		11.30	8.24	**8.24**	Regression Eqn.	OUTLET
21.10		14.00	8.74	**8.74**	Regression Eqn.	OUTLET
21.35		16.50	10.22	**10.22**	Regression Eqn.	OUTLET
21.60		18.70	12.08	**12.08**	Regression Eqn.	OUTLET
21.85		20.80	14.44	**14.44**	Regression Eqn.	OUTLET
22.10		22.60	16.42	**16.42**	Regression Eqn.	OUTLET

Made By: DPM 5/23/14
Checked: ATN 5/23/14
Reviewed: JRD 6/6/14

CALCULATIONS

Date:	December 16, 2014	**Made by:**	DPM
Project No.:	130-0193	**Checked by:**	
Subject:	Stormwater Pond Lining and Riser Replacement	**Reviewed by:**	
Project:	**CEC ASH LANDFILL – SWP #440**		

This purpose of this evaluation is to verify the design and performance of the stormwater pond after it is lined with a geomembrane liner. The installation of the liner and soil layers in the pond will consume a portion of the pond volume. A new square concrete riser will be installed and connected to the existing 24" outlet pipe. Wet storage and dry storage elevations will be set to meet the minimum standards set for sediment ponds in the Virginia Erosion and Sediment Control Handbook (VESCH) Standard 3.14.

1.0 CALCULATIONS

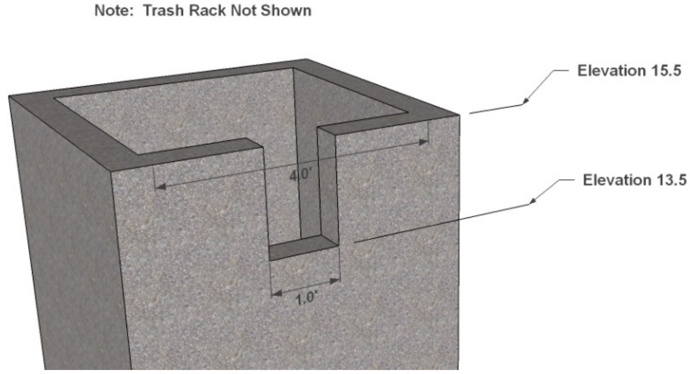
1.1 Pond Storage Volume

The minimum required wet storage (WS) and dry storage (DS) volumes are 67 cubic yards (CY) per acre of drainage area. The drainage area for the pond is 37.85 acres, so the required WS and DS volumes are 2,536 CY each. The pond volume was calculated using the Conical Method for Reservoir Volume, as shown on the attached calculation worksheet. The pond volumes as proposed are below.

Elevation	Pool Area, Ac.	Cumulative Volume, CY	Location
20	5.487	55,896	Top of berm
15.5	4.501	19,710	Riser crest (DS elevation, DS = 13,596 CY)
13.5	3.929	6,114	Permanent pool (WS elevation, WS = 6,114 CY)
12.5	3.651	0	Bottom

1.2 Riser Design and Capacity

The existing pond riser will be replaced with a square reinforced concrete structure that connects to the existing 24" outlet pipe. The riser has an inside width of 4 feet square and one section will have a one-foot wide slot weir at elevation 13.5 to set the permanent pool. The top of the riser will be at elevation 15.5, which will be the primary riser crest. There is no auxiliary spillway proposed, as modeling shows the riser has capacity for the 100-year storm event with adequate pond freeboard.



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1.3 Storm Routing Calculations

The stormwater pond is the receptor for the majority of stormwater from the landfill and the surrounding areas of the peninsula. A total area of 37.85 acres drains to the stormwater pond (including approximately 5.5 acres of the pond area itself). The perimeter channels around the landfill will convey water to the pond.

Analysis of the stormwater system at the landfill was performed using the US Army Corps of Engineers Hydrologic Engineering Center's Hydraulic Modeling System (HEC-HMS) software package (ref #1).

HMS Model Input

Figure 1 illustrates the connectivity of the stormwater elements as modeled in HEC-HMS:

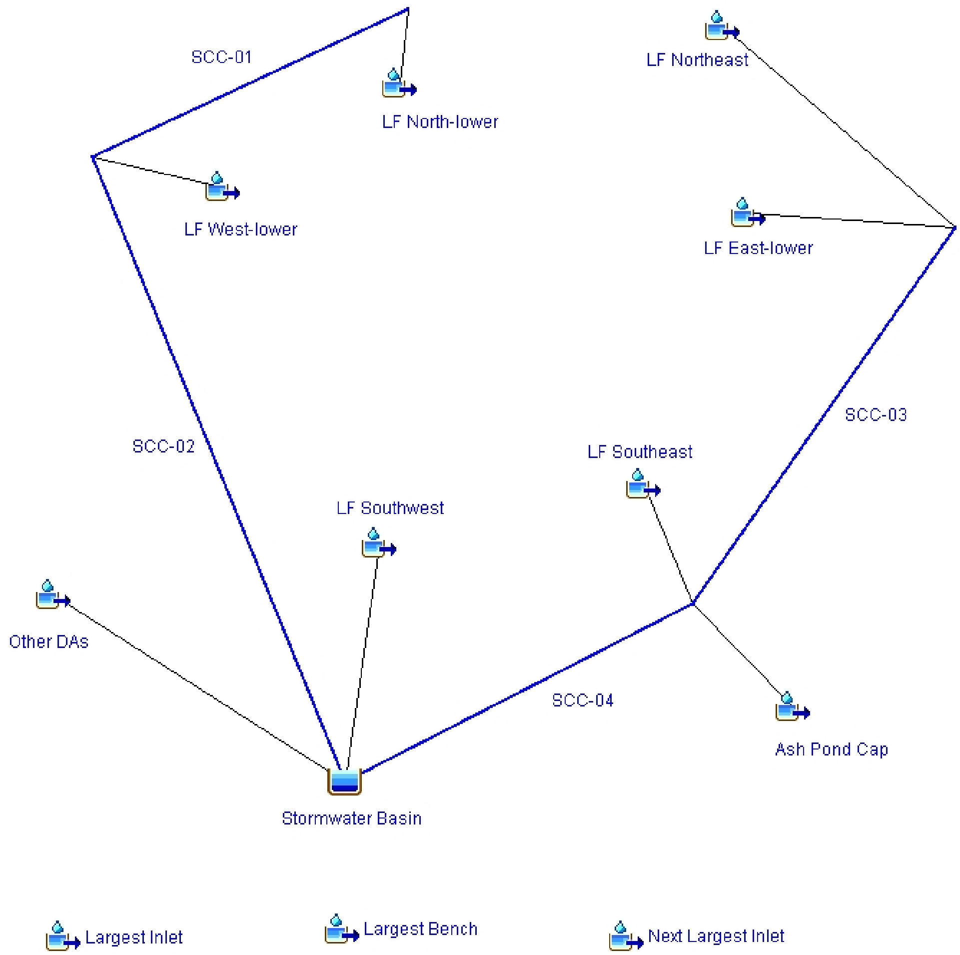

Figure 1 - HEC-HMS Model

Table 1: HEC-HMS Input Data

Element	DA (Ac)	CN	Lag Time (min)
LF Northeast	7.87	74	6.0
LF East-lower	3.90	74	6.0
SCC-03	11.78	74	6.0
Ash Pond Cap	5.12	74	6.0
LF Southeast	3.39	74	6.0
SCC-04	20.29	74	6.0
Other DAs	8.38	85	6.0
LF Southwest	4.86	74	6.0
LF West-lower	2.82	74	6.0
LF North-lower	1.47	74	6.0
SCC-01	1.47	74	6.0
SCC-02	4.29	74	6.0
Stormwater Basin in	37.85		

HMS Model Output

The following table summarizes the results of the HEC-HMS analysis for given storms through the system.

Table 2: HEC-HMS Output

Element	DA (Ac)	Q_2 (CFS)	Q_{10} (CFS)	Q_{25} (CFS)	Q_{100} (CFS)
LF Northeast	7.87	15.4	33.1	45.9	69.9
LF East-lower	3.90	7.6	16.4	22.8	34.7
SCC-03	11.78	22.6	48.8	68.5	104.3
Ash Pond Cap	5.12	10.0	21.5	29.9	45.5
LF Southeast	3.39	6.6	14.3	19.8	30.1
SCC-04	20.29	33.5	76.8	109.4	168.7
Other DAs	8.38	26.2	47.2	61.6	87.2
LF Southwest	4.86	9.5	20.4	28.4	43.2
LF West-lower	2.82	5.5	11.8	16.4	25.0
LF North-lower	1.47	2.9	6.2	8.6	13.1
SCC-01	1.47	2.8	6.2	8.6	13.0
SCC-02	4.29	7.5	16.7	23.6	36.3
Stormwater Basin in	37.85	61.6	144.9	203.9	314.6
Stormwater Basin out	37.85	2.2	5.8	9.1	38.1
Basin HW Elevation		14.3	15.0	15.5	16.1

Top of Basin embankment = 19.0'

Calculations for the HEC-HMS input and output are attached.

2.0 CONCLUSIONS

Based on the calculations presented herein, the size and riser capacity selected for the CEC stormwater pond is adequate to handle the runoff from the 25-year storm event. At the 25-year event, the pond has approximately 3.5 feet of freeboard.

3.0 REFERENCES

1) U.S. Army Corps of Engineers Hydrologic Engineering Center – Hydrologic Modeling System (HEC-HMS) release 3.5