Summary for Link F6: Flume 6

Inflow Area = 3.717 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 20.36 cfs @ 12.12 hrs, Volume= 0.985 af
Primary = 20.36 cfs @ 12.12 hrs, Volume= 0.985 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S3 R2 : Swale S3 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link F7: Existing East Flume

Inflow Area = 0.830 ac, 0.00% Impervious, Inflow Depth = 3.12" for 100-yr, 24-hr event
Inflow = 4.50 cfs @ 12.12 hrs, Volume= 0.216 af
Primary = 4.50 cfs @ 12.12 hrs, Volume= 0.216 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S2 R2 : Swale S2 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link F8: Existing West Flume

Inflow Area = 3.122 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 16.40 cfs @ 12.13 hrs, Volume= 0.828 af
Primary = 16.40 cfs @ 12.13 hrs, Volume= 0.828 af, Atten= 0%, Lag= 0.0 min
Routed to Link Swale S2 R2 : Swale S2 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link North Area: North Area

Inflow Area = 7.668 ac, 11.88% Impervious, Inflow Depth = 1.76" for 100-yr, 24-hr event
Inflow = 19.20 cfs @ 12.15 hrs, Volume= 1.127 af
Primary = 19.20 cfs @ 12.15 hrs, Volume= 1.127 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link RC1: Rock Chute 1

Inflow Area = 4.170 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 22.19 cfs @ 12.13 hrs, Volume= 1.105 af
Primary = 22.19 cfs @ 12.13 hrs, Volume= 1.105 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S4 R3 : Swale S4 Reach 3

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link RC2: Rock Chute 2

Inflow Area = 4.541 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 23.68 cfs @ 12.13 hrs, Volume= 1.204 af
Primary = 23.68 cfs @ 12.13 hrs, Volume= 1.204 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S4 R2 : Swale S4 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale 1 R6: Swale S1 Reach 6

Inflow Area = 23.788 ac, 0.00% Impervious, Inflow Depth = 2.23" for 100-yr, 24-hr event
Inflow = 62.73 cfs @ 12.20 hrs, Volume= 4.415 af
Primary = 62.73 cfs @ 12.20 hrs, Volume= 4.415 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S2 R1 : Swale S2 Reach 1

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S1 R1: Swale S1 Reach 1

Inflow Area = 0.691 ac, 0.00% Impervious, Inflow Depth = 2.23" for 100-yr, 24-hr event
Inflow = 2.68 cfs @ 12.12 hrs, Volume= 0.128 af
Primary = 2.68 cfs @ 12.12 hrs, Volume= 0.128 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1 R2 : Swale S1 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S1 R2: Swale S1 Reach 2

Inflow Area = 7.131 ac, 0.00% Impervious, Inflow Depth = 3.07" for 100-yr, 24-hr event
Inflow = 37.05 cfs @ 12.12 hrs, Volume= 1.827 af
Primary = 37.05 cfs @ 12.12 hrs, Volume= 1.827 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1 R3 : Swale S1 Reach 3

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S1 R3: Swale S1 Reach 3

Inflow Area = 14.170 ac, 0.00% Impervious, Inflow Depth = 2.58" for 100-yr, 24-hr event
Inflow = 47.76 cfs @ 12.15 hrs, Volume= 3.049 af
Primary = 47.76 cfs @ 12.15 hrs, Volume= 3.049 af, Atten= 0%, Lag= 0.0 min
Routed to Link C3 : Culvert C3

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S1 R4: Swale S1 Reach 4

Inflow Area = 17.714 ac, 0.00% Impervious, Inflow Depth = 2.61" for 100-yr, 24-hr event
Inflow = 62.23 cfs @ 12.15 hrs, Volume= 3.859 af
Primary = 62.23 cfs @ 12.15 hrs, Volume= 3.859 af, Atten= 0%, Lag= 0.0 min
Routed to Link C4 : Culvert C4

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S1 R5: Swale S1 Reach 5

Inflow Area = 20.996 ac, 0.00% Impervious, Inflow Depth = 2.43" for 100-yr, 24-hr event
Inflow = 65.15 cfs @ 12.17 hrs, Volume= 4.254 af
Primary = 65.15 cfs @ 12.17 hrs, Volume= 4.254 af, Atten= 0%, Lag= 0.0 min
Routed to Link C5 : Culvert C5

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S2 R1: Swale S2 Reach 1

Inflow Area = 25.901 ac, 0.00% Impervious, Inflow Depth = 2.10" for 100-yr, 24-hr event
Inflow = 58.13 cfs @ 12.24 hrs, Volume= 4.525 af
Primary = 58.13 cfs @ 12.24 hrs, Volume= 4.525 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S2 R2 : Swale S2 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S2 R2: Swale S2 Reach 2

Inflow Area = 48.985 ac, 0.00% Impervious, Inflow Depth = 2.20" for 100-yr, 24-hr event
Inflow = 103.37 cfs @ 12.20 hrs, Volume= 8.978 af
Primary = 103.37 cfs @ 12.20 hrs, Volume= 8.978 af, Atten= 0%, Lag= 0.0 min
Routed to Link C7 : Culvert C7

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S3 R1: Swale S3 Reach 1

Inflow Area = 6.548 ac, 0.00% Impervious, Inflow Depth = 2.65" for 100-yr, 24-hr event
Inflow = 27.22 cfs @ 12.13 hrs, Volume= 1.447 af
Primary = 27.22 cfs @ 12.13 hrs, Volume= 1.447 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S3 R2 : Swale S3 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S3 R2: Swale S3 Reach 2

Inflow Area = 11.158 ac, 0.00% Impervious, Inflow Depth = 2.72" for 100-yr, 24-hr event
Inflow = 47.83 cfs @ 12.13 hrs, Volume= 2.533 af
Primary = 47.83 cfs @ 12.13 hrs, Volume= 2.533 af, Atten= 0%, Lag= 0.0 min
Routed to Link C6 : Culvert C6

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S3 R3: Swale S3 Reach 3

Inflow Area = 14.511 ac, 0.00% Impervious, Inflow Depth = 2.36" for 100-yr, 24-hr event
Inflow = 47.45 cfs @ 12.15 hrs, Volume= 2.848 af
Primary = 47.45 cfs @ 12.15 hrs, Volume= 2.848 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S2 R2 : Swale S2 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S4 R4: Swale S4 Reach 4

Inflow Area = 67.064 ac, 0.04% Impervious, Inflow Depth = 2.29" for 100-yr, 24-hr event
Inflow = 157.92 cfs @ 12.21 hrs, Volume= 12.803 af
Primary = 157.92 cfs @ 12.21 hrs, Volume= 12.803 af, Atten= 0%, Lag= 0.0 min
Routed to Pond Sed Pond : Sedimentation Basin

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S5 R1: Swale S5 Reach 1

Inflow Area = 4.530 ac, 13.14% Impervious, Inflow Depth = 1.20" for 100-yr, 24-hr event
Inflow = 7.48 cfs @ 12.15 hrs, Volume= 0.454 af
Primary = 7.48 cfs @ 12.15 hrs, Volume= 0.454 af, Atten= 0%, Lag= 0.0 min
Routed to Link C1 : Culvert C1

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S5 R2: Swale S5 Reach 2

Inflow Area = 5.851 ac, 12.83% Impervious, Inflow Depth = 1.48" for 100-yr, 24-hr event
Inflow = 12.65 cfs @ 12.14 hrs, Volume= 0.720 af
Primary = 12.65 cfs @ 12.14 hrs, Volume= 0.720 af, Atten= 0%, Lag= 0.0 min
Routed to Link C8 : Culvert C8

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S5 R3: Swale S5 Reach 3

Inflow Area = 1.817 ac, 8.81% Impervious, Inflow Depth = 2.69" for 100-yr, 24-hr event
Inflow = 6.90 cfs @ 12.17 hrs, Volume= 0.408 af
Primary = 6.90 cfs @ 12.17 hrs, Volume= 0.408 af, Atten= 0%, Lag= 0.0 min
Routed to Link C8 : Culvert C8

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S6 R1: Swale S6 Reach 1

Inflow Area = 2.899 ac, 0.00% Impervious, Inflow Depth = 3.23" for 100-yr, 24-hr event
Inflow = 13.45 cfs @ 12.11 hrs, Volume= 0.780 af
Primary = 13.45 cfs @ 12.11 hrs, Volume= 0.780 af, Atten= 0%, Lag= 0.0 min
Routed to Link C2 : Culvert C2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Wetland: Wetland

Inflow Area = 74.393 ac, 2.06% Impervious, Inflow Depth = 1.09" for 100-yr, 24-hr event
Inflow = 39.85 cfs @ 12.70 hrs, Volume= 6.780 af
Primary = 39.85 cfs @ 12.70 hrs, Volume= 6.780 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Swale Sizing

SCS ENGINEERS

		Sheet No:	1 of 2
		Calc. No.	
		Rev. No.	0
Job No. 25220183.00	Job: Columbia Energy Center POO Landfill Closure	By: RJG	Date: 2/23/22
Client: WPL	Subject: Swale Sizing	Chk'd: MJT	Date: 4/5/22

Purpose:

To size the proposed swale along Module 10 and 11 to accommodate the 25-year, 24-hour storm event and determine required rolled erosion control product. To confirm capacity of existing swale during closure condition.

References:

1. WisDOT Facilities Development Manual Chapter 13, Section 30-15 - Grass Lined Channels.
2. Design of Roadside Channels with Flexible Linings, HEC-15, USDOT FHWA.
3. HydroCAD Report_POO Landfill Closure
4. Table 7E-5.01: Typical Rolled Erosion Control Product Properties and Uses, Iowa SUDAS Design and Specifications Manual.

Approach:

Use the HydroCAD Model results to obtain the peak flow during a 25-year, 24-hour storm event.

Use Grass Lined Channel Design WisDOT Spreadsheet, FDM 13-30 Attachment 15.2 (from Reference #1) to size the swale for each design swale cross section. The WisDOT spreadsheet incorporates the design guidelines and equations described in "Design of Roadside Channels with Flexible Linings", HEC-15, USDOT FHWA (Reference #2).

Confirm the swale is stable and has enough capacity for the design flow rate.

Use Table 7E-5.01 (see Reference #4) to select appropriate erosion control mat based on shear stress and application.

Assumptions:

1. Swales geometry shown on the drawing set.

2. Assume the following parameters per Section 15.2 - Grass Lining Properties from Reference #1:
   - Vegetation Retardance Class = C for Swales
   - Vegetation Condition = Good
   - Vegetation Growth Form = Turf
3. Assume cohesive soil type with ASTM Soil Class SC and a Plasticity Index (PI) of 16.

Calculations:

From the HydroCAD Report, the 25-year, 24-hour peak discharge rates in the swales are

Swales:	25-year			25-year			25-year	
Swale S1 Reach 1=	1.37	cfs	**Swale S2 Reach 2=**	52.2	cfs	**Swale S4 Reach 4=**	80.1	cfs
Swale S1 Reach 2=	21.7	cfs	**Swale S3 Reach 1=**	15.9	cfs	**Swale S5 Reach 1=**	2.1	cfs
Swale S1 Reach 3=	27.4	cfs	**Swale S3 Reach 2=**	27.9	cfs	**Swale S5 Reach 2=**	4.7	cfs
Swale S1 Reach 4=	35.4	cfs	**Swale S3 Reach 3=**	26.7	cfs	**Swale S5 Reach 3=**	3.8	cfs
Swale S1 Reach 5=	35.2	cfs	**Swale S4 Reach 1*=**		cfs	**Swale S6 Reach 1=**	9.7	cfs
Swale S1 Reach 6=	33.2	cfs	**Swale S4 Reach 2*=**		cfs			
Swale S2 Reach 1=	30.0	cfs	**Swale S4 Reach 3*=**		cfs			

Use max. flow from Swale S1 reaches to confirm swale works since slope is constant.

*Use full Swale S4 Reach 4 for swale flow in Swale S4 reaches.

Use the WisDOT Grass Swale Design Spreadsheet (Page 2) to determine the flow depth, velocity and shear stress in the swales.

Results:

The swales are adequately designed to accommodate the flows from the 25-year, 24-hour storm event.

The swales are stable at the design flow rates.

Use Class I, Type B erosion mat.

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Sheet No:
Calc. No.
Rev. No.
By: RJG Date: 2/23/22
Chk'd: MJT Date: 4/5/22

Job No. 25220183.00
Client: WPL

Job: Columbia Energy Center POO Landfill Closure
Subject: Swale Sizing

Channel/Ditch Geometry	Swale S1	Swale S1 Reach 1	Swale S1 Reach 2	Swale S1 Reach 3	Swale S1 Reach 4	Swale S1 Reach 5	Swale S1 Reach 6	Swale S2 Reach 1	Swale S2 Reach 2	Swale S3 Reach 1	Swale S3 Reach 2	Swale S3 Reach 3	Swale S4 Reach 1	Swale S4 Reach 2	Swale S4 Reach 3	Swale S4 Reach 4	Swale S5 Reach 1	Swale S5 Reach 2	Swale S5 Reach 3	Swale S6 Reach 1
Channel Slope, S_o (ft/ft)	0.0055	0.0053	0.0055	0.0051	0.0069	0.0053	0.0084	0.0020	0.0069	0.0070	0.0070	0.0097	0.0155	0.0069	0.0056	0.0082	0.0096	0.0024	0.0024	0.0066
Channel Bottom Width, B (ft)	8	8	8	8	8	8	8	8	10	8	8	0	10	10	10	10	0	0	0	8
Channel Side Slope, z_l	4	4	4	4	4	4	4	4	4	2	2	4	4	4	4	4	6	6	6	2.5
Channel Side Slope, z_r	4	4	4	4	4	4	4	4	4	2	2	4	3	3	3	3	7	2.5	2.5	2.5
Flow Depth, d (ft) Solve iteratively	1.59	0.37	1.30	1.47	1.46	1.61	1.32	2.18	1.61	1.07	1.39	1.81	1.42	1.97	2.13	1.85	0.67	1.51	1.41	0.85
Safety Factor, SF	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Vegetation/Soil Parameters																				
Vegetation Retardance Class	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Vegetation Condition	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good
Vegetation Growth Form	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf
Soil Type	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive
D_{75} (in) (Set at 0.00 for cohesive soils)																				
ASTM Soil Class	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC
Plasticity Index, PI	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Results Summary																				
Design Q (ft^3/s)	35.4	1.4	21.7	27.4	35.4	35.2	33.2	30.0	52.2	15.9	27.9	26.7	80.1	80.1	80.1	80.1	2.1	4.7	3.8	9.7
1. Swales geometry shown on the drawing set	35.4	1.4	22.1	27.4	35.4	35.2	33.5	29.8	52.5	16.0	28.0	27.1	79.6	80.5	79.5	81.6	2.1	4.7	3.8	9.6
Difference Between Design & Calc. Flow (%)	0.2%	0.2%	1.9%	0.0%	0.1%	0.0%	1.0%	-0.4%	0.6%	0.5%	0.6%	1.6%	-0.6%	0.5%	-0.7%	1.8%	0.0%	-0.3%	0.2%	-0.5%
Stable (Yes or No)	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Channel Parameters																				
Vegetation Height, h (ft)	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Grass Roughness Coefficient, C_n	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238
Cover Factor, C_f	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Noncohesive Soil																				
Soil Grain Roughness, n_s	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016
Permissible Soil Shear Stress, τ_p (lb/ft^2)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cohesive Soil																				
Porosity, e	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Soil Coefficient 1, c_1	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700
Soil Coefficient 2, c_2	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30
Soil Coefficient 3, c_3	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700
Soil Coefficient 4, c_4	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42
Soil Coefficient 5, c_5	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61
Soil Coefficient 6, c_6	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010
Permissible Soil Shear Stress, τ_p (lb/ft^2)	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080
Total Permissible Shear Stress, τ_p (lb/ft^2)	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080
Cross Sectional Area, A (ft^2)	22.832	3.453	17.160	20.404	20.206	23.248	17.530	36.450	26.468	10.850	14.984	13.104	21.257	33.283	37.179	30.479	2.874	9.690	8.449	8.606
Wetted Perimeter, P (ft)	21.11	11.01	18.72	20.12	20.04	21.28	18.88	25.98	23.28	12.79	14.22	14.93	20.35	24.35	25.52	23.48	8.75	13.25	12.37	12.58
Hydraulic Radius, R (ft)	1.082	0.314	0.917	1.014	1.008	1.093	0.928	1.403	1.137	0.849	1.054	0.878	1.045	1.367	1.457	1.298	0.329	0.731	0.683	0.684
Top Width, T (ft)	20.72	10.92	18.40	19.76	19.68	20.88	18.56	25.44	22.88	12.28	13.56	14.48	19.94	23.79	24.91	22.95	8.65	12.84	11.99	12.25
Hydraulic Depth, D (ft)	1.102	0.316	0.933	1.033	1.027	1.113	0.944	1.433	1.157	0.884	1.105	0.905	1.066	1.399	1.493	1.328	0.333	0.755	0.705	0.703
Froude Number (Q design)	0.261	0.125	0.235	0.233	0.305	0.253	0.347	0.121	0.325	0.276	0.314	0.383	0.639	0.360	0.309	0.409	0.219	0.098	0.094	0.235
Channel Shear Stress, τ_o (lb/ft^2)	0.37	0.10	0.31	0.32	0.43	0.36	0.49	0.18	0.49	0.37	0.46	0.53	1.01	0.59	0.51	0.66	0.20	0.11	0.10	0.28
Actual Sheer Stress, τ_d (lb/ft^2)	0.55	0.12	0.45	0.47	0.63	0.53	0.69	0.27	0.69	0.47	0.61	1.10	1.37	0.85	0.74	0.95	0.40	0.23	0.21	0.35
Mannings n	0.075	0.126	0.081	0.080	0.071	0.076	0.068	0.102	0.068	0.076	0.069	0.065	0.051	0.063	0.067	0.060	0.097	0.123	0.126	0.084
Average Velocity, V (ft/s)	1.55	0.40	1.26	1.34	1.75	1.51	1.89	0.82	1.97	1.46	1.86	2.04	3.77	2.41	2.15	2.63	0.72	0.48	0.45	1.12
Calculated Flow, Q (ft^3/s)	35.4	1.4	22.1	27.4	35.4	35.2	33.5	29.8	52.5	16.0	28.0	27.1	79.6	80.5	79.5	81.6	2.1	4.7	3.8	9.6
Difference Between Design & Calc. Flow (%)	0.2%	0.2%	1.9%	0.0%	0.1%	0.0%	1.0%	-0.4%	0.6%	0.5%	0.6%	1.6%	-0.6%	0.5%	-0.7%	1.8%	0.0%	-0.3%	0.2%	-0.5%
Effective Shear on Soil Surface, τ_e (lb/ft^2)	0.002	0.000	0.002	0.002	0.003	0.002	0.004	0.001	0.004	0.002	0.003	0.007	0.014	0.005	0.004	0.007	0.001	0.000	0.000	0.001
Total Permissible Shear on Veg., $\tau_{p,veg}$ (lb/ft^2)	17.60	49.69	20.53	20.03	15.78	18.08	14.47	32.56	14.47	18.08	14.90	13.22	8.14	12.42	14.05	11.27	29.45	47.35	49.69	22.08
Stable (Y or N)	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Source: Grass Lined Channel Design WisDOT Spreadsheet, FDM 13-30 Attachment 15.2

Non-Channel Erosion Mat
(1052)

Wisconsin Department of Natural Resources
Conservation Practice Standard

To differentiate applications Erosion mats are organized into three Classes of mats, which are further broken down into various Types.

A. **Class I**: A short-term duration (minimum of 6 months), light duty, organic mat with photodegradable plastic or biodegradable netting.

   1. **Type A** – Use on erodible slopes 2.5:1 or flatter.

   2. **Type B** – Double netted product for use on erodible slopes 2:1 or flatter.

B. **Class I, Urban**: A short-term duration (minimum of 6 months), light duty, organic erosion control mat for areas where mowing may be accomplished within two weeks after installation.

   1. **Urban, Type A** – Use on erodible soils with slopes 4:1 or flatter.

   2. **Urban, Type B** – A double netted product for use on slopes 2.5:1 or flatter.

C. **Class II**: A long-term duration (three years or greater), organic erosion control revegetative mat.

   1. **Type A** – Jute fiber only for use on slopes 2:1 or flatter for sod reinforcement.

   2. **Type B** – For use on slopes 2:1 or greater made with plastic or biodegradable net.

   3. **Type C** – A woven mat of 100% organic fibers for use on slopes 2:1 or flatter and in environmentally and biologically sensitive areas where plastic netting is inappropriate.

D. **Class III**: A permanent 100% synthetic ECRM or TRM. Either a soil stabilizer Type A or Class I, Type A or B erosion mat must be placed over the soil filled TRM.

   1. **Type A** – An ECRM for use on slopes 2:1 or flatter.

   2. **Type B or C** – A TRM for use on slopes 2:1 or flatter.

   3. **Type D** – A TRM for use on slopes 1:1 or flatter.

Channel Erosion Mat
(1053)

Wisconsin Department of Natural Resources
Conservation Practice Standard

To differentiate applications WisDOT organizes erosion mats into three classes of mats, which are further broken down into various Types.

A. **Class I**: A short-term duration (minimum of 6 months), light duty, organic ECRM with plastic or biodegradable netting.

   1. **Type A** – Only suitable for slope applications, not channel applications.

   2. **Type B** – Double netted product for use in channels where the calculated (design) shear stress is 1.5 lbs/ft^2 or less.

B. **Class II**: A long-term duration (three years or greater), organic ECRM.

   1. **Type A** – Jute fiber only for use in channels to reinforce sod.

   2. **Type B** – For use in channels where the calculated (design) shear stress is 2.0 lbs/ft^2 or less. Made with plastic or biodegradable mat.

   3. **Type C** – A woven mat of 100% organic material for use in channels where the calculated (design) shear stress is 2.0 lbs/ft^2 or less. Applicable for use in environmentally sensitive areas where plastic netting is inappropriate.

C. **Class III**: A permanent 100% synthetic ECRM or TRM. Class I, Type B erosion mat or Class II, Type B or C erosion mat must be placed over a soil filled TRM.

   1. **Type A** – An ECRM for use in channels where the calculated (design) shear stress of 2.0 lbs/ft^2 or less.

   2. **Type B** – A TRM for use in channels where the calculated (design) shear stress of 2.0 lbs/ft^2 or less.

   3. **Type C** – A TRM for use in channels where the calculated (design) shear stress of 3.5 lbs/ft^2 or less.

   4. **Type D** – A TRM for use in channels where the calculated (design) shear stress of 5.0 lbs/ft^2 or less.

Culvert Sizing

SCS ENGINEERS

		Sheet No: 1/7	
		Calc. No.	
		Rev. No.	
Job No. 25220183.00	Job: COL - POO	By: RJG	Date: 4/7/22
Client: WPL	Subject: Culvert Sizing	Chk'd: MJT	Date:

Purpose:

To size the post closure culverts to accommodate the 25-year, 24-hour storm event.

References:

1. HY-8 7.40 Computer Model
2. HydroCAD Report_Post Construction and HydroCAD Report_Post Construction Temporary Culvert
3. Figure 1 - Storm Water Post Construction

Approach:

1. Create culvert crossing in HY-8 and input data from Reference #2 and #3.
2. Adjust diameter size and number of culverts in model until design flow does not over top berm/road crossing.

Assumptions:

1. Assume the tailwater channel data is a based on discharge swale or rock chute geometry (Reference #2).
2. Culverts are circular, PE Pipe with smooth interior, and with square edge with headwall.
3. Culvert elevatons,lengths, and slopes based on Figure 1 (Reference #3).
4. Roadwa data for crossing based on Figure 1 (Reference #3).
5. Discharge flows from HydroCAD report (Refence #2).

Calculations:

See attached HY-8 Model output reports.

Results:

The culverts are adequately designed to accommodate the flows from the 25-year, 24-hour storm event.

Culvert	Dia. (ft)	# of Barrels	Upstream Invert (ft)	Downstream Invert (ft)	Slope (%)	Length (ft)
C1	2	1	815.70	814.55	2.22	52
C2	1.5	2	814.40	814.20	0.49	41
C3	2.5	2	811.17	811.16	0.02	50
C4	2.5	2	809.87	809.74	0.26	50
C5	2.5	2	807.57	807.15	0.84	50
C6	2	2	805.40	804.76	0.61	105
C7	3.5	2	796.64	796.34	0.50	60
C8	2	1	807.54	806.81	0.73	100

HY-8 Culvert Analysis Report _ Culvert C1

Site Data - Culvert C1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 815.70 ft

Outlet Station: 51.88 ft

Outlet Elevation: 814.55 ft

Number of Barrels: 1

Culvert Data Summary - Culvert C1

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 2.06 cfs

Design Flow: 2.06 cfs

Maximum Flow: 7.48 cfs

Tailwater Channel Data - Culvert C1

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 6.00 (_:1)

Channel Slope: 0.0300

Channel Manning's n: 0.0300

Channel Invert Elevation: 815.32 ft

Table 1 - Culvert Summary Table: Culvert C1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2.06	2.06	816.37	0.670	0.0*	1-JS1t	0.321	0.498	1.127	0.357	1.129	2.695
2.60	2.60	816.46	0.758	0.031	1-JS1t	0.361	0.562	1.160	0.390	1.378	2.857
3.14	3.14	816.54	0.838	0.070	1-JS1t	0.396	0.619	1.188	0.418	1.616	2.995
3.69	3.69	816.61	0.912	0.108	1-JS1t	0.428	0.672	1.214	0.444	1.847	3.117
4.23	4.23	816.68	0.982	0.145	1-JS1t	0.459	0.722	1.237	0.467	2.072	3.226
4.77	4.77	816.76	1.058	0.182	1-S2n	0.487	0.768	0.503	0.489	7.698	3.324
5.31	5.31	816.83	1.134	0.220	1-S2n	0.515	0.813	0.533	0.509	7.895	3.415
5.85	5.85	816.91	1.206	0.258	1-S2n	0.541	0.855	0.562	0.528	8.081	3.499
6.40	6.40	816.98	1.275	0.298	1-S2n	0.566	0.895	0.590	0.546	8.262	3.577
6.94	6.94	817.04	1.342	0.338	1-S2n	0.590	0.934	0.617	0.563	8.416	3.651
7.48	7.48	817.11	1.406	0.379	1-S2n	0.614	0.972	0.643	0.579	8.566	3.720

* Full Flow Headwater elevation is below inlet invert.

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Straight Culvert

Inlet Elevation (invert): 815.70 ft, Outlet Elevation (invert): 814.55 ft

Culvert Length: 51.89 ft, Culvert Slope: 0.0222

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Table 2 - Summary of Culvert Flows at Crossing: Culvert C1

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert C1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
816.37	2.06	2.06	0.00	1
816.46	2.60	2.60	0.00	1
816.54	3.14	3.14	0.00	1
816.61	3.69	3.69	0.00	1
816.68	4.23	4.23	0.00	1
816.76	4.77	4.77	0.00	1
816.83	5.31	5.31	0.00	1
816.91	5.85	5.85	0.00	1
816.98	6.40	6.40	0.00	1
817.04	6.94	6.94	0.00	1
817.11	7.48	7.48	0.00	1
819.06	22.61	22.61	0.00	Overtopping

HY-8 Culvert Analysis Report _ Culvert C2

Site Data - C2

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 814.40 ft

Outlet Station: 41.00 ft

Outlet Elevation: 814.20 ft

Number of Barrels: 2

Culvert Data Summary - C2

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Tailwater Channel Data - Culvert C2

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 8.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0050

Channel Manning's n: 0.0300

Channel Invert Elevation: 814.10 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 9.68 cfs

Design Flow: 9.68 cfs

Maximum Flow: 13.45 cfs

Table 1 - Culvert Summary Table: C2

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
9.68	9.68	815.67	1.271	0.199	1-S2n	0.767	0.842	0.767	0.499	4.728	1.939
10.06	10.06	815.70	1.302	0.926	1-S2n	0.786	0.858	0.786	0.510	4.769	1.963
10.43	10.43	815.73	1.333	0.966	1-S2n	0.805	0.877	0.805	0.521	4.807	1.987
10.81	10.81	815.76	1.364	1.003	1-S2n	0.824	0.893	0.824	0.531	4.842	2.010
11.19	11.19	815.79	1.395	1.041	1-S2n	0.843	0.909	0.843	0.542	4.871	2.032
11.57	11.57	815.83	1.426	1.079	1-S2n	0.863	0.924	0.863	0.552	4.899	2.053
11.94	11.94	815.86	1.457	1.117	1-S2n	0.882	0.939	0.882	0.562	4.943	2.074
12.32	12.32	815.89	1.489	1.156	1-S2n	0.902	0.954	0.902	0.572	4.973	2.095
12.70	12.70	815.92	1.521	1.196	5-S2n	0.921	0.968	0.921	0.581	5.001	2.115
13.07	13.07	815.95	1.553	1.240	5-S2n	0.941	0.987	0.941	0.591	5.028	2.134
13.45	13.45	815.99	1.586	1.281	5-S2n	0.962	1.001	0.962	0.600	5.048	2.153

****

Straight Culvert

Inlet Elevation (invert): 814.40 ft, Outlet Elevation (invert): 814.20 ft

Culvert Length: 41.00 ft, Culvert Slope: 0.0049

****

Table 2 - Summary of Culvert Flows at Crossing: Culvert C2

Headwater Elevation (ft)	Total Discharge (cfs)	C2 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
815.67	9.68	9.68	0.00	1
815.70	10.06	10.06	0.00	1
815.73	10.43	10.43	0.00	1
815.76	10.81	10.81	0.00	1
815.79	11.19	11.19	0.00	1
815.83	11.57	11.57	0.00	1
815.86	11.94	11.94	0.00	1
815.89	12.32	12.32	0.00	1
815.92	12.70	12.70	0.00	1
815.95	13.07	13.07	0.00	1
815.99	13.45	13.45	0.00	1
816.90	21.79	21.79	0.00	Overtopping

HY-8 Culvert Analysis Report _ Culvert C3

Site Data - C3

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 811.17 ft

Outlet Station: 50.00 ft

Outlet Elevation: 811.16 ft

Number of Barrels: 2

Culvert Data Summary - C3

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Tailwater Channel Data - Culvert C3

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 8.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0050

Channel Manning's n: 0.0300

Channel Invert Elevation: 811.17 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 27.38 cfs

Design Flow: 27.38 cfs

Maximum Flow: 47.76 cfs

Table 1 - Culvert Summary Table: C3

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
27.38	27.38	813.15	1.836	1.981	7-H2c	-1.000	1.245	1.245	0.886	5.607	2.677
29.42	29.42	813.23	1.918	2.064	7-H2c	-1.000	1.292	1.292	0.921	5.745	2.735
31.46	31.46	813.32	1.998	2.147	7-H2c	-1.000	1.339	1.339	0.954	5.878	2.789
33.49	33.49	813.40	2.077	2.228	7-H2c	-1.000	1.383	1.383	0.987	6.009	2.841
35.53	35.53	813.48	2.155	2.308	7-H2c	-1.000	1.427	1.427	1.018	6.137	2.891
37.57	37.46	813.55	2.229	2.384	7-H2c	-1.000	1.467	1.467	1.049	6.257	2.938
39.61	38.68	813.60	2.276	2.431	7-H2c	-1.000	1.492	1.492	1.078	6.332	2.983
41.65	39.64	813.64	2.312	2.468	7-H2c	-1.000	1.511	1.511	1.107	6.391	3.027
43.68	40.50	813.67	2.345	2.502	7-H2c	-1.000	1.528	1.528	1.135	6.443	3.068
45.72	41.26	813.70	2.374	2.531	7-H2c	-1.000	1.543	1.543	1.163	6.490	3.109
47.76	42.00	813.73	2.403	2.559	7-H2c	-1.000	1.557	1.557	1.189	6.534	3.148

****

Straight Culvert

Inlet Elevation (invert): 811.17 ft,   Outlet Elevation (invert): 811.16 ft

Culvert Length: 50.00 ft,   Culvert Slope: 0.0002

****

Table 2 - Summary of Culvert Flows at Crossing: Culvert C3

Headwater Elevation (ft)	Total Discharge (cfs)	C3 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
813.15	27.38	27.38	0.00	1
813.23	29.42	29.42	0.00	1
813.32	31.46	31.46	0.00	1
813.40	33.49	33.49	0.00	1
813.48	35.53	35.53	0.00	1
813.55	37.57	37.46	0.02	10
813.60	39.61	38.68	0.85	6
813.64	41.65	39.64	1.94	5
813.67	43.68	40.50	3.15	5
813.70	45.72	41.26	4.38	4
813.73	47.76	42.00	5.71	4
813.55	37.37	37.37	0.00	Overtopping

HY-8 Culvert Analysis Report _ Culvert C4

Site Data - C4

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 809.87 ft

Outlet Station: 50.00 ft

Outlet Elevation: 809.74 ft

Number of Barrels: 2

Culvert Data Summary - C4

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Tailwater Channel Data - Culvert C4

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 8.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0070

Channel Manning's n: 0.0300

Channel Invert Elevation: 809.87 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 35.39 cfs

Design Flow: 35.39 cfs

Maximum Flow: 62.23 cfs

Table 1 - Culvert Summary Table: C4

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
35.39	35.39	812.13	2.147	2.263	2-M2c	1.660	1.424	1.424	0.929	6.128	3.252
38.07	38.07	812.24	2.249	2.365	2-M2c	1.752	1.479	1.479	0.966	6.295	3.322
40.76	40.41	812.32	2.338	2.454	2-M2c	1.837	1.526	1.526	1.002	6.438	3.389
43.44	41.81	812.38	2.392	2.507	7-M2c	1.891	1.553	1.553	1.036	6.523	3.453
46.13	42.96	812.42	2.437	2.550	7-M2c	1.938	1.575	1.575	1.069	6.593	3.513
48.81	44.01	812.46	2.478	2.589	7-M2c	1.983	1.595	1.595	1.102	6.656	3.571
51.49	44.95	812.49	2.515	2.624	7-M2c	2.027	1.613	1.613	1.133	6.713	3.627
54.18	45.85	812.53	2.550	2.658	7-M2c	2.073	1.629	1.629	1.163	6.767	3.680
56.86	46.71	812.56	2.585	2.691	7-M2c	2.121	1.645	1.645	1.193	6.819	3.731
59.55	47.53	812.59	2.617	2.721	7-M2c	2.174	1.660	1.660	1.222	6.868	3.781
62.23	48.31	812.62	2.649	2.751	7-M2c	2.500	1.674	1.674	1.250	6.915	3.828

****

Straight Culvert

Inlet Elevation (invert): 809.87 ft, Outlet Elevation (invert): 809.74 ft

Culvert Length: 50.00 ft, Culvert Slope: 0.0026

****

Table 2 - Summary of Culvert Flows at Crossing: Culvert C4

Headwater Elevation (ft)	Total Discharge (cfs)	C4 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
812.13	35.39	35.39	0.00	1
812.24	38.07	38.07	0.00	1
812.32	40.76	40.41	0.26	9
812.38	43.44	41.81	1.56	6
812.42	46.13	42.96	3.08	5
812.46	48.81	44.01	4.75	5
812.49	51.49	44.95	6.46	4
812.53	54.18	45.85	8.25	4
812.56	56.86	46.71	10.10	4
812.59	59.55	47.53	11.98	4
812.62	62.23	48.31	13.89	4
812.30	39.78	39.78	0.00	Overtopping

HY-8 Culvert Analysis Report _ Culvert C5

Site Data - C5

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 807.57 ft

Outlet Station: 50.00 ft

Outlet Elevation: 807.15 ft

Number of Barrels: 2

Culvert Data Summary - C5

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Tailwater Channel Data - Culvert C5

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 8.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0050

Channel Manning's n: 0.0300

Channel Invert Elevation: 807.59 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 35.21 cfs

Design Flow: 35.21 cfs

Maximum Flow: 65.15 cfs

Table 1 - Culvert Summary Table: C5

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
35.21	35.21	809.70	2.133	1.411	1-S2n	1.148	1.420	1.190	1.013	7.642	2.883
38.20	38.20	809.82	2.247	1.523	1-S2n	1.203	1.482	1.248	1.058	7.801	2.952
41.20	41.20	809.93	2.362	1.638	1-S2n	1.257	1.541	1.305	1.101	7.950	3.017
44.19	44.19	810.05	2.478	1.773	1-S2n	1.311	1.598	1.360	1.142	8.093	3.079
47.19	47.19	810.17	2.596	1.912	5-S2n	1.364	1.654	1.415	1.182	8.230	3.137
50.18	50.18	810.29	2.719	2.054	5-S2n	1.417	1.707	1.470	1.220	8.362	3.193
53.17	53.17	810.42	2.846	2.199	5-S2n	1.470	1.758	1.523	1.257	8.490	3.246
56.17	55.74	810.53	2.959	2.326	5-S2n	1.516	1.800	1.569	1.294	8.595	3.296
59.16	57.10	810.59	3.021	2.395	5-S2n	1.541	1.822	1.593	1.329	8.650	3.345
62.16	58.20	810.64	3.072	2.451	5-S2n	1.561	1.839	1.613	1.363	8.693	3.391
65.15	59.19	810.69	3.118	2.501	5-S2n	1.578	1.854	1.630	1.396	8.732	3.436

****

Straight Culvert

Inlet Elevation (invert): 807.57 ft, Outlet Elevation (invert): 807.15 ft

Culvert Length: 50.00 ft, Culvert Slope: 0.0084

****

Table 24 - Summary of Culvert Flows at Crossing: Culvert C5

Headwater Elevation (ft)	Total Discharge (cfs)	C5 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
809.70	35.21	35.21	0.00	1
809.82	38.20	38.20	0.00	1
809.93	41.20	41.20	0.00	1
810.05	44.19	44.19	0.00	1
810.17	47.19	47.19	0.00	1
810.29	50.18	50.18	0.00	1
810.42	53.17	53.17	0.00	1
810.53	56.17	55.74	0.36	10
810.59	59.16	57.10	1.98	6
810.64	62.16	58.20	3.88	5
810.69	65.15	59.19	5.92	5
810.50	55.08	55.08	0.00	Overtopping

HY-8 Culvert Analysis Report _ Culvert C6

Site Data - C6

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 805.40 ft

Outlet Station: 104.56 ft

Outlet Elevation: 804.76 ft

Number of Barrels: 2

Culvert Data Summary - C6

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope

Inlet Depression: None

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 27.86 cfs

Design Flow: 27.86 cfs

Maximum Flow: 47.83 cfs

Tailwater Channel Data - Culvert C6

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 10.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0070

Channel Manning's n: 0.0300

Channel Invert Elevation: 804.56 ft

Table 1 - Culvert Summary Table: C6

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
27.86	27.86	807.61	2.214	1.559	5-S2n	1.263	1.344	1.263	0.769	6.666	3.141
29.86	29.86	807.76	2.362	1.734	5-S2n	1.325	1.392	1.325	0.800	6.758	3.216
31.85	31.85	807.92	2.520	1.916	5-S2n	1.390	1.439	1.391	0.831	6.829	3.287
33.85	33.85	808.09	2.689	2.105	5-S2n	1.458	1.483	1.458	0.861	6.901	3.355
35.85	35.85	808.27	2.869	2.806	7-M2c	1.531	1.525	1.525	0.890	6.973	3.420
37.84	37.84	808.46	3.061	2.896	7-M2c	1.613	1.565	1.565	0.918	7.174	3.483
39.84	39.00	808.58	3.176	2.950	7-M2c	1.669	1.587	1.587	0.946	7.293	3.543
41.84	39.67	808.64	3.245	2.982	7-M2c	1.705	1.600	1.600	0.973	7.363	3.601
43.84	40.22	808.70	3.302	3.010	7-M2c	1.740	1.610	1.610	0.999	7.421	3.656
45.83	40.73	808.76	3.356	3.038	7-M2c	1.780	1.619	1.619	1.025	7.474	3.710
47.83	41.19	808.80	3.404	3.064	7-M2c	2.000	1.627	1.627	1.051	7.523	3.762

****

Straight Culvert

Inlet Elevation (invert): 805.40 ft, Outlet Elevation (invert): 804.76 ft

Culvert Length: 104.56 ft, Culvert Slope: 0.0061

****

Table 2 - Summary of Culvert Flows at Crossing: Culvert C6

Headwater Elevation (ft)	Total Discharge (cfs)	C6 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
807.61	27.86	27.86	0.00	1
807.76	29.86	29.86	0.00	1
807.92	31.85	31.85	0.00	1
808.09	33.85	33.85	0.00	1
808.27	35.85	35.85	0.00	1
808.46	37.84	37.84	0.00	1
808.58	39.84	39.00	0.80	8
808.64	41.84	39.67	2.13	6
808.70	43.84	40.22	3.56	5
808.76	45.83	40.73	5.07	5
808.80	47.83	41.19	6.62	5
808.50	38.24	38.24	0.00	Overtopping

HY-8 Culvert Analysis Report _ Culvert C7

Site Data - C7

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 796.64 ft

Outlet Station: 60.20 ft

Outlet Elevation: 796.34 ft

Number of Barrels: 2

Culvert Data Summary - C7

Barrel Shape: Circular

Barrel Diameter: 3.50 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Tailwater Channel Data - Culvert C7

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 10.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0300

Channel Invert Elevation: 795.60 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 52.15 cfs

Design Flow: 52.15 cfs

Maximum Flow: 103.37 cfs

Table 1 - Culvert Summary Table: C7

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
52.15	52.15	799.12	2.228	2.484	2-M2c	2.109	1.572	1.572	0.943	6.224	4.017
57.27	57.27	799.26	2.356	2.622	2-M2c	2.247	1.651	1.651	0.992	6.414	4.133
62.39	62.39	799.40	2.481	2.756	2-M2c	2.389	1.727	1.727	1.039	6.596	4.241
67.52	67.52	799.53	2.604	2.889	2-M2c	2.539	1.800	1.800	1.084	6.773	4.342
72.64	72.64	799.66	2.725	3.019	2-M2c	2.703	1.870	1.870	1.128	6.945	4.438
77.76	77.76	799.79	2.846	3.148	2-M2c	2.898	1.938	1.938	1.170	7.112	4.528
82.88	82.88	799.92	2.966	3.277	2-M2c	3.500	2.004	2.004	1.210	7.277	4.614
88.00	88.00	800.04	3.086	3.405	2-M2c	3.500	2.067	2.067	1.250	7.439	4.696
93.13	93.13	800.17	3.207	3.534	7-M2c	3.500	2.129	2.129	1.288	7.599	4.774
98.25	98.25	800.30	3.330	3.663	7-M2c	3.500	2.189	2.189	1.324	7.758	4.849
103.37	103.37	800.43	3.454	3.794	7-M2c	3.500	2.248	2.248	1.360	7.916	4.921

****

Straight Culvert

Inlet Elevation (invert): 796.64 ft, Outlet Elevation (invert): 796.34 ft

Culvert Length: 60.20 ft, Culvert Slope: 0.0050

****

Table 15 - Summary of Culvert Flows at Crossing: Culvert C7

Headwater Elevation (ft)	Total Discharge (cfs)	C7 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
799.12	52.15	52.15	0.00	1
799.26	57.27	57.27	0.00	1
799.40	62.39	62.39	0.00	1
799.53	67.52	67.52	0.00	1
799.66	72.64	72.64	0.00	1
799.79	77.76	77.76	0.00	1
799.92	82.88	82.88	0.00	1
800.04	88.00	88.00	0.00	1
800.17	93.13	93.13	0.00	1
800.30	98.25	98.25	0.00	1
800.43	103.37	103.37	0.00	1
802.50	162.85	162.85	0.00	Overtopping

HY-8 Culvert Analysis Report _ Culvert C8

Site Data - C8

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 807.54 ft

Outlet Station: 99.86 ft

Outlet Elevation: 806.81 ft

Number of Barrels: 1

Culvert Data Summary - C8

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: None

Tailwater Channel Data - Culvert C8

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 12.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0560

Channel Manning's n: 0.0450

Channel Invert Elevation: 807.44 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 8.32 cfs

Design Flow: 8.32 cfs

Maximum Flow: 19.2 cfs

Table 1 - Culvert Summary Table: C8

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
8.32	8.32	809.29	1.614	1.747	2-M2c	1.344	1.028	1.028	0.230	5.117	2.797
9.41	9.41	809.43	1.751	1.891	2-M2c	1.478	1.096	1.096	0.248	5.339	2.926
10.50	10.50	809.58	1.890	2.038	7-M2c	1.639	1.160	1.160	0.264	5.553	3.045
11.58	11.58	809.74	2.033	2.199	7-M2c	2.000	1.222	1.222	0.280	5.762	3.156
12.67	12.67	809.92	2.182	2.381	7-M2c	2.000	1.280	1.280	0.295	5.968	3.260
13.76	13.76	810.22	2.338	2.679	7-M2c	2.000	1.336	1.336	0.310	6.173	3.357
14.85	14.85	810.57	2.504	3.026	7-M2c	2.000	1.389	1.389	0.324	6.378	3.451
15.94	15.94	810.93	2.679	3.391	7-M2c	2.000	1.439	1.439	0.337	6.585	3.538
17.02	17.02	811.32	2.866	3.776	7-M2c	2.000	1.487	1.487	0.351	6.796	3.622
18.11	18.11	811.72	3.066	4.183	7-M2c	2.000	1.533	1.533	0.364	7.011	3.703
19.20	19.20	812.15	3.279	4.611	7-M2c	2.000	1.576	1.576	0.376	7.231	3.780

****

Straight Culvert

Inlet Elevation (invert): 807.54 ft,   Outlet Elevation (invert): 806.81 ft

Culvert Length: 99.86 ft,   Culvert Slope: 0.0073

****

Table 2 - Summary of Culvert Flows at Crossing: Culvert C8

Headwater Elevation (ft)	Total Discharge (cfs)	C8 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
809.29	8.32	8.32	0.00	1
809.43	9.41	9.41	0.00	1
809.58	10.50	10.50	0.00	1
809.74	11.58	11.58	0.00	1
809.92	12.67	12.67	0.00	1
810.22	13.76	13.76	0.00	1
810.57	14.85	14.85	0.00	1
810.93	15.94	15.94	0.00	1
811.32	17.02	17.02	0.00	1
811.72	18.11	18.11	0.00	1
812.15	19.20	19.20	0.00	1
812.40	19.87	19.87	0.00	Overtopping

Diversion Berm Sizing

Purpose:

Determine the spacing between diversion berms on the landfill final cover, with the goal of maintaining ≤ 3 ton/acre of soil loss along the final cover.

References

1. "Predicting Rainfall Erosion Losses," USDA Agriculture Handbook Number 537, 1978. (Figure 1 on Sheet 2 and Tables 10 and 13 on Sheet 4).
2. Erosion and Sediment Control Handbook," Goldman, Jackson, & Bursztynsky, 1986. (Table 5.5 on Sheet 5).
3. Rainfed retention probabilities computed for different cropping tillage systems. Agricultural Water Management, A.W. Mills & G.W. Thomas, 1985. Table 5.10 on Sheet 3)
4. Colombia Energy Center POO Update Drawings

Approach:

Use the Universal Soil Loss Equation (USLE) to determine diversion berm spacing. Longest flow length is 401 feet.

USLE Equation: $A = R * K * LS * C * P$

where:
- A = Average annual soil loss, tons/acre
- R = Rainfall and runoff erosivity index
- K = Soil erodibility factor, tons/acre
- LS = Slope length and steepness factor
- C = Cover management factor
- P = Practice factor

or $$LS = \frac{A}{R \times K \times C \times P}$$

Assumptions:

A =	3	tons/acre
R =	145	see Figure 1 on Sheet 2 (Reference #1)
K =	0.38	see Table 5.10 on Sheet 3 for Loamy Very Fine Sand (Reference #3)
C =	0.0064	see Table 10 on Sheet 4, assuming 90% cover (Reference #1)
P =	1.0	assume no support practice used

Calculation:

$$LS = \frac{A}{R \times K \times C \times P} = \frac{3}{145 \times 0.38 \times 0.0064 \times 1.0} = 8.51$$

From the LS Values Table (Sheet 5), based on the 4:1 final cover slope, the slope distance is between 200 and 250 feet.
Use linear interpolation between the LS values for 200 and 250 feet to determine the slope length value for the 4:1 slope.

Slope Length @	200	ft	LS=	8.33
Slope Length @	250	ft	LS=	9.31

Slope length for the calculate LS factor = 209 ft

Results:

The maximum distance between diversion berms along the final cover to maintain less than 3 tons/acre soil loss is 209 ft.

SCS ENGINEERS

		Sheet No.	2 of 5
		Calc. No.	
		Rev. No.	
Job No. 25220183.00	Job: Columbia POO Update	By: RJG	Date: 2/15/22
Client: WPL	Subject: Diversion Berm Spacing Calculation	Chk'd: MJT	Date: 4/1/22

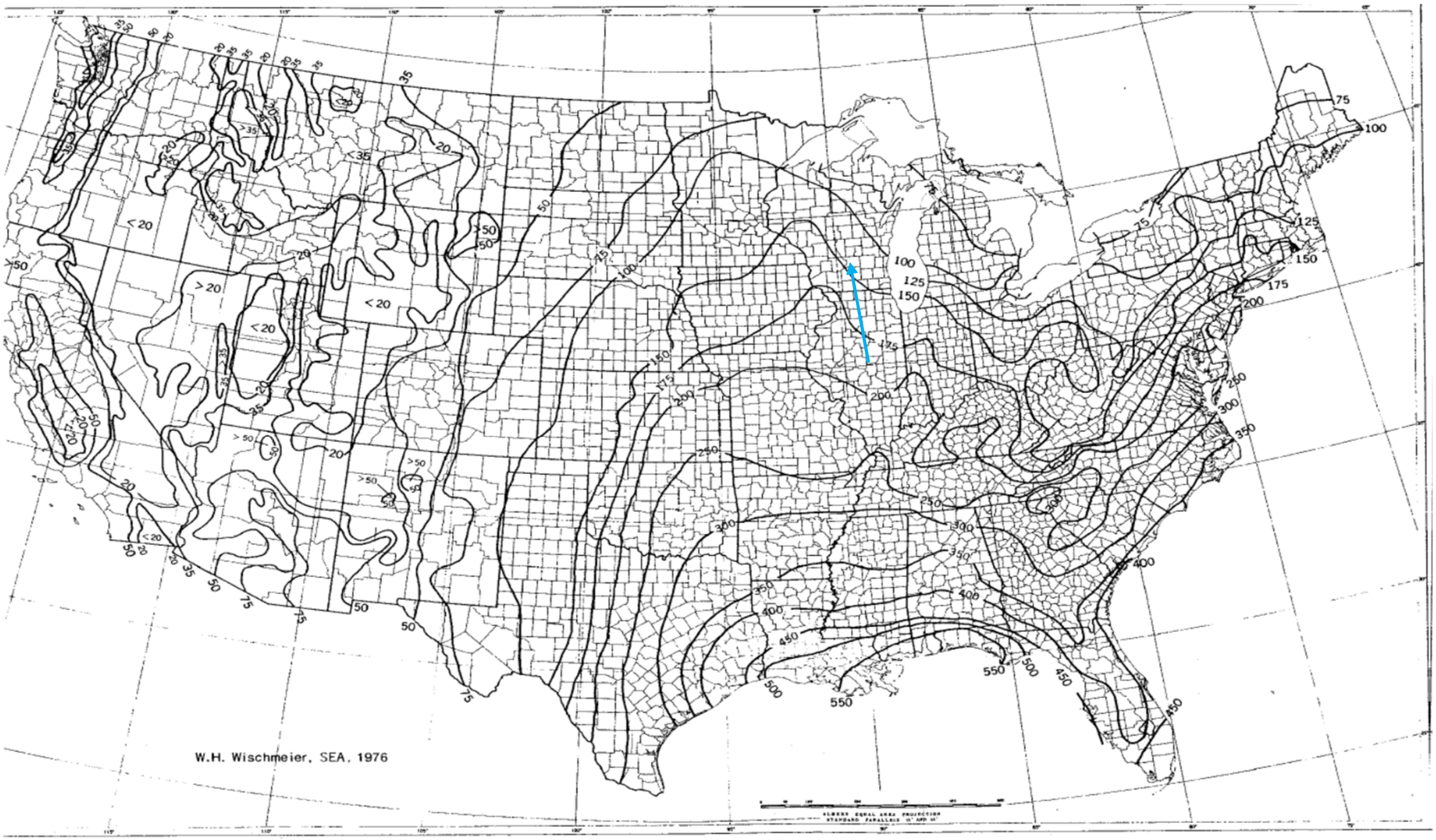


FIGURE 1.—Average annual values of the rainfall erosion index.

Source: "Predicting Rainfall Erosion Losses," USDA Agriculture Handbook Number 537, 1978.

Table 5.10. Soil Erodibility Factor K_{fact} (after Stewart et al. 1975)[a]

	P_{om}(%)		
Textural Class	<0.5	2	4
Sand	0.05	0.03	0.02
Fine sand	0.16	0.14	0.10
Very finesand	0.42	0.36	0.28
Loamy sand	0.12	0.10	0.08
Loamy finesand	0.24	0.20	0.16
Loamy veryfine sand	0.44	0.38	0.30
Sandy loam	0.27	0.24	0.19
Fine sandyloam	0.35	0.30	0.24
Very fine sandy loam	0.47	0.41	0.33
Loam	0.38	0.34	0.29
Silt loam	0.48	0.42	0.33
Silt	0.60	0.52	0.42
Sandy clayloam	0.27	0.25	0.21
Clay loam	0.28	0.25	0.21
Silty clayloam	0.37	0.32	0.26
Sandy clay	0.14	0.13	0.12
Silty clay	0.25	0.23	0.19
Clay		0.13-0.2	

(a) The values shown are estimated averages of broad ranges of specific soil values. When a texture is near the border line of two texture classes, use the average of the two K_{fact} values. In addition, the values shown are commensurate with the English units used in the cited reference (and as used in the source-term module input files). To obtain analagous values in the metric units used in this report, the above values should be multiplied by 1.292.

TABLE 10.—*Factor* **C** *for permanent pasture, range, and idle land*[1]

Vegetative canopy: Type and height[2]	Vegetative canopy: Percent cover[3]	Cover that contacts the soil surface: Type[4]	Percent ground cover: 0	20	40	60	80	95+
No appreciable canopy		G	0.45	0.20	0.10	0.042	0.013	0.003
		W	.45	.24	.15	.091	.043	.011
Tall weeds or short brush with average drop fall height of 20 in	25	G	.36	.17	.09	.038	.013	.003
		W	.36	.20	.13	.083	.041	.011
	50	G	.26	.13	.07	.035	.012	.003
		W	.26	.16	.11	.076	.039	.011
	75	G	.17	.10	.06	.032	.011	.003
		W	.17	.12	.09	.068	.038	.011
Appreciable brush or bushes, with average drop fall height of 6½ ft	25	G	.40	.18	.09	.040	.013	.003
		W	.40	.22	.14	.087	.042	.011
	50	G	.34	.16	.08	.038	.012	.003
		W	.34	.19	.13	.082	.041	.011
	75	G	.28	.14	.08	.036	.012	.003
		W	.28	.17	.12	.078	.040	.011
Trees, but no appreciable low brush. Average drop fall height of 13 ft	25	G	.42	.19	.10	.041	.013	.003
		W	.42	.23	.14	.089	.042	.011
	50	G	.39	.18	.09	.040	.013	.003
		W	.39	.21	.14	.087	.042	.011
	75	G	.36	.17	.09	.039	.012	.003
		W	.36	.20	.13	.084	.041	.011

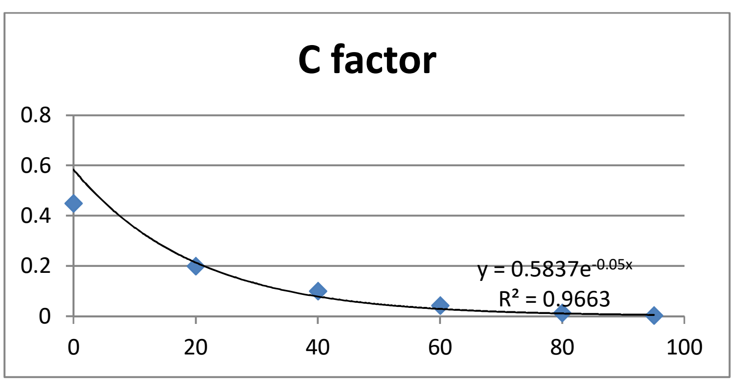
[1] The listed **C** values assume that the vegetation and mulch are randomly distributed over the entire area.

[2] Canopy height is measured as the average fall height of water drops falling from the canopy to the ground. Canopy effect is inversely proportional to drop fall height and is negligible if fall height exceeds 33 ft.

[3] Portion of total-area surface that would be hidden from view by canopy in a vertical projection (a bird's-eye view).

[4] G: cover at surface is grass, grasslike plants, decaying compacted duff, or litter at least 2 in deep.
W: cover at surface is mostly broadleaf herbaceous plants (as weeds with little lateral-root network near the surface) or undecayed residues or both.

Source: "Predicting Rainfall Erosion Losses," USDA Agriculture Handbook Number 537, 1978.



90 % cover
= 0.0065

TABLE 5.5 LS Values* (10)

Slope ratio	Slope gradient s, %	LS values for following slope lengths l, ft (m)										LS values for following slope lengths l, ft (m)												
		10 (3.0)	20 (6.1)	30 (9.1)	40 (12.2)	50 (15.2)	60 (18.3)	70 (21.3)	80 (24.4)	90 (27.4)	100 (30.5)	150 (46)	200 (61)	250 (76)	300 (91)	350 (107)	400 (122)	450 (137)	500 (152)	600 (183)	700 (213)	800 (244)	900 (274)	1000 (305)
	0.5	0.06	0.07	0.07	0.08	0.08	0.09	0.09	0.09	0.09	0.10	0.10	0.11	0.11	0.12	0.12	0.13	0.13	0.13	0.14	0.14	0.14	0.15	0.15
100:1	1	0.08	0.09	0.10	0.10	0.11	0.11	0.12	0.12	0.12	0.12	0.14	0.14	0.15	0.16	0.16	0.16	0.17	0.17	0.18	0.18	0.19	0.19	0.20
	2	0.10	0.12	0.14	0.15	0.16	0.17	0.18	0.19	0.19	0.20	0.23	0.25	0.26	0.28	0.29	0.30	0.32	0.33	0.34	0.36	0.37	0.39	0.40
	3	0.14	0.18	0.20	0.22	0.23	0.25	0.26	0.27	0.28	0.29	0.32	0.35	0.38	0.40	0.42	0.43	0.45	0.46	0.49	0.51	0.54	0.55	0.57
	4	0.16	0.21	0.25	0.28	0.30	0.33	0.35	0.37	0.38	0.40	0.47	0.53	0.58	0.62	0.66	0.70	0.73	0.76	0.82	0.87	0.92	0.96	1.00
20:1	5	0.17	0.24	0.29	0.34	0.38	0.41	0.45	0.48	0.51	0.53	0.66	0.76	0.85	0.93	1.00	1.07	1.13	1.20	1.31	1.42	1.51	1.60	1.69
	6	0.21	0.30	0.37	0.43	0.48	0.52	0.56	0.60	0.64	0.67	0.82	0.95	1.06	1.16	1.26	1.34	1.43	1.50	1.65	1.78	1.90	2.02	2.13
	7	0.26	0.37	0.45	0.52	0.58	0.64	0.69	0.74	0.78	0.82	1.01	1.17	1.30	1.43	1.54	1.65	1.75	1.84	2.02	2.18	2.33	2.47	2.61
12½:1	8	0.31	0.44	0.54	0.63	0.70	0.77	0.83	0.89	0.94	0.99	1.21	1.40	1.57	1.72	1.85	1.98	2.10	2.22	2.43	2.62	2.80	2.97	3.13
	9	0.37	0.52	0.64	0.74	0.83	0.91	0.98	1.05	1.11	1.17	1.44	1.66	1.85	2.03	2.19	2.35	2.49	2.62	2.87	3.10	3.32	3.52	3.71
10:1	10	0.43	0.61	0.75	0.87	0.97	1.06	1.15	1.22	1.30	1.37	1.68	1.94	2.16	2.37	2.56	2.74	2.90	3.06	3.35	3.62	3.87	4.11	4.33
	11	0.50	0.71	0.86	1.00	1.12	1.22	1.32	1.41	1.50	1.58	1.93	2.23	2.50	2.74	2.95	3.16	3.35	3.53	3.87	4.18	4.47	4.74	4.99
8:1	12.5	0.61	0.86	1.05	1.22	1.36	1.49	1.61	1.72	1.82	1.92	2.35	2.72	3.04	3.33	3.59	3.84	4.08	4.30	4.71	5.08	5.43	5.76	6.08
	15	0.81	1.14	1.40	1.62	1.81	1.98	2.14	2.29	2.43	2.56	3.13	3.62	4.05	4.43	4.79	5.12	5.43	5.72	6.27	6.77	7.24	7.68	8.09
6:1	16.7	0.96	1.36	1.67	1.92	2.15	2.36	2.54	2.72	2.88	3.04	3.72	4.30	4.81	5.27	5.69	6.08	6.45	6.80	7.45	8.04	8.60	9.12	9.62
5:1	20	1.29	1.82	2.23	2.58	2.88	3.16	3.41	3.65	3.87	4.08	5.00	5.77	6.45	7.06	7.63	8.16	8.65	9.12	9.99	10.79	11.54	12.24	12.90
4½:1	22	1.51	2.13	2.61	3.02	3.37	3.69	3.99	4.27	4.53	4.77	5.84	6.75	7.54	8.26	8.92	9.54	10.12	10.67	11.68	12.62	13.49	14.31	15.08
→ 4:1	25	1.86	2.63	3.23	3.73	4.16	4.56	4.93	5.27	5.59	5.89	7.21	8.33	9.31	10.20	11.02	11.78	12.49	13.17	14.43	15.58	16.66	17.67	18.63
	30	2.51	3.56	4.36	5.03	5.62	6.16	6.65	7.11	7.54	7.95	9.74	11.25	12.57	13.77	14.88	15.91	16.87	17.78	19.48	21.04	22.49	23.86	25.15
3:1	33.3	2.98	4.22	5.17	5.96	6.67	7.30	7.89	8.43	8.95	9.43	11.55	13.34	14.91	16.33	17.64	18.86	20.00	21.09	23.10	24.95	26.67	28.29	29.82
	35	3.23	4.57	5.60	6.46	7.23	7.92	8.55	9.14	9.70	10.22	12.52	14.46	16.16	17.70	19.12	20.44	21.68	22.86	25.04	27.04	28.91	30.67	32.32
2½:1	40	4.00	5.66	6.93	8.00	8.95	9.80	10.59	11.32	12.00	12.65	15.50	17.89	20.01	21.91	23.67	25.30	26.84	28.29	30.99	33.48	35.79	37.96	40.01
	45	4.81	6.80	8.33	9.61	10.75	11.77	12.72	13.60	14.42	15.20	18.62	21.50	24.03	26.33	28.44	30.40	32.24	33.99	37.23	40.22	42.99	45.60	48.07
2:1	50	5.64	7.97	9.76	11.27	12.60	13.81	14.91	15.94	16.91	17.82	21.83	25.21	28.18	30.87	33.34	35.65	37.81	39.85	43.66	47.16	50.41	53.47	56.36
	55	6.48	9.16	11.22	12.96	14.48	15.87	17.14	18.32	19.43	20.48	25.09	28.97	32.39	35.48	38.32	40.97	43.45	45.80	50.18	54.20	57.94	61.45	64.78
1¾:1	57	6.82	9.64	11.80	13.63	15.24	16.69	18.03	19.28	20.45	21.55	26.40	30.48	34.08	37.33	40.32	43.10	45.72	48.19	52.79	57.02	60.96	64.66	68.15
	60	7.32	10.35	12.68	14.64	16.37	17.93	19.37	20.71	21.96	23.15	28.35	32.74	36.60	40.10	43.31	46.30	49.11	51.77	56.71	61.25	65.48	69.45	73.21
1½:1	66.7	8.44	11.93	14.61	16.88	18.87	20.67	22.32	23.87	25.31	26.68	32.68	37.74	42.19	46.22	49.92	53.37	56.60	59.66	65.36	70.60	75.47	80.05	84.38
	70	8.98	12.70	15.55	17.96	20.08	21.99	23.75	25.39	26.93	28.39	34.77	40.15	44.89	49.17	53.11	56.78	60.23	63.48	69.54	75.12	80.30	85.17	89.78
	75	9.78	13.83	16.94	19.56	21.87	23.95	25.87	27.66	29.34	30.92	37.87	43.73	48.89	53.56	57.85	61.85	65.60	69.15	75.75	81.82	87.46	92.77	97.79
1¼:1	80	10.55	14.93	18.28	21.11	23.60	25.85	27.93	29.85	31.66	33.38	40.88	47.20	52.77	57.81	62.44	66.75	70.80	74.63	81.76	88.31	94.41	100.13	105.55
	85	11.30	15.98	19.58	22.61	25.27	27.69	29.90	31.97	33.91	35.74	43.78	50.55	56.51	61.91	66.87	71.48	75.82	79.92	87.55	94.57	101.09	107.23	113.03
	90	12.02	17.00	20.82	24.04	26.88	29.44	31.80	34.00	36.06	38.01	46.55	53.76	60.10	65.84	71.11	76.02	80.63	84.99	93.11	100.57	107.51	114.03	120.20
	95	12.71	17.97	22.01	25.41	28.41	31.12	33.62	35.94	38.12	40.18	49.21	56.82	63.53	69.59	75.17	80.36	85.23	89.84	98.42	106.30	113.64	120.54	127.06
1:1	100	13.36	18.89	23.14	26.72	29.87	32.72	35.34	37.78	40.08	42.24	51.74	59.74	66.79	73.17	79.03	84.49	89.61	94.46	103.48	111.77	119.48	126.73	133.59

*Calculated from

$$LS = \left(\frac{65.41 \times s^2}{s^2 + 10{,}000} + \frac{4.56 \times s}{\sqrt{s^2 + 10{,}000}} + 0.065\right)\left(\frac{l}{72.5}\right)^m$$

LS = topographic factor
l = slope length, ft (m × 0.3048)
s = slope steepness,
m = exponent dependent upon slope steep
(0.2 for slopes < 1%, 0.3 for slopes 1
0.4 for slopes 3.5 to 4.5%, and
0.5 for slopes > 5%)

FROM "EROSION & SEDIMENT CONTROL HANDBOOK", Goldman, Jackson, + Bursztynsky, 1986

Source: Erosion and Sediment Control Handbook," Goldman, Jackson, & Bursztynsky, 1986.

SCS ENGINEERS

Sheet No: 1/2	
Calc. No.	
Rev. No.	

Job No. 25220183.00	Project: Columbia Energy Center POO Update	By: RJG	Date: 2/23/22
Client: WPL	Subject: Diversion Berm Sizing	Chk'd: MJT	Date: 4/1/22

Purpose:

To size the post closure diversion berms on the final cover to accommodate the 25-year, 24-hour storm event.

References:

1. WisDOT Facilities Development Manual Chapter 13, Section 30-15 - Grass Lined Channels.
2. Design of Roadside Channels with Flexible Linings, HEC-15, USDOT FHWA.
3. HydroCAD Report_Post Construction

Approach:

Use the Post Closure HydroCAD Model results to obtain the peak flow during a 25-year, 24-hour storm event along the diversion berms.

Use Grass Lined Channel Design WisDOT Spreadsheet, FDM 13-30 Attachment 15.2 (from Reference #1) to size the swale for each design swale cross section. The WisDOT spreadsheet incorporates the design guidelines and equations described in "Design of Roadside Channels with Flexible Linings", HEC-15, USDOT FHWA (Reference #2).

Confirm the swale is stable and has enough capacity for the design flow rate.

Assumptions:

1. Assume the channel geometry is a v-notch swale with one sideslope at 4:1 and one sideslope at 2:1 and a depth of 2.0 ft.
2. Assume 2.0% slope along the flowpath of the diversion swale.
3. Assume the following parameters per Section 15.2 - Grass Lining Properties from Reference #1:
   Vegetation Retardance Class = C for Swales
   Vegetation Condition = Good
   Vegetation Growth Form = Turf
4. Assume cohesive soil type with ASTM Soil Class SC and a Plasticity Index (PI) of 16.

Calculations:

From the HydroCAD Report, the peak flow rate along the diversion berms are as follows:

Areas			Areas			Areas			Areas		
1	4.58	cfs	8	3.29	cfs	14	3.66	cfs	20	3.43	cfs
2	3.73	cfs	9	3.40	cfs	15	1.71	cfs	21	3.35	cfs
3	2.17	cfs	10	3.17	cfs	16	4.89	cfs	22	3.35	cfs
4	3.74	cfs	11	3.10	cfs	17	4.00	cfs	23	4.89	cfs
5	3.58	cfs	12	0.35	cfs	18	2.66	cfs	24	6.05	cfs
6	2.92	cfs	13	2.91	cfs	19	2.77	cfs	25	5.13	cfs

Use highest flow to confirm diversion berm functions.

Use the Grass Swale Design Spreadsheet (Page 2) to determine the flow depth, velocity and shear stress in the swales.

Results:

The diversion berms are adequately designed to accommodate the flows from the 25-year, 24-hour storm event.
The diversion berms are stable at the design flow rates. The design flow depth of 2.0 feet maintains at least 0.5 ft of freeboard during the 25-year, 24-hour storm event.

Channel/Ditch Geometry	*Area 24*
Channel Slope, S_o (ft/ft)	**0.02**
Channel Bottom Width, B (ft)	**0**
Channel Side Slope, z_1	**4**
Channel Side Slope, z_2	**2**
Flow Depth, d (ft) Solve iteratively	**1.00**
Safety Factor, SF	**1.0**
Vegetation/Soil Parameters	
Vegetation Retardance Class	**C**
Vegetation Condition	**good**
Vegetation Growth Form	**turf**
Soil Type	**cohesive**
D_{75} (in) (Set at 0.00 for cohesive soils)	
ASTM Soil Class	**SC**
Plasticity Index, PI	**16**
Results Summary	
Design Q (ft^3/s)	**6.1**
Calculated Q (ft^3/s)	6.1
Difference Between Design & Calc. Flow (%)	0.5%
Stable (Yes or No)	**YES**
Channel Parameters	
Vegetation Height, h (ft)	0.67
Grass Roughness Coefficient, C_n	0.238
Cover Factor, C_f	0.90
Noncohesive Soil	
Soil Grain Roughness, n_s	0.016
Permissible Soil Shear Stress, τ_p (lb/ft^2)	N/A
Cohesive Soil	
Porosity, e	0.35
Soil Coefficient 1, c_1	1.0700
Soil Coefficient 2, c_2	14.30
Soil Coefficient 3, c_3	47.700
Soil Coefficient 4, c_4	1.42
Soil Coefficient 5, c_5	-0.61
Soil Coefficient 6, c_6	0.00010
Permissible Soil Shear Stress, τ_p (lb/ft^2)	0.080
Total Permissible Shear Stress, τ_p (lb/ft^2)	0.080
Cross Sectional Area, A (ft^2)	3.000
Wetted Perimeter, P (ft)	6.36
Hydraulic Radius, R (ft)	0.472
Top Width, T (ft)	6.00
Hydraulic Depth, D (ft)	0.500
Froude Number (Q design)	0.505
Channel Shear Stress, τ_o (lb/ft^2)	0.59
Actual Sheer Stress, τ_d (lb/ft^2)	1.25
Mannings n	0.063
Average Velocity, V (ft/s)	2.02
Calculated Flow, Q (ft^3/s)	6.1
Difference Between Design & Calc. Flow (%)	0.5%
Effective Shear on Soil Surface, τ_e (lb/ft^2)	0.008
Total Permissible Shear on Veg., $\tau_{p,veg}$ (lb/ft^2)	12.42
Stable (Y or N)	YES

Source: Grass Lined Channel Design WisDOT Spreadsheet, FDM 13-30 Attachment 15.2

Downslope Flume & Energy Dissipater Sizing

SCS ENGINEERS

		Sheet No: 1/3	
		Calc. No.	
		Rev. No.	
Job No. 25220183.00	Job: Columbia Energy Center POO Landfill Closure	By: RJG	Date: 2/23/22
Client: WPL	Subject: Downslope Pipe and Inlet Sizing	Chk'd: MJT	Date: 04/04/22

Purpose:

To size the downslope pipe and inlet to accommodate the 25-year, 24-hour storm event.

References:

1. HydroCAD Report_POO Landfill Closure

Approach:

Use the orifice equation to size the downslope pipe inlet. Size the inlet for the largest diversion berm flow rate and apply that inlet size to all downslope pipe inlets. Confirm the head (h) acting on the orifice will not overtop the diversion berm depth of 2.0 ft.

Use Manning's equation to size the downslope pipe based on the largest diversion berm flow rate. Confirm the pipe has capacity for the design flow under open channel flow conditions.

Assumptions:

1. Orifice coefficient = 0.63
2. Assume the orifice head (h) acts on the centerline of the inlet pipe.
3. Manning's n = 0.012 (For smooth walled HDPE pipe: http://www.engineeringtoolbox.com/mannings-roughness-d_799.html)
4. Size flumes under the vegetated cover condition.

Calculations:

Size the downslope pipe inlet:

From the HydroCAD report (Reference #1), the maximum 25-year, 24-hour flow along a diversion berm is 6.1 cfs in HydroCAD model). Flume 3 Area 24

Orifice Equation: $Q = C * A * (2 * g * h)^{0.5}$

where: Q = flow rate (cfs) = 6.1 (From above)

C = orifice coefficient = 0.63 (See assumption #1)

A = orifice area (sf) = 1.77 (area of 18" diameter pipe) Actual Pipe Diameter = 18 inches

g = gravity (ft/sec^2)= 32.2

h = orifice head acting on centerline (ft)

$h = (Q/(C * A))^2/(2 * g) =$ 0.5 ft

Given Assumption #2, depth of flow along diversion berm = h + D/2/12 = 1.21 ft

Results:

Based on the inlet sizing calculation, an 18" diameter inlet will convey the stormwater runoff from the largest flow rate to a flume.

Based on the Manning's calculation for flow within the pipe, the 12" diameter downslope pipe will accommodate the design flow under open channel flow conditions. Although the flow for the downslope pipes can be handled by 12" dia. pipes, for ease of construction, all downslope pipes will be 18" dia.

Calculations (Continued):

The diversion swale depth of 2 ft is sufficient to prevent overtopping at the downslope pipe inlet locations.
The depth of the diversion berm increases at the entrance of the down slope pipes due to mounding of the soil over the pipe.

Size the downslope flume pipe:

Use Manning's equation to size the downslope pipe.

Manning's Equation: Q = (1.49/n) x A x R^(2/3) x S^(1/2)

where:
- Q = Flow Rate, cfs
- n = Manning's Roughness Coefficient
- A = Flow Area, sf
- R = Hydraulic Radius, ft (= A/P)
- S = Channel Slope, ft/ft

From the HydroCAD Report (Reference 1) , the peak discharge to each downslope flume resulting from a 25-year, 24-hour storm is as follows:

Flume 1	3.58 cfs	**Flume 2**	4.89 cfs	**Flume 3**	6.05 cfs	**Flume 4**	3.66 cfs	**Flume 5**	4.89 cfs
Area 5	3.58	Area 3	2.17	Area 1	4.58	Area 12	0.35	Area 10	3.17
Area 6	2.92	Area 4	3.74	Area 2	3.73	Area 13	2.91	Area 11	3.10
Area 20	3.43	Area 22	3.35	Area 24	6.05	Area 14	3.66	Area 16	4.89
Area 21	3.35	Area 23	4.89	Area 25	5.13	Area 15	1.71	Area 17	4.00
Total =	13.28		14.15		19.49		8.63		15.16

Flume 6	3.40 cfs
Area 8	3.29
Area 9	3.40
Area 18	2.66
Area 19	2.77
Total =	12.12

For flow rates < 20 cfs, assume a 12" diameter downslope flume:

Use 19.49 cfs to Flume 3 to check sizing (max flow to a flume that is < 20 cfs)

Design Criteria

- Pipe Diameter (in) = D = 12
- Pipe Slope (ft/ft) = S = 0.25
- Manning's Roughness Coefficient = n = 0.012

See Downslope Flume 3 pipe flow calculator on Sheet 3

Calculations (Continued):

Manning Formula Uniform Pipe Flow at Given Slope and Depth

Inputs:

Pipe Diameter, d_o	12.00	in
Manning Roughness, n	0.0120	
Pressure slope (possibly equal to pipe slope), S_0	0.2500	slope
Percent of (or ratio to) full depth (100% or 1 if flowing full)	0.8290	fraction

Results:

Flow, Q	19.4905	ft^3/s
Velocity, v	27.9991	ft/s
Velocity head, hv	12.1838	ft
Flow Area, A	0.6961	ft^2
Wetted Perimeter, P	2.2890	ft
Hydraulic Radius	0.3041	ft
Top Width, T	0.7530	ft
Froude Number, F	5.21	
Shear Stress (tractive force), τ	12.9373	psf

Version 2.0 (20 June 2017)

HawsEDC Calculators

SCS ENGINEERS

Sheet No:	4/4
Calc. No.	
Rev. No.	

Job No. 25220183.00	Job: Columbia Energy Center POO Landfill Closure	By: RJG	Date: 2/23/22
Client: WPL	Subject: Downslope Pipe and Inlet Sizing	Chk'd: MJT	Date: 04/04/22

Calculations (Continued):

Manning Formula Uniform Pipe Flow at Given Slope and Depth

Inputs:

Pipe Diameter, d_o	18.00	in
Manning Roughness, n	0.0120	
Pressure slope (possibly equal to pipe slope), S_o	0.2500	slope
Percent of (or ratio to) full depth (100% or 1 if flowing full)	0.4037	fraction

Results:

Flow, Q	19.4983	ft^3/s
Velocity, v	29.1783	ft/s
Velocity head, hv	13.2317	ft
Flow Area, A	0.6682	ft^2
Wetted Perimeter, P	2.0655	ft
Hydraulic Radius	0.3235	ft
Top Width, T	1.4719	ft
Froude Number, F	7.75	
Shear Stress (tractive force), τ	9.4502	psf

Version 2.0 (20 June 2017)

HawsEDC Calculators

Purpose:

To size an energy dissipator structure and riprap apron at the outlet of the downslope flume pipes.

References:

1. "Hydraulic Design of Energy Dissipators for Culverts and Channels," HEC-14, Third Edition, July 2006, USDOT FHWA.
2. Downslope Pipe and Inlet Sizing calculation (for pipe size, flow rate, and pipe velocity).
3. HydroCAD Model_POO Landfill Closure
4. Facilities Development Manual Chapter 13, Section 13-30 - Rock Riprap Lined Chutes.

Approach:

Use the downslope pipe outlet velocity to size an energy dissipator structure (USBR Type VI Impact Basin) following the design approach outlined in Section 9.4 of Reference #1.

Use Rock Chute Data Spreadsheet, FDM 13-30-30 Attachment 30.1 (from Reference #5) to design the rock chute.

For construction purposes use the maximum flow to size all dissipators and riprap apron.

Assumptions:

1. Riprap specific gravity = 2.65
2. From the HydroCAD Report, the 25-year, 24-hour peak discharge to each downslope flume is as follows:

Flume 1 3.58 cfs		**Flume 2** 4.89 cfs		**Flume 3** 6.05 cfs		**Flume 4** 3.66 cfs		**Flume 5** 4.89 cfs	
Area 5	3.58	Area 3	2.17	Area 1	4.58	Area 12	0.35	Area 10	3.17
Area 6	2.92	Area 4	3.74	Area 2	3.73	Area 13	2.91	Area 11	3.10
Area 20	3.43	Area 22	3.35	Area 24	6.05	Area 14	3.66	Area 16	4.89
Area 21	3.35	Area 23	4.89	Area 25	5.13	Area 15	1.71	Area 17	4.00
Total =	13.28		14.15		19.49		8.63		15.16

Flume 6 3.40 cfs	
Area 8	3.29
Area 9	3.40
Area 18	2.66
Area 19	2.77
Total =	12.12

Using Figure 9.14 (See Sheet 4), enter the Froude Number and the Energy from Step 2 to determine the from the downslope flume pipe and inlet sizing calculation.

Results:

The energy dissipator structures for the 18" dia. downslope flume pipes will consist of dissipator structures with widths (W_B) of 6 feet, with the remaining dimensions from Table 9.2 on Sheets 5 and 6.

Riprap at the Flume 3, 4, 5 and 6 energy dissipator outlets will consist of WisDOT Light Riprap (D50= 5.5 inches) (See Page 3).

The riprap apron footprint will be based on the energy dissipator width and the outlet swale geometry.

Riprap at Flume 1 and 2 energy dissipator outlets will consist of WisDOT Light Riprap (D50= 5.8 and 3.6 inches). The riprap apron footprint will be 6 feet wide (based on rock chute calcs for RC1 and RC2) and extend down to the existing swale (Swale S4).

Calculations:

For 18" dia. downslope flume pipes

From Reference #2:

Flow rate (Q) = 19.5 cfs

Pipe velocity (V) = 8.9 ft/s

Flow area (A) = Q/V = 2.19 sf

Design procedure from pg. 9-40 of Reference #1:

Step 1: Compute the Equivalent Depth of Flow Entering Dissipator:

$Y_e = (A/2)^{1/2}$ where: Ye = Equivalent depth

A = Area (from above)

$Y_e =$ 1.05 ft

Step 2: Compute the Froude Number and the energy at the end of the pipe:

$Fr = V/[(g*Y_e)^{1/2}]$ where: Fr = Froude Number

V = Velocity (from above)

g = Gravity constant (32.2 ft/sec^2)

Fr = 1.5

Y_e = Equivalent depth (from Step 1 above)

$H_o = Y_e+V^2/2g$ where: H_o = Energy at the end of the pipe

Y_e = Equivalent depth (from above)

V = Velocity (from above)

Ho = 2.3 ft

g = Gravity constant (32.2 ft/sec^2)

Step 3: Determine H_o/W_B and calculate the required width of the energy dissipator:

Using Figure 9.14 (See Sheet 4), enter the Froude Number and the Energy from Step 2 to determine the width of the energy dissipator.

From Figure 9.14, H_o/W_B = 0.40

$W_B = H_o/(H_o/W_B)$ W_B = 5.7 ft.

Use W_B = 6.0 ft.

Step 4: Obtain the remaining energy dissipator dimensions from Table 9.2 from Reference #1 (see Sheets 5 and 6)

Step 5: Size the riprap at the structure outlet

From Reference #5, use Rock Chute Design spreadsheet (see Sheet 3)

Rock Chute Design Data

(Version WI-April-2005, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)
Revised for WisDOT 9/2010

Project: COL - POO Landfill Closure | **County:** Columbia
Designer: RJG | **Checked by:** MJT
Date: February 23, 2022 | **Date:** 04/05/22

Input Geometry:

Upstream Channel		Chute			Downstream Channel	
Bottom Width =	6.0 ft.	Bottom Width =	6.0 ft.		Bottom Width =	6.0 ft.
Side slopes =	1.0 (m:1)	Factor of safety =	1.20 (SF)	1.2 Min	Side slopes =	2.0 (m:1)
Mannings n value =	0.012	Side slopes =	2.0 (z:1)	2.0:1 max.	Mannings n value =	0.030
Bed slope =	0.0001 ft./ft.	Bed slope =	0.2500 ft./ft	3.0:1 max.	Bed slope =	0.0050 ft./ft.
		Freeboard =	1.0 ft.			
		Outlet apron depth, d =	1.0 ft.		Base flow =	0.0 cfs

Note: Use procedures 13-30-15 or 13-30-25 for upstream and downstream Mannings n

Flow and Elevation Data:

Apron elev. --- Inlet = 818.0 ft. ------- Outlet 816.0 ft. --- (H_{drop} = 1 ft.)

Degree of angularity = 1
1 --> 50% angular, 50% rounded
2 --> 100 % rounded

Q_{high} = Runoff from design storm
Q_5 = Runoff from a 5-year,24-hour storm

Q_{high}= 19.5 cfs — High flow storm through chute ——> Tw (ft.) = Program
Q_{low} = 19.5 cfs — Low flow storm through chute ——> Tw (ft.) = Program

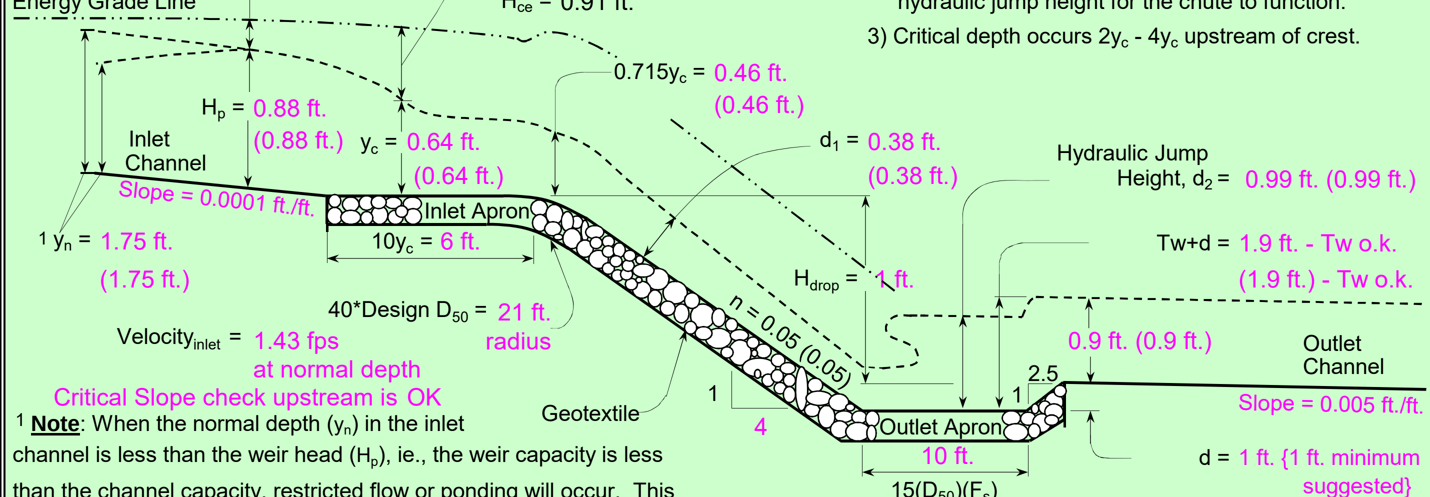
Note: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.

Input tailwater (Tw): 0.25 1.20

Profile and Cross Section (Output):

Starting Station = 3+00.0

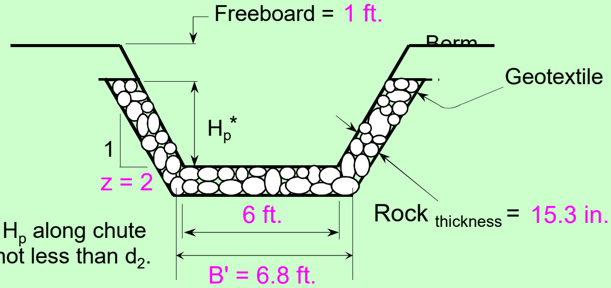
Notes:
1) Output given as **High Flow (Low Flow)** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs $2y_c$ - $4y_c$ upstream of crest.



[1] **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., the weir capacity is less than the channel capacity, restricted flow or ponding will occur. This reduces velocity and prevents erosion upstream of the inlet apron.

Profile Along Centerline of Chute

Typical Cross Section



* Use H_p along chute but not less than d_2.

	2.9 cfs/ft.	Equivalent unit discharge
SF =	1.20	Factor of safety (multiplier)
d_1 =	0.38 ft.	Normal depth in chute
n-value =	0.05	Manning's roughness coefficient
D_{50}(SF) =	7.6 in.	Minimum Design D_{50}*
2(D_{50})(SF) =	15.3 in.	Rock chute thickness
Tw + d =	1.9 ft.	Tailwater above outlet apron
d_2 =	0.99 ft.	Hydraulic jump height
***** The outlet**	**will**	**function adequately**

High Flow Storm Information

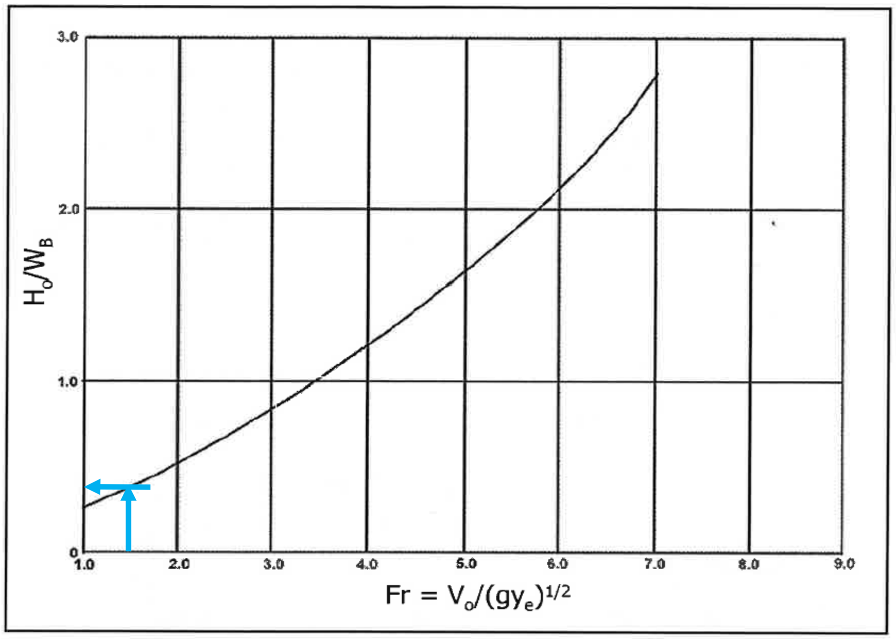


Figure 9.14. Design Curve for USBR Type VI Impact Basin

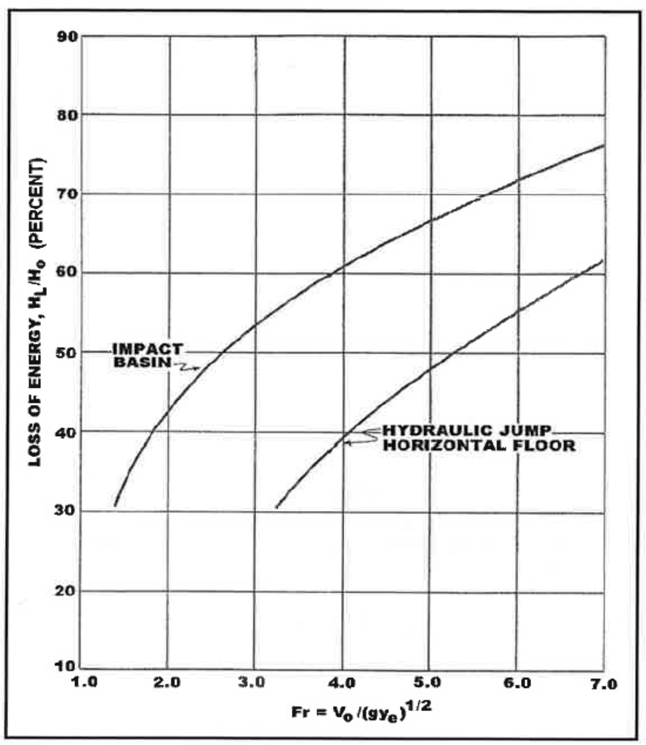


Figure 9.15. Energy Loss of USBR Type VI Impact Basin versus Hydraulic Jump

Table 9.2 (CU). USBR Type VI Impact Basin Dimensions (ft) (AASHTO, 2005)

W_B	h_1	h_2	h_3	h_4	L	L_1	L_2
4.	3.08	1.50	0.67	1.67	5.42	2.33	3.08
5.	3.83	1.92	0.83	2.08	6.67	2.92	3.83
6.	4.58	2.25	1.00	2.50	8.00	3.42	4.58
7.	5.42	2.58	1.17	2.92	9.42	4.00	5.42
8.	6.17	3.00	1.33	3.33	10.67	4.58	6.17
9.	6.92	3.42	1.50	3.75	12.00	5.17	6.92
10.	7.58	3.75	1.67	4.17	13.42	5.75	7.67
11.	8.42	4.17	1.83	4.58	14.58	6.33	8.42
12.	9.17	4.50	2.00	5.00	16.00	6.83	9.17
13.	10.17	4.92	2.17	5.42	17.33	7.42	10.00
14.	10.75	5.25	2.33	5.83	18.67	8.00	10.75
15.	11.50	5.58	2.50	6.25	20.00	8.50	11.50
16.	12.25	6.00	2.67	6.67	21.33	9.08	12.25
17.	13.00	6.33	2.83	7.08	21.50	9.67	13.00
18.	13.75	6.67	3.00	7.50	23.92	10.25	13.75
19.	14.58	7.08	3.17	7.92	25.33	10.83	14.58
20.	15.33	7.50	3.33	8.33	26.58	11.42	15.33

W_B	W_1	W_2	t_1	t_2	t_3	t_4	t_5
4.	0.33	1.08	0.50	0.50	0.50	0.50	0.25
5.	0.42	1.42	0.50	0.50	0.50	0.50	0.25
6.	0.50	1.67	0.50	0.50	0.50	0.50	0.25
7.	0.50	1.92	0.50	0.50	0.50	0.50	0.25
8.	0.58	2.17	0.50	0.58	0.58	0.50	0.25
9.	0.67	2.50	0.58	0.58	0.67	0.58	0.25
10.	0.75	2.75	0.67	0.67	0.75	0.67	0.25
11.	0.83	3.00	0.67	0.75	0.75	0.67	0.33
12.	0.92	3.00	0.67	0.83	0.83	0.75	0.33
13.	1.00	3.00	0.67	0.92	0.83	0.83	0.33
14.	1.08	3.00	0.67	1.00	0.92	0.92	0.42
15.	1.17	3.00	0.67	1.00	1.00	1.00	0.42
16.	1.25	3.00	0.75	1.00	1.00	1.00	0.50
17.	1.33	3.00	0.75	1.08	1.00	1.00	0.50
18.	1.33	3.00	0.75	1.08	1.08	1.08	0.58
19.	1.42	3.00	0.83	1.17	1.08	1.08	0.58
20.	1.50	3.00	0.83	1.17	1.17	1.17	0.67

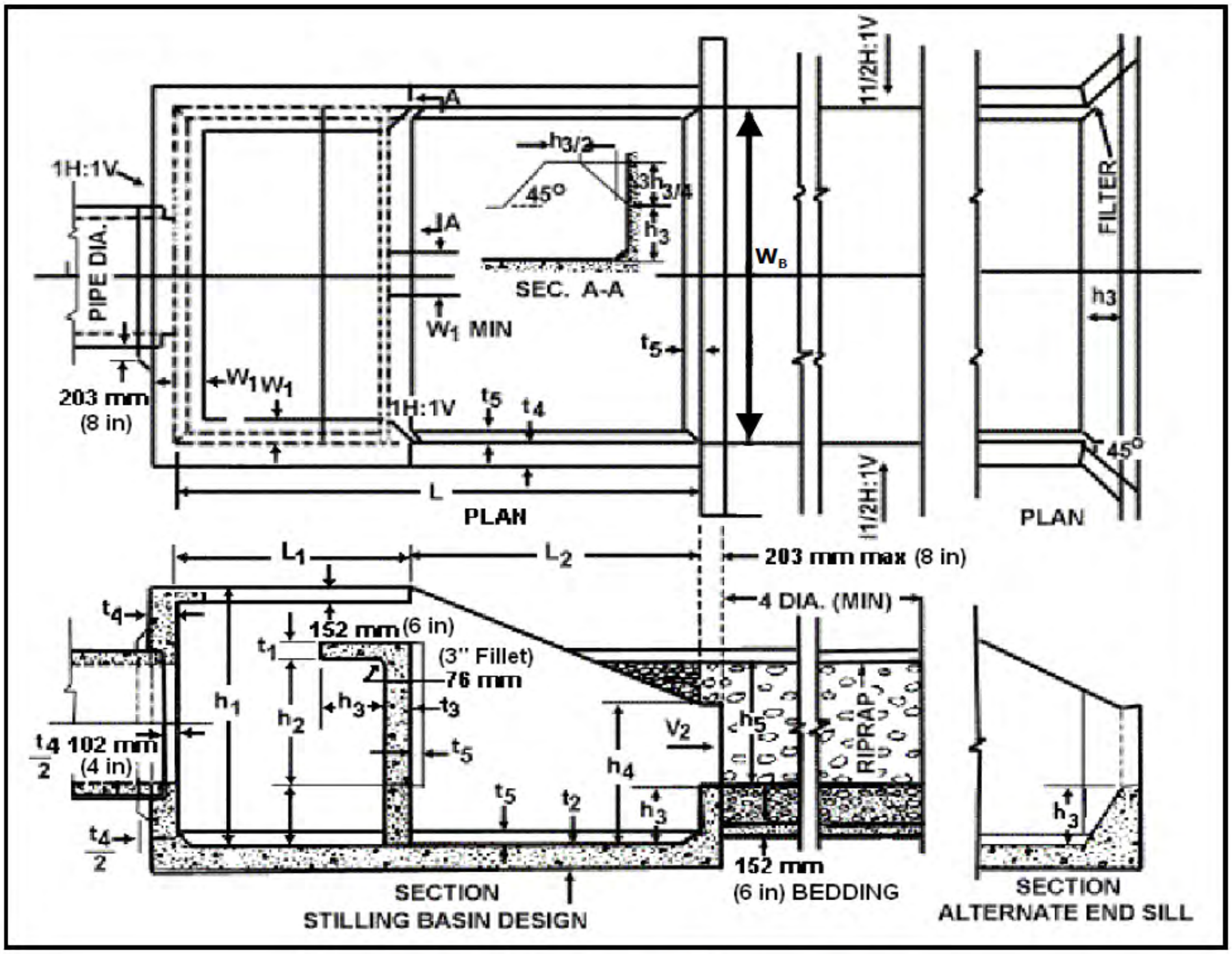


Figure 9.13. USBR Type VI Impact Basin

Calculations (Continued):

Downslope Flume 3 - Velocity Calculator (Q = 19.49 cfs)

Manning Formula Uniform Pipe Flow at Given Slope and Depth

Inputs:

Pipe Diameter, d_o	18	in
Manning Roughness, n	0.0120	
Pressure slope	0.2500	slope
Percent of (or ratio to) full depth (100% or 1 if flowing full)	0.4037	fraction

Results:

Flow, Q	19.4983	ft^3/s
Velocity, v	8.8936	m/s
Velocity head, hv	4.0330	m
Flow Area, A	0.0621	m^2
Wetted Perimeter, P	0.6296	m
Hydraulic Radius	0.0986	m
Top Width, T	0.4486	m
Froude Number, F	7.75	
Shear Stress (tractive force), τ	452.4774	N/m^2

Version 2.0 (20 June 2017)

HawsEDC Calculators

Rock Chute

SCS ENGINEERS

		Sheet No:	1 of 4
		Calc. No.	
		Rev. No.	
Job No. 25220183.00	Job: COL - POO	By: RJG	Date: 4/11/22
Client: WPL	Subject: Rock Chute Sizing & Riprap Size	Chk'd: MJT	Date: 4/13/22

Purpose:

To size the rock chutes to accommodate the 25-year, 24-hour storm event.

References:

1. Rock Chute Design Data spreadsheet Version WI-April-2005, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998.
2. HydroCAD Report_Post Construction
3. Figure 1 - Storm Water Post Construction
4. Stable 25.1 Typical Particle Sizes of Native Sands at 75 Percent Passing (D75) from WisDOT Facilities. Development Manual (FDM).

Approach:

1. Enter Inlet Channel data based on culvert apron or swale geometry Reference #2 and #3.
2. Enter Chute data based on slope from Reference #3, start the width, Bw equal to inlet channel Bw.
3. Enter Outlet Channel data based on Reference #3, start the width, Bw equal to inlet channel Bw.
4. Enter drainage area, apron elevations, flow (Q), and rainfall.
5. Adjust Bw for Chute and Outlet Channel until spreadsheet shows the rock chute "will" function adequately.
6. Determine rip rap classification based on D50 weight per Reference #4.

Assumptions:

1. Assume side slopes of chute and outlet channel are 2:1.
2. Assume Factor of Safey is 1.2.
3. n-value is based on proposed conditions at the channel.
4. Assume Outlet apron depth, d is 1.0 ft.
5. Freeboard is 1.0 ft.
6. Use 25-year, 24-hour storm event flow (Reference #2) for Q_{high} and Q_{low}.
7. Classification of riprap is based on weight (Reference #4).

Calculations:

See attached spreadsheet calcs for each rock chute.

Results:

The rock chutes are adequately designed to accommodate the flows from the 25-year, 24-hour storm event.

Rock Chute	Width (ft)	Thickness (in)	Apron Width (ft)	Apron Length (ft)	D_{50} (in)	WisDOT Rip Rap Classification
RC1	6	12	6	7	5.8	Light Riprap Type R
RC2	6	8	6	5	3.6	Light Riprap Type R

Rock Chute Design Data

(Version WI-April-2005, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)
Revised for WisDOT 9/2010

Project:	COL - POO Landfill Closure RC1	**County:**	Columbia
Designer:	RJG	**Checked by:**	MJT
Date:	April 11, 2022	**Date:**	04/13/22

Input Geometry:

Upstream Channel		Chute			Downstream Channel	
Bottom Width =	6.0 ft.	Bottom Width =	6.0 ft.		Bottom Width =	6.0 ft.
Side slopes =	1.0 (m:1)	Factor of safety =	1.20 (SF)	1.2 Min	Side slopes =	2.0 (m:1)
Mannings n value =	0.012	Side slopes =	2.0 (z:1)	2.0:1 max.	Mannings n value =	0.030
Bed slope =	0.0001 ft./ft.	Bed slope =	0.1967 ft./ft	3.0:1 max.	Bed slope =	0.0050 ft./ft.
		Freeboard =	1.0 ft.			
		Outlet apron depth, d =	1.0 ft.		Base flow =	0.0 cfs

Note: Use procedures 13-30-15 or 13-30-25 for upstream and downstream Mannings n

Flow and Elevation Data:

Apron elev. --- Inlet = 822.8 ft. ------- Outlet 802.4 ft. --- (H_{drop} = 19.4 ft.)

Degree of angularity = 1

1 --> 50% angular, 50% rounded

2 --> 100 % rounded

Q_{high} = Runoff from design storm

Q_5 = Runoff from a 5-year,24-hour storm

Q_{high} = 13.2 cfs — High flow storm through chute → Tw (ft.) = Program

Q_{low} = 13.2 cfs — Low flow storm through chute → Tw (ft.) = Program

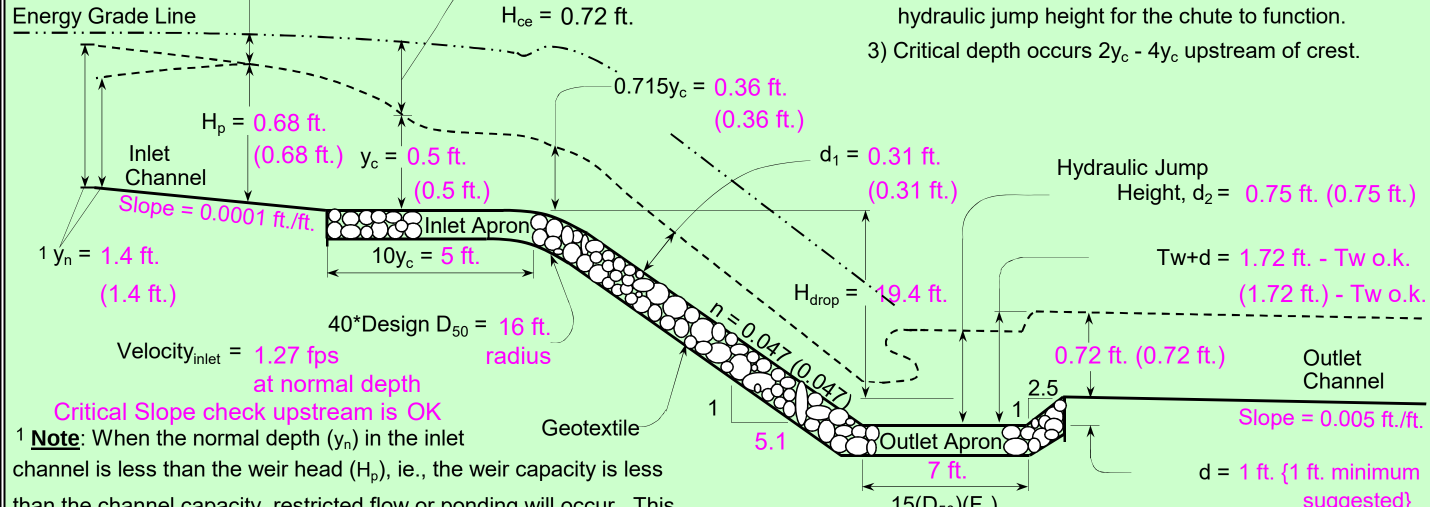
Note: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.

Input tailwater (Tw): 0.20 1.20

Profile and Cross Section (Output):

Starting Station = 3+00.0

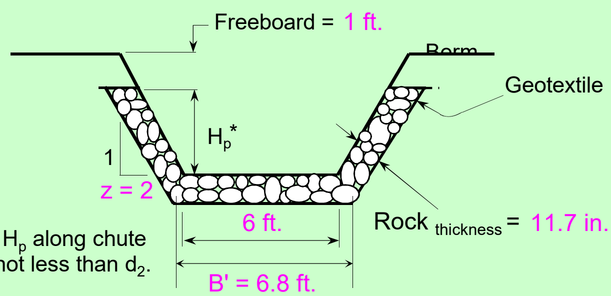
Notes:
1) Output given as **High Flow (Low Flow)** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs $2y_c$ - $4y_c$ upstream of crest.



[1] **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., the weir capacity is less than the channel capacity, restricted flow or ponding will occur. This reduces velocity and prevents erosion upstream of the inlet apron.

Profile Along Centerline of Chute

Typical Cross Section



* Use H_p along chute but not less than d_2.

	2.01 cfs/ft.	Equivalent unit discharge
SF =	1.20	Factor of safety (multiplier)
d_1 =	0.31 ft.	Normal depth in chute
n-value =	0.047	Manning's roughness coefficient
D_{50}(SF) =	5.8 in.	Minimum Design D_{50}*
$2(D_{50})$(SF) =	11.7 in.	Rock chute thickness
Tw + d =	1.72 ft.	Tailwater above outlet apron
d_2 =	0.75 ft.	Hydraulic jump height
*** **The outlet**	**will**	**function adequately**

High Flow Storm Information

Rock Chute Design Data

(Version WI-April-2005, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)
Revised for WisDOT 9/2010

Project: COL - POO Landfill Closure RC2 **County:** Columbia
Designer: RJG **Checked by:** MJT
Date: April 11, 2022 **Date:** 04/13/22

Input Geometry:

Upstream Channel

Bottom Width =	6.0 ft.
Side slopes =	1.0 (m:1)
Mannings n value =	0.012
Bed slope =	0.0001 ft./ft.

Note: Use procedures 13-30-15 or 13-30-25 for upstream and downstream Mannings n

Chute

Bottom Width =	6.0 ft.	
Factor of safety =	1.20 (SF)	1.2 Min
Side slopes =	2.0 (z:1)	2.0:1 max.
Bed slope =	0.0690 ft./ft	3.0:1 max.
Freeboard =	1.0 ft.	
Outlet apron depth, d =	1.0 ft.	

Downstream Channel

Bottom Width =	6.0 ft.
Side slopes =	2.0 (m:1)
Mannings n value =	0.030
Bed slope =	0.0050 ft./ft.
Base flow =	0.0 cfs

Flow and Elevation Data:

Apron elev. --- Inlet = 815.8 ft. ------- Outlet 808.4 ft. --- (H_{drop} = 6.4 ft.)

Degree of angularity = 1
1 --> 50% angular, 50% rounded
2 --> 100 % rounded

Q_{high} = Runoff from design storm
Q_5 = Runoff from a 5-year,24-hour storm

Q_{high} = 14.0 cfs High flow storm through chute → Tw (ft.) = Program
Q_{low} = 14.0 cfs Low flow storm through chute → Tw (ft.) = Program

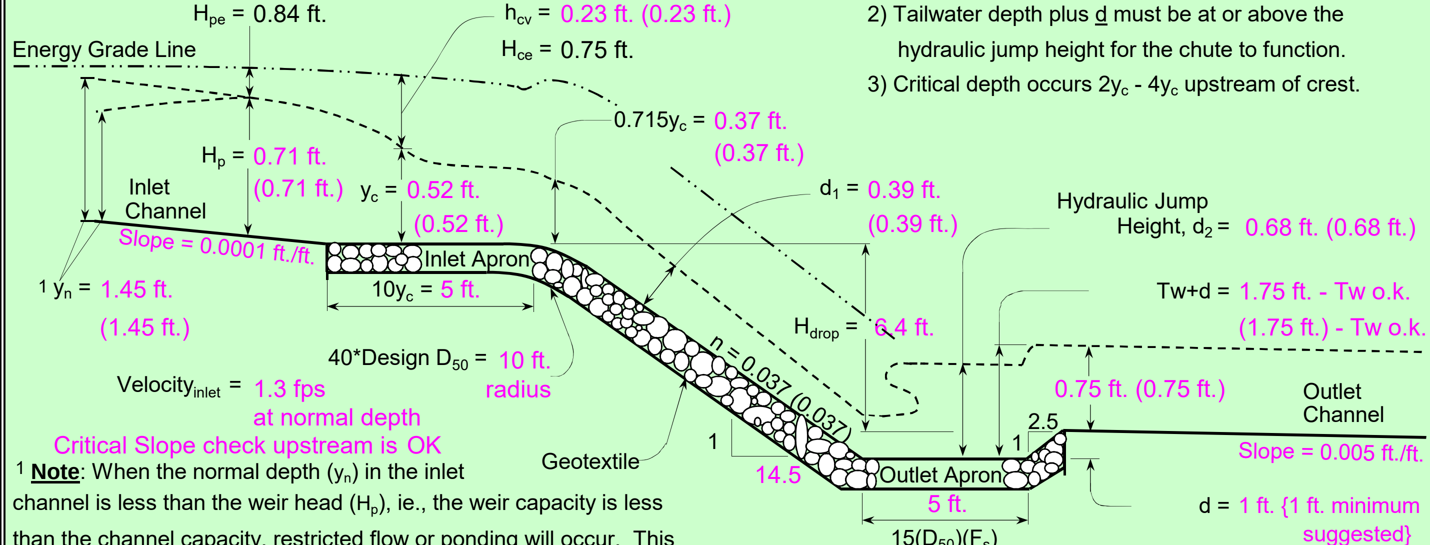
Note: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.

Input tailwater (Tw):

Profile and Cross Section (Output):

Starting Station = 3+00.0

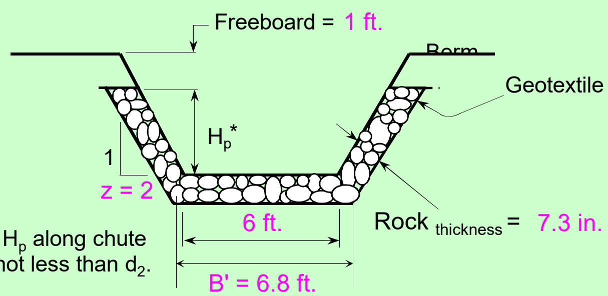
Notes:
1) Output given as **High Flow (Low Flow)** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs $2y_c$ - $4y_c$ upstream of crest.



[1] **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., the weir capacity is less than the channel capacity, restricted flow or ponding will occur. This reduces velocity and prevents erosion upstream of the inlet apron.

Profile Along Centerline of Chute

Typical Cross Section



* Use H_p along chute but not less than d_2.

	2.14 cfs/ft.	Equivalent unit discharge
SF =	1.20	Factor of safety (multiplier)
d_1 =	0.39 ft.	Normal depth in chute
n-value =	0.037	Manning's roughness coefficient
$D_{50}(SF)$ =	3.6 in.	Minimum Design D_{50}*
$2(D_{50})(SF)$ =	7.3 in.	Rock chute thickness
Tw + d =	1.75 ft.	Tailwater above outlet apron
d_2 =	0.68 ft.	Hydraulic jump height
*** The outlet	will	function adequately

High Flow Storm Information

Discharge Apron Sizing

Purpose:

To size the riprap apron dimensions at culvert C2, C3, C4, and C5 based on a 25-year, 24 hour storm event:

References:

1. "Energy Dissipators," Wisconsin Department of Transportation (WisDOT), Facilities Development Manual (FDM) 13-35-5.
2. Post Construction Condition HydroCAD Model.
3. "Rock Riprap Lined Channels," WisDOT FDM 13-30-25.
4. Culvert Sizing Calculation.
5. WisDOT FDM Chapter 13, Section 30 - Rock Riprap Lined Chutes

Approach:

Use the equations in Section 5.2 - Riprap Blanket of WisDOT FDM 13-35-5 (Energy Dissipators) to determine the average size of stone (d_{50}) and riprap apron length. Round up the calculated d_{50} to the nearest WisDOT standard riprap size.

Use WisDOT FDM 13-35 Attachment 5.2 to determine the width of the riprap apron for discharges to a flat area. For discharges to channels, extend riprap across the channel bottom and up the sides.

Assumptions:

Assume riprap apron thickness (T) is 2 * d_{50} to protect against washout and undercutting of the riprap.

Assume tailwater depth, TW = 0.40 * D_o

Assume max TW conditions for the riprap apron width.

Assume that when there are multiple culverts, the total discharge to the culverts is distributed evenly through each barrel.

Calculation:

From WisDOT Section 5.2 - Riprap Blanket:

$$d_{50}/D_o = 0.020\ (D_o/TW)\ (Q/D_o^{5/2})^{4/3}$$

$$L_{sp}/D_o = 1.7\ (Q/D_o^{5/2}) + 8$$

Or:

$$d_{50} = 0.02 \times (D_o/TW) \times (Q/D_o^{5/2})^{4/3} \times D_o$$

$$L_{sp} = (1.7\ (Q/D_o^{5/2}) + 8) \times D_o$$

where: D_o = Diameter or width of culvert (ft)

Q = Flow rate (cfs) (discharge rate through culvert, from Worst Case Condition HydroCAD Model (Reference #2))

TW = Tail water depth (ft)

d_{50} = Average size of stone (ft)

L_{sp} = Length of stone protection (Apron Length) (ft)

Location	Total Flow (Q, cfs)	Number of Pipes	D_o (ft)	Q (cfs)	TW (ft)	$d_{50\ calculated}$	$d_{50\ Design}$	L_{sp}
Culvert C2	9.68	2	1.5	4.8	0.60	0.16	0.83	16
Culvert C3	27.38	2	2.5	13.7	1.00	0.19	0.83	26
Culvert C4	35.39	2	2.5	17.7	1.00	0.27	0.83	28
Culvert C5	35.21	2	2.5	17.6	1.00	0.27	0.83	28

Results:

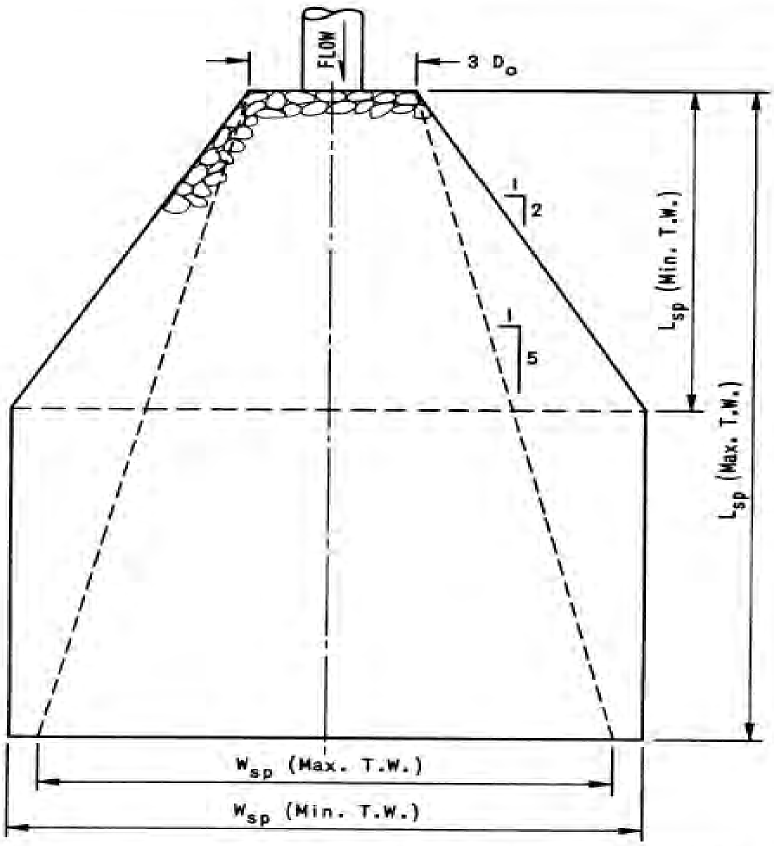
Below is a summary of the d_{50} , thickness (T), and configuration of the riprap apron. Also refer to WisDOT FDM Attachment 5.2 (Sheet 2) for details on apron layout. Use WisDOT Light Riprap at culvert discharge.

Location	d_{50} (in)*	T (in)	L_{sp} (ft)	W_{sp} (ft)
Culvert C2	10.0	20	16	See Note 1
Culvert C3	10.0	20	26	See Note 1
Culvert C4	10.0	20	28	See Note 1
Culvert C5	10.0	20	28	See Note 1

1. For discharges to channels, place riprap along channel bottom and up side of channel.

*Per Table 25.1 on Sheet 2 for standard WisDOT riprap sizes use Light Riprap.

FDM 13-35 Attachment 5.2 Recommended Configuration of Riprap Blanket Subject to Maximum and Minimum Tail Waters



RECOMMENDED CONFIGURATION OF RIPRAP BLANKET SUBJECT TO MAXIMUM AND MINIMUM TAILWATERS

Source: Miscellaneous paper H-72-5, "Practical Guidance for Estimating and Controlling Erosion at Culvert Outlets", U.S. Army Engineer Waterways Experiment Station, May, 1972.

***Table 25.1** Typical Particle Sizes of Native Sands at 75 Percent Passing (D_{75})*

Riprap Type	D50 (inches)	D50 (feet)	Riprap Thickness (in)	Geotextile Type
Select Crushed Material	2.2	0.18	5	Type R
Light Riprap	10	0.83	12	Type R
Medium Riprap	12.5	1.04	18	Type HR
Heavy Riprap	16	1.33	24	Type HR
Extra-Heavy Riprap	20	1.67	30	Type HR

Source: Table 25.1 from WisDOT FDM.

Appendix B2

GCL Compatibility Test Results

GSE Environmental
19103 Gundle Rd
Houston, TX 77073
[o] (832) 657-4857

GSE ENVIRONMENTAL™

November 23, 2015

Phillip Gearing
Geological Engineer

SCS ENGINEERS
2830 Dairy Drive
Madison, WI 53718
608.224.2830
Direct: 608.216.7324 • Cell: 608.316.5452
www.scsengineers.com

RE: **GSE CAR GCL Compatibility Test – Coal Ash Resistant**
Alliant Energy – Columbia Energy Center

Dear Mr. Phillip Gearing,

This letter summarizes the testing GSE performed on the coal combustion residual (CCR) samples that were supplied by Alliant Energy from their Columbia Energy Center. Alliant Energy supplied samples of dry fly ash from its operating coal-fired facility at Columbia Energy Center. The samples were used to generate a leachate for the GCL chemical compatibility testing. Based on the chemical constituents in the leachate, GSE selected the BentoLiner CAR GCL product for compatibility testing per ASTM D 6766 Scenario 2.

Leachate was derived by the following methods:

- The samples of CCR fly ash were received in buckets at the testing lab.
- The CCR fly ash samples were then leached with de-ionized water to produce sufficient leachate for the chemical compatibility testing using ASTM D 6141 procedure for generating a test liquid from a soil.
- The resulting leachate was analyzed for chemical constituents.
- GSE selected a polymer enhanced CAR (Coal Ash Resistant) Series Geosynthetic Clay Liner product deemed to be compatible based on chemical analysis of the leachate.
- JLT laboratories performed Hydraulic Conductivity testing per ASTM D6766 using the site generated leachates from above. GSE used scenario 2 which calls for permeation using the site specific leachate, not deionized water. This places the GCL with leachate as opposed to the deionized water prior to start of the compatibility test.
- The ASTM D 6766 Scenario 2 compatibility test for GCL ran uninterrupted for a period of 6 months. The test terminated at 6 months with test parameters and results listed below.
- The CAR GCL had a permeability of 3.4×10^{-10} cm/s after 180 days of testing when tested against the site specific leachate produced from Columbia Energy Center ash. This value is greater (less permeable) than the GSE certified GCL permeability of 3×10^{-9} cm/s.
- The CAR GCL meets or exceeds the Federal CCR Rule CCL Hydraulic Flux Equivalence (found in Section 40 CFR 257.70) per Table 1 below.

Table 1: Hydraulic Equivalency Calculation GCL vs. CCL

Compacted Clay Liner Calculated Flux with 60 cm (2 ft.) Thickness

Compacted Clay Liner Thickness	thickness	water head	gradient	hydraulic conductivity	Flux
	T	H	i=(H/T)+1	k	q =ki
	cm	cm		cm/s	cm/s
CCL - 2 ft.	60	30	1.50	1.0E-07	1.5E-07

GCL Equivalency with GCL Thickness of 6 mm

GCL Type	thickness	water head	gradient	hydraulic conductivity	Flux
	T	H	i=(H/T)+1	k	q =ki
	cm	cm		cm/s	cm/s
GSE CAR BentoLiner GCL 6 mm thickness	0.6	30	51.00	3.0E-9	1.5E-07

As required by the Federal CCR Rule, the liquid flow rate of BentoLiner CAR Series GCL, as manufactured by GSE Environmental, LLC, is less than the liquid flow rate for a 2-feet thick layer of compacted clay liner with a maximum hydraulic conductivity of 1E-7 cm/sec.

The purpose of this test is to demonstrate geosynthetic clay liner (GCL) liquid flow rate equivalency to compacted clay liner per Federal CCR Rule (published version posted to the US EPA website December 19, 2014). The Federal CCR Rule is found in Section 40 CFR 257.70.

GSE BentoLiner CAR NSL GCL is deemed chemically compatible with the leachate that will be encountered in the CCR waste management liner system at Columbia Energy Center.

Please review the results and contact me with any questions.

Respectfully,

Vincent Diviacchi
Technical Manager – Canada & Midwest USA
M: 832-657-4857
E: vdiviacchi@gseworld.com
W: www.gseworld.com

SUMMARY OF FLEX WALL PERMEABILITY COMPATIBILITY TEST RESULTS

ASTM D-6766

JLT

Client	:	GSE	Print Date	:	09/15/2015
Project	:	Alliant Columbia FGD	Job No.	:	15LR3160.01
Description	:	No. 502194242	Tested By	:	MLB/DB
	:	Lot 21101409	Checked By	:	JBJr
Permeant Fluid	:	Lab Generated Leachate	Panel No	:	20
Start Date : March 17, 2015		Stop Date : September 1	Spec. Gravity	:	2.74 Assumed

Physical Property Data

Initial Height (in)	:	0.29	Final Height (in)	:	0.32
Initial Diameter (in)	:	4.00	Final Diameter (in)	:	4.00
Initial Wet Weight (g)	:	41.50	Final Wet Weight (g)	:	84.40
Wet Density (pcf)	:	43.34	Wet Density (pcf)	:	79.89
Moisture Content %	:	9.60	Moisture Content %	:	148.20
Dry Density (pcf)	:	39.55	Dry Density (pcf)	:	32.19

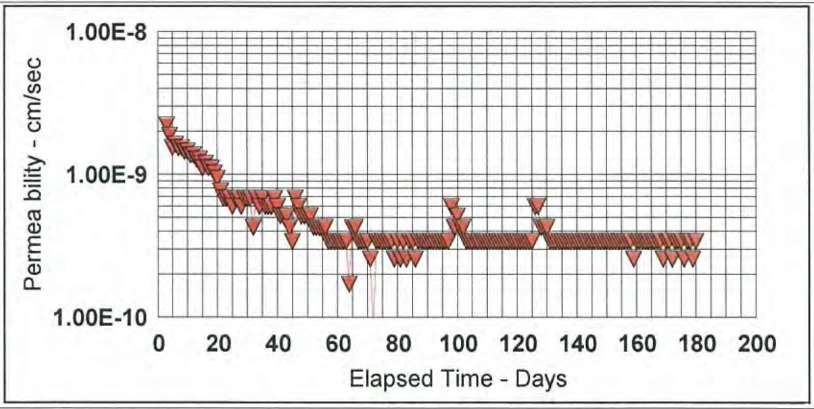
Test Parameters

Fluid	:	Lab Generated Leachate	**Average Effective**		
Cell Pressure ɔsi)	:	80.00	**Confining Pressure (psi)**	:	4.00
Head Water ɔsi)	:	77.00	Gradient	:	172.50
Tail Water ɔsi)	:	75.00	**Eff Stress at Base (psi)**	:	5

Permeability Input Data

For Last Data Point

Flow, Q	(cc)	:	0.40
Length, L	(in)	:	0.32
Area, A	(sqin)	:	12.57
Head, h	**(psi)**	:	**2.00**
Time, t	(min)	:	1444.00
Temp, T	(Deg C)	:	18.7



Computed Permeability

PERMEABILITY, K = 3.40E-010 (cm/sec) at 20 Degrees C

Day 180 Total Inflow to Date : 103.5 cc

19103 Gundle Road
Houston, Texas 77073

[O] 281.443.8564
[F] 281.875.6010
[TF] 800.435.2008

GSE ENVIRONMENTAL™

5/18/2015

Phillip Gearing
Geological Engineer

SCS ENGINEERS
2830 Dairy Drive
Madison, WI 53718
608.224.2830
Direct: 608.216.7324 • Cell: 608.316.5452
www.scsengineers.com

RE: GCL Compatibility Analysis
Alliant Energy – Columbia Power Plant in Wisconsin

Dear Mr. Phillip Gearing,

As requested, the purpose of this correspondence is to confirm suitability of GSE geosynthetic clay liner (GCL) for FGD waste at the Alliant Energy Columbia Power Plant. This analysis is based on FGD being shipped to GSE for leaching. The leached solution was then analyzed for chemical constituents so GSE can assess the need and use of polymer enhancement in the GCL.

GCL is an active barrier system which relies on the swelling capacity of the sodium bentonite to decrease flow through the liner. Different chemical ions in the leachate can affect the GCL negatively and increase its permeability through cation exchange. GSE can modify our GCL products with polymers to resist this exchange and maintain the GCL impermeability.

Based on the chemical constituents identified in the Columbia Power Plant ash received by GSE, our CAR Series of GCL is recommended for use on site as an effective containment barrier.

GSE will run a permeability test per ASTM D 6766 Scenario 2 with the site specific leachate for an extended period of time. Ideally this time period will exceed 6 months so we have solid data to monitor the leachate interaction with the polymer enhanced GCL.

Should you wish to discuss or need additional information, please contact me at 832-657-4857.

Respectfully,

Vincent Diviacchi
Technical Manager – Midwest USA & Canada
C: 832-657-4857
E: vdiviacchi@gseworld.com
www.gseworld.com

19103 Gundle Road
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GSE ENVIRONMENTAL™

May 7, 2015

Vince Diviacchi
GSE Environmental
19103 Gundle Road
Houston, TX 77073

RE: Alliant Columbia FGD Leachate Analysis Summary for GCL Compatibility Test

Dear Mr. Diviacchi,

The ash that was sent to GSE was leached with Deionized water, and samples of the solution were sent to a third party lab for analysis. I have listed the key chemical constituents that will affect GCL performance in table below.

Chemical Ions	**Bottom Ash Leachate (mg/l)**
Calcium	1,000
Magnesium	ND
Potassium	110
Sodium	120
Chlorides	380
Sulfates	410
pH	12.5

*ND – Not Detected

Please feel free to contact me with any questions.

Thank You,

Jimmy Youngblood
GSE Technical Support Manager
(800) 435-2008 ext. 2523
jyoungblood@gseworld.com

Appendix B3

HELP Model

Purpose: To evaluate the effect of the most critical Module area and flow length for Phases 1 and 2 on the average leachate head levels on the landfill liner. The critical area is Module 13 in Phase 2. The other Modules have smaller areas and shorter drainage lengths.

Approach: Use the Hydrologic Evaluation of Landfill Performance (HELP) model to calculate the average leachate head.

References: 1.) HELP Model Version 3.07
2.) The Hydrolic Evaluation of Landfill Performance (HELP) Model, Engineering Documentation for Version 3.

Assumptions: Weather data obtained from Madison, Wisconsin.

Total Area of Module 13 = 5.0 acres
Slope of Liner System = 2.0 percent
Longest Drainage Length = 185.0 feet

Layer 1 - Vertical Percolation Layer (Type 1)
HELP Default Waste Characteristics for High-Density Electric Plant Coal Fly Ash (30)
A waste thickness of 3 ft was assumed.

Layer 2 - Lateral Drainage Layer (Type 2)
HELP Default Waste Characteristics for High-Density Electric Plant Coal Bottom Ash (31)
Effective Saturated Hydraulic Conductivity was changed to tested value of 2.5×10^{-2} cm/s

Layer 3 - Flexible Membrane Liner (Type 4)
HELP Default Geosynthetic Material Characteristics for High Density Polyethylene Membrane (35)

Layer 4 - Barrier Soil Liner (Type 3)
HELP Default High Density Soils for Bentonite (17)

Calculation: Assumed properties of the liner system components and weather data were entered into the HELP model. The model was executed for a 15 year time frame. The HELP model output is attached.

The average head on the top of the HDPE geomembrane over the 15 years is 1.5 inches.
The average peak daily value for head on the geomembrane over 15 years is 7.2 inches.
The maximum head on top of the geomembrane over 15 years is 10.1 inches.

Conclustion: The proposed leachate collection system will maintain the average head on the liner below the required 1-foot.

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**
 **             HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
**
 **               HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)
**
 **                DEVELOPED BY ENVIRONMENTAL LABORATORY
**
 **                  USAE WATERWAYS EXPERIMENT STATION
**
 **          FOR USEPA RISK REDUCTION ENGINEERING LABORATORY
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 PRECIPITATION DATA FILE:     I:\4071\CALCUL~1\HELP\DATA4.D4
 TEMPERATURE DATA FILE:       I:\4071\CALCUL~1\HELP\DATA7.D7
 SOLAR RADIATION DATA FILE:   I:\4071\CALCUL~1\HELP\DATA13.D13
 EVAPOTRANSPIRATION DATA:     I:\4071\CALCUL~1\HELP\DATA11.D11
 SOIL AND DESIGN DATA FILE:   I:\4071\CALCUL~1\HELP\CRITICAL.D10
 OUTPUT DATA FILE:            I:\4071\CALCUL~1\HELP\TEST1.OUT


 TIME:  11:22     DATE:  10/28/2010


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     TITLE:  COLUMBIA PLAN OF OPERATION UPDATE LEACHATE HEAD
CALCULATION

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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 30

THICKNESS	=	36.00	INCHES
POROSITY	=	0.5410	VOL/VOL
FIELD CAPACITY	=	0.1870	VOL/VOL
WILTING POINT	=	0.0470	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3191	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.499999987000E-04	CM/SEC

LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	12.00	INCHES
POROSITY	=	0.5780	VOL/VOL
FIELD CAPACITY	=	0.0760	VOL/VOL
WILTING POINT	=	0.0250	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0916	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.250000004000E-01	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	185.0	FEET

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.04	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.50	HOLES/ACRE
FML INSTALLATION DEFECTS	=	2.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.20	INCHES

POROSITY	=	0.7500 VOL/VOL
FIELD CAPACITY	=	0.7470 VOL/VOL
WILTING POINT	=	0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	73.00	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	5.000	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	3.878	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	4.328	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.376	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	12.737	INCHES
TOTAL INITIAL WATER	=	12.737	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
MADISON WISCONSIN

STATION LATITUDE	=	43.13 DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00
START OF GROWING SEASON (JULIAN DATE)	=	124
END OF GROWING SEASON (JULIAN DATE)	=	279
EVAPORATIVE ZONE DEPTH	=	8.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	9.80 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	74.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	74.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	77.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MADISON WISCONSIN

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.11	1.02	2.15	3.10	3.34	3.89
3.75	3.82	3.06	2.24	1.83	1.53

5/9

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MADISON WISCONSIN

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
15.60	20.50	31.20	45.80	57.00	66.30
70.60	68.50	60.10	49.50	35.10	22.40

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MADISON WISCONSIN
AND STATION LATITUDE = 43.13 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 15

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.98	0.97	2.10	3.13	3.38	4.46
	4.29	3.23	2.70	1.96	1.34	1.74
STD. DEVIATIONS	0.44	0.62	0.86	1.24	2.13	2.09
	1.70	1.71	1.11	0.61	0.70	0.85
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.402	0.411	0.543	2.578	2.946	

3.519

	3.934	2.761	1.924	1.775	0.961
0.387					
STD. DEVIATIONS	0.062	0.125	0.433	0.959	1.162
1.434					
	1.216	1.218	0.758	0.411	0.332
0.118					

LATERAL DRAINAGE COLLECTED FROM LAYER 2

TOTALS	0.3414	0.2706	0.2383	0.5824	1.4744
1.2200					
	1.0240	0.8998	0.6957	0.5561	0.4454
0.4085					
STD. DEVIATIONS	0.1748	0.1239	0.0960	0.5207	0.7942
0.5444					
	0.4877	0.5256	0.4057	0.3178	0.2080
0.1697					

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000					
	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000					
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000					
	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000					

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	0.7190	0.6254	0.5018	1.2675	3.1053
2.6551					
	2.1568	1.8952	1.5141	1.1712	0.9694
0.8604					
STD. DEVIATIONS	0.3682	0.2794	0.2022	1.1332	1.6726
1.1847					
	1.0271	1.1070	0.8829	0.6694	0.4528
0.3574					

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 15

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.28 (5.206)	549654.7	100.00
RUNOFF	0.000 (0.0000)	0.00	0.000
EVAPOTRANSPIRATION	22.141 (3.3629)	401853.31	73.110
LATERAL DRAINAGE COLLECTED FROM LAYER 2	8.15656 (3.37153)	148041.516	26.93355
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00019 (0.00009)	3.493	0.00064
AVERAGE HEAD ON TOP OF LAYER 3	1.453 (0.600)		
CHANGE IN WATER STORAGE	-0.013 (1.1178)	-243.71	-0.044

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 15

	(INCHES)	(CU. FT.)
PRECIPITATION	4.26	77319.008
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 2	0.11095	2013.80457
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000004	0.06510
AVERAGE HEAD ON TOP OF LAYER 3	7.244	
MAXIMUM HEAD ON TOP OF LAYER 3	10.173	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	55.0 FEET	
SNOW WATER	4.51	81827.5312
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.5410
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.0470

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 15

LAYER	(INCHES)	(VOL/VOL)
1	9.6571	0.2683
2	1.5771	0.1314
3	0.0000	0.0000
4	0.1500	0.7500
SNOW WATER	1.152	

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BT SQUARED
CIVIL & ENVIRONMENTAL ENGINEERING

		Sheet No.	1 of 9		
		Calc. No.			
		Rev. No.			
Job No. 4071	Job: Columbia Plan of Operation Update	By: PEG	Date	10/28/2010	
Client: Wisconsin Power & Light	Subject: HELP Model Calculation	Chk'd: BLP	Date	10/28/2010	

Purpose: To determine the required minimum hydraulic conductivity of the bottom ash drainage layer to maintain an average leachate head level on the geomembrane to less than 1 foot.

Approach: Use the Hydrologic Evaluation of Landfill Performance (HELP) model to calculate the average leachate head. Adjust the permeability of the drainage layer until the resulting head on the liner is approximately 1 foot.

References: 1.) HELP Model Version 3.07
2.) "The Hydrolic Evaluation of Landfill Performance (HELP) Model, Engineering Documentation for Version 3.

Assumptions: Weather data obtained from Madison, Wisconsin.

Total Area of Module 13 = 5.0 acres
Slope of Liner System = 2.0 percent
Longest Drainage Length = 185.0 feet

Layer 1 - Vertical Percolation Layer (Type 1)
HELP Default Waste Characteristics for High-Density Electric Plant Coal Fly Ash (30)
A waste thickness of 3 ft was assumed.

Layer 2 - Lateral Drainage Layer (Type 2)
HELP Default Waste Characteristics for High-Density Electric Plant Coal Bottom Ash (31)
Effective Saturated Hydraulic Conductivity was changed until the average leachate head was close to 1 foot.

Layer 3 - Flexible Membrane Liner (Type 4)
HELP Default Geosynthetic Material Characteristics for High Density Polyethylene Membrane (35)

Layer 4 - Barrier Soil Liner (Type 3)
HELP Default High Density Soils for Bentonite (17)

Calculation: Assumed properties of the liner system components and weather data were entered into the HELP model. The model was executed for a 15 year time frame. The HELP model output is attached.

The conductivity of the bottom ash at which the average head on top of the HDPE geomembrane over the 15 years is approximately 12 inches is 3.7×10^{-3} cm/s

Conclustion: A hydraulic conductivity of 3.7×10^{-3} cm/s for the bottom ash will be used in the specifications for the leachate drainage system construction.

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 **            HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
**
 **              HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)
**
 **               DEVELOPED BY ENVIRONMENTAL LABORATORY
**
 **                 USAE WATERWAYS EXPERIMENT STATION
**
 **           FOR USEPA RISK REDUCTION ENGINEERING LABORATORY
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 PRECIPITATION DATA FILE:     I:\4071\CALCUL~1\HELP\DATA4.D4
 TEMPERATURE DATA FILE:       I:\4071\CALCUL~1\HELP\DATA7.D7
 SOLAR RADIATION DATA FILE:   I:\4071\CALCUL~1\HELP\DATA13.D13
 EVAPOTRANSPIRATION DATA:     I:\4071\CALCUL~1\HELP\DATA11.D11
 SOIL AND DESIGN DATA FILE:   I:\4071\CALCUL~1\HELP\BOTTAS~1.D10
 OUTPUT DATA FILE:            I:\4071\CALCUL~1\HELP\TEST1.OUT


 TIME:  13:19    DATE:  10/28/2010



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     TITLE:  COLUMBIA PLAN OF OPERATION UPDATE BOTTOM ASH CONDUCTIVITY

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
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COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 30

THICKNESS	=	36.00 INCHES
POROSITY	=	0.5410 VOL/VOL
FIELD CAPACITY	=	0.1870 VOL/VOL
WILTING POINT	=	0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3191 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.499999987000E-04 CM/SEC

LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5780 VOL/VOL
FIELD CAPACITY	=	0.0760 VOL/VOL
WILTING POINT	=	0.0250 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1693 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.370000000000E-02 CM/SEC
SLOPE	=	2.00 PERCENT
DRAINAGE LENGTH	=	185.0 FEET

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.04 INCHES
POROSITY	=	0.0000 VOL/VOL
FIELD CAPACITY	=	0.0000 VOL/VOL
WILTING POINT	=	0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY	=	0.50 HOLES/ACRE
FML INSTALLATION DEFECTS	=	2.00 HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.20 INCHES
POROSITY	=	0.7500 VOL/VOL

FIELD CAPACITY	=	0.7470 VOL/VOL
WILTING POINT	=	0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	73.00	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	5.000	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	3.878	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	4.328	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.376	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	13.669	INCHES
TOTAL INITIAL WATER	=	13.669	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
MADISON WISCONSIN

STATION LATITUDE	=	43.13	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	124	
END OF GROWING SEASON (JULIAN DATE)	=	279	
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	9.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	74.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	74.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	77.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MADISON WISCONSIN

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.11	1.02	2.15	3.10	3.34	3.89
3.75	3.82	3.06	2.24	1.83	1.53

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MADISON WISCONSIN

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
15.60	20.50	31.20	45.80	57.00	66.30
70.60	68.50	60.10	49.50	35.10	22.40

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MADISON WISCONSIN
AND STATION LATITUDE = 43.13 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 15

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.98	0.97	2.10	3.13	3.38	4.46
	4.29	3.23	2.70	1.96	1.34	1.74
STD. DEVIATIONS	0.44	0.62	0.86	1.24	2.13	2.09
	1.70	1.71	1.11	0.61	0.70	0.85
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.402	0.411	0.543	2.578	2.946	

```
3.519
                              3.934    2.761    1.924    1.775    0.961
0.387

   STD. DEVIATIONS            0.062    0.125    0.433    0.959    1.162
1.434
                              1.216    1.218    0.758    0.411    0.332
0.118

  LATERAL DRAINAGE COLLECTED FROM LAYER  2
  ----------------------------------------
   TOTALS                     0.5915   0.5096   0.5218   0.5357   0.7327
0.7471
                              0.7756   0.7670   0.7185   0.7119   0.6619
0.6555

   STD. DEVIATIONS            0.2336   0.1960   0.1979   0.1970   0.1942
0.1804
                              0.1988   0.1997   0.1965   0.2100   0.2087
0.2115

  PERCOLATION/LEAKAGE THROUGH LAYER  4
  ------------------------------------
   TOTALS                     0.0002   0.0001   0.0001   0.0002   0.0003
0.0003
                              0.0004   0.0004   0.0003   0.0003   0.0003
0.0002

   STD. DEVIATIONS            0.0002   0.0001   0.0001   0.0001   0.0002
0.0003
                              0.0003   0.0003   0.0003   0.0003   0.0002
0.0002


-----------------------------------------------------------------------
-------
            AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

-----------------------------------------------------------------------
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  DAILY AVERAGE HEAD ON TOP OF LAYER  3
  -------------------------------------
   AVERAGES                   9.5449   8.5281   7.6638   8.7552  13.1237
14.1258
                             14.6048  14.5199  13.9431  13.1631  12.3437
11.1322

   STD. DEVIATIONS            5.4346   4.3145   3.4099   4.6143   6.6383
7.4800
                              8.5318   8.3411   7.8508   7.4872   7.0064
6.0237

***********************************************************************
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7/9

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 15

	INCHES		CU. FEET	PERCENT
PRECIPITATION	30.28	(5.206)	549654.7	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	22.141	(3.3629)	401853.31	73.110
LATERAL DRAINAGE COLLECTED FROM LAYER 2	7.92858	(2.04986)	143903.781	26.18076
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00304	(0.00225)	55.220	0.01005
AVERAGE HEAD ON TOP OF LAYER 3	11.787	(5.511)		
CHANGE IN WATER STORAGE	0.212	(2.3167)	3842.32	0.699

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 15

	(INCHES)	(CU. FT.)
PRECIPITATION	4.26	77319.008
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 2	0.03793	688.50275
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000044	0.79949
AVERAGE HEAD ON TOP OF LAYER 3	37.157	
MAXIMUM HEAD ON TOP OF LAYER 3	43.377	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	105.3 FEET	
SNOW WATER	4.51	81827.5312
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.5410
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.0470

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 15

LAYER	(INCHES)	(VOL/VOL)
1	9.6571	0.2683
2	5.8860	0.4905
3	0.0000	0.0000
4	0.1500	0.7500
SNOW WATER	1.152	

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Appendix B4

Pipe Strength Calculation

Purpose: To evaluate the pipe strength of 6-in. dia., SDR 11 HDPE leachate collection piping in the base system of the Columbia Dry Ash Disposal Facility Modules 10 and 11 using designed properties and parameters.

Approach: Use referenced formulas to determine the maximum height waste can be placed above the leachate piping and the specific physical pipe properties necessary to perform adequately.

References:

1. Plastics Pipe Institute, 2nd Edition Handbook of PE Pipe, Buried PE Pipe Design (Attachment 1)
2. ISCO Industries, Typical Physical Properties and Dimension Charts, www.isco-pipe.com (Attachment 2)
3. "Soil Reaction for Buried Flexible Pipe", Amster K. Howard, U.S. Bureau of Reclamation
4. Plan of Operation, Metro Landfill Western Expansion, Appendix F - "Report on Metro Landfill - Pipe Design", Watkins, 1989
5. U.S. Department of Transportation, Federal Highway Administration, Recycled Materials, Coal Ash User's Guide
6. "HDPE Leachate Collection Pipe Design by Fundamentals of Mechanics", Harrison and Watkins, 1996, Nineteenth International Madison Waste Conference.
7. SCS Engineers, Plan of Operation Update, Dry Ash Disposal Facility - Columbia Energy Center , Base / Final Grades Plan Sheets, April 2022

Assumptions:

1. Waste above the piping is assumed to be wet.
2. Wet waste unit weight is a conservative 135 pcf from research and typical project experience values.
3. Live loads are negligible above the piping. The maximum fill height over an 6-in SDR 11 HDPE pipe will be 104 feet for the current design.
4. Leachate collection pipes will be 6-in., SDR 11 HDPE in Modules 10 and 11.
5. Allowable compressive stress for HDPE pipe is 1,000 psi (Plastic Pipe Institute, Attachment 1).

Calculations: **Pipe Loading, P_y**

$$P_y = DL + LL$$

where,
P_y = Pipe Load, lb/in²
DL = Dead Load, lb/in²
LL = Live Load, lb/in²

Dead Load, *DL*

$$DL = \frac{\gamma \cdot H}{144}$$

where,

γ	=	Fill Unit Weight, lb/ft^3	=	**135**	(waste unit weight)
H	=	Height of cover, ft	=	**104**	(max. waste height)
DL	=	Dead Load, lb/in^2	=	**98**	

In our case the live load = 0, due to limited live loads above the piping after placement.

So, P_y = DL = 98 lb/in^2

Assuming, 6 inch SDR 11 HDPE for leachate collection piping

Outer Diameter of Pipe (OD) = 6.625 in. (From Attachment 2)
Min. Pipe wall thickness (t) = 0.602 in. (From Attachment 2)

Calculations: (cont.)

Deflection

A deflection of 5 to 7.5% has become the standard for limiting deflection in flexible pipes. Based on Figure 7.16 in Uni-Bell (1991) and Watkins (1989) a vertical strain of greater than 5% will never be reached for flexible pipe bedded in compacted gravel, independent of vertical soil pressure. At 90% compaction the vertical strain will always be less than 2%. The height of fill over the pipe is not a factor when the pipe is well bedded in gravel. These findings are consistent for HDPE piping with the Harrison and Watkins (1996) paper.

Wall Crushing

where,
σ = *Compressive Stress, lb/in²*
T = *Wall Thrust, lb/in*
A = *Area of Pipe Wall, in²/in*

$$\sigma = \frac{T}{A}$$

Wall Thrust, T

$$T = \frac{P_y \cdot D_o}{2}$$

SDR 11 HDPE Piping

where,	P_y	= Vertical Fill Pressure lb/in^2	=	**98**	(Previously Calculated)
	D_0	= Outside Diameter, in	=	**6.625**	(SDR 11, 6-inch)
	T	= Wall Thrust, lb/in	=	**323**	
	A	= Area of Pipe Wall, in^2/in	=	**0.602**	(Solid=Thickness)

So, σ = *Compressive Stress, lb/in²* = **536**

Result: The allowable compressive strength of HDPE pipe is approximately 1,000 psi, so the calculated compressive stress values are acceptable and wall crushing of the pipe will be avoided when the pipe is at least SDR 11, 6-inch diameter for the leachate collection pipe.

Leachate Collection Piping Maximum Height - SDR 11 HDPE

For	P_y	= Vertical Fill Pressure lb/in^2	=	**182**	
	D_0	= Outside Diameter, in	=	**6.625**	(SDR 11, 6-inch)
	T	= Wall Thrust, lb/in	=	**602**	
	A	= Area of Pipe Wall, in^2/in	=	**0.602**	(Solid=Thickness)

So, σ = *Compressive Stress, lb/in²* = **1,000**

Maximum Height (feet) = Py*(144)/γ = **194**

Result: The maximum height of fill above the 6-inch SDR 11 HDPE piping is 194 feet for a fill unit weight of 135 lb/ft^3 to maintain the required minimum factor of safety against wall crushing. Wall crushing controls the maximum fill height that can be placed above the leachate collection pipes. The maximum fill height above the 6-inch diameter piping when Modules 10 and 11 are filled will be approximately 104 feet, which is lower than the maximum allowable fill height.

Attachment 1

From the Handbook of PE Pipe 2008, Second Edition by the Plastics Pipe Institute

TABLE C.1
Allowable Compressive Stress for 73°F (23°C)

	Pe Pipe Material Designation Code (1)					
	PE 2406		PE3408		PE 4710	
	PE 2708		PE 3608			
			PE 3708			
			PE 3710			
			PE 4708			
	psi	MPa	psi	MPa	psi	MPa
Allowable Compressive Stress	800	5.52	1000	6.90	1150	7.93

(1) See Chapter 5 for an explanation of the PE Pipe Material Designation Code.

Attachment 2

From the ISCO Product Catalog dated Q4 2020

IPS ASTM ISCO

For reference only. Actual dimensions may vary.

ASTM MATERIALS | Materiales ASTM

PE4710 HDPE PIPE SIZES IPS AND LARGE DIAMETER METRIC

PE4710 Tamaños HDPE tuberías IPS y Diámetro Grande Métrico

DR		11			13.5			15.5		
PE4710 Pressure Rating / Resistencia a la Presión		200 psi			160 psi			138 psi		
Nom. OD (in)	Actual OD (in)	Min Wall (in)	Avg ID (in)	Weight (lb/ft)	Min Wall (in)	Avg ID (in)	Weight (lb/ft)	Min Wall (in)	Avg ID (in)	Weight (lb/ft)
¾"	1.05	0.095	0.848	0.13	---	---	---	---	---	---
1"	1.315	0.12	1.062	0.2	---	---	---	---	---	---
1¼"	1.66	0.151	1.34	0.314	---	---	---	---	---	---
1½"	1.9	0.173	1.534	0.411	---	---	---	---	---	---
2"	2.375	0.216	1.917	0.642	0.176	2.002	0.534	0.153	2.05	0.47
3"	3.5	0.318	2.825	1.395	0.259	2.95	1.16	0.226	3.021	1.02
4"	4.5	0.409	3.633	2.31	0.333	3.793	1.92	0.29	3.885	1.687
5"	5.563	0.506	4.491	3.523	0.412	4.689	2.928	0.359	4.802	2.58
6"	6.625	0.602	5.348	4.93	0.491	5.585	4.152	0.427	5.719	3.656
8"	8.625	0.784	6.963	8.47	0.639	7.271	7.04	0.556	7.445	6.197
10"	10.75	0.977	8.678	13.16	0.796	9.062	10.932	0.694	9.28	9.626
12"	12.75	1.159	10.293	18.51	0.944	10.748	15.38	0.823	11.006	13.53
14"	14	1.273	11.302	22.32	1.037	11.801	18.54	0.903	12.085	16.31
16"	16	1.455	12.916	29.15	1.185	13.487	24.22	1.032	13.812	21.3
18"	18	1.636	14.531	36.89	1.333	15.173	30.651	1.161	15.538	26.95
20"	20	1.818	16.145	45.541	1.481	16.859	37.84	1.29	17.265	33.28
22"	22	2	17.76	55.105	1.63	18.545	45.79	1.419	18.991	39.712
24"	24	2.182	19.375	65.58	1.778	20.231	54.49	1.548	20.717	47.92
26"	26	2.364	20.989	77.44	1.926	21.917	64.261	1.677	22.444	56.532
28"	28	2.545	22.604	89.785	2.074	23.603	74.522	1.806	24.17	65.563
30"	30	2.727	24.218	103.076	2.222	25.289	85.543	1.935	25.897	75.264
32"	32	2.909	25.833	117.285	2.37	26.975	97.324	2.065	27.623	85.673
34"	34	3.091	27.447	132.411	2.519	28.661	109.905	2.194	29.35	96.714
36"	36	3.273	29.062	148.454	2.667	30.347	123.208	2.323	31.076	108.424
42"	42	3.818	33.906	202.039	3.111	35.404	167.675	2.71	36.255	147.568
48"	48	4.364	38.749	278.27	3.556	40.461	216.74	3.097	41.435	192.774
54"	54	4.909	43.59	352.14	4.00	45.75	286.94	3.484	46.614	243.921
1600mm/63"	62.99	---	---	---	4.667	53.107	390.58	4.065	54.383	340.15
1800mm	70.87	---	---	---	5.2*	60.1*	Call	---	---	---
2000mm	78.74	---	---	---	5.8*	66.8*	Call	---	---	---
2250mm	88.58	---	---	---	---	---	---	---	---	---
2500mm	98.43	---	---	---	---	---	---	---	---	---
2720mm	107.1	---	---	---	---	---	---	---	---	---
2800mm	110.2	---	---	---	---	---	---	---	---	---
3000mm	118.1	---	---	---	---	---	---	---	---	---
3500mm	137.8	---	---	---	---	---	---	---	---	---

1. Pressures are based on using water at 23°C (73°F)
2. Average inside diameter calculated using actual OD and minimum wall plus 6% for use in estimating fluid flows. Actual ID will vary.
3. Other piping sizes or DR's may be available upon request.
4. Standard Lengths:
   - 40' for 2"-24"
   - 50' for 26" and larger
   - Coils available for ¾ - 4" (6" by special order)

*DR 13.6

1. Las presiones están basadas en el uso de agua a 23°C (73°F)
2. El diámetro interno promedio calculado el diámetro externo real y la pared mínima más 6% para uso a estimación de flujos de fluidos. El diámetro interno real variará.
3. Otros tamaños o DR de tubería pueden estar disponibles bajo pedido.
4. Longitudes estándar
   - 40 pies para 2"-24 pulgadas
   - 50 pies para 26 pulgadas o mayores
   - Bobinas disponibles para ¾-4 pulgadas (6 pulgadas bajo pedidos especiales)

Purpose: To evaluate the pipe strength of 18-in. dia., SDR 17 HDPE sump riser piping in the base system of the Columbia Dry Ash Disposal Facility Modules 10 and 11 using designed properties and parameters.

Approach: Use referenced formulas to determine the maximum height waste can be placed above the sump riser piping and the specific physical pipe properties necessary to perform adequately.

References:

1. Plastics Pipe Institute, 2nd Edition Handbook of PE Pipe, Buried PE Pipe Design (Attachment 1)
2. ISCO Industries, Typical Physical Properties and Dimension Charts, www.isco-pipe.com (Attachment 2)
3. "Soil Reaction for Buried Flexible Pipe", Amster K. Howard, U.S. Bureau of Reclamation
4. Plan of Operation, Metro Landfill Western Expansion, Appendix F - "Report on Metro Landfill - Pipe Design", Watkins, 1989
5. U.S. Department of Transportation, Federal Highway Administration, Recycled Materials, Coal Ash User's Guide
6. "HDPE Leachate Collection Pipe Design by Fundamentals of Mechanics", Harrison and Watkins, 1996, Nineteenth International Madison Waste Conference.
7. SCS Engineers, Plan of Operation Update, Dry Ash Disposal Facility - Columbia Energy Center , Base / Final Grades Plan Sheets, April 2022

Assumptions:

1. Waste above the piping is assumed to be wet.
2. Wet waste unit weight is a conservative 135 pcf from research and typical project experience values.
3. Live loads are negligible above the piping. The maximum fill height over an 18-in SDR 17 HDPE pipe will be 35 feet for the current design.
4. Sump riser pipes will be 18-in., SDR 17 HDPE in Modules 10 and 11.
5. Allowable compressive stress for HDPE pipe is 1,000 psi (Plastic Pipe Institute, Attachment 1).

Calculations: **Pipe Loading, P_y**

$$P_y = DL + LL$$

where,
P_y = Pipe Load, lb/in^2
DL = Dead Load, lb/in^2
LL = Live Load, lb/in^2

Dead Load, *DL*

$$DL = \frac{\gamma \cdot H}{144}$$

where,					
γ	=	Fill Unit Weight, lb/ft^3	=	**135**	(waste unit weight)
H	=	Height of cover, ft	=	**35**	(max. waste height)
DL	=	Dead Load, lb/in^2	=	**33**	

In our case the live load = 0, due to limited live loads above the piping after placement.

So, P_y = DL = 33 lb/in^2

Assuming, 18 inch SDR 17 HDPE for leachate sump riser piping

Outer Diameter of Pipe (OD) = 18 in. (From Attachment 2)

Min. Pipe wall thickness (t) = 1.059 in. (From Attachment 2)

Calculations: (cont.)

Deflection

A deflection of 5 to 7.5% has become the standard for limiting deflection in flexible pipes. Based on Figure 7.16 in Uni-Bell (1991) and Watkins (1989) a vertical strain of greater than 5% will never be reached for flexible pipe bedded in compacted gravel, independent of vertical soil pressure. At 90% compaction the vertical strain will always be less than 2%. The height of fill over the pipe is not a factor when the pipe is well bedded in gravel. These findings are consistent for HDPE piping with the Harrison and Watkins (1996) paper.

Wall Crushing

where,
σ = *Compressive Stress, lb/in²*
T = *Wall Thrust, lb/in*
A = *Area of Pipe Wall, in²/in*

$$\sigma = \frac{T}{A}$$

Wall Thrust, T

$$T = \frac{P_y \cdot D_0}{2}$$

SDR 17 HDPE Piping

where, P_y	=	Vertical Fill Pressure lb/in^2	=	**33**	(Previously Calculated)
D_0	=	Outside Diameter, in	=	**18.000**	(SDR 17, 18-inch)
T	=	Wall Thrust, lb/in	=	**295**	
A	=	Area of Pipe Wall, in^2/in	=	**1.059**	(Solid=Thickness)

So, σ = *Compressive Stress, lb/in²* = **279**

Result: The allowable compressive strength of HDPE pipe is approximately 1,000 psi, so the calculated compressive stress values are acceptable and wall crushing of the pipe will be avoided when the pipe is at least SDR 17, 18-inch diameter for the sump riser pipe.

Sump Riser Piping Maximum Height - SDR 17 HDPE

For P_y	=	Vertical Fill Pressure lb/in^2	=	**118**	
D_0	=	Outside Diameter, in	=	**18.000**	(SDR 17, 18-inch)
T	=	Wall Thrust, lb/in	=	**1,059**	
A	=	Area of Pipe Wall, in^2/in	=	**1.059**	(Solid=Thickness)

So, σ = *Compressive Stress, lb/in²* = **1,000**

Maximum Height (feet) = Py*(144)/ɣ = **126**

Result: The maximum height of fill above the 18-inch SDR 17 HDPE piping is 126 feet for a fill unit weight of 135 lb/ft^3 to maintain the required minimum factor of safety against wall crushing. Wall crushing controls the maximum fill height that can be placed above the sump riser pipes. The maximum fill height above the 18-inch diameter piping when Modules 10 and 11 are filled will be approximately 35 feet, which is lower than the maximum allowable fill height.

Attachment 1

From the Handbook of PE Pipe 2008, Second Edition by the Plastics Pipe Institute

TABLE C.1

Allowable Compressive Stress for 73°F (23°C)

<table>
<tr><td rowspan="7"></td><td colspan="6">Pe Pipe Material Designation Code [1]</td></tr>
<tr><td colspan="2">PE 2406</td><td colspan="2">PE3408</td><td colspan="2" rowspan="5">PE 4710</td></tr>
<tr><td colspan="2" rowspan="4">PE 2708</td><td colspan="2">PE 3608</td></tr>
<tr><td colspan="2">PE 3708</td></tr>
<tr><td colspan="2">PE 3710</td></tr>
<tr><td colspan="2">PE 4708</td></tr>
<tr><td>psi</td><td>MPa</td><td>psi</td><td>MPa</td><td>psi</td><td>MPa</td></tr>
<tr><td>Allowable Compressive Stress</td><td>800</td><td>5.52</td><td>1000</td><td>6.90</td><td>1150</td><td>7.93</td></tr>
</table>

(1) See Chapter 5 for an explanation of the PE Pipe Material Designation Code.

Attachment 2

From the ISCO Product Catalog dated Q4 2020

ISCO ASTM IPS

For reference only. Actual dimensions may vary.

PE4710 HDPE PIPE SIZES IPS AND LARGE DIAMETER METRIC

PE4710 Tamaños HDPE tuberías IPS y Diámetro Grande Métrico

DR		17			19			21		
PE4710 Pressure Rating Resistencia a la Presión		125 psi			111 psi			100 psi		
Nom. OD DE Nominal (in)	Actual OD DE Actual (in)	Min Wall Espesor Mínimo de Pared (in)	Avg ID DI Promedio (in)	Weight Peso (lb/ft)	Min Wall Espesor Mínimo de Pared (in)	Avg ID DI Promedio (in)	Weight Peso (lb/ft)	Min Wall Espesor Mínimo de Pared (in)	Avg ID DI Promedio (in)	Weight Peso (lb/ft)
¾"	1.05	---	---	---	---	---	---	---	---	---
1"	1.315	---	---	---	---	---	---	---	---	---
1¼"	1.66	---	---	---	---	---	---	---	---	---
1½"	1.9	---	---	---	---	---	---	---	---	---
2"	2.375	0.14	2.079	0.431	---	---	---	---	---	---
3"	3.5	0.206	3.064	0.94	---	---	---	0.167	3.147	0.757
4"	4.5	0.265	3.939	1.55	0.237	3.998	1.39	0.214	4.046	1.27
5"	5.563	0.327	4.869	2.36	0.293	4.942	2.12	0.265	5.001	1.94
6"	6.625	0.39	5.799	3.36	0.349	5.886	3.01	0.315	5.956	2.75
8"	8.625	0.507	7.549	5.69	0.454	7.663	5.1	0.411	7.754	4.662
10"	10.75	0.632	9.409	8.834	0.566	9.551	7.92	0.512	9.665	7.242
12"	12.75	0.75	11.16	12.43	0.671	11.327	11.14	0.607	11.463	10.19
14"	14	0.824	12.254	14.983	0.737	12.438	13.43	0.667	12.587	12.282
16"	16	0.941	14.005	19.57	0.842	14.215	17.54	0.762	14.385	16.042
18"	18	1.059	15.755	24.77	0.947	15.992	22.2	0.857	16.183	20.304
20"	20	1.176	17.506	30.58	1.053	17.768	27.41	0.952	17.981	25.07
22"	22	1.294	19.256	37	1.158	19.545	33.162	1.048	19.779	30.33
24"	24	1.412	21.007	44.031	1.263	21.322	39.47	1.143	21.577	36.1
26"	26	1.529	22.758	51.856	1.368	23.099	46.701	1.238	23.375	42.486
28"	28	1.647	24.508	60.154	1.474	24.876	54.189	1.333	25.173	49.266
30"	30	1.765	26.259	69.068	1.579	26.653	62.196	1.429	26.971	56.585
32"	32	1.882	28.009	78.557	1.684	28.429	70.755	1.524	28.77	64.37
34"	34	2	29.76	88.7	1.789	30.206	79.865	1.619	30.568	72.657
36"	36	2.118	31.511	99.457	1.895	31.983	89.571	1.714	32.366	81.446
42"	42	2.471	36.762	135.372	2.211	37.314	121.925	2	37.76	110.874
48"	48	2.824	42.014	176.813	2.526	42.644	159.198	2.286	43.154	144.833
54"	54	3.176	47.266	223.713	2.842	47.975	201.502	2.571	48.549	183.253
1600mm/63"	62.99	3.706	55.143	303.398	3.315	55.97	273.362	3	56.631	249.57
1800mm	70.87	4.169	62.029	Call	---	---	---	3.375	63.712	Call
2000mm	78.74	4.632	68.921	Call	---	---	---	3.75	70.791	Call
2250mm	88.58	5.211	77.536	Call	---	---	---	4.218	79.64	Call
2500mm	98.43	5.79	86.151	Call	---	---	---	4.687	88.489	Call
2720mm	107.1	---	---	---	---	---	---	5.1	96.6	Call
2800mm	110.2	---	---	---	---	---	---	5.3	99.4	Call
3000mm	118.1	---	---	---	---	---	---	5.6	106.5	Call
3500mm	137.8	---	---	---	---	---	---	6.6	124.3	Call

1. Pressures are based on using water at 23°C (73°F).
2. Average inside diameter calculated using actual OD and minimum wall plus 6% for use in estimating fluid flows. Actual ID will vary.
3. Other piping sizes or DR's may be available upon request.
4. Standard Lengths
   - 40' for 2"-24"
   - 50' for 26" and larger
   - Coils available for ¾ - 4" (6" by special order).

ASTM MATERIALS Materiales ASTM

Appendix B5

Liner Flow Rate Calculation

Purpose: To determine that the liquid flow rate through a combined geosynthetic clay liner (GCL) and clay liner system is equivalent to just a clay liner.

References:
1. GSE Environmental, BentoLiner CAR-NWL35 GCL product specifications.
2. Columbia Energy Center, Construction Quality Assuracnce Plan, December 2017
3. JLT Laboratories, Inc., Fexible Wall Permeability Compatibility Test Results, September 2015
4. 40 CRF 257.70, Design criteria for new CCR landfills and any lateral expansion of a CCR landfill, 2017
5. Permeability of Stratifed Deposits, NPTEL website, December 2009

Approach: The following equation will be used to calcuate the flow rate per unit area (q) based on the liner thickness (H), hydaulic conductivity (k), and hydrualic head above the liner (h).

(Eq. 1) $$\frac{Q}{A} = q = k\left(\frac{h}{H} + 1\right)$$

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Where,

Q = flow rate (cubic centimeters/second);

A = surface area of the liner (squared centimeters);

q = flow rate per unit area (cubic centimeters/second/squared centimeter);

k = hydraulic conductivity of the liner (centimeters/second);

h = hydraulic head above the liner (centimeters); and

H = thickness of the liner (centimeters).

For the combined GCL and clay liner, an average hydraulic conductivity (k_v) will be calculated uing the following equation:

$$k_V = \frac{H}{\frac{H_1}{k_1} + \frac{H_2}{k_2} + \ldots\ldots\ldots\ldots}$$

Where k_v is the average hydraulic conductvity for the system, H is the total thickness of the combined liner system, k_1 and k_2 are the hydraulic conductivity of the clay liner and the GCL respectivitly, and H_1 and H_2 is the thickness of the clay liner and the GCL respectively.

Assumptions:
1. The clay liner hydraulic conducivity (k_1) is 1x10-7 cm/sec.
2. The hydraulic conductivity (k_2) for the GCL, 5x10-9 cm/sec was used based on the maximum allowable from the CQA Plan.
3. A hydraulic head (h) of 30 cm was assumed above the liner.
4. GCL thickness (H_2) of 0.74 cm was based on typical manufactured product thickness.

Calculations:

Calculation for clay liner

H_1 = 60.96 cm (2 ft x 30.48cm/ft = 60.96 cm)

h = 30 cm

k_1 = 1E-07 cm/sec

q = k_1*(h/H_1 + 1) = **1.49E-07** cm/sec

Calculation for clay liner with a geosynthetic clay liner (GCL)

H_2 = 0.74 cm

h = 30 cm

k_2 = 5.00E-09 cm/sec

H = H_1 + H_2 = 61.70 cm

k_v = H / ((H_1/k_1) + (H_2/k_2)) = 8.14E-08 cm/sec

q = k_v*(h/H + 1) = **1.21E-07** cm/sec

Clay Liner Flow Rate (cm/sec)		Combined GCL and Clay Liner Flow Rate (cm/sec)
1.49E-07	>	1.21E-07

Conclusion: A combined GCL and clay liner system has an equivalent or lower flow rate per unit area to just a clay liner.

Appendix B6

Water Levels

Table 3. Groundwater Elevation - State Monitoring Program and CCR Well Network
Columbia Dry Ash and Ash Pond Disposal Facilities / SCS Engineers Project #25222067.00

	Raw Data	MW-1AR	MW-4	MW-5R	MW-33AR	MW-33BR	MW-34A	MW-34B	MW-37A	MW-83	MW-84A	MW-84B	MW-86	MW-91AR	MW-91B	MW-92A	MW-92B	MW-93A	MW-93B	MW-312	LS-1	LS-3R	LH-2	LH-3	LH-4
	Measurement Date																								
	October 2, 2012	39.14	36.04	20.48	25.91	26.16	22.92	23.06	30.38	dry	30.44	30.32	40.98	24.94	24.55	23.98	24.35	NI	NI	NI	16.90	16.64	dry	--	--
	April 15, 2013	37.11	35.72	19.35	24.13	24.25	21.21	21.26	29.17	23.47	28.45	28.50	39.57	23.89	23.44	22.72	23.07	NI	NI	NI	8.94	dry	dry	--	--
	October 8, 2013													23.37	23.03	22.5	22.89	NI	NI	NI				--	--
	October 15, 2013	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	23.37	23.03	22.5	22.89	NI	NI	NI	9.15	dry	(4)	--	--
	April 14, 2014	37.60	35.65	19.81	24.55	24.48	21.32	21.35	29.59	24.23	28.70	28.74	39.83	23.99	23.49	22.48	22.87	NI	NI	NI	9.61	dry	0.2	--	--
	October 2-3, 2014	37.52	34.35	19.36	23.92	24.11	21.38	21.51	28.48	dry	29.04	29.08	39.60	23.56	23.17	22.72	23.08	NI	NI	NI	9.06	dry	0.3	--	--
	April 13-14, 2015	38.59	36.11	20.19	25.28	25.65	22.30	22.10	30.17	dry	29.85	29.75	40.62	24.55	24.08	23.40	23.75	NI	NI	NI	dry	9.62	dry	--	--
	October 6-7, 2015	38.27	35.30	19.72	24.61	25.06	21.90	22.03	29.38	24.31	29.48	29.5	40.13	24.14	23.75	23.27	23.65	NI	NI	NI	broken	dry	14.8 inches	--	--
	April 4-6, 2016	36.73	aband	18.42	23.00	23.32	20.32	20.38	28.28	22.53	27.91	28.00	38.90	22.98	22.50	21.86	22.20	NI	NI	NI	broken	dry	15.9"	--	--
	October 11-13, 2016	35.91	aband	17.44	20.93	21.93	19.50	19.73	26.64	21.15	27.06	27.15	37.83	21.86	21.64	20.79	21.16	NI	NI	NI	13.00	dry	0.8"	1.4"	--
	April 10-13, 2017	35.59	aband	17.31	21.90	22.40	19.65	19.77	26.70	21.73	27.12	27.20	37.83	21.79	21.42	20.57	20.81	NI	NI	NI	13.10	dry	-0.3	1.4"	--
	October 3-5, 2017	37.07	aband	18.78	23.78	24.17	21.28	21.42	28.18	23.67	NM	27.77	39.21	22.95	22.62	22.00	22.39	NI	NI	NI	13.26	dry	NM	NM	--
	October 9-10, 2017	--	aband	NM	NM	NM	NM	NM	NM	NM	28.72 [6]	NM	NM	NM	NM	NM	NM	NI	NI	NI	NM	NM	1.4" [5]	1.6" [5]	--
	February 21, 2018	38.58	aband	NM	NM	NM	NM	NM	NM	NM	--	NM	NM	24.35	23.99	NM	NM	NI	NI	NI	NM	NM	NM	NM	--
	April 23-25, 2018	38.56	aband	20.08	25.20	22.03	24.18	25.26	29.76	24.64	28.40	29.35	42.25	24.32	23.92	23.24	23.60	NI	NI	NI	13.26	NM	NM	NM	--
	October 23-25, 2018	34.30	aband	15.73	19.52	20.43	18.07	18.32	25.42	19.70	25.96	26.07	36.58	20.44	20.14	19.15	19.54	NI	NI	NI	dry	13.59	4.6	4	--
	April 1-4, 2019	35.50	aband	16.80	21.66	21.85	19.13	19.13	26.57	21.18	26.93	26.92	37.63	21.58	21.27	20.43	20.78	NI	NI	NI	13.51	dry	42.0	4	169
	October 7-9, 2019	35.29	aband	16.21	20.03	20.75	18.03	18.31	26.27	19.06	26.49	26.53	37.35	21.25	20.83	19.84	20.24	NI	NI	NI	13.60	dry	-0.1"	11.7"	13.1"
	May 27-28, 2020	35.63	aband	17.10	22.28	22.64	19.97	20.06	26.82	21.93	27.26	27.27	37.85	21.77	21.40	20.61	20.94	NI	NI	NI	13.62	dry	-0.1	2.40	2.4
	October 7-8, 2020	36.60	aband	17.68	22.38	22.94	20.25	20.37	27.52	22.24	28.18	28.20	38.69	22.48	22.12	21.62	22.03	NI	NI	NI	13.62	dry	-0.1	2.70	2.4
	February 25, 2021	NM	aband	NM	NM	NM	21.20	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NI	NI	NI	NM	NM	-0.1	2.70	2.6
	April 14, 2021	44.43	aband	18.15	24.02	24.34	21.18	21.28	28.58	23.62	28.44	28.45	39.19	23.17	22.76	22.00	22.35	NI	NI	NI	13.71	dry	-0.1"	2.8"	2.6"
	June 11, 2021	NM	aband	NM	24.10	NM	21.29	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NI	NI	NI					
	October 11-12, 14, 2021	38.08	aband	18.66	24.56	24.79	21.53	21.64	29.16	24.09	29.32	29.38	40.00	23.89	23.51	22.92	23.30	NI	NI	NI	13.71	dry			
	October 17, 2021	NM	aband	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NI	NI	NI	NM	NM	-0.1"	3.1"	2.8"
	April 1, 2022	aband	aband	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	-"0.1"	3.1"	2.9"
	April 11-13, 2022	aband	aband	19.92	25.02	24.94	21.65	21.63	29.78	24.18	29.26	29.26	40.09	24.20	23.73	23.02	23.39	43.90	43.74	43.06	13.60	dry	NM	NM	NM
	October 24-28, 2022	aband	aband	20.01	26.35	26.78	22.34	22.44	30.76	dry	29.71	29.72	40.41	24.39	23.98	23.42	23.79	44.15	44.95	43.29	13.78	dry	NM	NM	NM
	Well Number	**MW-1AR**	**MW-4**	**MW-5R**	**MW-33AR**	**MW-33BR**	**MW-34A**	**MW-34B**	**MW-37A**	**MW-83**	**MW-84A**	**MW-84B**	**MW-86**	**MW-91AR**	**MW-91B**	**MW-92A**	**MW-92B**	**MW-93A**	**MW-93B**	**MW-312**	**LS-1**	**LS-3R**	**LH-2**	**LH-3**	**LH-4**
Dry Ash Facility (Facility ID #03025)	**Top of Casing Elevation (feet amsl)**	822.55	819.74	805.44	808.29	808.39	805.95	806.05	813.04	807.96	814.28	814.26	824.79	809.03	808.45	808.47	808.41	827.89	827.71	826.79					
	Screen Length (ft)																	10	5	10					
	Total Depth (ft from top of casing)	44.40	39.58	25.97	31.08	57.50	35.43	56.95	31.80	25.42	40.21	52.02	45.43	32.90	52.38	28.94	51.75	50.7	82.5	52.5	17.42	17.10	19.90		
	Top of Well Screen Elevation (ft)	778.15	780.16	779.47	777.21	750.89	770.52	749.10	781.24	782.54	774.07	762.24	779.36	776.13	756.07	779.53	756.66	787.19	750.21	784.29	NM	NM	NM		
	Measurement Date																								
	October 2, 2012	783.41	783.70	784.96	782.38	782.23	783.03	782.99	782.66	dry	783.84	783.94	783.81	784.09	783.90	784.49	784.06	NI	NI	NI			dry	--	
	April 15, 2013	785.44	784.02	786.09	784.16	784.14	784.74	784.79	783.87	784.49	785.83	785.76	785.22	785.14	785.01	785.75	785.34	NI	NI	NI	NM	dry	dry	--	
	October 8, 2013													785.66	785.42	785.97	785.52	NI	NI	NI	NM	NM	NM	--	
	October 15, 2013	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	785.66	785.42	785.97	785.52	NI	NI	NI				--	
	April 14, 2014	784.95	784.09	785.63	783.74	783.91	784.63	784.70	783.45	783.73	785.58	785.52	784.96	785.04	784.96	785.99	785.54	NI	NI	NI	NM	dry	leachate depth = 0.2 in.	--	
	October 2-3, 2014	785.03	785.39	786.08	784.37	784.28	784.57	784.54	784.56	dry	785.24	785.18	785.19	785.47	785.28	785.75	785.33	NI	NI	NI	NM	dry	leachate depth = 0.3 in.	--	
	April 13-14, 2015	783.96	783.63	785.25	783.01	782.74	783.65	783.95	782.87	dry	784.43	784.51	784.17	784.48	784.37	785.07	784.66	NI	NI	NI	dry	--	dry	--	
	October 6-7, 2015	784.28	784.44	785.72	783.68	783.33	784.05	784.02	783.66	dry	784.80	784.76	784.66	784.89	784.70	785.20	784.76	NI	NI	NI	broken	dry	leachate depth = 14.8 in.	--	
	April 4-6, 2016	785.82	aband	787.02	785.29	785.07	785.63	785.67	784.76	785.43	786.37	786.26	785.89	786.05	785.95	786.61	786.21	NI	NI	NI	broken	dry	15.9"	--	
	October 11-13, 2016	786.64	aband	788.00	787.36	786.46	786.45	786.32	786.40	786.81	787.22	787.11	786.96	787.17	786.81	787.68	787.25	NI	NI	NI	liquid depth = 3.5'	dry	0.8"	1.4"	
	April 10-13, 2017	786.96	aband	788.13	786.39	785.99	786.30	786.28	786.34	786.23	787.16	787.06	786.96	787.24	787.03	787.90	787.60	NI	NI	NI	liquid depth = 3.0'	dry	-0.3	1.4"	
	October 3-5, 2017	785.48	aband	786.66	784.51	784.22	784.67	784.63	784.86	784.29	NM	786.49	785.58	786.08	785.83	786.47	786.02	NI	NI	NI	liquid depth = 2.7'	dry	NM	NM	
	October 9-10, 2017	NM	aband	NM	NM	NM	NM	NM	NM	NM	785.56 [6]	NM	NM	NM	NM	NM	NM	NI	NI	NI	NM	NM	1.4" [5]	1.6" [5]	
	February 21, 2018	783.97	aband	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	784.68	784.46	NM	NM	NI	NI	NI	NM	NM	NM	NM	
	April 23-25, 2018	783.99	aband	785.36	783.09	786.36	781.77	780.79	783.28	783.32	785.88	784.91	782.54	784.71	784.53	785.23	784.81	NI	NI	NI	liquid depth = 2.7'	NM	NM	NM	
	October 23-25, 2018	788.25	aband	789.71	788.77	787.96	787.88	787.73	787.62	788.26	788.32	788.19	788.21	788.59	788.31	789.32	788.87	NI	NI	NI	dry	liquid depth = 2.4'	4.6	4	--
	April 1-4, 2019	787.05	aband	788.64	786.63	786.54	786.82	786.92	786.47	786.78	787.35	787.34	787.16	787.45	787.18	788.04	787.63	NI	NI	NI	liquid depth = 3.9'	dry	--	--	
	October 7-9, 2019	787.26	aband	789.23	788.26	787.64	787.92	787.74	786.77	788.90	787.79	787.73	787.44	787.78	787.62	788.63	788.17	NI	NI	NI	liquid depth = 3.8'	dry	-0.1"	11.7"	13.1"
	May 27-28, 2020	786.92	aband	788.34	786.01	785.75	785.98	785.99	786.22	786.03	787.02	786.99	786.94	787.26	787.05	787.86	787.47	NI	NI	NI	liquid depth = 3.8'	dry	-0.1	2.4	2.4
	October 7-8, 2020	785.95	aband	787.76	785.91	785.45	785.70	785.68	785.52	785.72	786.10	786.06	786.10	786.55	786.33	786.85	786.38	NI	NI	NI	liquid depth = 3.8'	dry	-0.1	2.7	2.4
	February 25, 2021	NM	aband	NM	NM	NM	784.75	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NI	NI	NI	NM	NM	-0.1	2.7	2.6
	April 14, 2021	778.12	aband	787.29	784.27	784.05	784.77	784.77	784.46	c	785.84	785.81	785.60	785.86	785.69	786.47	786.06	NI	NI	NI	liquid depth = 3.7'		--	0.233333333	0.216666667
	June 11, 2021	NM	aband	NM	784.19	NM	784.66	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NI	NI	NI	NM	NM	NM	NM	NM
	October 11-12, 14, 2021	784.47	adand	786.78	783.73	783.60	784.42	784.41	783.88	783.87	784.96	784.88	784.79	785.14	784.94	785.55	785.11	NI	NI	NI	liquid depth = 3.7'	--			
	October 17, 2021	NM	adand	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NI	NI	NI	NM	NM	-0.01	0.26	0.23
	April 1, 2022	aband	aband	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	-"0.1"	3.1"	2.9"
	April 11-13, 2022	aband	adand	785.52	783.27	783.45	784.30	784.42	783.26	783.78	785.02	785.00	784.70	784.83	784.72	785.45	785.02	783.99	783.97	783.73	liquid depth = 3.8'	dry	NM	NM	NM
	October 24-28, 2022	aband	aband	785.43	781.94	781.61	783.61	783.61	782.28	dry	784.57	784.54	784.38	784.64	784.47	785.05	784.62	783.74	782.76	783.50	liquid depth = 3.6'	dry	NM	NM	NM
	Bottom of Well Elevation (ft)	778.15	780.16	779.47	777.21	750.89	770.52	749.10	781.24	782.54	774.07	762.24	779.36	776.13	756.07	779.53	756.66	777.19	745.21	774.29	NM	NM	NM	NM	

Table 3. Groundwater Elevation - State Monitoring Program and CCR Well Network
Columbia Dry Ash and Ash Pond Disposal Facilities / SCS Engineers Project #25222067.00

	Raw Data	M-3	M-4R	MW-39A	MW-39B	MW-48A	MW-48B	MW-57	MW-59	MW-216R	MW-217	MW-220RR	SG-1	SG-2	SG-3	SG-4
	Measurement Date															
	October 2, 2012	8.10	19.34	28.13	28.16	46.83	46.91	5.71	35.60	32.30	10.60	12.35	2.92	1.40	dry	dry
	April 15, 2013	3.07	17.71	25.65	25.50	45.09	45.06	1.60	31.82	30.12	6.80	7.88	(1)	NM(2)	dry	dry
	October 8, 2013	7.01	19.43	NM	NM	45.17	45.26	NM	NM	30.82	9.28	10.54	(3)	3.92	(3)	dry
	October 15, 2013	NM	NM	26.68	26.69	NM	NM	3.82	31.99	NM	NM	NM	NM	NM	NM	NM
	April 14, 2014	2.19	17.14	26.05	25.82	45.30	45.27	0.78	32.07	30.48	6.30	7.03	788.90	NM	NM	NM
	October 1-3, 2014	7.07	18.55	26.20	26.18	44.81	44.90	3.97	31.93	30.42	8.92	9.87	cannot read	dry	dry	dry
	April 13-14, 2015	5.15	19.27	26.85	26.82	46.06	46.02	3.48	32.65	31.28	8.21	9.48	(1)	3.55	dry	dry
	October 6-7, 2015	7.57	19.98	26.65	26.69	45.76	45.83	4.47	32.23	31.03	9.6	10.64	NM	3.67	dry	dry
	April 4-6, 2016	4.02	17.01	24.35	24.23	44.07	44.08	3.08	30.51	28.53	6.53	8.54	From NS	1.85	dry	dry
	October 11-13, 2016	6.35	18.22	23.87	23.98	43.13	43.23	3.17	28.97	28.05	7.80	8.81	From NS	2.73	dry	dry
	April 10-13, 2017	5.29	18.15	24.18	24.30	43.04	43.15	3.52	29.39	28.26	7.26	8.81	From NS	1.40	dry	dry
	October 3-5, 2017	7.30	19.06	26.27	26.32	44.56	44.65	3.92	31.25	30.32	9.07	10.29	From NS	1.8	dry	dry
	April 23-25, 2018	5.34	15.67	26.76	26.63	45.72	45.75	3.25	32.46	30.98	8.29	9.45	From NS	above gauge	dry	dry
	October 23-25, 2018	5.28	17.63	22.50	22.62	41.74	41.85	2.81	27.75	26.72	6.65	8.38	From NS	2.00	dry	dry
	April 1-4, 2019	2.55	16.66	23.34	23.19	42.30	42.39	1.02	28.09	27.68	5.22	7.44	From BC	0.65	dry	dry
	October 7-9, 2019	2.90	15.45	22.52	22.48	42.18	42.19	1.00	28.80	27.14	5.54	7.48	From BC	0.05	dry	dry
	May 27-29, 2020	6.43	18.37	24.50	24.58	43.12	43.25	3.18	29.59	28.61	8.14	9.01	From BC	above gauge	dry	dry
	October 7-8 &17, 2020	6.81	18.36	24.88	24.86	43.83	43.88	3.46	30.05	29.11	8.49	9.41	From BC	1.93	dry	NM
	April 12, 2021	5.93	19.76	25.96	25.85	44.73	44.76	3.50	31.40	30.24	8.40	9.41	From BC	1.80	below gauge	dry
	October 11-12, 14, 2021	7.20	19.77	26.68	26.65	45.77	45.81	4.35	32.37	31.17	9.40	10.24	From BC	0.12	dry	dry
	April 11-13, 2022	4.28	17.84	26.25	26.16	45.76	45.74	NM	32.49	30.81	7.62	9.07	From BC	0.60	dry	dry
	June 3, 2022	NM	NM	NM	NM	NM	NM	4.16	NM	NM	NM	NM	NM	NM	NM	NM
	October 25, 26, 28, 2022	7.82	22.25	28.86	28.84	49.29	49.29	7.06	36.50	35.60	11.22	11.41	NM	0.04	dry	dry
	Well Number	**M-3**	**M-4R**	**MW-39A**	**MW-39B**	**MW-48A**	**MW-48B**	**MW-57**	**MW-59**	**MW-216R**	**MW-217**	**MW-220RR**	**SG-1**	**SG-2**	**SG-3**	**SG-4**
	Top of Casing Elevation (feet amsl)	788.23	806.10	809.62	809.50	828.86	828.84	786.29	815.48	814.21	791.55	792.90	792.06	795.25	808.60	805.36
Ash Pond Facility (Facility ID #02325)	**Screen Length (ft)**															
	Total Depth (ft from top of casing)	16.90	25.55	34.80	76.07	51.88	75.80	14.40	38.50	37.85	37.37	18.96	--	--	--	--
	Top of Well Screen Elevation (ft)	771.33	780.55	774.82	733.43	776.98	753.04	771.89	776.98	776.36	754.18	773.94	--	--	--	--
	Measurement Date															
	October 2, 2012	780.13	786.76	781.49	781.34	782.03	781.93	780.58	779.88	781.91	780.95	780.55	789.14	793.85	dry	dry
	April 15, 2013	785.16	788.39	783.97	784.00	783.77	783.78	784.69	783.66	784.09	784.75	785.02	789.5(1)	NM	dry	dry
	October 8, 2013	781.22	786.67	NM	NM	783.69	783.58	NM	NM	783.39	782.27	782.36	789.5(1)	791.33	dry	dry
	October 15, 2013	NM	NM	782.94	782.81	NM	NM	782.47	783.49	NM	NM	NM	NM	NM	NM	NM
	April 14, 2014	786.04	788.96	783.57	783.68	783.56	783.57	785.51	783.41	783.73	785.25	785.87	788.90	dry	dry	dry
	October 1-3, 2014	781.16	787.55	783.42	783.32	784.05	783.94	782.32	783.55	783.79	782.63	783.03	NM	dry	dry	dry
	April 13-14, 2015	783.08	786.83	782.77	782.68	782.80	782.82	782.81	782.83	782.93	783.34	783.42	789.3	791.70	dry	dry
	October 6-7, 2015	780.66	786.12	782.97	782.81	783.10	783.01	781.82	783.25	783.18	781.95	782.26	788.48	791.58	dry	dry
	April 4-6, 2016	784.21	789.09	785.27	785.27	784.79	784.76	783.21	784.97	785.68	785.02	784.36	NM	793.40	dry	dry
	October 11-13, 2016	781.88	787.88	785.75	785.52	785.73	785.61	783.12	786.51	786.16	783.75	784.09	788.32	792.52	dry	dry
	April 10-13, 2017	782.94	787.95	785.44	785.20	785.82	785.69	782.77	786.09	785.95	784.29	784.09	788.31	793.85	dry	dry
	October 3-5, 2017	780.93	787.04	783.35	783.18	784.30	784.19	782.37	784.23	783.89	782.48	782.61	788.3	793.45	dry	dry
	April 23-25, 2018	782.89	790.43	782.86	782.87	783.14	783.09	783.04	783.02	783.23	783.26	783.45	788.38	>795.25	dry	dry
	October 23-25, 2018	782.95	788.47	787.12	786.88	787.12	786.99	783.48	787.73	787.49	784.90	784.52	787.76	793.25	dry	dry
	April 1-4, 2019	785.68	789.44	786.28	786.31	786.56	786.45	785.27	787.39	786.53	786.33	785.46	788.40	794.60	dry	dry
	October 7-9, 2019	785.33	790.65	787.10	787.02	786.68	786.65	785.29	786.68	787.07	786.01	785.42	748.48	795.20	dry	dry
	May 27-29, 2020	781.80	787.73	785.12	784.92	785.74	785.59	783.11	785.89	785.60	783.41	783.89	748.48	>795.25	dry	dry
	October 7-8 &17, 2020	781.42	787.74	784.74	784.64	785.03	784.96	782.83	785.43	785.10	783.06	783.49	788.34	793.32	dry	NM
	April 12, 2021	782.30	786.34	783.66	783.65	784.13	784.08	782.79	784.08	783.97	783.15	783.49	788.03	793.45	below gauge	dry
	October 11-12, 14, 2021	781.03	786.33	782.94	782.85	783.09	783.03	781.94	783.11	783.04	782.15	782.66	788.59	795.13	dry	dry
	April 11-13, 2022	783.95	788.26	783.37	783.34	783.10	783.10	NM	782.99	783.40	783.93	783.83	788.4	794.65	dry	dry
	June 3, 2022	NM	NM	NM	NM	NM	NM	782.13	NM	NM	NM	NM	NM	NM	NM	NM
	October 25, 26, 28, 2022	780.41	783.85	780.76	780.66	779.57	779.55	779.23	778.98	778.61	780.33	781.49	NM	795.21	dry	dry
	Bottom of Well Elevation (ft)	771.33	780.55	774.82	733.43	776.98	753.04	771.89	776.98	776.36	754.18	773.94	--	--	--	--

Table 3. Groundwater Elevation - State Monitoring Program and CCR Well Network
Columbia Dry Ash and Ash Pond Disposal Facilities / SCS Engineers Project #25222067.00

	Raw Data	MW-301	MW-302	MW-303	MW-304	MW-305	M-4R	MW-33AR	MW-34A	MW-84A	MW-306	MW-307	MW-308	MW-309	MW-310	MW-311
CCR Rule Wells	**Measurement Date**															
	December 21-22, 2015	21.33	28.22	27.41	19.29	17.36	18.52	24.52	22.45	28.97	NI	NI	NI	NI	NI	NI
	April 4-5, 2016	20.11	27.19	26.04	17.34	16.71	17.01	23.00	20.32	27.91	NI	NI	NI	NI	NI	NI
	July 7-8, 2016	20.58	26.72	26.92	18.06	17.06	18.67	23.10	20.90	28.39	NI	NI	NI	NI	NI	NI
	July 28, 2016	NM	NM	27.17	NM	NM	NM	NM	21.09	28.67	NI	NI	NI	NI	NI	NI
	October 11-13, 2016	19.25	25.24	25.34	17.24	16.54	18.22	20.93	19.50	27.06	NI	NI	NI	NI	NI	NI
	December 29, 2016	19.52	25.95	NM	NM	NM	NM	22.63	20.23	27.65	NI	NI	NI	NI	NI	NI
	January 25-26, 2017	19.62	26.11	26.24	16.08	16.96	16.46	22.41	19.97	27.58	22.13	21.53	21.17	NI	NI	NI
	April 10 & 11, 2017	19.00	25.45	25.52	17.20	16.75	18.15	21.9	19.65	27.12	21.41	21.25	20.39	NI	NI	NI
	June 6, 2017	18.64	24.63	25.03	16.84	16.53	18.27	21.02	19.29	26.65	20.78	20.82	20.44	NI	NI	NI
	August 7-9, 2017	19.55	25.45	26.10	15.90	17.02	17.56	22.18	20.14	27.60	21.94	21.70	21.53	NI	NI	NI
	October 23-24, 2017	21.00	27.06	27.60	16.45	18.18	18.10	24.16	21.45	28.96	23.66	22.10	22.73	NI	NI	NI
	February 21, 2018	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	30.08	30.57	26.72
	March 23, 2018	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	30.17	30.52	26.74
	April 23-25, 2018	21.60	28.63	28.25	15.73	18.65	15.67	25.20	24.18	28.40	24.39	23.24	24.25	30.20	30.65	27.91
	May 24, 2018	NM	NM	NM	NM	NM	NM	NM	NM	NM	21.84	21.80	NM	27.82	27.65	23.63
	June 23, 2018	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	27.24	26.98	23.27
	July 23, 2018	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	27.00	27.27	23.19
	August 7, 2018	19.83	NM	26.32	17.17	17.76	18.47	NM	NM	27.73	NM	NM	NM	NM	NM	NM
	August 22, 2018	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	27.73	28.22	24.28
	September 21, 2018	NM	24.63	25.02	NM	NM	NM	20.39	18.94	NM	NM	NM	NM	26.19	26.38	22.08
	October 22-24, 2018	17.91	23.84	24.01	16.37	16.28	17.63	19.52	18.07	25.96	19.97	20.32	19.09	25.28	25.44	21.10
	April 1-4, 2019	19.85	25.44	25.00	15.70	16.25	16.66	21.66	19.13	26.93	20.91	20.18	19.37	26.97	27.24	23.36
	June 12, 2019	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	26.37	NM
	June 19, 2019	NM	NM	24.71	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
	October 7-9, 2019	18.42	24.69	24.50	15.01	15.96	15.45	NM	NM	NM	20.16	19.90	19.72	26.01	25.68	22.10
	December 13, 2019	NM	NM	NM	NM	NM	NM	NM	NM	NM	20.60	21.21	20.47	NM	NM	NM
	December 23, 2019	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	38.40	NM
	January 17, 2020	NM	NM	25.94	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
	February 3, 2020	19.65	NM	--	NM	NM	NM	NM	NM	27.78	21.86	21.32	20.42	NM	NM	NM
	May 27-29, 2020	19.12	25.71	25.96	16.12	18.54	18.37	22.28	19.97	27.26	21.86	21.54	20.62	27.29	27.81	23.89
	June 30, 2020	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	27.09	NM	NM
	August 6, 2020	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	27.34	NM	NM
	October 7-8, 2020	20.36	26.26	26.36	16.90	18.36	18.36	22.38	20.25	28.18	22.24	22.18	21.22	27.80	28.06	23.91
	December 11, 2020	NM	NM	NM	NM	18.13	NM	NM	NM	NM	NM	NM	NM	28.01	28.36	NM
	February 25, 2021	NM	NM	27.25	NM	17.96	NM	NM	21.20	NM	NM	NM	NM	NM	NM	NM
	April 12, 2021	20.39	27.23	27.45	17.43	18.21	19.76	24.02	21.18	28.44	23.31	22.68	21.35	28.98	29.38	25.59
	June 11, 2021	NM	NM	NM	NM	NM	NM	24.10	21.29	NM	NM	NM	NM	29.07	29.57	NM
	July 20, 2021	NM	NM	27.88	NM	17.93	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
	October 11-12, 14, 2021	21.61	27.91	28.43	17.64	18.57	19.77	24.56	21.53	29.32	24.70	24.45	23.14	29.62	30.14	26.26
	December 21, 2021	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	30.34	NM	NM
	February 24, 2022	NM	NM	29.18	NM	19.83	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
	April 11-13, 2022	21.45	28.58	28.12	17.22	18.45	17.84	25.02	21.65	29.26	24.52	23.57	22.71	30.13	30.43	26.70
	July 27, 2022	NM	NM	28.45	NM	19.29	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
	October 25-27, 2022	21.98	28.38	36.78	23.63	21.35	22.25	26.35	22.34	29.71	29.31	29.00	22.74	31.77	32.66	28.51
	November 30, 2022	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	31.65	32.48	28.59
	December 2, 2022	21.77	28.52	NM	21.45	NM	NM	26.38	22.24	29.52	29.11	27.35	NM	NM	NM	NM

Table 3. Groundwater Elevation - State Monitoring Program and CCR Well Network
Columbia Dry Ash and Ash Pond Disposal Facilities / SCS Engineers Project #25222067.00

	Well Number	MW-301	MW-302	MW-303	MW-304	MW-305	M-4R	MW-33AR	MW-34A	MW-84A	MW-306	MW-307	MW-308	MW-309	MW-310	MW-311
	Top of Casing Elevation (feet amsl)	806.89	813.00	815.72	805.42	806.32	806.10	808.29	805.95	814.28	807.63	806.89	806.9	813.27	813.62	809.74
	Screen Length (ft)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
	Total Depth (ft from top of casing)	29.40	33.6	35.80	25.7	25.6	39.58	31.08	35.43	40.21	27	26.5	28	37.67	38.41	36.19
	Top of Well Screen Elevation (ft)	787.49	789.40	785.72	789.72	790.72	776.52	787.21	780.52	784.07	790.63	790.39	788.90	785.60	785.21	783.55
	Measurement Date															
	December 21-22, 2015	785.56	784.78	784.11	786.13	788.96	787.58	783.77	783.50	785.31	NI	NI	NI	NI	NI	NI
	April 4-5, 2016	786.78	785.81	785.48	788.08	789.61	789.09	785.29	785.63	786.37	--	--	--	--	--	--
	July 7-8, 2016	786.31	786.28	784.60	787.36	789.26	787.43	785.19	785.05	785.89	--	--	--	--	--	--
	July 28, 2016	NM	NM	784.35	NM	NM	NM	NM	784.86	785.61	--	--	--	--	--	--
	October 11-13, 2016	787.64	787.76	786.18	788.18	789.78	787.88	787.36	786.45	787.22	--	--	--	--	--	--
	December 29, 2016	787.37	787.05	NM	NM	NM	NM	785.66	785.72	786.63	--	--	--	--	--	--
	January 25-26, 2017	787.27	786.89	785.28	789.34	789.36	789.64	785.88	785.98	786.70	785.50	785.36	785.73	--	--	--
	April 10 & 11, 2017	787.89	787.55	786.00	788.22	789.57	787.95	786.39	786.30	787.16	786.22	785.64	786.51	--	--	--
	June 6, 2017	788.25	788.37	786.49	788.58	789.79	787.83	787.27	786.66	787.63	786.85	786.07	786.46	--	--	--
	August 7-9, 2017	787.34	787.55	785.42	789.52	789.30	788.54	786.11	785.81	786.68	785.69	785.19	785.37	--	--	--
	October 23-24, 2017	785.89	785.94	783.92	788.97	788.14	788.00	784.13	784.50	785.32	783.97	784.79	784.17	--	--	--
	February 21, 2018	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	783.19	783.05	783.02
	March 23, 2018	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	783.10	783.10	783.00
	April 23-25, 2018	785.29	784.37	783.27	789.69	787.67	790.43	783.09	781.77	785.88	783.24	783.65	782.65	783.07	782.97	781.83
	May 24, 2018	NM	NM	NM	NM	NM	NM	NM	NM	NM	785.79	785.09	NM	785.45	785.97	786.11
	June 23, 2018	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	786.03	786.64	786.47
	July 23, 2018	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	786.27	786.35	786.55
	August 7, 2018	787.06	NM	785.20	788.25	788.56	787.63	NM	NM	786.55	NM	NM	NM	NM	NM	NM
	August 22, 2018	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	785.54	785.40	785.46
	September 21, 2018	NM	788.37	786.50	NM	NM	NM	787.90	787.01	NM	NM	NM	NM	787.08	787.24	787.66
CCR Rule Wells	October 22-24, 2018	788.98	789.16	787.51	789.05	790.04	788.47	788.77	787.88	788.32	787.66	786.57	787.81	787.99	788.18	788.64
	April 1-4, 2019	787.04	787.56	786.52	789.72	790.07	789.44	786.63	786.82	787.35	786.72	786.71	787.53	786.30	786.38	786.38
	June 12, 2019	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	787.25	NM
	June 19, 2019	NM	NM	786.81	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
	October 7-9, 2019	788.47	788.31	787.02	790.41	790.36	790.65	NM	NM	NM	787.47	786.99	787.18	787.26	787.94	787.64
	December 13, 2019	--	--	--	--	--	--	--	--	--	787.03	785.68	786.43	--	--	--
	December 23, 2019	--	--	--	--	--	--	--	--	--	--	--	--	--	775.22	--
	January 17, 2020	--	--	785.58	--	--	--	--	--	--	--	--	--	--	--	--
	February 3, 2020	787.24	NM	NM	NM	NM	NM	NM	NM	786.50	785.77	785.57	786.48	NM	NM	NM
	May 27-29, 2020	787.77	787.29	785.56	789.30	787.78	787.73	786.01	785.98	787.02	785.77	785.35	786.28	785.98	785.81	785.85
	June 30, 2020	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	786.18	NM	NM
	August 6, 2020	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	785.93	NM	NM
	October 7-8, 2020	786.53	786.74	785.16	788.52	787.96	787.74	785.91	785.70	786.10	785.39	784.71	785.68	785.47	785.56	785.83
	December 11, 2020	NM	NM	NM	NM	788.19	NM	NM	NM	NM	NM	NM	NM	785.26	785.26	NM
	February 25, 2021	NM	NM	784.27	NM	788.36	NM	NM	784.75	NM	NM	NM	NM	NM	NM	NM
	April 12, 2021	786.50	785.77	784.07	787.99	788.11	786.34	784.27	784.77	785.84	784.32	784.21	785.55	784.29	784.24	784.15
	June 11, 2021	NM	NM	NM	NM	NM	NM	784.19	784.66	NM	NM	NM	NM	784.20	784.05	NM
	July 20, 2021	NM	NM	783.64	NM	788.39	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
	October 11-12, 14, 2021	785.28	785.09	783.09	787.78	787.75	786.33	783.73	784.42	784.96	782.93	782.44	783.76	783.65	783.48	783.48
	December 21, 2021	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	782.93	NM	NM
	February 24, 2022	NM	NM	782.34	NM	786.49	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
	April 11-13, 2022	785.44	784.42	783.40	788.20	787.87	788.26	783.27	784.30	785.02	783.11	783.32	784.19	783.14	783.19	783.04
	July 27, 2022	NM	NM	783.07	NM	787.03	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
	October 25-27, 2022	784.91	784.62	778.94	781.79	784.97	783.85	781.94	783.61	784.57	778.32	777.89	784.16	781.50	780.96	781.23
	November 30, 2022	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	781.62	781.14	781.15
	December 2, 2022	785.12	784.48	NM	783.97	NM	NM	781.91	783.71	784.76	778.52	779.54	NM	NM	NM	NM
	Bottom of Well Elevation (ft)	777.49	779.40	775.72	779.72	780.72	766.52	777.21	770.52	774.07	780.63	780.39	778.90	775.60	775.21	773.55

Notes:
NM = not measured

Created by: MDB Date: 5/6/2013
Last revision by: JR Date: 12/13/2022
Checked by: RM Date: 12/23/2022

(1) The elevation for SG-1 is read off of the staff gauge (rather than measured from the top of the gauge).
(2) SG-2 could not be located during the April 2013 event.
(3) SG-3 could not be located during the October 2013 event. SG-1 could not be safely accessed during the October 2013 event.
(4) LH-2 measurements are given as leachate depth, measured by a transducer.
(5) LH-2 and LH-3 measurements were collected by WPL staff on October 9, 2017.
(6) The depth to water at MW-84A was not measured prior to purging for sampling during the October 3-5 sampling event. The level was allowed to return to static and was measured on 10/10/2017.
(7) BC = Brian Clepper; NS= Nate Sievers - Columbia Site employees.
(8) MW-303 was extended in 2022 due to regrading. Prior to October 2022, the TOC elevation was 811.52'. For events in October 2022 and later, the TOC elevation is 815.72'.

I:\25222260.00\Deliverables\Plan Modification\Appendices\B_Design Demonstration\[B7_wlstat_Columbia_2012-Dec 2022.xls]levels

Appendix B7

Final Cover Calculations

Appendix B7.1

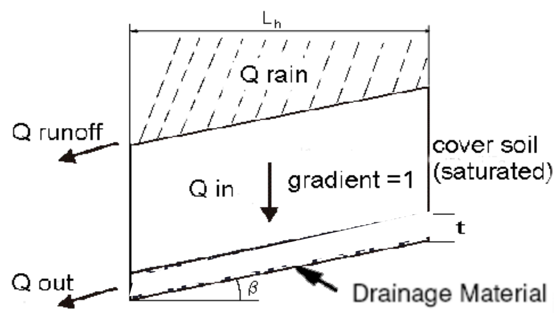
Cover Unit Gradient for Existing Final Cover

Purpose: To determine the maximum length of slope that the final cover drainage layer (sand) can carry infiltrating water and remain stable.

Approach: Use the unit gradient method to determine the maximum slope length.

References:

1. Landfilldesign.com
2. "GRI-GC8, Determination of the Allowable Flow Rate of a Drainage Geocomposite". Geosynthetics Research Institute, 2001
3. "Beyond a factor-of-safety value, i.e., the proabability of failure". GRI Newsletter/Report, Vol. 15, no. 3
4. "Designing with Geosynthetics". R.M. Koerner, Prentice Hall Publishing Co., Englewood Cliffs, NJ, 1998
5. "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers". J. P. Giroud, J. G. Zornberg and A. Zhao, Geosynthetics International, Vol. 7, Nos 4-5
6. "Lateral Drainage Design update - part 2". G. N. Richardson, J. P. Giroud and A. Zhao, Geotechnical Fabrics Report, March 2002
7. HELP Model "User's Guide", Table 4: Default Soil, Waste, and Geosynthetic Characteristics
8. SCS Engineers, Plan Modification Request/Plan of Operation Update, Dry Ash Disposal Facility, COL Energy Center, Final Grades Plan Sheet, May 2022



With Darcy's Law:

$$Q = k \; X \; i \; X \; A$$

Inflow of water in the Drainage Material

$$Q_{in} = k_{veg} \; X \; i \; X \; A = k_{veg} \; X \; 1 \; X \; L_h \; X \; 1$$

Outflow of water from the geocomposite at the toe of the slope

$$Q_{out} = k_{drain} \; X \; i \; X \; A = k_{drain} \; X \; t \; X \; \sin\beta$$

This results in a required k_{drain} of:

$$k_{drain} = \frac{k_{veg} \; X \; L_h}{t \; X \; \sin\beta} \; X \; FS$$

Assumptions: 1. Soil hydraulic gradient *i* = 1.0.

2. Top soil will be clay. Soil permeability is 4.2×10^{-5} cm/sec for a CL clay from HELP model user's guide.
3. Drainage Layer hydraulic gradient = sinβ where β=14° (4:1 horizontal/vertical final cover slope).
4. Maximum horizontal final cover slope length from crest to toe drain is 368 feet as shown in Module 1 on the final grades plan sheet.
5. The minimum hydraulic conductivity ($k_{drain,ave}$) is 1.0×10^{-2} cm/s for the sand.
6. Cover drainage layer thickness t = 1 foot.

Calculation: Constants

L_h	=	Drainage pipe spacing or length of slope measured horizontally	=	See Below	
k_{veg}	=	Permeability of the vegetative supporting soil	=	0.000042	cm/sec
S	=	The liner's slope, **S** = tan **b**	=	25%	b = 14°
FS_{slope}	=	Minimum factor of safety against sliding, for drainage layer/geomembrane interface	=	1.5	
$\delta_{req'd}$	=	Minimum interface friction angle = $\tan^{-1}(FS*\tan(b))$	=	20.6	degrees

Determine the maximum slope length for the given minimum required drainage layer permeability

L_h (feet)	L_h (meter)	$k_{drain, req}$ (cm/s)	
30	9.1	7.69E-03	Design

Conclusions: The design has an intermediate pipe every 30 feet spaced evenly up the slope. The intermediate pipe spacing design with the sand material has a factor of safety of 1.95.

Appendix B7.2

Cover Unit Gradient for Alternative Final Cover

Purpose: To determine the geocomposite drainage requirements in the final cover where flow converges in the north and south corners of Modules 10 and 11so the final cover drainage geocomposite can carry infiltrating water and remain stable. Also to determine the recommended minimum interface friction angle for final cover stability.

Approach: Use the unit gradient method and flow path geometry to determine the geocomposite transmissivity required at locations within the converging flow area.

References:

1. Landfilldesign.com - Lateral Drainage System - Single Slope, Unit Gradient Method

2. "GRI-GC8, Determination of the Allowable Flow Rate of a Drainage Geocomposite". Geosynthetics Research Institute, 2001.

3. "Beyond a factor-of-safety value, i.e., the proabability of failure". GRI Newsletter/Report, Vol. 15, no. 3.

4. "Designing with Geosynthetics". R.M. Koerner, Prentice Hall Publishing Co., Englewood Cliffs, NJ, 1998.

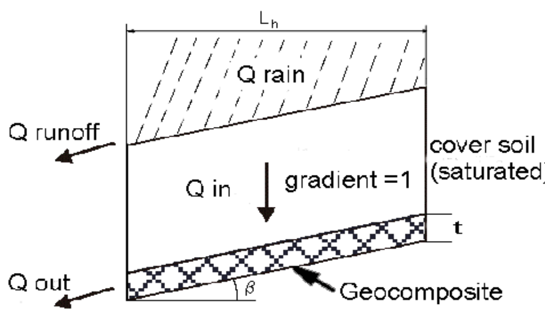
5. "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers". J. P. Giroud, J. G. Zornberg and A. Zhao, Geosynthetics International, Vol. 7, Nos 4-5.

6. "Lateral Drainage Design update - part 2". G. N. Richardson, J. P. Giroud and A. Zhao, Geotechnical Fabrics Report, March 2002.

7. Giroud, Zornberg, and Zhao, 2000, "Hydraulic Design of Liquid Collection Layers", Geosynthetics International

8. SCS Engineers, Plan Modification Request/Plan of Operation Update, Dry Ash Disposal Facility, COL Energy Center, Final Grades Plan Sheet, April 2022

9. HELP Model "User's Guide" in conjunction with GRI report #19, pages 34-37 (Leachate Collection System)



With Darcy's law:

$$Q = k * i * A$$

Inflow of water in the geocomposite

$$Q_{in} = k_{veg} * i * A = k_{veg} * 1 * L_h * 1$$

Outflow of water from the geocomposite at the toe of the slope

$$Q_{out} = k_{comp} * i * A = k_{comp} * i * t * 1 = \theta_{required} * \sin\ \beta$$

= θ*i*1 where θ = k_{comp} * t (minimum allowable outflow to keep head within geocomposite)

Inflow equals outflow (Factor of Safety = 1)

$$Q_{in} = Q_{out}$$

This results in a required transmissivity of the geocomposite of:

$$\theta_{required} = \frac{k_{veg} * L_h}{\sin\ \beta}$$

Which results in the ultimate transmissivity after multiplying by the Total Serviceability Factor (TSF)

$$\theta_{ultimate} = \theta_{required} * FS_d * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

Assumptions: 1. Soil hydraulic gradient *i* = 1.0.

2. Top soil will be clay. Soil permeability is 4.2×10^{-5} cm/sec for a CL clay from HELP model user's guide.

3. Geocomposite hydraulic gradient = sinβ where β=14° (4:1 horizontal/vertical final cover slope).

4. Factor of safety and transmissivity reduction factors are from recommended values in GRI report #19 (Leachate collection system example) and HELP model "Users Guide"

5. Flow paths A-E and F-J are as shown on attached drawing. Assume circular arc with radius measured from the corner of the toe drain.

6. Intermediate drainage piping will be used at 3 locations along the slope in each area to divert flow from the drainage layer to the diversion berms and downslope flume.

Calculation: Constants

L_h	=	Drainage pipe spacing or length of slope measured horizontally	=	See Below	
k_{veg}	=	Permeability of the vegetative supporting soil	=	0.000042	cm/sec
S	=	The liner's slope, **S** = tan **b**	=	25%	b = 14°
FS_{slope}	=	Minimum factor of safety against sliding, for soil/geocomposite or geocomposite/geomembrane interfaces	=	1.5	
$\delta_{req'd}$	=	Minimum interface friction angle = $\tan^{-1}$(FS*tan(b))	=	20.6	degrees
FS_d	=	Overall factor of safety for drainage	=	2.0	
RF_{in}	=	Intrusion Reduction Factor	=	1.1	
RF_{cr}	=	Creep Reduction Factor	=	1.2	
RF_{cc}	=	Chemical Clogging Reduction Factor	=	1.1	
RF_{bc}	=	Biological Clogging Reduction Factor	=	1.4	
w	=	Geocomposite width at drainage outlet			
A	=	Final cover plan area upslope of geocomposite drainage outlet			

Determine the maximum slope length for a given ultimate transmissivity

Min. Θ_{req} = A X k_{veg} / (w X sinβ)

For the outlet at the corner, use minimum 5 foot width and 2 foot width of geocomposite to connect the toe drain to drain the converging flow area:

Area	A (sq. feet)	w (feet)	w (meter)	Min. Θ_{ult} (m^2/sec)	Proposed Θ_{ult} (m^2/sec)
1	420	5	1.52	1.81E-04	1.00E-03
4	70	2	0.61	7.53E-05	1.00E-03

The toe drainage areas, Area 1 and Area 4, include only converging flow below the lowest intermediate drainage piping, as flow above this area is diverted. There are intermediate drainage pipes in Areas 1 and 4 which divert flow from the outlet corner to the downslope flume.

For converging flow in a circular arc, from radius R-top to radius R-bottom:

L = R-top - R-bottom

w-bot = w-top * (R-bot/R-top)

A = L* (1+ (R-bot/R-top))/2 (assuming unit width at top and trapezoid vs arc to simplify)

Θult-bot = (Θult calculated for L) * R-top/R-bot * (1+ (R-bot/R-top))/2

Calculation: (Cont.) For the southern convergence area, flow paths A-E, calculate Θult for selected R-bot values to determine appropriate geocomposite products as flow converges down the slope:

Flow Path	R-top (feet)	R-bot (feet)	L_h (feet)	L_h (meters)	Θ_{ult} (m^2/sec)	Proposed Θ_{ult} (m^2/sec)
Area 1						
A1	138	26	112	34	7.57E-04	1.00E-03
B1	132	24	108	32	7.34E-04	1.00E-03
C1	129	23	106	32	7.47E-04	1.00E-03
D1	126	21	105	32	7.91E-04	1.00E-03
E1	122	20	102	31	7.77E-04	1.00E-03
Area 2						
A2	306	138	168	51	5.79E-04	1.00E-03
B2	294	132	162	49	5.58E-04	1.00E-03
C2	286	129	157	47	5.34E-04	1.00E-03
D2	278	126	152	46	5.21E-04	1.00E-03
E2	270	122	148	45	5.11E-04	1.00E-03
Area 3						
A3	328	306	22	6	4.39E-05	1.00E-03
B3	357	294	63	19	1.49E-04	1.00E-03
C3	419	286	133	40	3.48E-04	1.00E-03
D3	319	278	41	12	9.10E-05	1.00E-03
E3	285	270	15	4	2.91E-05	1.00E-03

Conclusions: For the southern area proposed design with intermediate slope outlets and a toe-of-slope drainage outlet, placement of geocomposite with the required transmissivities to the minimum lengths/areas shown in the table above and on the attached drawing will provide adequate drainage for the converging flow.

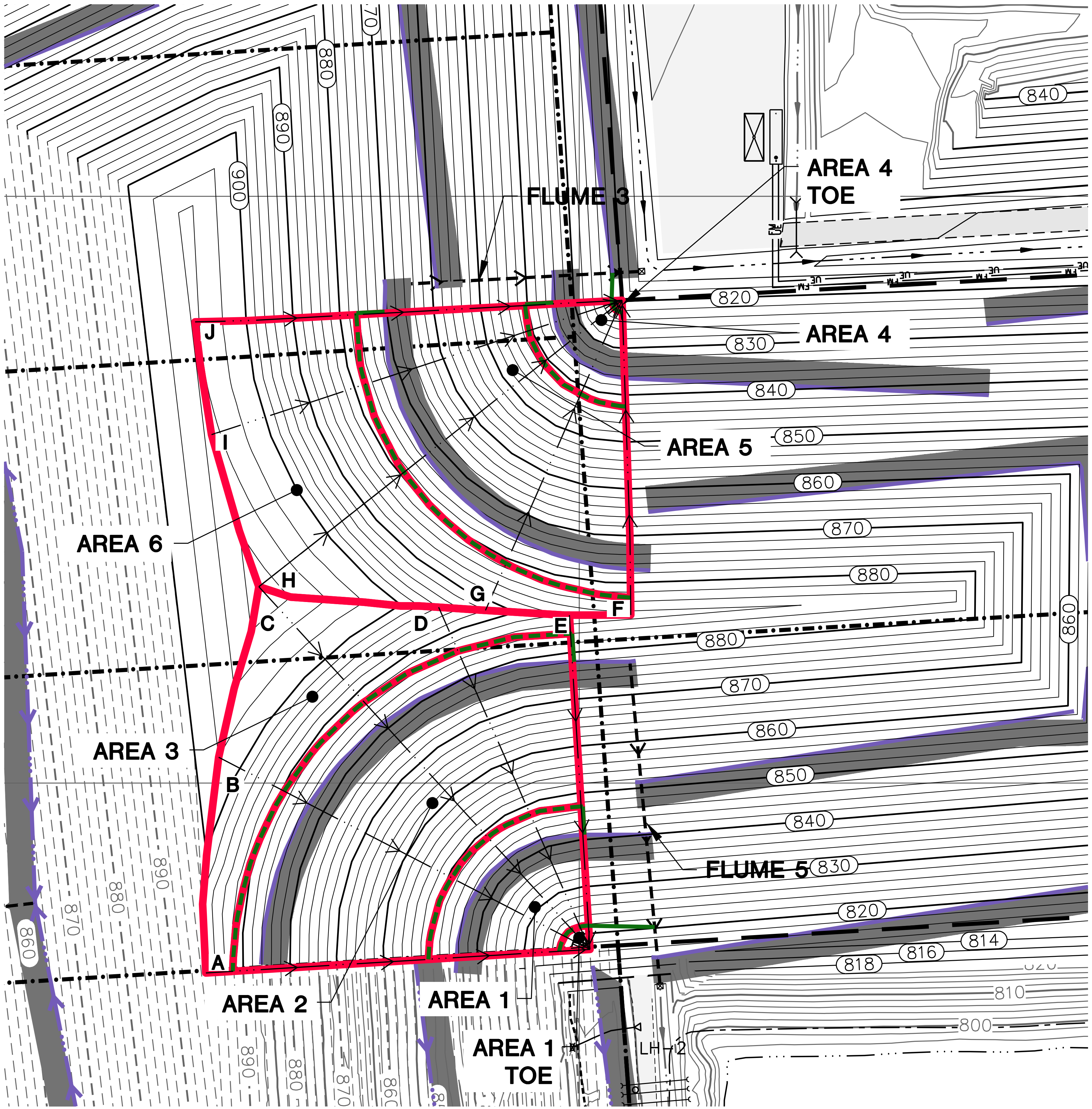
A minimum interface friction angle of 20.6 degrees for the geocomposite, geomembrane, and GCL interfaces is required to achieve a minimum recommended final cover slope stability safety factor of 1.5.

Calculation: (Cont.) For the northern convergence area, flow paths F-J, calculate Θult for selected R-bot values to determine appropriate geocomposite products as flow converges down the slope:

Flow Path	R-top (feet)	R-bot (feet)	L_h (feet)	L_h (meters)	Θ_{ult} (m^2/sec)	Proposed Θ_{ult} (m^2/sec)
Area 4						
F4	91	11	80	24	7.86E-04	1.00E-03
G4	87	10	77	23	7.88E-04	1.00E-03
H4	86	9	77	23	8.57E-04	1.00E-03
I4	84	9	75	22	8.03E-04	1.00E-03
J4	83	9	74	22	7.94E-04	1.00E-03
Area 5						
F5	254	91	163	49	6.56E-04	1.00E-03
G5	245	87	158	48	6.47E-04	1.00E-03
H5	237	86	151	46	6.10E-04	1.00E-03
I5	231	84	147	44	5.83E-04	1.00E-03
J5	227	83	144	43	5.67E-04	1.00E-03
Area 6						
F6	268	254	14	4	2.90E-05	1.00E-03
G6	289	245	44	13	1.00E-04	1.00E-03
H6	395	237	158	48	4.52E-04	1.00E-03
I6	368	231	137	41	3.75E-04	1.00E-03
J6	365	227	138	42	3.87E-04	1.00E-03

Conclusions: For the northern area proposed design with intermediate slope outlets and a toe-of-slope drainage outlet, placement of geocomposite with the required transmissivities to the minimum lengths/areas shown in the table above and on the attached drawing will provide adequate drainage for the converging flow.

A minimum interface friction angle of 20.6 degrees for the geocomposite, geomembrane, and GCL interfaces is required to achieve a minimum recommended final cover slope stability safety factor of 1.5.



LEGEND

- LIMITS OF WASTE
- LINER PHASE/MODULE LIMIT
- EXISTING GRADE (10' INTERVAL) — 810
- EXISTING GRADE (2' INTERVAL)
- SWALE
- EDGE OF WATER
- WETLAND
- PROPOSED PHASE 1 FINAL GRADE (10' INTERVAL) — 840
- PROPOSED PHASE 1 FINAL GRADE (2' INTERVAL)
- PROPOSED GRADE (10' INTERVAL) — 840
- PROPOSED GRADE (2' INTERVAL)
- PROPOSED PERIMETER ROAD
- PROPOSED SWALE
- PROPOSED CULVERT
- PROPOSED LEACHATE COLLECTION SYSTEM CLEANOUT
- PROPOSED LEACHATE VAULT
- PROPOSED LEACHATE FORCEMAIN — FM
- PROPOSED UNDERGROUND ELECTRIC — UE
- PROPOSED DIVERSION BERM
- PROPOSED DOWNSLOPE FLUME
- PROPOSED ENERGY DISSIPATOR
- PROPOSED RIPRAP
- CONVERGENCE FLOW PATH
- PERFORATED SUBSURFACE PIPING
- SOLID SUBSURFACE PIPING

N

10 0 10

SCALE: 1" = 10'

GEOTECHNICAL CALCULATION – FLOW CONVERGENCE

FIGURE 1

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

ENGINEER

PLAN OF OPERATION
2022 UPDATE
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

SITE

DRAWN BY: KP/MJT
CHECKED BY: DN
APPROVED BY:

WISCONSIN POWER AND LIGHT
COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

CLIENT

PROJECT NO. 25220183.00
DRAWN: 01/25/2022
REVISED: 05/02/2022

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Appendix B7.3

Geocomposite Drainage Layer

Purpose: To determine the maximum length of slope that the final cover drainage geocomposite can carry infiltrating water and remain stable. Also determine the recommended minimum friction angle for final cover side slope stability. Note: This calculation does not include the flow convergence areas where a separate calculation is required.

Approach: Use the unit gradient method to determine the maximum slope length.

References:

1. Landfilldesign.com - Lateral Drainage System - Single Slope, Unit Gradient Method

2. "GRI-GC8, Determination of the Allowable Flow Rate of a Drainage Geocomposite". Geosynthetics Research Institute, 2001.

3. "Beyond a factor-of-safety value, i.e., the proabability of failure". GRI Newsletter/Report, Vol. 15, no. 3.

4. "Designing with Geosynthetics". R.M. Koerner, Prentice Hall Publishing Co., Englewood Cliffs, NJ, 1998.

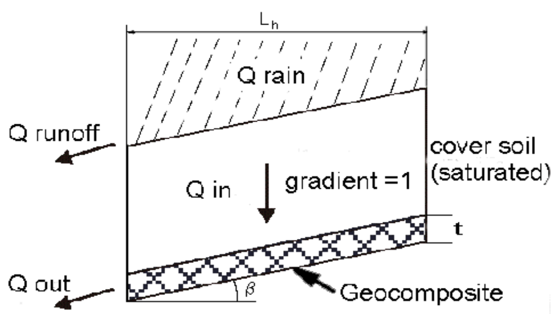
5. "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers". J. P. Giroud, J. G. Zornberg and A. Zhao, Geosynthetics International, Vol. 7, Nos 4-5.

6. "Lateral Drainage Design update - part 2". G. N. Richardson, J. P. Giroud and A. Zhao, Geotechnical Fabrics Report, March 2002.

7. Giroud, Zornberg, and Zhao, 2000, "Hydraulic Design of Liquid Collection Layers", Geosynthetics International

8. SCS Engineers, Plan Modification Request/Plan of Operation Update, Dry Ash Disposal Facility, COL Energy Center, Final Grades Plan Sheet, May 2022

9. HELP Model "User's Guide" in conjunction with GRI report #19, pages 34-37 (Leachate Collection System)



With Darcy's law:

$$Q = k * i * A$$

Inflow of water in the geocomposite

$$Q_{in} = k_{veg} * i * A = k_{veg} * 1 * L_h * 1$$

Outflow of water from the geocomposite at the toe of the slope

$$Q_{out} = k_{comp} * i * A = k_{comp} * i * t * 1 = \theta_{required} * \sin \beta \quad = \theta * j * 1 \text{ where } \theta = k_{comp} * t$$

Inflow equals outflow (Factor of Safety = 1)

$$Q_{in} = Q_{out}$$

This results in a required transmissivity of the geocomposite of:

$$\theta_{required} = \frac{k_{veg} * L_h}{\sin \beta}$$

Which results in the ultimate transmissivity after multiplying by the Total Serviceability Factor (TSF)

$$\theta_{ultimate} = \theta_{required} * FS_d * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

Assumptions: 1. Soil hydraulic gradient *i* = 1.0.

2. Top soil will be clay. Soil permeability is 4.2 x 10 $^{-5}$ cm/sec for a CL clay from HELP model user's guide.
3. Geocomposite hydraulic gradient = sinβ where β=14° (4:1 horizontal/vertical final cover slope).
4. Factor of safety and transmissivity reduction factors are from recommended values in GRI report #19 (Leachate collection system example) and HELP model "Users Guide"
5. Maximum horizontal final cover slope length from crest to toe drain is 397 feet as shown on Module 10 and 11 Final Grades plan sheet. This includes 58' of 10:1 slope length at the peak.

Calculation: Constants

L_h	=	Drainage pipe spacing or length of slope measured horizontally	=	See Below	
k_{veg}	=	Permeability of the vegetative supporting soil	=	0.000042	cm/sec
S	=	The liner's slope, **S** = tan **b**	=	25%	b = 14°
FS_{slope}	=	Minimum factor of safety against sliding, for soil/geocomposite or geocomposite/geomembrane interfaces	=	1.5	
$\delta_{req'd}$	=	Minimum interface friction angle = $\tan^{-1}$(FS*tan(b))	=	20.6	degrees
FS_d	=	Overall factor of safety for drainage	=	2.0	
RF_{in}	=	Intrusion Reduction Factor	=	1.1	
RF_{cr}	=	Creep Reduction Factor	=	1.2	
RF_{cc}	=	Chemical Clogging Reduction Factor	=	1.1	
RF_{bc}	=	Biological Clogging Reduction Factor	=	1.4	

Determine the maximum slope length for a given ultimate transmissivity

Θ_{ult} (m^2/sec)	L_h (meter)	L_h (feet)
1.00E-03	141.7	465

Determine the ultimate transmissivity based on a given slope length

L_h (feet)	L_h (meter)	Θ_{ult} (m^2/sec)	
397	121.0	8.55E-04	~ Total slope length
199	60.5	4.27E-04	~ 1/2 of total slope length
132	40.3	2.85E-04	~ 1/3 of total slope length

Conclusions: If no intermediate drainage outlets were constructed on the final cover, a minimum transmissivity of 8.55 x 10 $^{-4}$ m^2/sec would need to be obtained.

A minimum interface friction angle of 20.6 degrees between cover soil and geocomposite is required to achieve a minimum recommended final cover slope stability safety factor of 1.5.

Appendix B7.4

GCL Cover Strength

SCS ENGINEERS

		Sheet No.	1 of 1
		Calc. No.	
		Rev. No.	
Job No. 25220183.00	Job: Columbia Dry Ash Disposal Facility	By: MJT	Date: 04/25/22
Client: WPL	Subject: GCL Internal Shear on Final Cover	Chk'd: DLN	Date: 04/26/22

Purpose: Determine the maximum shear stress acting on a Geosynthetic Clay Liner (GCL) and the GCL internal shear strength required to provide a minimum slope stability safety factor (FS) of 1.5 for the final cover.

Approach: Use maximum shear stress formula and assumed values.

References: Design of GCL Barrier for Final Cover Side Slope Applications, Gregory N. Richardson, Ph.D., P.E., Geosynthetics '97-541

Calculation: The maximum shear stress acting on the GCL can be calculated as follows:

$$\tau_{act} = W_T \sin \beta$$

$$\beta = 14^\circ$$

$$W_T = \gamma \times h$$

Where: γ = Soil Unit Weight = 120 pcf

h = Cover Thickness = 2.5 ft

$$W_T = 300 \text{ psf}$$

$$\tau_{act} = 72.6 \text{ psf}$$

$$FS = \frac{\tau_{resist}}{\tau_{act}} = 1.5$$

$$\tau_{resist} = FS \times \tau_{act} = 1.5 \times 72.6 = 109 \text{ psf}$$

Assumptions: Slope angle, $\beta = 14^\circ$ (4:1 horizontal / vertical final cover slope)

Soil unit weight, $\gamma = 120$ pcf

Conclusion: For a total weight of the final cover system of 300 psf and a slope angle of 4:1, the maximum shear stress will be 72.6 psf. A minimum GCL internal shear strength of 109 psf is required to provide a slope stability safety factor of 1.5.

Appendix C

Operational Plans

Appendix C1

Fugitive Dust Control Plan

Wisconsin Power and Light Company

Columbia Energy Center (COL)

Coal Combustion Residuals (CCR) Fugitive Dust Control Plan

February 1, 2023

The procedures in this plan apply to the following CCR units at this facility:

CCR Surface Impoundments

COL Primary Ash Pond

COL Secondary Ash Pond

CCR Landfill

COL Dry Ash Disposal Facility Module 1

COL Dry Ash Disposal Facility Module 2

COL Dry Ash Disposal Facility Module 3

COL Dry Ash Disposal Facility Module 4

COL Dry Ash Disposal Facility Module 5

COL Dry Ash Disposal Facility Module 6

COL Dry Ash Disposal Facility Module 10

COL Dry Ash Disposal Facility Module 11

Coal Combustion Residuals (CCR) Fugitive Dust Control Plan for CCR Landfills
February 1, 2023

Purpose of CCR Fugitive Dust Control Plan

This plan describes the measures used to minimize fugitive CCR dust from facilities with CCR landfills[1], the procedure for logging citizen complaints involving CCR fugitive dust events, and the procedure for periodic review of this plan. This plan has been developed in accordance with 40 CFR 257.80(b) and NR 514.07(10)(a).

Measures for Controlling Fugitive Dust

The following measures are appropriate for minimizing CCR from becoming airborne at this facility:

- Establishing and enforcing a vehicle speed limit of 10 mph or less. Reduced speeds minimize fugitive dust generated from vehicle traffic.
- Covering all open-bodied vehicles that are transporting CCR to minimize the generation of fugitive dust during transport of CCR.
- Minimizing fall distances when handling or transferring CCR. The facility uses best practices when handling CCR with end loaders, and other best management practices, to minimize the generation of fugitive dust.
- Promptly collecting CCR that is observed in vehicle loading/unloading areas to minimize the potential for CCR to become airborne.
- Applying water directly to CCR using a water truck or irrigation system. Moistened CCR is less likely to become airborne.
- Suspending CCR management activities, including placement of CCR, during excessively windy conditions to minimize CCR from becoming airborne.
- Placement of soil and/or vegetated cover to minimize exposure of CCR in inactive landfill areas to conditions that could lead to fugitive dust.

These measures are applicable to the CCR managed at this facility and appropriate for the conditions at this site because they are compatible with current operations and they effectively minimize the generation of fugitive dust.

Procedure for Conditioning CCR Prior to Placement

CCR is routinely conditioned with water prior to placement to prevent wind dispersal. Conditioning of scrubber by-products occurs through the use of a pug mill within an enclosed building. Conditioning may also occur by wetting with a water truck as material is placed in the CCR landfill. Conditioning will not result in free liquids.

[1] "CCR" and "CCR landfill" are defined at 40 CFR 257.53 and NR 500.03.

Procedure for Logging Citizen Complaints

Citizen complaints pertaining to fugitive dust will be managed in accordance with Alliant Corporate Policy ENV-107. Specifically, the complaint must be reported to Environmental Services (1) via phone call and (2) in writing by submitting a completed Environmental Incident Report to Environmental Services within 10 business days. Citizen complaints will be tracked within the Alliant Environmental Management Information System ("ENVIANCE").

Visual Inspections

In accordance with NR 514.07(10)(a)(3), the owner/operator will perform visual inspections of the landfill surface at least every 7 days. If fugitive dust concerns are observed during the inspection, action will be taken to remedy the situation. Visual fugitive dust inspections will not be performed if the CCR disposal area is covered by intermediate or final cover and there is no potential for CCR to become airborne.

Procedure for Periodic Review of CCR Fugitive Dust Control Plan

The CCR Fugitive Dust Control Plan will be reviewed annually, and updated as necessary, in conjunction with preparation of the Annual CCR Fugitive Dust Control Report [40 CFR 257.80(c) and NR 514.07(10)(a)(5)]. The Annual CCR Fugitive Dust Control Report will be included in the annual report in accordance with NR 506.20(3)(a) and include a description of the actions taken by the owner or operator to control CCR fugitive dust, a record of all citizen complaints, and a summary of any corrective measures taken.

During the periodic review, staff will evaluate each measure for controlling fugitive dust to ensure that it is still appropriate for minimizing CCR from becoming airborne at the facility, will verify that the procedures for conditioning CCR prior to landfilling and the procedure for logging complaints are sufficient, and will evaluate other operations changes at the facility to determine whether additional dust control measures should be added.

In accordance with NR 514.07(10)(a)(4), the CCR Fugitive Dust Control Plan will be modified in accordance with NR 514.04(6) whenever there is a change in conditions that may substantially affect the plan of operation.

- END -

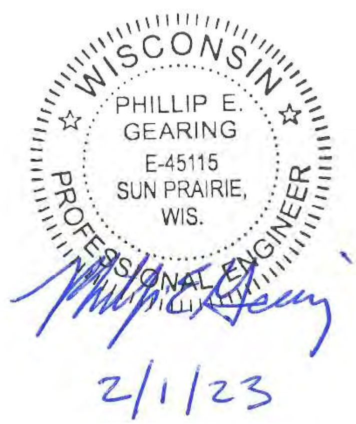
P.E. Certification

I, Phillip Gearing, hereby certify that I am a licensed professional engineer in the State of Wisconsin in accordance with the requirements of ch. A−E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A−E 8, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 500 to 538, Wis. Adm. Code.

Specifically,

- This CCR Fugitive Dust Control Plan was prepared by me or under my direct supervision and meets the requirements of 40 CFR 257.80(b) and NR 514.07 (10)(a)

____
Signature



February 1, 2023
Date

License number E-45115

My license renewal date is July 31, 2024.

Appendix C2

Run-on and Run-off Control System Plan

Run-On and Run-Off Control Plan Update – Phase 1, Modules 1 through 6 and Phase 2, Modules 10 and 11

Columbia Dry Ash Disposal Facility
Columbia Energy Center
W8375 Murray Road
Pardeeville, Wisconsin 53954

Prepared for:

Wisconsin Power and Light Company
Columbia Energy Center
W8375 Murray Road
Pardeeville, Wisconsin 53954

SCS ENGINEERS

25222260.00 | February 1, 2023

2830 Dairy Drive
Madison, WI 53718-6751
608-224-2830

Table of Contents

Section | Page

Tables

Figures

Appendices

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PE CERTIFICATION

I, Phillip Gearing, hereby certify that I am a licensed professional engineer in the State of Wisconsin in accordance with the requirements of ch. A–E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A–E 8, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 500 to 538, Wis. Adm. Code.

Specifically,

- This Run-On and Run-Off Control Plan Update was prepared by me or under my direct supervision and meets the requirements of 40 CFR 257.81(c) and NR 514.07(10)(b)

February 1, 2023

(signature) (date)

Phillip E. Gearing

(printed or typed name)

License number ______E-45115______________

My license renewal date is __July 31, 2024___.

Pages or sheets covered by this seal:

Run-On and Run-Off Control Plan Update – Phase 1, Modules 1 through 6 and Phase 2, Modules 10 and 11

Columbia Dry Ash Disposal Facility, Columbia Energy Center

W8375 Murray Road, Pardeeville, Wisconsin 53954

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1.0 INTRODUCTION AND PROJECT SUMMARY

The Columbia Dry Ash Disposal Facility includes an active coal combustion residual (CCR) landfill, which currently consists of the following modules, located in Phase 1 and Phase 2 of the facility.

- **Phase 1, Module 1** – This module has received final cover over completed outer sideslope areas that will no longer receive additional CCR; intermediate cover has been placed over remaining areas.
- **Phase 1, Module 2** – This module has received intermediate cover over a majority of the in-place CCR.
- **Phase 1, Module 3** – This module has received intermediate cover over a majority of the in-place CCR.
- **Phase 1, Module 4** – This module is currently being filled.
- **Phase 1, Module 5** – This module was constructed in 2021 and is approved by Wisconsin Department of Natural Resources (WDNR) to receive CCR.
- **Phase 1, Module 6** – This module was constructed in 2021 and is approved by WDNR to receive CCR.
- **Phase 2, Module 10** – Module 10 liner construction began in 2022. The new module will be used for disposal following approval of the liner Construction Documentation Report, which will be submitted for WDNR review in 2023.
- **Phase 2, Module 11** – Module 11 liner construction began in 2022. The new module will be used for disposal following approval of the liner Construction Documentation Report, which will be submitted for WDNR review in 2023.

Phase 1, Modules 1-3 were previously described as separate existing CCR landfills although they are contiguous and are managed as a single landfill by the facility and by the WDNR. WPL clarified that Modules 1-3 are one existing CCR landfill under the federal CCR Rule. Phase 1, Modules 4-6 are considered a new CCR landfill that initiated construction after October 19, 2015, and are therefore managed as a separate CCR unit under the federal CCR Rule even though they are contiguous to Modules 1-3. In addition, the new CCR landfill will include Phase 2, Modules 10 and 11, which is near completion and will begin receiving CCR in 2023 after full WDNR approval.

Phase 2, Modules 7-9 and 12-13 are permitted with the WDNR, but have not been developed. If developed, the units will also be part of the new CCR landfill, as defined at 40 CFR 257.53 and NR 500.03. Construction of additional modules is not currently planned prior to retirement of the Columbia Energy Center, which is currently scheduled to occur no later than June 1, 2026.

Figure 1 shows the site location. **Figure 2** shows the run-on and run-off drainage areas.

On behalf of Wisconsin Power and Light Company (WPL), SCS Engineers (SCS) has prepared this Run-On and Run-Off Control Plan Update for the Columbia (COL) Dry Ash Disposal Facility in accordance with 40 CFR 257.81(c)(1) and NR 514.07(10)(b) as follows.

40 CFR 257.81(c)(4). *"The owner or operator of the CCR unit must prepare periodic run-on and run-off control system plans required by paragraph (c)(1) of this section every five years. The date of completing the initial plan is the basis for establishing the deadline to complete the first subsequent plan. The owner or operator may complete any required plan prior to the required deadline provided the owner or operator places the completed plan into the facility's operating record within a reasonable amount of time. In all cases, the deadline for completing a subsequent plan is based on* *the date of completing the previous plan. For purposes of this paragraph (c)(4), the owner or operator has completed a periodic run-on and run-off control system plan when the plan has been placed in the facility's operating record as required by §257.105(g)(3)."*

NR 514.07(10)(b)(4). *"Modification every 5 years from the date of the most recent plan approval or whenever there is a change in conditions that may substantially affect the written plan in effect. The modification shall be requested by the owner or operator in accordance with s. NR 514.04 (6) prior to the 5-year deadline."*

The initial Run-On and Run-Off Control Plan was completed in 2016, and updates were completed in 2018 prior to receipt of CCR in Phase 1, Module 4 and in 2021, prior to receipt of CCR in Phase 1, Modules 5 and 6.

1.1 PERIODIC PLAN UPDATES

The following items have been updated in this plan prior to receipt of CCR in Phase 2, Modules 10 and 11:

- **Run-On and Run-Off Drainage Areas** – **Figure 2** has been updated to show topographic data for active landfill areas obtained during the most recent survey of the existing landfill in January 2023 and construction of Phase 2, Modules 10 and 11 in 2022. Additional intermediate cover has been placed in Modules 3, 4, 5, and 6 since the latest survey reducing the area contributing run-off as contact water. Modules 5 and 6 no longer have a temporary rain cover; however, rain cover may be used in the future to reduce the area contributing run-off as contact water (refer to **Section 2.0**). Additional intermediate cover will be added to active landfill areas as Modules 10 and 11 begin receiving CCR to maintain contributing run-off area.

- **Storm Water Calculations** – Additional storm water calculations were completed for Modules 10 and 11 as described in **Section 2.0**.

- **Primary Ash Pond** – The Primary Ash Pond will no longer accept contact water from the landfill. As needed, contact water will be transported to the plant for discharge through Outfall 003 rather than disposal at the Primary Ash Pond.

- No other changes impacting the run-on and run-off controls have been identified with this update.

- This update also incorporates the requirements of NR 514.07(10)(b), which became effective August 1, 2022.

2.0 RUN-ON AND RUN-OFF CONTROL PLAN

40 CFR 257.81(a). *"The owner or operator of an existing or new CCR landfill or any lateral expansion of a CCR landfill must design, construct, operate, and maintain:*

(1) A run-on control system to prevent flow onto the active portion of the CCR unit during the peak discharge from a 24-hour, 25-year storm."

NR 514.07(10)(b). *"A run−on and run−off control system plan that includes all of the following:*

(1) *A run–on and run–off control system designed in accordance with the requirements under s. NR 504.12 (2).”*

NR 504.12 (2). *“An existing or new CCR landfill or any lateral expansion of a CCR landfill shall be designed, constructed, operated, and maintained with a run–off and run–on control system in accordance with the requirements under s. NR 504.09 (1) (f) and (g) and all of the following:*

(a) *A run–on control system shall prevent flow onto the active portion of the CCR landfill during the peak discharge from a 24–hour, 25–year storm.”*

The entire facility has run-on and run-off control in place, as approved by the WDNR and further described below. Run-on is controlled by berms and swales around the perimeter of the landfill that divert storm water away from the landfill to a sedimentation basin.

40 CFR 257.81(a)(2) *“A run-off control system from the active portion of the CCR unit to collect and control at least the water volume resulting from a 24-hour, 25-year storm.”*

NR 504.12 (2)(b) *“A run–off control system from the active portion of the CCR landfill shall collect and control, at a minimum, the water volume resulting from a 24–hour, 25–year storm.”*

Run-off from the active portions of the facility is handled as leachate and is collected by a leachate collection system and internal swales, which route the contact water run-off to the Leachate/Surface Water Pond. Modules 4-6 and all module fills going forward will have intermediate cover added to reduce contact water that is directed to the pond. The contact water in the basin is used for dust control or other actions within the active landfill or, if needed, is transported with a water wagon to the generating station where it may be discharged through Outfall 003 inside the plant in accordance with a Wisconsin Pollutant Discharge Elimination System (WPDES) permit.

Run-off from areas outside existing CCR units and areas of the existing CCR units where final or intermediate cover is in place is diverted into the perimeter drainage swales, which drain to the South Sedimentation Basin and a lower are north of the landfill. Intermediate swales/berms and downslope channels on the final cover help minimize erosion of the final cover and divert water to the perimeter drainage system, and ultimately to the on-site detention/sedimentation basin. Per 40 CFR 257.81(b), this is consistent with the surface water requirements under 40 CFR 257.3-3.

In addition to these controls, a temporary rain cover may be installed to limit leachate and contact water production when needed. Storm water collected on the rain cover will be diverted to perimeter swales. The rain cover will be removed in sections to accommodate waste placement. As the rain cover is removed, new diversion berms will be constructed to form the perimeter of a storm water containment area. The berms will prevent contact water from running onto the rain cover and will anchor or ballast the rain cover at the new limits. When the rain cover has been fully removed, run-off will be controlled by the limits of the developed modules, and all water inside the lined waste limits will be managed as contact water.

2.1 DESIGN CRITERIA

The storm water features described above are designed to handle run-on and run-off from a 25-year, 24-hour storm event, as required by 40 CFR 257.81(a)(1) and (2) and NR 504.12(2)(a) and (b). Storm water run-off calculations were updated in 2022. The calculations were performed assuming a 25-year, 24-hour precipitation depth of 4.91 inches, based on National Oceanic and Atmospheric Administration (NOAA) Atlas 14 precipitation data published in April 2013. The detention/sedimentation basin and associated basin outlet structures are designed to safely pass run-off from a 100-year, 24-hour storm event.

Table 1. Storm Water Updates

Year Conducted	Description of Update	Included in Appendix A
Run-On and Run-Off		
2000	Run-on calculations performed as part of the 2000 Plan of Operation Update; performed assuming 25-year, 24-hour precipitation depth of 4.7 inches, based on Technical Paper-40 (TP-40) precipitation data published in May 1961.	Yes, Included in Appendix A
2010	Run-off calculations performed as part of the 2010 Plan of Operation Update; performed assuming 25-year, 24-hour precipitation depth of 4.7 inches, based on TP-40 precipitation data published in May 1961.	Superseded by Phase 1, Modules 5 & 6
2015	Update to leachate/surface water pond calculations; performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	Superseded by Phase 1, Module 4
2016	Update to run-on to a ditch along the north end of Module 3; performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	Superseded by Phase 1, Module 4
2016	Calculations to evaluate installation of a rain cover in Module 3; performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	Superseded by Phase 1, Module 4
2017	Update to leachate/surface water pond calculations with consideration of Phase 1, Module 4 construction; performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	Superseded by Phase 1, Modules 5 & 6
2018	Calculations to evaluate installation of a rain cover in Module 4; performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	Superseded by Phase 1, Modules 5 & 6
2018	Calculations to size swales and culverts to divert run-on as part of construction of Module 4, performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	Superseded by Phase 1, Modules 5 & 6
2021	Update to leachate/surface water pond calculations with consideration of Phase 1, Modules 5 and 6 construction; performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	Superseded by Phase 2, Modules 10 & 11
2021	Calculations to size swales and culverts to divert run-on as part of construction of Modules 5 and 6, performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	Superseded by Phase 2, Modules 10 & 11

Year Conducted	Description of Update	Included in Appendix A
Run-On and Run-Off		
2021	Calculations to confirm South Sedimentation Basin can handle storm water after construction of Modules 5 and 6, performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	Superseded by Phase 2, Modules 10 & 11
2022	Update to leachate/surface water pond calculations with consideration of Phase 2, Modules 10 and 11 construction; performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	Yes, Included in Appendix A
2022	Calculations to size swales and culverts to divert run-on as part of construction of Modules 10 and 11, performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	Yes, Included in Appendix A
2022	Calculations to confirm South Sedimentation Basin can handle storm water after construction of Modules 10 and 11, performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	Yes, Included in Appendix A

2.2 DESIGN WITH CALCULATIONS

Storm water management design calculations are contained in **Appendix A**, as required by 40 CFR 257.81(c)(1) and NR 514.07(10)(b)(2). As described in **Section 2.1**, the calculations from the 2000 Plan of Operation Update and the 2022 calculations describe the storm water management design and provide calculations showing that the run-on control system will prevent flow onto the active portion of the CCR units during the peak discharge from a 25-year, 24-hour storm. The 2022 calculations also describe the storm water management design and provide calculations showing that the run-off control system for the active portions of the CCR units will collect and control the water volume resulting from a 25-year, 24-hour storm. The calculations were performed by or overseen by a professional engineer licensed in the State of Wisconsin.

2.3 CONSTRUCTION

Existing storm water management features were constructed to site specifications with construction oversight directed by a professional engineer licensed in the State of Wisconsin. Construction documentation reports for the storm water management features were prepared, submitted to the WDNR, and approved by the WDNR. Any future construction features will have been previously approved.

3.0 CERTIFICATIONS

40 CFR 257.81(c)(5). *"The owner or operator must obtain a certification from a qualified professional engineer stating that the initial and periodic run-on and run-off control system plans meet the requirements of this section."*

Phillip Gearing, PE, a licensed profession engineer in the State of Wisconsin, has overseen the preparation of this Run-On and Run-Off Control Plan. A certification statement is provided on **page iii** of this plan.

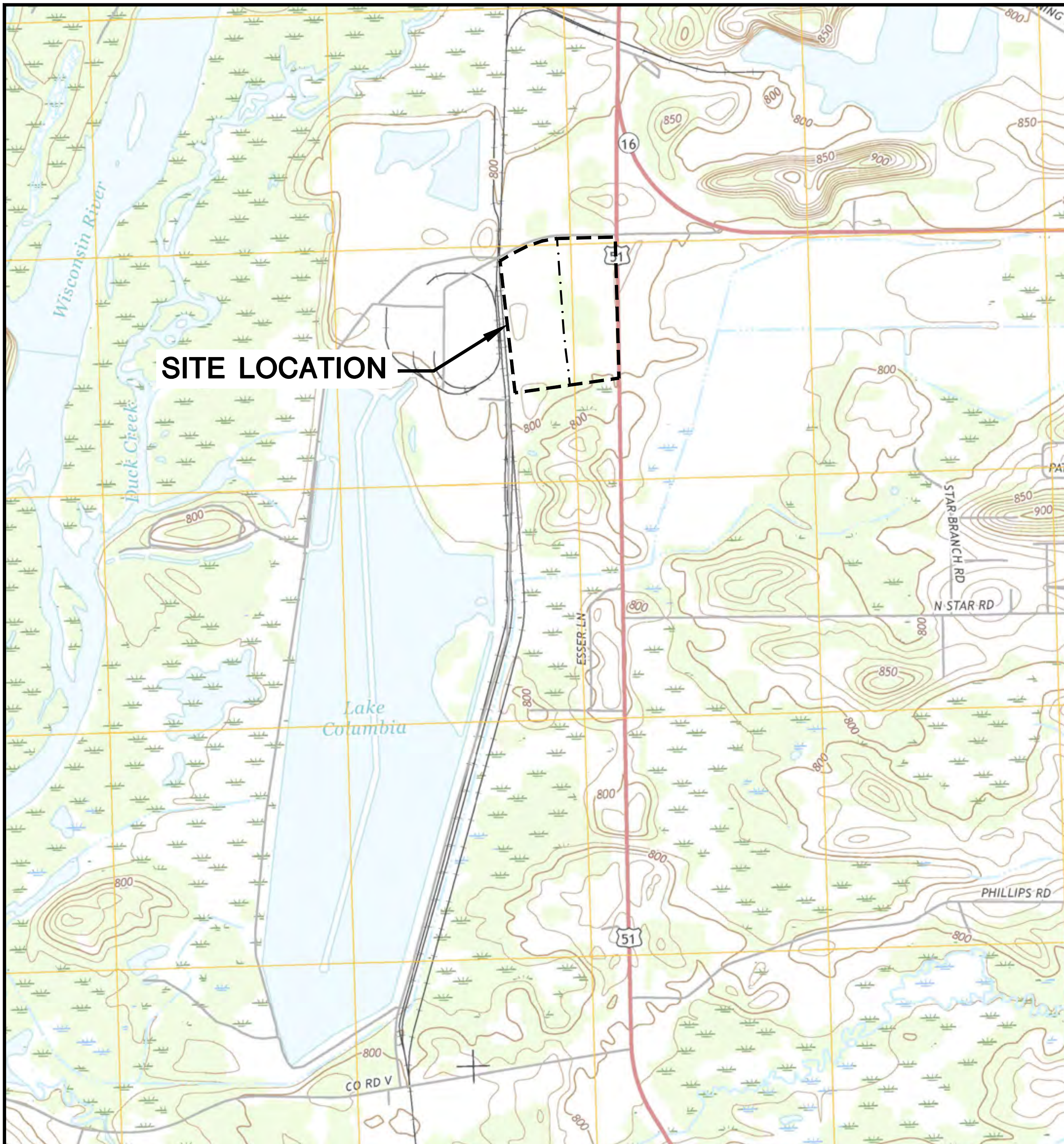
4.0 RECORDKEEPING AND PERIODIC UPDATES

40 CFR 257.81(d). *"The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in section 257.105(g), the notification requirements specified in section 257.106(g), and the internet requirements specified in section 257.107(g)."*

This Run-On and Run-Off Control Plan, and all periodic plans, will be placed in the facility's operating record and on Alliant Energy's CCR Rule Compliance Data and Information website, as will all amendments. Periodic plan updates will be completed at least every 5 years per 40 CFR 257.81(c)(4) and NR 514.07(10)(b)(4).

WPL will notify the State Director when this Run-On and Run-Off Control Plan, and all subsequent updates, are available in the facility's operating record and on the facility's website per 40 CFR 257.105(g), 257.106(g), and 257.107(g) and NR 506.17(2) and (3).

Figures



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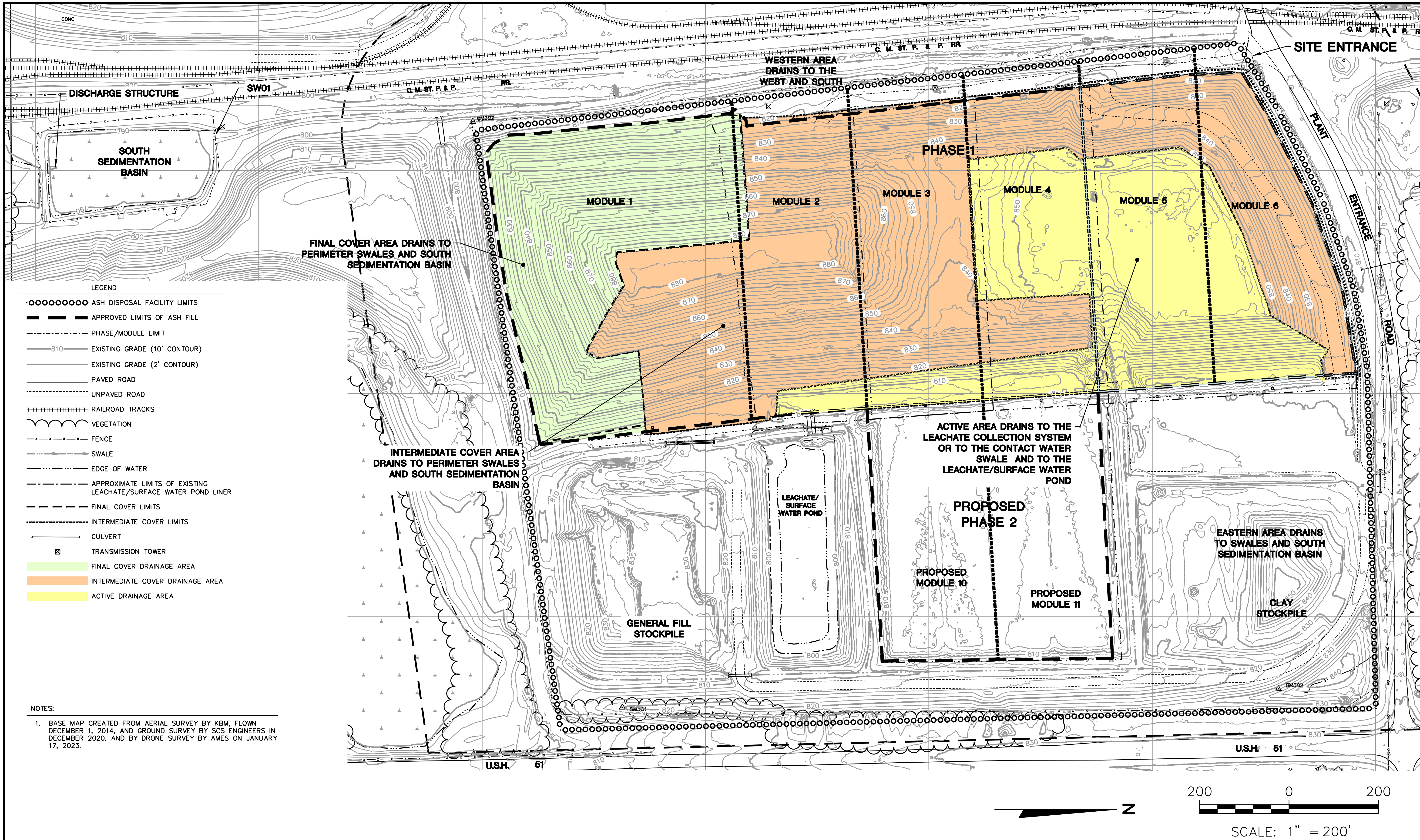
POYNETTE QUADRANGLE
WISCONSIN–COLUMBIA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
2016
SCALE: 1" = 2,000'

CLIENT	SITE	
WISCONSIN POWER AND LIGHT COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WISCONSIN 53954	RUN–ON AND RUN–OFF CONTROL PLAN COLUMBIA DRY ASH DISPOSAL FACILITY TOWN OF PACIFIC, WISCONSIN	SITE LOCATION MAP

				ENGINEER	FIGURE
PROJECT NO.	25222260.00	DRAWN BY:	AHB/RJG	SCS ENGINEERS 2830 DAIRY DRIVE MADISON, WI 53718–6751 PHONE: (608) 224–2830	1
DRAWN:	08/09/16	CHECKED BY:	PG		
REVISED:	07/16/21	APPROVED BY:	PG 12/01/21		

I:\25222260.00\Drawings\Run-On Run-Off\1_Site Location.dwg, 1/10/2023 4:36:34 PM



NOTES:

1. BASE MAP CREATED FROM AERIAL SURVEY BY KBM, FLOWN DECEMBER 1, 2014, AND GROUND SURVEY BY SCS ENGINEERS IN DECEMBER 2020, AND BY DRONE SURVEY BY AMES ON JANUARY 17, 2023.

PROJECT NO.	25222260.00	DRAWN BY:	RJG/KP/MJT
DRAWN:	12/18/2017	CHECKED BY:	PG
REVISED:	01/25/2023	APPROVED BY:	PG 01/31/23

ENGINEER: SCS ENGINEERS, 2830 DAIRY DRIVE MADISON, WI 53718-6751, PHONE: (608) 224-2830

CLIENT: WISCONSIN POWER AND LIGHT, COLUMBIA ENERGY CENTER, W8375 MURRAY ROAD, PARDEEVILLE, WISCONSIN 53954

SITE: RUN-ON AND RUN-OFF CONTROL PLAN, COLUMBIA DRY ASH DISPOSAL FACILITY, TOWN OF PACIFIC, WISCONSIN

RUN-ON AND RUN-OFF CONTROL PLAN

FIGURE 2

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Appendix A

Storm Water Design Calculations

Appendix A1

2000 Plan of Operations Update

SURFACE WATER MANAGEMENT CALCULATIONS
COLUMBIA DRY ASH DISPOSAL FACILITY

PURPOSE:

The purpose of the surface water runoff calculations is to demonstrate that the surface water control features incorporated into the proposed design will collect and transfer surface water from the landfill in a controlled manner and will minimize erosion. The surface water runoff calculations were performed for the western half (Phase 1) of the landfill, which this 10-year Plan of Operation Update report addresses.

SITE GEOMETRY:

The surface water runoff from Phase 1 of the landfill will be routed to the existing South Sedimentation Basin. Diversion berms, downslope channels, and perimeter ditches are incorporated into the design to route the surface water to the southwestern corner of the landfill, where it is then routed to the South Sedimentation Basin. The South Sedimentation Basin was constructed during construction of Module 1 North. The south sedimentation pond discharges to a wetland area to the south of the pond.

METHODOLOGIES:

The following methods and procedures were used to demonstrate that the proposed surface water control features will collect and transfer surface water in controlled manner and minimize erosion potential:

<u>Hydrograph Generation</u>

Peak stormwater flows for the 25-year, 24-hour and 100-year, 24-hour storm events were calculated using the Quick TR-55 computer model developed by the National Resources Conservation Service (NRCS) (formerly known as the Soil Conservation Service (SCS)). The Quick TR-55 methods for computing hydrographs are based on the methodologies presented in the Urban Hydrology for Small Watersheds manual. The Quick TR-55 model is designed to simulate the surface runoff response of a watershed to a precipitation event. Input parameters for the model include precipitation depth for a particular storm event, contributing drainage areas, runoff curve numbers, and time of concentration.

SURFACE WATER MANAGEMENT CALCULATIONS (CONTINUED)
COLUMBIA DRY ASH DISPOSAL FACILITY

The time of concentration calculations combine overland flow time (i.e., sheet flow), shallow concentrated flow time, and channel flow time. Curve numbers for a specified drainage area were also calculated using the methodologies and tables presented in TR-55 (see **Reference** section at the end of this appendix).

Diversion Berm, Downslope Channels, and Perimeter Ditch Sizing

These control structures are sized to channel the peak storm runoff to the sedimentation basin while maintaining low enough velocities to limit the erosion potential. The proposed design allows storm water which comes into contact with the final cover to be routed by diversion berms and downslope channels to the perimeter ditches, which will then transport the water to the south sedimentation basin.

Diversion berm, downslope channels, and perimeter ditch locations and details are shown on the Plan Sheets. A portion of the perimeter ditch along the western side of the landfill was constructed as part of the construction of Module 1 North.

In conjunction with the graphical peak discharge methods as presented in TR-55, the Flowmaster computer modeling program was used to assist in the design of these control structures. This program allows the user to input the channel geometry, the slope of the channel, an estimated Manning's "n" value for the channel, and the peak flow in the channel. The program then determines the peak flow depth and the peak velocity for the given geometry of the control feature.

The diversion berms, downslope channels, and perimeter ditches were sized by calculating the peak flow each structure would have to manage in a worst-case design scenario (i.e., surface water runoff from the largest area of landfill final cover during the 25-year, 24-hour storm event). The drainage structure was modeled using the Flowmaster computer model to verify channel depth and velocity in the structure.

Sedimentation Pond Sizing

The sedimentation pond sizing process involved determining the proper ratio of surface area to flowrate that would allow a 15 micron particle size to settle out during a design storm event.

SURFACE WATER MANAGEMENT CALCULATIONS (CONTINUED)
COLUMBIA DRY ASH DISPOSAL FACILITY

A table presented in the Erosion and Sediment Control Handbook (Goldman et al., 1986) provides the surface area-to-discharge ratios required to achieve settlement of the desired particle sizes (see the **Reference** section of this appendix).

The Pond Pack 6.0 computer program was used in conjunction with accepted formulas and engineering calculations to size the sedimentation basins. Calculations were performed to determine the performance of the basins as follows:

1. The inflow hydrograph for the basin was calculated as part of the hydrograph computations. The regulations require that sediment basins be sized for a 25-year, 6-hour storm event. Sediment basin calculations for the Alliant Columbia Ash Disposal Facility were based on the basin's peak discharge during the 25-year, 24-hour storm which equals or exceeds the basin inflow for average rainfall intensity of the 25-year, 6-hour storm.

2. Outlet structures were designed to provide the necessary detention of peak stormwater runoff from the final cover for the 25-year, 24-hour storm event.

3. The inflow hydrograph was routed through the sedimentation pond using the Pond Pack 6.0 program to determine the basin's peak water elevation and discharge during the 25-year, 24-hour storm.

4. The emergency spillways for the sedimentation basins were sized for the 100-year, 24-hour storm event.

ASSUMPTIONS:

Summarized below are some of the major assumptions and data used in the computations:

1. Due to the presence of a drainage layer in the proposed landfill final cover, the soil for the landfill area was modeled between a Type B and C soil to account for greater water infiltration

through the cover. The final cover was modeled as a grassland in good condition, which resulted in a runoff curve number of 67.5.

2. SCS Type II storm was selected according to SCS storm distribution maps for the United States.

3. A 2-year, 24-hour storm event in the vicinity of the facility equates to 2.7 inches according to figures provided in TR-55.

4. A 25-year, 24-hour storm event in the vicinity of the facility equates to 4.7 inches according to precipitation data provided in TR-55.

5. A 100-year, 24-hour storm event in the vicinity of the facility equates to 5.9 inches according to precipitation data provided in TR-55.

6. Grass-lined berms and channels were designed for a maximum velocity of 4 feet per second (fps).

7. A Manning's "n" value of 0.045 was used to model a grass-lined berm or channel, as provided by the parameters set in the Flowmaster model.

8. Depths of channels were designed to be a minimum of 1 foot, with a minimum freeboard of 0.5 foot. Depths of diversion berms were designated to be a minimum of 2 feet, with a minimum of 0.5 foot of freeboard.

9. A 15-micron particle was targeted to be settled out of the water column. The 15-micron particle is classified as a medium-fine silt by the AASHTO Soil Classification System.

SURFACE WATER MANAGEMENT CALCULATIONS (CONTINUED)
COLUMBIA DRY ASH DISPOSAL FACILITY

RESULTS:

Based on the results of the surface water runoff computations presented in this appendix, the proposed surface water control features will adequately handle the runoff from a 25-year, 24-hour storm event while minimizing erosion. The drainage features will be constructed as shown on the Plan Sheets.

All diversion berms and perimeter ditches will maintain greater than 0.5 foot of freeboard during the design storm event. The sedimentation basins will settle out particles 15 microns and larger in diameter and will dewater in no less than three days. The detailed calculations are included with this appendix.

I:\1370\Reports\surface water calcs writeup.wpd

Time of Concentration Calculations

File.... I:\1370\Columbia.ppk
Title... Landfill runoff to south basin

Landfill Area (1/2)

:::
TIME OF CONCENTRATION CALCULATOR
:::

Landfill runoff to south basin

Segment #1: Tc: TR-55 Sheet
Description: final cover slope

Mannings n	.1900	
Hydraulic Length	60.00	ft
2yr, 24hr P	2.7000	in
Slope	.050000	ft/ft

Avg.Velocity .17 ft/sec

Segment #1 Time: .0989 hrs

Segment #2: Tc: TR-55 Sheet
Description: final cover slope

Mannings n	.1900	
Hydraulic Length	60.00	ft
2yr, 24hr P	2.7000	in
Slope	.250000	ft/ft

Avg.Velocity .32 ft/sec

Segment #2 Time: .0520 hrs

Segment #3: Tc: TR-55 Shallow
Description: diversion berm

Hydraulic Length	1530.00	ft
Slope	.020000	ft/ft
Unpaved		

Avg.Velocity 2.28 ft/sec

Segment #3 Time: .1863 hrs

Type.... Tc Calcs
Name.... LF TO S BASIN

File.... I:\1370\Columbia.ppk
Title... Landfill runoff to south basin

Landfill Area (2/2)

Segment #4: Tc: TR-55 Channel
Description: perimeter ditch

Flow Area	32.0000	sq.ft
Wetted Perimeter	22.60	ft
Hydraulic Radius	1.42	ft
Slope	.006000	ft/ft
Mannings n	.0300	
Hydraulic Length	320.00	ft

Avg.Velocity 4.85 ft/sec

Segment #4 Time: .0183 hrs

Total Tc: .3555 hrs

West peripheral area leading to west perimeter ditch (1/2)

File.... I:\1370\COLUMBIA.PPK
Title... Peripheral area to south basin (area outside of LF leading to basin)

::

TIME OF CONCENTRATION CALCULATOR

::

Peripheral area to south basin (area outside of LF leading to basin)

Segment #1: Tc: TR-55 Sheet
Description: flow into ditch

Mannings n	.1900	
Hydraulic Length	10.00	ft
2yr, 24hr P	2.7000	in
Slope	.330000	ft/ft

Avg.Velocity .25 ft/sec

Segment #1 Time: .0111 hrs

Segment #2: Tc: TR-55 Channel
Description: flow along perimeter ditch

Flow Area	22.0000	sq.ft
Wetted Perimeter	17.60	ft
Hydraulic Radius	1.25	ft
Slope	.006000	ft/ft
Mannings n	.0300	
Hydraulic Length	800.00	ft

Avg.Velocity 4.46 ft/sec

Segment #2 Time: .0498 hrs

Segment #3: Tc: TR-55 Channel
Description: flow along perimeter ditch

Flow Area	57.0000	sq.ft
Wetted Perimeter	29.00	ft
Hydraulic Radius	1.97	ft
Slope	.006000	ft/ft
Mannings n	.0300	
Hydraulic Length	1010.00	ft

Avg.Velocity 6.04 ft/sec

Segment #3 Time: .0465 hrs

West peripheral area leading to west perimeter ditch (2/2)

File.... I:\1370\COLUMBIA.PPK
Title... Peripheral area to south basin (area outside of LF leading to basin)

==========================
Total Tc: .1073 hrs
==========================

Northeast peripheral area leading to east perimeter ditch (1/1)

File.... I:\1370\COLUMBIA.PPK
Title... Eastern peripheral area (north of leachate basin) leading to east ditch

:::

TIME OF CONCENTRATION CALCULATOR

:::

Eastern peripheral area (north of leachate basin) leading to east ditch

---

Segment #1: Tc: TR-55 Sheet

Mannings n	.1900	
Hydraulic Length	40.00	ft
2yr, 24hr P	2.7000	in
Slope	.425000	ft/ft

Avg.Velocity .37 ft/sec

Segment #1 Time: .0304 hrs

Segment #2: Tc: TR-55 Sheet

Mannings n	.1900	
Hydraulic Length	260.00	ft
2yr, 24hr P	2.7000	in
Slope	.023000	ft/ft

Avg.Velocity .17 ft/sec

Segment #2 Time: .4362 hrs

Segment #3: Tc: TR-55 Shallow

Hydraulic Length	520.00	ft
Slope	.014000	ft/ft
Unpaved		

Avg.Velocity 1.91 ft/sec

Segment #3 Time: .0757 hrs

========================

Total Tc: .5423 hrs

========================

Southeast/South peripheral area leading to South perimeter ditch (1/2)

File.... I:\1370\COLUMBIA.PPK
Title... South peripheral area to south perimeter ditch

::
TIME OF CONCENTRATION CALCULATOR
::

South peripheral area to south perimeter ditch

Segment #1: Tc: TR-55 Sheet

Mannings n	.1900
Hydraulic Length	300.00 ft
2yr, 24hr P	2.7000 in
Slope	.010000 ft/ft

Avg.Velocity .12 ft/sec

Segment #1 Time: .6825 hrs

Segment #2: Tc: TR-55 Shallow

Hydraulic Length	110.00 ft
Slope	.096000 ft/ft
Unpaved	

Avg.Velocity 5.00 ft/sec

Segment #2 Time: .0061 hrs

Segment #3: Tc: TR-55 Shallow

Hydraulic Length	550.00 ft
Slope	.022000 ft/ft
Unpaved	

Avg.Velocity 2.39 ft/sec

Segment #3 Time: .0638 hrs

Type.... Tc Calcs
Name.... BASIN PERIPHERAL

Southeast/south peripheral area leading to south perimeter ditch (2/2)

File.... I:\1370\COLUMBIA.PPK
Title... South peripheral area to south perimeter ditch

Segment #4: Tc: TR-55 Channel
Description: flow along south perimeter ditch

Flow Area	100.0000	sq.ft
Wetted Perimeter	32.40	ft
Hydraulic Radius	3.09	ft
Slope	.012000	ft/ft
Mannings n	.0300	
Hydraulic Length	1030.00	ft
Avg.Velocity	11.53	ft/sec

Segment #4 Time: .0248 hrs

Total Tc: .7773 hrs

Equations used by PondPack to calculate Tc (1/2)

Tc Equations used...

==== SCS TR-55 Sheet Flow ====

```
Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

Where:  Tc = Time of concentration, hrs
        n  = Mannings n
        Lf = Flow length, ft
        P  = 2yr, 24hr Rain depth, inches
        Sf = Slope, ft/ft
```

==== SCS TR-55 Shallow Concentrated Flow ====

```
Unpaved surface:
V  = 16.1345 * (Sf**0.5)

Paved surface:
V  = 20.3282 * (Sf**0.5)

Tc = (Lf / V) / (3600sec/hr)

Where:  V  = Velocity, ft/sec
        Sf = Slope, ft/ft
        Tc = Time of concentration, hrs
        Lf = Flow length, ft
```

Type.... Tc Calcs
Name.... LF TO S BASIN

Equations used by Pond Pack to Calculate Tc (2/2)

File.... I:\1370\Columbia.ppk
Title... Landfill runoff to south basin

==== SCS Channel Flow ==

```
R  = Aq / Wp
V  = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

Tc = (Lf / V) / (3600sec/hr)

Where:  R  = Hydraulic radius
        Aq = Flow area, sq.ft.
        Wp = Wetted perimeter, ft
        V  = Velocity, ft/sec
        Sf = Slope, ft/ft
        n  = Mannings n
        Tc = Time of concentration, hrs
        Lf = Flow length, ft
```

Hydrograph Generation

Type.... TR-55 Tabular Hyd.Input Data
Name.... TO SOUTH BASIN Tag: 25

To South Basin
25-yr, 24-hr Storm
(1/2)

File.... I:\1370\COLUMBIA.PPK
Title... Runoff to south basin
HYG Dir = I:\1370\
HYG file = S BASIN.HYG south basin 25

TR-55 TABULAR HYDROGRAPH METHOD
TYPE II Distribution
25yr, 24hr Rainfall Depth = 4.70 in

Total Area = 63.400 acres or .099063 sq.mi.
Peak Discharge = 69 cfs
WARNING: Drainage areas of two or more subareas differ by a factor of 5 or greater.

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input	Ia/p used
Landfill area	29.600	67.5	.4000	.0000	4.70	1.63	I.20	.20
W peripheral	4.600	67.5	.1000	.0000	4.70	1.63	I.20	.20
Basin area	1.800	98.0	.1000	.0000	4.70	4.46	I.01	.10
NE peripheral	13.700	67.5	.5000	.0000	4.70	1.63	I.20	.20
SE/S periphera	13.700	67.5	.7500	.0000	4.70	1.63	I.20	.20

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hrs)	Input Values * Tt (hrs)	Rounded Values Tc (hrs)	Rounded Values * Tt (hrs)	Ia/p Interpolated (Yes/No)	Ia/p Messages
Landfill area	.3600	.0000	.40	.00	Yes	--
W peripheral	.1000	.0000	**	**	Yes	--
Basin area	.1000	.0000	**	**	No	Computed Ia/p < .1
NE peripheral	.5400	.0000	.50	.00	Yes	--
SE/S periphera	.7800	.0000	.75	.00	Yes	--

* Travel time from subarea outfall to composite watershed outfall point.
* Tc & Tt are available in the hydrograph tables.

Type.... TR-55 Tabular Hyd.Peaks
Name.... TO SOUTH BASIN Tag: 25

File.... I:\1370\COLUMBIA.PPK
Title... Runoff to south basin
HYG Dir = I:\1370\
HYG file = S BASIN.HYG south basin 25

To South Basin
25-yr, 24-hr Storm
(2/2)

TR-55 TABULAR HYDROGRAPH METHOD
TYPE II Distribution
25yr, 24hr Rainfall Depth = 4.70 in

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
Landfill area	40	12.3
W peripheral	11	12.1
Basin area	13	12.1
NE peripheral	17	12.4
SE/S periphera	13	12.6
Composite Watershed	69	12.4

Type.... TR-55 Tabular Hyd.Input Data
Name.... TO SOUTH BASIN   Tag: 100

To South Basin
100-yr, 24-hr

File.... I:\1370\COLUMBIA.PPK
Title... Runoff to south basin
HYG Dir = I:\1370\
HYG file = S BASIN.HYG south basin 100

TR-55 TABULAR HYDROGRAPH METHOD
TYPE II Distribution
100yr, 24hr Rainfall Depth = 5.90 in

Total Area = 63.400 acres or .099063 sq.mi.
Peak Discharge = 110 cfs
WARNING: Drainage areas of two or more subareas differ by a factor of 5 or greater.

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input	Ia/p used
Landfill area	29.600	67.5	.4000	.0000	5.90	2.50	I.16	.16
W peripheral	4.600	67.5	.1000	.0000	5.90	2.50	I.16	.16
Basin area	1.800	98.0	.1000	.0000	5.90	5.66	I.01	.10
E peripheral	13.700	67.5	.5000	.0000	5.90	2.50	I.16	.16
SE/S periphera	13.700	67.5	.7500	.0000	5.90	2.50	I.16	.16

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hrs)	Input Values * Tt (hrs)	Rounded Values Tc (hrs)	Rounded Values * Tt (hrs)	Ia/p Interpolated (Yes/No)	Ia/p Messages
andfill area	.3600	.0000	.40	.00	Yes	--
W peripheral	.1000	.0000	**	**	Yes	--
Basin area	.1000	.0000	**	**	No	Computed Ia/p < .1
peripheral	.5400	.0000	.50	.00	Yes	--
E/S periphera	.7800	.0000	.75	.00	Yes	--

* Travel time from subarea outfall to composite watershed outfall point.
* Tc & Tt are available in the hydrograph tables.

Type.... TR-55 Tabular Hyd.Peaks
Name.... TO SOUTH BASIN Tag: 100

File.... I:\1370\COLUMBIA.PPK
Title... Runoff to south basin
HYG Dir = I:\1370\
HYG file = S BASIN.HYG south basin 100

TR-55 TABULAR HYDROGRAPH METHOD
TYPE II Distribution
100yr, 24hr Rainfall Depth = 5.90 in

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
Landfill area	65	12.3
W peripheral	18	12.1
Basin area	16	12.1
NE peripheral	27	12.4
SE/S periphera	21	12.6
Composite Watershed	110	12.4

Diversion Berm, Downslope Swale, and Perimeter Ditch Sizing Calculations

Type.... Tc Calcs
Name.... WORSTCASE DIV BE

File.... I:\1370\COLUMBIA.PPK
Title... Tc for worst case diversion berm sizing calcs

::

TIME OF CONCENTRATION CALCULATOR

::

Tc for worst case diversion berm sizing calcs

Segment #1: Tc: TR-55 Sheet
Description: final cover slope - 25%

Mannings n	.1900	
Hydraulic Length	95.00	ft
2yr, 24hr P	2.7000	in
Slope	.250000	ft/ft
Avg.Velocity	.35	ft/sec

Segment #1 Time: .0751 hrs

Segment #2: Tc: TR-55 Shallow
Description: diversion berm

Hydraulic Length	2090.00	ft
Slope	.020000	ft/ft
Unpaved		
Avg.Velocity	2.28	ft/sec

Segment #2 Time: .2544 hrs

=========================

Total Tc: .3295 hrs

=========================

Worst-case diversion berm

Type.... TR-55 Tabular Hyd.Input Data
Name.... WORSTCASE DIV BE   Tag: 25

File.... I:\1370\COLUMBIA.PPK
Title... Hydrograph for worst-case diversion berm sizing calcs
HYG Dir = I:\1370\
HYG file = NONE STORED WORSTCASE DIV BE 25

TR-55 TABULAR HYDROGRAPH METHOD
TYPE II Distribution
25yr, 24hr Rainfall Depth = 4.70 in

Total Area = 4.600 acres or .007187 sq.mi.
Peak Discharge = 7 cfs

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
east side ph 1	4.600	67.5	.3000	.0000	4.70	1.63	I.20	.20

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hrs)	* Tt (hrs)	Rounded Values Tc (hrs)	* Tt (hrs)	Ia/p Interpolated (Yes/No)	Ia/p Messages
east side ph 1	.3300	.0000	.30	.00	Yes	--

* Travel time from subarea outfall to composite watershed outfall point.

Worst-case diversion berm

Name.... WORSTCASE DIV BE Tag: 25

File.... I:\1370\COLUMBIA.PPK
Title... Hydrograph for worst-case diversion berm sizing calcs
HYG Dir = I:\1370\
HYG file = NONE STORED WORSTCASE DIV BE 25

TR-55 TABULAR HYDROGRAPH METHOD
TYPE II Distribution
25yr, 24hr Rainfall Depth = 4.70 in

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
east side ph 1	7	12.2
Composite Watershed	7	12.2

Worksheet
Worksheet for Triangular Channel

Worst-case diversion berm

Project Description	
Worksheet	Triangular Channe
Flow Element	Triangular Channe
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Slope	020000	ft/ft
Left Side Slope	4.00	H : V
Right Side Slope	3.00	H : V
Discharge	7.00	cfs

Results		
Depth	0.75	ft
Flow Area	2.0	ft²
Wetted Perim	5.47	ft
Top Width	5.25	ft
Critical Depth	0.76	ft
Critical Slope	0.019122	ft/ft
Velocity	3.55	ft/s
Velocity Head	0.20	ft
Specific Energ	0.95	ft
Froude Numb	1.02	
Flow Type	Supercritical	

Worst-case downslope channel

Type.... Tc Calcs
Name.... WORST CASE FLUME

File.... I:\1370\COLUMBIA.PPK
Title... Tc for worst case downslope flume sizing calcs

::
TIME OF CONCENTRATION CALCULATOR
::

Tc for worst case downslope flume sizing calcs

Segment #1: Tc: TR-55 Sheet
Description: final cover slope - 5%

Mannings n	.1900	
Hydraulic Length	60.00	ft
2yr, 24hr P	2.7000	in
Slope	.050000	ft/ft
Avg.Velocity	.17	ft/sec

Segment #1 Time: .0989 hrs

Segment #2: Tc: TR-55 Sheet
Description: final cover slope - 25%

Mannings n	.1900	
Hydraulic Length	60.00	ft
2yr, 24hr P	2.7000	in
Slope	.250000	ft/ft
Avg.Velocity	.32	ft/sec

Segment #2 Time: .0520 hrs

Segment #3: Tc: TR-55 Shallow
Description: diversion berm

Hydraulic Length	1790.00	ft
Slope	.020000	ft/ft
Unpaved		
Avg.Velocity	2.28	ft/sec

Segment #3 Time: .2179 hrs

========================
Total Tc: .3688 hrs
========================

Worst-case downslope channel

Type.... TR-55 Tabular Hyd.Input Data
Name.... WORST CASE FLUME Tag: 25

File.... I:\1370\COLUMBIA.PPK
Title... Hydrograph for worst-case downslope flume sizing calcs
HYG Dir = I:\1370\
HYG file = NONE STORED WORST CASE FLUME 25

TR-55 TABULAR HYDROGRAPH METHOD
TYPE II Distribution
25yr, 24hr Rainfall Depth = 4.70 in

Total Area = 7.500 acres or .011719 sq.mi.
Peak Discharge = 10 cfs

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
To SE flume	7.500	67.5	.4000	.0000	4.70	1.63	I.20	.20

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hrs)	Input Values * Tt (hrs)	Rounded Values Tc (hrs)	Rounded Values * Tt (hrs)	Ia/p Interpolated (Yes/No)	Ia/p Messages
To SE flume	.3700	.0000	.40	.00	Yes	--

* Travel time from subarea outfall to composite watershed outfall point.

Worst-case downslope channel

Type.... TR-55 Tabular Hyd.Peaks
Name.... WORST CASE FLUME Tag: 25

File.... I:\1370\COLUMBIA.PPK
Title... Hydrograph for worst-case downslope flume sizing calcs
HYG Dir = I:\1370\
HYG file = NONE STORED WORST CASE FLUME 25

TR-55 TABULAR HYDROGRAPH METHOD
TYPE II Distribution
25yr, 24hr Rainfall Depth = 4.70 in

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
To SE flume	10	12.3
Composite Watershed	10	12.3

Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	downslope flume
Flow Element	Trapezoidal Cha
Method	Manning's Form
Solve For	Channel Depth

Worst-case downslope channel (SW channel)

Input Data		
Mannings Coeffic	0.040	
Slope	200000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	10.00	ft
Discharge	10.00	cfs

Results		
Depth	0.18	ft
Flow Area	1.9	ft²
Wetted Perim	11.16	ft
Top Width	11.10	ft
Critical Depth	0.30	ft
Critical Slope	0.035988	ft/ft
Velocity	5.17	ft/s
Velocity Head	0.41	ft
Specific Energ	0.60	ft
Froude Numb	2.18	
Flow Type	Supercritical	

Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	worst-case west perimetei
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Worst-case west perimeter ditch

Input Data		
Mannings Coeffic	0.030	
Slope	006000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	5.00	ft
Discharge	31.00	cfs

Results		
Depth	1.13	ft
Flow Area	9.5	ft²
Wetted Perim	12.17	ft
Top Width	11.80	ft
Critical Depth	0.88	ft
Critical Slope	0.015659	ft/ft
Velocity	3.26	ft/s
Velocity Head	0.16	ft
Specific Energ	1.30	ft
Froude Numb	0.64	
Flow Type	Subcritical	

Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	worst-case east perimeter
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Worst-case east perimeter ditch

Input Data		
Mannings Coeffic	0.030	
Slope	005000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	10.00	ft
Discharge	57.00	cfs

Results		
Depth	1.23	ft
Flow Area	16.9	ft²
Wetted Perim	17.79	ft
Top Width	17.39	ft
Critical Depth	0.91	ft
Critical Slope	0.014803	ft/ft
Velocity	3.38	ft/s
Velocity Head	0.18	ft
Specific Enerç	1.41	ft
Froude Numb	0.61	
Flow Type	Subcritical	

Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	worst case south perimetei
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Worst-case south perimeter ditch

Input Data		
Mannings Coeffic	0.030	
Slope	012000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	10.00	ft
Discharge	70.00	cfs

Results		
Depth	1.08	ft
Flow Area	14.4	ft^2
Wetted Perim	16.85	ft
Top Width	16.50	ft
Critical Depth	1.03	ft
Critical Slope	0.014316	ft/ft
Velocity	4.88	ft/s
Velocity Head	0.37	ft
Specific Enerç	1.45	ft
Froude Numb	0.92	
Flow Type	Subcritical	

Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	ditch from SW corner of LF to !
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Ditch from SW corner of Landfill to South Basin

Input Data		
Mannings Coeffic	0.030	
Slope	006000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	15.00	ft
Discharge	69.00	cfs

Results		
Depth	1.07	ft
Flow Area	19.4	ft²
Wetted Perim	21.74	ft
Top Width	21.40	ft
Critical Depth	0.82	ft
Critical Slope	0.014896	ft/ft
Velocity	3.56	ft/s
Velocity Head	0.20	ft
Specific Energ	1.26	ft
Froude Numb	0.66	
Flow Type	Subcritical	

Basin Volume Computations

Type.... Vol: Planimeter
Name.... SOUTH BASIN

File.... I:\1370\COLUMBIA.PPK
Title... south basin volume

POND VOLUME CALCULATIONS

Planimeter scale: 1.00 ft/in

Elevation (ft)	Planimeter (sq.in)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	Volume (ac-ft)	Volume Sum (ac-ft)
789.00	62411.000	1.4328	.0000	.000	.000
790.00	68355.000	1.5692	4.5014	1.500	1.500
792.00	74865.000	1.7187	4.9301	3.287	4.787
794.00	82150.000	1.8859	5.4049	3.603	8.390

POND VOLUME EQUATIONS

* Incremental volume computed by the Conic Method for Reservoir Volumes.

Volume = (1/3) * (EL2-EL1) * (Area1 + Area2 + sq.rt.(Area1*Area2))

where: EL1, EL2 = Lower and upper elevations of the increment
Area1,Area2 = Areas computed for EL1, EL2, respectively
Volume = Incremental volume between EL1 and EL2

Outlet Structure Data

File.... I:\1370\COLUMBIA.PPK
Title... south basin outlet structure

REQUESTED POND WS ELEVATIONS:

Min. Elev.= 789.50 ft
Increment = 1.00 ft
Max. Elev.= 794.00 ft

****
OUTLET CONNECTIVITY
****

---> Forward Flow Only (UpStream to DnStream)
<--- Reverse Flow Only (DnStream to UpStream)
<---> Forward and Reverse Both Allowed

Structure	No.		Outfall	E1, ft	E2, ft
Weir-Rectangular	e1	--->	TW	793.000	794.000
Stand Pipe	s1	--->	c1	791.000	794.000
Orifice-Circular	o1	--->	c1	789.500	794.000
Culvert-Circular	c1	--->	TW	789.000	794.000
TW SETUP, DS Channel					

OUTLET STRUCTURE INPUT DATA

```
Structure ID       = e1
Structure Type     = Weir-Rectangular
------------------------------------
# of Openings      =          1
Crest Elev.        =     793.00 ft
Weir Length        =      10.00 ft
Weir Coeff.        =   3.300000

Weir TW effects      (Use adjustment equation)


Structure ID       = s1
Structure Type     = Stand Pipe
------------------------------------
# of Openings      =          1
Invert Elev.       =     791.00 ft
Diameter           =     2.5000 ft
Orifice Area       =     4.9087 sq.ft
Orifice Coeff.     =       .600
Weir Length        =       7.85 ft
Weir Coeff.        =      3.300
K, Submerged       =       .000
K, Reverse         =      1.000
Kb,Barrel          =    .000000  (per ft of full flow)
Barrel Length      =        .00 ft
Mannings n         =      .0000


Structure ID       = o1
Structure Type     = Orifice-Circular
------------------------------------
# of Openings      =         72
Invert Elev.       =     789.50 ft
Diameter           =      .0400 ft
Orifice Coeff.     =       .600
```

OUTLET STRUCTURE INPUT DATA

```
Structure ID        = c1
Structure Type      = Culvert-Circular
------------------------------------
No. Barrels         =         1
Barrel Diameter     =    1.2500 ft
Upstream Invert     =    789.00 ft
Dnstream Invert     =    788.50 ft
Horiz. Length       =     50.00 ft
Barrel Length       =     50.00 ft
Barrel Slope        =    .01000 ft/ft

OUTLET CONTROL DATA...
Mannings n          =     .0130
Ke                  =     .9000  (forward entrance loss)
Kb                  =   .023225  (per ft of full flow)
Kr                  =     .9000  (reverse entrance loss)
HW Convergence      =      .001  +/- ft

INLET CONTROL DATA...
Equation form       =         1
Inlet Control K     =     .0340
Inlet Control M     =    1.5000
Inlet Control c     =    .05530
Inlet Control Y     =     .5400
T1 ratio (HW/D)     =     1.258
T2 ratio (HW/D)     =     1.420
Slope Factor        =     -.500
```

Use unsubmerged inlet control Form 1 equ. below T1 elev.
Use   submerged inlet control Form 1 equ. above T2 elev.

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...
At T1 Elev =   790.57 ft   ---> Flow =   4.80 cfs
At T2 Elev =   790.77 ft   ---> Flow =   5.49 cfs

```
Structure ID        = TW
Structure Type      = TW SETUP, DS Channel
------------------------------------
FREE OUTFALL CONDITIONS SPECIFIED

CONVERGENCE TOLERANCES...
Maximum Iterations=    30
Min. TW tolerance =    .01 ft
Max. TW tolerance =    .01 ft
Min. HW tolerance =    .01 ft
Max. HW tolerance =    .01 ft
```

RATING TABLE FOR ONE OUTLET TYPE

Structure ID = e1 (Weir-Rectangular)

Upstream ID = (Pond Water Surface)
DNstream ID = TW (Pond Outfall)

WS Elev, Device Q		Tail Water		Notes
WS Elev. ft	Q cfs	TW Elev ft	Converge +/-ft	Computation Messages
789.50	.00	Free Outfall		WS below an invert; no flow.
790.50	.00	Free Outfall		WS below an invert; no flow.
791.00	.00	Free Outfall		WS below an invert; no flow.
791.50	.00	Free Outfall		WS below an invert; no flow.
792.50	.00	Free Outfall		WS below an invert; no flow.
793.00	.00	Free Outfall		WS below an invert; no flow.
793.50	11.67	Free Outfall		H=.50; Htw=.00; Qfree=11.67;
794.00	33.00	Free Outfall		H=1.00; Htw=.00; Qfree=33.00;

RATING TABLE FOR ONE OUTLET TYPE

Structure ID = s1 (Stand Pipe)

Upstream ID = (Pond Water Surface)
DNstream ID = c1 (Culvert-Circular)

Pond WS. Elev. ft	Device Q cfs	(into) HW HGL ft	Converge DS HGL ft	Next DS HGL ft	DS HGL Error +/-ft	Q SUM Error +/-cfs	DS Chan. TW ft	TW Error +/-ft
789.50	.00	...	...	...	...	...	Free Outfall	
	WS below an invert; no flow.							
790.50	.00	...	...	...	...	...	Free Outfall	
	WS below an invert; no flow.							
791.00	.00	...	...	...	...	...	Free Outfall	
	WS below an invert; no flow.							
791.50	7.06	791.50	791.50	791.50	.000	.000	Free Outfall	
	DS HGL+Loss > crest: Flow set to Downstream outlet.							
792.50	8.78	792.50	792.50	792.50	.000	.000	Free Outfall	
	DS HGL+Loss > crest: Flow set to Downstream outlet.							
793.00	9.52	793.00	793.00	793.00	.000	.000	Free Outfall	
	DS HGL+Loss > crest: Flow set to Downstream outlet.							
793.50	10.21	793.50	793.50	793.50	.000	.000	Free Outfall	
	DS HGL+Loss > crest: Flow set to Downstream outlet.							
794.00	10.86	794.00	794.00	794.00	.000	.000	Free Outfall	
	DS HGL+Loss > crest: Flow set to Downstream outlet.							

File.... I:\1370\COLUMBIA.PPK
Title... south basin outlet structure

RATING TABLE FOR ONE OUTLET TYPE

Structure ID = o1 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
DNstream ID = c1 (Culvert-Circular)

NUMBER OF OPENINGS = 72
EACH FLOW = SUM OF OPENINGS x FLOW FOR ONE OPENING

Pond WS. Elev. ft	Device Q cfs	(into) HW HGL ft	Converge DS HGL ft	Next DS HGL ft	DS HGL Error +/-ft	Q SUM Error +/-cfs	DS Chan. TW ft	TW Error +/-ft
789.50	.00	...	...	...	...	...	Free Outfall	
	WS below an invert; no flow.							
790.50	.43	790.50	Free	789.42	.000	.000	Free Outfall	
	H =.98							
791.00	.53	791.00	Free	789.47	.000	.000	Free Outfall	
	H =1.48							
791.50	.00	791.50	791.50	791.50	.000	.000	Free Outfall	
				Full riser flow. Q=0 this opening.				
792.50	.00	792.50	792.50	792.50	.000	.000	Free Outfall	
				Full riser flow. Q=0 this opening.				
793.00	.00	793.00	793.00	793.00	.000	.000	Free Outfall	
				Full riser flow. Q=0 this opening.				
793.50	.00	793.50	793.50	793.50	.000	.000	Free Outfall	
				Full riser flow. Q=0 this opening.				
794.00	.00	794.00	794.00	794.00	.000	.000	Free Outfall	
				Full riser flow. Q=0 this opening.				

File.... I:\1370\COLUMBIA.PPK
Title... south basin outlet structure

RATING TABLE FOR ONE OUTLET TYPE

Structure ID = c1 (Culvert-Circular)

Mannings open channel maximum capacity: 6.95 cfs
UPstream ID's= s1, o1
DNstream ID = TW (Pond Outfall)

Pond WS. Elev. ft	Device Q cfs	(into) HW HGL ft	Converge DS HGL ft	Next DS HGL ft	DS HGL Error +/-ft	Q SUM Error +/-cfs	DS Chan. TW ft	TW Error +/-ft
789.50	.00	789.00	Free	Free	.000	.000	Free	Outfall
790.50	.43	789.42	Free	Free	.000	.000	Free	Outfall
		CRIT.DEPTH	CONTROL	Vh= .089ft	Dcr= .255ft		CRIT.DEPTH	
791.00	.53	789.47	Free	Free	.000	.000	Free	Outfall
		CRIT.DEPTH	CONTROL	Vh= .100ft	Dcr= .283ft		CRIT.DEPTH	
791.50	7.06	791.50	Free	Free	.000	.000	Free	Outfall
		INLET CONTROL...		Submerged:	HW =2.50			
792.50	8.78	792.50	Free	Free	.000	.000	Free	Outfall
		INLET CONTROL...		Submerged:	HW =3.50			
793.00	9.52	793.00	Free	Free	.000	.000	Free	Outfall
		INLET CONTROL...		Submerged:	HW =4.00			
793.50	10.21	793.50	Free	Free	.000	.000	Free	Outfall
		INLET CONTROL...		Submerged:	HW =4.50			
794.00	10.86	794.00	Free	Free	.000	.000	Free	Outfall
		INLET CONTROL...		Submerged:	HW =5.00			

Pond Routing Summary

```
Type.... Pond Routing Summary
Name.... SOUTH BASIN2        Tag:     25

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin
```

South Basin
25-yr, 24-hr Storm

LEVEL POOL ROUTING SUMMARY

```
HYG Dir            = I:\1370\
Inflow  HYG file = SBASIN.HYG - south basin       25
Outflow HYG file = NONE STORED - SOUTH BASIN2 OUT 25

Pond Node   Data = south basin
Pond Volume Data = south basin
Pond Outlet Data = south basin2

No Infiltration

INITIAL CONDITIONS
---------------------------------
Starting WS Elev    =  789.00 ft
Starting Volume     =    .000 ac-ft
Starting Outflow    =     .00 cfs
Starting Infiltr.   =     .00 cfs
Starting Total Qout=      .00 cfs
Time Increment      =   .1000 hrs


INFLOW/OUTFLOW HYDROGRAPH SUMMARY
====================================================
Peak Inflow        =    69.00 cfs    at   12.4000 hrs
Peak Outflow       =     7.94 cfs    at   14.1000 hrs  <- Peak discharge from basin
----------------------------------------------------
Peak Elevation     =   792.01 ft  <- Peak water elevation
Peak Storage =          4.805 ac-ft
====================================================


MASS BALANCE (ac-ft)
-------------------------
+ Initial Vol   =       .000
+ HYG Vol IN    =      8.872
- Infiltration  =       .000
- HYG Vol OUT   =      8.101
- Retained Vol  =       .769
                   ----------
  Unrouted Vol  =     -.001 ac-ft  (.016% of Inflow Volume)


WARNING: Inflow hydrograph truncated on left side.
WARNING: Outflow hydrograph truncated on right side.
```

Job No. 1370	Job Columbia Plan of Op Update	Sheet No.
Client Alliant	Subject Basin Calcs	Calc. No.
		Rev. No.
		By BLP Date 8/23/00
		Chk'd. MKH Date 8-31-00

Basin Particle Size Settling Capability

Basin required to settle out ≥ 15 micron (0.015 mm) particle for a 25-yr, 24-hr Storm event.

From calculations, peak discharge from basin is 7.94 cfs and peak water elevation is 792.0 ft. The corresponding surface area of the basin at elevation 792.0 is 74,865 sf (see Basin Volume Computations Sectio
The surface area to discharge ratio is therefore

$$\frac{74,865 \text{ sf}}{7.94 \text{ cfs}} = 9,429 \text{ sf/cfs}$$

From the Erosion and Sediment Control Handbook, the required surface area to discharge ratio to settle out a 15 micron particle is 3,125 sf/cfs.

9,429 cfs/sf > 3,125 sf/cfs, therefore the basin is adequately sized to settle out a 15 micron particle

Type.... Pond Routed HYG (total out)
Name.... SOUTH BASIN2 Tag: 25

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin

South Basin Outflow Hydrograph (1/7)

POND ROUTED TOTAL OUTFLOW HYG...
HYG file =
HYG ID = SOUTH BASIN2 OUT
HYG Tag = 25

Peak Discharge = 7.94 cfs
Time to Peak = 14.1000 hrs
HYG Volume = 8.101 ac-ft

Basin dewatering time -
Begin discharge: 12.2
End discharge: 113.8 sa
Total discharge time: 101.6 or 4.2 days, whic is greater than the required minimum of 3 days

WARNING: Hydrograph truncated on right side.

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
11.0000	.00	.00	.00	.00	.00
11.5000	.00	.00	.00	.00	.00
12.0000	.00	.00	.10 (Begin discharge)	.24	.39
12.5000	.48	.92	3.82	6.00	7.14
13.0000	7.31	7.44	7.55	7.64	7.72
13.5000	7.78	7.83	7.87	7.90	7.92
14.0000	7.93	7.94	7.94	7.94	7.93
14.5000	7.92	7.91	7.90	7.89	7.87
15.0000	7.84	7.82	7.80	7.77	7.75
15.5000	7.73	7.71	7.68	7.66	7.63
16.0000	7.60	7.57	7.54	7.51	7.48
16.5000	7.45	7.42	7.40	7.37	7.34
17.0000	7.31	7.28	7.26	7.23	7.20
17.5000	7.18	7.15	7.13	7.10	7.08
18.0000	6.96	6.77	6.60	6.44	6.28
18.5000	6.14	6.00	5.88	5.76	5.65
19.0000	5.55	5.45	5.36	5.27	5.19
19.5000	5.12	5.01	4.89	4.77	4.66
20.0000	4.55	4.46	4.36	4.28	4.20
20.5000	4.12	4.05	3.99	3.92	3.87
21.0000	3.81	3.76	3.71	3.67	3.63
21.5000	3.59	3.55	3.51	3.48	3.45
22.0000	3.42	3.40	3.37	3.35	3.33
22.5000	3.31	3.29	3.24	3.16	3.09
23.0000	3.02	2.95	2.89	2.84	2.78
23.5000	2.74	2.69	2.65	2.61	2.57
24.0000	2.53	2.47	2.37	2.29	2.21
24.5000	2.13	2.06	1.99	1.93	1.87
25.0000	1.82	1.77	1.72	1.67	1.60

Type.... Pond Routed HYG (total out)
Name.... SOUTH BASIN2 Tag: 25

South Basin
Outflow Hydrograph
(2/7)

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin

WARNING: Hydrograph truncated on right side.

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
25.5000	1.50	1.40	1.32	1.23	1.15
26.0000	1.08	1.01	.95	.89	.83
26.5000	.78	.73	.69	.64	.60
27.0000	.56	.53	.53	.53	.53
27.5000	.53	.53	.53	.53	.53
28.0000	.53	.52	.52	.52	.52
28.5000	.52	.52	.52	.52	.52
29.0000	.52	.52	.52	.52	.52
29.5000	.52	.52	.52	.52	.52
30.0000	.51	.51	.51	.51	.51
30.5000	.51	.51	.51	.51	.51
31.0000	.51	.51	.51	.51	.51
31.5000	.51	.51	.51	.51	.50
32.0000	.50	.50	.50	.50	.50
32.5000	.50	.50	.50	.50	.50
33.0000	.50	.50	.50	.50	.50
33.5000	.50	.50	.50	.50	.49
34.0000	.49	.49	.49	.49	.49
34.5000	.49	.49	.49	.49	.49
35.0000	.49	.49	.49	.49	.49
35.5000	.49	.49	.49	.49	.48
36.0000	.48	.48	.48	.48	.48
36.5000	.48	.48	.48	.48	.48
37.0000	.48	.48	.48	.48	.48
37.5000	.48	.48	.48	.48	.48
38.0000	.47	.47	.47	.47	.47
38.5000	.47	.47	.47	.47	.47
39.0000	.47	.47	.47	.47	.47
39.5000	.47	.47	.47	.47	.47
40.0000	.47	.46	.46	.46	.46
40.5000	.46	.46	.46	.46	.46
41.0000	.46	.46	.46	.46	.46
41.5000	.46	.46	.46	.46	.46
42.0000	.46	.46	.46	.45	.45
42.5000	.45	.45	.45	.45	.45
43.0000	.45	.45	.45	.45	.45
43.5000	.45	.45	.45	.45	.45
44.0000	.45	.45	.45	.45	.45
44.5000	.44	.44	.44	.44	.44
45.0000	.44	.44	.44	.44	.44
45.5000	.44	.44	.44	.44	.44
46.0000	.44	.44	.44	.44	.44
46.5000	.44	.44	.44	.43	.43

Type.... Pond Routed HYG (total out)
Name.... SOUTH BASIN2 Tag: 25

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin

South Basin Outflow Hydrograp (3/7)

WARNING: Hydrograph truncated on right side.

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
47.0000	.43	.43	.43	.43	.43
47.5000	.43	.43	.43	.43	.43
48.0000	.43	.43	.43	.42	.42
48.5000	.42	.42	.42	.42	.42
49.0000	.42	.42	.42	.41	.41
49.5000	.41	.41	.41	.41	.41
50.0000	.41	.41	.41	.41	.40
50.5000	.40	.40	.40	.40	.40
51.0000	.40	.40	.40	.40	.40
51.5000	.39	.39	.39	.39	.39
52.0000	.39	.39	.39	.39	.39
52.5000	.39	.38	.38	.38	.38
53.0000	.38	.38	.38	.38	.38
53.5000	.38	.38	.38	.37	.37
54.0000	.37	.37	.37	.37	.37
54.5000	.37	.37	.37	.37	.37
55.0000	.36	.36	.36	.36	.36
55.5000	.36	.36	.36	.36	.36
56.0000	.36	.36	.35	.35	.35
56.5000	.35	.35	.35	.35	.35
57.0000	.35	.35	.35	.35	.34
57.5000	.34	.34	.34	.34	.34
58.0000	.34	.34	.34	.34	.34
58.5000	.34	.34	.33	.33	.33
59.0000	.33	.33	.33	.33	.33
59.5000	.33	.33	.33	.33	.33
60.0000	.33	.32	.32	.32	.32
60.5000	.32	.32	.32	.32	.32
61.0000	.32	.32	.32	.32	.31
61.5000	.31	.31	.31	.31	.31
62.0000	.31	.31	.31	.31	.31
62.5000	.31	.31	.31	.30	.30
63.0000	.30	.30	.30	.30	.30
63.5000	.30	.30	.30	.30	.30
64.0000	.30	.30	.30	.29	.29
64.5000	.29	.29	.29	.29	.29
65.0000	.29	.29	.29	.29	.29
65.5000	.29	.29	.29	.28	.28
66.0000	.28	.28	.28	.28	.28
66.5000	.28	.28	.28	.28	.28
67.0000	.28	.28	.28	.28	.27
67.5000	.27	.27	.27	.27	.27
68.0000	.27	.27	.27	.27	.27

Type.... Pond Routed HYG (total out)
Name.... SOUTH BASIN2 Tag: 25

South Basin Outflow Hydrograph (4/7)

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin

WARNING: Hydrograph truncated on right side.

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
68.5000	.27	.27	.27	.27	.27
69.0000	.26	.26	.26	.26	.26
69.5000	.26	.26	.26	.26	.26
70.0000	.26	.26	.26	.26	.26
70.5000	.26	.26	.25	.25	.25
71.0000	.25	.25	.25	.25	.25
71.5000	.25	.25	.25	.25	.25
72.0000	.25	.25	.25	.25	.24
72.5000	.24	.24	.24	.24	.24
73.0000	.24	.24	.24	.24	.24
73.5000	.24	.24	.24	.24	.24
74.0000	.24	.24	.24	.23	.23
74.5000	.23	.23	.23	.23	.23
75.0000	.23	.23	.23	.23	.23
75.5000	.23	.23	.23	.23	.23
76.0000	.23	.23	.22	.22	.22
76.5000	.22	.22	.22	.22	.22
77.0000	.22	.22	.22	.22	.22
77.5000	.22	.22	.22	.22	.22
78.0000	.22	.22	.21	.21	.21
78.5000	.21	.21	.21	.21	.21
79.0000	.21	.21	.21	.21	.21
79.5000	.21	.21	.21	.21	.21
80.0000	.21	.21	.20	.20	.20
80.5000	.20	.20	.20	.20	.20
81.0000	.20	.20	.20	.20	.20
81.5000	.20	.20	.20	.20	.20
82.0000	.20	.20	.20	.20	.19
82.5000	.19	.19	.19	.19	.19
83.0000	.19	.19	.19	.19	.19
83.5000	.19	.19	.19	.19	.19
84.0000	.19	.19	.19	.19	.19
84.5000	.19	.19	.18	.18	.18
85.0000	.18	.18	.18	.18	.18
85.5000	.18	.18	.18	.18	.18
86.0000	.18	.18	.18	.18	.18
86.5000	.18	.18	.18	.18	.18
87.0000	.18	.18	.17	.17	.17
87.5000	.17	.17	.17	.17	.17
88.0000	.17	.17	.17	.17	.17
88.5000	.17	.17	.17	.17	.17
89.0000	.17	.17	.17	.17	.17
89.5000	.17	.17	.17	.16	.16

Type.... Pond Routed HYG (total out)
Name.... SOUTH BASIN2 Tag: 25

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin

South Basin Outflow Hydrograph (5/7)

WARNING: Hydrograph truncated on right side.

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
90.0000	.16	.16	.16	.16	.16
90.5000	.16	.16	.16	.16	.16
91.0000	.16	.16	.16	.16	.16
91.5000	.16	.16	.16	.16	.16
92.0000	.16	.16	.16	.16	.16
92.5000	.15	.15	.15	.15	.15
93.0000	.15	.15	.15	.15	.15
93.5000	.15	.15	.15	.15	.15
94.0000	.15	.15	.15	.15	.15
94.5000	.15	.15	.15	.15	.15
95.0000	.15	.15	.15	.15	.14
95.5000	.14	.14	.14	.14	.14
96.0000	.14	.14	.14	.14	.14
96.5000	.14	.14	.14	.14	.14
97.0000	.14	.14	.14	.14	.14
97.5000	.14	.14	.14	.14	.14
98.0000	.14	.14	.14	.14	.14
98.5000	.14	.13	.13	.13	.13
99.0000	.13	.13	.13	.13	.13
99.5000	.13	.13	.13	.13	.13
100.0000	.13	.13	.13	.13	.13
100.5000	.13	.13	.13	.13	.13
101.0000	.13	.13	.13	.13	.13
101.5000	.13	.13	.13	.13	.12
102.0000	.12	.12	.12	.12	.12
102.5000	.12	.12	.12	.12	.12
103.0000	.12	.12	.12	.12	.12
103.5000	.12	.12	.12	.12	.12
104.0000	.12	.12	.12	.12	.12
104.5000	.12	.12	.12	.12	.12
105.0000	.12	.12	.12	.12	.12
105.5000	.12	.11	.11	.11	.11
106.0000	.11	.11	.11	.11	.11
106.5000	.11	.11	.11	.11	.11
107.0000	.11	.11	.11	.11	.11
107.5000	.11	.11	.11	.11	.11
108.0000	.11	.11	.11	.11	.11
108.5000	.11	.11	.11	.11	.11
109.0000	.11	.11	.11	.11	.11
109.5000	.11	.10	.10	.10	.10
110.0000	.10	.10	.10	.10	.10
110.5000	.10	.10	.10	.10	.10
111.0000	.10	.10	.10	.10	.10

South Basin Outflow Hydrograph (6/7)

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin

WARNING: Hydrograph truncated on right side.

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
111.5000	.10	.10	.10	.10	.10
112.0000	.10	.10	.10	.10	.10
112.5000	.10	.10	.10	.10	.10
113.0000	.10	.10	.10	.10	.10
113.5000	.10	.10	.10	.10 End discharge	.09
114.0000	.09	.09	.09	.09	.09
114.5000	.09	.09	.09	.09	.09
115.0000	.09	.09	.09	.09	.09
115.5000	.09	.09	.09	.09	.09
116.0000	.09	.09	.09	.09	.09
116.5000	.09	.09	.09	.09	.09
117.0000	.09	.09	.09	.09	.09
117.5000	.09	.09	.09	.09	.09
118.0000	.09	.09	.09	.09	.09
118.5000	.09	.09	.09	.08	.08
119.0000	.08	.08	.08	.08	.08
119.5000	.08	.08	.08	.08	.08
120.0000	.08	.08	.08	.08	.08
120.5000	.08	.08	.08	.08	.08
121.0000	.08	.08	.08	.08	.08
121.5000	.08	.08	.08	.08	.08
122.0000	.08	.08	.08	.08	.08
122.5000	.08	.08	.08	.08	.08
123.0000	.08	.08	.08	.08	.08
123.5000	.08	.08	.08	.08	.08
124.0000	.08	.08	.08	.07	.07
124.5000	.07	.07	.07	.07	.07
125.0000	.07	.07	.07	.07	.07
125.5000	.07	.07	.07	.07	.07
126.0000	.07	.07	.07	.07	.07
126.5000	.07	.07	.07	.07	.07
127.0000	.07	.07	.07	.07	.07
127.5000	.07	.07	.07	.07	.07
128.0000	.07	.07	.07	.07	.07
128.5000	.07	.07	.07	.07	.07
129.0000	.07	.07	.07	.07	.07
129.5000	.07	.07	.07	.07	.07
130.0000	.07	.07	.07	.07	.07
130.5000	.07	.06	.06	.06	.06
131.0000	.06	.06	.06	.06	.06
131.5000	.06	.06	.06	.06	.06
132.0000	.06	.06	.06	.06	.06
132.5000	.06	.06	.06	.06	.06

Name.... SOUTH BASIN2 Tag: 25

South Basin Outflow Hydrograph (7/7)

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin

WARNING: Hydrograph truncated on right side.

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
133.0000	.06	.06	.06	.06	.06
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135.0000	.06	.06	.06	.06	.06
135.5000	.06	.06	.06	.06	.06
136.0000	.06	.06	.06	.06	.06
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137.0000	.06	.06	.06	.06	.06
137.5000	.06	.06	.06	.06	.05
138.0000	.05	.05	.05	.05	.05
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139.0000	.05	.05	.05	.05	.05
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141.0000	.05	.05	.05	.05	.05
141.5000	.05	.05	.05	.05	.05
142.0000	.05	.05	.05	.05	.05
142.5000	.05	.05	.05	.05	.05
143.0000	.05	.05	.05	.05	.05
143.5000	.05	.05	.05	.05	.05
144.0000	.05	.05	.05	.05	.05
144.5000	.05	.05	.05	.05	.05
145.0000	.05	.05	.05	.05	.05
145.5000	.05	.05	.05	.05	.05
146.0000	.05	.05	.05	.05	.05
146.5000	.05	.05	.04	.04	.04
147.0000	.04	.04	.04	.04	.04
147.5000	.04	.04	.04	.04	.04
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151.0000	.04	.04	.04	.04	.04
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152.5000	.04	.04	.04	.04	.04
153.0000	.04	.04	.04	.04	.04
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154.0000	.04	.04	.04	.04	.04

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Type.... Pond Routing Summary
Name.... SOUTH BASIN2 100    Tag:    100

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin
```

South Basin
100-yr, 24-hr Storm

LEVEL POOL ROUTING SUMMARY

```
HYG Dir           = I:\1370\
Inflow  HYG file  = SBASIN.HYG - south basin       100
Outflow HYG file  = NONE STORED - SOUTH BASIN2 OUT 100

Pond Node   Data = south basin
Pond Volume Data = south basin
Pond Outlet Data = south basin2

No Infiltration

INITIAL CONDITIONS
-----------------------------------
Starting WS Elev    =  789.00 ft
Starting Volume     =    .000 ac-ft
Starting Outflow    =     .00 cfs
Starting Infiltr.   =     .00 cfs
Starting Total Qout=      .00 cfs
Time Increment      =   .1000 hrs


INFLOW/OUTFLOW HYDROGRAPH SUMMARY
=====================================================
Peak Inflow      =   110.00 cfs    at    12.4000 hrs
Peak Outflow     =    16.79 cfs    at    13.7000 hrs
-----------------------------------------------------
Peak Elevation   =   793.29 ft
Peak Storage =        7.080 ac-ft
=====================================================
```

← Peak discharge from basin

← Peak water elevation

```
  MASS BALANCE (ac-ft)
  -------------------------
+ Initial Vol    =        .000
+ HYG Vol IN     =      13.207
- Infiltration =          .000
- HYG Vol OUT    =      12.435
- Retained Vol =          .770
                    ----------
  Unrouted Vol =         -.001 ac-ft  (.011% of Inflow Volume)


  WARNING: Inflow hydrograph truncated on left side.
  WARNING: Outflow hydrograph truncated on right side.
```

References

Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overton and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007\,(nL)^{0.8}}{(P_2)^{0.5}\,s^{0.4}} \qquad \text{[Eq. 3-3]}$$

Table 3-1.—Roughness coefficients (Manning's n) for sheet flow

Surface description	n[1]	
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011	
Fallow (no residue)	0.05	
Cultivated soils:		
Residue cover ≤20%	0.06	
Residue cover >20%	0.17	
Grass:		
Short grass prairie	0.15	} Ave =
Dense grasses[2]	0.24	0.19
Bermudagrass	0.41	
Range (natural)	0.13	
Woods:[3]		
Light underbrush	0.40	
Dense underbrush	0.80	

[1]The n values are a composite of information compiled by Engman (1986).
[2]Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
[3]When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

where

T_t = travel time (hr),
n = Manning's roughness coefficient (table 3-1),
L = flow length (ft),
P_2 = 2-year, 24-hour rainfall (in), and
s = slope of hydraulic grade line (land slope, ft/ft).

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full elevation.

Table 2-2c.—Runoff curve numbers for other agricultural lands[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing.[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element.[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	[4]30	48	65	73
Woods—grass combination (orchard or tree farm).[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods.[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	[4]30	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

[1]Average runoff condition, and $I_a = 0.2S$.

[2]*Poor:* <50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: >75% ground cover and lightly or only occasionally grazed.

[3]*Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

[4]Actual curve number is less than 30; use CN = 30 for runoff computations.

[5]CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

[6]*Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

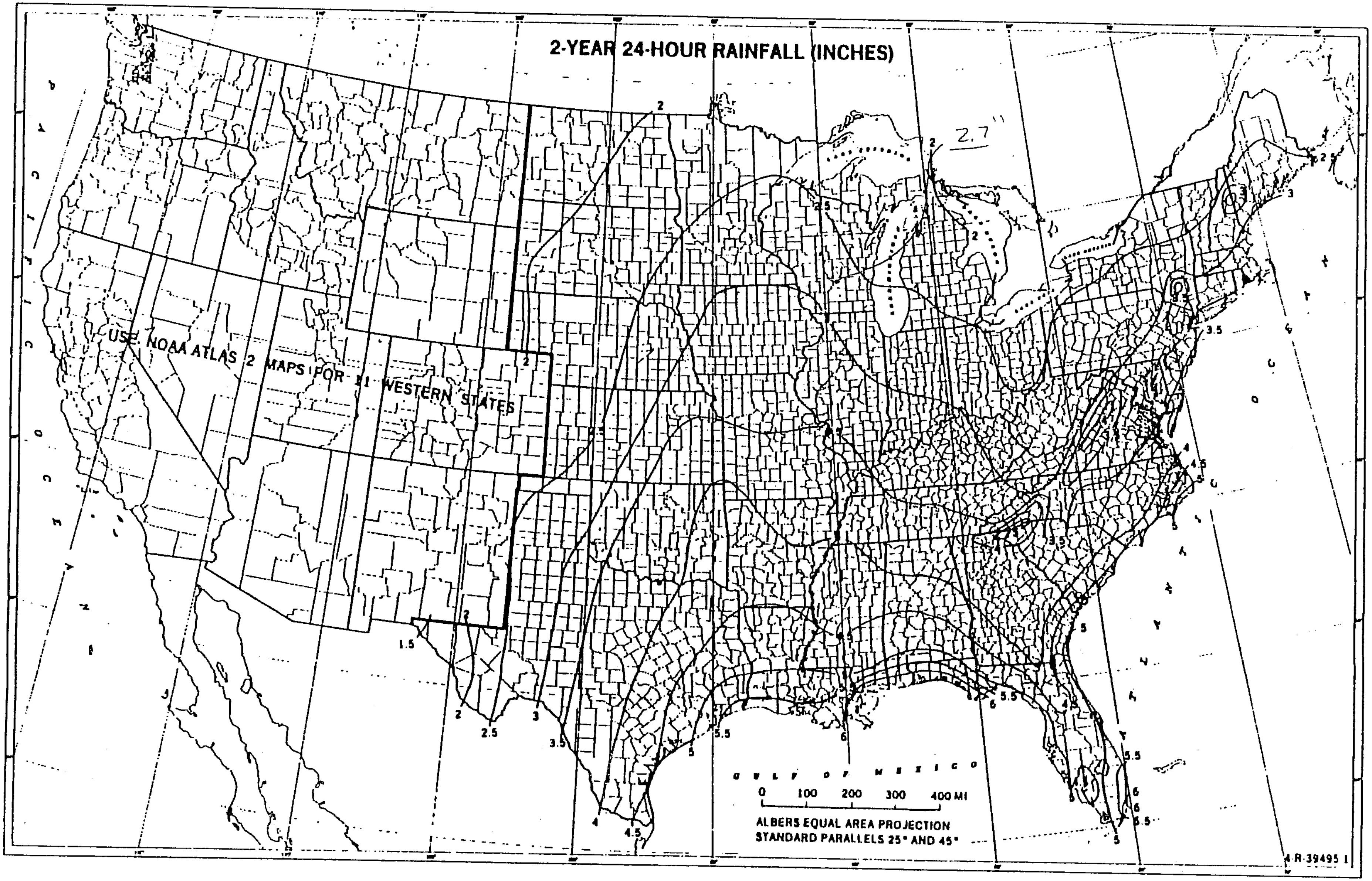


Figure B-3.—Two-year, 24-hour rainfall.

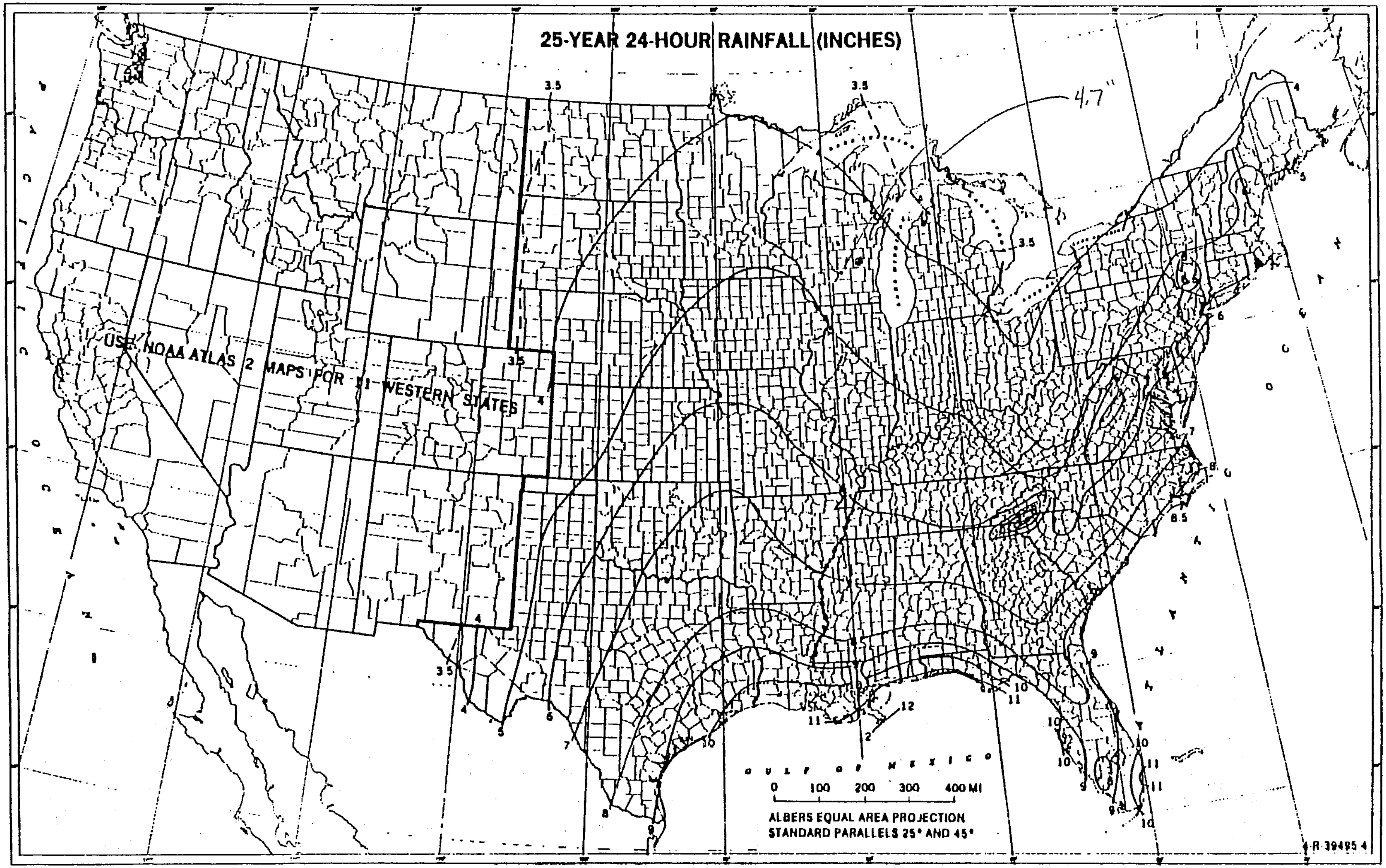


Figure B-6.—Twenty-five-year, 24-hour rainfall.

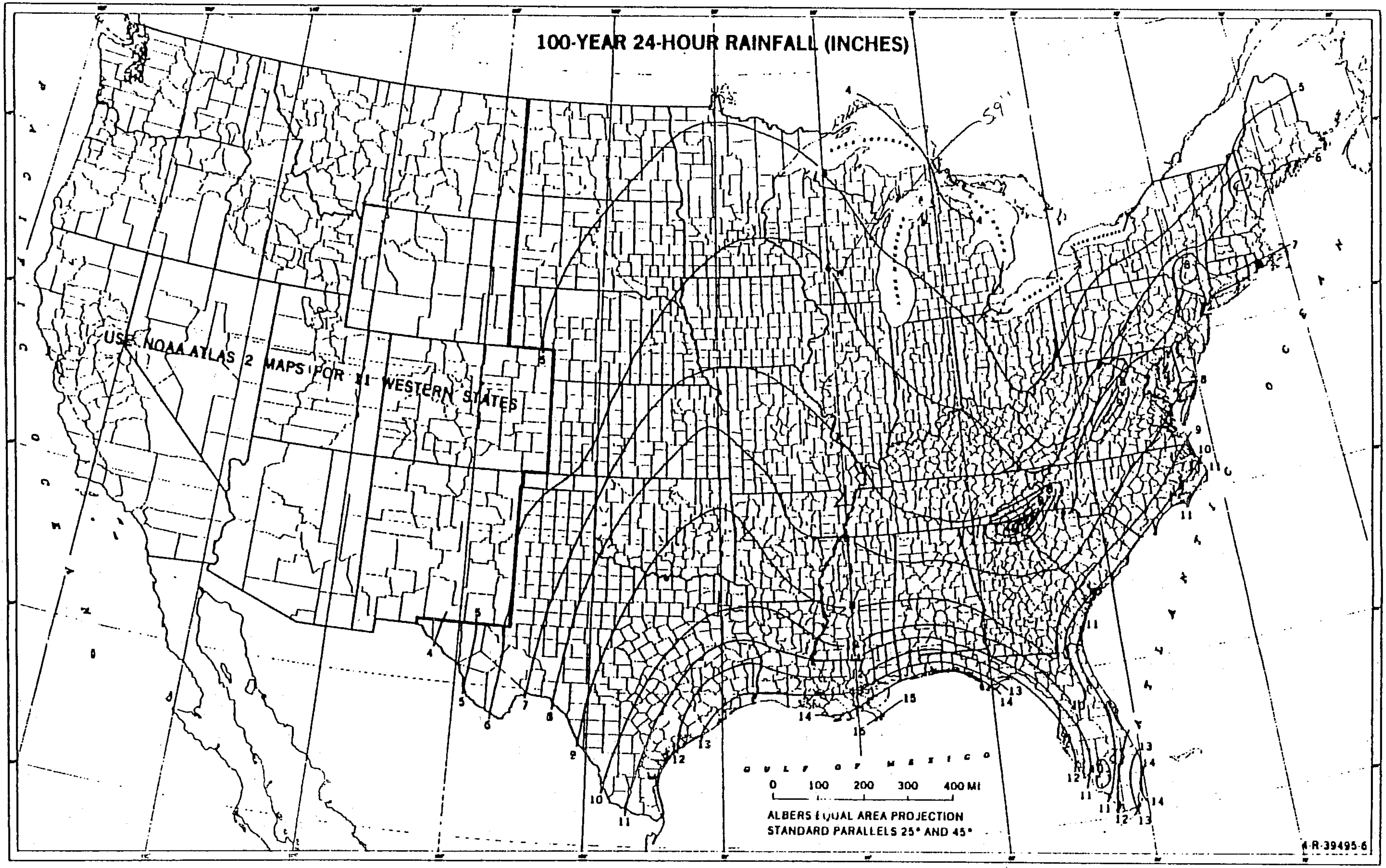


Figure B-8.—One-hundred-year, 24-hour rainfall.

TABLE 8.1 Surface Area Requirements of Sediment Traps and Basins

Particle size, mm	Settling velocity, ft/sec (m/sec)	Surface area requirements, ft^2 per ft^3/sec discharge	(m^2 per m^3/sec discharge)
0.5 (coarse sand)	0.19 (0.058)	6.3	(20.7)
0.2 (medium sand)	0.067 (0.020)	17.9	(58.7)
0.1 (fine sand)	0.023 (0.0070)	52.2	(171.0)
0.05 (coarse silt)	0.0062 (0.0019)	193.6	(635.0)
0.02 (medium silt)	0.00096 (0.00029)	1,250.0	(4,101.0)
0.01 (fine silt)	0.00024 (0.000073)	5,000.0	(16,404.0)
0.005 (clay)	0.00006 (0.000018)	20,000.0	(65,617.0)

0.015 <

→ Ave = 3,125 SF/cfs

weight composed of particles in the 0.01- to 0.02-mm range. A surface area 4 times larger would be needed to capture 5 percent more of this soil.

A balance between the cost-effectiveness of a certain basin size and the desire to capture fine particles must be achieved. It is desirable to capture the very small soil particles (clays and fine silts) because they cause turbidity and other water quality problems. However, Table 8.1 shows that a basin would have to be very large to capture particles smaller than 0.02 mm, particularly clay particles 0.005 mm and smaller. Because of the high cost of trapping very small particles, the authors recommend 0.02 as the design particle size for sediment basins except in areas with coarse soils, where a larger design particle may be used. The 0.02-mm particle is classified as a medium silt by the AASHTO soil classification system.

8.2d Basin Discharge Rate

The peak discharge, calculated by the rational or another approved method, is used to size the basin riser. During any major storm, a sediment basin should fill with water to the top of its riser and then discharge at the rate of inflow to the basin. A sediment basin is not designed with a large water storage volume as is a reservoir. If the inflow exceeds the design peak flow used to size the riser, the overflow should discharge down an emergency spillway.

8.2e Design Runoff Rate

In the equation for surface area of a sediment basin, the discharge rate Q is a variable to be chosen by the designer. The above discussion of basin discharge rate shows that the discharge rate is, to a large extent, equal to the inflow. The riser is sized to handle the peak inflow to the basin. The authors suggest determining the surface area by the *average runoff of a 10-year, 6-hr storm* instead

299

of the peak flow. A substantial savings in size, and therefore cost, is obtained, and basin efficiency is not significantly decreased.

Consider a basin designed to capture the 0.02-mm particle at the average runoff rate. The average rainfall per hour is 17 percent of the total rainfall in a 6-hr storm (Sec. 4.1f). On a site with soils with a moderately high clay content, under ideal settling conditions this basin would retain about 62 percent of the eroded soil (i.e., 62 percent of the soil, by weight, is composed of 0.02-mm or larger particles).

If the surface area of this basin were instead designed for the peak flow, it would be roughly 3 times larger. According to data from the U.S. Bureau of Reclamation (10), 25 percent of the total rainfall in a 6-hr storm falls in a ½-hr period (Fig. 4.2). Since the rainfall intensity i value is in units of inches (or millimeters) per hour, the peak flow can be calculated by using an i value of 50 percent of the 6-hr total. Since basin surface area is directly proportional to the discharge rate ($A = 1.2Q/V_s$) and the peak discharge rate in a 6-hr storm is 2.9 times the average rate (50% = 2.9 × 17%), the surface area sized for the peak flow would be about 3 times the surface area sized for the average flow. The basin sized for the peak flow would capture, during most of the storm except the peak, particles with approximately one-third the settling velocity of the design particle. Since the 0.02-mm particle settles at 0.00096 ft/sec (0.00029 m/sec), particles with a settling velocity of 0.00032 ft/sec (0.000098 m/sec) would then be captured. These are approximately 0.01-mm particles.

Suppose a basin on a site with clayey soils were sized by using the peak runoff rate. For the purpose of illustration, suppose the soil composition were typical of the San Francisco Bay Area as in the preceding example (62 percent of particles, by weight, greater than 0.02 mm and 5 percent, by weight, from 0.01 to 0.02 mm). A basin with a large surface area based on the peak runoff would capture the 0.01- to 0.02-mm particles as well as particles greater than 0.02 mm, or 67 percent of the eroded material. The basin efficiency would be increased 8 percent (5/62) by tripling the surface area. Thus it is generally much more cost-effective to size a basin by using the average runoff rather than the peak, and basin efficiency will not be significantly lower.

8.2f Settling Depth

If a basin is too shallow, water flowing rapidly through the basin may resuspend settled particles and decrease efficiency of capture. A similar problem occurs in grit-settling chambers at sewage treatment plants, where velocity must be controlled to prevent particle resuspension. An equation that describes scour in a grit chamber (2) is:

$$V_{scour} = \frac{1.486}{n} \times \left[r^{1/6} \times k(S_s - 1) \times \frac{d}{304.8} \right]^{1/2}$$

LEGEND

— —	PROPOSED LIMITS OF FILL		PAVED ROAD
- - -	APPROVED LIMITS OF FILL		UNPAVED ROAD
× 824.6	EXISTING SPOT ELEVATION		VEGETATION
	EXISTING GRADES (5' INTERVAL)		RAILROAD TRACKS
	EXISTING GRADES (1' INTERVAL)		FENCE
	EDGE OF WATER		CULVERT

Areas obtained from AutoCADD

SCALE: 1" = 60'

PROPOSED FINAL GRADES

PLAN OF OPERATION UPDATE
ALLIANT – COLUMBIA ASH DISPOSAL FACILITY
TOWN OF PACIFIC
COLUMBIA COUNTY, WISCONSIN

PROJECT NO. 1370
DRAWN BY: RR/KP
CHECKED BY: MRH
DRAWN: 07/28/00 REVISED: 08/16/00
J:\1370\PO UPDATE\1370FG04.DWG

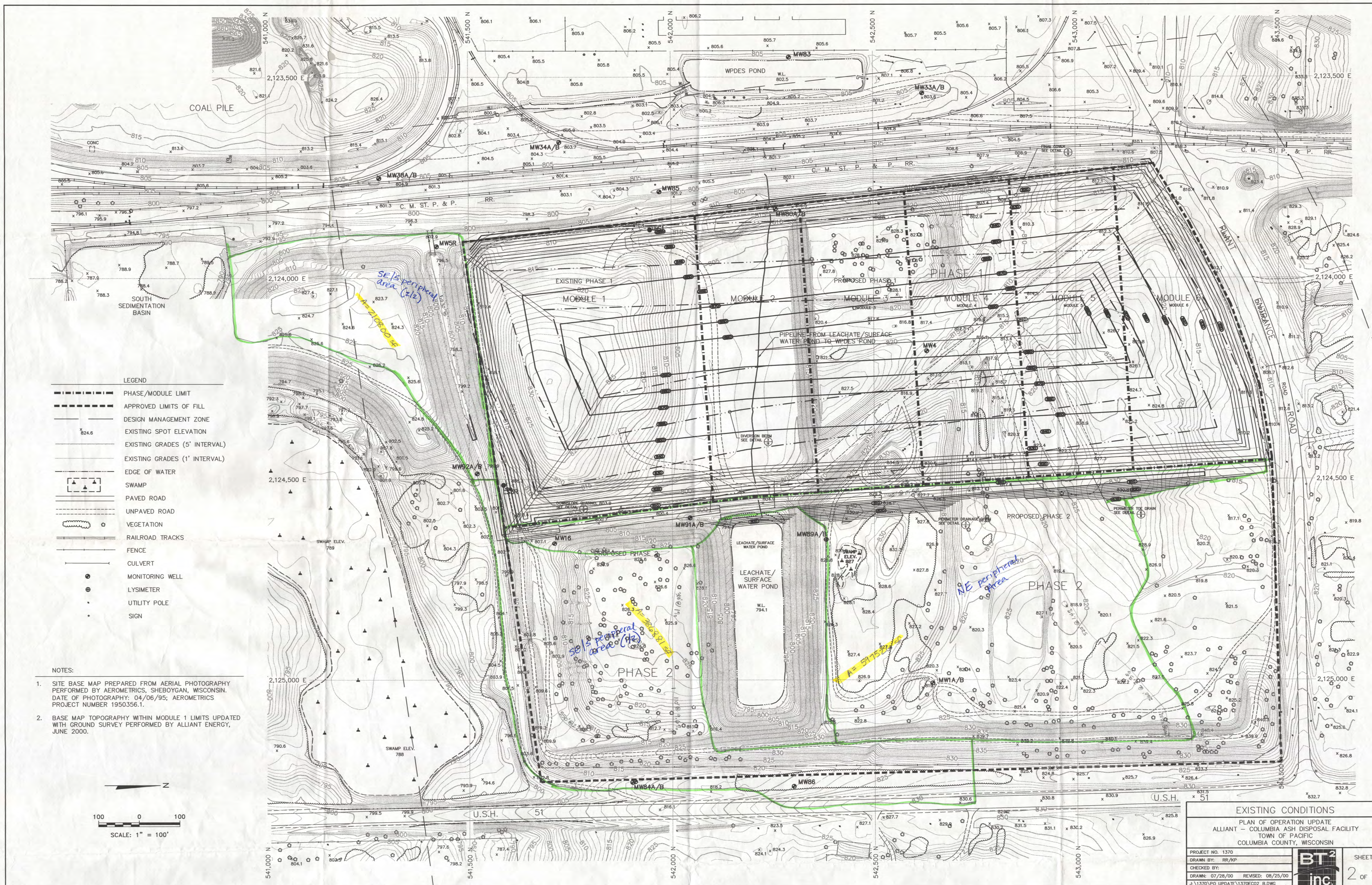
BT² inc.

SHEET 4 OF 8

#1370 ON

C. M. ST. P. & P. RR.
FINAL COVER SEE DETAIL 5/8
EXISTING PHASE 1
PROPOSED PHASE 1
PROPOSED PHASE 2
PROPOSED PHASE 2
MODULE 1
MODULE 2
MODULE 3
MODULE 4
MODULE 5
MODULE 6
PLANT ENTRANCE ROAD
A= 319679 sf
A= 327714 sf
A= 148872 sf
Worst-case downslope channel area
Worst-case diversion berm area
DIVERSION BERM SEE DETAIL 1/9
DOWNSLOPE CHANNEL SEE DETAIL 2/9
LEACHATE/SURFACE WATER POND
PERIMETER DRAINAGE DITCH SEE DETAIL 3/9
PERIMETER TOE DRAIN SEE DETAIL 6/8
MW34A/B
MW85
MW30A/B
MW4
MW91A/B
MW89A/B
MW92A/B
MW16
LS32
542,000 N
542,500 N
543,000 N
543,500 N
2,124,000 E
2,124,500 E
LEGEND
PHASE/MODULE LIMIT
APPROVED LIMITS OF FILL
EXISTING SPOT ELEVATION
EXISTING GRADES (5' INTERVAL)
EXISTING GRADES (1' INTERVAL)
EDGE OF WATER
PAVED ROAD
UNPAVED ROAD
VEGETATION
RAILROAD TRACKS
FENCE
CULVERT
PROPOSED FINAL GRADES (5' INTERVAL)
PROPOSED FINAL GRADES (1' INTERVAL)
PROPOSED DIVERSION BERM
PROPOSED DOWNSLOPE CHANNEL
DRAINAGE DITCH
Areas determined by planimeter
SCALE: 1" = 60'
DRAFT
PROPOSED FINAL GRADES
PLAN OF OPERATION UPDATE
ALLIANT - COLUMBIA ASH DISPOSAL FACILITY
TOWN OF PACIFIC
COLUMBIA COUNTY, WISCONSIN
PROJECT NO. 1370
DRAWN BY: RR/KP
CHECKED BY: MRH
DRAWN: 07/28/00 REVISED: 08/25/00
J:\1370\PO UPDATE\1370FG04.DWG
BT2 inc.
SHEET 4 OF 9

#1370 ON


COAL PILE
WPDES POND
C. M. ST. P. & P. RR.
SOUTH SEDIMENTATION BASIN
EXISTING PHASE 1
PROPOSED PHASE 1
PHASE 1
MODULE 1
MODULE 2
MODULE 3
MODULE 4
MODULE 5
MODULE 6
PIPELINE FROM LEACHATE/SURFACE WATER POND TO WPDES POND
LEACHATE/SURFACE WATER POND
PROPOSED PHASE 2
PHASE 2
SWAMP ELEV. 789
SWAMP ELEV. 788
U.S.H. 51
PLEASANT VALLEY ROAD
MW5R
MW16
MW1A/B
MW4
MW83
MW33A/B
MW34A/B
MW35A/B
MW85
MW80A/B
MW91A/B
MW92A/B
MW89A/B
MW84A/B
MW86
SE 1/4 peripheral area (z1z)
SE 1/4 peripheral area (z1z)
NE peripheral area
LEGEND
PHASE/MODULE LIMIT
APPROVED LIMITS OF FILL
DESIGN MANAGEMENT ZONE
EXISTING SPOT ELEVATION
EXISTING GRADES (5' INTERVAL)
EXISTING GRADES (1' INTERVAL)
EDGE OF WATER
SWAMP
PAVED ROAD
UNPAVED ROAD
VEGETATION
RAILROAD TRACKS
FENCE
CULVERT
MONITORING WELL
LYSIMETER
UTILITY POLE
SIGN
NOTES:
1. SITE BASE MAP PREPARED FROM AERIAL PHOTOGRAPHY PERFORMED BY AEROMETRICS, SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY: 04/06/95; AEROMETRICS PROJECT NUMBER 1950356.1.
2. BASE MAP TOPOGRAPHY WITHIN MODULE 1 LIMITS UPDATED WITH GROUND SURVEY PERFORMED BY ALLIANT ENERGY, JUNE 2000.
SCALE: 1" = 100'
EXISTING CONDITIONS
PLAN OF OPERATION UPDATE
ALLIANT – COLUMBIA ASH DISPOSAL FACILITY
TOWN OF PACIFIC
COLUMBIA COUNTY, WISCONSIN
PROJECT NO. 1370
DRAWN BY: RR/KP
CHECKED BY:
DRAWN: 07/28/00 REVISED: 08/25/00
J:\1370\PO UPDATE\1370EC02_B.DWG
BT2 inc.
SHEET 2 OF 9

#1370 ON

Appendix A2

Leachate/Surface Water Pond Capacity Evaluation

SCS ENGINEERS

Job No.	25220183.00	SHEET NO.	1		
Job:	Columbia Energy Center	CALC. NO.			
Client	WPL	REV. NO.			
Subject	Module 10/11 - Leachate/Surface Water Pond Evaluation	BY	RJG	DATE	05/25/22
		CHK'D.	MT	DATE	05/25/22

Purpose:

The purpose of the leachate/surface water pond evaluation is to determine the following based on the as-built leachate/surface water pond top of liner elevation of 796.97 (see Background section below):

- The maximum amount of open area during each filling phase in order to maintain the peak water elevation resulting from the 25-year, 24-hour storm event at the maximum allowable 796.97.
- The amount of open area allowable with pond closure filling in order to maintain the peak water elevation resulting from the 25-year, 24-hour storm event at the maximum allowable 796.97.
- Based on the amount of allowable open area determined from the above, determine the maximum starting water elevations in the leachate/surface water pond to accommodate 1, 2, 5, and 10-year, 24-hour storm events without overtopping.

Background:

- During construction of Module 2, the top of the leachate/surface water pond liner was determined to be at elevation 796.97.
- Previous calculations submitted to the WDNR on January 30, 2018, evaluated the leachate/surface water pond capacity based on the as-built pond liner elevation.
- A similar evaluation was performed for Module 3 and 4 construction and then Module 5 and 6 construction that produced a chart of maximum leachate/surface water pond starting elevations vs. rainfall storage capacity.
- Portions of Modules 1, 2, 3, and 4 currently have final or intermediate cover in place and Module 5 and 6 currently have rain cover (see **Figure 1 through 4**).
- Module 10 and 11 will be constructed in 2022.

Approach:

- Use the previously developed HydroCAD storm water model to model the below four filling scenarios.
    1. Filling Phase 0 – Assumes portions of Module 2, 3, 4, 5, and 6 contributing to the leachate/surface water pond while material is placed from the pond closure and the plant. See **Figure 1** for filling grades and contributing area
    2. Filling Phase 1 – Assumes portions of Module 2, 3, 4, 5, and 6 contributing to the leachate/surface water pond while material is placed from the pond closure and the plant. See **Figure 2** for filling grades and contributing area
    3. Filling Phase 2 – Assumes portions of Module 2, 3, 4, 5, and 6 contributing to the leachate/surface water pond while material is placed from the pond closure and the plant. See **Figure 3** for filling grades and contributing area.

4. Filling Phase 3 – Assumes portions of Module 2, 3, 4, 5, and 6 contributing to the leachate/surface water pond while material is placed from the pond closure and the plant. See **Figure 4** for filling grades and contributing area.
5. Filling Phase 4 – Assumes portions of Module 2, 3, 4, 5, 6, 10, and 11 contributing to the leachate/surface water pond while material is placed from the pond closure and the plant. See **Figure 5** for filling grades and contributing area.

Assumptions:

- Ash surfaces and intermediate cover areas were assumed to be impermeable (CN=98).
- The top of pond liner elevation is 796.97 (see Background section).
- Time of Concentration is 20 minutes for open areas.

Results:

1. Maximum allowable open area during filling and prior to permeter grade/Module 10 and 11 construction is 7.78 acres.

2. Maximum allowable open area during filling and after perimeter grades/Module 10 and 11 base grades are completed is 8.51 acres.

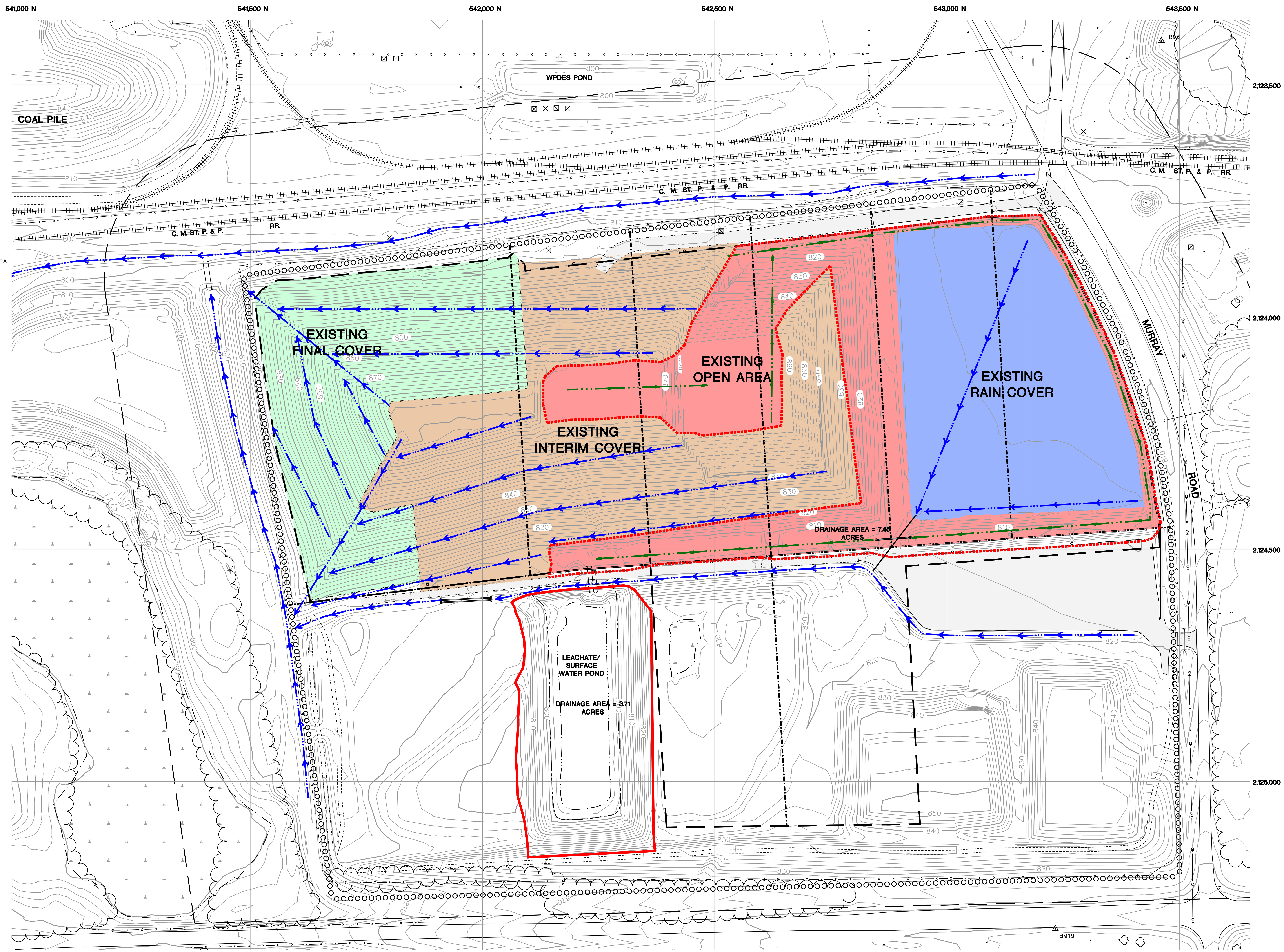
3. Filling Phase 0:
    - The contributing area of landfill to the leachate/surface water pond is 7.45 acres for the leachate/surface water pond to accommodate the runoff from a 25-year, 24-hour storm without overtopping.
    - The remainder of landfill would need to be closed/covered with final or intermediate cover and routed away from the pond.
    - **Figure 1** shows a proposed filling sequence, and **Figure 1a** shows the various operating levels of the leachate/surface water pond to accommodate the various storm events with the additional cover in place.
4. Filling Phase 1:
    - The contributing area of landfill to the leachate/surface water pond is 7.78 acres for the leachate/surface water pond to accommodate the runoff from a 25-year, 24-hour storm without overtopping.
    - The remainder of landfill would need to be closed/covered with final or intermediate cover and routed away from the pond.
    - **Figure 2** shows a proposed filling sequence, and **Figure 2a** shows the various operating levels of the leachate/surface water pond to accommodate the various storm events with the additional cover in place.
5. Filling Phase 2:
    - The contributing area of landfill to the leachate/surface water pond is 7.69 acres for the leachate/surface water pond to accommodate the runoff from a 25-year, 24-hour storm without overtopping.

- The remainder of landfill would need to be closed/covered with final or intermediate cover and routed away from the pond.
- **Figure 3** shows a proposed filling sequence, and **Figure 3a** shows the various operating levels of the leachate/surface water pond to accommodate the various storm events with the additional cover in place.

6. Filling Phase 3:
   - The contributing area of landfill to the leachate/surface water pond is 7.64 acres for the leachate/surface water pond to accommodate the runoff from a 25-year, 24-hour storm without overtopping.
   - The remainder of landfill would need to be closed/covered with final or intermediate cover and routed away from the pond.
   - **Figure 4** shows a proposed filling sequence, and **Figure 4a** shows the various operating levels of the leachate/surface water pond to accommodate the various storm events with the additional cover in place.

7. Filling Phase 4:
   - The contributing area of landfill to the leachate/surface water pond is 8.44 acres for the leachate/surface water pond to accommodate the runoff from a 25-year, 24-hour storm without overtopping.
   - The remainder of landfill would need to be closed/covered with final or intermediate cover and routed away from the pond.
   - **Figure 5** shows a proposed filling sequence, and **Figure 5a** shows the various operating levels of the leachate/surface water pond to accommodate the various storm events with the additional cover in place.

The HydroCAD reports for the maximum open contributing area, each scenario modeled are attached.



LEGEND

- DRY ASH DISPOSAL FACILITY LIMITS
- LIMITS OF WASTE
- LINER PHASE/MODULE LIMIT
- EXISTING GRADE (10' INTERVAL)
- EXISTING GRADE (2' INTERVAL)
- PROPOSED WASTE GRADE (10' INTERVAL)
- PROPOSED WASTE GRADE (2' INTERVAL)
- CONTACT WATER DRAINAGE
- SURFACE WATER DRAINAGE
- PROPOSED OPEN LANDFILL DRAINAGE AREA
- PROPOSED LEACHATE/SURFACE WATER DRAINAGE AREA

FILLING SEQUENCE	ESTIMATED AIRSPACE VOLUME	ESTIMATED OPEN AREA
0		7.0 ACRES
1		
2		
3		
TOTAL		7.0 ACRES

NOTES:

1. SEE SHEET 2 FOR BASE MAP LEGEND ITEMS AND NOTES.

SCALE: 1" = 100'

PROJECT NO.	25220183.00	DRAWN BY:	KP
DRAWN:	01/15/2022	CHECKED BY:	PEG/MJT
REVISED:	05/20/2022	APPROVED BY:	MRH 05/25/2022

WISCONSIN POWER AND LIGHT COMPANY
COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WI 53954

CLIENT

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ENGINEER

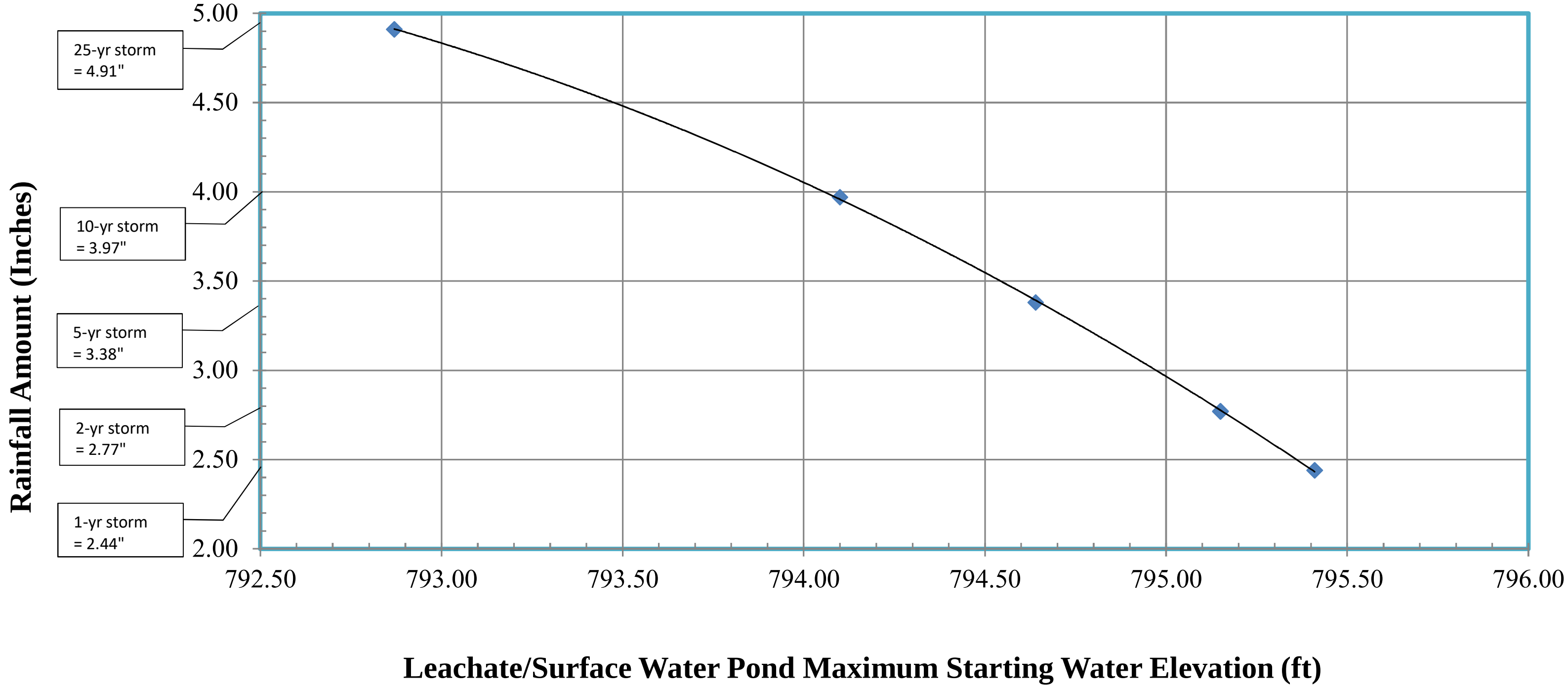
PLAN MODIFICATION REQUEST / PLAN OF OPERATION UPDATE
DRY ASH DISPOSAL FACILITY
COLUMBIA ENERGY CENTER
TOWN OF PACIFIC, WISCONSIN

SITE

STAGE 0 – EXISTING CONDITIONS

FIGURE 1

Figure 1A
Columbia Energy Center
Phase 0 Filling- Open Landfill Area
Leachate/Surface Water Pond Maximum Starting Water Elevation



Notes/Assumptions:

1. Maximum starting water elevations based on 2011 Mod 2 as-built survey which determined the top of pond liner elevation = 796.97.
2. Maximum starting water elevation assumes no freeboard.
3. Previously developed HydroCAD model utilized with curve number for intermediate cover areas and ash surfaces assumed at CN = 98.
4. HydroCAD model assumes drainage areas contributing to pond include (Figure 1):
   - Landfill open area = 7.46 acres.
   - Leachate/Surface Water Pond Area, 3.71 acres.
5. Maximum open area per HydroCAD model during filling is 7.78 acres.

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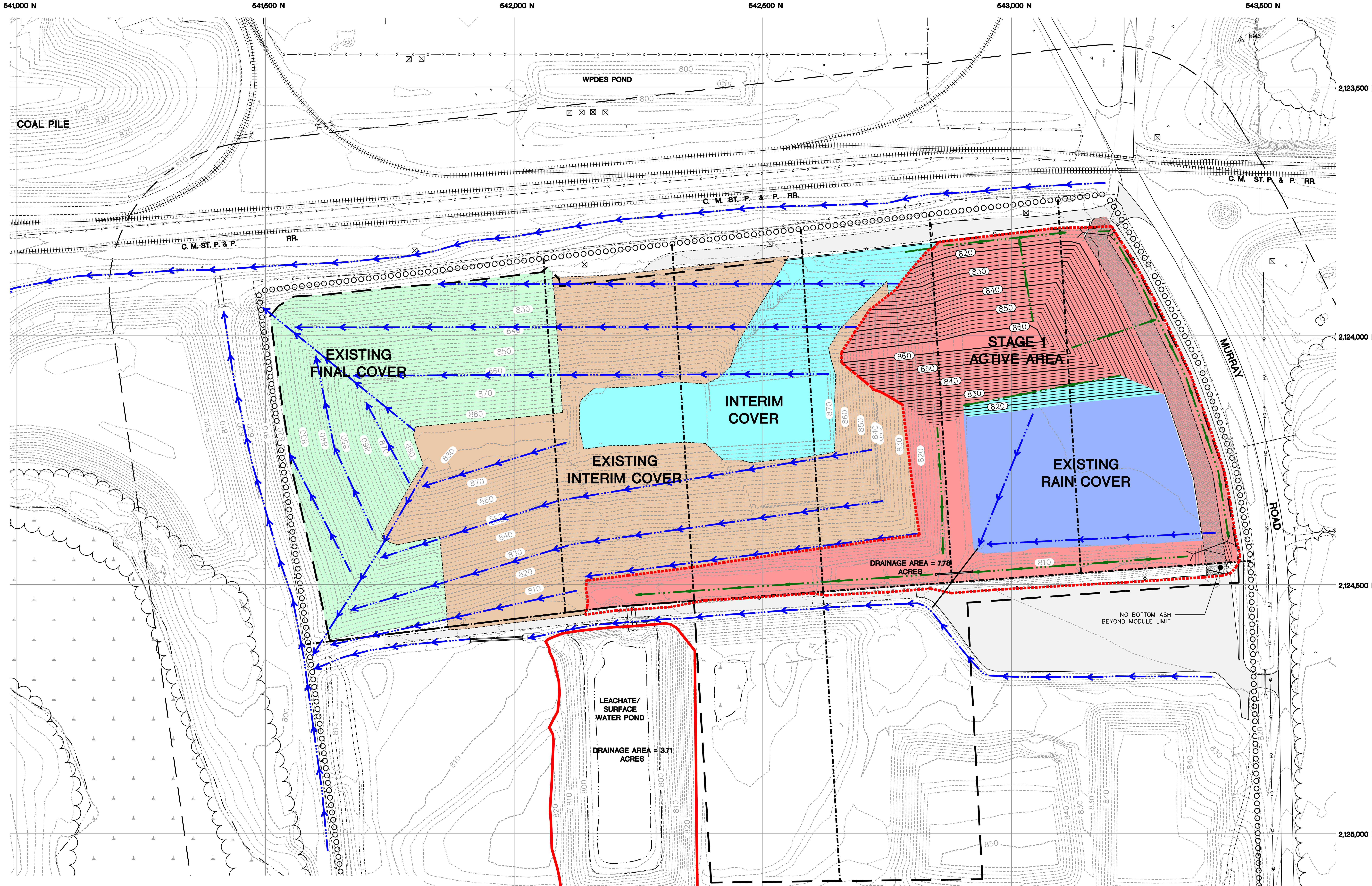


LEGEND

- DRY ASH DISPOSAL FACILITY LIMITS
- LIMITS OF WASTE
- LINER PHASE/MODULE LIMIT
- 810 — EXISTING GRADE (10' INTERVAL)
- EXISTING GRADE (2' INTERVAL)
- 840 — PROPOSED WASTE GRADE (10' INTERVAL)
- PROPOSED WASTE GRADE (2' INTERVAL)
- EXISTING CONTACT WATER DRAINAGE
- PROPOSED CONTACT WATER DRAINAGE

FILLING SEQUENCE	ESTIMATED AIRSPACE VOLUME	ESTIMATED OPEN AREA
1	121,600 CY	7.3 ACRES
2		
3		
4		
TOTAL	121,600 CY	7.3 ACRES

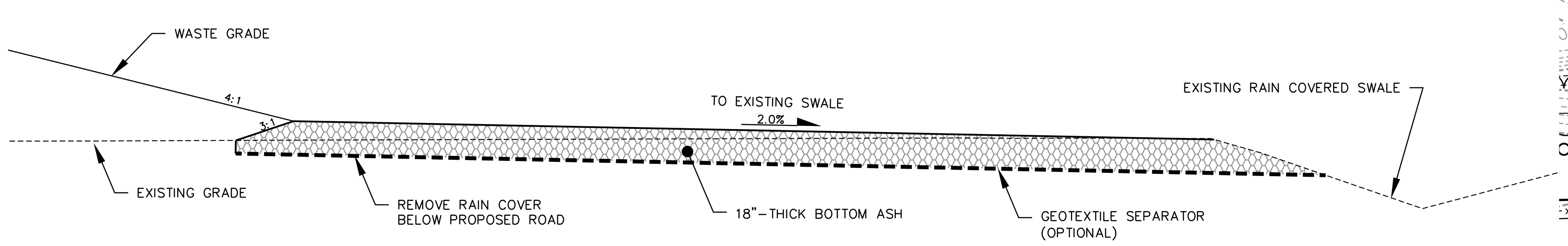
NOTES:

1. SEE SHEET 2 FOR BASE MAP LEGEND ITEMS AND NOTES.
2. PROPOSED GRADES ARE CONCEPTUAL. ACTUAL GRADES WILL BE BASED ON PRIMARY AND SECONDARY ASH POND EXCAVATION PRODUCTION RATES, WEATHER, AND PLANT OPERATIONS.
3. THE POND CLOSURE CONTRACTOR WILL CONSTRUCT ADDITIONAL ACCESS ROADS AS NEEDED TO PLACE MATERIAL IN THE ADF.

N

100 0 100

SCALE: 1" = 100'



1/2 **40' WIDE HAUL ROAD**
SCALE: 1" = 5'

PROJECT NO.	25220183.00	DRAWN BY:	KP
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REVISED:	05/11/2022	APPROVED BY:	MRH 05/25/2022

WISCONSIN POWER AND LIGHT COMPANY
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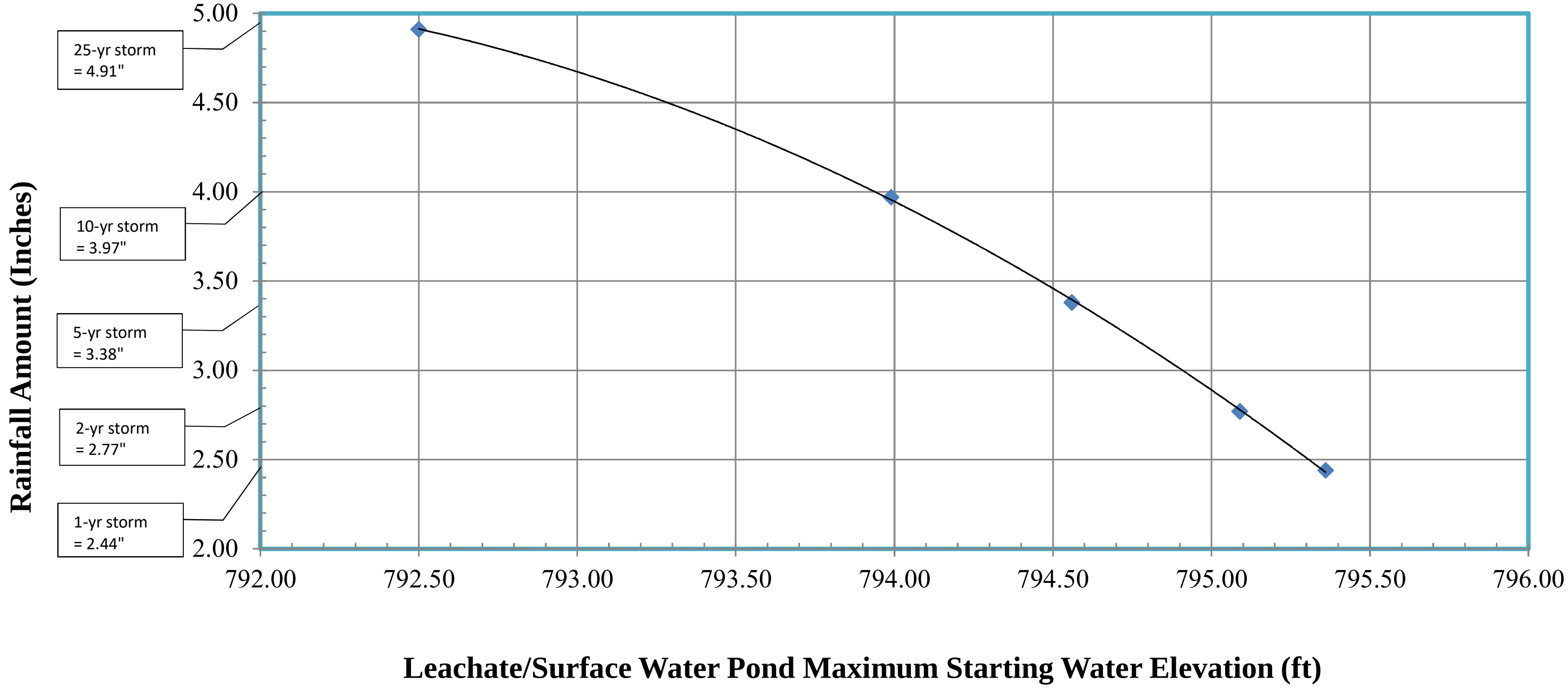
PLAN MODIFICATION REQUEST / PLAN OF OPERATION UPDATE
DRY ASH DISPOSAL FACILITY
COLUMBIA ENERGY CENTER
TOWN OF PACIFIC, WISCONSIN

SITE

STAGE 1 – FILLING MODULES 5 AND 6

FIGURE
2

Figure 2A
Columbia Energy Center
Phase 1 Filling- Open Landfill Area
Leachate/Surface Water Pond Maximum Starting Water Elevation



Notes/Assumptions:

1. Maximum starting water elevations based on 2011 Mod 2 as-built survey which determined the top of pond liner elevation = 796.97.
2. Maximum starting water elevation assumes no freeboard.
3. Previously developed HydroCAD model utilized with curve number for intermediate cover areas and ash surfaces assumed at CN = 98.
4. HydroCAD model assumes drainage areas contributing to pond include (Figure 1):
   - Landfill open area = 7.78 acres.
   - Leachate/Surface Water Pond Area, 3.71 acres.
5. Maximum open area per HydroCAD model during filling is 7.78 acres.

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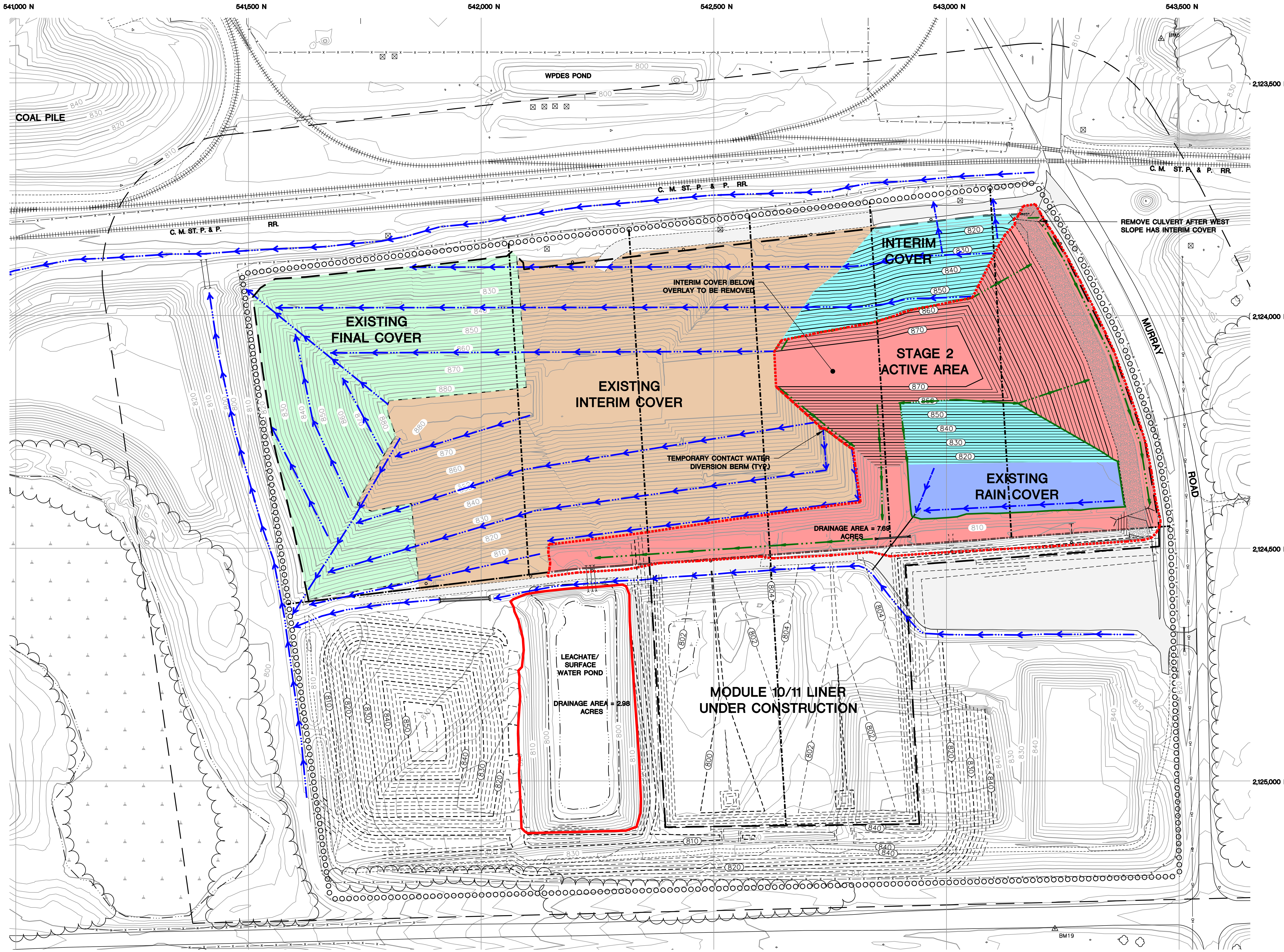
LEGEND

·○○○○○○○○○·	DRY ASH DISPOSAL FACILITY LIMITS
▬ ▬ ▬	LIMITS OF WASTE
-·-·-·-	LINER PHASE/MODULE LIMIT
——	FINAL COVER LIMITS
—810—	EXISTING GRADE (10' INTERVAL)
——	EXISTING GRADE (2' INTERVAL)
—(840)—	PROPOSED WASTE GRADE (10' INTERVAL)
——	PROPOSED WASTE GRADE (2' INTERVAL)
- - (840) - -	PROPOSED MODULE 10 AND 11 SUBBASE AND PERIMETER WASTE GRADE (10' INTERVAL)
- - - -	PROPOSED MODULE 10 AND 11 SUBBASE AND PERIMETER WASTE GRADE (2' INTERVAL)
green dash-dot arrow	EXISTING CONTACT WATER DRAINAGE
blue dash-dot arrow	PROPOSED CONTACT WATER DRAINAGE
red dashed line	PROPOSED OPEN LANDFILL DRAINAGE AREA
red solid line	PROPOSED LEACHATE/SURFACE WATER DRAINAGE AREA

FILLING SEQUENCE	ESTIMATED AIRSPACE VOLUME	ESTIMATED OPEN AREA
1	121,600 CY	
2	151,100 CY	7.2 ACRES
3		
4		
TOTAL	272,700 CY	7.2 ACRES



NOTES:

1. SEE SHEET 2 FOR BASE MAP LEGEND ITEMS AND NOTES.
2. PROPOSED GRADES ARE CONCEPTUAL. ACTUAL GRADES WILL BE BASED ON PRIMARY AND SECONDARY ASH POND EXCAVATION PRODUCTION RATES, WEATHER, AND PLANT OPERATIONS.
3. THE POND CLOSURE CONTRACTOR WILL CONSTRUCT ADDITIONAL ACCESS ROADS AS NEEDED TO PLACE MATERIAL IN THE ADF.

PROJECT NO.	25220183.00	DRAWN BY:	KP
DRAWN:	01/15/2022	CHECKED BY:	PEG/MJT
REVISED:	05/09/2022	APPROVED BY:	MRH 05/25/2022

CLIENT: WISCONSIN POWER AND LIGHT COMPANY, COLUMBIA ENERGY CENTER, W8375 MURRAY ROAD, PARDEEVILLE, WI 53954

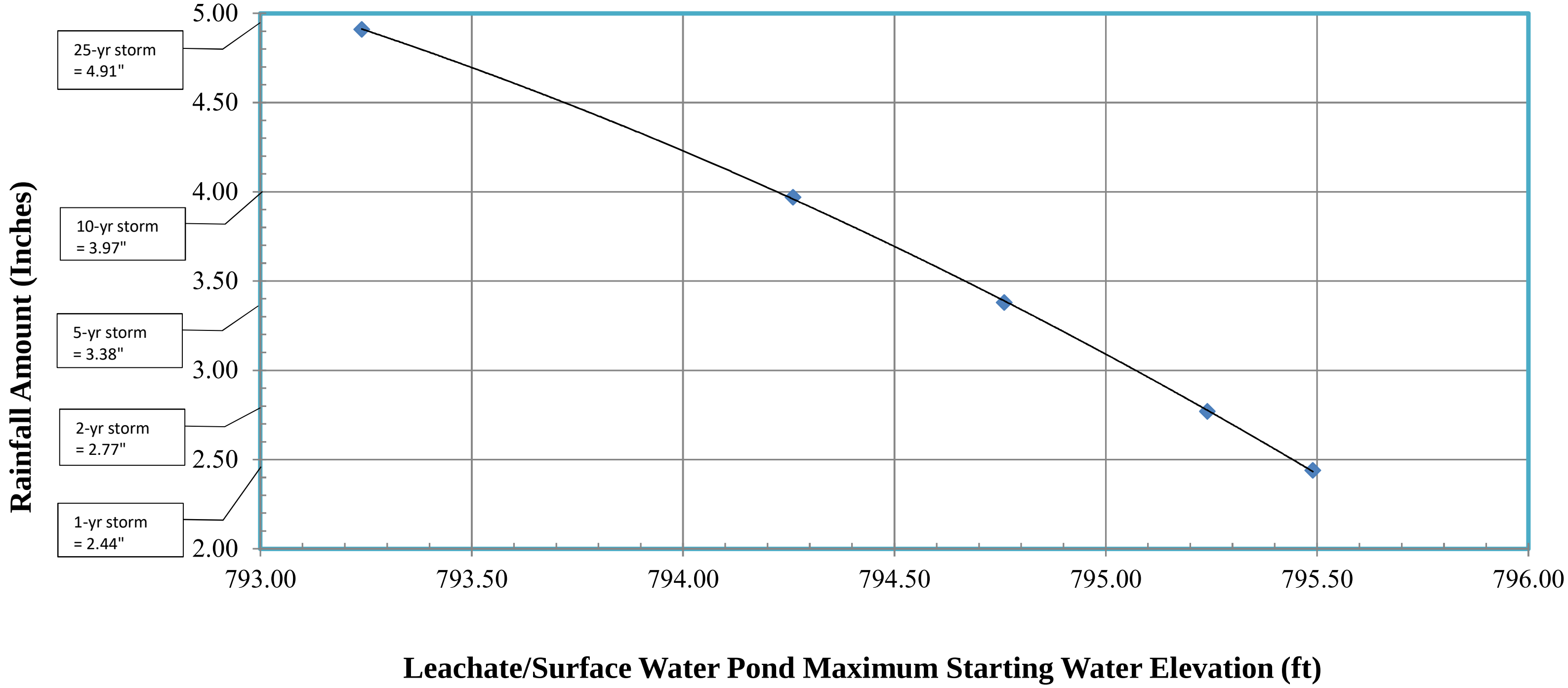
ENGINEER: SCS ENGINEERS, 2830 DAIRY DRIVE MADISON, WI 53718-6751, PHONE: (608) 224-2830

SITE: PLAN MODIFICATION REQUEST / PLAN OF OPERATION UPDATE, DRY ASH DISPOSAL FACILITY, COLUMBIA ENERGY CENTER, TOWN OF PACIFIC, WISCONSIN

STAGE 2 – FILLING MODULES 5 AND 6

FIGURE 3

Figure 3A
Columbia Energy Center
Phase 2 Filling- Open Landfill Area
Leachate/Surface Water Pond Maximum Starting Water Elevation



<u>Notes/Assumptions:</u>

1. Maximum starting water elevations based on 2011 Mod 2 as-built survey which determined the top of pond liner elevation = 796.97.
2. Maximum starting water elevation assumes no freeboard.
3. Previously developed HydroCAD model utilized with curve number for intermediate cover areas and ash surfaces assumed at CN = 98.
4. HydroCAD model assumes drainage areas contributing to pond include (Figure 1):
   - Landfill open area = 7.69 acres.
   - Leachate/Surface Water Pond Area, 2.98 acres.
5. Maximum open area per HydroCAD model during filling is 8.51 acres.

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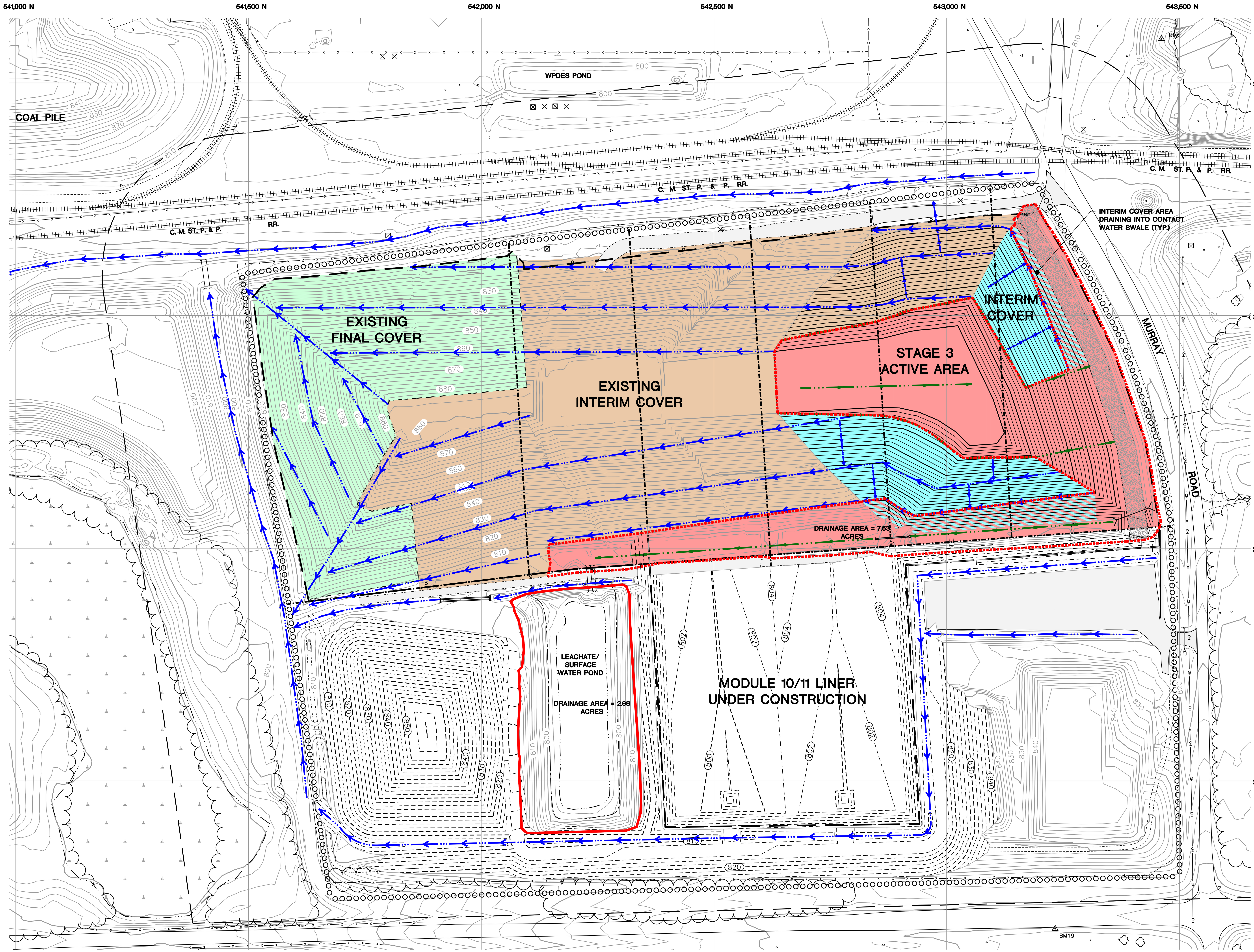

LEGEND

- DRY ASH DISPOSAL FACILITY LIMITS
- LIMITS OF WASTE
- LINER PHASE/MODULE LIMIT
- 810 EXISTING GRADE (10' INTERVAL)
- EXISTING GRADE (2' INTERVAL)
- 840 PROPOSED WASTE GRADE (10' INTERVAL)
- PROPOSED WASTE GRADE (2' INTERVAL)
- 840 PROPOSED MODULE 10 AND 11 SUBBASE AND PERIMETER WASTE GRADE (10' INTERVAL)
- PROPOSED MODULE 10 AND 11 SUBBASE AND PERIMETER WASTE GRADE (2' INTERVAL)
- EXISTING CONTACT WATER DRAINAGE
- PROPOSED CONTACT WATER DRAINAGE
- PROPOSED OPEN LANDFILL DRAINAGE AREA
- PROPOSED LEACHATE/SURFACE WATER DRAINAGE AREA

FILLING SEQUENCE	ESTIMATED AIRSPACE VOLUME	ESTIMATED OPEN AREA
1	121,600 CY	
2	151,100 CY	
3	107,300 CY	7.2 ACRES
4		
TOTAL	380,000 CY	7.2 ACRES

NOTES:

1. SEE SHEET 2 FOR BASE MAP LEGEND ITEMS AND NOTES.
2. PROPOSED GRADES ARE CONCEPTUAL. ACTUAL GRADES WILL BE BASED ON PRIMARY AND SECONDARY ASH POND EXCAVATION PRODUCTION RATES, WEATHER, AND PLANT OPERATIONS.
3. THE POND CLOSURE CONTRACTOR WILL CONSTRUCT ADDITIONAL ACCESS ROADS AS NEEDED TO PLACE MATERIAL IN THE ADF.

N

100 0 100

SCALE: 1" = 100'

PROJECT NO.	25220183.00	DRAWN BY:	KP
DRAWN:	01/15/2022	CHECKED BY:	PEG/MJT
REVISED:	05/09/2022	APPROVED BY:	MRH 05/25/2022

WISCONSIN POWER AND LIGHT COMPANY
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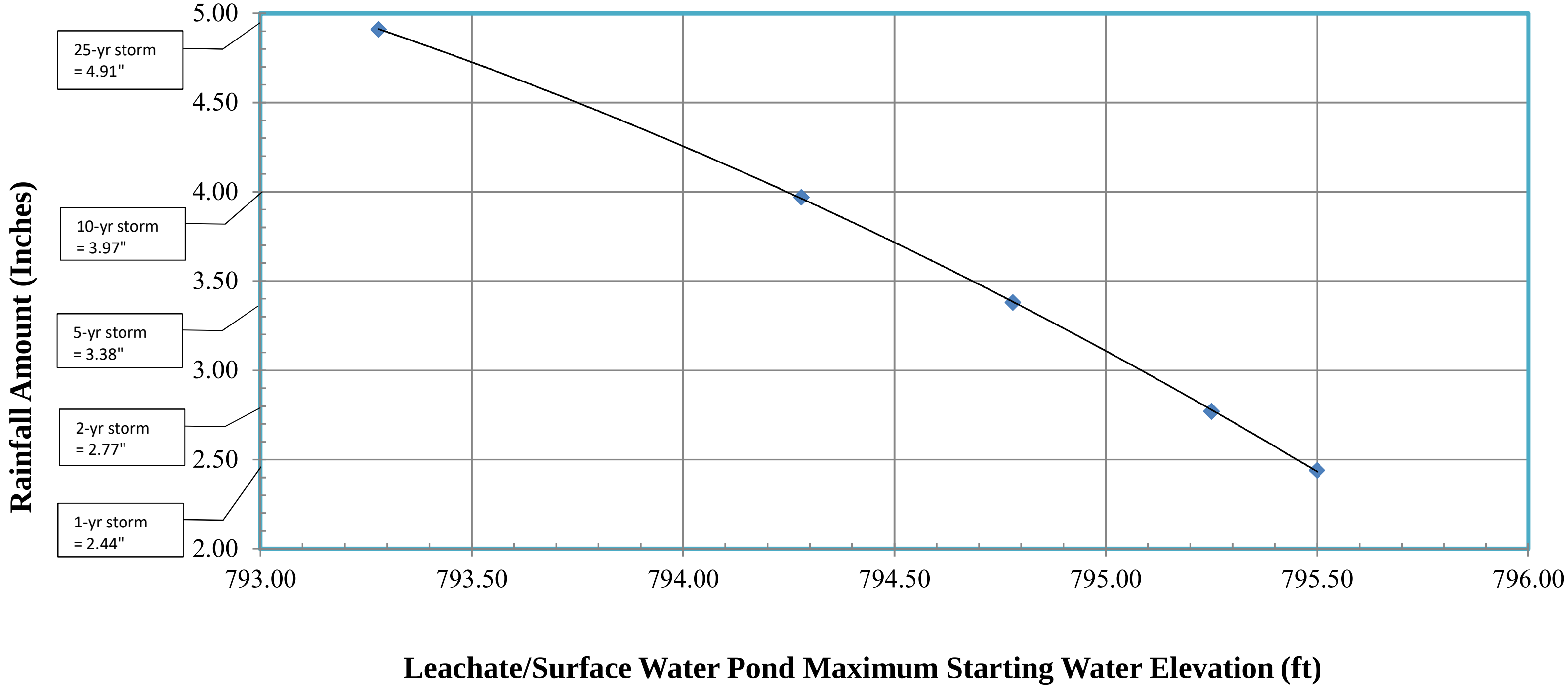
DRY ASH DISPOSAL FACILITY
COLUMBIA ENERGY CENTER
TOWN OF PACIFIC, WISCONSIN

SITE

STAGE 3 - FILLING MODULES 5 AND 6

FIGURE
4

Figure 4A
Columbia Energy Center
Phase 3 Filling- Open Landfill Area
Leachate/Surface Water Pond Maximum Starting Water Elevation



<u>Notes/Assumptions:</u>

1. Maximum starting water elevations based on 2011 Mod 2 as-built survey which determined the top of pond liner elevation = 796.97.
2. Maximum starting water elevation assumes no freeboard.
3. Previously developed HydroCAD model utilized with curve number for intermediate cover areas and ash surfaces assumed at CN = 98.
4. HydroCAD model assumes drainage areas contributing to pond include (Figure 1):
   - Landfill open area = 7.64 acres.
   - Leachate/Surface Water Pond Area, 2.98 acres.
5. Maximum open area per HydroCAD model during filling is 8.51 acres.

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LEGEND

·OOOOOOOOO·	DRY ASH DISPOSAL FACILITY LIMITS
— — —	LIMITS OF WASTE
-··-··-	LINER PHASE/MODULE LIMIT
———	FINAL COVER LIMITS
—810—	EXISTING GRADE (10' INTERVAL)
———	EXISTING GRADE (2' INTERVAL)
—840—	PROPOSED WASTE GRADE (10' INTERVAL)
———	PROPOSED WASTE GRADE (2' INTERVAL)
- -840- -	PROPOSED MODULE 10 AND 11 SUBBASE AND PERIMETER WASTE GRADE (10' INTERVAL)
- - - -	PROPOSED MODULE 10 AND 11 SUBBASE AND PERIMETER WASTE GRADE (2' INTERVAL)
green -··→	EXISTING CONTACT WATER DRAINAGE
blue -··→	PROPOSED CONTACT WATER DRAINAGE
red - - -	PROPOSED OPEN LANDFILL DRAINAGE AREA
red ———	PROPOSED LEACHATE/SURFACE WATER DRAINAGE AREA

FILLING SEQUENCE	ESTIMATED AIRSPACE VOLUME	ESTIMATED OPEN AREA
1	121,600 CY	
2	151,100 CY	
3	107,300 CY	
4	471,600 cy	7.3 ACRES
TOTAL	851,600 CY	7.3 ACRES

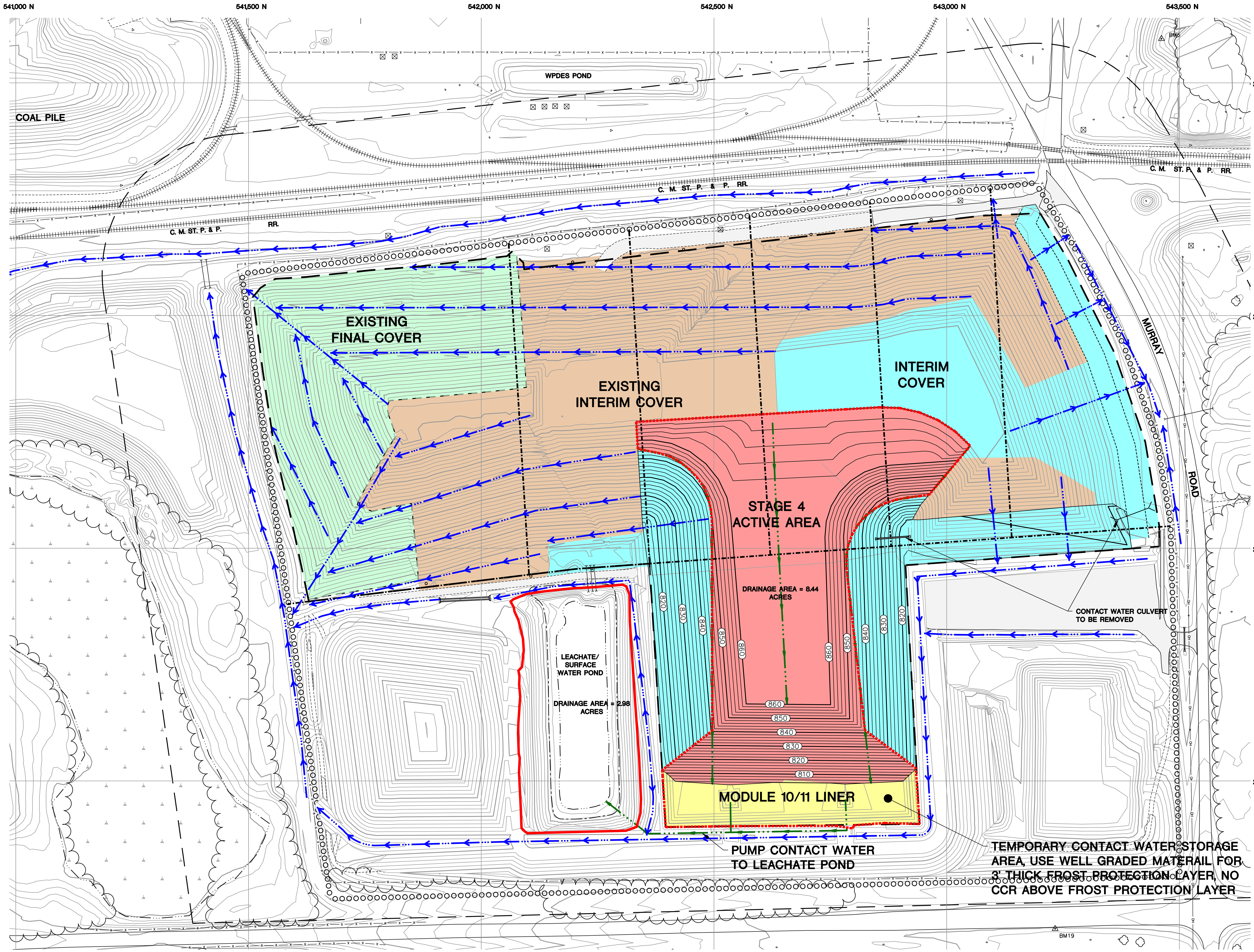
NOTES:

1. SEE SHEET 2 FOR BASE MAP LEGEND ITEMS AND NOTES.
2. PROPOSED GRADES ARE CONCEPTUAL. ACTUAL GRADES WILL BE BASED ON PRIMARY AND SECONDARY ASH POND EXCAVATION PRODUCTION RATES, WEATHER, AND PLANT OPERATIONS.
3. THE POND CLOSURE CONTRACTOR WILL CONSTRUCT ADDITIONAL ACCESS ROADS AS NEEDED TO PLACE MATERIAL IN THE ADF.

N

100 0 100

SCALE: 1" = 100'



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CLIENT: WISCONSIN POWER AND LIGHT COMPANY, COLUMBIA ENERGY CENTER, W8375 MURRAY ROAD, PARDEEVILLE, WI 53954

ENGINEER: SCS ENGINEERS, 2830 DAIRY DRIVE MADISON, WI 53718-6751, PHONE: (608) 224-2830

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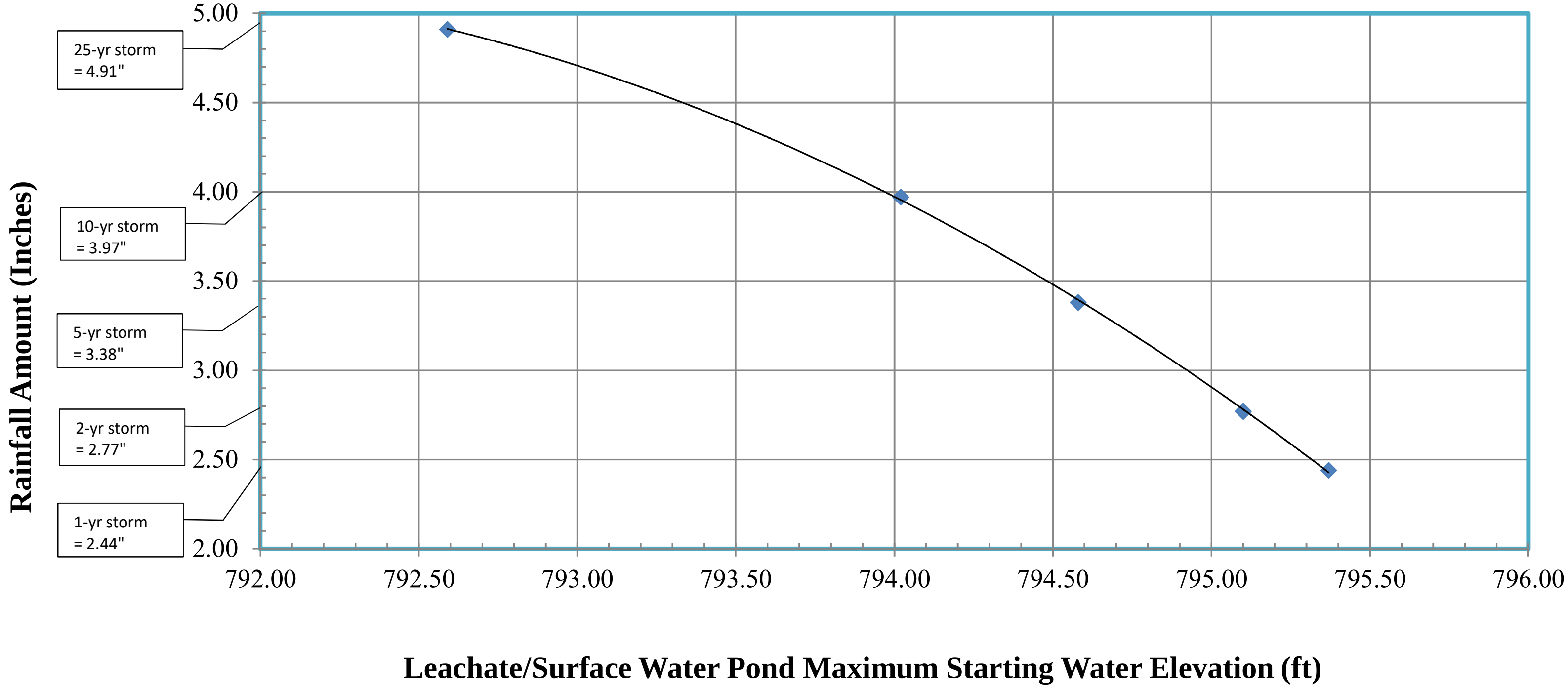
STAGE 4 – FILLING MODULES 10 AND 11

FIGURE 5

Figure 5A
Columbia Energy Center
Phase 4 Filling- Open Landfill Area
Leachate/Surface Water Pond Maximum Starting Water Elevation



<u>Notes/Assumptions:</u>

1. Maximum starting water elevations based on 2011 Mod 2 as-built survey which determined the top of pond liner elevation = 796.97.
2. Maximum starting water elevation assumes no freeboard.
3. Previously developed HydroCAD model utilized with curve number for intermediate cover areas and ash surfaces assumed at CN = 98.
4. HydroCAD model assumes drainage areas contributing to pond include (Figure 1):
   - Landfill open area = 8.44 acres.
   - Leachate/Surface Water Pond Area, 2.98 acres.
5. Maximum open area per HydroCAD model during filling is 8.51 acres.

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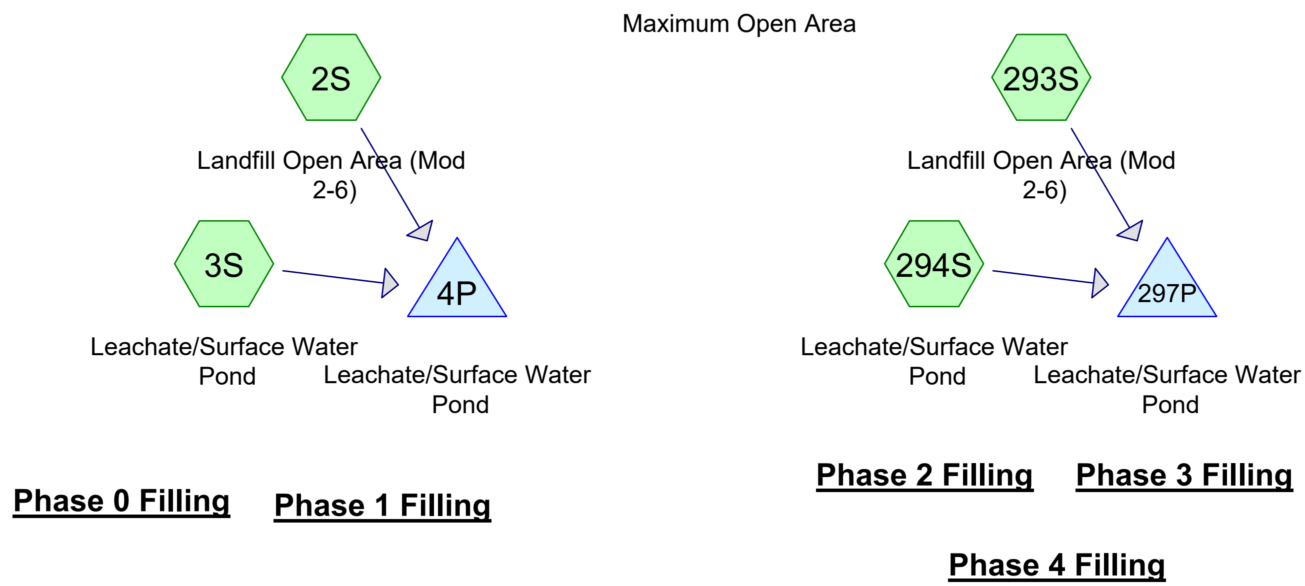
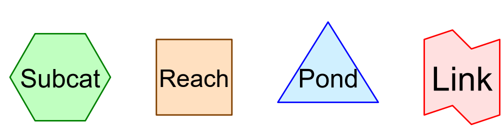




Routing Diagram for WPL Columbia_Leachate Pond Evaluation_220525
Prepared by SCS Engineers, Printed 5/25/2022
HydroCAD® 10.10-7a s/n 05804 © 2021 HydroCAD Software Solutions LLC

Time span=0.00-33.00 hrs, dt=0.05 hrs, 661 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 2S: Landfill Open Area Runoff Area=7.780 ac 100.00% Impervious Runoff Depth=4.67"
Tc=20.0 min CN=98 Runoff=31.75 cfs 3.030 af

Subcatchment 3S: Leachate/Surface Runoff Area=3.710 ac 100.00% Impervious Runoff Depth=4.67"
Tc=0.0 min CN=98 Runoff=26.38 cfs 1.445 af

Subcatchment 293S: Landfill Open Area Runoff Area=8.510 ac 100.00% Impervious Runoff Depth=4.67"
Tc=20.0 min CN=98 Runoff=34.73 cfs 3.314 af

Subcatchment 294S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=4.67"
Tc=0.0 min CN=98 Runoff=21.19 cfs 1.161 af

Pond 4P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,946 cf Inflow=40.23 cfs 4.475 af
Outflow=0.00 cfs 0.000 af

Pond 297P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,946 cf Inflow=39.03 cfs 4.475 af
Outflow=0.00 cfs 0.000 af

Summary for Subcatchment 2S: Landfill Open Area (Mod 2-6)

Runoff = 31.75 cfs @ 12.28 hrs, Volume= 3.030 af, Depth= 4.67"
Routed to Pond 4P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (ac)	CN	Description
*	7.075	98	Mod 2 - 6 Open Area
*	0.705	98	Access Road
	7.780	98	Weighted Average
	7.780		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 3S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 26.38 cfs @ 12.04 hrs, Volume= 1.445 af, Depth= 4.67"
Routed to Pond 4P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (ac)	CN	Description
*	3.710	98	Leachate Surface Water Pond
	3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 293S: Landfill Open Area (Mod 2-6)

Runoff = 34.73 cfs @ 12.28 hrs, Volume= 3.314 af, Depth= 4.67"
Routed to Pond 297P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (ac)	CN	Description
*	8.510	98	Mod 2 - 11 Open Area
	8.510		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 294S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 21.19 cfs @ 12.04 hrs, Volume= 1.161 af, Depth= 4.67"
Routed to Pond 297P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Pond 4P: Leachate/Surface Water Pond

Inflow Area = 11.490 ac,100.00% Impervious, Inflow Depth = 4.67" for 25-yr, 24-hr storm event
Inflow = 40.23 cfs @ 12.06 hrs, Volume= 4.475 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 792.50' Surf.Area= 11,070 sf Storage= 3,030 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,611 sf Storage= 197,946 cf (194,915 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (194,617 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Summary for Pond 297P: Leachate/Surface Water Pond

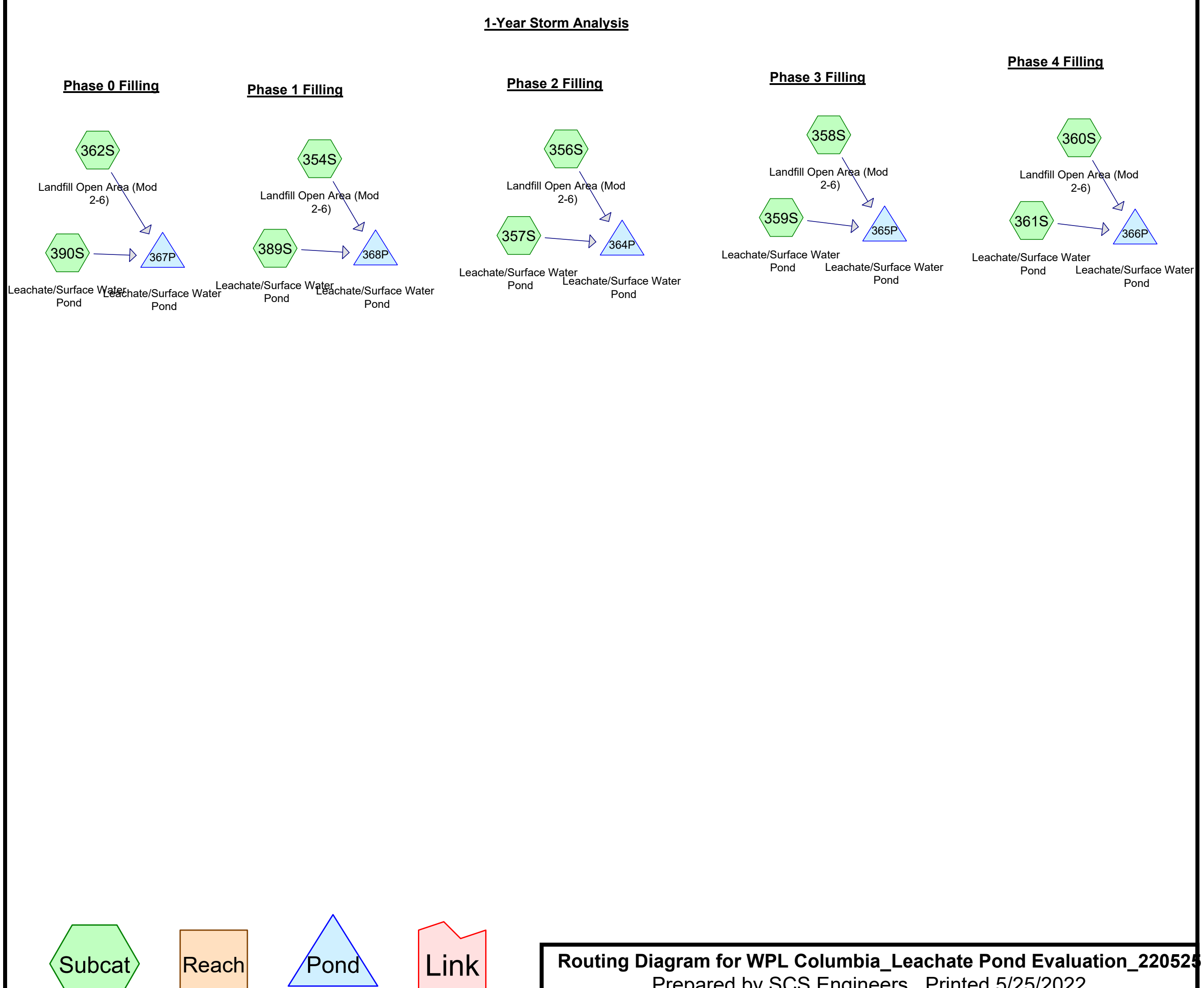
Inflow Area = 11.490 ac,100.00% Impervious, Inflow Depth = 4.67" for 25-yr, 24-hr storm event
Inflow = 39.03 cfs @ 12.27 hrs, Volume= 4.475 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 792.50' Surf.Area= 11,070 sf Storage= 3,030 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,611 sf Storage= 197,946 cf (194,915 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (194,617 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390



Routing Diagram for WPL Columbia_Leachate Pond Evaluation_220525
Prepared by SCS Engineers, Printed 5/25/2022
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Time span=0.00-33.00 hrs, dt=0.05 hrs, 661 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 354S: Landfill Open Area Runoff Area=339,047 sf 100.00% Impervious Runoff Depth=2.21"
Tc=20.0 min CN=98 Runoff=15.52 cfs 1.434 af

Subcatchment 356S: Landfill Open Area Runoff Area=335,031 sf 100.00% Impervious Runoff Depth=2.21"
Tc=20.0 min CN=98 Runoff=15.34 cfs 1.417 af

Subcatchment 357S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=2.21"
Tc=0.0 min CN=98 Runoff=10.38 cfs 0.549 af

Subcatchment 358S: Landfill Open Area Runoff Area=332,594 sf 100.00% Impervious Runoff Depth=2.21"
Tc=20.0 min CN=98 Runoff=15.23 cfs 1.407 af

Subcatchment 359S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=2.21"
Tc=0.0 min CN=98 Runoff=10.38 cfs 0.549 af

Subcatchment 360S: Landfill Open Area Runoff Area=367,758 sf 100.00% Impervious Runoff Depth=2.21"
Tc=20.0 min CN=98 Runoff=16.84 cfs 1.556 af

Subcatchment 361S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=2.21"
Tc=0.0 min CN=98 Runoff=10.38 cfs 0.549 af

Subcatchment 362S: Landfill Open Area Runoff Area=324,737 sf 100.00% Impervious Runoff Depth=2.21"
Tc=20.0 min CN=98 Runoff=14.87 cfs 1.374 af

Subcatchment 389S: Leachate/Surface Runoff Area=3.706 ac 100.00% Impervious Runoff Depth=2.21"
Tc=0.0 min CN=98 Runoff=12.91 cfs 0.683 af

Subcatchment 390S: Leachate/Surface Runoff Area=3.706 ac 100.00% Impervious Runoff Depth=2.21"
Tc=0.0 min CN=98 Runoff=12.91 cfs 0.683 af

Pond 364P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,850 cf Inflow=17.45 cfs 1.966 af
Outflow=0.00 cfs 0.000 af

Pond 365P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,930 cf Inflow=17.34 cfs 1.956 af
Outflow=0.00 cfs 0.000 af

Pond 366P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,593 cf Inflow=18.94 cfs 2.105 af
Outflow=0.00 cfs 0.000 af

Pond 367P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,577 cf Inflow=19.31 cfs 2.056 af
Outflow=0.00 cfs 0.000 af

Pond 368P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,611 cf Inflow=19.60 cfs 2.117 af
Outflow=0.00 cfs 0.000 af

Summary for Subcatchment 354S: Landfill Open Area (Mod 2-6)

Runoff = 15.52 cfs @ 12.29 hrs, Volume= 1.434 af, Depth= 2.21"
Routed to Pond 368P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 1-yr, 24-hr storm Rainfall=2.44"

	Area (sf)	CN	Description
*	339,047	98	Mod 2 - 6 Open Area
	339,047		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 356S: Landfill Open Area (Mod 2-6)

Runoff = 15.34 cfs @ 12.29 hrs, Volume= 1.417 af, Depth= 2.21"
Routed to Pond 364P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 1-yr, 24-hr storm Rainfall=2.44"

	Area (sf)	CN	Description
*	335,031	98	Mod 2 - 6 Open Area
	335,031		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 357S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 10.38 cfs @ 12.04 hrs, Volume= 0.549 af, Depth= 2.21"
Routed to Pond 364P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 1-yr, 24-hr storm Rainfall=2.44"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 358S: Landfill Open Area (Mod 2-6)

Runoff = 15.23 cfs @ 12.29 hrs, Volume= 1.407 af, Depth= 2.21"
Routed to Pond 365P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 1-yr, 24-hr storm Rainfall=2.44"

	Area (sf)	CN	Description
*	332,594	98	Mod 2 - 6 Open Area
	332,594		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 359S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 10.38 cfs @ 12.04 hrs, Volume= 0.549 af, Depth= 2.21"
Routed to Pond 365P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 1-yr, 24-hr storm Rainfall=2.44"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 360S: Landfill Open Area (Mod 2-6)

Runoff = 16.84 cfs @ 12.29 hrs, Volume= 1.556 af, Depth= 2.21"
Routed to Pond 366P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 1-yr, 24-hr storm Rainfall=2.44"

	Area (sf)	CN	Description
*	367,758	98	Mod 2 - 11 Open Area
	367,758		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 361S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 10.38 cfs @ 12.04 hrs, Volume= 0.549 af, Depth= 2.21"
Routed to Pond 366P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 1-yr, 24-hr storm Rainfall=2.44"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 362S: Landfill Open Area (Mod 2-6)

Runoff = 14.87 cfs @ 12.29 hrs, Volume= 1.374 af, Depth= 2.21"
Routed to Pond 367P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 1-yr, 24-hr storm Rainfall=2.44"

	Area (sf)	CN	Description
*	324,737	98	Mod 2 - 6 Open Area
	324,737		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 389S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 12.91 cfs @ 12.04 hrs, Volume= 0.683 af, Depth= 2.21"
Routed to Pond 368P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 1-yr, 24-hr storm Rainfall=2.44"

	Area (ac)	CN	Description
*	3.706	98	Leachate Surface Water Pond
	3.706		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 390S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 12.91 cfs @ 12.04 hrs, Volume= 0.683 af, Depth= 2.21"
Routed to Pond 367P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 1-yr, 24-hr storm Rainfall=2.44"

	Area (ac)	CN	Description
*	3.706	98	Leachate Surface Water Pond
	3.706		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Pond 364P: Leachate/Surface Water Pond

Inflow Area = 10.671 ac,100.00% Impervious, Inflow Depth = 2.21" for 1-yr, 24-hr storm event
Inflow = 17.45 cfs @ 12.27 hrs, Volume= 1.966 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 795.49' Surf.Area= 52,866 sf Storage= 112,201 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,604 sf Storage= 197,850 cf (85,648 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (85,446 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Summary for Pond 365P: Leachate/Surface Water Pond

Inflow Area = 10.615 ac,100.00% Impervious, Inflow Depth = 2.21" for 1-yr, 24-hr storm event
Inflow = 17.34 cfs @ 12.27 hrs, Volume= 1.956 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 795.50' Surf.Area= 52,945 sf Storage= 112,730 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,610 sf Storage= 197,930 cf (85,199 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (84,917 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Summary for Pond 366P: Leachate/Surface Water Pond

Inflow Area = 11.423 ac,100.00% Impervious, Inflow Depth = 2.21" for 1-yr, 24-hr storm event
Inflow = 18.94 cfs @ 12.27 hrs, Volume= 2.105 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 795.37' Surf.Area= 51,921 sf Storage= 105,914 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,583 sf Storage= 197,593 cf (91,679 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (91,733 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Summary for Pond 367P: Leachate/Surface Water Pond

Inflow Area = 11.161 ac,100.00% Impervious, Inflow Depth = 2.21" for 1-yr, 24-hr storm event
Inflow = 19.31 cfs @ 12.05 hrs, Volume= 2.056 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 795.41' Surf.Area= 52,236 sf Storage= 107,997 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,582 sf Storage= 197,577 cf (89,579 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (89,650 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Summary for Pond 368P: Leachate/Surface Water Pond

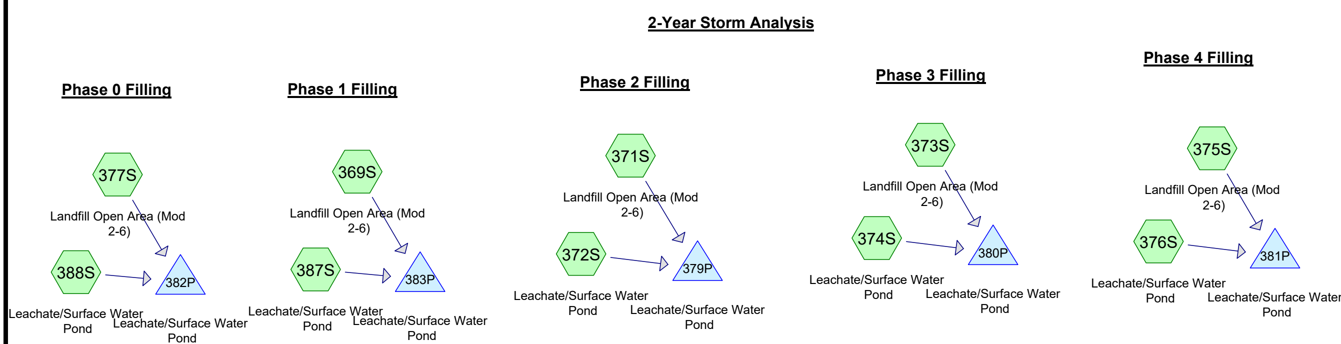
Inflow Area = 11.489 ac,100.00% Impervious, Inflow Depth = 2.21" for 1-yr, 24-hr storm event
Inflow = 19.60 cfs @ 12.06 hrs, Volume= 2.117 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

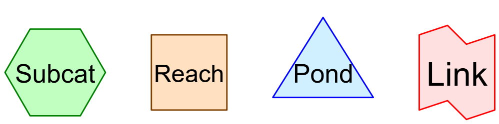
Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 795.36' Surf.Area= 51,842 sf Storage= 105,395 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,585 sf Storage= 197,611 cf (92,216 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (92,252 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390





Routing Diagram for WPL Columbia_Leachate Pond Evaluation_220525
Prepared by SCS Engineers, Printed 5/25/2022
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Time span=0.00-33.00 hrs, dt=0.05 hrs, 661 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 369S: Landfill Open Area Runoff Area=339,047 sf 100.00% Impervious Runoff Depth=2.54"
Tc=20.0 min CN=98 Runoff=17.70 cfs 1.647 af

Subcatchment 371S: Landfill Open Area Runoff Area=335,031 sf 100.00% Impervious Runoff Depth=2.54"
Tc=20.0 min CN=98 Runoff=17.49 cfs 1.628 af

Subcatchment 372S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=2.54"
Tc=0.0 min CN=98 Runoff=11.83 cfs 0.631 af

Subcatchment 373S: Landfill Open Area Runoff Area=332,594 sf 100.00% Impervious Runoff Depth=2.54"
Tc=20.0 min CN=98 Runoff=17.37 cfs 1.616 af

Subcatchment 374S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=2.54"
Tc=0.0 min CN=98 Runoff=11.83 cfs 0.631 af

Subcatchment 375S: Landfill Open Area Runoff Area=367,758 sf 100.00% Impervious Runoff Depth=2.54"
Tc=20.0 min CN=98 Runoff=19.20 cfs 1.787 af

Subcatchment 376S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=2.54"
Tc=0.0 min CN=98 Runoff=11.83 cfs 0.631 af

Subcatchment 377S: Landfill Open Area Runoff Area=324,737 sf 100.00% Impervious Runoff Depth=2.54"
Tc=20.0 min CN=98 Runoff=16.96 cfs 1.578 af

Subcatchment 387S: Leachate/Surface Runoff Area=3.706 ac 100.00% Impervious Runoff Depth=2.54"
Tc=0.0 min CN=98 Runoff=14.72 cfs 0.784 af

Subcatchment 388S: Leachate/Surface Runoff Area=3.706 ac 100.00% Impervious Runoff Depth=2.54"
Tc=0.0 min CN=98 Runoff=14.72 cfs 0.784 af

Pond 379P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,593 cf Inflow=19.90 cfs 2.258 af
Outflow=0.00 cfs 0.000 af

Pond 380P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,587 cf Inflow=19.77 cfs 2.246 af
Outflow=0.00 cfs 0.000 af

Pond 381P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,471 cf Inflow=21.61 cfs 2.417 af
Outflow=0.00 cfs 0.000 af

Pond 382P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,558 cf Inflow=22.04 cfs 2.362 af
Outflow=0.00 cfs 0.000 af

Pond 383P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,589 cf Inflow=22.37 cfs 2.431 af
Outflow=0.00 cfs 0.000 af

Summary for Subcatchment 369S: Landfill Open Area (Mod 2-6)

Runoff = 17.70 cfs @ 12.29 hrs, Volume= 1.647 af, Depth= 2.54"
Routed to Pond 383P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 2-yr, 24-hr storm Rainfall=2.77"

	Area (sf)	CN	Description
*	339,047	98	Mod 2 - 6 Open Area
	339,047		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 371S: Landfill Open Area (Mod 2-6)

Runoff = 17.49 cfs @ 12.29 hrs, Volume= 1.628 af, Depth= 2.54"
Routed to Pond 379P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 2-yr, 24-hr storm Rainfall=2.77"

	Area (sf)	CN	Description
*	335,031	98	Mod 2 - 6 Open Area
	335,031		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 372S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 11.83 cfs @ 12.04 hrs, Volume= 0.631 af, Depth= 2.54"
Routed to Pond 379P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 2-yr, 24-hr storm Rainfall=2.77"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 373S: Landfill Open Area (Mod 2-6)

Runoff = 17.37 cfs @ 12.29 hrs, Volume= 1.616 af, Depth= 2.54"
Routed to Pond 380P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 2-yr, 24-hr storm Rainfall=2.77"

	Area (sf)	CN	Description
*	332,594	98	Mod 2 - 6 Open Area
	332,594		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 374S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 11.83 cfs @ 12.04 hrs, Volume= 0.631 af, Depth= 2.54"
Routed to Pond 380P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 2-yr, 24-hr storm Rainfall=2.77"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 375S: Landfill Open Area (Mod 2-6)

Runoff = 19.20 cfs @ 12.29 hrs, Volume= 1.787 af, Depth= 2.54"
Routed to Pond 381P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 2-yr, 24-hr storm Rainfall=2.77"

	Area (sf)	CN	Description
*	367,758	98	Mod 2 - 11 Open Area
	367,758		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 376S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 11.83 cfs @ 12.04 hrs, Volume= 0.631 af, Depth= 2.54"
Routed to Pond 381P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 2-yr, 24-hr storm Rainfall=2.77"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 377S: Landfill Open Area (Mod 2-6)

Runoff = 16.96 cfs @ 12.29 hrs, Volume= 1.578 af, Depth= 2.54"
Routed to Pond 382P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 2-yr, 24-hr storm Rainfall=2.77"

	Area (sf)	CN	Description
*	324,737	98	Mod 2 - 6 Open Area
	324,737		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 387S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 14.72 cfs @ 12.04 hrs, Volume= 0.784 af, Depth= 2.54"
Routed to Pond 383P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 2-yr, 24-hr storm Rainfall=2.77"

	Area (ac)	CN	Description
*	3.706	98	Leachate Surface Water Pond
	3.706		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 388S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 14.72 cfs @ 12.04 hrs, Volume= 0.784 af, Depth= 2.54"
Routed to Pond 382P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 2-yr, 24-hr storm Rainfall=2.77"

	Area (ac)	CN	Description
*	3.706	98	Leachate Surface Water Pond
	3.706		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Pond 379P: Leachate/Surface Water Pond

Inflow Area = 10.671 ac,100.00% Impervious, Inflow Depth = 2.54" for 2-yr, 24-hr storm event
Inflow = 19.90 cfs @ 12.27 hrs, Volume= 2.258 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 795.24' Surf.Area= 50,897 sf Storage= 99,231 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,583 sf Storage= 197,593 cf (98,362 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (98,416 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Summary for Pond 380P: Leachate/Surface Water Pond

Inflow Area = 10.615 ac,100.00% Impervious, Inflow Depth = 2.54" for 2-yr, 24-hr storm event
Inflow = 19.77 cfs @ 12.27 hrs, Volume= 2.246 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 795.25' Surf.Area= 50,975 sf Storage= 99,740 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,583 sf Storage= 197,587 cf (97,847 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (97,907 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Summary for Pond 381P: Leachate/Surface Water Pond

Inflow Area = 11.423 ac,100.00% Impervious, Inflow Depth = 2.54" for 2-yr, 24-hr storm event
Inflow = 21.61 cfs @ 12.27 hrs, Volume= 2.417 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 795.10' Surf.Area= 49,793 sf Storage= 92,183 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,574 sf Storage= 197,471 cf (105,288 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (105,464 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Summary for Pond 382P: Leachate/Surface Water Pond

Inflow Area = 11.161 ac,100.00% Impervious, Inflow Depth = 2.54" for 2-yr, 24-hr storm event
Inflow = 22.04 cfs @ 12.05 hrs, Volume= 2.362 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 795.15' Surf.Area= 50,187 sf Storage= 94,682 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,581 sf Storage= 197,558 cf (102,876 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (102,965 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Summary for Pond 383P: Leachate/Surface Water Pond

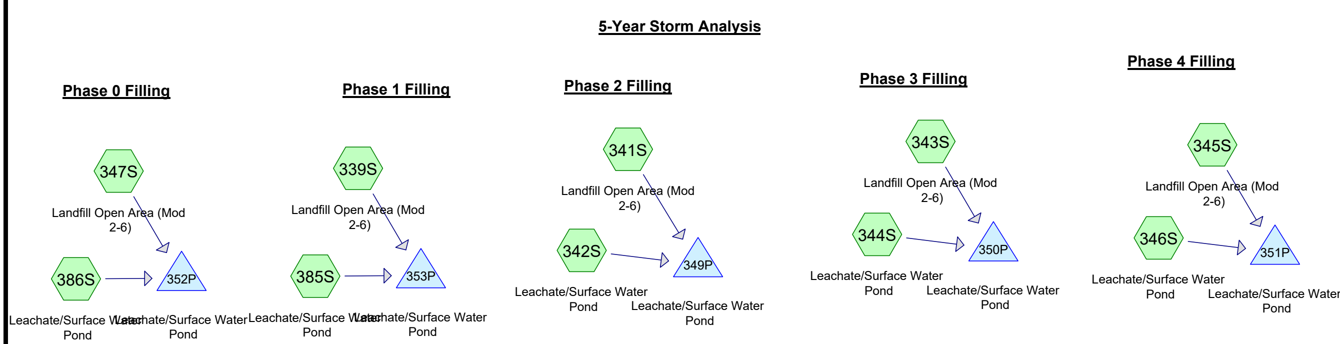
Inflow Area = 11.489 ac,100.00% Impervious, Inflow Depth = 2.54" for 2-yr, 24-hr storm event
Inflow = 22.37 cfs @ 12.06 hrs, Volume= 2.431 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

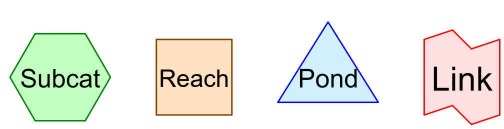
Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 795.09' Surf.Area= 49,715 sf Storage= 91,685 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,583 sf Storage= 197,589 cf (105,904 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (105,962 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390





Routing Diagram for WPL Columbia_Leachate Pond Evaluation_220525
Prepared by SCS Engineers, Printed 5/25/2022
HydroCAD® 10.10-7a s/n 05804 © 2021 HydroCAD Software Solutions LLC

Time span=0.00-33.00 hrs, dt=0.05 hrs, 661 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 339S: Landfill Open Area Runoff Area=339,047 sf 100.00% Impervious Runoff Depth=3.15"
Tc=20.0 min CN=98 Runoff=21.73 cfs 2.041 af

Subcatchment 341S: Landfill Open Area Runoff Area=335,031 sf 100.00% Impervious Runoff Depth=3.15"
Tc=20.0 min CN=98 Runoff=21.47 cfs 2.017 af

Subcatchment 342S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=3.15"
Tc=0.0 min CN=98 Runoff=14.51 cfs 0.781 af

Subcatchment 343S: Landfill Open Area Runoff Area=332,594 sf 100.00% Impervious Runoff Depth=3.15"
Tc=20.0 min CN=98 Runoff=21.31 cfs 2.002 af

Subcatchment 344S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=3.15"
Tc=0.0 min CN=98 Runoff=14.51 cfs 0.781 af

Subcatchment 345S: Landfill Open Area Runoff Area=367,758 sf 100.00% Impervious Runoff Depth=3.15"
Tc=20.0 min CN=98 Runoff=23.57 cfs 2.214 af

Subcatchment 346S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=3.15"
Tc=0.0 min CN=98 Runoff=14.51 cfs 0.781 af

Subcatchment 347S: Landfill Open Area Runoff Area=324,737 sf 100.00% Impervious Runoff Depth=3.15"
Tc=20.0 min CN=98 Runoff=20.81 cfs 1.955 af

Subcatchment 385S: Leachate/Surface Runoff Area=3.706 ac 100.00% Impervious Runoff Depth=3.15"
Tc=0.0 min CN=98 Runoff=18.04 cfs 0.972 af

Subcatchment 386S: Leachate/Surface Runoff Area=3.706 ac 100.00% Impervious Runoff Depth=3.15"
Tc=0.0 min CN=98 Runoff=18.04 cfs 0.972 af

Pond 349P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,605 cf Inflow=24.41 cfs 2.798 af
Outflow=0.00 cfs 0.000 af

Pond 350P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,910 cf Inflow=24.26 cfs 2.784 af
Outflow=0.00 cfs 0.000 af

Pond 351P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,834 cf Inflow=26.51 cfs 2.995 af
Outflow=0.00 cfs 0.000 af

Pond 352P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,602 cf Inflow=27.07 cfs 2.927 af
Outflow=0.00 cfs 0.000 af

Pond 353P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,686 cf Inflow=27.48 cfs 3.013 af
Outflow=0.00 cfs 0.000 af

Summary for Subcatchment 339S: Landfill Open Area (Mod 2-6)

Runoff = 21.73 cfs @ 12.29 hrs, Volume= 2.041 af, Depth= 3.15"
Routed to Pond 353P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 5-yr, 24-hr storm Rainfall=3.38"

	Area (sf)	CN	Description
*	339,047	98	Mod 2 - 6 Open Area
	339,047		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 341S: Landfill Open Area (Mod 2-6)

Runoff = 21.47 cfs @ 12.29 hrs, Volume= 2.017 af, Depth= 3.15"
Routed to Pond 349P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 5-yr, 24-hr storm Rainfall=3.38"

	Area (sf)	CN	Description
*	335,031	98	Mod 2 - 6 Open Area
	335,031		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 342S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 14.51 cfs @ 12.04 hrs, Volume= 0.781 af, Depth= 3.15"
Routed to Pond 349P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 5-yr, 24-hr storm Rainfall=3.38"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 343S: Landfill Open Area (Mod 2-6)

Runoff = 21.31 cfs @ 12.29 hrs, Volume= 2.002 af, Depth= 3.15"
Routed to Pond 350P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 5-yr, 24-hr storm Rainfall=3.38"

	Area (sf)	CN	Description
*	332,594	98	Mod 2 - 6 Open Area
	332,594		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 344S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 14.51 cfs @ 12.04 hrs, Volume= 0.781 af, Depth= 3.15"
Routed to Pond 350P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 5-yr, 24-hr storm Rainfall=3.38"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 345S: Landfill Open Area (Mod 2-6)

Runoff = 23.57 cfs @ 12.29 hrs, Volume= 2.214 af, Depth= 3.15"
Routed to Pond 351P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 5-yr, 24-hr storm Rainfall=3.38"

	Area (sf)	CN	Description
*	367,758	98	Mod 2 - 11 Open Area
	367,758		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 346S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 14.51 cfs @ 12.04 hrs, Volume= 0.781 af, Depth= 3.15"
Routed to Pond 351P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 5-yr, 24-hr storm Rainfall=3.38"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 347S: Landfill Open Area (Mod 2-6)

Runoff = 20.81 cfs @ 12.29 hrs, Volume= 1.955 af, Depth= 3.15"
Routed to Pond 352P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 5-yr, 24-hr storm Rainfall=3.38"

	Area (sf)	CN	Description
*	324,737	98	Mod 2 - 6 Open Area
	324,737		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 385S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 18.04 cfs @ 12.04 hrs, Volume= 0.972 af, Depth= 3.15"
Routed to Pond 353P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 5-yr, 24-hr storm Rainfall=3.38"

	Area (ac)	CN	Description
*	3.706	98	Leachate Surface Water Pond
	3.706		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 386S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 18.04 cfs @ 12.04 hrs, Volume= 0.972 af, Depth= 3.15"
Routed to Pond 352P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 5-yr, 24-hr storm Rainfall=3.38"

	Area (ac)	CN	Description
*	3.706	98	Leachate Surface Water Pond
	3.706		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Pond 349P: Leachate/Surface Water Pond

Inflow Area = 10.671 ac,100.00% Impervious, Inflow Depth = 3.15" for 5-yr, 24-hr storm event
Inflow = 24.41 cfs @ 12.27 hrs, Volume= 2.798 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 794.76' Surf.Area= 47,114 sf Storage= 75,708 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,584 sf Storage= 197,605 cf (121,897 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (121,939 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Summary for Pond 350P: Leachate/Surface Water Pond

Inflow Area = 10.615 ac,100.00% Impervious, Inflow Depth = 3.15" for 5-yr, 24-hr storm event
Inflow = 24.26 cfs @ 12.27 hrs, Volume= 2.784 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 794.78' Surf.Area= 47,272 sf Storage= 76,652 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,608 sf Storage= 197,910 cf (121,257 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (120,995 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Summary for Pond 351P: Leachate/Surface Water Pond

Inflow Area = 11.423 ac,100.00% Impervious, Inflow Depth = 3.15" for 5-yr, 24-hr storm event
Inflow = 26.51 cfs @ 12.27 hrs, Volume= 2.995 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 794.58' Surf.Area= 45,696 sf Storage= 67,355 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,602 sf Storage= 197,834 cf (130,479 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (130,292 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Summary for Pond 352P: Leachate/Surface Water Pond

Inflow Area = 11.161 ac,100.00% Impervious, Inflow Depth = 3.15" for 5-yr, 24-hr storm event
Inflow = 27.07 cfs @ 12.05 hrs, Volume= 2.927 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 794.64' Surf.Area= 46,169 sf Storage= 70,111 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,584 sf Storage= 197,602 cf (127,491 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (127,536 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Summary for Pond 353P: Leachate/Surface Water Pond

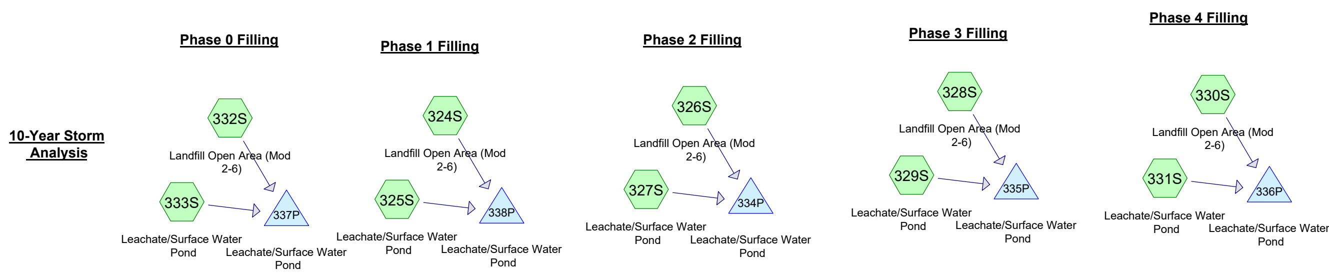
Inflow Area = 11.489 ac,100.00% Impervious, Inflow Depth = 3.15" for 5-yr, 24-hr storm event
Inflow = 27.48 cfs @ 12.06 hrs, Volume= 3.013 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

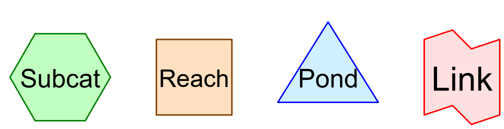
Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 794.56' Surf.Area= 45,539 sf Storage= 66,443 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,591 sf Storage= 197,686 cf (131,243 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (131,204 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390





Routing Diagram for WPL Columbia_Leachate Pond Evaluation_220525
Prepared by SCS Engineers, Printed 5/25/2022
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Time span=0.00-33.00 hrs, dt=0.05 hrs, 661 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 324S: Landfill Open Area Runoff Area=339,047 sf 100.00% Impervious Runoff Depth=3.74"
Tc=20.0 min CN=98 Runoff=25.60 cfs 2.423 af

Subcatchment 325S: Leachate/Surface Runoff Area=3.706 ac 100.00% Impervious Runoff Depth=3.74"
Tc=0.0 min CN=98 Runoff=21.25 cfs 1.154 af

Subcatchment 326S: Landfill Open Area Runoff Area=335,031 sf 100.00% Impervious Runoff Depth=3.74"
Tc=20.0 min CN=98 Runoff=25.30 cfs 2.394 af

Subcatchment 327S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=3.74"
Tc=0.0 min CN=98 Runoff=17.09 cfs 0.928 af

Subcatchment 328S: Landfill Open Area Runoff Area=332,594 sf 100.00% Impervious Runoff Depth=3.74"
Tc=20.0 min CN=98 Runoff=25.12 cfs 2.377 af

Subcatchment 329S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=3.74"
Tc=0.0 min CN=98 Runoff=17.09 cfs 0.928 af

Subcatchment 330S: Landfill Open Area Runoff Area=367,758 sf 100.00% Impervious Runoff Depth=3.74"
Tc=20.0 min CN=98 Runoff=27.77 cfs 2.628 af

Subcatchment 331S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=3.74"
Tc=0.0 min CN=98 Runoff=17.09 cfs 0.928 af

Subcatchment 332S: Landfill Open Area Runoff Area=324,737 sf 100.00% Impervious Runoff Depth=3.74"
Tc=20.0 min CN=98 Runoff=24.52 cfs 2.320 af

Subcatchment 333S: Leachate/Surface Runoff Area=3.706 ac 100.00% Impervious Runoff Depth=3.74"
Tc=0.0 min CN=98 Runoff=21.25 cfs 1.154 af

Pond 334P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,822 cf Inflow=28.77 cfs 3.322 af
Outflow=0.00 cfs 0.000 af

Pond 335P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,929 cf Inflow=28.58 cfs 3.304 af
Outflow=0.00 cfs 0.000 af

Pond 336P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,874 cf Inflow=31.24 cfs 3.555 af
Outflow=0.00 cfs 0.000 af

Pond 337P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,655 cf Inflow=31.91 cfs 3.474 af
Outflow=0.00 cfs 0.000 af

Pond 338P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,547 cf Inflow=32.39 cfs 3.576 af
Outflow=0.00 cfs 0.000 af

Summary for Subcatchment 324S: Landfill Open Area (Mod 2-6)

Runoff = 25.60 cfs @ 12.29 hrs, Volume= 2.423 af, Depth= 3.74"
Routed to Pond 338P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 10-yr, 24-hr storm Rainfall=3.97"

	Area (sf)	CN	Description
*	339,047	98	Mod 2 - 6 Open Area
	339,047		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 325S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 21.25 cfs @ 12.04 hrs, Volume= 1.154 af, Depth= 3.74"
Routed to Pond 338P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 10-yr, 24-hr storm Rainfall=3.97"

	Area (ac)	CN	Description
*	3.706	98	Leachate Surface Water Pond
	3.706		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 326S: Landfill Open Area (Mod 2-6)

Runoff = 25.30 cfs @ 12.29 hrs, Volume= 2.394 af, Depth= 3.74"
Routed to Pond 334P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 10-yr, 24-hr storm Rainfall=3.97"

	Area (sf)	CN	Description
*	335,031	98	Mod 2 - 6 Open Area
	335,031		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 327S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 17.09 cfs @ 12.04 hrs, Volume= 0.928 af, Depth= 3.74"
Routed to Pond 334P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 10-yr, 24-hr storm Rainfall=3.97"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 328S: Landfill Open Area (Mod 2-6)

Runoff = 25.12 cfs @ 12.29 hrs, Volume= 2.377 af, Depth= 3.74"
Routed to Pond 335P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 10-yr, 24-hr storm Rainfall=3.97"

	Area (sf)	CN	Description
*	332,594	98	Mod 2 - 6 Open Area
	332,594		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 329S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 17.09 cfs @ 12.04 hrs, Volume= 0.928 af, Depth= 3.74"
Routed to Pond 335P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 10-yr, 24-hr storm Rainfall=3.97"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 330S: Landfill Open Area (Mod 2-6)

Runoff = 27.77 cfs @ 12.29 hrs, Volume= 2.628 af, Depth= 3.74"
Routed to Pond 336P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 10-yr, 24-hr storm Rainfall=3.97"

	Area (sf)	CN	Description
*	367,758	98	Mod 2 - 11 Open Area
	367,758		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 331S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 17.09 cfs @ 12.04 hrs, Volume= 0.928 af, Depth= 3.74"
Routed to Pond 336P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 10-yr, 24-hr storm Rainfall=3.97"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 332S: Landfill Open Area (Mod 2-6)

Runoff = 24.52 cfs @ 12.29 hrs, Volume= 2.320 af, Depth= 3.74"
Routed to Pond 337P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 10-yr, 24-hr storm Rainfall=3.97"

	Area (sf)	CN	Description
*	324,737	98	Mod 2 - 6 Open Area
	324,737		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 333S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 21.25 cfs @ 12.04 hrs, Volume= 1.154 af, Depth= 3.74"
Routed to Pond 337P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 10-yr, 24-hr storm Rainfall=3.97"

	Area (ac)	CN	Description
*	3.706	98	Leachate Surface Water Pond
	3.706		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Pond 334P: Leachate/Surface Water Pond

Inflow Area = 10.671 ac,100.00% Impervious, Inflow Depth = 3.74" for 10-yr, 24-hr storm event
Inflow = 28.77 cfs @ 12.27 hrs, Volume= 3.322 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 794.26' Surf.Area= 43,175 sf Storage= 53,136 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,601 sf Storage= 197,822 cf (144,686 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (144,511 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Summary for Pond 335P: Leachate/Surface Water Pond

Inflow Area = 10.615 ac,100.00% Impervious, Inflow Depth = 3.74" for 10-yr, 24-hr storm event
Inflow = 28.58 cfs @ 12.27 hrs, Volume= 3.304 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 794.28' Surf.Area= 43,332 sf Storage= 54,001 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,610 sf Storage= 197,929 cf (143,927 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (143,646 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Summary for Pond 336P: Leachate/Surface Water Pond

Inflow Area = 11.423 ac,100.00% Impervious, Inflow Depth = 3.74" for 10-yr, 24-hr storm event
Inflow = 31.24 cfs @ 12.27 hrs, Volume= 3.555 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 794.02' Surf.Area= 41,284 sf Storage= 43,001 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,605 sf Storage= 197,874 cf (154,873 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (154,646 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Summary for Pond 337P: Leachate/Surface Water Pond

Inflow Area = 11.161 ac,100.00% Impervious, Inflow Depth = 3.74" for 10-yr, 24-hr storm event
Inflow = 31.91 cfs @ 12.05 hrs, Volume= 3.474 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 794.10' Surf.Area= 41,914 sf Storage= 46,329 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,588 sf Storage= 197,655 cf (151,326 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (151,318 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Summary for Pond 338P: Leachate/Surface Water Pond

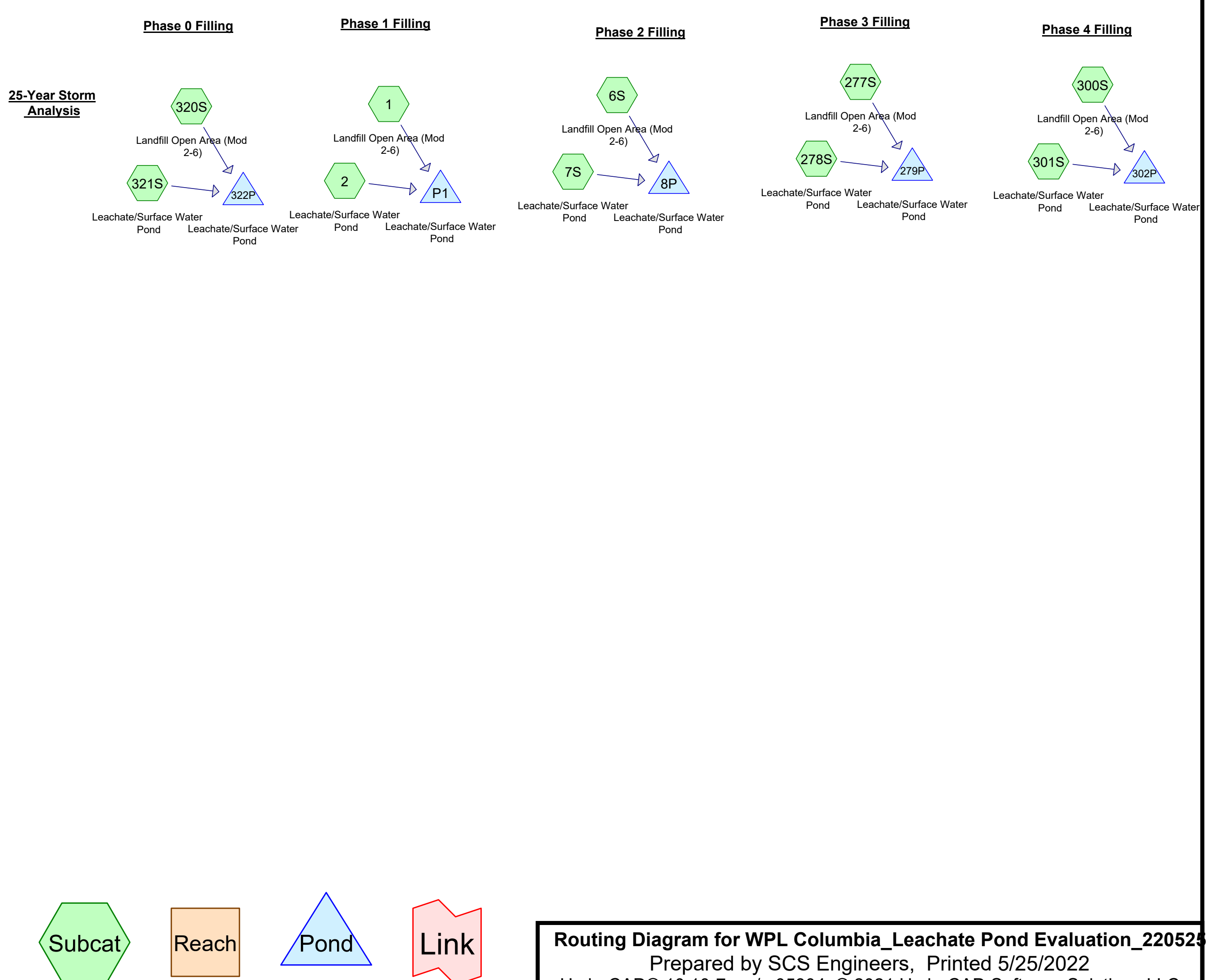
Inflow Area = 11.489 ac,100.00% Impervious, Inflow Depth = 3.74" for 10-yr, 24-hr storm event
Inflow = 32.39 cfs @ 12.06 hrs, Volume= 3.576 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 793.99' Surf.Area= 40,926 sf Storage= 41,767 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,580 sf Storage= 197,547 cf (155,781 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (155,880 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390



Routing Diagram for WPL Columbia_Leachate Pond Evaluation_220525
Prepared by SCS Engineers, Printed 5/25/2022
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Time span=0.00-33.00 hrs, dt=0.05 hrs, 661 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1: Landfill Open Area Runoff Area=339,047 sf 100.00% Impervious Runoff Depth=4.67"
Tc=20.0 min CN=98 Runoff=31.77 cfs 3.031 af

Subcatchment 2: Leachate/Surface Water Runoff Area=3.706 ac 100.00% Impervious Runoff Depth=4.67"
Tc=0.0 min CN=98 Runoff=26.35 cfs 1.443 af

Subcatchment 6S: Landfill Open Area Runoff Area=335,031 sf 100.00% Impervious Runoff Depth=4.67"
Tc=20.0 min CN=98 Runoff=31.39 cfs 2.995 af

Subcatchment 7S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=4.67"
Tc=0.0 min CN=98 Runoff=21.19 cfs 1.161 af

Subcatchment 277S: Landfill Open Area Runoff Area=332,594 sf 100.00% Impervious Runoff Depth=4.67"
Tc=20.0 min CN=98 Runoff=31.16 cfs 2.974 af

Subcatchment 278S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=4.67"
Tc=0.0 min CN=98 Runoff=21.19 cfs 1.161 af

Subcatchment 300S: Landfill Open Area Runoff Area=367,758 sf 100.00% Impervious Runoff Depth=4.67"
Tc=20.0 min CN=98 Runoff=34.46 cfs 3.288 af

Subcatchment 301S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=4.67"
Tc=0.0 min CN=98 Runoff=21.19 cfs 1.161 af

Subcatchment 320S: Landfill Open Area Runoff Area=324,737 sf 100.00% Impervious Runoff Depth=4.67"
Tc=20.0 min CN=98 Runoff=30.43 cfs 2.903 af

Subcatchment 321S: Leachate/Surface Runoff Area=3.706 ac 100.00% Impervious Runoff Depth=4.67"
Tc=0.0 min CN=98 Runoff=26.35 cfs 1.443 af

Pond 8P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,735 cf Inflow=35.69 cfs 4.156 af
Outflow=0.00 cfs 0.000 af

Pond 279P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,837 cf Inflow=35.46 cfs 4.134 af
Outflow=0.00 cfs 0.000 af

Pond 302P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,879 cf Inflow=38.75 cfs 4.448 af
Outflow=0.00 cfs 0.000 af

Pond 322P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,831 cf Inflow=39.61 cfs 4.347 af
Outflow=0.00 cfs 0.000 af

Pond P1: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,936 cf Inflow=40.21 cfs 4.474 af
Outflow=0.00 cfs 0.000 af

Summary for Subcatchment 1: Landfill Open Area (Mod 2-6)

Runoff = 31.77 cfs @ 12.28 hrs, Volume= 3.031 af, Depth= 4.67"
Routed to Pond P1 : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (sf)	CN	Description
*	339,047	98	Mod 2 - 6 Open Area
	339,047		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 2: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 26.35 cfs @ 12.04 hrs, Volume= 1.443 af, Depth= 4.67"
Routed to Pond P1 : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (ac)	CN	Description
*	3.706	98	Leachate Surface Water Pond
	3.706		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 6S: Landfill Open Area (Mod 2-6)

Runoff = 31.39 cfs @ 12.28 hrs, Volume= 2.995 af, Depth= 4.67"
Routed to Pond 8P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (sf)	CN	Description
*	335,031	98	Mod 2 - 6 Open Area
	335,031		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 7S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 21.19 cfs @ 12.04 hrs, Volume= 1.161 af, Depth= 4.67"
Routed to Pond 8P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 277S: Landfill Open Area (Mod 2-6)

Runoff = 31.16 cfs @ 12.28 hrs, Volume= 2.974 af, Depth= 4.67"
Routed to Pond 279P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (sf)	CN	Description
*	332,594	98	Mod 2 - 6 Open Area
	332,594		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 278S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 21.19 cfs @ 12.04 hrs, Volume= 1.161 af, Depth= 4.67"
Routed to Pond 279P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 300S: Landfill Open Area (Mod 2-6)

Runoff = 34.46 cfs @ 12.28 hrs, Volume= 3.288 af, Depth= 4.67"
Routed to Pond 302P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (sf)	CN	Description
*	367,758	98	Mod 2 - 11 Open Area
	367,758		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 301S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 21.19 cfs @ 12.04 hrs, Volume= 1.161 af, Depth= 4.67"
Routed to Pond 302P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 320S: Landfill Open Area (Mod 2-6)

Runoff = 30.43 cfs @ 12.28 hrs, Volume= 2.903 af, Depth= 4.67"
Routed to Pond 322P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (sf)	CN	Description
*	324,737	98	Mod 2 - 6 Open Area
	324,737		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 321S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 26.35 cfs @ 12.04 hrs, Volume= 1.443 af, Depth= 4.67"
Routed to Pond 322P : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (ac)	CN	Description
*	3.706	98	Leachate Surface Water Pond
	3.706		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Pond 8P: Leachate/Surface Water Pond

Inflow Area = 10.671 ac,100.00% Impervious, Inflow Depth = 4.67" for 25-yr, 24-hr storm event
Inflow = 35.69 cfs @ 12.27 hrs, Volume= 4.156 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 793.24' Surf.Area= 25,898 sf Storage= 16,708 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,594 sf Storage= 197,735 cf (181,027 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (180,939 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Summary for Pond 279P: Leachate/Surface Water Pond

Inflow Area = 10.615 ac,100.00% Impervious, Inflow Depth = 4.67" for 25-yr, 24-hr storm event
Inflow = 35.46 cfs @ 12.27 hrs, Volume= 4.134 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 793.28' Surf.Area= 26,699 sf Storage= 17,760 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,603 sf Storage= 197,837 cf (180,077 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (179,887 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Summary for Pond 302P: Leachate/Surface Water Pond

Inflow Area = 11.423 ac,100.00% Impervious, Inflow Depth = 4.67" for 25-yr, 24-hr storm event
Inflow = 38.75 cfs @ 12.27 hrs, Volume= 4.448 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 792.59' Surf.Area= 12,873 sf Storage= 4,108 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,606 sf Storage= 197,879 cf (193,772 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (193,540 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Summary for Pond 322P: Leachate/Surface Water Pond

Inflow Area = 11.161 ac,100.00% Impervious, Inflow Depth = 4.67" for 25-yr, 24-hr storm event
Inflow = 39.61 cfs @ 12.05 hrs, Volume= 4.347 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 792.87' Surf.Area= 18,484 sf Storage= 8,498 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,602 sf Storage= 197,831 cf (189,333 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (189,150 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Summary for Pond P1: Leachate/Surface Water Pond

Inflow Area = 11.489 ac,100.00% Impervious, Inflow Depth = 4.67" for 25-yr, 24-hr storm event
Inflow = 40.21 cfs @ 12.06 hrs, Volume= 4.474 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 792.50' Surf.Area= 11,070 sf Storage= 3,030 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,610 sf Storage= 197,936 cf (194,906 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (194,617 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Appendix A3

2022 Module 10 and Module 11 Design and South Sediment Basin Check

Storm Water Management Calculations

Purpose:
The purpose of the storm water runoff calculations is to demonstrate that the existing storm water sedimentation basin and proposed storm water management features included in the Modules 10 and 11 Plan Modification Request can accommodate and safely convey the runoff from a 25-year, 24-hour storm event during post closure conditions.

Items addressed in these calculations:

- Sedimentation Basin
- Swales
- Culverts
- Diversion Berms
- Downslope Flumes & Energy Dissipaters
- Rock Chutes
- Discharge Aprons

The proposed storm water management conditions are shown on **Figure 1**.

The calculations support the capacity check of the following existing storm water management feature:

Feature	Purpose	Design Method
Sedimentation Basin	To safely handle 25-year, 24-hour storm event without overtopping the 100-year, 24-hour emergency spillway.	HydroCAD runoff modeling
Swales	Convey storm water runoff from adjacent areas to Culvert C2 and offsite during post construction conditions	HydroCAD runoff modeling and Swale Calculation
Culverts	Convey storm water from the final cover perimeter swales during post construction conditions	HydroCAD runoff modeling and HY-8 Culvert Model
Diversion Berms	Reduce storm water runoff from long final cover slopes and to divert water to perimeter swales during post construction conditions	HydroCAD runoff modeling and Diversion Berm Calculations
Downslope Flumes & Energy Dissipators	Convey storm water from diversion berms down slope to discharge locations during post construction conditions	HydroCAD runoff modeling and Downslope Flume Calculations
Rock Chutes	Erosion protection and convey storm water from energy dissipators (Flume 1 and Flume 2) to existing swale during post construction conditions	HydroCAD runoff modeling and Rock Chute Calculation
Discharge Aprons	Erosion protection from culvert discharge at culverts	HydroCAD runoff modeling and Riprap Apron Calculation

Approach:
Hydrograph Generation
HydroCAD was used to model the storm water management system and develop the hydrographs

using TR-20 methodologies. The model is designed to simulate the surface runoff response of a watershed to a precipitation event. Input parameters for the model include precipitation depth for the design storm events from NOAA ATLAS 14, contributing drainage areas, runoff curve numbers, and time of concentration.

Swale Sizing

The proposed swales were sized for the 25-year, 24-hour storm event. A spreadsheet based on Manning's equation was used to determine the depth of flow and velocity in the swales based on the swale geometry and peak flow in the swales (as determined by the Hydrograph Generation models).

Culvert Sizing

Culverts were sized for the 25-year, 24-hour storm event using the HY-8 computer model developed by the US Department of Transportation, Federal Highway Administration.

Diversion Berms

Diversion berms were sized for the 25-year, 24-hour storm event using the Manning's Equation to determine the depth of flow and velocity in the swale based on the swale geometry and peak flow for the storm event (as determined by the Hydrograph Generation Calculations).

Downslope Flumes and Energy Dissipaters Sizing

Flumes and energy dissipaters were sized for the 25-year, 24-hour storm event. Manning's equation and the orifice equation were used to size the flumes. Energy dissipaters were sized using tables from the reference book "Hydraulic Design of Energy Dissipaters for Culverts and Channels" US Department of Transportation, Federal Highway Administration, July 2006.

Rock Cute Sizing

Rock chutes were sized for the 25-year, 24-hour storm event. Rock Chutes were sized based on the flow to each culvert location. The Iowa NRCS Rock Chute Design spreadsheet was used to size the chute and riprap.

Discharge Apron Sizing

Riprap aprons were sized for the 25-year, 24-hour storm event using equations in Section 5.2 – Riprap Blanket of WisDOT FDM 13-35-5. The riprap aprons were sized based on the flow to the culvert location. The riprap sizing was used to size the riprap discharge apron.

Basin Sizing

Route the proposed construction and existing drainage runoff through the sedimentation basin to confirm the basin can handle the 25-year, 24-hour storm event. HydroCAD was used to model the runoff flow through the basin outfall (as determined by the Hydrograph Generation model).

Key Assumptions:

- Drainage areas and time of concentration flow paths are as shown on **Figure 1** for Post Construction Conditions.
- An MSE4 rainfall distribution was used based on NRCS Wisconsin rainfall distribution regions. The precipitation depth for the 25-year, 24-hour storm was assumed to be 4.91 inches, based on NOAA ATLAS 14 Point Precipitation Frequency Estimates (NOAA's National Weather Service Hydrometeorological Design Studies Center Precipitation Frequency Data Server).
- Runoff curve numbers were based on tables presented in Urban Hydrology for Small Watersheds, and were assumed as follows and as listed in the modeling.

Cover Type	CN
Final Cover	69 – Pasture/grassland/range in good condition, hydrologic soil group (HSG) C/B (assumed mid value between each soil group)
Pasture, grassland or range	39 – Pasture/grassland/range, Good, HSG A
Rain Cover	98 – Rain Cover (plastic smooth material)
Pavement	98 – impervious HSG A
Gravel	96 – Gravel, HSG A

- Type A soil group for non-disturbed areas outside the landfill as soils are loamy sand.
- Other assumptions are included with the calculations attached to this appendix.

Results:

Hydrograph Generation

The hydrograph modeling results for the 25-year and 100-year, 24-hour storm events are included in the Post Construction Conditions Hydrograph Generation section.

Basin Sizing

The existing sedimentation basin has the capacity to safely contain the 25-year, 24-hour storm event and safely pass the 100-year, 24-hour storm event through the emergency spillway. Refer to the Basin Sizing section.

Swale Sizing

The proposed swales will be constructed as shown on the Drawings. The swales have the capacity to safely convey the both the 25-year, 24-hour storm events and maintain a minimum 0.5 foot of freeboard. Refer to the Swale Sizing section.
Appropriate erosion control product was selected based on the velocities and shear stress in the swales. Refer to the Swale Sizing section below for the evaluation.

Culvert Sizing

Culverts will be as shown in the Drawings. The culverts have the capacity to safely convey the 25-year, 24-hour storm event. Refer to the Culvert Sizing Section for the detailed calculations.

Diversion Berm Sizing

The proposed final berms will be constructed as shown on the Drawings. The diversion berms will contain the runoff from the 25-year, 24-hour storm event. Refer to the Diversion Berm Design section.

Downslope Flume and Energy Dissipater Sizing

The downslope flumes and energy dissipaters will be constructed as shown on the Drawings. The downslope flumes are designed to contain the runoff from the 25-year, 24-hour storm event. Energy dissipaters at the bottom of the downslope flumes have been designed to handle the peak velocities. Refer to the Downslope Flume and Energy Dissipater Sizing section below for detailed calculations.

Rock Chute Sizing

The proposed rock chutes will be constructed as shown in the Drawings. The rock chutes will accommodate the runoff from the 25-year, 24-hour storm event. Refer to the Rock Chute Sizing section.

Discharge Apron Sizing

The proposed riprap aprons will be constructed as shown in the Drawings. The aprons will accommodate the runoff from the 25-year, 24-hour storm event. Refer to Discharge Apron Sizing for design calculations.

LEGEND

DRY ASH DISPOSAL FACILITY LIMITS	EXISTING GRADE (10' INTERVAL)	PROPOSED PERIMETER ROAD	PROPOSED DOWNSLOPE FLUME
LIMITS OF WASTE	EXISTING GRADE (2' INTERVAL)	PROPOSED SWALE	PROPOSED ENERGY DISSIPATOR
LINER PHASE/MODULE LIMIT	SWALE	PROPOSED CULVERT	PROPOSED RIPRAP
FINAL COVER LIMITS	EDGE OF WATER	PROPOSED LEACHATE COLLECTION SYSTEM CLEANOUT	DRAINAGE AREA DIVIDES
APPROXIMATE INTERMEDIATE COVER LIMITS/AREA	WETLAND	PROPOSED LEACHATE VAULT	FLOW PATH
PAVED ROAD	PROPOSED PHASE 1 FINAL GRADE (10' INTERVAL)	PROPOSED LEACHATE FORCEMAIN	
UNPAVED ROAD	PROPOSED PHASE 1 FINAL GRADE (2' INTERVAL)	PROPOSED UNDERGROUND ELECTRIC	
VEGETATION	PROPOSED GRADE (10' INTERVAL)	PROPOSED DIVERSION BERM	
FENCE	PROPOSED GRADE (2' INTERVAL)		

NOTES:

1. SEE SHEET 2 OF PLAN OF OPERATION UPDATE (2022) PLAN SET FOR BASE MAP LEGEND ITEMS AND NOTES.
2. SWALE S4 REACHES ARE BETWEEN AREA BOUNDARY AND FLUMES IN AREA 45 AND 46.
3. FINAL SLOPES IN AREAS 27, 29, 32, 33, 34, AND 51 ARE ASSUMED DUE TO THESE AREAS BEING USED FOR STOCKPILES DURING CONSTRUCTION DURING THE LIFE OF THE DRY ASH DISPOSAL FACILITY.

SCALE: 1" = 100'

PROJECT NO.	25220183.00	DRAWN BY:	KP
DRAWN:	01/25/2022	CHECKED BY:	RJG
REVISED:	05/02/2022	APPROVED BY:	MRH 05/25/2022

WISCONSIN POWER AND LIGHT
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ENGINEER

PLAN OF OPERATION
2022 UPDATE
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

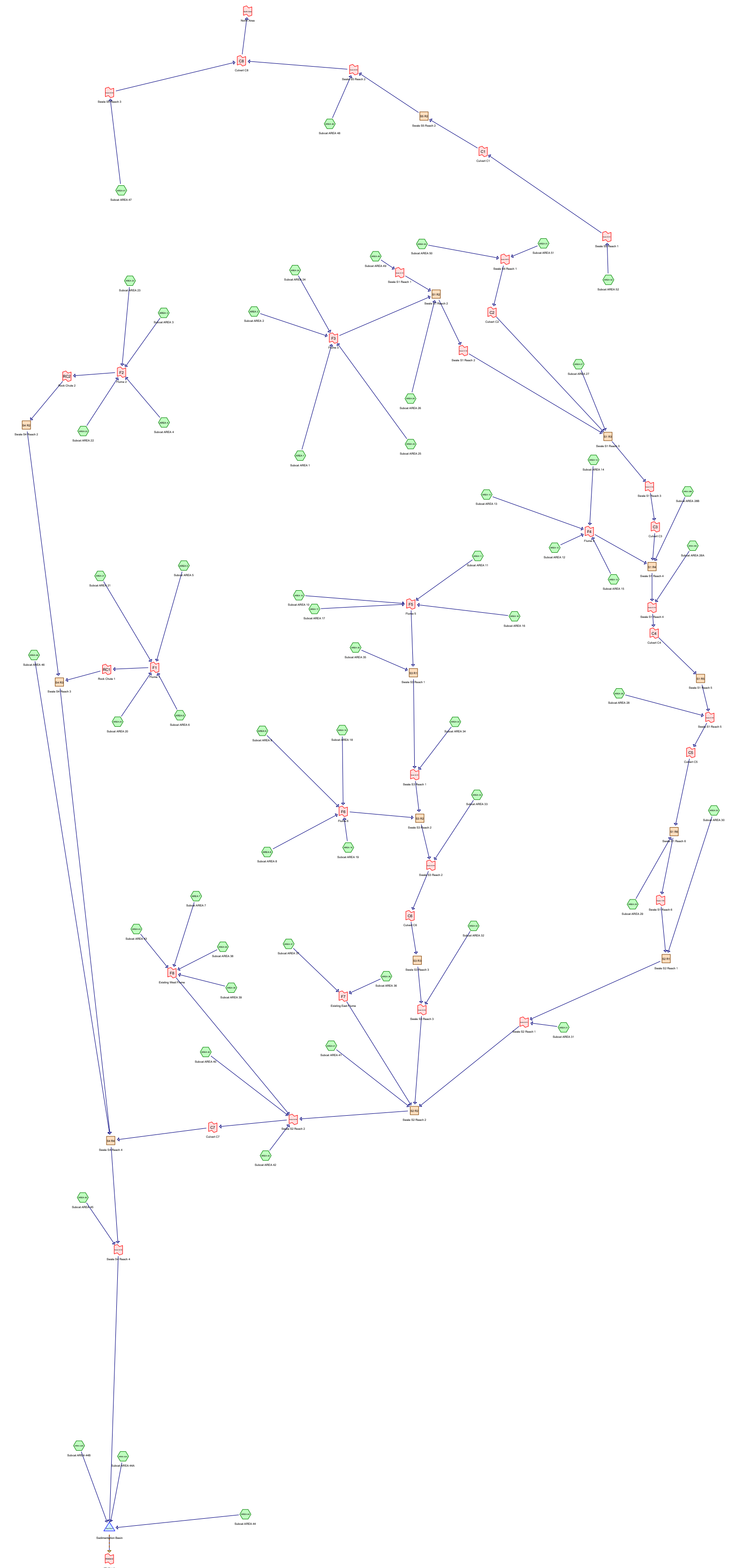
SITE

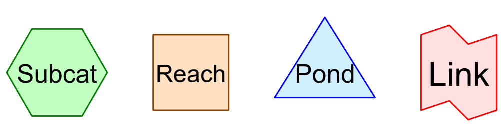
STORM WATER MODELING

FIGURE
1

Post Construction Conditions Hydrograph Generation

- 25-year, 24-hour Storm Event
- 100-year, 24-hour Storm Event





Routing Diagram for COL_POO Closure Conditions-031722
Prepared by SCS Engineers, Printed 4/11/2022
HydroCAD® 10.10-7a s/n 05804 © 2021 HydroCAD Software Solutions LLC

Time span=0.00-40.00 hrs, dt=0.01 hrs, 4001 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment AREA 1: Subcat AREA 1 Runoff Area=1.288 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=408' Tc=2.6 min CN=69 Runoff=4.58 cfs 0.203 af

Subcatchment AREA 10: Subcat AREA 10 Runoff Area=0.914 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=500' Tc=3.2 min CN=69 Runoff=3.17 cfs 0.144 af

Subcatchment AREA 11: Subcat AREA 11 Runoff Area=0.949 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=391' Tc=4.6 min CN=69 Runoff=3.10 cfs 0.150 af

Subcatchment AREA 12: Subcat AREA 12 Runoff Area=0.098 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=92' Tc=2.5 min CN=69 Runoff=0.35 cfs 0.015 af

Subcatchment AREA 13: Subcat AREA 13 Runoff Area=0.890 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=590' Tc=4.6 min CN=69 Runoff=2.91 cfs 0.140 af

Subcatchment AREA 14: Subcat AREA 14 Runoff Area=1.145 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=625' Tc=5.1 min CN=69 Runoff=3.66 cfs 0.181 af

Subcatchment AREA 15: Subcat AREA 15 Runoff Area=0.512 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=235' Tc=4.2 min CN=69 Runoff=1.71 cfs 0.081 af

Subcatchment AREA 16: Subcat AREA 16 Runoff Area=1.510 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=522' Tc=4.9 min CN=69 Runoff=4.89 cfs 0.238 af

Subcatchment AREA 17: Subcat AREA 17 Runoff Area=1.228 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=386' Tc=4.7 min CN=69 Runoff=4.00 cfs 0.194 af

Subcatchment AREA 18: Subcat AREA 18 Runoff Area=0.813 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=383' Tc=4.6 min CN=69 Runoff=2.66 cfs 0.128 af

Subcatchment AREA 19: Subcat AREA 19 Runoff Area=0.847 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=394' Tc=4.6 min CN=69 Runoff=2.77 cfs 0.134 af

Subcatchment AREA 2: Subcat AREA 2 Runoff Area=1.167 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=613' Tc=5.1 min CN=69 Runoff=3.73 cfs 0.184 af

Subcatchment AREA 20: Subcat AREA 20 Runoff Area=1.054 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=453' Tc=4.7 min CN=69 Runoff=3.43 cfs 0.166 af

Subcatchment AREA 21: Subcat AREA 21 Runoff Area=1.030 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=448' Tc=4.7 min CN=69 Runoff=3.35 cfs 0.162 af

Subcatchment AREA 22: Subcat AREA 22 Runoff Area=1.030 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=448' Tc=4.7 min CN=69 Runoff=3.35 cfs 0.162 af

Subcatchment AREA 23: Subcat AREA 23 Runoff Area=1.548 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=715' Tc=5.4 min CN=69 Runoff=4.89 cfs 0.244 af

Subcatchment AREA 24: Subcat AREA 24 Runoff Area=1.952 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=889' Tc=5.8 min CN=69 Runoff=6.05 cfs 0.308 af

Subcatchment AREA 25: Subcat AREA 25 Runoff Area=1.515 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=495' Tc=3.9 min CN=69 Runoff=5.13 cfs 0.239 af

Subcatchment AREA 26: Subcat AREA 26 Runoff Area=0.518 ac 0.00% Impervious Runoff Depth=1.74"
Flow Length=216' Tc=4.1 min CN=67 Runoff=1.59 cfs 0.075 af

Subcatchment AREA 27: Subcat AREA 27 Runoff Area=4.140 ac 0.00% Impervious Runoff Depth=0.55"
Flow Length=864' Tc=12.0 min CN=48 Runoff=1.68 cfs 0.191 af

Subcatchment AREA 28: Subcat AREA 28 Runoff Area=142,960 sf 0.00% Impervious Runoff Depth=0.66"
Flow Length=573' Tc=9.1 min CN=50 Runoff=2.08 cfs 0.179 af

Subcatchment AREA 28A: Subcat AREA 28A Runoff Area=0.423 ac 0.00% Impervious Runoff Depth=0.60"
Flow Length=234' Tc=9.1 min CN=49 Runoff=0.23 cfs 0.021 af

Subcatchment AREA 28B: Subcat AREA 28B Runoff Area=0.476 ac 0.00% Impervious Runoff Depth=0.71"
Flow Length=211' Tc=4.5 min CN=51 Runoff=0.47 cfs 0.028 af

Subcatchment AREA 29: Subcat AREA 29 Runoff Area=2.792 ac 0.00% Impervious Runoff Depth=0.22"
Flow Length=463' Tc=14.8 min CN=40 Runoff=0.16 cfs 0.050 af

Subcatchment AREA 3: Subcat AREA 3 Runoff Area=0.717 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=409' Tc=6.3 min CN=69 Runoff=2.17 cfs 0.113 af

Subcatchment AREA 30: Subcat AREA 30 Runoff Area=1.415 ac 0.00% Impervious Runoff Depth=0.18"
Flow Length=941' Slope=0.0260 '/' Tc=22.0 min CN=39 Runoff=0.06 cfs 0.021 af

Subcatchment AREA 31: Subcat AREA 31 Runoff Area=0.698 ac 0.00% Impervious Runoff Depth=0.18"
Flow Length=481' Tc=4.4 min CN=39 Runoff=0.03 cfs 0.011 af

Subcatchment AREA 32: Subcat AREA 32 Runoff Area=3.353 ac 0.00% Impervious Runoff Depth=0.46"
Flow Length=663' Tc=17.3 min CN=46 Runoff=0.81 cfs 0.128 af

Subcatchment AREA 33: Subcat AREA 33 Runoff Area=38,914 sf 0.00% Impervious Runoff Depth=0.60"
Flow Length=377' Tc=16.0 min CN=49 Runoff=0.37 cfs 0.045 af

Subcatchment AREA 34: Subcat AREA 34 Runoff Area=68,484 sf 0.00% Impervious Runoff Depth=0.37"
Flow Length=488' Tc=16.2 min CN=44 Runoff=0.25 cfs 0.049 af

Subcatchment AREA 35: Subcat AREA 35 Runoff Area=0.375 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=174' Slope=0.2500 '/' Tc=4.2 min CN=69 Runoff=1.25 cfs 0.059 af

Subcatchment AREA 36: Subcat AREA 36 Runoff Area=0.487 ac 0.00% Impervious Runoff Depth=1.82"
Flow Length=425' Tc=4.4 min CN=68 Runoff=1.54 cfs 0.074 af

Subcatchment AREA 37: Subcat AREA 37 Runoff Area=0.344 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=510' Tc=4.6 min CN=69 Runoff=1.12 cfs 0.054 af

Subcatchment AREA 38: Subcat AREA 38 Runoff Area=0.223 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=590' Tc=4.1 min CN=69 Runoff=0.75 cfs 0.035 af

Subcatchment AREA 39: Subcat AREA 39 Runoff Area=0.656 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=642' Tc=5.3 min CN=69 Runoff=2.08 cfs 0.103 af

Subcatchment AREA 4: Subcat AREA 4 Runoff Area=1.247 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=478' Tc=6.6 min CN=69 Runoff=3.74 cfs 0.197 af

Subcatchment AREA 40: Subcat AREA 40 Runoff Area=1.618 ac 0.00% Impervious Runoff Depth=1.18"
Flow Length=699' Tc=5.2 min CN=59 Runoff=3.05 cfs 0.160 af

Subcatchment AREA 41: Subcat AREA 41 Runoff Area=0.826 ac 0.00% Impervious Runoff Depth=1.12"
Flow Length=722' Tc=5.9 min CN=58 Runoff=1.40 cfs 0.077 af

Subcatchment AREA 42: Subcat AREA 42 Runoff Area=2.177 ac 0.00% Impervious Runoff Depth=0.18"
Flow Length=415' Tc=9.1 min CN=39 Runoff=0.09 cfs 0.033 af

Subcatchment AREA 43: Subcat AREA 43 Runoff Area=1.228 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=778' Tc=5.9 min CN=69 Runoff=3.79 cfs 0.194 af

Subcatchment AREA 44: Subcat AREA 44 Runoff Area=5.227 ac 0.00% Impervious Runoff Depth=0.18"
Flow Length=701' Tc=7.9 min CN=39 Runoff=0.22 cfs 0.079 af

Subcatchment AREA 44A: Subcat AREA Runoff Area=1.508 ac 100.00% Impervious Runoff Depth=4.67"
Tc=0.0 min CN=98 Runoff=10.70 cfs 0.587 af

Subcatchment AREA 44B: Subcat AREA 44B Runoff Area=0.594 ac 0.00% Impervious Runoff Depth=0.66"
Flow Length=147' Slope=0.0544 '/' Tc=7.6 min CN=50 Runoff=0.41 cfs 0.032 af

Subcatchment AREA 45: Subcat AREA 45 Runoff Area=2.001 ac 0.00% Impervious Runoff Depth=0.33"
Flow Length=681' Tc=21.9 min CN=43 Runoff=0.24 cfs 0.055 af

Subcatchment AREA 46: Subcat AREA 46 Runoff Area=7.367 ac 0.36% Impervious Runoff Depth=1.18"
Flow Length=1,904' Tc=9.2 min CN=59 Runoff=11.31 cfs 0.727 af

Subcatchment AREA 47: Subcat AREA 47 Runoff Area=79,132 sf 8.81% Impervious Runoff Depth=1.52"
Flow Length=582' Tc=9.1 min CN=64 Runoff=3.79 cfs 0.230 af

Subcatchment AREA 48: Subcat AREA 48 Runoff Area=57,540 sf 11.76% Impervious Runoff Depth=1.32"
Flow Length=489' Tc=5.4 min CN=61 Runoff=2.79 cfs 0.145 af

Subcatchment AREA 49: Subcat AREA 49 Runoff Area=0.691 ac 0.00% Impervious Runoff Depth=1.18"
Flow Length=522' Tc=4.3 min CN=59 Runoff=1.37 cfs 0.068 af

Subcatchment AREA 5: Subcat AREA 5 Runoff Area=1.195 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=482' Tc=6.6 min CN=69 Runoff=3.58 cfs 0.188 af

Subcatchment AREA 50: Subcat AREA 50 Runoff Area=1.482 ac 0.00% Impervious Runoff Depth=4.00"
Flow Length=570' Tc=3.4 min CN=92 Runoff=9.68 cfs 0.494 af

Subcatchment AREA 51: Subcat AREA 51 Runoff Area=1.417 ac 0.00% Impervious Runoff Depth=0.22"
Flow Length=884' Tc=12.2 min CN=40 Runoff=0.08 cfs 0.025 af

Subcatchment AREA 52: Subcat AREA 52 Runoff Area=197,330 sf 13.14% Impervious Runoff Depth=0.51"
Flow Length=1,294' Tc=6.3 min CN=47 Runoff=2.06 cfs 0.191 af

Subcatchment AREA 6: Subcat AREA 6 Runoff Area=0.892 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=415' Tc=4.6 min CN=69 Runoff=2.92 cfs 0.141 af

Subcatchment AREA 7: Subcat AREA 7 Runoff Area=1.017 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=833' Tc=5.8 min CN=69 Runoff=3.15 cfs 0.160 af

Subcatchment AREA 8: Subcat AREA 8 Runoff Area=1.009 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=409' Tc=4.7 min CN=69 Runoff=3.29 cfs 0.159 af

Subcatchment AREA 9: Subcat AREA 9 Runoff Area=1.047 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=426' Tc=4.8 min CN=69 Runoff=3.40 cfs 0.165 af

Reach S1 R2: Swale S1 Reach 2 Avg. Flow Depth=0.76' Max Vel=2.58 fps Inflow=22.03 cfs 1.077 af
n=0.030 L=127.0' S=0.0055 '/' Capacity=140.64 cfs Outflow=21.68 cfs 1.077 af

Reach S1 R3: Swale S1 Reach 3 Avg. Flow Depth=0.88' Max Vel=2.69 fps Inflow=31.44 cfs 1.788 af
n=0.030 L=578.0' S=0.0051 '/' Capacity=135.10 cfs Outflow=27.38 cfs 1.788 af

Reach S1 R4: Swale S1 Reach 4 Avg. Flow Depth=0.94' Max Vel=3.19 fps Inflow=35.79 cfs 2.233 af
n=0.030 L=195.8' S=0.0066 '/' Capacity=154.36 cfs Outflow=35.20 cfs 2.233 af

Reach S1 R5: Swale S1 Reach 5 Avg. Flow Depth=0.97' Max Vel=2.89 fps Inflow=35.39 cfs 2.255 af
n=0.030 L=411.6' S=0.0053 '/' Capacity=137.86 cfs Outflow=33.17 cfs 2.255 af

Reach S1 R6: Swale S1 Reach 6 Avg. Flow Depth=0.97' Max Vel=2.87 fps Inflow=35.21 cfs 2.484 af
n=0.030 L=430.9' S=0.0052 '/' Capacity=136.28 cfs Outflow=33.18 cfs 2.484 af

Reach S2 R1: Swale S2 Reach 1 Avg. Flow Depth=1.18' Max Vel=1.99 fps Inflow=33.19 cfs 2.506 af
n=0.030 L=472.0' S=0.0020 '/' Capacity=84.99 cfs Outflow=29.93 cfs 2.506 af

Reach S2 R2: Swale S2 Reach 2 Avg. Flow Depth=0.98' Max Vel=3.41 fps Inflow=48.80 cfs 4.314 af
n=0.030 L=751.0' S=0.0069 '/' Capacity=182.04 cfs Outflow=46.24 cfs 4.314 af

Reach S3 R1: Swale S3 Reach 1 Avg. Flow Depth=0.63' Max Vel=2.73 fps Inflow=16.31 cfs 0.785 af
n=0.030 L=215.0' S=0.0070 '/' Capacity=125.24 cfs Outflow=15.87 cfs 0.785 af

Reach S3 R2: Swale S3 Reach 2 Avg. Flow Depth=1.75' Max Vel=3.61 fps Inflow=27.94 cfs 1.419 af
n=0.030 L=97.0' S=0.0070 '/' Capacity=71.57 cfs Outflow=27.78 cfs 1.419 af

Reach S3 R3: Swale S3 Reach 3 Avg. Flow Depth=0.73' Max Vel=3.34 fps Inflow=27.86 cfs 1.464 af
n=0.030 L=353.0' S=0.0097 '/' Capacity=186.19 cfs Outflow=26.59 cfs 1.464 af

Reach S4 R2: Swale S4 Reach 2 Avg. Flow Depth=0.46' Max Vel=2.23 fps Inflow=14.04 cfs 0.716 af
n=0.030 L=601.0' S=0.0069 '/' Capacity=174.20 cfs Outflow=11.87 cfs 0.716 af

Reach S4 R3: Swale S4 Reach 3 Avg. Flow Depth=0.63' Max Vel=2.42 fps Inflow=23.93 cfs 1.374 af
n=0.030 L=946.0' S=0.0056 '/' Capacity=156.53 cfs Outflow=18.66 cfs 1.374 af

Reach S4 R4: Swale S4 Reach 4 Avg. Flow Depth=1.27' Max Vel=4.35 fps Inflow=81.28 cfs 7.099 af
n=0.030 L=483.0' S=0.0082 '/' Capacity=427.66 cfs Outflow=80.05 cfs 7.099 af

Reach S5 R2: Swale S5 Reach 2 Inflow=2.06 cfs 0.191 af
Outflow=2.06 cfs 0.191 af

Pond Sed Pond: Sedimentation Basin Peak Elev=791.59' Storage=137,326 cf Inflow=82.78 cfs 7.853 af
s 5.880 af Primary=9.42 cfs 1.973 af Secondary=0.00 cfs 0.000 af Tertiary=0.00 cfs 0.000 af Outflow=14.75 cfs 7.854 af

Link C1: Culvert C1 Inflow=2.06 cfs 0.191 af
Primary=2.06 cfs 0.191 af

Link C2: Culvert C2 Inflow=9.68 cfs 0.520 af
Primary=9.68 cfs 0.520 af

Link C3: Culvert C3 Inflow=27.38 cfs 1.788 af
Primary=27.38 cfs 1.788 af

Link C4: Culvert C4 Inflow=35.39 cfs 2.255 af
Primary=35.39 cfs 2.255 af

Link C5: Culvert C5 Inflow=35.21 cfs 2.434 af
Primary=35.21 cfs 2.434 af

Link C6: Culvert C6 Inflow=27.86 cfs 1.464 af
Primary=27.86 cfs 1.464 af

Link C7: Culvert C7 Inflow=52.15 cfs 4.999 af
Primary=52.15 cfs 4.999 af

Link C8: Culvert C8 Inflow=8.32 cfs 0.566 af
Primary=8.32 cfs 0.566 af

Link F1: Flume 1 Inflow=13.17 cfs 0.658 af
Primary=13.17 cfs 0.658 af

Link F2: Flume 2 Inflow=14.04 cfs 0.716 af
Primary=14.04 cfs 0.716 af

Link F3: Flume 3 Inflow=19.08 cfs 0.934 af
Primary=19.08 cfs 0.934 af

Link F4: Flume 4 Inflow=8.58 cfs 0.417 af
Primary=8.58 cfs 0.417 af

Link F5: Flume 5 Inflow=15.06 cfs 0.725 af
Primary=15.06 cfs 0.725 af

Link F6: Flume 6	Inflow=12.11 cfs 0.586 af Primary=12.11 cfs 0.586 af
Link F7: Existing East Flume	Inflow=2.66 cfs 0.128 af Primary=2.66 cfs 0.128 af
Link F8: Existing West Flume	Inflow=9.73 cfs 0.492 af Primary=9.73 cfs 0.492 af
Link North Area: North Area	Inflow=8.32 cfs 0.566 af Primary=8.32 cfs 0.566 af
Link RC1: Rock Chute 1	Inflow=13.17 cfs 0.658 af Primary=13.17 cfs 0.658 af
Link RC2: Rock Chute 2	Inflow=14.04 cfs 0.716 af Primary=14.04 cfs 0.716 af
Link Swale 1 R6: Swale S1 Reach 6	Inflow=33.18 cfs 2.484 af Primary=33.18 cfs 2.484 af
Link Swale S1 R1: Swale S1 Reach 1	Inflow=1.37 cfs 0.068 af Primary=1.37 cfs 0.068 af
Link Swale S1 R2: Swale S1 Reach 2	Inflow=21.68 cfs 1.077 af Primary=21.68 cfs 1.077 af
Link Swale S1 R3: Swale S1 Reach 3	Inflow=27.38 cfs 1.788 af Primary=27.38 cfs 1.788 af
Link Swale S1 R4: Swale S1 Reach 4	Inflow=35.39 cfs 2.255 af Primary=35.39 cfs 2.255 af
Link Swale S1 R5: Swale S1 Reach 5	Inflow=35.21 cfs 2.434 af Primary=35.21 cfs 2.434 af
Link Swale S2 R1: Swale S2 Reach 1	Inflow=29.95 cfs 2.516 af Primary=29.95 cfs 2.516 af
Link Swale S2 R2: Swale S2 Reach 2	Inflow=52.15 cfs 4.999 af Primary=52.15 cfs 4.999 af
Link Swale S3 R1: Swale S3 Reach 1	Inflow=15.88 cfs 0.833 af Primary=15.88 cfs 0.833 af
Link Swale S3 R2: Swale S3 Reach 2	Inflow=27.86 cfs 1.464 af Primary=27.86 cfs 1.464 af
Link Swale S3 R3: Swale S3 Reach 3	Inflow=26.70 cfs 1.592 af Primary=26.70 cfs 1.592 af

Link Swale S4 R4: Swale S4 Reach 4	Inflow=80.09 cfs 7.154 af Primary=80.09 cfs 7.154 af
Link Swale S5 R1: Swale S5 Reach 1	Inflow=2.06 cfs 0.191 af Primary=2.06 cfs 0.191 af
Link Swale S5 R2: Swale S5 Reach 2	Inflow=4.68 cfs 0.336 af Primary=4.68 cfs 0.336 af
Link Swale S5 R3: Swale S5 Reach 3	Inflow=3.79 cfs 0.230 af Primary=3.79 cfs 0.230 af
Link Swale S6 R1: Swale S6 Reach 1	Inflow=9.68 cfs 0.520 af Primary=9.68 cfs 0.520 af
Link Wetland: Wetland	Inflow=9.42 cfs 1.973 af Primary=9.42 cfs 1.973 af

Total Runoff Area = 82.060 ac Runoff Volume = 8.419 af Average Runoff Depth = 1.23"
97.02% Pervious = 79.615 ac 2.98% Impervious = 2.446 ac

Summary for Subcatchment AREA 1: Subcat AREA 1

Runoff = 4.58 cfs @ 12.11 hrs, Volume= 0.203 af, Depth= 1.89"
Routed to Link F3 : Flume 3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.288	69	Pasture/grassland/range, Fair, HSG B
1.288		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	37	0.2500	0.36		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.9	371	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
2.6	408	Total			

Summary for Subcatchment AREA 10: Subcat AREA 10

Runoff = 3.17 cfs @ 12.11 hrs, Volume= 0.144 af, Depth= 1.89"
Routed to Link F5 : Flume 5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.914	69	Pasture/grassland/range, Fair, HSG B
0.914		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.1	46	0.2500	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.1	454	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
3.2	500	Total			

Summary for Subcatchment AREA 11: Subcat AREA 11

Runoff = 3.10 cfs @ 12.12 hrs, Volume= 0.150 af, Depth= 1.89"
Routed to Link F5 : Flume 5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.949	69	Pasture/grassland/range, Fair, HSG B
0.949		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	14	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	277	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.6	391	Total			

Summary for Subcatchment AREA 12: Subcat AREA 12

Runoff = 0.35 cfs @ 12.11 hrs, Volume= 0.015 af, Depth= 1.89"
Routed to Link F4 : Flume 4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.098	69	Pasture/grassland/range, Fair, HSG B
0.098		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	56	0.2500	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	36	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
2.5	92	Total			

Summary for Subcatchment AREA 13: Subcat AREA 13

Runoff = 2.91 cfs @ 12.12 hrs, Volume= 0.140 af, Depth= 1.89"
Routed to Link F4 : Flume 4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.890	69	Pasture/grassland/range, Fair, HSG B
0.890		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	87	0.2500	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.2	503	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.6	590	Total			

Summary for Subcatchment AREA 14: Subcat AREA 14

Runoff = 3.66 cfs @ 12.13 hrs, Volume= 0.181 af, Depth= 1.89"
Routed to Link F4 : Flume 4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.145	69	Pasture/grassland/range, Fair, HSG B
1.145		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	27	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.2	498	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
5.1	625	Total			

Summary for Subcatchment AREA 15: Subcat AREA 15

Runoff = 1.71 cfs @ 12.12 hrs, Volume= 0.081 af, Depth= 1.89"
Routed to Link F4 : Flume 4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.512	69	Pasture/grassland/range, Fair, HSG B
0.512		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	85	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.2	235	Total			

Summary for Subcatchment AREA 16: Subcat AREA 16

Runoff = 4.89 cfs @ 12.13 hrs, Volume= 0.238 af, Depth= 1.89"
Routed to Link F5 : Flume 5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.510	69	Pasture/grassland/range, Fair, HSG B
1.510		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.9	372	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.9	522	Total			

Summary for Subcatchment AREA 17: Subcat AREA 17

Runoff = 4.00 cfs @ 12.12 hrs, Volume= 0.194 af, Depth= 1.89"
Routed to Link F5 : Flume 5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.228	69	Pasture/grassland/range, Fair, HSG B
1.228		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.3	63	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	223	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	386	Total			

Summary for Subcatchment AREA 18: Subcat AREA 18

Runoff = 2.66 cfs @ 12.12 hrs, Volume= 0.128 af, Depth= 1.89"
Routed to Link F6 : Flume 6

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.813	69	Pasture/grassland/range, Fair, HSG B
0.813		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	48	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	235	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.6	383	Total			

Summary for Subcatchment AREA 19: Subcat AREA 19

Runoff = 2.77 cfs @ 12.12 hrs, Volume= 0.134 af, Depth= 1.89"
Routed to Link F6 : Flume 6

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.847	69	Pasture/grassland/range, Fair, HSG B
0.847		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	244	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.6	394	Total			

Summary for Subcatchment AREA 2: Subcat AREA 2

Runoff = 3.73 cfs @ 12.13 hrs, Volume= 0.184 af, Depth= 1.89"
Routed to Link F3 : Flume 3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.167	69	Pasture/grassland/range, Fair, HSG B
1.167		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	18	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.2	495	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
5.1	613	Total			

Summary for Subcatchment AREA 20: Subcat AREA 20

Runoff = 3.43 cfs @ 12.12 hrs, Volume= 0.166 af, Depth= 1.89"
Routed to Link F1 : Flume 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.054	69	Pasture/grassland/range, Fair, HSG B
1.054		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	303	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	453	Total			

Summary for Subcatchment AREA 21: Subcat AREA 21

Runoff = 3.35 cfs @ 12.12 hrs, Volume= 0.162 af, Depth= 1.89"
Routed to Link F1 : Flume 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.030	69	Pasture/grassland/range, Fair, HSG B
1.030		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	298	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	448	Total			

Summary for Subcatchment AREA 22: Subcat AREA 22

Runoff = 3.35 cfs @ 12.12 hrs, Volume= 0.162 af, Depth= 1.89"
Routed to Link F2 : Flume 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.030	69	Pasture/grassland/range, Fair, HSG B
1.030		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	298	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	448	Total			

Summary for Subcatchment AREA 23: Subcat AREA 23

Runoff = 4.89 cfs @ 12.13 hrs, Volume= 0.244 af, Depth= 1.89"
Routed to Link F2 : Flume 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.548	69	Pasture/grassland/range, Fair, HSG B
1.548		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	24	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.5	591	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
5.4	715	Total			

Summary for Subcatchment AREA 24: Subcat AREA 24

Runoff = 6.05 cfs @ 12.13 hrs, Volume= 0.308 af, Depth= 1.89"
Routed to Link F3 : Flume 3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.952	69	Pasture/grassland/range, Fair, HSG B
1.952		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	24	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.9	765	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
5.8	889	Total			

Summary for Subcatchment AREA 25: Subcat AREA 25

Runoff = 5.13 cfs @ 12.12 hrs, Volume= 0.239 af, Depth= 1.89"
Routed to Link F3 : Flume 3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.515	69	Pasture/grassland/range, Fair, HSG B
1.515		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	67	0.2500	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.1	428	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
3.9	495	Total			

Summary for Subcatchment AREA 26: Subcat AREA 26

Runoff = 1.59 cfs @ 12.12 hrs, Volume= 0.075 af, Depth= 1.74"
Routed to Reach S1 R2 : Swale S1 Reach 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

	Area (ac)	CN	Description
	0.396	69	Pasture/grassland/range, Fair, HSG B
	0.072	39	Pasture/grassland/range, Good, HSG A
	0.049	96	Gravel surface, HSG A
*	0.000	0	Pasture/grassland/range, Fair
	0.518	67	Weighted Average
	0.518		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	93	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	123	0.0055	4.39	140.49	**Trap/Vee/Rect Channel Flow, Swale 1 Reach 2** Bot.W=8.00' D=2.00' Z= 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
4.1	216	Total			

Summary for Subcatchment AREA 27: Subcat AREA 27

Runoff = 1.68 cfs @ 12.25 hrs, Volume= 0.191 af, Depth= 0.55"
Routed to Reach S1 R3 : Swale S1 Reach 3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

	Area (ac)	CN	Description
	0.651	69	Pasture/grassland/range, Fair, HSG B
	2.758	39	Pasture/grassland/range, Good, HSG A
	0.010	96	Gravel surface, HSG A
	0.295	96	Gravel surface, HSG A
	0.426	39	Pasture/grassland/range, Good, HSG A
*	0.000	0	
*	0.000	0	
*	0.000	0	, HSG A
*	0.000	0	, HSG A
*	0.000	0	, HSG A
*	0.000	0	, HSG A
*	0.000	0	Pasture/grassland/range, Good
	4.140	48	Weighted Average
	4.140		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
2.3	217	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	20	0.0050	1.14		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.1	14	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.0	513	0.0051	4.23	135.28	**Trap/Vee/Rect Channel Flow, Swale 1 Reach 3** Bot.W=8.00' D=2.00' Z= 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
12.0	864	Total			

Summary for Subcatchment AREA 28: Subcat AREA 28

Runoff = 2.08 cfs @ 12.19 hrs, Volume= 0.179 af, Depth= 0.66"
Routed to Link Swale S1 R5 : Swale S1 Reach 5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

	Area (sf)	CN	Description
	30,267	69	Pasture/grassland/range, Fair, HSG B
	100,859	39	Pasture/grassland/range, Good, HSG A
*	11,834	96	Gravel surface
	142,960	50	Weighted Average
	142,960		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.9	78	0.0526	0.22		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.1	22	0.2500	0.32		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	24	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	23	0.0050	1.14		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.1	16	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.6	410	0.0053	4.31	137.91	**Trap/Vee/Rect Channel Flow, Swale 1 Reach** Bot.W=8.00' D=2.00' Z= 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
9.1	573	Total			

Summary for Subcatchment AREA 28A: Subcat AREA 28A

Runoff = 0.23 cfs @ 12.20 hrs, Volume= 0.021 af, Depth= 0.60"
Routed to Link Swale S1 R4 : Swale S1 Reach 4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.035	69	Pasture/grassland/range, Fair, HSG B
0.257	39	Pasture/grassland/range, Good, HSG A
0.075	39	Pasture/grassland/range, Good, HSG A
0.010	96	Gravel surface, HSG A
0.046	96	Gravel surface, HSG A
0.423	49	Weighted Average
0.423		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	82	0.0334	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.0	18	0.2500	0.31		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	34	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	20	0.0050	1.14		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.1	13	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	67	0.0069	4.92	157.36	**Trap/Vee/Rect Channel Flow,** Bot.W=8.00' D=2.00' Z= 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
9.1	234	Total			

Summary for Subcatchment AREA 28B: Subcat AREA 28B

Runoff = 0.47 cfs @ 12.13 hrs, Volume= 0.028 af, Depth= 0.71"
Routed to Reach S1 R4 : Swale S1 Reach 4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.050	69	Pasture/grassland/range, Fair, HSG B
0.110	39	Pasture/grassland/range, Good, HSG A
0.240	39	Pasture/grassland/range, Good, HSG A
0.009	96	Gravel surface, HSG A
0.067	96	Gravel surface, HSG A
0.476	51	Weighted Average
0.476		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	58	0.2500	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.6	20	0.0050	0.53		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
1.0	18	0.2500	0.31		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.4	115	0.0055	4.39	140.49	**Trap/Vee/Rect Channel Flow,** Bot.W=8.00' D=2.00' Z= 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
4.5	211	Total			

Summary for Subcatchment AREA 29: Subcat AREA 29

Runoff = 0.16 cfs @ 12.58 hrs, Volume= 0.050 af, Depth= 0.22"
Routed to Reach S1 R6 : Swale S1 Reach 6

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

	Area (ac)	CN	Description
	0.056	96	Gravel surface, HSG A
	2.735	39	Pasture/grassland/range, Good, HSG A
*	0.000	0	Gravel surface
	2.792	40	Weighted Average
	2.792		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.8	100	0.0150	0.14		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.9	100	0.0150	0.86		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	16	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	247	0.0052	4.27	136.60	**Trap/Vee/Rect Channel Flow, Swale S1 Reach 5** Bot.W=8.00' D=2.00' Z= 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
14.8	463	Total			

Summary for Subcatchment AREA 3: Subcat AREA 3

Runoff = 2.17 cfs @ 12.14 hrs, Volume= 0.113 af, Depth= 1.89"
Routed to Link F2 : Flume 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.717	69	Pasture/grassland/range, Fair, HSG B
0.717		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.9	44	0.1000	0.26		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
2.4	56	0.2500	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.4	76	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	233	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
6.3	409	Total			

Summary for Subcatchment AREA 30: Subcat AREA 30

Runoff = 0.06 cfs @ 13.18 hrs, Volume= 0.021 af, Depth= 0.18"
Routed to Reach S2 R1 : Swale S2 Reach 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.415	39	Pasture/grassland/range, Good, HSG A
1.415		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.5	100	0.0260	0.18		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
2.9	194	0.0260	1.13		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.6	647	0.0260	1.13		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
22.0	941	Total			

Summary for Subcatchment AREA 31: Subcat AREA 31

Runoff = 0.03 cfs @ 12.44 hrs, Volume= 0.011 af, Depth= 0.18"
Routed to Link Swale S2 R1 : Swale S2 Reach 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.698	39	Pasture/grassland/range, Good, HSG A
0.698		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	34	0.2500	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
2.8	447	0.0020	2.65	84.72	**Trap/Vee/Rect Channel Flow, Swale 2 Reach 1** Bot.W=8.00' D=2.00' Z= 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
4.4	481	Total			

Summary for Subcatchment AREA 32: Subcat AREA 32

Runoff = 0.81 cfs @ 12.38 hrs, Volume= 0.128 af, Depth= 0.46"
Routed to Link Swale S3 R3 : Swale S3 Reach 3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.567	69	Pasture/grassland/range, Fair, HSG B
2.413	39	Pasture/grassland/range, Good, HSG A
0.099	96	Gravel surface, HSG A
0.274	39	Pasture/grassland/range, Good, HSG A
3.353	46	Weighted Average
3.353		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.1	100	0.0140	0.14		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
4.2	211	0.0140	0.83		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	23	0.1740	2.92		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.9	329	0.0097	5.83	186.57	**Trap/Vee/Rect Channel Flow, Swale 3 Reach 3** Bot.W=8.00' D=2.00' Z= 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
17.3	663	Total			

Summary for Subcatchment AREA 33: Subcat AREA 33

Runoff = 0.37 cfs @ 12.32 hrs, Volume= 0.045 af, Depth= 0.60"
Routed to Link Swale S3 R2 : Swale S3 Reach 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

	Area (sf)	CN	Description
	4,079	96	Gravel surface, HSG A
	1,422	96	Gravel surface, HSG A
	30,707	39	Pasture/grassland/range, Good, HSG A
*	2,706	69	Pasture/grassland/range, Fair, HSG A
	38,914	49	Weighted Average
	38,914		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.1	100	0.0140	0.14		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
3.6	178	0.0140	0.83		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.0	12	0.4000	4.43		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	87	0.0070	5.23	125.44	**Trap/Vee/Rect Channel Flow, Swale 3 Reach 2** Bot.W=8.00' D=2.00' Z= 2.0 '/' Top.W=16.00' n= 0.030 Earth, grassed & winding
16.0	377	Total			

Summary for Subcatchment AREA 34: Subcat AREA 34

Runoff = 0.25 cfs @ 12.43 hrs, Volume= 0.049 af, Depth= 0.37"
Routed to Link Swale S3 R1 : Swale S3 Reach 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (sf)	CN	Description
5,695	69	Pasture/grassland/range, Fair, HSG B
3,470	96	Gravel surface, HSG A
59,319	39	Pasture/grassland/range, Good, HSG A
68,484	44	Weighted Average
68,484		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.1	100	0.0140	0.14		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
3.4	170	0.0140	0.83		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	15	0.4000	4.43		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	203	0.0070	5.23	125.44	**Trap/Vee/Rect Channel Flow, Swale 3 Reach 1** Bot.W=8.00' D=2.00' Z= 2.0 '/' Top.W=16.00' n= 0.030 Earth, grassed & winding
16.2	488	Total			

Summary for Subcatchment AREA 35: Subcat AREA 35

Runoff = 1.25 cfs @ 12.12 hrs, Volume= 0.059 af, Depth= 1.89"
Routed to Reach S3 R1 : Swale S3 Reach 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.375	69	Pasture/grassland/range, Fair, HSG B
0.375		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.4	74	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.2	174	Total			

Summary for Subcatchment AREA 36: Subcat AREA 36

Runoff = 1.54 cfs @ 12.12 hrs, Volume= 0.074 af, Depth= 1.82"
Routed to Link F7 : Existing East Flume

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

	Area (ac)	CN	Description
	0.470	69	Pasture/grassland/range, Fair, HSG B
	0.016	39	Pasture/grassland/range, Good, HSG A
*	0.000	0	Pasture/grassland/range, Good
	0.487	68	Weighted Average
	0.487		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	90	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.7	201	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.2	134	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
4.4	425	Total			

Summary for Subcatchment AREA 37: Subcat AREA 37

Runoff = 1.12 cfs @ 12.12 hrs, Volume= 0.054 af, Depth= 1.89"
Routed to Link F7 : Existing East Flume

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.344	69	Pasture/grassland/range, Fair, HSG B
0.344		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	30	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	126	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.3	254	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
4.6	510	Total			

Summary for Subcatchment AREA 38: Subcat AREA 38

Runoff = 0.75 cfs @ 12.12 hrs, Volume= 0.035 af, Depth= 1.89"
Routed to Link F8 : Existing West Flume

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.223	69	Pasture/grassland/range, Fair, HSG B
0.223		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	77	0.2500	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	156	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.5	357	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
4.1	590	Total			

Summary for Subcatchment AREA 39: Subcat AREA 39

Runoff = 2.08 cfs @ 12.13 hrs, Volume= 0.103 af, Depth= 1.89"
Routed to Link F8 : Existing West Flume

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.656	69	Pasture/grassland/range, Fair, HSG B
0.656		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	11	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	314	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.3	217	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
5.3	642	Total			

Summary for Subcatchment AREA 4: Subcat AREA 4

Runoff = 3.74 cfs @ 12.14 hrs, Volume= 0.197 af, Depth= 1.89"
Routed to Link F2 : Flume 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.247	69	Pasture/grassland/range, Fair, HSG B
1.247		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	57	0.1000	0.27		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
2.0	43	0.2500	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.4	83	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	295	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
6.6	478	Total			

Summary for Subcatchment AREA 40: Subcat AREA 40

Runoff = 3.05 cfs @ 12.13 hrs, Volume= 0.160 af, Depth= 1.18"
Routed to Link Swale S2 R2 : Swale S2 Reach 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

	Area (ac)	CN	Description
	1.079	69	Pasture/grassland/range, Fair, HSG B
	0.539	39	Pasture/grassland/range, Good, HSG A
*	0.000	0	Pasture/grassland/range, Good
	1.618	59	Weighted Average
	1.618		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	77	0.2500	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.8	237	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.3	70	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	315	0.0069	5.05	181.72	**Trap/Vee/Rect Channel Flow, Swale S2 Reach 2** Bot.W=10.00' D=2.00' Z= 4.0 '/' Top.W=26.00' n= 0.030 Earth, grassed & winding
5.2	699	Total			

Summary for Subcatchment AREA 41: Subcat AREA 41

Runoff = 1.40 cfs @ 12.14 hrs, Volume= 0.077 af, Depth= 1.12"
Routed to Reach S2 R2 : Swale S2 Reach 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.520	69	Pasture/grassland/range, Fair, HSG B
0.306	39	Pasture/grassland/range, Good, HSG A
0.826	58	Weighted Average
0.826		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	26	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.0	596	0.0069	5.05	181.72	**Trap/Vee/Rect Channel Flow, Swale S2 Reach 2** Bot.W=10.00' D=2.00' Z= 4.0 '/' Top.W=26.00' n= 0.030 Earth, grassed & winding
5.9	722	Total			

Summary for Subcatchment AREA 42: Subcat AREA 42

Runoff = 0.09 cfs @ 12.55 hrs, Volume= 0.033 af, Depth= 0.18"
Routed to Link Swale S2 R2 : Swale S2 Reach 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
2.177	39	Pasture/grassland/range, Good, HSG A
2.177		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.4	66	0.0303	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.6	34	0.2500	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	49	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.9	266	0.0069	5.05	181.72	**Trap/Vee/Rect Channel Flow, Swale S2 Reach 2** Bot.W=10.00' D=2.00' Z= 4.0 '/' Top.W=26.00' n= 0.030 Earth, grassed & winding
9.1	415	Total			

Summary for Subcatchment AREA 43: Subcat AREA 43

Runoff = 3.79 cfs @ 12.14 hrs, Volume= 0.194 af, Depth= 1.89"
Routed to Link F8 : Existing West Flume

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.228	69	Pasture/grassland/range, Fair, HSG B
1.228		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	6	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.9	541	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.2	131	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
5.9	778	Total			

Summary for Subcatchment AREA 44: Subcat AREA 44

Runoff = 0.22 cfs @ 12.54 hrs, Volume= 0.079 af, Depth= 0.18"
Routed to Pond Sed Pond : Sedimentation Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
5.227	39	Pasture/grassland/range, Good, HSG A
5.227		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.5	75	0.0933	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.3	25	0.2500	0.33		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	10	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	381	0.0265	7.85	109.92	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=2.00' Z= 4.0 & 3.0 '/' Top.W=14.00' n= 0.030 Earth, grassed & winding
0.8	162	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	48	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.9	701	Total			

Summary for Subcatchment AREA 44A: Subcat AREA 44A

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 10.70 cfs @ 12.09 hrs, Volume= 0.587 af, Depth= 4.67"
Routed to Pond Sed Pond : Sedimentation Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.508	98	Water Surface, HSG A
1.508		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment AREA 44B: Subcat AREA 44B

Runoff = 0.41 cfs @ 12.17 hrs, Volume= 0.032 af, Depth= 0.66"
Routed to Pond Sed Pond : Sedimentation Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

	Area (ac)	CN	Description
	0.479	39	Pasture/grassland/range, Good, HSG A
	0.115	96	Gravel surface, HSG A
*	0.000	0	, HSG A
*	0.000	0	, HSG A
	0.594	50	Weighted Average
	0.594		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.1	100	0.0544	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	47	0.0544	1.63		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.6	147	Total			

Summary for Subcatchment AREA 45: Subcat AREA 45

Runoff = 0.24 cfs @ 12.57 hrs, Volume= 0.055 af, Depth= 0.33"
Routed to Link Swale S4 R4 : Swale S4 Reach 4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

	Area (ac)	CN	Description
*	0.000	0	, HSG A
	1.870	39	Pasture/grassland/range, Good, HSG A
	0.000	96	Gravel surface, HSG A
	0.130	96	Gravel surface, HSG A
	2.001	43	Weighted Average
	2.001		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.7	100	0.0074	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
4.7	169	0.0074	0.60		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	49	0.0800	1.98		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	363	0.0082	5.42	162.67	**Trap/Vee/Rect Channel Flow, Swale S4 Reach 2** Bot.W=8.00' D=2.00' Z= 4.0 & 3.0 '/' Top.W=22.00' n= 0.030 Earth, grassed & winding
21.9	681	Total			

Summary for Subcatchment AREA 46: Subcat AREA 46

Runoff = 11.31 cfs @ 12.18 hrs, Volume= 0.727 af, Depth= 1.18"
Routed to Reach S4 R4 : Swale S4 Reach 4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

	Area (ac)	CN	Description
	3.081	69	Pasture/grassland/range, Fair, HSG B
	0.590	96	Gravel surface, HSG B
	3.264	39	Pasture/grassland/range, Good, HSG A
	0.017	98	Paved parking, HSG A
	0.009	98	Paved parking, HSG A
	0.378	96	Gravel surface, HSG A
	0.001	96	Gravel surface, HSG A
	0.026	96	Gravel surface, HSG A
*	0.000	0	, HSG A
*	0.000	0	, HSG A
*	0.000	0	, HSG A
*	0.000	0	, HSG A
*	0.000	0	, HSG A
*	0.000	0	, HSG A
*	0.000	0	Pasture/grassland/range, Fair
	7.367	59	Weighted Average
	7.340		99.64% Pervious Area
	0.027		0.36% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.2	51	0.2500	0.38		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	16	0.2500	2.44		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
0.9	31	0.0050	0.58		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
0.4	47	0.0650	1.78		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
5.6	1,759	0.0073	5.26	178.68	**Trap/Vee/Rect Channel Flow, Swale S4 Reach 1** Bot.W=10.00' D=2.00' Z= 3.0 & 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
9.2	1,904	Total			

Summary for Subcatchment AREA 47: Subcat AREA 47

Runoff = 3.79 cfs @ 12.17 hrs, Volume= 0.230 af, Depth= 1.52"
Routed to Link Swale S5 R3 : Swale S5 Reach 3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (sf)	CN	Description
49,617	69	Pasture/grassland/range, Fair, HSG B
6,971	98	Paved parking, HSG A
1,619	96	Gravel surface, HSG A
20,925	39	Pasture/grassland/range, Good, HSG A
79,132	64	Weighted Average
72,161		91.19% Pervious Area
6,971		8.81% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	43	0.2500	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	11	0.1111	1.63		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
0.7	12	0.2500	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
2.9	28	0.0393	0.16		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
3.4	488	0.0024	2.40	52.81	**Trap/Vee/Rect Channel Flow, Swale S5 Reach 3** Bot.W=0.00' D=2.00' Z= 5.0 & 6.0 '/' Top.W=22.00' n= 0.030 Earth, grassed & winding
9.1	582	Total			

Summary for Subcatchment AREA 48: Subcat AREA 48

Runoff = 2.79 cfs @ 12.13 hrs, Volume= 0.145 af, Depth= 1.32"
Routed to Link Swale S5 R2 : Swale S5 Reach 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (sf)	CN	Description
24,597	69	Pasture/grassland/range, Fair, HSG B
24,117	39	Pasture/grassland/range, Good, HSG A
2,057	96	Gravel surface, HSG A
6,769	98	Paved parking, HSG A
57,540	61	Weighted Average
50,771		88.24% Pervious Area
6,769		11.76% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	19	0.0050	0.53		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
1.7	29	0.1667	0.29		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
3.1	441	0.0024	2.38	40.39	**Trap/Vee/Rect Channel Flow, Swale S5 Reach 2** Bot.W=0.00' D=2.00' Z= 2.5 & 6.0 '/' Top.W=17.00' n= 0.030 Earth, grassed & winding
5.4	489	Total			

Summary for Subcatchment AREA 49: Subcat AREA 49

Runoff = 1.37 cfs @ 12.12 hrs, Volume= 0.068 af, Depth= 1.18"
Routed to Link Swale S1 R1 : Swale S1 Reach 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.439	69	Pasture/grassland/range, Fair, HSG B
0.246	39	Pasture/grassland/range, Good, HSG A
0.006	96	Gravel surface, HSG A
0.691	59	Weighted Average
0.691		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	59	0.2500	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.8	463	0.0053	4.31	137.91	**Trap/Vee/Rect Channel Flow, Swale S1 Reach 1** Bot.W=8.00' D=2.00' Z= 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding

4.3	522	Total

Summary for Subcatchment AREA 5: Subcat AREA 5

Runoff = 3.58 cfs @ 12.14 hrs, Volume= 0.188 af, Depth= 1.89"
Routed to Link F1 : Flume 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.195	69	Pasture/grassland/range, Fair, HSG B
1.195		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	59	0.1000	0.27		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.9	41	0.2500	0.36		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.4	85	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	297	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
6.6	482	Total			

Summary for Subcatchment AREA 50: Subcat AREA 50

Runoff = 9.68 cfs @ 12.11 hrs, Volume= 0.494 af, Depth= 4.00"
Routed to Link Swale S6 R1 : Swale S6 Reach 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.100	39	Pasture/grassland/range, Good, HSG A
0.001	39	Pasture/grassland/range, Good, HSG A
1.382	96	Gravel surface, HSG A
1.482	92	Weighted Average
1.482		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	100	0.0119	1.04		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
0.4	47	0.0119	1.76		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.0	10	0.5000	4.95		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.4	413	0.0066	5.00	130.01	**Trap/Vee/Rect Channel Flow, Swale S6 Reach 1** Bot.W=8.00' D=2.00' Z= 2.5 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
3.4	570	Total			

Summary for Subcatchment AREA 51: Subcat AREA 51

Runoff = 0.08 cfs @ 12.54 hrs, Volume= 0.025 af, Depth= 0.22"
Routed to Link Swale S6 R1 : Swale S6 Reach 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.396	39	Pasture/grassland/range, Good, HSG A
0.020	96	Gravel surface, HSG A
1.417	40	Weighted Average
1.417		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
3.2	302	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	53	0.0313	2.85		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.4	429	0.0066	5.00	130.01	**Trap/Vee/Rect Channel Flow, Swale S6 Reach 1** Bot.W=8.00' D=2.00' Z= 2.5 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
12.2	884	Total			

Summary for Subcatchment AREA 52: Subcat AREA 52

Runoff = 2.06 cfs @ 12.16 hrs, Volume= 0.191 af, Depth= 0.51"
Routed to Link Swale S5 R1 : Swale S5 Reach 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (sf)	CN	Description
169,213	39	Pasture/grassland/range, Good, HSG A
25,933	98	Paved parking, HSG A
2,184	96	Gravel surface, HSG A
197,330	47	Weighted Average
171,397		86.86% Pervious Area
25,933		13.14% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	18	0.0050	0.52		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
1.4	21	0.1333	0.25		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
4.3	1,255	0.0096	4.82	125.20	**Trap/Vee/Rect Channel Flow, Swale S5 Reach 1** Bot.W=0.00' D=2.00' Z= 6.0 & 7.0 '/' Top.W=26.00' n= 0.030 Earth, grassed & winding
6.3	1,294	Total			

Summary for Subcatchment AREA 6: Subcat AREA 6

Runoff = 2.92 cfs @ 12.12 hrs, Volume= 0.141 af, Depth= 1.89"
Routed to Link F1 : Flume 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.892	69	Pasture/grassland/range, Fair, HSG B
0.892		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	7	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	308	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.6	415	Total			

Summary for Subcatchment AREA 7: Subcat AREA 7

Runoff = 3.15 cfs @ 12.13 hrs, Volume= 0.160 af, Depth= 1.89"
Routed to Link F8 : Existing West Flume

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.017	69	Pasture/grassland/range, Fair, HSG B
1.017		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	18	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.5	419	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.4	296	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow,** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
5.8	833	Total			

Summary for Subcatchment AREA 8: Subcat AREA 8

Runoff = 3.29 cfs @ 12.12 hrs, Volume= 0.159 af, Depth= 1.89"
Routed to Link F6 : Flume 6

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.009	69	Pasture/grassland/range, Fair, HSG B
1.009		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.3	66	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	243	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	409	Total			

Summary for Subcatchment AREA 9: Subcat AREA 9

Runoff = 3.40 cfs @ 12.13 hrs, Volume= 0.165 af, Depth= 1.89"
Routed to Link F6 : Flume 6

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.047	69	Pasture/grassland/range, Fair, HSG B
1.047		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.4	76	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	250	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.8	426	Total			

Summary for Reach S1 R2: Swale S1 Reach 2

Inflow Area = 7.131 ac, 0.00% Impervious, Inflow Depth = 1.81" for 25-yr, 24-hr event
Inflow = 22.03 cfs @ 12.12 hrs, Volume= 1.077 af
Outflow = 21.68 cfs @ 12.13 hrs, Volume= 1.077 af, Atten= 2%, Lag= 0.5 min
Routed to Link Swale S1 R2 : Swale S1 Reach 2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.58 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 0.69 fps, Avg. Travel Time= 3.1 min

Peak Storage= 1,066 cf @ 12.13 hrs
Average Depth at Peak Storage= 0.76' , Surface Width= 14.08'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 140.64 cfs

8.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 127.0' Slope= 0.0055 '/'
Inlet Invert= 814.81', Outlet Invert= 814.11'

‡

Summary for Reach S1 R3: Swale S1 Reach 3

Inflow Area = 14.170 ac, 0.00% Impervious, Inflow Depth = 1.51" for 25-yr, 24-hr event
Inflow = 31.44 cfs @ 12.12 hrs, Volume= 1.788 af
Outflow = 27.38 cfs @ 12.15 hrs, Volume= 1.788 af, Atten= 13%, Lag= 1.6 min
Routed to Link Swale S1 R3 : Swale S1 Reach 3

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.69 fps, Min. Travel Time= 3.6 min
Avg. Velocity = 0.61 fps, Avg. Travel Time= 15.9 min

Peak Storage= 5,875 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.88' , Surface Width= 15.05'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 135.10 cfs

8.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 578.0' Slope= 0.0051 '/'
Inlet Invert= 814.11', Outlet Invert= 811.17'

‡

Summary for Reach S1 R4: Swale S1 Reach 4

Inflow Area = 17.292 ac, 0.00% Impervious, Inflow Depth = 1.55" for 25-yr, 24-hr event
Inflow = 35.79 cfs @ 12.14 hrs, Volume= 2.233 af
Outflow = 35.20 cfs @ 12.15 hrs, Volume= 2.233 af, Atten= 2%, Lag= 0.7 min
Routed to Link Swale S1 R4 : Swale S1 Reach 4

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.19 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 0.70 fps, Avg. Travel Time= 4.6 min

Peak Storage= 2,163 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.94' , Surface Width= 15.52'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 154.36 cfs

8.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 195.8' Slope= 0.0066 '/'
Inlet Invert= 811.17', Outlet Invert= 809.87'

‡

Summary for Reach S1 R5: Swale S1 Reach 5

Inflow Area = 17.714 ac, 0.00% Impervious, Inflow Depth = 1.53" for 25-yr, 24-hr event
Inflow = 35.39 cfs @ 12.15 hrs, Volume= 2.255 af
Outflow = 33.17 cfs @ 12.18 hrs, Volume= 2.255 af, Atten= 6%, Lag= 1.6 min
Routed to Link Swale S1 R5 : Swale S1 Reach 5

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.89 fps, Min. Travel Time= 2.4 min
Avg. Velocity = 0.64 fps, Avg. Travel Time= 10.7 min

Peak Storage= 4,722 cf @ 12.18 hrs
Average Depth at Peak Storage= 0.97' , Surface Width= 15.73'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 137.86 cfs

8.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 411.6' Slope= 0.0053 '/'
Inlet Invert= 809.77', Outlet Invert= 807.59'

‡

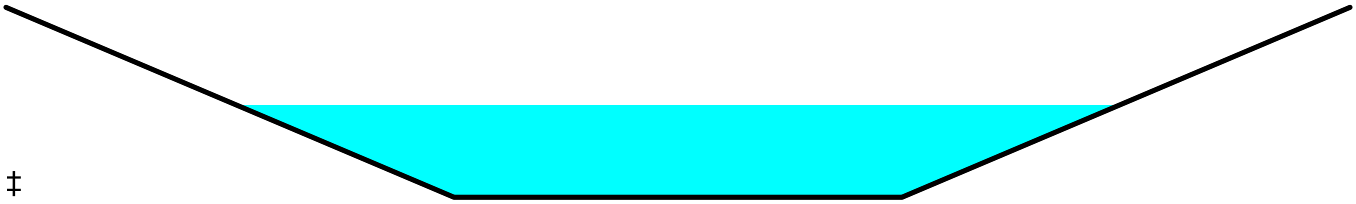
Summary for Reach S1 R6: Swale S1 Reach 6

Inflow Area = 23.788 ac, 0.00% Impervious, Inflow Depth = 1.25" for 25-yr, 24-hr event
Inflow = 35.21 cfs @ 12.18 hrs, Volume= 2.484 af
Outflow = 33.18 cfs @ 12.21 hrs, Volume= 2.484 af, Atten= 6%, Lag= 1.8 min
Routed to Link Swale 1 R6 : Swale S1 Reach 6

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.87 fps, Min. Travel Time= 2.5 min
Avg. Velocity = 0.65 fps, Avg. Travel Time= 11.0 min

Peak Storage= 4,986 cf @ 12.21 hrs
Average Depth at Peak Storage= 0.97' , Surface Width= 15.78'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 136.28 cfs

8.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 430.9' Slope= 0.0052 '/'
Inlet Invert= 807.15', Outlet Invert= 804.92'



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Summary for Reach S2 R1: Swale S2 Reach 1

Inflow Area = 25.203 ac, 0.00% Impervious, Inflow Depth = 1.19" for 25-yr, 24-hr event
Inflow = 33.19 cfs @ 12.21 hrs, Volume= 2.506 af
Outflow = 29.93 cfs @ 12.26 hrs, Volume= 2.506 af, Atten= 10%, Lag= 3.0 min
Routed to Link Swale S2 R1 : Swale S2 Reach 1

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.99 fps, Min. Travel Time= 4.0 min
Avg. Velocity = 0.45 fps, Avg. Travel Time= 17.6 min

Peak Storage= 7,099 cf @ 12.26 hrs
Average Depth at Peak Storage= 1.18' , Surface Width= 17.45'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 84.99 cfs

8.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 472.0' Slope= 0.0020 '/'
Inlet Invert= 802.25', Outlet Invert= 801.30'

‡

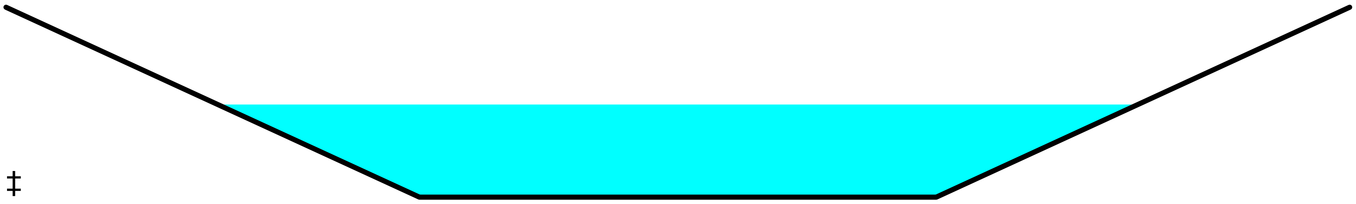
Summary for Reach S2 R2: Swale S2 Reach 2

Inflow Area = 42.068 ac, 0.00% Impervious, Inflow Depth = 1.23" for 25-yr, 24-hr event
Inflow = 48.80 cfs @ 12.18 hrs, Volume= 4.314 af
Outflow = 46.24 cfs @ 12.25 hrs, Volume= 4.314 af, Atten= 5%, Lag= 4.2 min
Routed to Link Swale S2 R2 : Swale S2 Reach 2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.41 fps, Min. Travel Time= 3.7 min
Avg. Velocity = 0.75 fps, Avg. Travel Time= 16.7 min

Peak Storage= 10,190 cf @ 12.25 hrs
Average Depth at Peak Storage= 0.98' , Surface Width= 17.81'
Bank-Full Depth= 2.00' Flow Area= 36.0 sf, Capacity= 182.04 cfs

10.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 '/' Top Width= 26.00'
Length= 751.0' Slope= 0.0069 '/'
Inlet Invert= 801.30', Outlet Invert= 796.10'



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Summary for Reach S3 R1: Swale S3 Reach 1

Inflow Area = 4.976 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 16.31 cfs @ 12.12 hrs, Volume= 0.785 af
Outflow = 15.87 cfs @ 12.13 hrs, Volume= 0.785 af, Atten= 3%, Lag= 0.7 min
Routed to Link Swale S3 R1 : Swale S3 Reach 1

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.73 fps, Min. Travel Time= 1.3 min
Avg. Velocity = 0.67 fps, Avg. Travel Time= 5.4 min

Peak Storage= 1,248 cf @ 12.13 hrs
Average Depth at Peak Storage= 0.63' , Surface Width= 10.51'
Bank-Full Depth= 2.00' Flow Area= 24.0 sf, Capacity= 125.24 cfs

8.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 215.0' Slope= 0.0070 '/'
Inlet Invert= 807.58', Outlet Invert= 806.08'

‡

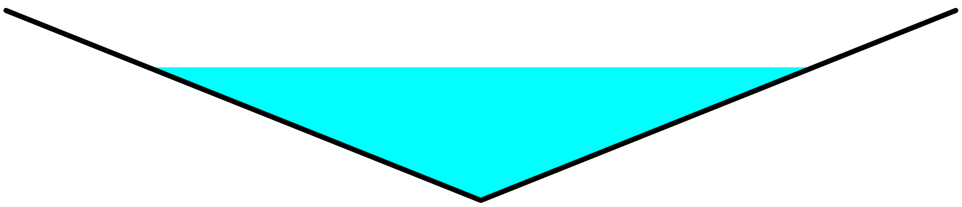
Summary for Reach S3 R2: Swale S3 Reach 2

Inflow Area = 10.265 ac, 0.00% Impervious, Inflow Depth = 1.66" for 25-yr, 24-hr event
Inflow = 27.94 cfs @ 12.13 hrs, Volume= 1.419 af
Outflow = 27.78 cfs @ 12.13 hrs, Volume= 1.419 af, Atten= 1%, Lag= 0.3 min
Routed to Link Swale S3 R2 : Swale S3 Reach 2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.61 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.31 fps, Avg. Travel Time= 1.2 min

Peak Storage= 745 cf @ 12.13 hrs
Average Depth at Peak Storage= 1.75' , Surface Width= 8.77'
Bank-Full Depth= 2.50' Flow Area= 15.6 sf, Capacity= 71.57 cfs

0.00' x 2.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.5 '/' Top Width= 12.50'
Length= 97.0' Slope= 0.0070 '/'
Inlet Invert= 806.08', Outlet Invert= 805.40'



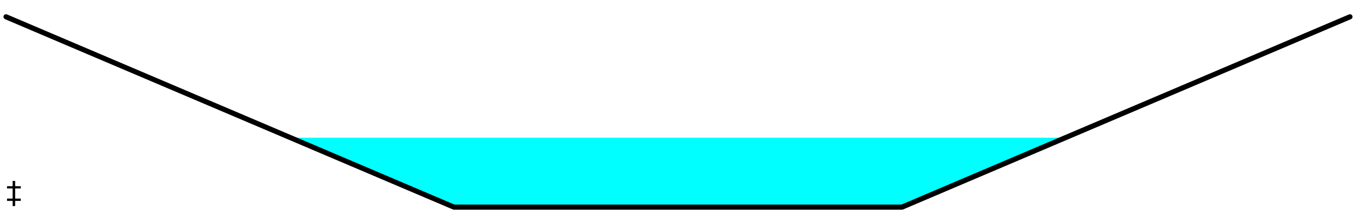
Summary for Reach S3 R3: Swale S3 Reach 3

Inflow Area = 11.158 ac, 0.00% Impervious, Inflow Depth = 1.57" for 25-yr, 24-hr event
Inflow = 27.86 cfs @ 12.13 hrs, Volume= 1.464 af
Outflow = 26.59 cfs @ 12.15 hrs, Volume= 1.464 af, Atten= 5%, Lag= 1.0 min
Routed to Link Swale S3 R3 : Swale S3 Reach 3

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.34 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 0.88 fps, Avg. Travel Time= 6.7 min

Peak Storage= 2,810 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.73' , Surface Width= 13.83'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 186.19 cfs

8.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 353.0' Slope= 0.0097 '/'
Inlet Invert= 804.71', Outlet Invert= 801.30'



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Summary for Reach S4 R2: Swale S4 Reach 2

Inflow Area = 4.541 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 14.04 cfs @ 12.13 hrs, Volume= 0.716 af
Outflow = 11.87 cfs @ 12.17 hrs, Volume= 0.716 af, Atten= 15%, Lag= 2.1 min
Routed to Reach S4 R3 : Swale S4 Reach 3

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.23 fps, Min. Travel Time= 4.5 min
Avg. Velocity = 0.55 fps, Avg. Travel Time= 18.3 min

Peak Storage= 3,193 cf @ 12.17 hrs
Average Depth at Peak Storage= 0.46' , Surface Width= 13.21'
Bank-Full Depth= 2.00' Flow Area= 34.0 sf, Capacity= 174.20 cfs

10.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 3.0 '/' Top Width= 24.00'
Length= 601.0' Slope= 0.0069 '/'
Inlet Invert= 806.43', Outlet Invert= 802.26'

‡

Summary for Reach S4 R3: Swale S4 Reach 3

[62] Hint: Exceeded Reach S4 R2 OUTLET depth by 0.23' @ 12.28 hrs

Inflow Area = 8.711 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 23.93 cfs @ 12.14 hrs, Volume= 1.374 af
Outflow = 18.66 cfs @ 12.20 hrs, Volume= 1.374 af, Atten= 22%, Lag= 3.4 min
Routed to Reach S4 R4 : Swale S4 Reach 4

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.42 fps, Min. Travel Time= 6.5 min
Avg. Velocity = 0.57 fps, Avg. Travel Time= 27.9 min

Peak Storage= 7,289 cf @ 12.20 hrs
Average Depth at Peak Storage= 0.63' , Surface Width= 14.42'
Bank-Full Depth= 2.00' Flow Area= 34.0 sf, Capacity= 156.53 cfs

10.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 4.0 '/' Top Width= 24.00'
Length= 946.0' Slope= 0.0056 '/'
Inlet Invert= 802.26', Outlet Invert= 796.96'

‡

Summary for Reach S4 R4: Swale S4 Reach 4

[62] Hint: Exceeded Reach S4 R3 OUTLET depth by 0.67' @ 12.27 hrs

Inflow Area = 65.063 ac, 0.04% Impervious, Inflow Depth = 1.31" for 25-yr, 24-hr event
Inflow = 81.28 cfs @ 12.20 hrs, Volume= 7.099 af
Outflow = 80.05 cfs @ 12.23 hrs, Volume= 7.099 af, Atten= 2%, Lag= 1.7 min
Routed to Link Swale S4 R4 : Swale S4 Reach 4

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.35 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 0.97 fps, Avg. Travel Time= 8.3 min

Peak Storage= 8,890 cf @ 12.23 hrs
Average Depth at Peak Storage= 1.27' , Surface Width= 18.91'
Bank-Full Depth= 3.00' Flow Area= 61.5 sf, Capacity= 427.66 cfs

10.00' x 3.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 4.0 '/' Top Width= 31.00'
Length= 483.0' Slope= 0.0082 '/'
Inlet Invert= 796.96', Outlet Invert= 793.00'

‡

Summary for Reach S5 R2: Swale S5 Reach 2

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 4.530 ac, 13.14% Impervious, Inflow Depth = 0.51" for 25-yr, 24-hr event
Inflow = 2.06 cfs @ 12.16 hrs, Volume= 0.191 af
Outflow = 2.06 cfs @ 12.16 hrs, Volume= 0.191 af, Atten= 0%, Lag= 0.0 min
Routed to Link Swale S5 R2 : Swale S5 Reach 2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Pond Sed Pond: Sedimentation Basin

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=42)

Inflow Area = 74.393 ac, 2.06% Impervious, Inflow Depth = 1.27" for 25-yr, 24-hr event
Inflow = 82.78 cfs @ 12.23 hrs, Volume= 7.853 af
Outflow = 14.75 cfs @ 13.29 hrs, Volume= 7.854 af, Atten= 82%, Lag= 64.1 min
Discarded = 5.33 cfs @ 13.29 hrs, Volume= 5.880 af
Primary = 9.42 cfs @ 13.29 hrs, Volume= 1.973 af
Routed to Link Wetland : Wetland
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link Wetland : Wetland
Tertiary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link Wetland : Wetland

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Peak Elev= 791.59' @ 13.29 hrs Surf.Area= 63,986 sf Storage= 137,326 cf
Flood Elev= 794.00' Surf.Area= 75,797 sf Storage= 304,443 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 184.8 min (1,043.0 - 858.2)

Volume	Invert	Avail.Storage	Storage Description
#1	789.00'	304,443 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
789.00	27,325	0	0
790.00	55,972	41,649	41,649
791.00	61,532	58,752	100,401
792.00	65,703	63,618	164,018
793.00	69,675	67,689	231,707
794.00	75,797	72,736	304,443

Device	Routing	Invert	Outlet Devices
#1	Primary	787.70'	**15.0" Round Culvert** L= 40.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 787.70' / 787.50' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.23 sf
#2	Device 1	791.00'	**30.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	790.50'	**0.8" Vert. Orifice/Grate X 4.00** C= 0.600 Limited to weir flow at low heads
#4	Device 1	790.00'	**0.8" Vert. Orifice/Grate X 4.00** C= 0.600 Limited to weir flow at low heads
#5	Device 1	789.00'	**0.5" Vert. Orifice/Grate X 14.00 columns** X 6 rows with 6.0" cc spacing C= 0.600 Limited to weir flow at low heads
#6	Secondary	792.50'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#7	Tertiary	793.00'	**158.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#8	Discarded	789.00'	**3.600 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=5.33 cfs @ 13.29 hrs HW=791.59' (Free Discharge)
└—**8=Exfiltration** (Exfiltration Controls 5.33 cfs)

Primary OutFlow Max=9.42 cfs @ 13.29 hrs HW=791.59' TW=0.00' (Dynamic Tailwater)
└—**1=Culvert** (Inlet Controls 9.42 cfs @ 7.67 fps)
  —**2=Orifice/Grate** (Passes < 11.59 cfs potential flow)
  —**3=Orifice/Grate** (Passes < 0.07 cfs potential flow)
  —**4=Orifice/Grate** (Passes < 0.08 cfs potential flow)
  └—**5=Orifice/Grate** (Passes < 0.58 cfs potential flow)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=789.00' TW=0.00' (Dynamic Tailwater)
└—**6=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Tertiary OutFlow Max=0.00 cfs @ 0.00 hrs HW=789.00' TW=0.00' (Dynamic Tailwater)
└—**7=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Link C1: Culvert C1

Inflow Area = 4.530 ac, 13.14% Impervious, Inflow Depth = 0.51" for 25-yr, 24-hr event
Inflow = 2.06 cfs @ 12.16 hrs, Volume= 0.191 af
Primary = 2.06 cfs @ 12.16 hrs, Volume= 0.191 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S5 R2 : Swale S5 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link C2: Culvert C2

Inflow Area = 2.899 ac, 0.00% Impervious, Inflow Depth = 2.15" for 25-yr, 24-hr event
Inflow = 9.68 cfs @ 12.11 hrs, Volume= 0.520 af
Primary = 9.68 cfs @ 12.11 hrs, Volume= 0.520 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1 R3 : Swale S1 Reach 3

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link C3: Culvert C3

Inflow Area = 14.170 ac, 0.00% Impervious, Inflow Depth = 1.51" for 25-yr, 24-hr event
Inflow = 27.38 cfs @ 12.15 hrs, Volume= 1.788 af
Primary = 27.38 cfs @ 12.15 hrs, Volume= 1.788 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1 R4 : Swale S1 Reach 4

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link C4: Culvert C4

Inflow Area = 17.714 ac, 0.00% Impervious, Inflow Depth = 1.53" for 25-yr, 24-hr event
Inflow = 35.39 cfs @ 12.15 hrs, Volume= 2.255 af
Primary = 35.39 cfs @ 12.15 hrs, Volume= 2.255 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1 R5 : Swale S1 Reach 5

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link C5: Culvert C5

Inflow Area = 20.996 ac, 0.00% Impervious, Inflow Depth = 1.39" for 25-yr, 24-hr event
Inflow = 35.21 cfs @ 12.18 hrs, Volume= 2.434 af
Primary = 35.21 cfs @ 12.18 hrs, Volume= 2.434 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1 R6 : Swale S1 Reach 6

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link C6: Culvert C6

Inflow Area = 11.158 ac, 0.00% Impervious, Inflow Depth = 1.57" for 25-yr, 24-hr event
Inflow = 27.86 cfs @ 12.13 hrs, Volume= 1.464 af
Primary = 27.86 cfs @ 12.13 hrs, Volume= 1.464 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S3 R3 : Swale S3 Reach 3

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link C7: Culvert C7

Inflow Area = 48.985 ac, 0.00% Impervious, Inflow Depth = 1.22" for 25-yr, 24-hr event
Inflow = 52.15 cfs @ 12.23 hrs, Volume= 4.999 af
Primary = 52.15 cfs @ 12.23 hrs, Volume= 4.999 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S4 R4 : Swale S4 Reach 4

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link C8: Culvert C8

Inflow Area = 7.668 ac, 11.88% Impervious, Inflow Depth = 0.89" for 25-yr, 24-hr event
Inflow = 8.32 cfs @ 12.15 hrs, Volume= 0.566 af
Primary = 8.32 cfs @ 12.15 hrs, Volume= 0.566 af, Atten= 0%, Lag= 0.0 min
Routed to Link North Area : North Area

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link F1: Flume 1

Inflow Area = 4.170 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 13.17 cfs @ 12.13 hrs, Volume= 0.658 af
Primary = 13.17 cfs @ 12.13 hrs, Volume= 0.658 af, Atten= 0%, Lag= 0.0 min
Routed to Link RC1 : Rock Chute 1

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link F2: Flume 2

Inflow Area = 4.541 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 14.04 cfs @ 12.13 hrs, Volume= 0.716 af
Primary = 14.04 cfs @ 12.13 hrs, Volume= 0.716 af, Atten= 0%, Lag= 0.0 min
Routed to Link RC2 : Rock Chute 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link F3: Flume 3

Inflow Area = 5.923 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 19.08 cfs @ 12.12 hrs, Volume= 0.934 af
Primary = 19.08 cfs @ 12.12 hrs, Volume= 0.934 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1 R2 : Swale S1 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link F4: Flume 4

Inflow Area = 2.645 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 8.58 cfs @ 12.12 hrs, Volume= 0.417 af
Primary = 8.58 cfs @ 12.12 hrs, Volume= 0.417 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1 R4 : Swale S1 Reach 4

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link F5: Flume 5

Inflow Area = 4.601 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 15.06 cfs @ 12.12 hrs, Volume= 0.725 af
Primary = 15.06 cfs @ 12.12 hrs, Volume= 0.725 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S3 R1 : Swale S3 Reach 1

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link F6: Flume 6

Inflow Area = 3.717 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 12.11 cfs @ 12.12 hrs, Volume= 0.586 af
Primary = 12.11 cfs @ 12.12 hrs, Volume= 0.586 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S3 R2 : Swale S3 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link F7: Existing East Flume

Inflow Area = 0.830 ac, 0.00% Impervious, Inflow Depth = 1.85" for 25-yr, 24-hr event
Inflow = 2.66 cfs @ 12.12 hrs, Volume= 0.128 af
Primary = 2.66 cfs @ 12.12 hrs, Volume= 0.128 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S2 R2 : Swale S2 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link F8: Existing West Flume

Inflow Area = 3.122 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 9.73 cfs @ 12.13 hrs, Volume= 0.492 af
Primary = 9.73 cfs @ 12.13 hrs, Volume= 0.492 af, Atten= 0%, Lag= 0.0 min
Routed to Link Swale S2 R2 : Swale S2 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link North Area: North Area

Inflow Area = 7.668 ac, 11.88% Impervious, Inflow Depth = 0.89" for 25-yr, 24-hr event
Inflow = 8.32 cfs @ 12.15 hrs, Volume= 0.566 af
Primary = 8.32 cfs @ 12.15 hrs, Volume= 0.566 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link RC1: Rock Chute 1

Inflow Area = 4.170 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 13.17 cfs @ 12.13 hrs, Volume= 0.658 af
Primary = 13.17 cfs @ 12.13 hrs, Volume= 0.658 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S4 R3 : Swale S4 Reach 3

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link RC2: Rock Chute 2

Inflow Area = 4.541 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 14.04 cfs @ 12.13 hrs, Volume= 0.716 af
Primary = 14.04 cfs @ 12.13 hrs, Volume= 0.716 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S4 R2 : Swale S4 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale 1 R6: Swale S1 Reach 6

Inflow Area = 23.788 ac, 0.00% Impervious, Inflow Depth = 1.25" for 25-yr, 24-hr event
Inflow = 33.18 cfs @ 12.21 hrs, Volume= 2.484 af
Primary = 33.18 cfs @ 12.21 hrs, Volume= 2.484 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S2 R1 : Swale S2 Reach 1

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S1 R1: Swale S1 Reach 1

Inflow Area = 0.691 ac, 0.00% Impervious, Inflow Depth = 1.18" for 25-yr, 24-hr event
Inflow = 1.37 cfs @ 12.12 hrs, Volume= 0.068 af
Primary = 1.37 cfs @ 12.12 hrs, Volume= 0.068 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1 R2 : Swale S1 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S1 R2: Swale S1 Reach 2

Inflow Area = 7.131 ac, 0.00% Impervious, Inflow Depth = 1.81" for 25-yr, 24-hr event
Inflow = 21.68 cfs @ 12.13 hrs, Volume= 1.077 af
Primary = 21.68 cfs @ 12.13 hrs, Volume= 1.077 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1 R3 : Swale S1 Reach 3

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S1 R3: Swale S1 Reach 3

Inflow Area = 14.170 ac, 0.00% Impervious, Inflow Depth = 1.51" for 25-yr, 24-hr event
Inflow = 27.38 cfs @ 12.15 hrs, Volume= 1.788 af
Primary = 27.38 cfs @ 12.15 hrs, Volume= 1.788 af, Atten= 0%, Lag= 0.0 min
Routed to Link C3 : Culvert C3

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S1 R4: Swale S1 Reach 4

Inflow Area = 17.714 ac, 0.00% Impervious, Inflow Depth = 1.53" for 25-yr, 24-hr event
Inflow = 35.39 cfs @ 12.15 hrs, Volume= 2.255 af
Primary = 35.39 cfs @ 12.15 hrs, Volume= 2.255 af, Atten= 0%, Lag= 0.0 min
Routed to Link C4 : Culvert C4

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S1 R5: Swale S1 Reach 5

Inflow Area = 20.996 ac, 0.00% Impervious, Inflow Depth = 1.39" for 25-yr, 24-hr event
Inflow = 35.21 cfs @ 12.18 hrs, Volume= 2.434 af
Primary = 35.21 cfs @ 12.18 hrs, Volume= 2.434 af, Atten= 0%, Lag= 0.0 min
Routed to Link C5 : Culvert C5

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S2 R1: Swale S2 Reach 1

Inflow Area = 25.901 ac, 0.00% Impervious, Inflow Depth = 1.17" for 25-yr, 24-hr event
Inflow = 29.95 cfs @ 12.26 hrs, Volume= 2.516 af
Primary = 29.95 cfs @ 12.26 hrs, Volume= 2.516 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S2 R2 : Swale S2 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S2 R2: Swale S2 Reach 2

Inflow Area = 48.985 ac, 0.00% Impervious, Inflow Depth = 1.22" for 25-yr, 24-hr event
Inflow = 52.15 cfs @ 12.23 hrs, Volume= 4.999 af
Primary = 52.15 cfs @ 12.23 hrs, Volume= 4.999 af, Atten= 0%, Lag= 0.0 min
Routed to Link C7 : Culvert C7

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S3 R1: Swale S3 Reach 1

Inflow Area = 6.548 ac, 0.00% Impervious, Inflow Depth = 1.53" for 25-yr, 24-hr event
Inflow = 15.88 cfs @ 12.13 hrs, Volume= 0.833 af
Primary = 15.88 cfs @ 12.13 hrs, Volume= 0.833 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S3 R2 : Swale S3 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S3 R2: Swale S3 Reach 2

Inflow Area = 11.158 ac, 0.00% Impervious, Inflow Depth = 1.57" for 25-yr, 24-hr event
Inflow = 27.86 cfs @ 12.13 hrs, Volume= 1.464 af
Primary = 27.86 cfs @ 12.13 hrs, Volume= 1.464 af, Atten= 0%, Lag= 0.0 min
Routed to Link C6 : Culvert C6

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S3 R3: Swale S3 Reach 3

Inflow Area = 14.511 ac, 0.00% Impervious, Inflow Depth = 1.32" for 25-yr, 24-hr event
Inflow = 26.70 cfs @ 12.15 hrs, Volume= 1.592 af
Primary = 26.70 cfs @ 12.15 hrs, Volume= 1.592 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S2 R2 : Swale S2 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S4 R4: Swale S4 Reach 4

Inflow Area = 67.064 ac, 0.04% Impervious, Inflow Depth = 1.28" for 25-yr, 24-hr event
Inflow = 80.09 cfs @ 12.23 hrs, Volume= 7.154 af
Primary = 80.09 cfs @ 12.23 hrs, Volume= 7.154 af, Atten= 0%, Lag= 0.0 min
Routed to Pond Sed Pond : Sedimentation Basin

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S5 R1: Swale S5 Reach 1

Inflow Area = 4.530 ac, 13.14% Impervious, Inflow Depth = 0.51" for 25-yr, 24-hr event
Inflow = 2.06 cfs @ 12.16 hrs, Volume= 0.191 af
Primary = 2.06 cfs @ 12.16 hrs, Volume= 0.191 af, Atten= 0%, Lag= 0.0 min
Routed to Link C1 : Culvert C1

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S5 R2: Swale S5 Reach 2

Inflow Area = 5.851 ac, 12.83% Impervious, Inflow Depth = 0.69" for 25-yr, 24-hr event
Inflow = 4.68 cfs @ 12.15 hrs, Volume= 0.336 af
Primary = 4.68 cfs @ 12.15 hrs, Volume= 0.336 af, Atten= 0%, Lag= 0.0 min
Routed to Link C8 : Culvert C8

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S5 R3: Swale S5 Reach 3

Inflow Area = 1.817 ac, 8.81% Impervious, Inflow Depth = 1.52" for 25-yr, 24-hr event
Inflow = 3.79 cfs @ 12.17 hrs, Volume= 0.230 af
Primary = 3.79 cfs @ 12.17 hrs, Volume= 0.230 af, Atten= 0%, Lag= 0.0 min
Routed to Link C8 : Culvert C8

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S6 R1: Swale S6 Reach 1

Inflow Area = 2.899 ac, 0.00% Impervious, Inflow Depth = 2.15" for 25-yr, 24-hr event
Inflow = 9.68 cfs @ 12.11 hrs, Volume= 0.520 af
Primary = 9.68 cfs @ 12.11 hrs, Volume= 0.520 af, Atten= 0%, Lag= 0.0 min
Routed to Link C2 : Culvert C2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Wetland: Wetland

Inflow Area = 74.393 ac, 2.06% Impervious, Inflow Depth = 0.32" for 25-yr, 24-hr event
Inflow = 9.42 cfs @ 13.29 hrs, Volume= 1.973 af
Primary = 9.42 cfs @ 13.29 hrs, Volume= 1.973 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Time span=0.00-40.00 hrs, dt=0.01 hrs, 4001 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment AREA 1: Subcat AREA 1 Runoff Area=1.288 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=408' Tc=2.6 min CN=69 Runoff=7.63 cfs 0.342 af

Subcatchment AREA 10: Subcat AREA 10 Runoff Area=0.914 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=500' Tc=3.2 min CN=69 Runoff=5.29 cfs 0.242 af

Subcatchment AREA 11: Subcat AREA 11 Runoff Area=0.949 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=391' Tc=4.6 min CN=69 Runoff=5.21 cfs 0.251 af

Subcatchment AREA 12: Subcat AREA 12 Runoff Area=0.098 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=92' Tc=2.5 min CN=69 Runoff=0.58 cfs 0.026 af

Subcatchment AREA 13: Subcat AREA 13 Runoff Area=0.890 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=590' Tc=4.6 min CN=69 Runoff=4.89 cfs 0.236 af

Subcatchment AREA 14: Subcat AREA 14 Runoff Area=1.145 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=625' Tc=5.1 min CN=69 Runoff=6.17 cfs 0.303 af

Subcatchment AREA 15: Subcat AREA 15 Runoff Area=0.512 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=235' Tc=4.2 min CN=69 Runoff=2.86 cfs 0.136 af

Subcatchment AREA 16: Subcat AREA 16 Runoff Area=1.510 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=522' Tc=4.9 min CN=69 Runoff=8.20 cfs 0.400 af

Subcatchment AREA 17: Subcat AREA 17 Runoff Area=1.228 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=386' Tc=4.7 min CN=69 Runoff=6.72 cfs 0.326 af

Subcatchment AREA 18: Subcat AREA 18 Runoff Area=0.813 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=383' Tc=4.6 min CN=69 Runoff=4.47 cfs 0.215 af

Subcatchment AREA 19: Subcat AREA 19 Runoff Area=0.847 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=394' Tc=4.6 min CN=69 Runoff=4.66 cfs 0.225 af

Subcatchment AREA 2: Subcat AREA 2 Runoff Area=1.167 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=613' Tc=5.1 min CN=69 Runoff=6.28 cfs 0.309 af

Subcatchment AREA 20: Subcat AREA 20 Runoff Area=1.054 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=453' Tc=4.7 min CN=69 Runoff=5.77 cfs 0.279 af

Subcatchment AREA 21: Subcat AREA 21 Runoff Area=1.030 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=448' Tc=4.7 min CN=69 Runoff=5.64 cfs 0.273 af

Subcatchment AREA 22: Subcat AREA 22 Runoff Area=1.030 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=448' Tc=4.7 min CN=69 Runoff=5.64 cfs 0.273 af

Subcatchment AREA 23: Subcat AREA 23 Runoff Area=1.548 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=715' Tc=5.4 min CN=69 Runoff=8.23 cfs 0.410 af

Subcatchment AREA 24: Subcat AREA 24 Runoff Area=1.952 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=889' Tc=5.8 min CN=69 Runoff=10.20 cfs 0.517 af

Subcatchment AREA 25: Subcat AREA 25 Runoff Area=1.515 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=495' Tc=3.9 min CN=69 Runoff=8.59 cfs 0.402 af

Subcatchment AREA 26: Subcat AREA 26 Runoff Area=0.518 ac 0.00% Impervious Runoff Depth=2.98"
Flow Length=216' Tc=4.1 min CN=67 Runoff=2.74 cfs 0.129 af

Subcatchment AREA 27: Subcat AREA 27 Runoff Area=4.140 ac 0.00% Impervious Runoff Depth=1.28"
Flow Length=864' Tc=12.0 min CN=48 Runoff=5.63 cfs 0.442 af

Subcatchment AREA 28: Subcat AREA 28 Runoff Area=142,960 sf 0.00% Impervious Runoff Depth=1.44"
Flow Length=573' Tc=9.1 min CN=50 Runoff=5.98 cfs 0.395 af

Subcatchment AREA 28A: Subcat AREA 28A Runoff Area=0.423 ac 0.00% Impervious Runoff Depth=1.36"
Flow Length=234' Tc=9.1 min CN=49 Runoff=0.71 cfs 0.048 af

Subcatchment AREA 28B: Subcat AREA 28B Runoff Area=0.476 ac 0.00% Impervious Runoff Depth=1.53"
Flow Length=211' Tc=4.5 min CN=51 Runoff=1.20 cfs 0.061 af

Subcatchment AREA 29: Subcat AREA 29 Runoff Area=2.792 ac 0.00% Impervious Runoff Depth=0.69"
Flow Length=463' Tc=14.8 min CN=40 Runoff=1.21 cfs 0.161 af

Subcatchment AREA 3: Subcat AREA 3 Runoff Area=0.717 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=409' Tc=6.3 min CN=69 Runoff=3.66 cfs 0.190 af

Subcatchment AREA 30: Subcat AREA 30 Runoff Area=1.415 ac 0.00% Impervious Runoff Depth=0.63"
Flow Length=941' Slope=0.0260 '/' Tc=22.0 min CN=39 Runoff=0.43 cfs 0.074 af

Subcatchment AREA 31: Subcat AREA 31 Runoff Area=0.698 ac 0.00% Impervious Runoff Depth=0.63"
Flow Length=481' Tc=4.4 min CN=39 Runoff=0.42 cfs 0.036 af

Subcatchment AREA 32: Subcat AREA 32 Runoff Area=3.353 ac 0.00% Impervious Runoff Depth=1.13"
Flow Length=663' Tc=17.3 min CN=46 Runoff=3.11 cfs 0.315 af

Subcatchment AREA 33: Subcat AREA 33 Runoff Area=38,914 sf 0.00% Impervious Runoff Depth=1.36"
Flow Length=377' Tc=16.0 min CN=49 Runoff=1.14 cfs 0.101 af

Subcatchment AREA 34: Subcat AREA 34 Runoff Area=68,484 sf 0.00% Impervious Runoff Depth=0.98"
Flow Length=488' Tc=16.2 min CN=44 Runoff=1.20 cfs 0.128 af

Subcatchment AREA 35: Subcat AREA 35 Runoff Area=0.375 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=174' Slope=0.2500 '/' Tc=4.2 min CN=69 Runoff=2.10 cfs 0.099 af

Subcatchment AREA 36: Subcat AREA 36 Runoff Area=0.487 ac 0.00% Impervious Runoff Depth=3.08"
Flow Length=425' Tc=4.4 min CN=68 Runoff=2.62 cfs 0.125 af

Subcatchment AREA 37: Subcat AREA 37 Runoff Area=0.344 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=510' Tc=4.6 min CN=69 Runoff=1.89 cfs 0.091 af

Subcatchment AREA 38: Subcat AREA 38 Runoff Area=0.223 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=590' Tc=4.1 min CN=69 Runoff=1.25 cfs 0.059 af

Subcatchment AREA 39: Subcat AREA 39 Runoff Area=0.656 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=642' Tc=5.3 min CN=69 Runoff=3.50 cfs 0.174 af

Subcatchment AREA 4: Subcat AREA 4 Runoff Area=1.247 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=478' Tc=6.6 min CN=69 Runoff=6.31 cfs 0.331 af

Subcatchment AREA 40: Subcat AREA 40 Runoff Area=1.618 ac 0.00% Impervious Runoff Depth=2.23"
Flow Length=699' Tc=5.2 min CN=59 Runoff=6.03 cfs 0.300 af

Subcatchment AREA 41: Subcat AREA 41 Runoff Area=0.826 ac 0.00% Impervious Runoff Depth=2.13"
Flow Length=722' Tc=5.9 min CN=58 Runoff=2.84 cfs 0.147 af

Subcatchment AREA 42: Subcat AREA 42 Runoff Area=2.177 ac 0.00% Impervious Runoff Depth=0.63"
Flow Length=415' Tc=9.1 min CN=39 Runoff=0.93 cfs 0.114 af

Subcatchment AREA 43: Subcat AREA 43 Runoff Area=1.228 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=778' Tc=5.9 min CN=69 Runoff=6.39 cfs 0.325 af

Subcatchment AREA 44: Subcat AREA 44 Runoff Area=5.227 ac 0.00% Impervious Runoff Depth=0.63"
Flow Length=701' Tc=7.9 min CN=39 Runoff=2.38 cfs 0.273 af

Subcatchment AREA 44A: Subcat AREA Runoff Area=1.508 ac 100.00% Impervious Runoff Depth=6.35"
Tc=0.0 min CN=98 Runoff=14.38 cfs 0.798 af

Subcatchment AREA 44B: Subcat AREA 44B Runoff Area=0.594 ac 0.00% Impervious Runoff Depth=1.44"
Flow Length=147' Slope=0.0544 '/' Tc=7.6 min CN=50 Runoff=1.17 cfs 0.071 af

Subcatchment AREA 45: Subcat AREA 45 Runoff Area=2.001 ac 0.00% Impervious Runoff Depth=0.90"
Flow Length=681' Tc=21.9 min CN=43 Runoff=1.16 cfs 0.150 af

Subcatchment AREA 46: Subcat AREA 46 Runoff Area=7.367 ac 0.36% Impervious Runoff Depth=2.23"
Flow Length=1,904' Tc=9.2 min CN=59 Runoff=22.74 cfs 1.366 af

Subcatchment AREA 47: Subcat AREA 47 Runoff Area=79,132 sf 8.81% Impervious Runoff Depth=2.69"
Flow Length=582' Tc=9.1 min CN=64 Runoff=6.90 cfs 0.408 af

Subcatchment AREA 48: Subcat AREA 48 Runoff Area=57,540 sf 11.76% Impervious Runoff Depth=2.41"
Flow Length=489' Tc=5.4 min CN=61 Runoff=5.30 cfs 0.265 af

Subcatchment AREA 49: Subcat AREA 49 Runoff Area=0.691 ac 0.00% Impervious Runoff Depth=2.23"
Flow Length=522' Tc=4.3 min CN=59 Runoff=2.68 cfs 0.128 af

Subcatchment AREA 5: Subcat AREA 5 Runoff Area=1.195 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=482' Tc=6.6 min CN=69 Runoff=6.05 cfs 0.317 af

Subcatchment AREA 50: Subcat AREA 50 Runoff Area=1.482 ac 0.00% Impervious Runoff Depth=5.65"
Flow Length=570' Tc=3.4 min CN=92 Runoff=13.35 cfs 0.698 af

Subcatchment AREA 51: Subcat AREA 51 Runoff Area=1.417 ac 0.00% Impervious Runoff Depth=0.69"
Flow Length=884' Tc=12.2 min CN=40 Runoff=0.67 cfs 0.082 af

Subcatchment AREA 52: Subcat AREA 52 Runoff Area=197,330 sf 13.14% Impervious Runoff Depth=1.20"
Flow Length=1,294' Tc=6.3 min CN=47 Runoff=7.48 cfs 0.454 af

Subcatchment AREA 6: Subcat AREA 6 Runoff Area=0.892 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=415' Tc=4.6 min CN=69 Runoff=4.90 cfs 0.236 af

Subcatchment AREA 7: Subcat AREA 7 Runoff Area=1.017 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=833' Tc=5.8 min CN=69 Runoff=5.31 cfs 0.269 af

Subcatchment AREA 8: Subcat AREA 8 Runoff Area=1.009 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=409' Tc=4.7 min CN=69 Runoff=5.52 cfs 0.268 af

Subcatchment AREA 9: Subcat AREA 9 Runoff Area=1.047 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=426' Tc=4.8 min CN=69 Runoff=5.71 cfs 0.278 af

Reach S1 R2: Swale S1 Reach 2 Avg. Flow Depth=1.01' Max Vel=3.03 fps Inflow=37.51 cfs 1.827 af
n=0.030 L=127.0' S=0.0055 '/' Capacity=140.64 cfs Outflow=37.05 cfs 1.827 af

Reach S1 R3: Swale S1 Reach 3 Avg. Flow Depth=1.18' Max Vel=3.17 fps Inflow=53.22 cfs 3.049 af
n=0.030 L=578.0' S=0.0051 '/' Capacity=135.10 cfs Outflow=47.76 cfs 3.049 af

Reach S1 R4: Swale S1 Reach 4 Avg. Flow Depth=1.26' Max Vel=3.74 fps Inflow=62.37 cfs 3.811 af
n=0.030 L=195.8' S=0.0066 '/' Capacity=154.36 cfs Outflow=61.58 cfs 3.811 af

Reach S1 R5: Swale S1 Reach 5 Avg. Flow Depth=1.31' Max Vel=3.42 fps Inflow=62.23 cfs 3.859 af
n=0.030 L=411.6' S=0.0053 '/' Capacity=137.86 cfs Outflow=59.21 cfs 3.859 af

Reach S1 R6: Swale S1 Reach 6 Avg. Flow Depth=1.36' Max Vel=3.44 fps Inflow=65.66 cfs 4.415 af
n=0.030 L=430.9' S=0.0052 '/' Capacity=136.28 cfs Outflow=62.73 cfs 4.415 af

Reach S2 R1: Swale S2 Reach 1 Avg. Flow Depth=1.65' Max Vel=2.39 fps Inflow=62.82 cfs 4.489 af
n=0.030 L=472.0' S=0.0020 '/' Capacity=84.99 cfs Outflow=57.87 cfs 4.489 af

Reach S2 R2: Swale S2 Reach 2 Avg. Flow Depth=1.40' Max Vel=4.16 fps Inflow=95.28 cfs 7.736 af
n=0.030 L=751.0' S=0.0069 '/' Capacity=182.04 cfs Outflow=90.88 cfs 7.736 af

Reach S3 R1: Swale S3 Reach 1 Avg. Flow Depth=0.85' Max Vel=3.26 fps Inflow=27.41 cfs 1.319 af
n=0.030 L=215.0' S=0.0070 '/' Capacity=125.24 cfs Outflow=26.88 cfs 1.319 af

Reach S3 R2: Swale S3 Reach 2 Avg. Flow Depth=2.14' Max Vel=4.13 fps Inflow=47.52 cfs 2.432 af
n=0.030 L=97.0' S=0.0070 '/' Capacity=71.57 cfs Outflow=47.32 cfs 2.432 af

Reach S3 R3: Swale S3 Reach 3 Avg. Flow Depth=0.98' Max Vel=3.94 fps Inflow=47.83 cfs 2.533 af
n=0.030 L=353.0' S=0.0097 '/' Capacity=186.19 cfs Outflow=46.22 cfs 2.533 af

Reach S4 R2: Swale S4 Reach 2 Avg. Flow Depth=0.63' Max Vel=2.70 fps Inflow=23.68 cfs 1.204 af
n=0.030 L=601.0' S=0.0069 '/' Capacity=174.20 cfs Outflow=20.91 cfs 1.204 af

Reach S4 R3: Swale S4 Reach 3 Avg. Flow Depth=0.89' Max Vel=2.94 fps Inflow=41.60 cfs 2.309 af
n=0.030 L=946.0' S=0.0056 '/' Capacity=156.53 cfs Outflow=34.31 cfs 2.309 af

Reach S4 R4: Swale S4 Reach 4 Avg. Flow Depth=1.82' Max Vel=5.29 fps Inflow=159.67 cfs 12.653 af
n=0.030 L=483.0' S=0.0082 '/' Capacity=427.66 cfs Outflow=157.44 cfs 12.653 af

Reach S5 R2: Swale S5 Reach 2 Inflow=7.48 cfs 0.454 af
Outflow=7.48 cfs 0.454 af

Pond Sed Pond: Sedimentation Basin Peak Elev=793.06' Storage=236,005 cf Inflow=164.77 cfs 13.946 af
.167 af Primary=11.35 cfs 4.914 af Secondary=22.50 cfs 1.762 af Tertiary=6.00 cfs 0.104 af Outflow=45.68 cfs 13.947 af

Link C1: Culvert C1 Inflow=7.48 cfs 0.454 af
Primary=7.48 cfs 0.454 af

Link C2: Culvert C2 Inflow=13.45 cfs 0.780 af
Primary=13.45 cfs 0.780 af

Link C3: Culvert C3 Inflow=47.76 cfs 3.049 af
Primary=47.76 cfs 3.049 af

Link C4: Culvert C4 Inflow=62.23 cfs 3.859 af
Primary=62.23 cfs 3.859 af

Link C5: Culvert C5 Inflow=65.15 cfs 4.254 af
Primary=65.15 cfs 4.254 af

Link C6: Culvert C6 Inflow=47.83 cfs 2.533 af
Primary=47.83 cfs 2.533 af

Link C7: Culvert C7 Inflow=103.37 cfs 8.978 af
Primary=103.37 cfs 8.978 af

Link C8: Culvert C8 Inflow=19.20 cfs 1.127 af
Primary=19.20 cfs 1.127 af

Link F1: Flume 1 Inflow=22.19 cfs 1.105 af
Primary=22.19 cfs 1.105 af

Link F2: Flume 2 Inflow=23.68 cfs 1.204 af
Primary=23.68 cfs 1.204 af

Link F3: Flume 3 Inflow=32.10 cfs 1.570 af
Primary=32.10 cfs 1.570 af

Link F4: Flume 4 Inflow=14.43 cfs 0.701 af
Primary=14.43 cfs 0.701 af

Link F5: Flume 5 Inflow=25.31 cfs 1.219 af
Primary=25.31 cfs 1.219 af

Link F6: Flume 6	Inflow=20.36 cfs 0.985 af Primary=20.36 cfs 0.985 af
Link F7: Existing East Flume	Inflow=4.50 cfs 0.216 af Primary=4.50 cfs 0.216 af
Link F8: Existing West Flume	Inflow=16.40 cfs 0.828 af Primary=16.40 cfs 0.828 af
Link North Area: North Area	Inflow=19.20 cfs 1.127 af Primary=19.20 cfs 1.127 af
Link RC1: Rock Chute 1	Inflow=22.19 cfs 1.105 af Primary=22.19 cfs 1.105 af
Link RC2: Rock Chute 2	Inflow=23.68 cfs 1.204 af Primary=23.68 cfs 1.204 af
Link Swale 1 R6: Swale S1 Reach 6	Inflow=62.73 cfs 4.415 af Primary=62.73 cfs 4.415 af
Link Swale S1 R1: Swale S1 Reach 1	Inflow=2.68 cfs 0.128 af Primary=2.68 cfs 0.128 af
Link Swale S1 R2: Swale S1 Reach 2	Inflow=37.05 cfs 1.827 af Primary=37.05 cfs 1.827 af
Link Swale S1 R3: Swale S1 Reach 3	Inflow=47.76 cfs 3.049 af Primary=47.76 cfs 3.049 af
Link Swale S1 R4: Swale S1 Reach 4	Inflow=62.23 cfs 3.859 af Primary=62.23 cfs 3.859 af
Link Swale S1 R5: Swale S1 Reach 5	Inflow=65.15 cfs 4.254 af Primary=65.15 cfs 4.254 af
Link Swale S2 R1: Swale S2 Reach 1	Inflow=58.13 cfs 4.525 af Primary=58.13 cfs 4.525 af
Link Swale S2 R2: Swale S2 Reach 2	Inflow=103.37 cfs 8.978 af Primary=103.37 cfs 8.978 af
Link Swale S3 R1: Swale S3 Reach 1	Inflow=27.22 cfs 1.447 af Primary=27.22 cfs 1.447 af
Link Swale S3 R2: Swale S3 Reach 2	Inflow=47.83 cfs 2.533 af Primary=47.83 cfs 2.533 af
Link Swale S3 R3: Swale S3 Reach 3	Inflow=47.45 cfs 2.848 af Primary=47.45 cfs 2.848 af

Link Swale S4 R4: Swale S4 Reach 4 Inflow=157.92 cfs 12.803 af
Primary=157.92 cfs 12.803 af

Link Swale S5 R1: Swale S5 Reach 1 Inflow=7.48 cfs 0.454 af
Primary=7.48 cfs 0.454 af

Link Swale S5 R2: Swale S5 Reach 2 Inflow=12.65 cfs 0.720 af
Primary=12.65 cfs 0.720 af

Link Swale S5 R3: Swale S5 Reach 3 Inflow=6.90 cfs 0.408 af
Primary=6.90 cfs 0.408 af

Link Swale S6 R1: Swale S6 Reach 1 Inflow=13.45 cfs 0.780 af
Primary=13.45 cfs 0.780 af

Link Wetland: Wetland Inflow=39.85 cfs 6.780 af
Primary=39.85 cfs 6.780 af

Total Runoff Area = 82.060 ac Runoff Volume = 15.074 af Average Runoff Depth = 2.20"
97.02% Pervious = 79.615 ac 2.98% Impervious = 2.446 ac

Summary for Subcatchment AREA 1: Subcat AREA 1

Runoff = 7.63 cfs @ 12.11 hrs, Volume= 0.342 af, Depth= 3.18"
Routed to Link F3 : Flume 3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.288	69	Pasture/grassland/range, Fair, HSG B
1.288		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	37	0.2500	0.36		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.9	371	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
2.6	408	Total			

Summary for Subcatchment AREA 10: Subcat AREA 10

Runoff = 5.29 cfs @ 12.11 hrs, Volume= 0.242 af, Depth= 3.18"
Routed to Link F5 : Flume 5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.914	69	Pasture/grassland/range, Fair, HSG B
0.914		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.1	46	0.2500	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.1	454	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
3.2	500	Total			

Summary for Subcatchment AREA 11: Subcat AREA 11

Runoff = 5.21 cfs @ 12.12 hrs, Volume= 0.251 af, Depth= 3.18"
Routed to Link F5 : Flume 5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.949	69	Pasture/grassland/range, Fair, HSG B
0.949		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	14	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	277	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.6	391	Total			

Summary for Subcatchment AREA 12: Subcat AREA 12

Runoff = 0.58 cfs @ 12.11 hrs, Volume= 0.026 af, Depth= 3.18"
Routed to Link F4 : Flume 4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.098	69	Pasture/grassland/range, Fair, HSG B
0.098		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	56	0.2500	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	36	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
2.5	92	Total			

Summary for Subcatchment AREA 13: Subcat AREA 13

Runoff = 4.89 cfs @ 12.12 hrs, Volume= 0.236 af, Depth= 3.18"
Routed to Link F4 : Flume 4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.890	69	Pasture/grassland/range, Fair, HSG B
0.890		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	87	0.2500	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.2	503	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.6	590	Total			

Summary for Subcatchment AREA 14: Subcat AREA 14

Runoff = 6.17 cfs @ 12.13 hrs, Volume= 0.303 af, Depth= 3.18"
Routed to Link F4 : Flume 4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.145	69	Pasture/grassland/range, Fair, HSG B
1.145		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	27	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.2	498	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
5.1	625	Total			

Summary for Subcatchment AREA 15: Subcat AREA 15

Runoff = 2.86 cfs @ 12.12 hrs, Volume= 0.136 af, Depth= 3.18"
Routed to Link F4 : Flume 4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.512	69	Pasture/grassland/range, Fair, HSG B
0.512		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	85	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.2	235	Total			

Summary for Subcatchment AREA 16: Subcat AREA 16

Runoff = 8.20 cfs @ 12.12 hrs, Volume= 0.400 af, Depth= 3.18"
Routed to Link F5 : Flume 5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.510	69	Pasture/grassland/range, Fair, HSG B
1.510		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.9	372	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.9	522	Total			

Summary for Subcatchment AREA 17: Subcat AREA 17

Runoff = 6.72 cfs @ 12.12 hrs, Volume= 0.326 af, Depth= 3.18"
Routed to Link F5 : Flume 5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.228	69	Pasture/grassland/range, Fair, HSG B
1.228		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.3	63	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	223	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	386	Total			

Summary for Subcatchment AREA 18: Subcat AREA 18

Runoff = 4.47 cfs @ 12.12 hrs, Volume= 0.215 af, Depth= 3.18"
Routed to Link F6 : Flume 6

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.813	69	Pasture/grassland/range, Fair, HSG B
0.813		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	48	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	235	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.6	383	Total			

Summary for Subcatchment AREA 19: Subcat AREA 19

Runoff = 4.66 cfs @ 12.12 hrs, Volume= 0.225 af, Depth= 3.18"
Routed to Link F6 : Flume 6

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.847	69	Pasture/grassland/range, Fair, HSG B
0.847		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	244	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.6	394	Total			

Summary for Subcatchment AREA 2: Subcat AREA 2

Runoff = 6.28 cfs @ 12.13 hrs, Volume= 0.309 af, Depth= 3.18"
Routed to Link F3 : Flume 3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.167	69	Pasture/grassland/range, Fair, HSG B
1.167		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	18	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.2	495	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
5.1	613	Total			

Summary for Subcatchment AREA 20: Subcat AREA 20

Runoff = 5.77 cfs @ 12.12 hrs, Volume= 0.279 af, Depth= 3.18"
Routed to Link F1 : Flume 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.054	69	Pasture/grassland/range, Fair, HSG B
1.054		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	303	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	453	Total			

Summary for Subcatchment AREA 21: Subcat AREA 21

Runoff = 5.64 cfs @ 12.12 hrs, Volume= 0.273 af, Depth= 3.18"
Routed to Link F1 : Flume 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.030	69	Pasture/grassland/range, Fair, HSG B
1.030		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	298	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	448	Total			

Summary for Subcatchment AREA 22: Subcat AREA 22

Runoff = 5.64 cfs @ 12.12 hrs, Volume= 0.273 af, Depth= 3.18"
Routed to Link F2 : Flume 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.030	69	Pasture/grassland/range, Fair, HSG B
1.030		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	298	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	448	Total			

Summary for Subcatchment AREA 23: Subcat AREA 23

Runoff = 8.23 cfs @ 12.13 hrs, Volume= 0.410 af, Depth= 3.18"
Routed to Link F2 : Flume 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.548	69	Pasture/grassland/range, Fair, HSG B
1.548		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	24	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.5	591	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
5.4	715	Total			

Summary for Subcatchment AREA 24: Subcat AREA 24

Runoff = 10.20 cfs @ 12.13 hrs, Volume= 0.517 af, Depth= 3.18"
Routed to Link F3 : Flume 3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.952	69	Pasture/grassland/range, Fair, HSG B
1.952		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	24	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.9	765	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
5.8	889	Total			

Summary for Subcatchment AREA 25: Subcat AREA 25

Runoff = 8.59 cfs @ 12.12 hrs, Volume= 0.402 af, Depth= 3.18"
Routed to Link F3 : Flume 3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.515	69	Pasture/grassland/range, Fair, HSG B
1.515		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	67	0.2500	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.1	428	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
3.9	495	Total			

Summary for Subcatchment AREA 26: Subcat AREA 26

Runoff = 2.74 cfs @ 12.12 hrs, Volume= 0.129 af, Depth= 2.98"
Routed to Reach S1 R2 : Swale S1 Reach 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

	Area (ac)	CN	Description
	0.396	69	Pasture/grassland/range, Fair, HSG B
	0.072	39	Pasture/grassland/range, Good, HSG A
	0.049	96	Gravel surface, HSG A
*	0.000	0	Pasture/grassland/range, Fair
	0.518	67	Weighted Average
	0.518		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	93	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	123	0.0055	4.39	140.49	**Trap/Vee/Rect Channel Flow, Swale 1 Reach 2** Bot.W=8.00' D=2.00' Z= 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
4.1	216	Total			

Summary for Subcatchment AREA 27: Subcat AREA 27

Runoff = 5.63 cfs @ 12.22 hrs, Volume= 0.442 af, Depth= 1.28"
Routed to Reach S1 R3 : Swale S1 Reach 3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

	Area (ac)	CN	Description
	0.651	69	Pasture/grassland/range, Fair, HSG B
	2.758	39	Pasture/grassland/range, Good, HSG A
	0.010	96	Gravel surface, HSG A
	0.295	96	Gravel surface, HSG A
	0.426	39	Pasture/grassland/range, Good, HSG A
*	0.000	0	
*	0.000	0	
*	0.000	0	, HSG A
*	0.000	0	, HSG A
*	0.000	0	, HSG A
*	0.000	0	, HSG A
*	0.000	0	Pasture/grassland/range, Good
	4.140	48	Weighted Average
	4.140		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
2.3	217	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	20	0.0050	1.14		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.1	14	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.0	513	0.0051	4.23	135.28	**Trap/Vee/Rect Channel Flow, Swale 1 Reach 3** Bot.W=8.00' D=2.00' Z= 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
12.0	864	Total			

Summary for Subcatchment AREA 28: Subcat AREA 28

Runoff = 5.98 cfs @ 12.18 hrs, Volume= 0.395 af, Depth= 1.44"
Routed to Link Swale S1 R5 : Swale S1 Reach 5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

	Area (sf)	CN	Description
	30,267	69	Pasture/grassland/range, Fair, HSG B
	100,859	39	Pasture/grassland/range, Good, HSG A
*	11,834	96	Gravel surface
	142,960	50	Weighted Average
	142,960		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.9	78	0.0526	0.22		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.1	22	0.2500	0.32		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	24	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	23	0.0050	1.14		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.1	16	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.6	410	0.0053	4.31	137.91	**Trap/Vee/Rect Channel Flow, Swale 1 Reach** Bot.W=8.00' D=2.00' Z= 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
9.1	573	Total			

Summary for Subcatchment AREA 28A: Subcat AREA 28A

Runoff = 0.71 cfs @ 12.18 hrs, Volume= 0.048 af, Depth= 1.36"
Routed to Link Swale S1 R4 : Swale S1 Reach 4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.035	69	Pasture/grassland/range, Fair, HSG B
0.257	39	Pasture/grassland/range, Good, HSG A
0.075	39	Pasture/grassland/range, Good, HSG A
0.010	96	Gravel surface, HSG A
0.046	96	Gravel surface, HSG A
0.423	49	Weighted Average
0.423		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	82	0.0334	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.0	18	0.2500	0.31		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	34	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	20	0.0050	1.14		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.1	13	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	67	0.0069	4.92	157.36	**Trap/Vee/Rect Channel Flow,** Bot.W=8.00' D=2.00' Z= 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
9.1	234	Total			

Summary for Subcatchment AREA 28B: Subcat AREA 28B

Runoff = 1.20 cfs @ 12.13 hrs, Volume= 0.061 af, Depth= 1.53"
Routed to Reach S1 R4 : Swale S1 Reach 4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.050	69	Pasture/grassland/range, Fair, HSG B
0.110	39	Pasture/grassland/range, Good, HSG A
0.240	39	Pasture/grassland/range, Good, HSG A
0.009	96	Gravel surface, HSG A
0.067	96	Gravel surface, HSG A
0.476	51	Weighted Average
0.476		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	58	0.2500	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.6	20	0.0050	0.53		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
1.0	18	0.2500	0.31		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.4	115	0.0055	4.39	140.49	**Trap/Vee/Rect Channel Flow,** Bot.W=8.00' D=2.00' Z= 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
4.5	211	Total			

Summary for Subcatchment AREA 29: Subcat AREA 29

Runoff = 1.21 cfs @ 12.31 hrs, Volume= 0.161 af, Depth= 0.69"
Routed to Reach S1 R6 : Swale S1 Reach 6

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

	Area (ac)	CN	Description
	0.056	96	Gravel surface, HSG A
	2.735	39	Pasture/grassland/range, Good, HSG A
*	0.000	0	Gravel surface
	2.792	40	Weighted Average
	2.792		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.8	100	0.0150	0.14		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.9	100	0.0150	0.86		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	16	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	247	0.0052	4.27	136.60	**Trap/Vee/Rect Channel Flow, Swale S1 Reach 5** Bot.W=8.00' D=2.00' Z= 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
14.8	463	Total			

Summary for Subcatchment AREA 3: Subcat AREA 3

Runoff = 3.66 cfs @ 12.14 hrs, Volume= 0.190 af, Depth= 3.18"
Routed to Link F2 : Flume 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.717	69	Pasture/grassland/range, Fair, HSG B
0.717		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.9	44	0.1000	0.26		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
2.4	56	0.2500	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.4	76	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	233	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
6.3	409	Total			

Summary for Subcatchment AREA 30: Subcat AREA 30

Runoff = 0.43 cfs @ 12.46 hrs, Volume= 0.074 af, Depth= 0.63"
Routed to Reach S2 R1 : Swale S2 Reach 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.415	39	Pasture/grassland/range, Good, HSG A
1.415		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.5	100	0.0260	0.18		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
2.9	194	0.0260	1.13		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.6	647	0.0260	1.13		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
22.0	941	Total			

Summary for Subcatchment AREA 31: Subcat AREA 31

Runoff = 0.42 cfs @ 12.14 hrs, Volume= 0.036 af, Depth= 0.63"
Routed to Link Swale S2 R1 : Swale S2 Reach 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.698	39	Pasture/grassland/range, Good, HSG A
0.698		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	34	0.2500	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
2.8	447	0.0020	2.65	84.72	**Trap/Vee/Rect Channel Flow, Swale 2 Reach 1** Bot.W=8.00' D=2.00' Z= 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
4.4	481	Total			

Summary for Subcatchment AREA 32: Subcat AREA 32

Runoff = 3.11 cfs @ 12.31 hrs, Volume= 0.315 af, Depth= 1.13"
Routed to Link Swale S3 R3 : Swale S3 Reach 3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.567	69	Pasture/grassland/range, Fair, HSG B
2.413	39	Pasture/grassland/range, Good, HSG A
0.099	96	Gravel surface, HSG A
0.274	39	Pasture/grassland/range, Good, HSG A
3.353	46	Weighted Average
3.353		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.1	100	0.0140	0.14		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
4.2	211	0.0140	0.83		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	23	0.1740	2.92		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.9	329	0.0097	5.83	186.57	**Trap/Vee/Rect Channel Flow, Swale 3 Reach 3** Bot.W=8.00' D=2.00' Z= 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
17.3	663	Total			

Summary for Subcatchment AREA 33: Subcat AREA 33

Runoff = 1.14 cfs @ 12.28 hrs, Volume= 0.101 af, Depth= 1.36"
Routed to Link Swale S3 R2 : Swale S3 Reach 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

	Area (sf)	CN	Description
	4,079	96	Gravel surface, HSG A
	1,422	96	Gravel surface, HSG A
	30,707	39	Pasture/grassland/range, Good, HSG A
*	2,706	69	Pasture/grassland/range, Fair, HSG A
	38,914	49	Weighted Average
	38,914		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.1	100	0.0140	0.14		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
3.6	178	0.0140	0.83		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.0	12	0.4000	4.43		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	87	0.0070	5.23	125.44	**Trap/Vee/Rect Channel Flow, Swale 3 Reach 2** Bot.W=8.00' D=2.00' Z= 2.0 '/' Top.W=16.00' n= 0.030 Earth, grassed & winding
16.0	377	Total			

Summary for Subcatchment AREA 34: Subcat AREA 34

Runoff = 1.20 cfs @ 12.30 hrs, Volume= 0.128 af, Depth= 0.98"
Routed to Link Swale S3 R1 : Swale S3 Reach 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (sf)	CN	Description
5,695	69	Pasture/grassland/range, Fair, HSG B
3,470	96	Gravel surface, HSG A
59,319	39	Pasture/grassland/range, Good, HSG A
68,484	44	Weighted Average
68,484		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.1	100	0.0140	0.14		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
3.4	170	0.0140	0.83		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	15	0.4000	4.43		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	203	0.0070	5.23	125.44	**Trap/Vee/Rect Channel Flow, Swale 3 Reach 1** Bot.W=8.00' D=2.00' Z= 2.0 '/' Top.W=16.00' n= 0.030 Earth, grassed & winding
16.2	488	Total			

Summary for Subcatchment AREA 35: Subcat AREA 35

Runoff = 2.10 cfs @ 12.12 hrs, Volume= 0.099 af, Depth= 3.18"
Routed to Reach S3 R1 : Swale S3 Reach 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.375	69	Pasture/grassland/range, Fair, HSG B
0.375		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.4	74	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.2	174	Total			

Summary for Subcatchment AREA 36: Subcat AREA 36

Runoff = 2.62 cfs @ 12.12 hrs, Volume= 0.125 af, Depth= 3.08"
Routed to Link F7 : Existing East Flume

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

	Area (ac)	CN	Description
	0.470	69	Pasture/grassland/range, Fair, HSG B
	0.016	39	Pasture/grassland/range, Good, HSG A
*	0.000	0	Pasture/grassland/range, Good
	0.487	68	Weighted Average
	0.487		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	90	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.7	201	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.2	134	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
4.4	425	Total			

Summary for Subcatchment AREA 37: Subcat AREA 37

Runoff = 1.89 cfs @ 12.12 hrs, Volume= 0.091 af, Depth= 3.18"
Routed to Link F7 : Existing East Flume

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.344	69	Pasture/grassland/range, Fair, HSG B
0.344		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	30	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	126	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.3	254	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
4.6	510	Total			

Summary for Subcatchment AREA 38: Subcat AREA 38

Runoff = 1.25 cfs @ 12.12 hrs, Volume= 0.059 af, Depth= 3.18"
Routed to Link F8 : Existing West Flume

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.223	69	Pasture/grassland/range, Fair, HSG B
0.223		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	77	0.2500	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	156	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.5	357	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
4.1	590	Total			

Summary for Subcatchment AREA 39: Subcat AREA 39

Runoff = 3.50 cfs @ 12.13 hrs, Volume= 0.174 af, Depth= 3.18"
Routed to Link F8 : Existing West Flume

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.656	69	Pasture/grassland/range, Fair, HSG B
0.656		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	11	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	314	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.3	217	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
5.3	642	Total			

Summary for Subcatchment AREA 4: Subcat AREA 4

Runoff = 6.31 cfs @ 12.14 hrs, Volume= 0.331 af, Depth= 3.18"
Routed to Link F2 : Flume 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.247	69	Pasture/grassland/range, Fair, HSG B
1.247		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	57	0.1000	0.27		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
2.0	43	0.2500	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.4	83	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	295	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
6.6	478	Total			

Summary for Subcatchment AREA 40: Subcat AREA 40

Runoff = 6.03 cfs @ 12.13 hrs, Volume= 0.300 af, Depth= 2.23"
Routed to Link Swale S2 R2 : Swale S2 Reach 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

	Area (ac)	CN	Description
	1.079	69	Pasture/grassland/range, Fair, HSG B
	0.539	39	Pasture/grassland/range, Good, HSG A
*	0.000	0	Pasture/grassland/range, Good
	1.618	59	Weighted Average
	1.618		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	77	0.2500	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.8	237	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.3	70	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	315	0.0069	5.05	181.72	**Trap/Vee/Rect Channel Flow, Swale S2 Reach 2** Bot.W=10.00' D=2.00' Z= 4.0 '/' Top.W=26.00' n= 0.030 Earth, grassed & winding
5.2	699	Total			

Summary for Subcatchment AREA 41: Subcat AREA 41

Runoff = 2.84 cfs @ 12.14 hrs, Volume= 0.147 af, Depth= 2.13"
Routed to Reach S2 R2 : Swale S2 Reach 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.520	69	Pasture/grassland/range, Fair, HSG B
0.306	39	Pasture/grassland/range, Good, HSG A
0.826	58	Weighted Average
0.826		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	26	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.0	596	0.0069	5.05	181.72	**Trap/Vee/Rect Channel Flow, Swale S2 Reach 2** Bot.W=10.00' D=2.00' Z= 4.0 '/' Top.W=26.00' n= 0.030 Earth, grassed & winding
5.9	722	Total			

Summary for Subcatchment AREA 42: Subcat AREA 42

Runoff = 0.93 cfs @ 12.22 hrs, Volume= 0.114 af, Depth= 0.63"
Routed to Link Swale S2 R2 : Swale S2 Reach 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
2.177	39	Pasture/grassland/range, Good, HSG A
2.177		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.4	66	0.0303	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.6	34	0.2500	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	49	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.9	266	0.0069	5.05	181.72	**Trap/Vee/Rect Channel Flow, Swale S2 Reach 2** Bot.W=10.00' D=2.00' Z= 4.0 '/' Top.W=26.00' n= 0.030 Earth, grassed & winding
9.1	415	Total			

Summary for Subcatchment AREA 43: Subcat AREA 43

Runoff = 6.39 cfs @ 12.13 hrs, Volume= 0.325 af, Depth= 3.18"
Routed to Link F8 : Existing West Flume

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.228	69	Pasture/grassland/range, Fair, HSG B
1.228		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	6	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.9	541	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.2	131	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
5.9	778	Total			

Summary for Subcatchment AREA 44: Subcat AREA 44

Runoff = 2.38 cfs @ 12.19 hrs, Volume= 0.273 af, Depth= 0.63"
Routed to Pond Sed Pond : Sedimentation Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
5.227	39	Pasture/grassland/range, Good, HSG A
5.227		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.5	75	0.0933	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.3	25	0.2500	0.33		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	10	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	381	0.0265	7.85	109.92	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=2.00' Z= 4.0 & 3.0 '/' Top.W=14.00' n= 0.030 Earth, grassed & winding
0.8	162	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	48	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.9	701	Total			

Summary for Subcatchment AREA 44A: Subcat AREA 44A

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 14.38 cfs @ 12.09 hrs, Volume= 0.798 af, Depth= 6.35"
Routed to Pond Sed Pond : Sedimentation Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.508	98	Water Surface, HSG A
1.508		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment AREA 44B: Subcat AREA 44B

Runoff = 1.17 cfs @ 12.16 hrs, Volume= 0.071 af, Depth= 1.44"
Routed to Pond Sed Pond : Sedimentation Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

	Area (ac)	CN	Description
	0.479	39	Pasture/grassland/range, Good, HSG A
	0.115	96	Gravel surface, HSG A
*	0.000	0	, HSG A
*	0.000	0	, HSG A
	0.594	50	Weighted Average
	0.594		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.1	100	0.0544	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	47	0.0544	1.63		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.6	147	Total			

Summary for Subcatchment AREA 45: Subcat AREA 45

Runoff = 1.16 cfs @ 12.41 hrs, Volume= 0.150 af, Depth= 0.90"
Routed to Link Swale S4 R4 : Swale S4 Reach 4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

	Area (ac)	CN	Description
*	0.000	0	, HSG A
	1.870	39	Pasture/grassland/range, Good, HSG A
	0.000	96	Gravel surface, HSG A
	0.130	96	Gravel surface, HSG A
	2.001	43	Weighted Average
	2.001		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.7	100	0.0074	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
4.7	169	0.0074	0.60		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	49	0.0800	1.98		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	363	0.0082	5.42	162.67	**Trap/Vee/Rect Channel Flow, Swale S4 Reach 2** Bot.W=8.00' D=2.00' Z= 4.0 & 3.0 '/' Top.W=22.00' n= 0.030 Earth, grassed & winding
21.9	681	Total			

Summary for Subcatchment AREA 46: Subcat AREA 46

Runoff = 22.74 cfs @ 12.17 hrs, Volume= 1.366 af, Depth= 2.23"
Routed to Reach S4 R4 : Swale S4 Reach 4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

	Area (ac)	CN	Description
	3.081	69	Pasture/grassland/range, Fair, HSG B
	0.590	96	Gravel surface, HSG B
	3.264	39	Pasture/grassland/range, Good, HSG A
	0.017	98	Paved parking, HSG A
	0.009	98	Paved parking, HSG A
	0.378	96	Gravel surface, HSG A
	0.001	96	Gravel surface, HSG A
	0.026	96	Gravel surface, HSG A
*	0.000	0	, HSG A
*	0.000	0	, HSG A
*	0.000	0	, HSG A
*	0.000	0	, HSG A
*	0.000	0	, HSG A
*	0.000	0	, HSG A
*	0.000	0	Pasture/grassland/range, Fair
	7.367	59	Weighted Average
	7.340		99.64% Pervious Area
	0.027		0.36% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.2	51	0.2500	0.38		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	16	0.2500	2.44		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
0.9	31	0.0050	0.58		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
0.4	47	0.0650	1.78		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
5.6	1,759	0.0073	5.26	178.68	**Trap/Vee/Rect Channel Flow, Swale S4 Reach 1** Bot.W=10.00' D=2.00' Z= 3.0 & 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
9.2	1,904	Total			

Summary for Subcatchment AREA 47: Subcat AREA 47

Runoff = 6.90 cfs @ 12.17 hrs, Volume= 0.408 af, Depth= 2.69"
Routed to Link Swale S5 R3 : Swale S5 Reach 3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (sf)	CN	Description
49,617	69	Pasture/grassland/range, Fair, HSG B
6,971	98	Paved parking, HSG A
1,619	96	Gravel surface, HSG A
20,925	39	Pasture/grassland/range, Good, HSG A
79,132	64	Weighted Average
72,161		91.19% Pervious Area
6,971		8.81% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	43	0.2500	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	11	0.1111	1.63		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
0.7	12	0.2500	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
2.9	28	0.0393	0.16		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
3.4	488	0.0024	2.40	52.81	**Trap/Vee/Rect Channel Flow, Swale S5 Reach 3** Bot.W=0.00' D=2.00' Z= 5.0 & 6.0 '/' Top.W=22.00' n= 0.030 Earth, grassed & winding
9.1	582	Total			

Summary for Subcatchment AREA 48: Subcat AREA 48

Runoff = 5.30 cfs @ 12.13 hrs, Volume= 0.265 af, Depth= 2.41"
Routed to Link Swale S5 R2 : Swale S5 Reach 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (sf)	CN	Description
24,597	69	Pasture/grassland/range, Fair, HSG B
24,117	39	Pasture/grassland/range, Good, HSG A
2,057	96	Gravel surface, HSG A
6,769	98	Paved parking, HSG A
57,540	61	Weighted Average
50,771		88.24% Pervious Area
6,769		11.76% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	19	0.0050	0.53		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
1.7	29	0.1667	0.29		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
3.1	441	0.0024	2.38	40.39	**Trap/Vee/Rect Channel Flow, Swale S5 Reach 2** Bot.W=0.00' D=2.00' Z= 2.5 & 6.0 '/' Top.W=17.00' n= 0.030 Earth, grassed & winding
5.4	489	Total			

Summary for Subcatchment AREA 49: Subcat AREA 49

Runoff = 2.68 cfs @ 12.12 hrs, Volume= 0.128 af, Depth= 2.23"
Routed to Link Swale S1 R1 : Swale S1 Reach 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.439	69	Pasture/grassland/range, Fair, HSG B
0.246	39	Pasture/grassland/range, Good, HSG A
0.006	96	Gravel surface, HSG A
0.691	59	Weighted Average
0.691		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	59	0.2500	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.8	463	0.0053	4.31	137.91	**Trap/Vee/Rect Channel Flow, Swale S1 Reach 1** Bot.W=8.00' D=2.00' Z= 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding

4.3	522	Total

Summary for Subcatchment AREA 5: Subcat AREA 5

Runoff = 6.05 cfs @ 12.14 hrs, Volume= 0.317 af, Depth= 3.18"
Routed to Link F1 : Flume 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.195	69	Pasture/grassland/range, Fair, HSG B
1.195		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	59	0.1000	0.27		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.9	41	0.2500	0.36		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.4	85	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	297	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
6.6	482	Total			

Summary for Subcatchment AREA 50: Subcat AREA 50

Runoff = 13.35 cfs @ 12.11 hrs, Volume= 0.698 af, Depth= 5.65"
Routed to Link Swale S6 R1 : Swale S6 Reach 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.100	39	Pasture/grassland/range, Good, HSG A
0.001	39	Pasture/grassland/range, Good, HSG A
1.382	96	Gravel surface, HSG A
1.482	92	Weighted Average
1.482		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	100	0.0119	1.04		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
0.4	47	0.0119	1.76		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.0	10	0.5000	4.95		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.4	413	0.0066	5.00	130.01	**Trap/Vee/Rect Channel Flow, Swale S6 Reach 1** Bot.W=8.00' D=2.00' Z= 2.5 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
3.4	570	Total			

Summary for Subcatchment AREA 51: Subcat AREA 51

Runoff = 0.67 cfs @ 12.27 hrs, Volume= 0.082 af, Depth= 0.69"
Routed to Link Swale S6 R1 : Swale S6 Reach 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.396	39	Pasture/grassland/range, Good, HSG A
0.020	96	Gravel surface, HSG A
1.417	40	Weighted Average
1.417		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
3.2	302	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	53	0.0313	2.85		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.4	429	0.0066	5.00	130.01	**Trap/Vee/Rect Channel Flow, Swale S6 Reach 1** Bot.W=8.00' D=2.00' Z= 2.5 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
12.2	884	Total			

Summary for Subcatchment AREA 52: Subcat AREA 52

Runoff = 7.48 cfs @ 12.15 hrs, Volume= 0.454 af, Depth= 1.20"
Routed to Link Swale S5 R1 : Swale S5 Reach 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (sf)	CN	Description
169,213	39	Pasture/grassland/range, Good, HSG A
25,933	98	Paved parking, HSG A
2,184	96	Gravel surface, HSG A
197,330	47	Weighted Average
171,397		86.86% Pervious Area
25,933		13.14% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	18	0.0050	0.52		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
1.4	21	0.1333	0.25		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
4.3	1,255	0.0096	4.82	125.20	**Trap/Vee/Rect Channel Flow, Swale S5 Reach 1** Bot.W=0.00' D=2.00' Z= 6.0 & 7.0 '/' Top.W=26.00' n= 0.030 Earth, grassed & winding
6.3	1,294	Total			

Summary for Subcatchment AREA 6: Subcat AREA 6

Runoff = 4.90 cfs @ 12.12 hrs, Volume= 0.236 af, Depth= 3.18"
Routed to Link F1 : Flume 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.892	69	Pasture/grassland/range, Fair, HSG B
0.892		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	7	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	308	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.6	415	Total			

Summary for Subcatchment AREA 7: Subcat AREA 7

Runoff = 5.31 cfs @ 12.13 hrs, Volume= 0.269 af, Depth= 3.18"
Routed to Link F8 : Existing West Flume

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.017	69	Pasture/grassland/range, Fair, HSG B
1.017		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	18	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.5	419	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.4	296	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow,** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
5.8	833	Total			

Summary for Subcatchment AREA 8: Subcat AREA 8

Runoff = 5.52 cfs @ 12.12 hrs, Volume= 0.268 af, Depth= 3.18"
Routed to Link F6 : Flume 6

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.009	69	Pasture/grassland/range, Fair, HSG B
1.009		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.3	66	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	243	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	409	Total			

Summary for Subcatchment AREA 9: Subcat AREA 9

Runoff = 5.71 cfs @ 12.12 hrs, Volume= 0.278 af, Depth= 3.18"
Routed to Link F6 : Flume 6

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.047	69	Pasture/grassland/range, Fair, HSG B
1.047		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.4	76	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	250	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.8	426	Total			

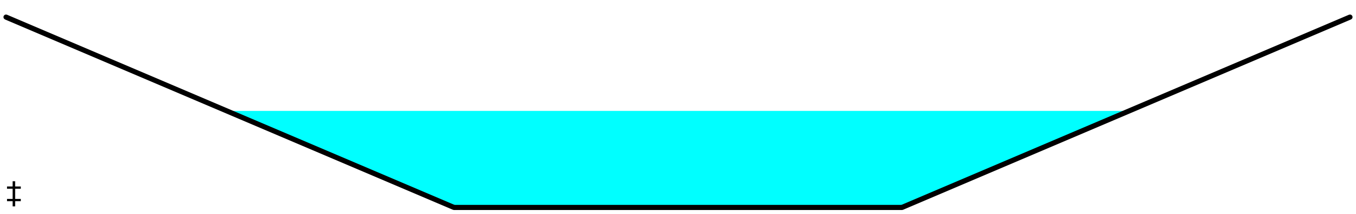
Summary for Reach S1 R2: Swale S1 Reach 2

Inflow Area = 7.131 ac, 0.00% Impervious, Inflow Depth = 3.07" for 100-yr, 24-hr event
Inflow = 37.51 cfs @ 12.12 hrs, Volume= 1.827 af
Outflow = 37.05 cfs @ 12.12 hrs, Volume= 1.827 af, Atten= 1%, Lag= 0.4 min
Routed to Link Swale S1 R2 : Swale S1 Reach 2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.03 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 0.80 fps, Avg. Travel Time= 2.7 min

Peak Storage= 1,553 cf @ 12.12 hrs
Average Depth at Peak Storage= 1.01' , Surface Width= 16.12'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 140.64 cfs

8.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 127.0' Slope= 0.0055 '/'
Inlet Invert= 814.81', Outlet Invert= 814.11'



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Summary for Reach S1 R3: Swale S1 Reach 3

Inflow Area = 14.170 ac, 0.00% Impervious, Inflow Depth = 2.58" for 100-yr, 24-hr event
Inflow = 53.22 cfs @ 12.12 hrs, Volume= 3.049 af
Outflow = 47.76 cfs @ 12.15 hrs, Volume= 3.049 af, Atten= 10%, Lag= 1.5 min
Routed to Link Swale S1 R3 : Swale S1 Reach 3

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.17 fps, Min. Travel Time= 3.0 min
Avg. Velocity = 0.70 fps, Avg. Travel Time= 13.8 min

Peak Storage= 8,716 cf @ 12.15 hrs
Average Depth at Peak Storage= 1.18' , Surface Width= 17.47'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 135.10 cfs

8.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 578.0' Slope= 0.0051 '/'
Inlet Invert= 814.11', Outlet Invert= 811.17'

‡

Summary for Reach S1 R4: Swale S1 Reach 4

Inflow Area = 17.292 ac, 0.00% Impervious, Inflow Depth = 2.64" for 100-yr, 24-hr event
Inflow = 62.37 cfs @ 12.14 hrs, Volume= 3.811 af
Outflow = 61.58 cfs @ 12.15 hrs, Volume= 3.811 af, Atten= 1%, Lag= 0.6 min
Routed to Link Swale S1 R4 : Swale S1 Reach 4

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.74 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 0.81 fps, Avg. Travel Time= 4.0 min

Peak Storage= 3,220 cf @ 12.15 hrs
Average Depth at Peak Storage= 1.26' , Surface Width= 18.09'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 154.36 cfs

8.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 195.8' Slope= 0.0066 '/'
Inlet Invert= 811.17', Outlet Invert= 809.87'

‡

Summary for Reach S1 R5: Swale S1 Reach 5

Inflow Area = 17.714 ac, 0.00% Impervious, Inflow Depth = 2.61" for 100-yr, 24-hr event
Inflow = 62.23 cfs @ 12.15 hrs, Volume= 3.859 af
Outflow = 59.21 cfs @ 12.17 hrs, Volume= 3.859 af, Atten= 5%, Lag= 1.3 min
Routed to Link Swale S1 R5 : Swale S1 Reach 5

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.42 fps, Min. Travel Time= 2.0 min
Avg. Velocity = 0.74 fps, Avg. Travel Time= 9.2 min

Peak Storage= 7,135 cf @ 12.17 hrs
Average Depth at Peak Storage= 1.31' , Surface Width= 18.48'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 137.86 cfs

8.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 411.6' Slope= 0.0053 '/'
Inlet Invert= 809.77', Outlet Invert= 807.59'

‡

Summary for Reach S1 R6: Swale S1 Reach 6

Inflow Area = 23.788 ac, 0.00% Impervious, Inflow Depth = 2.23" for 100-yr, 24-hr event
Inflow = 65.66 cfs @ 12.17 hrs, Volume= 4.415 af
Outflow = 62.73 cfs @ 12.20 hrs, Volume= 4.415 af, Atten= 4%, Lag= 1.5 min
Routed to Link Swale 1 R6 : Swale S1 Reach 6

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.44 fps, Min. Travel Time= 2.1 min
Avg. Velocity = 0.76 fps, Avg. Travel Time= 9.4 min

Peak Storage= 7,852 cf @ 12.20 hrs
Average Depth at Peak Storage= 1.36' , Surface Width= 18.86'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 136.28 cfs

8.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 430.9' Slope= 0.0052 '/'
Inlet Invert= 807.15', Outlet Invert= 804.92'

‡

Summary for Reach S2 R1: Swale S2 Reach 1

Inflow Area = 25.203 ac, 0.00% Impervious, Inflow Depth = 2.14" for 100-yr, 24-hr event
Inflow = 62.82 cfs @ 12.20 hrs, Volume= 4.489 af
Outflow = 57.87 cfs @ 12.24 hrs, Volume= 4.489 af, Atten= 8%, Lag= 2.5 min
Routed to Link Swale S2 R1 : Swale S2 Reach 1

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.39 fps, Min. Travel Time= 3.3 min
Avg. Velocity = 0.52 fps, Avg. Travel Time= 15.1 min

Peak Storage= 11,415 cf @ 12.24 hrs
Average Depth at Peak Storage= 1.65' , Surface Width= 21.24'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 84.99 cfs

8.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 472.0' Slope= 0.0020 '/'
Inlet Invert= 802.25', Outlet Invert= 801.30'

‡

Summary for Reach S2 R2: Swale S2 Reach 2

Inflow Area = 42.068 ac, 0.00% Impervious, Inflow Depth = 2.21" for 100-yr, 24-hr event
Inflow = 95.28 cfs @ 12.17 hrs, Volume= 7.736 af
Outflow = 90.88 cfs @ 12.23 hrs, Volume= 7.736 af, Atten= 5%, Lag= 3.1 min
Routed to Link Swale S2 R2 : Swale S2 Reach 2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.16 fps, Min. Travel Time= 3.0 min
Avg. Velocity = 0.88 fps, Avg. Travel Time= 14.3 min

Peak Storage= 16,407 cf @ 12.23 hrs
Average Depth at Peak Storage= 1.40' , Surface Width= 21.20'
Bank-Full Depth= 2.00' Flow Area= 36.0 sf, Capacity= 182.04 cfs

10.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 '/' Top Width= 26.00'
Length= 751.0' Slope= 0.0069 '/'
Inlet Invert= 801.30', Outlet Invert= 796.10'

‡

Summary for Reach S3 R1: Swale S3 Reach 1

Inflow Area = 4.976 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 27.41 cfs @ 12.12 hrs, Volume= 1.319 af
Outflow = 26.88 cfs @ 12.13 hrs, Volume= 1.319 af, Atten= 2%, Lag= 0.6 min
Routed to Link Swale S3 R1 : Swale S3 Reach 1

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.26 fps, Min. Travel Time= 1.1 min
Avg. Velocity = 0.77 fps, Avg. Travel Time= 4.7 min

Peak Storage= 1,774 cf @ 12.13 hrs
Average Depth at Peak Storage= 0.85' , Surface Width= 11.40'
Bank-Full Depth= 2.00' Flow Area= 24.0 sf, Capacity= 125.24 cfs

8.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 215.0' Slope= 0.0070 '/'
Inlet Invert= 807.58', Outlet Invert= 806.08'

‡

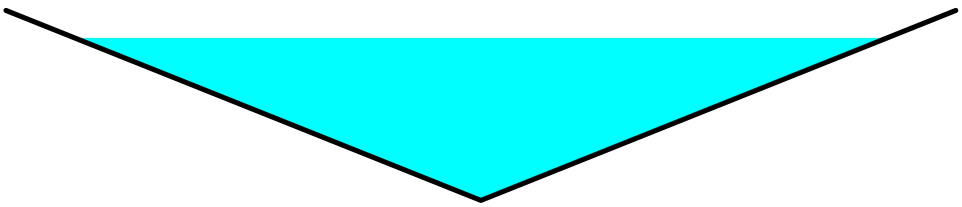
Summary for Reach S3 R2: Swale S3 Reach 2

Inflow Area = 10.265 ac, 0.00% Impervious, Inflow Depth = 2.84" for 100-yr, 24-hr event
Inflow = 47.52 cfs @ 12.13 hrs, Volume= 2.432 af
Outflow = 47.32 cfs @ 12.13 hrs, Volume= 2.432 af, Atten= 0%, Lag= 0.3 min
Routed to Link Swale S3 R2 : Swale S3 Reach 2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.13 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.45 fps, Avg. Travel Time= 1.1 min

Peak Storage= 1,111 cf @ 12.13 hrs
Average Depth at Peak Storage= 2.14' , Surface Width= 10.70'
Bank-Full Depth= 2.50' Flow Area= 15.6 sf, Capacity= 71.57 cfs

0.00' x 2.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.5 '/' Top Width= 12.50'
Length= 97.0' Slope= 0.0070 '/'
Inlet Invert= 806.08', Outlet Invert= 805.40'



Summary for Reach S3 R3: Swale S3 Reach 3

Inflow Area = 11.158 ac, 0.00% Impervious, Inflow Depth = 2.72" for 100-yr, 24-hr event
Inflow = 47.83 cfs @ 12.13 hrs, Volume= 2.533 af
Outflow = 46.22 cfs @ 12.15 hrs, Volume= 2.533 af, Atten= 3%, Lag= 0.9 min
Routed to Link Swale S3 R3 : Swale S3 Reach 3

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.94 fps, Min. Travel Time= 1.5 min
Avg. Velocity = 1.02 fps, Avg. Travel Time= 5.8 min

Peak Storage= 4,140 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.98' , Surface Width= 15.86'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 186.19 cfs

8.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 353.0' Slope= 0.0097 '/'
Inlet Invert= 804.71', Outlet Invert= 801.30'

‡

Summary for Reach S4 R2: Swale S4 Reach 2

Inflow Area = 4.541 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 23.68 cfs @ 12.13 hrs, Volume= 1.204 af
Outflow = 20.91 cfs @ 12.16 hrs, Volume= 1.204 af, Atten= 12%, Lag= 1.8 min
Routed to Reach S4 R3 : Swale S4 Reach 3

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.70 fps, Min. Travel Time= 3.7 min
Avg. Velocity = 0.63 fps, Avg. Travel Time= 16.0 min

Peak Storage= 4,652 cf @ 12.16 hrs
Average Depth at Peak Storage= 0.63' , Surface Width= 14.44'
Bank-Full Depth= 2.00' Flow Area= 34.0 sf, Capacity= 174.20 cfs

10.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 3.0 '/' Top Width= 24.00'
Length= 601.0' Slope= 0.0069 '/'
Inlet Invert= 806.43', Outlet Invert= 802.26'

‡

Summary for Reach S4 R3: Swale S4 Reach 3

[62] Hint: Exceeded Reach S4 R2 OUTLET depth by 0.32' @ 12.25 hrs

Inflow Area = 8.711 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 41.60 cfs @ 12.14 hrs, Volume= 2.309 af
Outflow = 34.31 cfs @ 12.18 hrs, Volume= 2.309 af, Atten= 18%, Lag= 2.7 min
Routed to Reach S4 R4 : Swale S4 Reach 4

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.94 fps, Min. Travel Time= 5.4 min
Avg. Velocity = 0.64 fps, Avg. Travel Time= 24.5 min

Peak Storage= 11,027 cf @ 12.18 hrs
Average Depth at Peak Storage= 0.89' , Surface Width= 16.22'
Bank-Full Depth= 2.00' Flow Area= 34.0 sf, Capacity= 156.53 cfs

10.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 4.0 '/' Top Width= 24.00'
Length= 946.0' Slope= 0.0056 '/'
Inlet Invert= 802.26', Outlet Invert= 796.96'

‡

Summary for Reach S4 R4: Swale S4 Reach 4

[62] Hint: Exceeded Reach S4 R3 OUTLET depth by 0.96' @ 12.25 hrs

Inflow Area = 65.063 ac, 0.04% Impervious, Inflow Depth = 2.33" for 100-yr, 24-hr event
Inflow = 159.67 cfs @ 12.19 hrs, Volume= 12.653 af
Outflow = 157.44 cfs @ 12.21 hrs, Volume= 12.653 af, Atten= 1%, Lag= 1.3 min
Routed to Link Swale S4 R4 : Swale S4 Reach 4

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.29 fps, Min. Travel Time= 1.5 min
Avg. Velocity = 1.12 fps, Avg. Travel Time= 7.2 min

Peak Storage= 14,379 cf @ 12.21 hrs
Average Depth at Peak Storage= 1.82' , Surface Width= 22.73'
Bank-Full Depth= 3.00' Flow Area= 61.5 sf, Capacity= 427.66 cfs

10.00' x 3.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 4.0 '/' Top Width= 31.00'
Length= 483.0' Slope= 0.0082 '/'
Inlet Invert= 796.96', Outlet Invert= 793.00'

‡

Summary for Reach S5 R2: Swale S5 Reach 2

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 4.530 ac, 13.14% Impervious, Inflow Depth = 1.20" for 100-yr, 24-hr event
Inflow = 7.48 cfs @ 12.15 hrs, Volume= 0.454 af
Outflow = 7.48 cfs @ 12.15 hrs, Volume= 0.454 af, Atten= 0%, Lag= 0.0 min
Routed to Link Swale S5 R2 : Swale S5 Reach 2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Pond Sed Pond: Sedimentation Basin

Inflow Area = 74.393 ac, 2.06% Impervious, Inflow Depth = 2.25" for 100-yr, 24-hr event
Inflow = 164.77 cfs @ 12.20 hrs, Volume= 13.946 af
Outflow = 45.68 cfs @ 12.70 hrs, Volume= 13.947 af, Atten= 72%, Lag= 30.2 min
Discarded = 5.84 cfs @ 12.70 hrs, Volume= 7.167 af
Primary = 11.35 cfs @ 12.70 hrs, Volume= 4.914 af
Routed to Link Wetland : Wetland
Secondary = 22.50 cfs @ 12.70 hrs, Volume= 1.762 af
Routed to Link Wetland : Wetland
Tertiary = 6.00 cfs @ 12.70 hrs, Volume= 0.104 af
Routed to Link Wetland : Wetland

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Peak Elev= 793.06' @ 12.70 hrs Surf.Area= 70,052 sf Storage= 236,005 cf
Flood Elev= 794.00' Surf.Area= 75,797 sf Storage= 304,443 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 169.7 min (1,014.6 - 845.0)

Volume	Invert	Avail.Storage	Storage Description
#1	789.00'	304,443 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
789.00	27,325	0	0
790.00	55,972	41,649	41,649
791.00	61,532	58,752	100,401
792.00	65,703	63,618	164,018
793.00	69,675	67,689	231,707
794.00	75,797	72,736	304,443

Device	Routing	Invert	Outlet Devices
#1	Primary	787.70'	**15.0" Round Culvert** L= 40.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 787.70' / 787.50' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.23 sf
#2	Device 1	791.00'	**30.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	790.50'	**0.8" Vert. Orifice/Grate X 4.00** C= 0.600 Limited to weir flow at low heads
#4	Device 1	790.00'	**0.8" Vert. Orifice/Grate X 4.00** C= 0.600 Limited to weir flow at low heads
#5	Device 1	789.00'	**0.5" Vert. Orifice/Grate X 14.00 columns** X 6 rows with 6.0" cc spacing C= 0.600 Limited to weir flow at low heads
#6	Secondary	792.50'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#7	Tertiary	793.00'	**158.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#8	Discarded	789.00'	**3.600 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=5.84 cfs @ 12.70 hrs HW=793.06' (Free Discharge)
└─**8=Exfiltration** (Exfiltration Controls 5.84 cfs)

Primary OutFlow Max=11.35 cfs @ 12.70 hrs HW=793.06' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 11.35 cfs @ 9.25 fps)
  ├─**2=Orifice/Grate** (Passes < 33.94 cfs potential flow)
  ├─**3=Orifice/Grate** (Passes < 0.11 cfs potential flow)
  ├─**4=Orifice/Grate** (Passes < 0.12 cfs potential flow)
  └─**5=Orifice/Grate** (Passes < 0.91 cfs potential flow)

Secondary OutFlow Max=22.49 cfs @ 12.70 hrs HW=793.06' TW=0.00' (Dynamic Tailwater)
└─**6=Broad-Crested Rectangular Weir** (Weir Controls 22.49 cfs @ 2.00 fps)

Tertiary OutFlow Max=5.99 cfs @ 12.70 hrs HW=793.06' TW=0.00' (Dynamic Tailwater)
└─**7=Broad-Crested Rectangular Weir** (Weir Controls 5.99 cfs @ 0.62 fps)

Summary for Link C1: Culvert C1

Inflow Area = 4.530 ac, 13.14% Impervious, Inflow Depth = 1.20" for 100-yr, 24-hr event
Inflow = 7.48 cfs @ 12.15 hrs, Volume= 0.454 af
Primary = 7.48 cfs @ 12.15 hrs, Volume= 0.454 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S5 R2 : Swale S5 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link C2: Culvert C2

Inflow Area = 2.899 ac, 0.00% Impervious, Inflow Depth = 3.23" for 100-yr, 24-hr event
Inflow = 13.45 cfs @ 12.11 hrs, Volume= 0.780 af
Primary = 13.45 cfs @ 12.11 hrs, Volume= 0.780 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1 R3 : Swale S1 Reach 3

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link C3: Culvert C3

Inflow Area = 14.170 ac, 0.00% Impervious, Inflow Depth = 2.58" for 100-yr, 24-hr event
Inflow = 47.76 cfs @ 12.15 hrs, Volume= 3.049 af
Primary = 47.76 cfs @ 12.15 hrs, Volume= 3.049 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1 R4 : Swale S1 Reach 4

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link C4: Culvert C4

Inflow Area = 17.714 ac, 0.00% Impervious, Inflow Depth = 2.61" for 100-yr, 24-hr event
Inflow = 62.23 cfs @ 12.15 hrs, Volume= 3.859 af
Primary = 62.23 cfs @ 12.15 hrs, Volume= 3.859 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1 R5 : Swale S1 Reach 5

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link C5: Culvert C5

Inflow Area = 20.996 ac, 0.00% Impervious, Inflow Depth = 2.43" for 100-yr, 24-hr event
Inflow = 65.15 cfs @ 12.17 hrs, Volume= 4.254 af
Primary = 65.15 cfs @ 12.17 hrs, Volume= 4.254 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1 R6 : Swale S1 Reach 6

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link C6: Culvert C6

Inflow Area = 11.158 ac, 0.00% Impervious, Inflow Depth = 2.72" for 100-yr, 24-hr event
Inflow = 47.83 cfs @ 12.13 hrs, Volume= 2.533 af
Primary = 47.83 cfs @ 12.13 hrs, Volume= 2.533 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S3 R3 : Swale S3 Reach 3

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link C7: Culvert C7

Inflow Area = 48.985 ac, 0.00% Impervious, Inflow Depth = 2.20" for 100-yr, 24-hr event
Inflow = 103.37 cfs @ 12.20 hrs, Volume= 8.978 af
Primary = 103.37 cfs @ 12.20 hrs, Volume= 8.978 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S4 R4 : Swale S4 Reach 4

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link C8: Culvert C8

Inflow Area = 7.668 ac, 11.88% Impervious, Inflow Depth = 1.76" for 100-yr, 24-hr event
Inflow = 19.20 cfs @ 12.15 hrs, Volume= 1.127 af
Primary = 19.20 cfs @ 12.15 hrs, Volume= 1.127 af, Atten= 0%, Lag= 0.0 min
Routed to Link North Area : North Area

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link F1: Flume 1

Inflow Area = 4.170 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 22.19 cfs @ 12.13 hrs, Volume= 1.105 af
Primary = 22.19 cfs @ 12.13 hrs, Volume= 1.105 af, Atten= 0%, Lag= 0.0 min
Routed to Link RC1 : Rock Chute 1

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link F2: Flume 2

Inflow Area = 4.541 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 23.68 cfs @ 12.13 hrs, Volume= 1.204 af
Primary = 23.68 cfs @ 12.13 hrs, Volume= 1.204 af, Atten= 0%, Lag= 0.0 min
Routed to Link RC2 : Rock Chute 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link F3: Flume 3

Inflow Area = 5.923 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 32.10 cfs @ 12.12 hrs, Volume= 1.570 af
Primary = 32.10 cfs @ 12.12 hrs, Volume= 1.570 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1 R2 : Swale S1 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link F4: Flume 4

Inflow Area = 2.645 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 14.43 cfs @ 12.12 hrs, Volume= 0.701 af
Primary = 14.43 cfs @ 12.12 hrs, Volume= 0.701 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1 R4 : Swale S1 Reach 4

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link F5: Flume 5

Inflow Area = 4.601 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 25.31 cfs @ 12.12 hrs, Volume= 1.219 af
Primary = 25.31 cfs @ 12.12 hrs, Volume= 1.219 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S3 R1 : Swale S3 Reach 1

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link F6: Flume 6

Inflow Area = 3.717 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 20.36 cfs @ 12.12 hrs, Volume= 0.985 af
Primary = 20.36 cfs @ 12.12 hrs, Volume= 0.985 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S3 R2 : Swale S3 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link F7: Existing East Flume

Inflow Area = 0.830 ac, 0.00% Impervious, Inflow Depth = 3.12" for 100-yr, 24-hr event
Inflow = 4.50 cfs @ 12.12 hrs, Volume= 0.216 af
Primary = 4.50 cfs @ 12.12 hrs, Volume= 0.216 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S2 R2 : Swale S2 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link F8: Existing West Flume

Inflow Area = 3.122 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 16.40 cfs @ 12.13 hrs, Volume= 0.828 af
Primary = 16.40 cfs @ 12.13 hrs, Volume= 0.828 af, Atten= 0%, Lag= 0.0 min
Routed to Link Swale S2 R2 : Swale S2 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link North Area: North Area

Inflow Area = 7.668 ac, 11.88% Impervious, Inflow Depth = 1.76" for 100-yr, 24-hr event
Inflow = 19.20 cfs @ 12.15 hrs, Volume= 1.127 af
Primary = 19.20 cfs @ 12.15 hrs, Volume= 1.127 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link RC1: Rock Chute 1

Inflow Area = 4.170 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 22.19 cfs @ 12.13 hrs, Volume= 1.105 af
Primary = 22.19 cfs @ 12.13 hrs, Volume= 1.105 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S4 R3 : Swale S4 Reach 3

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link RC2: Rock Chute 2

Inflow Area = 4.541 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 23.68 cfs @ 12.13 hrs, Volume= 1.204 af
Primary = 23.68 cfs @ 12.13 hrs, Volume= 1.204 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S4 R2 : Swale S4 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale 1 R6: Swale S1 Reach 6

Inflow Area = 23.788 ac, 0.00% Impervious, Inflow Depth = 2.23" for 100-yr, 24-hr event
Inflow = 62.73 cfs @ 12.20 hrs, Volume= 4.415 af
Primary = 62.73 cfs @ 12.20 hrs, Volume= 4.415 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S2 R1 : Swale S2 Reach 1

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S1 R1: Swale S1 Reach 1

Inflow Area = 0.691 ac, 0.00% Impervious, Inflow Depth = 2.23" for 100-yr, 24-hr event
Inflow = 2.68 cfs @ 12.12 hrs, Volume= 0.128 af
Primary = 2.68 cfs @ 12.12 hrs, Volume= 0.128 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1 R2 : Swale S1 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S1 R2: Swale S1 Reach 2

Inflow Area = 7.131 ac, 0.00% Impervious, Inflow Depth = 3.07" for 100-yr, 24-hr event
Inflow = 37.05 cfs @ 12.12 hrs, Volume= 1.827 af
Primary = 37.05 cfs @ 12.12 hrs, Volume= 1.827 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1 R3 : Swale S1 Reach 3

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S1 R3: Swale S1 Reach 3

Inflow Area = 14.170 ac, 0.00% Impervious, Inflow Depth = 2.58" for 100-yr, 24-hr event
Inflow = 47.76 cfs @ 12.15 hrs, Volume= 3.049 af
Primary = 47.76 cfs @ 12.15 hrs, Volume= 3.049 af, Atten= 0%, Lag= 0.0 min
Routed to Link C3 : Culvert C3

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S1 R4: Swale S1 Reach 4

Inflow Area = 17.714 ac, 0.00% Impervious, Inflow Depth = 2.61" for 100-yr, 24-hr event
Inflow = 62.23 cfs @ 12.15 hrs, Volume= 3.859 af
Primary = 62.23 cfs @ 12.15 hrs, Volume= 3.859 af, Atten= 0%, Lag= 0.0 min
Routed to Link C4 : Culvert C4

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S1 R5: Swale S1 Reach 5

Inflow Area = 20.996 ac, 0.00% Impervious, Inflow Depth = 2.43" for 100-yr, 24-hr event
Inflow = 65.15 cfs @ 12.17 hrs, Volume= 4.254 af
Primary = 65.15 cfs @ 12.17 hrs, Volume= 4.254 af, Atten= 0%, Lag= 0.0 min
Routed to Link C5 : Culvert C5

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S2 R1: Swale S2 Reach 1

Inflow Area = 25.901 ac, 0.00% Impervious, Inflow Depth = 2.10" for 100-yr, 24-hr event
Inflow = 58.13 cfs @ 12.24 hrs, Volume= 4.525 af
Primary = 58.13 cfs @ 12.24 hrs, Volume= 4.525 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S2 R2 : Swale S2 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S2 R2: Swale S2 Reach 2

Inflow Area = 48.985 ac, 0.00% Impervious, Inflow Depth = 2.20" for 100-yr, 24-hr event
Inflow = 103.37 cfs @ 12.20 hrs, Volume= 8.978 af
Primary = 103.37 cfs @ 12.20 hrs, Volume= 8.978 af, Atten= 0%, Lag= 0.0 min
Routed to Link C7 : Culvert C7

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S3 R1: Swale S3 Reach 1

Inflow Area = 6.548 ac, 0.00% Impervious, Inflow Depth = 2.65" for 100-yr, 24-hr event
Inflow = 27.22 cfs @ 12.13 hrs, Volume= 1.447 af
Primary = 27.22 cfs @ 12.13 hrs, Volume= 1.447 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S3 R2 : Swale S3 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S3 R2: Swale S3 Reach 2

Inflow Area = 11.158 ac, 0.00% Impervious, Inflow Depth = 2.72" for 100-yr, 24-hr event
Inflow = 47.83 cfs @ 12.13 hrs, Volume= 2.533 af
Primary = 47.83 cfs @ 12.13 hrs, Volume= 2.533 af, Atten= 0%, Lag= 0.0 min
Routed to Link C6 : Culvert C6

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S3 R3: Swale S3 Reach 3

Inflow Area = 14.511 ac, 0.00% Impervious, Inflow Depth = 2.36" for 100-yr, 24-hr event
Inflow = 47.45 cfs @ 12.15 hrs, Volume= 2.848 af
Primary = 47.45 cfs @ 12.15 hrs, Volume= 2.848 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S2 R2 : Swale S2 Reach 2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S4 R4: Swale S4 Reach 4

Inflow Area = 67.064 ac, 0.04% Impervious, Inflow Depth = 2.29" for 100-yr, 24-hr event
Inflow = 157.92 cfs @ 12.21 hrs, Volume= 12.803 af
Primary = 157.92 cfs @ 12.21 hrs, Volume= 12.803 af, Atten= 0%, Lag= 0.0 min
Routed to Pond Sed Pond : Sedimentation Basin

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S5 R1: Swale S5 Reach 1

Inflow Area = 4.530 ac, 13.14% Impervious, Inflow Depth = 1.20" for 100-yr, 24-hr event
Inflow = 7.48 cfs @ 12.15 hrs, Volume= 0.454 af
Primary = 7.48 cfs @ 12.15 hrs, Volume= 0.454 af, Atten= 0%, Lag= 0.0 min
Routed to Link C1 : Culvert C1

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S5 R2: Swale S5 Reach 2

Inflow Area = 5.851 ac, 12.83% Impervious, Inflow Depth = 1.48" for 100-yr, 24-hr event
Inflow = 12.65 cfs @ 12.14 hrs, Volume= 0.720 af
Primary = 12.65 cfs @ 12.14 hrs, Volume= 0.720 af, Atten= 0%, Lag= 0.0 min
Routed to Link C8 : Culvert C8

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S5 R3: Swale S5 Reach 3

Inflow Area = 1.817 ac, 8.81% Impervious, Inflow Depth = 2.69" for 100-yr, 24-hr event
Inflow = 6.90 cfs @ 12.17 hrs, Volume= 0.408 af
Primary = 6.90 cfs @ 12.17 hrs, Volume= 0.408 af, Atten= 0%, Lag= 0.0 min
Routed to Link C8 : Culvert C8

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Swale S6 R1: Swale S6 Reach 1

Inflow Area = 2.899 ac, 0.00% Impervious, Inflow Depth = 3.23" for 100-yr, 24-hr event
Inflow = 13.45 cfs @ 12.11 hrs, Volume= 0.780 af
Primary = 13.45 cfs @ 12.11 hrs, Volume= 0.780 af, Atten= 0%, Lag= 0.0 min
Routed to Link C2 : Culvert C2

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Summary for Link Wetland: Wetland

Inflow Area = 74.393 ac, 2.06% Impervious, Inflow Depth = 1.09" for 100-yr, 24-hr event
Inflow = 39.85 cfs @ 12.70 hrs, Volume= 6.780 af
Primary = 39.85 cfs @ 12.70 hrs, Volume= 6.780 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Swale Sizing

SCS ENGINEERS

		Sheet No:	1 of 2
		Calc. No.	
		Rev. No.	0
Job No. 25220183.00	Job: Columbia Energy Center POO Landfill Closure	By: RJG	Date: 2/23/22
Client: WPL	Subject: Swale Sizing	Chk'd: MJT	Date: 4/5/22

Purpose:

To size the proposed swale along Module 10 and 11 to accommodate the 25-year, 24-hour storm event and determine required rolled erosion control product. To confirm capacity of existing swale during closure condition.

References:

1. WisDOT Facilities Development Manual Chapter 13, Section 30-15 - Grass Lined Channels.
2. Design of Roadside Channels with Flexible Linings, HEC-15, USDOT FHWA.
3. HydroCAD Report_POO Landfill Closure
4. Table 7E-5.01: Typical Rolled Erosion Control Product Properties and Uses, Iowa SUDAS Design and Specifications Manual.

Approach:

Use the HydroCAD Model results to obtain the peak flow during a 25-year, 24-hour storm event.

Use Grass Lined Channel Design WisDOT Spreadsheet, FDM 13-30 Attachment 15.2 (from Reference #1) to size the swale for each design swale cross section. The WisDOT spreadsheet incorporates the design guidelines and equations described in "Design of Roadside Channels with Flexible Linings", HEC-15, USDOT FHWA (Reference #2).

Confirm the swale is stable and has enough capacity for the design flow rate.

Use Table 7E-5.01 (see Reference #4) to select appropriate erosion control mat based on shear stress and application.

Assumptions:

1. Swales geometry shown on the drawing set.

2. Assume the following parameters per Section 15.2 - Grass Lining Properties from Reference #1:
   - Vegetation Retardance Class = C for Swales
   - Vegetation Condition = Good
   - Vegetation Growth Form = Turf
3. Assume cohesive soil type with ASTM Soil Class SC and a Plasticity Index (PI) of 16.

Calculations:

From the HydroCAD Report, the 25-year, 24-hour peak discharge rates in the swales are

Swales:	25-year		25-year		25-year
Swale S1 Reach 1=	1.37 cfs	**Swale S2 Reach 2=**	52.2 cfs	**Swale S4 Reach 4=**	80.1 cfs
Swale S1 Reach 2=	21.7 cfs	**Swale S3 Reach 1=**	15.9 cfs	**Swale S5 Reach 1=**	2.1 cfs
Swale S1 Reach 3=	27.4 cfs	**Swale S3 Reach 2=**	27.9 cfs	**Swale S5 Reach 2=**	4.7 cfs
Swale S1 Reach 4=	35.4 cfs	**Swale S3 Reach 3=**	26.7 cfs	**Swale S5 Reach 3=**	3.8 cfs
Swale S1 Reach 5=	35.2 cfs	**Swale S4 Reach 1*=**	cfs	**Swale S6 Reach 1=**	9.7 cfs
Swale S1 Reach 6=	33.2 cfs	**Swale S4 Reach 2*=**	cfs		
Swale S2 Reach 1=	30.0 cfs	**Swale S4 Reach 3*=**	cfs		

Use max. flow from Swale S1 reaches to confirm swale works since slope is constant.

*Use full Swale S4 Reach 4 for swale flow in Swale S4 reaches.

Use the WisDOT Grass Swale Design Spreadsheet (Page 2) to determine the flow depth, velocity and shear stress in the swales.

Results:

The swales are adequately designed to accommodate the flows from the 25-year, 24-hour storm event.

The swales are stable at the design flow rates.

Use Class I, Type B erosion mat.

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Channel/Ditch Geometry	Swale S1	Swale S1 Reach 1	Swale S1 Reach 2	Swale S1 Reach 3	Swale S1 Reach 4	Swale S1 Reach 5	Swale S1 Reach 6	Swale S2 Reach 1	Swale S2 Reach 2	Swale S3 Reach 1	Swale S3 Reach 2	Swale S3 Reach 3	Swale S4 Reach 1	Swale S4 Reach 2	Swale S4 Reach 3	Swale S4 Reach 4	Swale S5 Reach 1	Swale S5 Reach 2	Swale S5 Reach 3	Swale S6 Reach 1
Channel Slope, S_o (ft/ft)	0.0055	0.0053	0.0055	0.0051	0.0069	0.0053	0.0084	0.0020	0.0069	0.0070	0.0070	0.0097	0.0155	0.0069	0.0056	0.0082	0.0096	0.0024	0.0024	0.0066
Channel Bottom Width, B (ft)	8	8	8	8	8	8	8	8	10	8	8	0	10	10	10	10	0	0	0	8
Channel Side Slope, z_l	4	4	4	4	4	4	4	4	4	2	2	4	4	4	4	4	6	6	6	2.5
Channel Side Slope, z_r	4	4	4	4	4	4	4	4	4	2	2	4	3	3	3	3	7	2.5	2.5	2.5
Flow Depth, d (ft) Solve iteratively	1.59	0.37	1.30	1.47	1.46	1.61	1.32	2.18	1.61	1.07	1.39	1.81	1.42	1.97	2.13	1.85	0.67	1.51	1.41	0.85
Safety Factor, SF	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Vegetation/Soil Parameters																				
Vegetation Retardance Class	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Vegetation Condition	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good
Vegetation Growth Form	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf
Soil Type	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive
D_{75} (in) (Set at 0.00 for cohesive soils)																				
ASTM Soil Class	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC
Plasticity Index, PI	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Results Summary																				
Design Q (ft^3/s)	35.4	1.4	21.7	27.4	35.4	35.2	33.2	30.0	52.2	15.9	27.9	26.7	80.1	80.1	80.1	80.1	2.1	4.7	3.8	9.7
1. Swales geometry shown on the drawing set	35.4	1.4	22.1	27.4	35.4	35.2	33.5	29.8	52.5	16.0	28.0	27.1	79.6	80.5	79.5	81.6	2.1	4.7	3.8	9.6
Difference Between Design & Calc. Flow (%)	0.2%	0.2%	1.9%	0.0%	0.1%	0.0%	1.0%	-0.4%	0.6%	0.5%	0.6%	1.6%	-0.6%	0.5%	-0.7%	1.8%	0.0%	-0.3%	0.2%	-0.5%
Stable (Yes or No)	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Channel Parameters																				
Vegetation Height, h (ft)	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Grass Roughness Coefficient, C_n	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238
Cover Factor, C_f	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Noncohesive Soil																				
Soil Grain Roughness, n_s	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016
Permissible Soil Shear Stress, τ_p (lb/ft^2)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cohesive Soil																				
Porosity, e	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Soil Coefficient 1, c_1	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700
Soil Coefficient 2, c_2	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30
Soil Coefficient 3, c_3	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700
Soil Coefficient 4, c_4	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42
Soil Coefficient 5, c_5	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61
Soil Coefficient 6, c_6	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010
Permissible Soil Shear Stress, τ_p (lb/ft^2)	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080
Total Permissible Shear Stress, τ_p (lb/ft^2)	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080
Cross Sectional Area, A (ft^2)	22.832	3.453	17.160	20.404	20.206	23.248	17.530	36.450	26.468	10.850	14.984	13.104	21.257	33.283	37.179	30.479	2.874	9.690	8.449	8.606
Wetted Perimeter, P (ft)	21.11	11.01	18.72	20.12	20.04	21.28	18.88	25.98	23.28	12.79	14.22	14.93	20.35	24.35	25.52	23.48	8.75	13.25	12.37	12.58
Hydraulic Radius, R (ft)	1.082	0.314	0.917	1.014	1.008	1.093	0.928	1.403	1.137	0.849	1.054	0.878	1.045	1.367	1.457	1.298	0.329	0.731	0.683	0.684
Top Width, T (ft)	20.72	10.92	18.40	19.76	19.68	20.88	18.56	25.44	22.88	12.28	13.56	14.48	19.94	23.79	24.91	22.95	8.65	12.84	11.99	12.25
Hydraulic Depth, D (ft)	1.102	0.316	0.933	1.033	1.027	1.113	0.944	1.433	1.157	0.884	1.105	0.905	1.066	1.399	1.493	1.328	0.333	0.755	0.705	0.703
Froude Number (Q design)	0.261	0.125	0.235	0.233	0.305	0.253	0.347	0.121	0.325	0.276	0.314	0.383	0.639	0.360	0.309	0.409	0.219	0.098	0.094	0.235
Channel Shear Stress, τ_o (lb/ft^2)	0.37	0.10	0.31	0.32	0.43	0.36	0.49	0.18	0.49	0.37	0.46	0.53	1.01	0.59	0.51	0.66	0.20	0.11	0.10	0.28
Actual Sheer Stress, τ_d (lb/ft^2)	0.55	0.12	0.45	0.47	0.63	0.53	0.69	0.27	0.69	0.47	0.61	1.10	1.37	0.85	0.74	0.95	0.40	0.23	0.21	0.35
Mannings n	0.075	0.126	0.081	0.080	0.071	0.076	0.068	0.102	0.068	0.076	0.069	0.065	0.051	0.063	0.067	0.060	0.097	0.123	0.126	0.084
Average Velocity, V (ft/s)	1.55	0.40	1.26	1.34	1.75	1.51	1.89	0.82	1.97	1.46	1.86	2.04	3.77	2.41	2.15	2.63	0.72	0.48	0.45	1.12
Calculated Flow, Q (ft^3/s)	35.4	1.4	22.1	27.4	35.4	35.2	33.5	29.8	52.5	16.0	28.0	27.1	79.6	80.5	79.5	81.6	2.1	4.7	3.8	9.6
Difference Between Design & Calc. Flow (%)	0.2%	0.2%	1.9%	0.0%	0.1%	0.0%	1.0%	-0.4%	0.6%	0.5%	0.6%	1.6%	-0.6%	0.5%	-0.7%	1.8%	0.0%	-0.3%	0.2%	-0.5%
Effective Shear on Soil Surface, τ_e (lb/ft^2)	0.002	0.000	0.002	0.002	0.003	0.002	0.004	0.001	0.004	0.002	0.003	0.007	0.014	0.005	0.004	0.007	0.001	0.000	0.000	0.001
Total Permissible Shear on Veg., $\tau_{p,veg}$ (lb/ft^2)	17.60	49.69	20.53	20.03	15.78	18.08	14.47	32.56	14.47	18.08	14.90	13.22	8.14	12.42	14.05	11.27	29.45	47.35	49.69	22.08
Stable (Y or N)	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Source: Grass Lined Channel Design WisDOT Spreadsheet, FDM 13-30 Attachment 15.2

Non-Channel Erosion Mat
(1052)

Wisconsin Department of Natural Resources
Conservation Practice Standard

To differentiate applications Erosion mats are organized into three Classes of mats, which are further broken down into various Types.

A. **Class I**: A short-term duration (minimum of 6 months), light duty, organic mat with photodegradable plastic or biodegradable netting.

1. **Type A** – Use on erodible slopes 2.5:1 or flatter.
2. **Type B** – Double netted product for use on erodible slopes 2:1 or flatter.

B. **Class I, Urban**: A short-term duration (minimum of 6 months), light duty, organic erosion control mat for areas where mowing may be accomplished within two weeks after installation.

1. **Urban, Type A** – Use on erodible soils with slopes 4:1 or flatter.
2. **Urban, Type B** – A double netted product for use on slopes 2.5:1 or flatter.

C. **Class II**: A long-term duration (three years or greater), organic erosion control revegetative mat.

1. **Type A** – Jute fiber only for use on slopes 2:1 or flatter for sod reinforcement.
2. **Type B** – For use on slopes 2:1 or greater made with plastic or biodegradable net.
3. **Type C** – A woven mat of 100% organic fibers for use on slopes 2:1 or flatter and in environmentally and biologically sensitive areas where plastic netting is inappropriate.

D. **Class III**: A permanent 100% synthetic ECRM or TRM. Either a soil stabilizer Type A or Class I, Type A or B erosion mat must be placed over the soil filled TRM.

1. **Type A** – An ECRM for use on slopes 2:1 or flatter.
2. **Type B or C** – A TRM for use on slopes 2:1 or flatter.
3. **Type D** – A TRM for use on slopes 1:1 or flatter.

Channel Erosion Mat
(1053)

Wisconsin Department of Natural Resources
Conservation Practice Standard

To differentiate applications WisDOT organizes erosion mats into three classes of mats, which are further broken down into various Types.

A. **Class I**: A short-term duration (minimum of 6 months), light duty, organic ECRM with plastic or biodegradable netting.

1. **Type A** – Only suitable for slope applications, not channel applications.
2. **Type B** – Double netted product for use in channels where the calculated (design) shear stress is 1.5 lbs/ft^2 or less.

B. **Class II**: A long-term duration (three years or greater), organic ECRM.

1. **Type A** – Jute fiber only for use in channels to reinforce sod.
2. **Type B** – For use in channels where the calculated (design) shear stress is 2.0 lbs/ft^2 or less. Made with plastic or biodegradable mat.
3. **Type C** – A woven mat of 100% organic material for use in channels where the calculated (design) shear stress is 2.0 lbs/ft^2 or less. Applicable for use in environmentally sensitive areas where plastic netting is inappropriate.

C. **Class III**: A permanent 100% synthetic ECRM or TRM. Class I, Type B erosion mat or Class II, Type B or C erosion mat must be placed over a soil filled TRM.

1. **Type A** – An ECRM for use in channels where the calculated (design) shear stress of 2.0 lbs/ft^2 or less.
2. **Type B** – A TRM for use in channels where the calculated (design) shear stress of 2.0 lbs/ft^2 or less.
3. **Type C** – A TRM for use in channels where the calculated (design) shear stress of 3.5 lbs/ft^2 or less.
4. **Type D** – A TRM for use in channels where the calculated (design) shear stress of 5.0 lbs/ft^2 or less.

Culvert Sizing

SCS ENGINEERS

		Sheet No: 1/7	
		Calc. No.	
		Rev. No.	
Job No. 25220183.00	Job: COL - POO	By: RJG	Date: 4/7/22
Client: WPL	Subject: Culvert Sizing	Chk'd: MJT	Date:

Purpose:

To size the post closure culverts to accommodate the 25-year, 24-hour storm event.

References:

1. HY-8 7.40 Computer Model
2. HydroCAD Report_Post Construction and HydroCAD Report_Post Construction Temporary Culvert
3. Figure 1 - Storm Water Post Construction

Approach:

1. Create culvert crossing in HY-8 and input data from Reference #2 and #3.
2. Adjust diameter size and number of culverts in model until design flow does not over top berm/road crossing.

Assumptions:

1. Assume the tailwater channel data is a based on discharge swale or rock chute geometry (Reference #2).
2. Culverts are circular, PE Pipe with smooth interior, and with square edge with headwall.
3. Culvert elevatons,lengths, and slopes based on Figure 1 (Reference #3).
4. Roadwa data for crossing based on Figure 1 (Reference #3).
5. Discharge flows from HydroCAD report (Refence #2).

Calculations:

See attached HY-8 Model output reports.

Results:

The culverts are adequately designed to accommodate the flows from the 25-year, 24-hour storm event.

Culvert	Dia. (ft)	# of Barrels	Upstream Invert (ft)	Downstream Invert (ft)	Slope (%)	Length (ft)
C1	2	1	815.70	814.55	2.22	52
C2	1.5	2	814.40	814.20	0.49	41
C3	2.5	2	811.17	811.16	0.02	50
C4	2.5	2	809.87	809.74	0.26	50
C5	2.5	2	807.57	807.15	0.84	50
C6	2	2	805.40	804.76	0.61	105
C7	3.5	2	796.64	796.34	0.50	60
C8	2	1	807.54	806.81	0.73	100

HY-8 Culvert Analysis Report _ Culvert C1

Site Data - Culvert C1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 815.70 ft

Outlet Station: 51.88 ft

Outlet Elevation: 814.55 ft

Number of Barrels: 1

Culvert Data Summary - Culvert C1

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 2.06 cfs

Design Flow: 2.06 cfs

Maximum Flow: 7.48 cfs

Tailwater Channel Data - Culvert C1

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 6.00 (_:1)

Channel Slope: 0.0300

Channel Manning's n: 0.0300

Channel Invert Elevation: 815.32 ft

Table 1 - Culvert Summary Table: Culvert C1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2.06	2.06	816.37	0.670	0.0*	1-JS1t	0.321	0.498	1.127	0.357	1.129	2.695
2.60	2.60	816.46	0.758	0.031	1-JS1t	0.361	0.562	1.160	0.390	1.378	2.857
3.14	3.14	816.54	0.838	0.070	1-JS1t	0.396	0.619	1.188	0.418	1.616	2.995
3.69	3.69	816.61	0.912	0.108	1-JS1t	0.428	0.672	1.214	0.444	1.847	3.117
4.23	4.23	816.68	0.982	0.145	1-JS1t	0.459	0.722	1.237	0.467	2.072	3.226
4.77	4.77	816.76	1.058	0.182	1-S2n	0.487	0.768	0.503	0.489	7.698	3.324
5.31	5.31	816.83	1.134	0.220	1-S2n	0.515	0.813	0.533	0.509	7.895	3.415
5.85	5.85	816.91	1.206	0.258	1-S2n	0.541	0.855	0.562	0.528	8.081	3.499
6.40	6.40	816.98	1.275	0.298	1-S2n	0.566	0.895	0.590	0.546	8.262	3.577
6.94	6.94	817.04	1.342	0.338	1-S2n	0.590	0.934	0.617	0.563	8.416	3.651
7.48	7.48	817.11	1.406	0.379	1-S2n	0.614	0.972	0.643	0.579	8.566	3.720

* Full Flow Headwater elevation is below inlet invert.

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Straight Culvert

Inlet Elevation (invert): 815.70 ft, Outlet Elevation (invert): 814.55 ft

Culvert Length: 51.89 ft, Culvert Slope: 0.0222

****

Table 2 - Summary of Culvert Flows at Crossing: Culvert C1

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert C1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
816.37	2.06	2.06	0.00	1
816.46	2.60	2.60	0.00	1
816.54	3.14	3.14	0.00	1
816.61	3.69	3.69	0.00	1
816.68	4.23	4.23	0.00	1
816.76	4.77	4.77	0.00	1
816.83	5.31	5.31	0.00	1
816.91	5.85	5.85	0.00	1
816.98	6.40	6.40	0.00	1
817.04	6.94	6.94	0.00	1
817.11	7.48	7.48	0.00	1
819.06	22.61	22.61	0.00	Overtopping

HY-8 Culvert Analysis Report _ Culvert C2

Site Data - C2

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 814.40 ft

Outlet Station: 41.00 ft

Outlet Elevation: 814.20 ft

Number of Barrels: 2

Culvert Data Summary - C2

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Tailwater Channel Data - Culvert C2

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 8.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0050

Channel Manning's n: 0.0300

Channel Invert Elevation: 814.10 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 9.68 cfs

Design Flow: 9.68 cfs

Maximum Flow: 13.45 cfs

Table 1 - Culvert Summary Table: C2

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
9.68	9.68	815.67	1.271	0.199	1-S2n	0.767	0.842	0.767	0.499	4.728	1.939
10.06	10.06	815.70	1.302	0.926	1-S2n	0.786	0.858	0.786	0.510	4.769	1.963
10.43	10.43	815.73	1.333	0.966	1-S2n	0.805	0.877	0.805	0.521	4.807	1.987
10.81	10.81	815.76	1.364	1.003	1-S2n	0.824	0.893	0.824	0.531	4.842	2.010
11.19	11.19	815.79	1.395	1.041	1-S2n	0.843	0.909	0.843	0.542	4.871	2.032
11.57	11.57	815.83	1.426	1.079	1-S2n	0.863	0.924	0.863	0.552	4.899	2.053
11.94	11.94	815.86	1.457	1.117	1-S2n	0.882	0.939	0.882	0.562	4.943	2.074
12.32	12.32	815.89	1.489	1.156	1-S2n	0.902	0.954	0.902	0.572	4.973	2.095
12.70	12.70	815.92	1.521	1.196	5-S2n	0.921	0.968	0.921	0.581	5.001	2.115
13.07	13.07	815.95	1.553	1.240	5-S2n	0.941	0.987	0.941	0.591	5.028	2.134
13.45	13.45	815.99	1.586	1.281	5-S2n	0.962	1.001	0.962	0.600	5.048	2.153

****

Straight Culvert

Inlet Elevation (invert): 814.40 ft, Outlet Elevation (invert): 814.20 ft

Culvert Length: 41.00 ft, Culvert Slope: 0.0049

****

Table 2 - Summary of Culvert Flows at Crossing: Culvert C2

Headwater Elevation (ft)	Total Discharge (cfs)	C2 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
815.67	9.68	9.68	0.00	1
815.70	10.06	10.06	0.00	1
815.73	10.43	10.43	0.00	1
815.76	10.81	10.81	0.00	1
815.79	11.19	11.19	0.00	1
815.83	11.57	11.57	0.00	1
815.86	11.94	11.94	0.00	1
815.89	12.32	12.32	0.00	1
815.92	12.70	12.70	0.00	1
815.95	13.07	13.07	0.00	1
815.99	13.45	13.45	0.00	1
816.90	21.79	21.79	0.00	Overtopping

HY-8 Culvert Analysis Report _ Culvert C3

Site Data - C3

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 811.17 ft

Outlet Station: 50.00 ft

Outlet Elevation: 811.16 ft

Number of Barrels: 2

Culvert Data Summary - C3

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Tailwater Channel Data - Culvert C3

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 8.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0050

Channel Manning's n: 0.0300

Channel Invert Elevation: 811.17 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 27.38 cfs

Design Flow: 27.38 cfs

Maximum Flow: 47.76 cfs

Table 1 - Culvert Summary Table: C3

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
27.38	27.38	813.15	1.836	1.981	7-H2c	-1.000	1.245	1.245	0.886	5.607	2.677
29.42	29.42	813.23	1.918	2.064	7-H2c	-1.000	1.292	1.292	0.921	5.745	2.735
31.46	31.46	813.32	1.998	2.147	7-H2c	-1.000	1.339	1.339	0.954	5.878	2.789
33.49	33.49	813.40	2.077	2.228	7-H2c	-1.000	1.383	1.383	0.987	6.009	2.841
35.53	35.53	813.48	2.155	2.308	7-H2c	-1.000	1.427	1.427	1.018	6.137	2.891
37.57	37.46	813.55	2.229	2.384	7-H2c	-1.000	1.467	1.467	1.049	6.257	2.938
39.61	38.68	813.60	2.276	2.431	7-H2c	-1.000	1.492	1.492	1.078	6.332	2.983
41.65	39.64	813.64	2.312	2.468	7-H2c	-1.000	1.511	1.511	1.107	6.391	3.027
43.68	40.50	813.67	2.345	2.502	7-H2c	-1.000	1.528	1.528	1.135	6.443	3.068
45.72	41.26	813.70	2.374	2.531	7-H2c	-1.000	1.543	1.543	1.163	6.490	3.109
47.76	42.00	813.73	2.403	2.559	7-H2c	-1.000	1.557	1.557	1.189	6.534	3.148

****

Straight Culvert

Inlet Elevation (invert): 811.17 ft, Outlet Elevation (invert): 811.16 ft

Culvert Length: 50.00 ft, Culvert Slope: 0.0002

****

Table 2 - Summary of Culvert Flows at Crossing: Culvert C3

Headwater Elevation (ft)	Total Discharge (cfs)	C3 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
813.15	27.38	27.38	0.00	1
813.23	29.42	29.42	0.00	1
813.32	31.46	31.46	0.00	1
813.40	33.49	33.49	0.00	1
813.48	35.53	35.53	0.00	1
813.55	37.57	37.46	0.02	10
813.60	39.61	38.68	0.85	6
813.64	41.65	39.64	1.94	5
813.67	43.68	40.50	3.15	5
813.70	45.72	41.26	4.38	4
813.73	47.76	42.00	5.71	4
813.55	37.37	37.37	0.00	Overtopping

HY-8 Culvert Analysis Report _ Culvert C4

Site Data - C4

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 809.87 ft

Outlet Station: 50.00 ft

Outlet Elevation: 809.74 ft

Number of Barrels: 2

Culvert Data Summary - C4

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Tailwater Channel Data - Culvert C4

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 8.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0070

Channel Manning's n: 0.0300

Channel Invert Elevation: 809.87 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 35.39 cfs

Design Flow: 35.39 cfs

Maximum Flow: 62.23 cfs

Table 1 - Culvert Summary Table: C4

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
35.39	35.39	812.13	2.147	2.263	2-M2c	1.660	1.424	1.424	0.929	6.128	3.252
38.07	38.07	812.24	2.249	2.365	2-M2c	1.752	1.479	1.479	0.966	6.295	3.322
40.76	40.41	812.32	2.338	2.454	2-M2c	1.837	1.526	1.526	1.002	6.438	3.389
43.44	41.81	812.38	2.392	2.507	7-M2c	1.891	1.553	1.553	1.036	6.523	3.453
46.13	42.96	812.42	2.437	2.550	7-M2c	1.938	1.575	1.575	1.069	6.593	3.513
48.81	44.01	812.46	2.478	2.589	7-M2c	1.983	1.595	1.595	1.102	6.656	3.571
51.49	44.95	812.49	2.515	2.624	7-M2c	2.027	1.613	1.613	1.133	6.713	3.627
54.18	45.85	812.53	2.550	2.658	7-M2c	2.073	1.629	1.629	1.163	6.767	3.680
56.86	46.71	812.56	2.585	2.691	7-M2c	2.121	1.645	1.645	1.193	6.819	3.731
59.55	47.53	812.59	2.617	2.721	7-M2c	2.174	1.660	1.660	1.222	6.868	3.781
62.23	48.31	812.62	2.649	2.751	7-M2c	2.500	1.674	1.674	1.250	6.915	3.828

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Straight Culvert

Inlet Elevation (invert): 809.87 ft, Outlet Elevation (invert): 809.74 ft

Culvert Length: 50.00 ft, Culvert Slope: 0.0026

****

Table 2 - Summary of Culvert Flows at Crossing: Culvert C4

Headwater Elevation (ft)	Total Discharge (cfs)	C4 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
812.13	35.39	35.39	0.00	1
812.24	38.07	38.07	0.00	1
812.32	40.76	40.41	0.26	9
812.38	43.44	41.81	1.56	6
812.42	46.13	42.96	3.08	5
812.46	48.81	44.01	4.75	5
812.49	51.49	44.95	6.46	4
812.53	54.18	45.85	8.25	4
812.56	56.86	46.71	10.10	4
812.59	59.55	47.53	11.98	4
812.62	62.23	48.31	13.89	4
812.30	39.78	39.78	0.00	Overtopping

HY-8 Culvert Analysis Report _ Culvert C5

Site Data - C5

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 807.57 ft

Outlet Station: 50.00 ft

Outlet Elevation: 807.15 ft

Number of Barrels: 2

Culvert Data Summary - C5

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Tailwater Channel Data - Culvert C5

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 8.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0050

Channel Manning's n: 0.0300

Channel Invert Elevation: 807.59 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 35.21 cfs

Design Flow: 35.21 cfs

Maximum Flow: 65.15 cfs

Table 1 - Culvert Summary Table: C5

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
35.21	35.21	809.70	2.133	1.411	1-S2n	1.148	1.420	1.190	1.013	7.642	2.883
38.20	38.20	809.82	2.247	1.523	1-S2n	1.203	1.482	1.248	1.058	7.801	2.952
41.20	41.20	809.93	2.362	1.638	1-S2n	1.257	1.541	1.305	1.101	7.950	3.017
44.19	44.19	810.05	2.478	1.773	1-S2n	1.311	1.598	1.360	1.142	8.093	3.079
47.19	47.19	810.17	2.596	1.912	5-S2n	1.364	1.654	1.415	1.182	8.230	3.137
50.18	50.18	810.29	2.719	2.054	5-S2n	1.417	1.707	1.470	1.220	8.362	3.193
53.17	53.17	810.42	2.846	2.199	5-S2n	1.470	1.758	1.523	1.257	8.490	3.246
56.17	55.74	810.53	2.959	2.326	5-S2n	1.516	1.800	1.569	1.294	8.595	3.296
59.16	57.10	810.59	3.021	2.395	5-S2n	1.541	1.822	1.593	1.329	8.650	3.345
62.16	58.20	810.64	3.072	2.451	5-S2n	1.561	1.839	1.613	1.363	8.693	3.391
65.15	59.19	810.69	3.118	2.501	5-S2n	1.578	1.854	1.630	1.396	8.732	3.436

****

Straight Culvert

Inlet Elevation (invert): 807.57 ft, Outlet Elevation (invert): 807.15 ft

Culvert Length: 50.00 ft, Culvert Slope: 0.0084

****

Table 24 - Summary of Culvert Flows at Crossing: Culvert C5

Headwater Elevation (ft)	Total Discharge (cfs)	C5 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
809.70	35.21	35.21	0.00	1
809.82	38.20	38.20	0.00	1
809.93	41.20	41.20	0.00	1
810.05	44.19	44.19	0.00	1
810.17	47.19	47.19	0.00	1
810.29	50.18	50.18	0.00	1
810.42	53.17	53.17	0.00	1
810.53	56.17	55.74	0.36	10
810.59	59.16	57.10	1.98	6
810.64	62.16	58.20	3.88	5
810.69	65.15	59.19	5.92	5
810.50	55.08	55.08	0.00	Overtopping

HY-8 Culvert Analysis Report _ Culvert C6

Site Data - C6

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 805.40 ft

Outlet Station: 104.56 ft

Outlet Elevation: 804.76 ft

Number of Barrels: 2

Culvert Data Summary - C6

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope

Inlet Depression: None

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 27.86 cfs

Design Flow: 27.86 cfs

Maximum Flow: 47.83 cfs

Tailwater Channel Data - Culvert C6

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 10.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0070

Channel Manning's n: 0.0300

Channel Invert Elevation: 804.56 ft

Table 1 - Culvert Summary Table: C6

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
27.86	27.86	807.61	2.214	1.559	5-S2n	1.263	1.344	1.263	0.769	6.666	3.141
29.86	29.86	807.76	2.362	1.734	5-S2n	1.325	1.392	1.325	0.800	6.758	3.216
31.85	31.85	807.92	2.520	1.916	5-S2n	1.390	1.439	1.391	0.831	6.829	3.287
33.85	33.85	808.09	2.689	2.105	5-S2n	1.458	1.483	1.458	0.861	6.901	3.355
35.85	35.85	808.27	2.869	2.806	7-M2c	1.531	1.525	1.525	0.890	6.973	3.420
37.84	37.84	808.46	3.061	2.896	7-M2c	1.613	1.565	1.565	0.918	7.174	3.483
39.84	39.00	808.58	3.176	2.950	7-M2c	1.669	1.587	1.587	0.946	7.293	3.543
41.84	39.67	808.64	3.245	2.982	7-M2c	1.705	1.600	1.600	0.973	7.363	3.601
43.84	40.22	808.70	3.302	3.010	7-M2c	1.740	1.610	1.610	0.999	7.421	3.656
45.83	40.73	808.76	3.356	3.038	7-M2c	1.780	1.619	1.619	1.025	7.474	3.710
47.83	41.19	808.80	3.404	3.064	7-M2c	2.000	1.627	1.627	1.051	7.523	3.762

****

Straight Culvert

Inlet Elevation (invert): 805.40 ft, Outlet Elevation (invert): 804.76 ft

Culvert Length: 104.56 ft, Culvert Slope: 0.0061

****

Table 2 - Summary of Culvert Flows at Crossing: Culvert C6

Headwater Elevation (ft)	Total Discharge (cfs)	C6 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
807.61	27.86	27.86	0.00	1
807.76	29.86	29.86	0.00	1
807.92	31.85	31.85	0.00	1
808.09	33.85	33.85	0.00	1
808.27	35.85	35.85	0.00	1
808.46	37.84	37.84	0.00	1
808.58	39.84	39.00	0.80	8
808.64	41.84	39.67	2.13	6
808.70	43.84	40.22	3.56	5
808.76	45.83	40.73	5.07	5
808.80	47.83	41.19	6.62	5
808.50	38.24	38.24	0.00	Overtopping

HY-8 Culvert Analysis Report _ Culvert C7

Site Data - C7

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 796.64 ft

Outlet Station: 60.20 ft

Outlet Elevation: 796.34 ft

Number of Barrels: 2

Culvert Data Summary - C7

Barrel Shape: Circular

Barrel Diameter: 3.50 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Tailwater Channel Data - Culvert C7

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 10.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0300

Channel Invert Elevation: 795.60 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 52.15 cfs

Design Flow: 52.15 cfs

Maximum Flow: 103.37 cfs

Table 1 - Culvert Summary Table: C7

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
52.15	52.15	799.12	2.228	2.484	2-M2c	2.109	1.572	1.572	0.943	6.224	4.017
57.27	57.27	799.26	2.356	2.622	2-M2c	2.247	1.651	1.651	0.992	6.414	4.133
62.39	62.39	799.40	2.481	2.756	2-M2c	2.389	1.727	1.727	1.039	6.596	4.241
67.52	67.52	799.53	2.604	2.889	2-M2c	2.539	1.800	1.800	1.084	6.773	4.342
72.64	72.64	799.66	2.725	3.019	2-M2c	2.703	1.870	1.870	1.128	6.945	4.438
77.76	77.76	799.79	2.846	3.148	2-M2c	2.898	1.938	1.938	1.170	7.112	4.528
82.88	82.88	799.92	2.966	3.277	2-M2c	3.500	2.004	2.004	1.210	7.277	4.614
88.00	88.00	800.04	3.086	3.405	2-M2c	3.500	2.067	2.067	1.250	7.439	4.696
93.13	93.13	800.17	3.207	3.534	7-M2c	3.500	2.129	2.129	1.288	7.599	4.774
98.25	98.25	800.30	3.330	3.663	7-M2c	3.500	2.189	2.189	1.324	7.758	4.849
103.37	103.37	800.43	3.454	3.794	7-M2c	3.500	2.248	2.248	1.360	7.916	4.921

****

Straight Culvert

Inlet Elevation (invert): 796.64 ft, Outlet Elevation (invert): 796.34 ft

Culvert Length: 60.20 ft, Culvert Slope: 0.0050

****

Table 15 - Summary of Culvert Flows at Crossing: Culvert C7

Headwater Elevation (ft)	Total Discharge (cfs)	C7 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
799.12	52.15	52.15	0.00	1
799.26	57.27	57.27	0.00	1
799.40	62.39	62.39	0.00	1
799.53	67.52	67.52	0.00	1
799.66	72.64	72.64	0.00	1
799.79	77.76	77.76	0.00	1
799.92	82.88	82.88	0.00	1
800.04	88.00	88.00	0.00	1
800.17	93.13	93.13	0.00	1
800.30	98.25	98.25	0.00	1
800.43	103.37	103.37	0.00	1
802.50	162.85	162.85	0.00	Overtopping

HY-8 Culvert Analysis Report _ Culvert C8

Site Data - C8

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 807.54 ft

Outlet Station: 99.86 ft

Outlet Elevation: 806.81 ft

Number of Barrels: 1

Culvert Data Summary - C8

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: None

Tailwater Channel Data - Culvert C8

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 12.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0560

Channel Manning's n: 0.0450

Channel Invert Elevation: 807.44 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 8.32 cfs

Design Flow: 8.32 cfs

Maximum Flow: 19.2 cfs

Table 1 - Culvert Summary Table: C8

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
8.32	8.32	809.29	1.614	1.747	2-M2c	1.344	1.028	1.028	0.230	5.117	2.797
9.41	9.41	809.43	1.751	1.891	2-M2c	1.478	1.096	1.096	0.248	5.339	2.926
10.50	10.50	809.58	1.890	2.038	7-M2c	1.639	1.160	1.160	0.264	5.553	3.045
11.58	11.58	809.74	2.033	2.199	7-M2c	2.000	1.222	1.222	0.280	5.762	3.156
12.67	12.67	809.92	2.182	2.381	7-M2c	2.000	1.280	1.280	0.295	5.968	3.260
13.76	13.76	810.22	2.338	2.679	7-M2c	2.000	1.336	1.336	0.310	6.173	3.357
14.85	14.85	810.57	2.504	3.026	7-M2c	2.000	1.389	1.389	0.324	6.378	3.451
15.94	15.94	810.93	2.679	3.391	7-M2c	2.000	1.439	1.439	0.337	6.585	3.538
17.02	17.02	811.32	2.866	3.776	7-M2c	2.000	1.487	1.487	0.351	6.796	3.622
18.11	18.11	811.72	3.066	4.183	7-M2c	2.000	1.533	1.533	0.364	7.011	3.703
19.20	19.20	812.15	3.279	4.611	7-M2c	2.000	1.576	1.576	0.376	7.231	3.780

****

Straight Culvert

Inlet Elevation (invert): 807.54 ft, Outlet Elevation (invert): 806.81 ft

Culvert Length: 99.86 ft, Culvert Slope: 0.0073

****

Table 2 - Summary of Culvert Flows at Crossing: Culvert C8

Headwater Elevation (ft)	Total Discharge (cfs)	C8 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
809.29	8.32	8.32	0.00	1
809.43	9.41	9.41	0.00	1
809.58	10.50	10.50	0.00	1
809.74	11.58	11.58	0.00	1
809.92	12.67	12.67	0.00	1
810.22	13.76	13.76	0.00	1
810.57	14.85	14.85	0.00	1
810.93	15.94	15.94	0.00	1
811.32	17.02	17.02	0.00	1
811.72	18.11	18.11	0.00	1
812.15	19.20	19.20	0.00	1
812.40	19.87	19.87	0.00	Overtopping

Diversion Berm Sizing

Job No. 25220183.00	Job: Columbia POO Update	By: RJG	Date: 2/15/22
Client: WPL	Subject: Diversion Berm Spacing Calculation	Chk'd: MJT	Date: 4/1/22

Purpose:

Determine the spacing between diversion berms on the landfill final cover, with the goal of maintaining ≤ 3 ton/acre of soil loss along the final cover.

References

1. "Predicting Rainfall Erosion Losses," USDA Agriculture Handbook Number 537, 1978. (Figure 1 on Sheet 2 and Tables 10 and 13 on Sheet 4).
2. Erosion and Sediment Control Handbook," Goldman, Jackson, & Bursztynsky, 1986. (Table 5.5 on Sheet 5).
3. Rainfed retention probabilities computed for different cropping tillage systems. Agricultural Water Management, A.W. Mills & G.W. Thomas, 1985. Table 5.10 on Sheet 3)
4. Colombia Energy Center POO Update Drawings

Approach:

Use the Universal Soil Loss Equation (USLE) to determine diversion berm spacing. Longest flow length is 401 feet.

USLE Equation: $A = R * K * LS * C * P$

where:
- A = Average annual soil loss, tons/acre
- R = Rainfall and runoff erosivity index
- K = Soil erodibility factor, tons/acre
- LS = Slope length and steepness factor
- C = Cover management factor
- P = Practice factor

or $$LS = \frac{A}{R \times K \times C \times P}$$

Assumptions:

A =	3	tons/acre
R =	145	see Figure 1 on Sheet 2 (Reference #1)
K =	0.38	see Table 5.10 on Sheet 3 for Loamy Very Fine Sand (Reference #3)
C =	0.0064	see Table 10 on Sheet 4, assuming 90% cover (Reference #1)
P =	1.0	assume no support practice used

Calculation:

$$LS = \frac{A}{R \times K \times C \times P} = \frac{3}{145 \times 0.38 \times 0.0064 \times 1.0} = 8.51$$

From the LS Values Table (Sheet 5), based on the 4:1 final cover slope, the slope distance is between 200 and 250 feet.

Use linear interpolation between the LS values for 200 and 250 feet to determine the slope length value for the 4:1 slope.

Slope Length @	200	ft	LS=	8.33
Slope Length @	250	ft	LS=	9.31

Slope length for the calculate LS factor = 209 ft

Results:

The maximum distance between diversion berms along the final cover to maintain less than 3 tons/acre soil loss is 209 ft.

SCS ENGINEERS

		Sheet No.	2 of 5
		Calc. No.	
		Rev. No.	
Job No. 25220183.00	Job: Columbia POO Update	By: RJG	Date: 2/15/22
Client: WPL	Subject: Diversion Berm Spacing Calculation	Chk'd: MJT	Date: 4/1/22

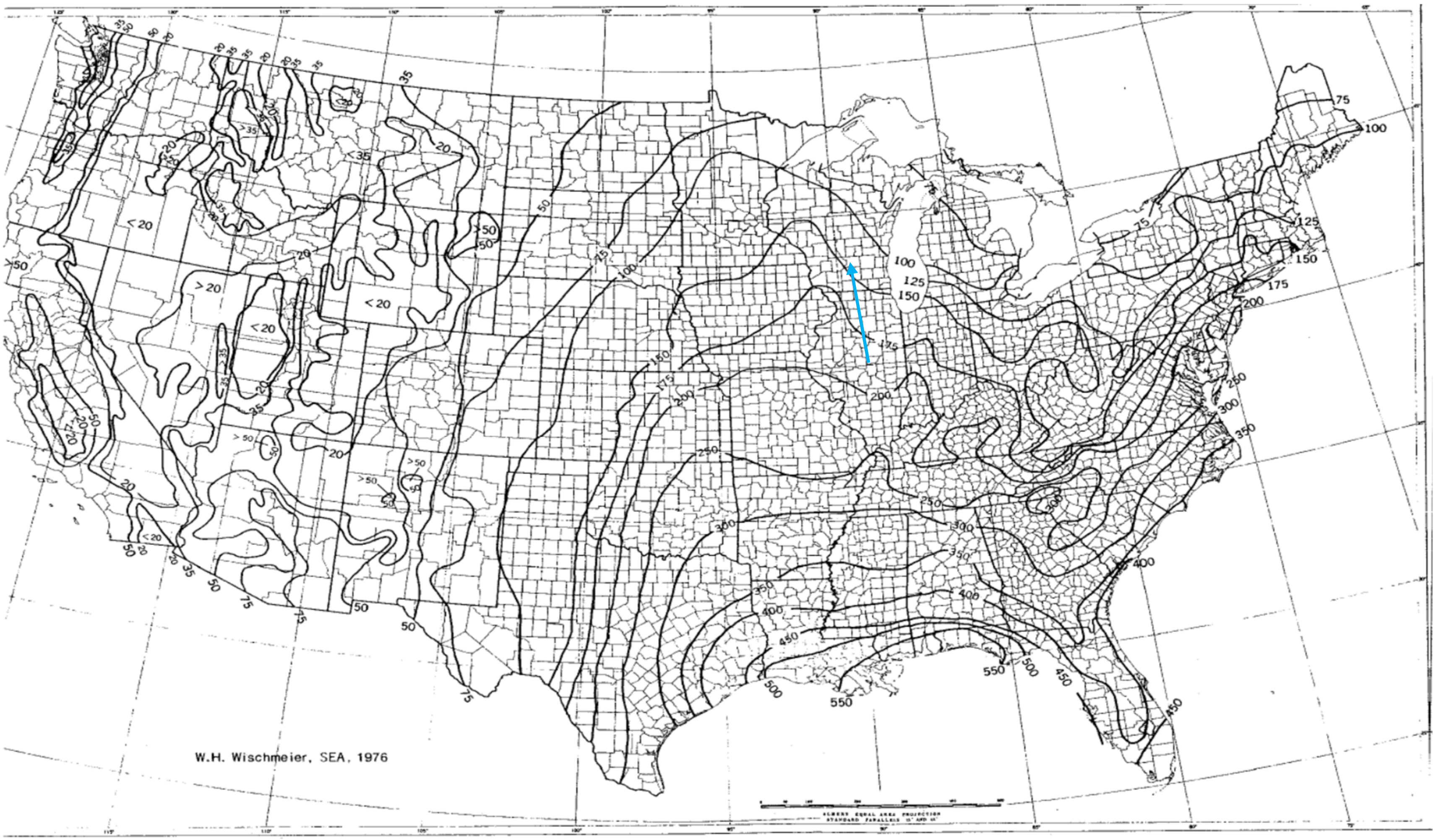


FIGURE 1.—Average annual values of the rainfall erosion index.

Source: "Predicting Rainfall Erosion Losses," USDA Agriculture Handbook Number 537, 1978.

Table 5.10. Soil Erodibility Factor K_{fact} (after Stewart et al. 1975)[a]

	P_{om}(%)		
Textural Class	<0.5	2	4
Sand	0.05	0.03	0.02
Fine sand	0.16	0.14	0.10
Very finesand	0.42	0.36	0.28
Loamy sand	0.12	0.10	0.08
Loamy finesand	0.24	0.20	0.16
Loamy veryfine sand	0.44	0.38	0.30
Sandy loam	0.27	0.24	0.19
Fine sandyloam	0.35	0.30	0.24
Very fine sandy loam	0.47	0.41	0.33
Loam	0.38	0.34	0.29
Silt loam	0.48	0.42	0.33
Silt	0.60	0.52	0.42
Sandy clayloam	0.27	0.25	0.21
Clay loam	0.28	0.25	0.21
Silty clayloam	0.37	0.32	0.26
Sandy clay	0.14	0.13	0.12
Silty clay	0.25	0.23	0.19
Clay		0.13-0.2	

(a) The values shown are estimated averages of broad ranges of specific soil values. When a texture is near the border line of two texture classes, use the average of the two K_{fact} values. In addition, the values shown are commensurate with the English units used in the cited reference (and as used in the source-term module input files). To obtain analagous values in the metric units used in this report, the above values should be multiplied by 1.292.

TABLE 10.—*Factor* **C** *for permanent pasture, range, and idle land*[1]

Vegetative canopy		Cover that contacts the soil surface						
			Percent ground cover					
Type and height[2]	Percent cover[3]	Type[4]	0	20	40	60	80	95+
No appreciable canopy		G	0.45	0.20	0.10	0.042	0.013	0.003
		W	.45	.24	.15	.091	.043	.011
Tall weeds or short brush with average drop fall height of 20 in	25	G	.36	.17	.09	.038	.013	.003
		W	.36	.20	.13	.083	.041	.011
	50	G	.26	.13	.07	.035	.012	.003
		W	.26	.16	.11	.076	.039	.011
	75	G	.17	.10	.06	.032	.011	.003
		W	.17	.12	.09	.068	.038	.011
Appreciable brush or bushes, with average drop fall height of 6½ ft	25	G	.40	.18	.09	.040	.013	.003
		W	.40	.22	.14	.087	.042	.011
	50	G	.34	.16	.08	.038	.012	.003
		W	.34	.19	.13	.082	.041	.011
	75	G	.28	.14	.08	.036	.012	.003
		W	.28	.17	.12	.078	.040	.011
Trees, but no appreciable low brush. Average drop fall height of 13 ft	25	G	.42	.19	.10	.041	.013	.003
		W	.42	.23	.14	.089	.042	.011
	50	G	.39	.18	.09	.040	.013	.003
		W	.39	.21	.14	.087	.042	.011
	75	G	.36	.17	.09	.039	.012	.003
		W	.36	.20	.13	.084	.041	.011

[1] The listed C values assume that the vegetation and mulch are randomly distributed over the entire area.

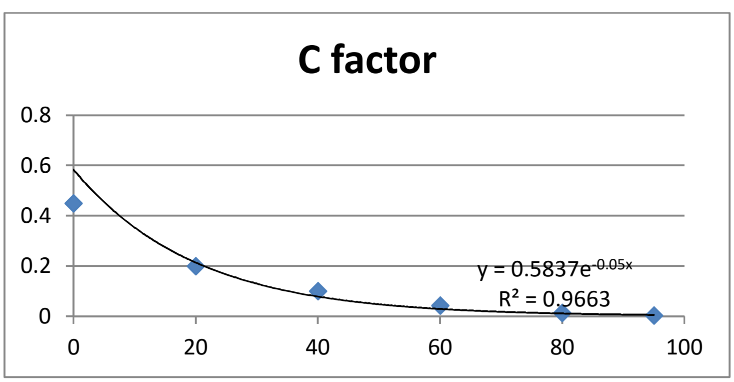
[2] Canopy height is measured as the average fall height of water drops falling from the canopy to the ground. Canopy effect is inversely proportional to drop fall height and is negligible if fall height exceeds 33 ft.

[3] Portion of total-area surface that would be hidden from view by canopy in a vertical projection (a bird's-eye view).

[4] G: cover at surface is grass, grasslike plants, decaying compacted duff, or litter at least 2 in deep.

W: cover at surface is mostly broadleaf herbaceous plants (as weeds with little lateral-root network near the surface) or undecayed residues or both.

Source: "Predicting Rainfall Erosion Losses," USDA Agriculture Handbook Number 537, 1978.



90 % cover

= 0.0065

Job No. 25220183.00 | Job: Columbia POO Update | By: RJG | Date: 2/15/22
Client: WPL | Subject: Diversion Berm Spacing Calculation | Chk'd: MJT | Date: 4/1/22

TABLE 5.5 LS Values* (10)

Slope ratio	Slope gradient s, %	LS values for following slope lengths l, ft (m)										LS values for following slope lengths l, ft (m)												
		10 (3.0)	20 (6.1)	30 (9.1)	40 (12.2)	50 (15.2)	60 (18.3)	70 (21.3)	80 (24.4)	90 (27.4)	100 (30.5)	150 (46)	200 (61)	250 (76)	300 (91)	350 (107)	400 (122)	450 (137)	500 (152)	600 (183)	700 (213)	800 (244)	900 (274)	1000 (305)
	0.5	0.06	0.07	0.07	0.08	0.08	0.09	0.09	0.09	0.09	0.10	0.10	0.11	0.11	0.12	0.12	0.13	0.13	0.13	0.14	0.14	0.14	0.15	0.15
100:1	1	0.08	0.09	0.10	0.10	0.11	0.11	0.12	0.12	0.12	0.12	0.14	0.14	0.15	0.16	0.16	0.16	0.17	0.17	0.18	0.18	0.19	0.19	0.20
	2	0.10	0.12	0.14	0.15	0.16	0.17	0.18	0.19	0.19	0.20	0.23	0.25	0.26	0.28	0.29	0.30	0.32	0.33	0.34	0.36	0.37	0.39	0.40
	3	0.14	0.18	0.20	0.22	0.23	0.25	0.26	0.27	0.28	0.29	0.32	0.35	0.38	0.40	0.42	0.43	0.45	0.46	0.49	0.51	0.54	0.55	0.57
	4	0.16	0.21	0.25	0.28	0.30	0.33	0.35	0.37	0.38	0.40	0.47	0.53	0.58	0.62	0.66	0.70	0.73	0.76	0.82	0.87	0.92	0.96	1.00
20:1	5	0.17	0.24	0.29	0.34	0.38	0.41	0.45	0.48	0.51	0.53	0.66	0.76	0.85	0.93	1.00	1.07	1.13	1.20	1.31	1.42	1.51	1.60	1.69
	6	0.21	0.30	0.37	0.43	0.48	0.52	0.56	0.60	0.64	0.67	0.82	0.95	1.06	1.16	1.26	1.34	1.43	1.50	1.65	1.78	1.90	2.02	2.13
	7	0.26	0.37	0.45	0.52	0.58	0.64	0.69	0.74	0.78	0.82	1.01	1.17	1.30	1.43	1.54	1.65	1.75	1.84	2.02	2.18	2.33	2.47	2.61
12½:1	8	0.31	0.44	0.54	0.63	0.70	0.77	0.83	0.89	0.94	0.99	1.21	1.40	1.57	1.72	1.85	1.98	2.10	2.22	2.43	2.62	2.80	2.97	3.13
	9	0.37	0.52	0.64	0.74	0.83	0.91	0.98	1.05	1.11	1.17	1.44	1.66	1.85	2.03	2.19	2.35	2.49	2.62	2.87	3.10	3.32	3.52	3.71
10:1	10	0.43	0.61	0.75	0.87	0.97	1.06	1.15	1.22	1.30	1.37	1.68	1.94	2.16	2.37	2.56	2.74	2.90	3.06	3.35	3.62	3.87	4.11	4.33
	11	0.50	0.71	0.86	1.00	1.12	1.22	1.32	1.41	1.50	1.58	1.93	2.23	2.50	2.74	2.95	3.16	3.35	3.53	3.87	4.18	4.47	4.74	4.99
8:1	12.5	0.61	0.86	1.05	1.22	1.36	1.49	1.61	1.72	1.82	1.92	2.35	2.72	3.04	3.33	3.59	3.84	4.08	4.30	4.71	5.08	5.43	5.76	6.08
	15	0.81	1.14	1.40	1.62	1.81	1.98	2.14	2.29	2.43	2.56	3.13	3.62	4.05	4.43	4.79	5.12	5.43	5.72	6.27	6.77	7.24	7.68	8.09
6:1	16.7	0.96	1.36	1.67	1.92	2.15	2.36	2.54	2.72	2.88	3.04	3.72	4.30	4.81	5.27	5.69	6.08	6.45	6.80	7.45	8.04	8.60	9.12	9.62
5:1	20	1.29	1.82	2.23	2.58	2.88	3.16	3.41	3.65	3.87	4.08	5.00	5.77	6.45	7.06	7.63	8.16	8.65	9.12	9.99	10.79	11.54	12.24	12.90
4½:1	22	1.51	2.13	2.61	3.02	3.37	3.69	3.99	4.27	4.53	4.77	5.84	6.75	7.54	8.26	8.92	9.54	10.12	10.67	11.68	12.62	13.49	14.31	15.08
→ 4:1	25	1.86	2.63	3.23	3.73	4.16	4.56	4.93	5.27	5.59	5.89	7.21	8.33	9.31	10.20	11.02	11.78	12.49	13.17	14.43	15.58	16.66	17.67	18.63
	30	2.51	3.56	4.36	5.03	5.62	6.16	6.65	7.11	7.54	7.95	9.74	11.25	12.57	13.77	14.88	15.91	16.87	17.78	19.48	21.04	22.49	23.86	25.15
3:1	33.3	2.98	4.22	5.17	5.96	6.67	7.30	7.89	8.43	8.95	9.43	11.55	13.34	14.91	16.33	17.64	18.86	20.00	21.09	23.10	24.95	26.67	28.29	29.82
	35	3.23	4.57	5.60	6.46	7.23	7.92	8.55	9.14	9.70	10.22	12.52	14.46	16.16	17.70	19.12	20.44	21.68	22.86	25.04	27.04	28.91	30.67	32.32
2½:1	40	4.00	5.66	6.93	8.00	8.95	9.80	10.59	11.32	12.00	12.65	15.50	17.89	20.01	21.91	23.67	25.30	26.84	28.29	30.99	33.48	35.79	37.96	40.01
	45	4.81	6.80	8.33	9.61	10.75	11.77	12.72	13.60	14.42	15.20	18.62	21.50	24.03	26.33	28.44	30.40	32.24	33.99	37.23	40.22	42.99	45.60	48.07
2:1	50	5.64	7.97	9.76	11.27	12.60	13.81	14.91	15.94	16.91	17.82	21.83	25.21	28.18	30.87	33.34	35.65	37.81	39.85	43.66	47.16	50.41	53.47	56.36
	55	6.48	9.16	11.22	12.96	14.48	15.87	17.14	18.32	19.43	20.48	25.09	28.97	32.39	35.48	38.32	40.97	43.45	45.80	50.18	54.20	57.94	61.45	64.78
1¾:1	57	6.82	9.64	11.80	13.63	15.24	16.69	18.03	19.28	20.45	21.55	26.40	30.48	34.08	37.33	40.32	43.10	45.72	48.19	52.79	57.02	60.96	64.66	68.15
	60	7.32	10.35	12.68	14.64	16.37	17.93	19.37	20.71	21.96	23.15	28.35	32.74	36.60	40.10	43.31	46.30	49.11	51.77	56.71	61.25	65.48	69.45	73.21
1½:1	66.7	8.44	11.93	14.61	16.88	18.87	20.67	22.32	23.87	25.31	26.68	32.68	37.74	42.19	46.22	49.92	53.37	56.60	59.66	65.36	70.60	75.47	80.05	84.38
	70	8.98	12.70	15.55	17.96	20.08	21.99	23.75	25.39	26.93	28.39	34.77	40.15	44.89	49.17	53.11	56.78	60.23	63.48	69.54	75.12	80.30	85.17	89.78
	75	9.78	13.83	16.94	19.56	21.87	23.95	25.87	27.66	29.34	30.92	37.87	43.73	48.89	53.56	57.85	61.85	65.60	69.15	75.75	81.82	87.46	92.77	97.79
1¼:1	80	10.55	14.93	18.28	21.11	23.60	25.85	27.93	29.85	31.66	33.38	40.88	47.20	52.77	57.81	62.44	66.75	70.80	74.63	81.76	88.31	94.41	100.13	105.55
	85	11.30	15.98	19.58	22.61	25.27	27.69	29.90	31.97	33.91	35.74	43.78	50.55	56.51	61.91	66.87	71.48	75.82	79.92	87.55	94.57	101.09	107.23	113.03
	90	12.02	17.00	20.82	24.04	26.88	29.44	31.80	34.00	36.06	38.01	46.55	53.76	60.10	65.84	71.11	76.02	80.63	84.99	93.11	100.57	107.51	114.03	120.20
	95	12.71	17.97	22.01	25.41	28.41	31.12	33.62	35.94	38.12	40.18	49.21	56.82	63.53	69.59	75.17	80.36	85.23	89.84	98.42	106.30	113.64	120.54	127.06
1:1	100	13.36	18.89	23.14	26.72	29.87	32.72	35.34	37.78	40.08	42.24	51.74	59.74	66.79	73.17	79.03	84.49	89.61	94.46	103.48	111.77	119.48	126.73	133.59

*Calculated from

$$LS = \left(\frac{65.41 \times s^2}{s^2 + 10{,}000} + \frac{4.56 \times s}{\sqrt{s^2 + 10{,}000}} + 0.065\right)\left(\frac{l}{72.5}\right)^m$$

LS = topographic factor
l = slope length, ft (m × 0.3048)
s = slope steepness,
m = exponent dependent upon slope steep
(0.2 for slopes < 1%, 0.3 for slopes 1
0.4 for slopes 3.5 to 4.5%, and
0.5 for slopes > 5%)

FROM "EROSION & SEDIMENT CONTROL HANDBOOK", Goldman, Jackson, + Burszytynsky, 1986

Source: Erosion and Sediment Control Handbook," Goldman, Jackson, & Bursztynsky, 1986.

SCS ENGINEERS

		Sheet No: 1/2	
		Calc. No.	
		Rev. No.	
Job No. 25220183.00	Project: Columbia Energy Center POO Update	By: RJG	Date: 2/23/22
Client: WPL	Subject: Diversion Berm Sizing	Chk'd: MJT	Date: 4/1/22

Purpose:

To size the post closure diversion berms on the final cover to accommodate the 25-year, 24-hour storm event.

References:

1. WisDOT Facilities Development Manual Chapter 13, Section 30-15 - Grass Lined Channels.
2. Design of Roadside Channels with Flexible Linings, HEC-15, USDOT FHWA.
3. HydroCAD Report_Post Construction

Approach:

Use the Post Closure HydroCAD Model results to obtain the peak flow during a 25-year, 24-hour storm event along the diversion berms.

Use Grass Lined Channel Design WisDOT Spreadsheet, FDM 13-30 Attachment 15.2 (from Reference #1) to size the swale for each design swale cross section. The WisDOT spreadsheet incorporates the design guidelines and equations described in "Design of Roadside Channels with Flexible Linings", HEC-15, USDOT FHWA (Reference #2).

Confirm the swale is stable and has enough capacity for the design flow rate.

Assumptions:

1. Assume the channel geometry is a v-notch swale with one sideslope at 4:1 and one sideslope at 2:1 and a depth of 2.0 ft.
2. Assume 2.0% slope along the flowpath of the diversion swale.
3. Assume the following parameters per Section 15.2 - Grass Lining Properties from Reference #1:
   Vegetation Retardance Class = C for Swales
   Vegetation Condition = Good
   Vegetation Growth Form = Turf
4. Assume cohesive soil type with ASTM Soil Class SC and a Plasticity Index (PI) of 16.

Calculations:

From the HydroCAD Report, the peak flow rate along the diversion berms are as follows:

Areas			Areas			Areas			Areas		
1	4.58	cfs	8	3.29	cfs	14	3.66	cfs	20	3.43	cfs
2	3.73	cfs	9	3.40	cfs	15	1.71	cfs	21	3.35	cfs
3	2.17	cfs	10	3.17	cfs	16	4.89	cfs	22	3.35	cfs
4	3.74	cfs	11	3.10	cfs	17	4.00	cfs	23	4.89	cfs
5	3.58	cfs	12	0.35	cfs	18	2.66	cfs	24	6.05	cfs
6	2.92	cfs	13	2.91	cfs	19	2.77	cfs	25	5.13	cfs

Use highest flow to confirm diversion berm functions.

Use the Grass Swale Design Spreadsheet (Page 2) to determine the flow depth, velocity and shear stress in the swales.

Results:

The diversion berms are adequately designed to accommodate the flows from the 25-year, 24-hour storm event.

The diversion berms are stable at the design flow rates. The design flow depth of 2.0 feet maintains at least 0.5 ft of freeboard during the 25-year, 24-hour storm event.

Channel/Ditch Geometry	*Area 24*
Channel Slope, S_o (ft/ft)	**0.02**
Channel Bottom Width, B (ft)	**0**
Channel Side Slope, z_1	**4**
Channel Side Slope, z_2	**2**
Flow Depth, d (ft) Solve iteratively	**1.00**
Safety Factor, SF	**1.0**
Vegetation/Soil Parameters	
Vegetation Retardance Class	**C**
Vegetation Condition	**good**
Vegetation Growth Form	**turf**
Soil Type	**cohesive**
D_{75} (in) (Set at 0.00 for cohesive soils)	
ASTM Soil Class	**SC**
Plasticity Index, PI	**16**
Results Summary	
Design Q (ft^3/s)	**6.1**
Calculated Q (ft^3/s)	6.1
Difference Between Design & Calc. Flow (%)	0.5%
Stable (Yes or No)	**YES**
Channel Parameters	
Vegetation Height, h (ft)	0.67
Grass Roughness Coefficient, C_n	0.238
Cover Factor, C_f	0.90
Noncohesive Soil	
Soil Grain Roughness, n_s	0.016
Permissible Soil Shear Stress, τ_p (lb/ft^2)	N/A
Cohesive Soil	
Porosity, e	0.35
Soil Coefficient 1, c_1	1.0700
Soil Coefficient 2, c_2	14.30
Soil Coefficient 3, c_3	47.700
Soil Coefficient 4, c_4	1.42
Soil Coefficient 5, c_5	-0.61
Soil Coefficient 6, c_6	0.00010
Permissible Soil Shear Stress, τ_p (lb/ft^2)	0.080
Total Permissible Shear Stress, τ_p (lb/ft^2)	0.080
Cross Sectional Area, A (ft^2)	3.000
Wetted Perimeter, P (ft)	6.36
Hydraulic Radius, R (ft)	0.472
Top Width, T (ft)	6.00
Hydraulic Depth, D (ft)	0.500
Froude Number (Q design)	0.505
Channel Shear Stress, τ_o (lb/ft^2)	0.59
Actual Sheer Stress, τ_d (lb/ft^2)	1.25
Mannings n	0.063
Average Velocity, V (ft/s)	2.02
Calculated Flow, Q (ft^3/s)	6.1
Difference Between Design & Calc. Flow (%)	0.5%
Effective Shear on Soil Surface, τ_e (lb/ft^2)	0.008
Total Permissible Shear on Veg., $\tau_{p,veg}$ (lb/ft^2)	12.42
Stable (Y or N)	YES

Source: Grass Lined Channel Design WisDOT Spreadsheet, FDM 13-30 Attachment 15.2

Downslope Flume & Energy Dissipater Sizing

SCS ENGINEERS

		Sheet No: 1/3	
		Calc. No.	
		Rev. No.	
Job No. 25220183.00	Job: Columbia Energy Center POO Landfill Closure	By: RJG	Date: 2/23/22
Client: WPL	Subject: Downslope Pipe and Inlet Sizing	Chk'd: MJT	Date: 04/04/22

Purpose:

To size the downslope pipe and inlet to accommodate the 25-year, 24-hour storm event.

References:

1. HydroCAD Report_POO Landfill Closure

Approach:

Use the orifice equation to size the downslope pipe inlet. Size the inlet for the largest diversion berm flow rate and apply that inlet size to all downslope pipe inlets. Confirm the head (h) acting on the orifice will not overtop the diversion berm depth of 2.0 ft.

Use Manning's equation to size the downslope pipe based on the largest diversion berm flow rate.
Confirm the pipe has capacity for the design flow under open channel flow conditions.

Assumptions:

1. Orifice coefficient = 0.63
2. Assume the orifice head (h) acts on the centerline of the inlet pipe.
3. Manning's n = 0.012 (For smooth walled HDPE pipe: http://www.engineeringtoolbox.com/mannings-roughness-d_799.html)
4. Size flumes under the vegetated cover condition.

Calculations:

Size the downslope pipe inlet:

From the HydroCAD report (Reference #1), the maximum 25-year, 24-hour flow along a diversion berm is 6.1 cfs

in HydroCAD model). Flume 3 Area 24

Orifice Equation: $Q = C * A * (2 * g * h)^{0.5}$

where: Q = flow rate (cfs) = 6.1 (From above)

C = orifice coefficient = 0.63 (See assumption #1)

A = orifice area (sf) = 1.77 (area of 18" diameter pipe) Actual Pipe Diameter = 18 inches

g = gravity (ft/sec^2)= 32.2

h = orifice head acting on centerline (ft)

$h = (Q/(C * A))^2/(2 * g)$ = 0.5 ft

Given Assumption #2, depth of flow along diversion berm = h + D/2/12 = 1.21 ft

Results:

Based on the inlet sizing calculation, an 18" diameter inlet will convey the stormwater runoff from the largest flow rate to a flume.

Based on the Manning's calculation for flow within the pipe, the 12" diameter downslope pipe will accommodate the design flow under open channel flow conditions. Although the flow for the downslope pipes can be handled by 12" dia. pipes, for ease of construction, all downslope pipes will be 18" dia.

Calculations (Continued):

The diversion swale depth of 2 ft is sufficient to prevent overtopping at the downslope pipe inlet locations.
The depth of the diversion berm increases at the entrance of the down slope pipes due to mounding of the soil over the pipe.

Size the downslope flume pipe:

Use Manning's equation to size the downslope pipe.

Manning's Equation: Q = (1.49/n) x A x R^(2/3) x S^(1/2)

where: Q = Flow Rate, cfs
n = Manning's Roughness Coefficient
A = Flow Area, sf
R = Hydraulic Radius, ft (= A/P)
S = Channel Slope, ft/ft

From the HydroCAD Report (Reference 1) , the peak discharge to each downslope flume resulting from a 25-year, 24-hour storm is as follows:

Flume 1	3.58 cfs	**Flume 2**	4.89 cfs	**Flume 3**	6.05 cfs	**Flume 4**	3.66 cfs	**Flume 5**	4.89 cfs
Area 5	3.58	Area 3	2.17	Area 1	4.58	Area 12	0.35	Area 10	3.17
Area 6	2.92	Area 4	3.74	Area 2	3.73	Area 13	2.91	Area 11	3.10
Area 20	3.43	Area 22	3.35	Area 24	6.05	Area 14	3.66	Area 16	4.89
Area 21	3.35	Area 23	4.89	Area 25	5.13	Area 15	1.71	Area 17	4.00
Total =	13.28		14.15		19.49		8.63		15.16

Flume 6	3.40 cfs
Area 8	3.29
Area 9	3.40
Area 18	2.66
Area 19	2.77
Total =	12.12

For flow rates < 20 cfs, assume a 12" diameter downslope flume:

Use 19.49 cfs to Flume 3 to check sizing (max flow to a flume that is < 20 cfs)

Design Criteria

Pipe Diameter (in) = D = 12

Pipe Slope (ft/ft) = S = 0.25

Manning's Roughness Coefficient = n = 0.012

See Downslope Flume 3 pipe flow calculator on Sheet 3

SCS ENGINEERS

Sheet No:	3/3
Calc. No.	
Rev. No.	

Job No. 25220183.00	Job: Columbia Energy Center POO Landfill Closure	By: RJG	Date: 2/23/22
Client: WPL	Subject: Downslope Pipe and Inlet Sizing	Chk'd: MJT	Date: 04/04/22

Calculations (Continued):

Manning Formula Uniform Pipe Flow at Given Slope and Depth

Inputs:

Pipe Diameter, d_o	12.00	in
Manning Roughness, n	0.0120	
Pressure slope (possibly equal to pipe slope), S_0	0.2500	slope
Percent of (or ratio to) full depth (100% or 1 if flowing full)	0.8290	fraction

Results:

Flow, Q	19.4905	ft^3/s
Velocity, v	27.9991	ft/s
Velocity head, hv	12.1838	ft
Flow Area, A	0.6961	ft^2
Wetted Perimeter, P	2.2890	ft
Hydraulic Radius	0.3041	ft
Top Width, T	0.7530	ft
Froude Number, F	5.21	
Shear Stress (tractive force), τ	12.9373	psf

Version 2.0 (20 June 2017)

HawsEDC Calculators

SCS ENGINEERS

		Sheet No:	4/4
		Calc. No.	
		Rev. No.	
Job No. 25220183.00	Job: Columbia Energy Center POO Landfill Closure	By: RJG	Date: 2/23/22
Client: WPL	Subject: Downslope Pipe and Inlet Sizing	Chk'd: MJT	Date: 04/04/22

Calculations (Continued):

Manning Formula Uniform Pipe Flow at Given Slope and Depth

Inputs:

Pipe Diameter, d_o	18.00	in
Manning Roughness, n	0.0120	
Pressure slope (possibly equal to pipe slope), S_o	0.2500	slope
Percent of (or ratio to) full depth (100% or 1 if flowing full)	0.4037	fraction

Results:

Flow, Q	19.4983	ft^3/s
Velocity, v	29.1783	ft/s
Velocity head, hv	13.2317	ft
Flow Area, A	0.6682	ft^2
Wetted Perimeter, P	2.0655	ft
Hydraulic Radius	0.3235	ft
Top Width, T	1.4719	ft
Froude Number, F	7.75	
Shear Stress (tractive force), τ	9.4502	psf

Version 2.0 (20 June 2017)

HawsEDC Calculators

SCS ENGINEERS

Sheet No. 1 of 7	
Calc. No.	
Rev. No.	

Job No. 25220183.00	Job: Columbia Energy Center POO Landfill Closure	By: RJG	Date: 2/23/22
Client: WPL	Subject: Energy Dissipator Sizing	Chk'd: MJT	Date: 4/1/22

Purpose:

To size an energy dissipator structure and riprap apron at the outlet of the downslope flume pipes.

References:

1. "Hydraulic Design of Energy Dissipators for Culverts and Channels," HEC-14, Third Edition, July 2006, USDOT FHWA.
2. Downslope Pipe and Inlet Sizing calculation (for pipe size, flow rate, and pipe velocity).
3. HydroCAD Model_POO Landfill Closure
4. Facilities Development Manual Chapter 13, Section 13-30 - Rock Riprap Lined Chutes.

Approach:

Use the downslope pipe outlet velocity to size an energy dissipator structure (USBR Type VI Impact Basin) following the design approach outlined in Section 9.4 of Reference #1.

Use Rock Chute Data Spreadsheet, FDM 13-30-30 Attachment 30.1 (from Reference #5) to design the rock chute.

For construction purposes use the maximum flow to size all dissipators and riprap apron.

Assumptions:

1. Riprap specific gravity = 2.65
2. From the HydroCAD Report, the 25-year, 24-hour peak discharge to each downslope flume is as follows:

Flume 1 3.58 cfs		**Flume 2** 4.89 cfs		**Flume 3** 6.05 cfs		**Flume 4** 3.66 cfs		**Flume 5** 4.89 cfs	
Area 5	3.58	Area 3	2.17	Area 1	4.58	Area 12	0.35	Area 10	3.17
Area 6	2.92	Area 4	3.74	Area 2	3.73	Area 13	2.91	Area 11	3.10
Area 20	3.43	Area 22	3.35	Area 24	6.05	Area 14	3.66	Area 16	4.89
Area 21	3.35	Area 23	4.89	Area 25	5.13	Area 15	1.71	Area 17	4.00
Total =	13.28		14.15		19.49		8.63		15.16

Flume 6 3.40 cfs	
Area 8	3.29
Area 9	3.40
Area 18	2.66
Area 19	2.77
Total =	12.12

Using Figure 9.14 (See Sheet 4), enter the Froude Number and the Energy from Step 2 to determine the from the downslope flume pipe and inlet sizing calculation.

Results:

The energy dissipator structures for the 18" dia. downslope flume pipes will consist of dissipator structures with widths (W_B) of 6 feet, with the remaining dimensions from Table 9.2 on Sheets 5 and 6.

Riprap at the Flume 3, 4, 5 and 6 energy dissipator outlets will consist of WisDOT Light Riprap (D50= 5.5 inches) (See Page 3). The riprap apron footprint will be based on the energy dissipator width and the outlet swale geometry.

Riprap at Flume 1 and 2 energy dissipator outlets will consist of WisDOT Light Riprap (D50= 5.8 and 3.6 inches). The riprap apron footprint will be 6 feet wide (based on rock chute calcs for RC1 and RC2) and extend down to the existing swale (Swale S4).

Calculations:

For 18" dia. downslope flume pipes

From Reference #2:

Flow rate (Q) = 19.5 cfs

Pipe velocity (V) = 8.9 ft/s

Flow area (A) = Q/V = 2.19 sf

Design procedure from pg. 9-40 of Reference #1:

Step 1: Compute the Equivalent Depth of Flow Entering Dissipator:

$Y_e = (A/2)^{1/2}$ where: Ye = Equivalent depth

A = Area (from above)

Y_e = 1.05 ft

Step 2: Compute the Froude Number and the energy at the end of the pipe:

$Fr = V/[(g*Y_e)^{1/2}]$ where: Fr = Froude Number

V = Velocity (from above)

g = Gravity constant (32.2 ft/sec^2)

Fr = 1.5 Y_e = Equivalent depth (from Step 1 above)

$H_o = Y_e+V^2/2g$ where: H_o = Energy at the end of the pipe

Y_e = Equivalent depth (from above)

V = Velocity (from above)

Ho = 2.3 ft g = Gravity constant (32.2 ft/sec^2)

Step 3: Determine H_o/W_B and calculate the required width of the energy dissipator:

Using Figure 9.14 (See Sheet 4), enter the Froude Number and the Energy from Step 2 to determine the width of the energy dissipator.

From Figure 9.14, H_o/W_B = 0.40

$W_B = H_o/(H_o/W_B)$ W_B = 5.7 ft.

Use W_B = 6.0 ft.

Step 4: Obtain the remaining energy dissipator dimensions from Table 9.2 from Reference #1 (see Sheets 5 and 6)

Step 5: Size the riprap at the structure outlet

From Reference #5, use Rock Chute Design spreadsheet (see Sheet 3)

Rock Chute Design Data

(Version WI-April-2005, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)
Revised for WisDOT 9/2010

Project: COL - POO Landfill Closure **County:** Columbia
Designer: RJG **Checked by:** MJT
Date: February 23, 2022 **Date:** 04/05/22

Input Geometry:

Upstream Channel		Chute			Downstream Channel	
Bottom Width =	6.0 ft.	Bottom Width =	6.0 ft.		Bottom Width =	6.0 ft.
Side slopes =	1.0 (m:1)	Factor of safety =	1.20 (SF)	1.2 Min	Side slopes =	2.0 (m:1)
Mannings n value =	0.012	Side slopes =	2.0 (z:1)	2.0:1 max.	Mannings n value =	0.030
Bed slope =	0.0001 ft./ft.	Bed slope =	0.2500 ft./ft	3.0:1 max.	Bed slope =	0.0050 ft./ft.
		Freeboard =	1.0 ft.			
		Outlet apron depth, d =	1.0 ft.		Base flow =	0.0 cfs

Note: Use procedures 13-30-15 or 13-30-25 for upstream and downstream Mannings n

Flow and Elevation Data:

Apron elev. --- Inlet = 818.0 ft. ------- Outlet 816.0 ft. --- (H_{drop} = 1 ft.)

Degree of angularity = 1
1 --> 50% angular, 50% rounded
2 --> 100 % rounded

Q_{high} = Runoff from design storm
Q_5 = Runoff from a 5-year,24-hour storm

Q_{high} = 19.5 cfs — High flow storm through chute —> Tw (ft.) = Program
Q_{low} = 19.5 cfs — Low flow storm through chute —> Tw (ft.) = Program

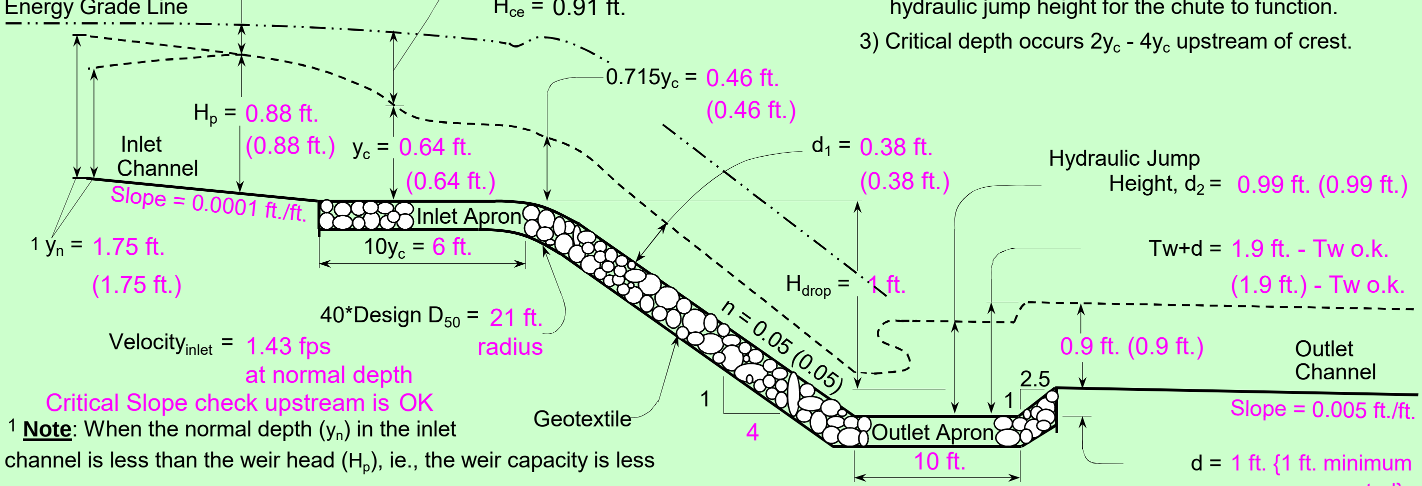
Note: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.

Input tailwater (Tw): 0.25 1.20

Profile and Cross Section (Output):

Starting Station = 3+00.0

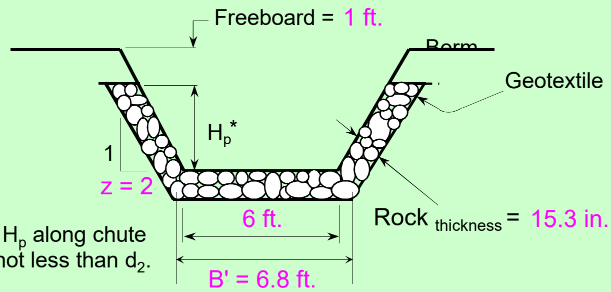
Notes:
1) Output given as **High Flow (Low Flow)** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs $2y_c$ - $4y_c$ upstream of crest.



[1] **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., the weir capacity is less than the channel capacity, restricted flow or ponding will occur. This reduces velocity and prevents erosion upstream of the inlet apron.

Profile Along Centerline of Chute

Typical Cross Section



* Use H_p along chute but not less than d_2.

	2.9 cfs/ft.	Equivalent unit discharge
SF =	1.20	Factor of safety (multiplier)
d_1 =	0.38 ft.	Normal depth in chute
n-value =	0.05	Manning's roughness coefficient
D_{50}(SF) =	7.6 in.	Minimum Design D_{50}*
2(D_{50})(SF) =	15.3 in.	Rock chute thickness
Tw + d =	1.9 ft.	Tailwater above outlet apron
d_2 =	0.99 ft.	Hydraulic jump height
*** The outlet	will	function adequately

High Flow Storm Information

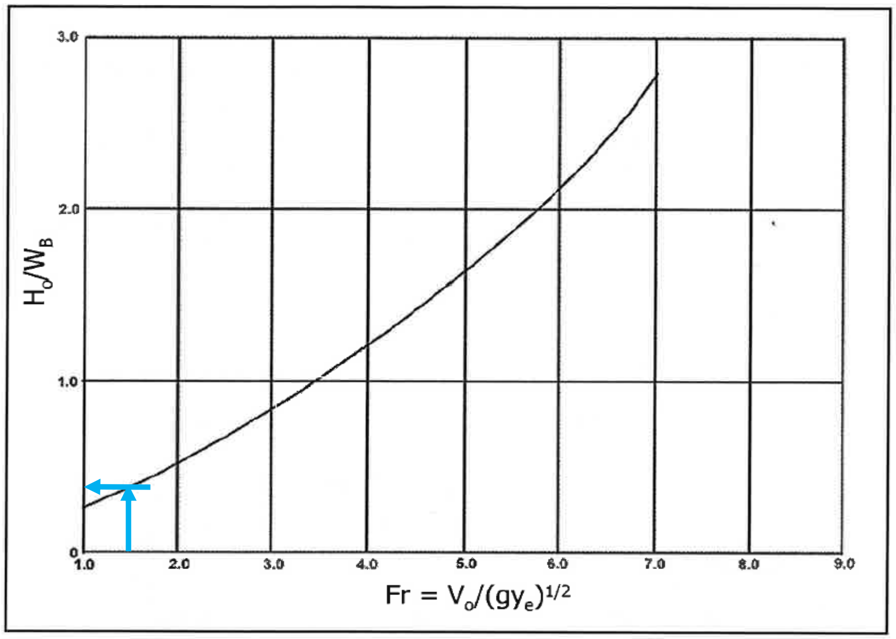


Figure 9.14. Design Curve for USBR Type VI Impact Basin

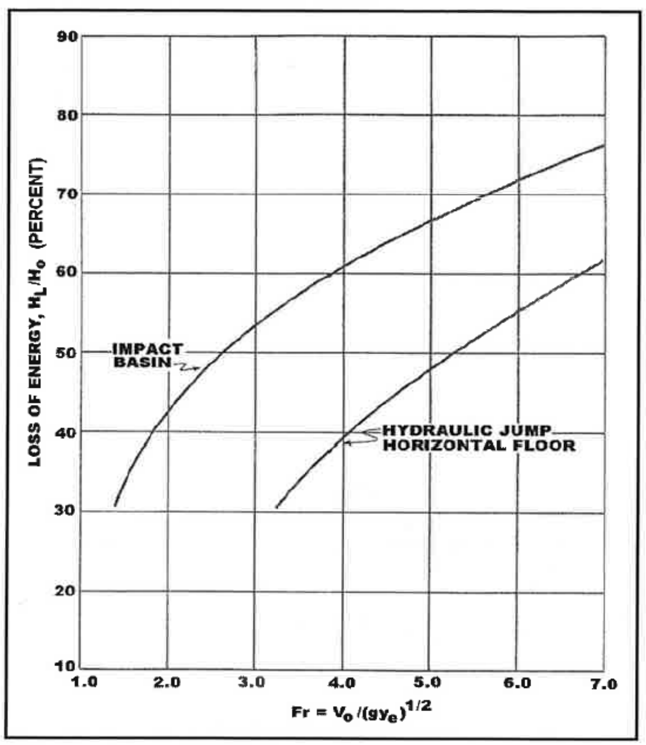


Figure 9.15. Energy Loss of USBR Type VI Impact Basin versus Hydraulic Jump

Table 9.2 (CU). USBR Type VI Impact Basin Dimensions (ft) (AASHTO, 2005)

W_B	h_1	h_2	h_3	h_4	L	L_1	L_2
4.	3.08	1.50	0.67	1.67	5.42	2.33	3.08
5.	3.83	1.92	0.83	2.08	6.67	2.92	3.83
6.	4.58	2.25	1.00	2.50	8.00	3.42	4.58
7.	5.42	2.58	1.17	2.92	9.42	4.00	5.42
8.	6.17	3.00	1.33	3.33	10.67	4.58	6.17
9.	6.92	3.42	1.50	3.75	12.00	5.17	6.92
10.	7.58	3.75	1.67	4.17	13.42	5.75	7.67
11.	8.42	4.17	1.83	4.58	14.58	6.33	8.42
12.	9.17	4.50	2.00	5.00	16.00	6.83	9.17
13.	10.17	4.92	2.17	5.42	17.33	7.42	10.00
14.	10.75	5.25	2.33	5.83	18.67	8.00	10.75
15.	11.50	5.58	2.50	6.25	20.00	8.50	11.50
16.	12.25	6.00	2.67	6.67	21.33	9.08	12.25
17.	13.00	6.33	2.83	7.08	21.50	9.67	13.00
18.	13.75	6.67	3.00	7.50	23.92	10.25	13.75
19.	14.58	7.08	3.17	7.92	25.33	10.83	14.58
20.	15.33	7.50	3.33	8.33	26.58	11.42	15.33

W_B	W_1	W_2	t_1	t_2	t_3	t_4	t_5
4.	0.33	1.08	0.50	0.50	0.50	0.50	0.25
5.	0.42	1.42	0.50	0.50	0.50	0.50	0.25
6.	0.50	1.67	0.50	0.50	0.50	0.50	0.25
7.	0.50	1.92	0.50	0.50	0.50	0.50	0.25
8.	0.58	2.17	0.50	0.58	0.58	0.50	0.25
9.	0.67	2.50	0.58	0.58	0.67	0.58	0.25
10.	0.75	2.75	0.67	0.67	0.75	0.67	0.25
11.	0.83	3.00	0.67	0.75	0.75	0.67	0.33
12.	0.92	3.00	0.67	0.83	0.83	0.75	0.33
13.	1.00	3.00	0.67	0.92	0.83	0.83	0.33
14.	1.08	3.00	0.67	1.00	0.92	0.92	0.42
15.	1.17	3.00	0.67	1.00	1.00	1.00	0.42
16.	1.25	3.00	0.75	1.00	1.00	1.00	0.50
17.	1.33	3.00	0.75	1.08	1.00	1.00	0.50
18.	1.33	3.00	0.75	1.08	1.08	1.08	0.58
19.	1.42	3.00	0.83	1.17	1.08	1.08	0.58
20.	1.50	3.00	0.83	1.17	1.17	1.17	0.67

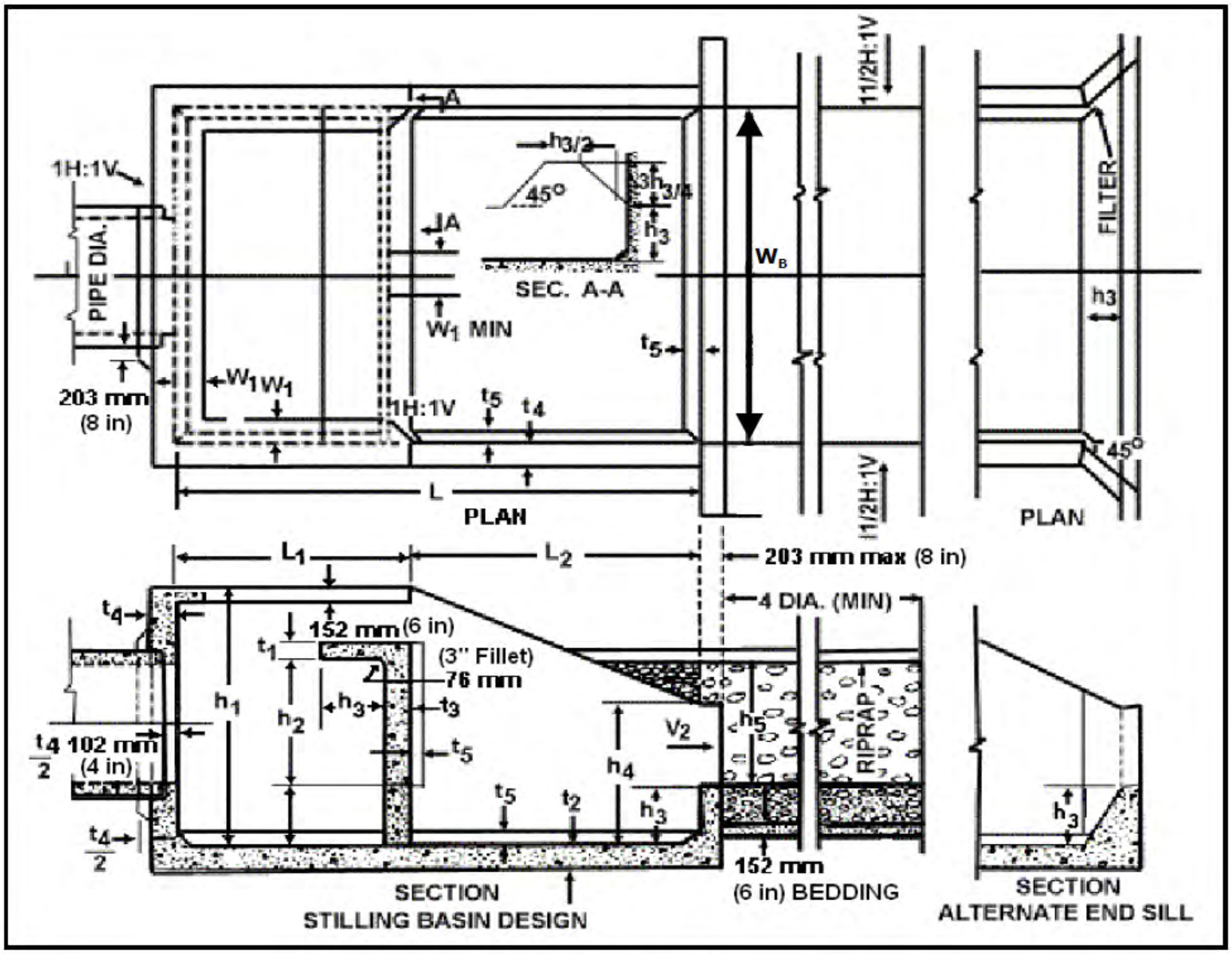


Figure 9.13. USBR Type VI Impact Basin

Calculations (Continued):

Downslope Flume 3 - Velocity Calculator (Q = 19.49 cfs)

Manning Formula Uniform Pipe Flow at Given Slope and Depth

Inputs:

Pipe Diameter, d_o	18	in
Manning Roughness, n	0.0120	
Pressure slope	0.2500	slope
Percent of (or ratio to) full depth (100% or 1 if flowing full)	0.4037	fraction

Results:

Flow, Q	19.4983	ft^3/s
Velocity, v	8.8936	m/s
Velocity head, hv	4.0330	m
Flow Area, A	0.0621	m^2
Wetted Perimeter, P	0.6296	m
Hydraulic Radius	0.0986	m
Top Width, T	0.4486	m
Froude Number, F	7.75	
Shear Stress (tractive force), τ	452.4774	N/m^2

Version 2.0 (20 June 2017)

HawsEDC Calculators

Rock Chute

		Sheet No:	1 of 4
		Calc. No.	
		Rev. No.	
Job No. 25220183.00	Job: COL - POO	By: RJG	Date: 4/11/22
Client: WPL	Subject: Rock Chute Sizing & Riprap Size	Chk'd: MJT	Date: 4/13/22

Purpose:

To size the rock chutes to accommodate the 25-year, 24-hour storm event.

References:

1. Rock Chute Design Data spreadsheet Version WI-April-2005, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998.
2. HydroCAD Report_Post Construction
3. Figure 1 - Storm Water Post Construction
4. Stable 25.1 Typical Particle Sizes of Native Sands at 75 Percent Passing (D75) from WisDOT Facilities. Development Manual (FDM).

Approach:

1. Enter Inlet Channel data based on culvert apron or swale geometry Reference #2 and #3.
2. Enter Chute data based on slope from Reference #3, start the width, Bw equal to inlet channel Bw.
3. Enter Outlet Channel data based on Reference #3, start the width, Bw equal to inlet channel Bw.
4. Enter drainage area, apron elevations, flow (Q), and rainfall.
5. Adjust Bw for Chute and Outlet Channel until spreadsheet shows the rock chute "will" function adequately.
6. Determine rip rap classification based on D50 weight per Reference #4.

Assumptions:

1. Assume side slopes of chute and outlet channel are 2:1.
2. Assume Factor of Safey is 1.2.
3. n-value is based on proposed conditions at the channel.
4. Assume Outlet apron depth, d is 1.0 ft.
5. Freeboard is 1.0 ft.
6. Use 25-year, 24-hour storm event flow (Reference #2) for Q_{high} and Q_{low}.
7. Classification of riprap is based on weight (Reference #4).

Calculations:

See attached spreadsheet calcs for each rock chute.

Results:

The rock chutes are adequately designed to accommodate the flows from the 25-year, 24-hour storm event.

Rock Chute	Width (ft)	Thickness (in)	Apron Width (ft)	Apron Length (ft)	D_{50} (in)	WisDOT Rip Rap Classification
RC1	6	12	6	7	5.8	Light Riprap Type R
RC2	6	8	6	5	3.6	Light Riprap Type R

Rock Chute Design Data

(Version WI-April-2005, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)
Revised for WisDOT 9/2010

Project: COL - POO Landfill Closure RC1 **County:** Columbia
Designer: RJG **Checked by:** MJT
Date: April 11, 2022 **Date:** 04/13/22

Input Geometry:

Upstream Channel		Chute			Downstream Channel	
Bottom Width =	6.0 ft.	Bottom Width =	6.0 ft.		Bottom Width =	6.0 ft.
Side slopes =	1.0 (m:1)	Factor of safety =	1.20 (SF)	1.2 Min	Side slopes =	2.0 (m:1)
Mannings n value =	0.012	Side slopes =	2.0 (z:1)	2.0:1 max.	Mannings n value =	0.030
Bed slope =	0.0001 ft./ft.	Bed slope =	0.1967 ft./ft	3.0:1 max.	Bed slope =	0.0050 ft./ft.
		Freeboard =	1.0 ft.			
		Outlet apron depth, d =	1.0 ft.		Base flow =	0.0 cfs

Note: Use procedures 13-30-15 or 13-30-25 for upstream and downstream Mannings n

Flow and Elevation Data:

Apron elev. --- Inlet = 822.8 ft. ------- Outlet 802.4 ft. --- (H_{drop} = 19.4 ft.)

Degree of angularity = 1

1 --> 50% angular, 50% rounded

2 --> 100 % rounded

Q_{high} = Runoff from design storm

Q_5 = Runoff from a 5-year,24-hour storm

Q_{high} = 13.2 cfs High flow storm through chute → Tw (ft.) = Program

Q_{low} = 13.2 cfs Low flow storm through chute → Tw (ft.) = Program

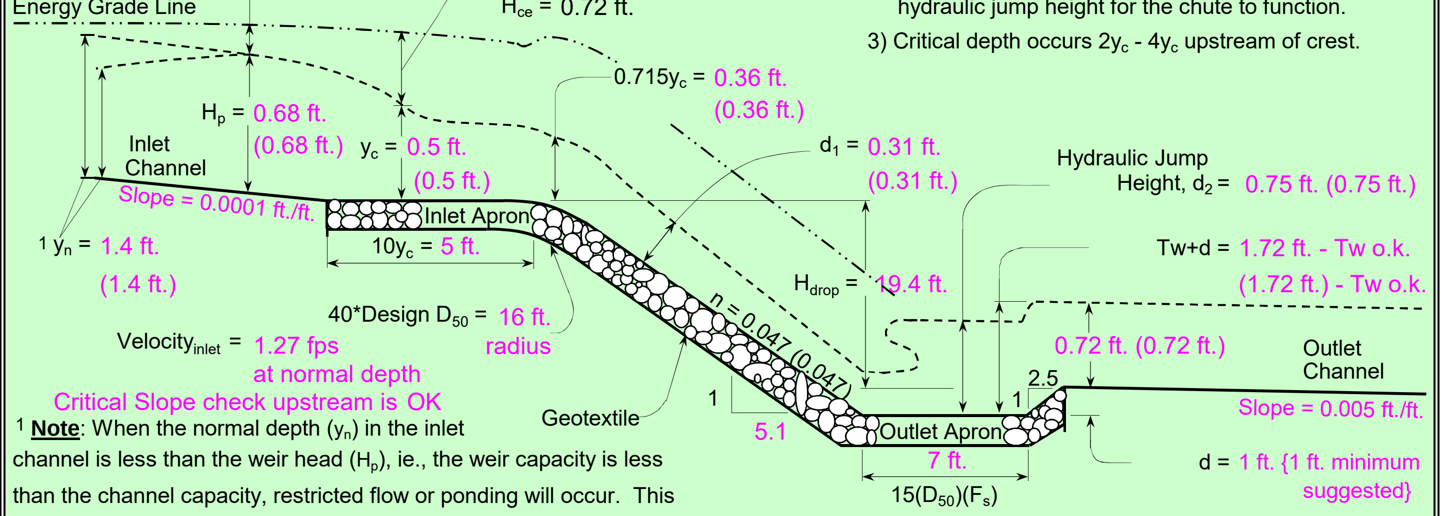
Note: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.

Input tailwater (Tw): 0.20 1.20

Profile and Cross Section (Output):

Starting Station = 3+00.0

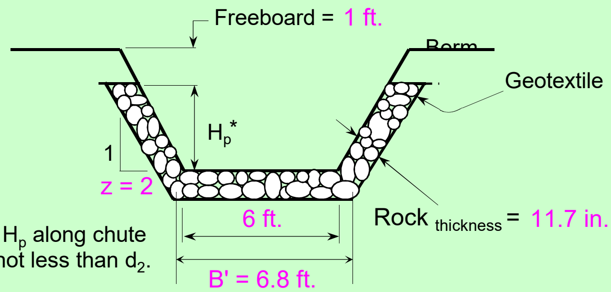
Notes:
1) Output given as **High Flow (Low Flow)** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs $2y_c$ - $4y_c$ upstream of crest.



[1] **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., the weir capacity is less than the channel capacity, restricted flow or ponding will occur. This reduces velocity and prevents erosion upstream of the inlet apron.

Profile Along Centerline of Chute

Typical Cross Section



* Use H_p along chute but not less than d_2.

	2.01 cfs/ft.	Equivalent unit discharge
SF =	1.20	Factor of safety (multiplier)
d_1 =	0.31 ft.	Normal depth in chute
n-value =	0.047	Manning's roughness coefficient
$D_{50}(SF)$ =	5.8 in.	Minimum Design D_{50}*
$2(D_{50})(SF)$ =	11.7 in.	Rock chute thickness
Tw + d =	1.72 ft.	Tailwater above outlet apron
d_2 =	0.75 ft.	Hydraulic jump height
*** The outlet	will	function adequately

High Flow Storm Information

Rock Chute Design Data

(Version WI-April-2005, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)
Revised for WisDOT 9/2010

Project: COL - POO Landfill Closure RC2 **County:** Columbia
Designer: RJG **Checked by:** MJT
Date: April 11, 2022 **Date:** 04/13/22

Input Geometry:

Upstream Channel		Chute			Downstream Channel	
Bottom Width =	6.0 ft.	Bottom Width =	6.0 ft.		Bottom Width =	6.0 ft.
Side slopes =	1.0 (m:1)	Factor of safety =	1.20 (SF)	1.2 Min	Side slopes =	2.0 (m:1)
Mannings n value =	0.012	Side slopes =	2.0 (z:1)	2.0:1 max.	Mannings n value =	0.030
Bed slope =	0.0001 ft./ft.	Bed slope =	0.0690 ft./ft	3.0:1 max.	Bed slope =	0.0050 ft./ft.
		Freeboard =	1.0 ft.			
		Outlet apron depth, d =	1.0 ft.		Base flow =	0.0 cfs

Note: Use procedures 13-30-15 or 13-30-25 for upstream and downstream Mannings n

Flow and Elevation Data:

Apron elev. --- Inlet = 815.8 ft. ------- Outlet 808.4 ft. --- (H_{drop} = 6.4 ft.)

Degree of angularity = 1
1 --> 50% angular, 50% rounded
2 --> 100 % rounded

Q_{high} = Runoff from design storm
Q_5 = Runoff from a 5-year,24-hour storm

Q_{high} = 14.0 cfs — High flow storm through chute → Tw (ft.) = **Program**
Q_{low} = 14.0 cfs — Low flow storm through chute → Tw (ft.) = **Program**

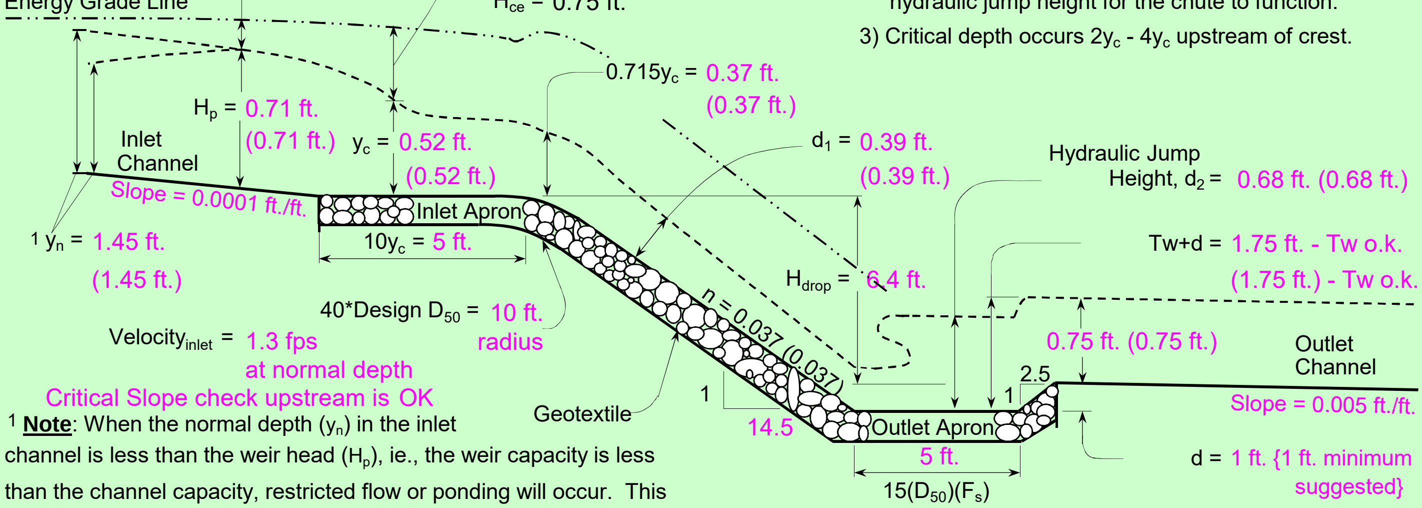
Note: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.

Input tailwater (Tw): 0.07 1.20

Profile and Cross Section (Output):

Starting Station = 3+00.0

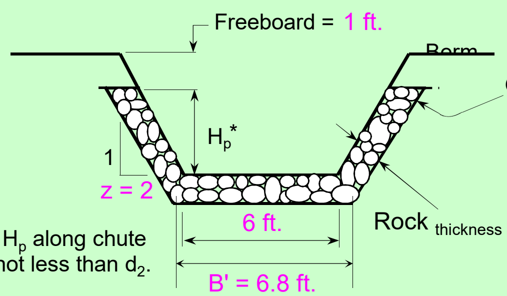
Notes:
1) Output given as **High Flow (Low Flow)** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs $2y_c$ - $4y_c$ upstream of crest.



[1] **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., the weir capacity is less than the channel capacity, restricted flow or ponding will occur. This reduces velocity and prevents erosion upstream of the inlet apron.

Profile Along Centerline of Chute

Typical Cross Section



* Use H_p along chute but not less than d_2.

	2.14 cfs/ft.	Equivalent unit discharge
SF =	1.20	Factor of safety (multiplier)
d_1 =	0.39 ft.	Normal depth in chute
n-value =	0.037	Manning's roughness coefficient
D_{50}(SF) =	3.6 in.	Minimum Design D_{50}*
$2(D_{50})$(SF) =	7.3 in.	Rock chute thickness
Tw + d =	1.75 ft.	Tailwater above outlet apron
d_2 =	0.68 ft.	Hydraulic jump height
*** The outlet	will	function adequately

High Flow Storm Information

Discharge Apron Sizing

Purpose:

To size the riprap apron dimensions at culvert C2, C3, C4, and C5 based on a 25-year, 24 hour storm event:

References:

1. "Energy Dissipators," Wisconsin Department of Transportation (WisDOT), Facilities Development Manual (FDM) 13-35-5.
2. Post Construction Condition HydroCAD Model.
3. "Rock Riprap Lined Channels," WisDOT FDM 13-30-25.
4. Culvert Sizing Calculation.
5. WisDOT FDM Chapter 13, Section 30 - Rock Riprap Lined Chutes

Approach:

Use the equations in Section 5.2 - Riprap Blanket of WisDOT FDM 13-35-5 (Energy Dissipators) to determine the average size of stone (d_{50}) and riprap apron length. Round up the calculated d_{50} to the nearest WisDOT standard riprap size.

Use WisDOT FDM 13-35 Attachment 5.2 to determine the width of the riprap apron for discharges to a flat area. For discharges to channels, extend riprap across the channel bottom and up the sides.

Assumptions:

Assume riprap apron thickness (T) is 2 * d_{50} to protect against washout and undercutting of the riprap.

Assume tailwater depth, TW = 0.40 * D_o

Assume max TW conditions for the riprap apron width.

Assume that when there are multiple culverts, the total discharge to the culverts is distributed evenly through each barrel.

Calculation:

From WisDOT Section 5.2 - Riprap Blanket:

$$d_{50}/D_o = 0.020\ (D_o/TW)\ (Q/D_o^{5/2})^{4/3}$$

$$L_{sp}/D_o = 1.7\ (Q/D_o^{5/2}) + 8$$

Or:

$d_{50} = 0.02 \times (D_o/TW) \times (Q/D_o^{5/2})^{4/3} \times D_o$

$L_{sp} = (1.7\ (Q/D_o^{5/2}) + 8) \times D_o$

where: D_o = Diameter or width of culvert (ft)

Q = Flow rate (cfs) (discharge rate through culvert, from Worst Case Condition HydroCAD Model (Reference #2))

TW = Tail water depth (ft)

d_{50} = Average size of stone (ft)

L_{sp} = Length of stone protection (Apron Length) (ft)

Location	Total Flow (Q, cfs)	Number of Pipes	D_o (ft)	Q (cfs)	TW (ft)	$d_{50\ calculated}$	$d_{50\ Design}$	L_{sp}
Culvert C2	9.68	2	1.5	4.8	0.60	0.16	0.83	16
Culvert C3	27.38	2	2.5	13.7	1.00	0.19	0.83	26
Culvert C4	35.39	2	2.5	17.7	1.00	0.27	0.83	28
Culvert C5	35.21	2	2.5	17.6	1.00	0.27	0.83	28

Results:

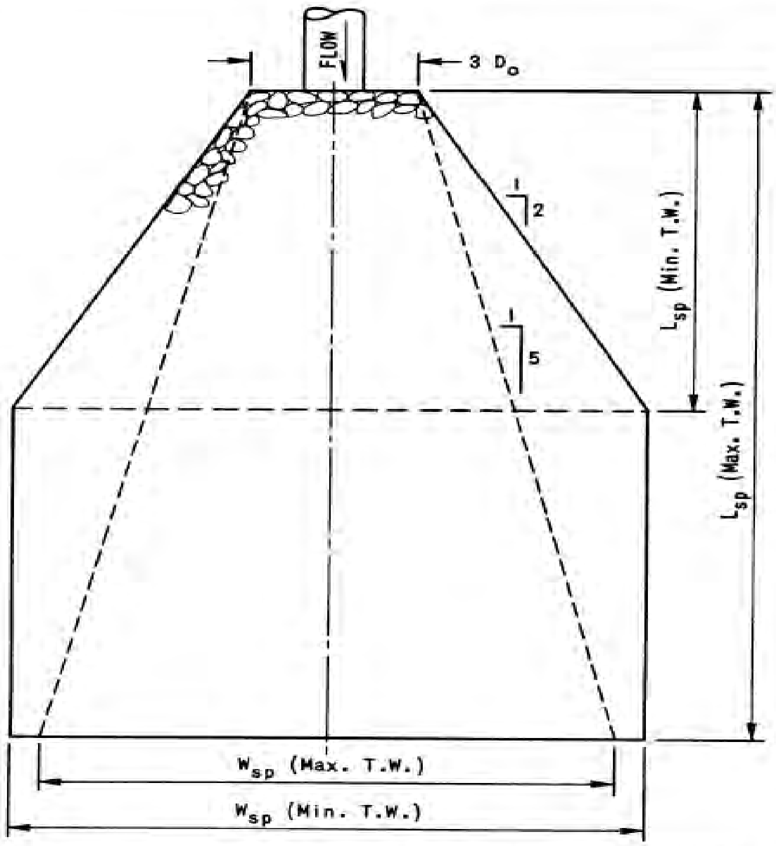
Below is a summary of the d_{50} , thickness (T), and configuration of the riprap apron. Also refer to WisDOT FDM Attachment 5.2 (Sheet 2) for details on apron layout. Use WisDOT Light Riprap at culvert discharge.

Location	d_{50} (in)*	T (in)	L_{sp} (ft)	W_{sp} (ft)
Culvert C2	10.0	20	16	See Note 1
Culvert C3	10.0	20	26	See Note 1
Culvert C4	10.0	20	28	See Note 1
Culvert C5	10.0	20	28	See Note 1

1. For discharges to channels, place riprap along channel bottom and up side of channel.

*Per Table 25.1 on Sheet 2 for standard WisDOT riprap sizes use Light Riprap.

FDM 13-35 Attachment 5.2 Recommended Configuration of Riprap Blanket Subject to Maximum and Minimum Tail Waters



RECOMMENDED CONFIGURATION OF RIPRAP BLANKET SUBJECT TO MAXIMUM AND MINIMUM TAILWATERS

Source: Miscellaneous paper H-72-5, "Practical Guidance for Estimating and Controlling Erosion at Culvert Outlets", U.S. Army Engineer Waterways Experiment Station, May, 1972.

***Table 25.1** Typical Particle Sizes of Native Sands at 75 Percent Passing (D_{75})*

Riprap Type	D50 (inches)	D50 (feet)	Riprap Thickness (in)	Geotextile Type
Select Crushed Material	2.2	0.18	5	Type R
Light Riprap	10	0.83	12	Type R
Medium Riprap	12.5	1.04	18	Type HR
Heavy Riprap	16	1.33	24	Type HR
Extra-Heavy Riprap	20	1.67	30	Type HR

Source: Table 25.1 from WisDOT FDM.

Appendix C3

Written Closure Plan

Closure Plan

Columbia Dry Ash Disposal Facility

Phase 1 Module 1
Phase 1 Module 2
Phase 1 Module 3
Phase 1 Module 4
Phase 1 Module 5
Phase 1 Module 6
Phase 2 Module 10
Phase 2 Module 11

Prepared for:

Wisconsin Power and Light Company
Columbia Energy Center
W8375 Murray Road
Pardeeville, Wisconsin 53954

SCS ENGINEERS

25222260.00 | February 1, 2023

2830 Dairy Drive
Madison, WI 53718-6751
608-224-2830

Table of Contents

Figures

Appendices

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PE CERTIFICATION

I, Phillip Gearing, hereby certify that I am a licensed professional engineer in the State of Wisconsin in accordance with the requirements of ch. A–E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A–E 8, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 500 to 538, Wis. Adm. Code.

Specifically,

- This Closure Plan was prepared by me or under my direct supervision and meets the requirements of 40 CFR 257.102(b) and NR 514.07(10)(c)

February 1, 2023

(signature) (date)

Phillip E. Gearing

(printed or typed name)

License number E-45115

My license renewal date is July 31, 2024.

Pages or sheets covered by this seal:

ALL

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1.0 INTRODUCTION AND PROJECT SUMMARY

On behalf of Wisconsin Power and Light Company (WPL), SCS Engineers (SCS) has prepared this Closure Plan for the Columbia (COL) Dry Ash Disposal Facility Phase 1, Modules 1 through 6 and Phase 2, Modules 10 and 11 as required by 40 Code of Federal Regulations (CFR) 257.102(b) and Wisconsin Administrative Code NR 514.07(10)(c), as stated below.

40 CFR 257.102(b) *"Written closure plan – (1) Content of the plan. The owner or operator of a CCR unit must prepare a written closure plan that describes the steps necessary to close the CCR unit at any point during the active life of the CCR unit consistent with recognized and generally accepted good engineering practices. The written closure plan must include, at a minimum, the information specified in paragraphs (b)(1)(i) through (vi) of this section."*

NR 517.07(10)(c) *"A written closure plan in accordance with the requirements under s. NR 514.06 (10) and all of the following: (1) A narrative description of how the CCR landfill will be closed, including a description of the steps necessary to close the CCR unit at any point during the active life of the CCR unit, consistent with recognized and generally accepted good engineering practices."*

The COL facility includes an active coal combustion residual (CCR) landfill, which currently consists of the following modules, located in Phase 1 and Phase 2 of the facility.

- **Phase 1, Module 1** – This module has received final cover over outer sideslope areas that will no longer receive additional CCR; intermediate cover has been placed over remaining areas. The final cover placed complies with the CCR Rule.
- **Phase 1, Module 2** – This module has received intermediate cover over a majority of the in-place CCR.
- **Phase 1, Module 3** – This module has received intermediate cover over a majority of the in-place CCR.
- **Phase 1, Module 4** – This module is currently being filled and also has received intermediate cover over areas of the in-place CCR.
- **Phase 1, Module 5** – This module is currently being filled and has received intermediate cover over areas of the in-place CCR.
- **Phase 1, Module 6** – This module is currently being filled and has received intermediate cover over areas of the in-place CCR.
- **Phase 2, Module 10** – Construction of the Module 10 liner began in 2022. The new module will be used for disposal following approval of the liner Construction Documentation Report, which will be submitted for WDNR review early in 2023. Filling is anticipated to begin in 2023.
- **Phase 2, Module 11** – Construction of the Module 11 liner began in 2022. The new module will be used for disposal following approval of the liner Construction Documentation Report, which will be submitted for WDNR review early in 2023. Filling is anticipated to begin in 2023.

Phase 1, Modules 1-3 were previously described as separate existing CCR landfills although they are contiguous and are managed as a single landfill by the facility and by the WDNR. WPL has clarified in the operating record for the Columbia facility that Modules 1-3 are one existing CCR landfill as defined in 40 CFR 257.53 of the federal CCR Rule. Phase 1, Modules 4-6 are considered to be a new CCR landfill that initiated construction after October 19, 2015, and is therefore managed as a separate CCR unit under the CCR Rule even though they are contiguous to the existing CCR landfill (Modules 1-3). In addition, the new CCR landfill will include Phase 2, Modules 10 and 11, once the liner construction documentation is approved by the WDNR in 2023. Construction of additional modules is not currently planned prior to retirement of the Columbia Energy Center, which is currently scheduled to occur no later than June 1, 2026.

Figure 1 shows the site location. **Figure 2** shows the closure areas. A detail of the final cover system is shown on **Figure 3.**

2.0 PROPOSED CLOSURE PLAN NARRATIVE

40 CFR 257.102(b)(1)(i) *"A narrative description of how the CCR unit will be closed in accordance with this section."*

NR 517.07(10)(c)(1) *"A narrative description of how the CCR landfill will be closed, including a description of the steps necessary to close the CCR unit at any point during the active life of the CCR unit, consistent with recognized and generally accepted good engineering practices."*

When CCR placement is completed in the CCR unit, or if early closure is required, the unit will be closed by covering the CCR with the final cover system described in **Section 3.0**. Prior to final cover system construction, the CCR surfaces will be graded and compacted to establish a firm subgrade for final cover construction. In addition, all required notifications will be submitted to the Wisconsin Department of Natural Resources (WDNR, or "Department"), and WPL will obtain all additional necessary permits (for example, general permit coverage for construction storm water management). WPL may also engage in procurement activities to secure services for installing the final cover system.

The timing for completion of CCR placement in the units that are addressed with this closure plan will depend on CCR generation and disposal rates. Future CCR unit development will also impact the timing of closure. Each of the existing CCR units is designed to receive additional CCR once adjacent units are constructed and overlay airspace is available for filling. Based on the current CCR units alone, if early closure of all units is required, final cover will be placed in the active landfill areas shown on **Figure 2.** A closure schedule is discussed in **Section 6.0** and presented in **Appendix B.**

The initiation of closure activities will commence no later than 30 days after the known final receipt of CCR as required by 40 CFR 257.102(e)(1) and NR 506.083(2)(a), or in accordance with 40 CFR 257.102(e)(2) and NR 506.083(2)(b).

3.0 FINAL COVER SYSTEM AND PERFORMANCE

40 CFR 257.102(b)(1)(iii) *"If closure of the CCR unit will be accomplished by leaving CCR in place, a description of the final cover system, designed in accordance with paragraph (d) of this section, and the methods and procedures to be used to install the final cover. The closure plan must also discuss how the final cover system will achieve the performance standards specified in paragraph (d) of this section."*

40 CFR 257.102(d) *"Closure performance standard when leaving CCR in place."*

40 CFR 257.102(d)(1) *"The owner or operator of a CCR unit must ensure that, at a minimum, the CCR unit is closed in a manner that will:"*

> 40 CFR 257.102(d)(1)(i) *"Control, minimize or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere;"*

NR 514.07(10)(c)(3) *"A demonstration, including a narrative discussion, of how final closure will meet the performance standards under s. NR 506.083(6)."*

NR 506.083(6) *"Closure performance standards when leaving CCR in place. An owner or operator of a CCR landfill shall ensure that, at a minimum the CCR landfill is closed in a manner that will achieve all of the following performance standards:"*

> NR 506.083(6)(a) *"Control, minimization or elimination, to the maximum extent feasible, of post-closure infiltration of liquids into the waste and of releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere."*

The final cover system design will minimize or eliminate infiltration, as further described below.

> 40 CFR 257.102(d)(1)(ii) *"Preclude the probability of future impoundment of water, sediment, or slurry;"*
>
> NR 506.083(6)(b) *"Prevention of the impoundment of water, sediment or slurry."*

The final cover system will meet these criteria, as further described below.

> 40 CFR 257.102(d)(1)(iii) *"Include measures that provide for major slope stability to prevent the sloughing or movement of the final cover system during the closure and post-closure care period;"*
>
> NR 506.083(6)(c) *"Slope stability to prevent the sloughing or movement of the final cover system during the closure and long-term care period.*

The final cover system is designed to provide slope stability and to prevent sloughing or movement during the closure and post-closure care period. Stability of the final cover system was assessed as part of the WDNR landfill permitting process and is further addressed below.

> 40 CFR 257.102(d)(1)(iv) *"Minimize the need for further maintenance of the CCR unit; and"*
>
> NR 506.083(6)(d) *"Minimization of the need for long-term maintenance of the CCR landfill."*

Maintenance of the final cover will be minimized by the establishment of vegetative cover and the erosion control systems, which are further described below.

> 40 CFR 257.102(d)(1)(v) *"Be completed in the shortest amount of time consistent with recognized and generally accepted good engineering practices."*
>
> NR 506.083(6)(e) *"Complete closure in the shortest amount of time consistent with recognized and generally accepted good engineering practices."*

All closure activities for the CCR units will be completed within 6 months, as stated in **Section 7.0** below.

40 CFR 257.102(d)(2) *"Drainage and stabilization of CCR surface impoundments."*

This does not apply to the COL CCR landfill units.

40 CFR 257.102(d)(3) *"Final cover system"*

NR 517.07(10)(c)(2) *"A description of the final cover system, designed in accordance with s. NR 504.07, and the methods and procedures to be used to install the final cover."*

NR 504.12(4)(b) *"The owner or operator of a new or existing CCR landfill or a lateral expansion of a CCR landfill may propose an alternative final cover system design within a written closure plan in accordance with s. NR 504.10 and all of the following:"*

The alternative final cover design has been developed to meet the requirements of NR 504.12(4)(b) and is discussed in detail below.

The existing final cover system (see **Figure 3** for details) in place on part of Module 1 will be extended to cover the remaining portion of Module 1. The Module 1 final cover system is as follows from the bottom up:

- 3-inch grading layer
- Geosynthetic clay liner (GCL)
- 40-millimeters (mil) linear low-density polyethylene (LLDPE) geomembrane
- 12 inches of drainage material
- 12 inches of rooting zone
- 6 inches of topsoil

This final cover meets and exceeds the minimum requirements of 40 CFR 257.102(d)(3)(i)(A) through (D) and NR 504.12(4)(b)(1) through (4) as follows:

- Per 257.102(d)(3)(i)(A) and NR 504.12(4)(b)(1), the permeability of the final cover system is less than or equal to the permeability of the bottom liner system and is less than $1x10^{-5}$ centimeters per second (cm/sec) required by the rule. The COL cover system contains a GCL with a permeability of $5x10^{-9}$ cm/sec. The geomembrane above the GCL makes the cover system even less permeable.

The bottom liner system for the existing CCR landfill in Module 1 is as follows:

- Phase 1, Module 1 South:
  - GCL
  - 40-mil high density polyethylene (HDPE) geomembrane
  - The layers of the liner system are less than the cover system layers; therefore, infiltration will be more than the cover system.

- Phase 1, Module 1 North:
  - 3 feet of compacted ash
  - The liner here does not include a geomembrane, and therefore the infiltration through the cover system will be less than this base liner.

An alternate final cover system will be installed in future remaining areas of final cover north of Module 1 (Phase 1, Modules 2, 3, 4, 5, and 6 and Phase 2, Modules 10 and 11). The alternate cover consists of the following components, from bottom to top:

- 3-inch-thick grading layer
- GCL
- 40-mil polyethylene geomembrane
- Geocomposite drainage layer
- 24-inch-thick rooting zone layer
- 6-inch-thick topsoil layer

This alternative final cover meets and exceeds the minimum requirements of 40 CFR 257.102(d)(3)(i)(A) through (D) and NR 504.12(4)(b)(1) through (4) as follows:

- Per 257.102(d)(3)(ii)(A), 257.102(d)(3)(i)(A), and NR 504.12(4)(b)(1), the permeability of the final cover system is less than or equal to the permeability of the bottom liner system and is less than $1x10^{-5}$ centimeters per second (cm/sec) required by the rule. The COL cover system contains a GCL with a permeability of $5x10^{-9}$ cm/sec. The geomembrane above the GCL makes the cover system even less permeable.

The bottom liner system for the existing CCR landfill is as follows:

- Phase 1, Modules 2 and 3:
  - 2 feet of compacted clay
  - GCL
  - 60-mil HDPE geomembrane

The bottom liner system for the new CCR landfill is as follows:

- Phase 1, Modules 4, 5, and 6 and Phase 2, Modules 10 and 11:
  - 2 feet of compacted clay
  - GCL
  - 60-mil HDPE geomembrane

Based on a comparison of the design slopes and drainage system components in the liner system and final cover system (described in greater detail below), the final cover system is at least equivalent in permeability when compared to the liner system in Phase 1, Modules 1, 2, 3, 4, 5, and 6 and Phase 2, Modules 10 and 11.

- Per 257.102(d)(3)(i)(B), the existing final cover system includes 2.5 feet of soil, which is greater than the 18 inches of earthen material required to minimize infiltration.

- Per 257.102(d)(3)(ii)(A) and 257.102(d)(3)(i)(B), the alternative final cover system includes 2.5 feet of soil, which is greater than the 18 inches of earthen material required to minimize infiltration.

- Per NR 504.12(4)(b)(2), the proposed final cover contains a GCL infiltration layer. Water infiltrating the final cover will be contained in the drainage layers (sand, geocomposite, and high capacity geocomposite), which will limit infiltration further through the final cover system. Based on our understanding of the regulations, it is unclear if the WDNR will require a soil barrier layer to be added below the final cover GCL. Further discussions with the WDNR will be needed to determine if the current final cover design is acceptable or if updates to the design are required.

- Per 257.102(d)(3)(i)(C) and NR 504.12(4)(b)(3), erosion of the existing final cover system is minimized with a vegetative support layer consisting of 12 inches of uncompacted rooting zone material and 6 inches of topsoil. This provides more than the required 6-inch thickness for plant growth.

- Per 257.102(d)(3)(ii)(B), 257.102(d)(3)(i)(C), and NR 504.12(4)(b)(3), erosion of the alternative final cover system is minimized with a vegetative support layer consisting of 24 inches of uncompacted rooting zone material and 6 inches of topsoil. This provides more than the required 6-inch thickness for plant growth.

Also, the existing final cover system and alternative final cover system limits infiltration while promoting surface water run-off in a controlled manner to minimize erosion and promote stability. The surface layer of 18 inches (existing) or 30 inches (alternative) of soil supports vegetation that assists with erosion control. Water that infiltrates will be collected by the 12-inch drainage layer (existing) or geocomposite drainage layer (alternate) and will be routed to the perimeter drainage system.

In addition, the surface has intermediate drainage swales to reduce the flow lengths down the final cover slope, also aiding in erosion control. Where needed, the intermediate drainage swales are connected to downslope channels to control storm water runoff and prevent erosion of the final cover.

- Per 257.102(d)(3)(i)(D) and NR 504.12(4)(b)(4), the design of the existing final cover system minimizes disruptions to the final cover system. Stability of the final cover system was assessed as part of the WDNR landfill permitting process. The stability calculations are included in **Appendix A1**.

- Per 257.102(d)(3)(ii)(C) and NR 504.12(4)(b)(4), the design of the alternative final cover system minimizes disruptions to the final cover system. Stability of the final cover system was assessed as part of the WDNR landfill permitting process. The stability calculations are included in **Appendix A2**.

The design of the final cover system accommodates settling and subsidence of the CCR fill below the cover. The CCR at COL is placed dry and is compacted in place. CCR continues to consolidate and gain strength as filling progresses prior to final cover placement. The final cover system is designed with a maximum slope of 25 percent (4 horizontal to 1 vertical). Because the final cover has a relatively large positive slope and the CCR has been gaining strength over time, the final cover is expected to easily accommodate the remaining relatively minor settlement potential of the CCR fill when fill placement ends and the landfill is closed.

All final cover materials will be tested to confirm they meet specifications, and construction will be overseen and documented by a licensed engineer. Rooting zone and topsoil layers will be checked for thickness. All areas will be restored after final cover is placed. Vegetation will be monitored and maintained.

4.0 MAXIMUM INVENTORY OF CCR

40 CFR 257.102(b)(1)(iv) *"An estimate of the maximum inventory of CCR ever on-site over the active life of the CCR unit."*

NR 514.07(10)(c)(4) *"An estimate of the maximum volume in cubic yards of CCR that will be disposed on–site over the active life of the CCR landfill."*

The following table reflects the estimated maximum volume of CCR disposed on site at the COL facility.

Area	Maximum Capacity (cy)
Phase 1, Modules 1-6, Phase 2, Modules 10-11	2,583,692

The estimated maximum inventory of CCR ever on site over the active life of the CCR landfill units is based on the design capacity of the landfill. The maximum design capacity was submitted in the WDNR approved 2022 Plan of Operation Update.

5.0 LARGEST AREA OF CCR UNIT REQUIRING FINAL COVER

40 CFR 257.102(b)(1)(v) *"An estimate of the largest area of the CCR unit ever requiring a final cover as required by paragraph (d) of this section at any time during the CCR unit's active life."*

NR 514.07(10)(c)(5) *"An estimate of the largest area of the CCR landfill that will require a final cover at any time during the CCR landfill's active life."*

The largest area of each CCR unit requiring final cover is the open area shown on **Figure 2**, with areas as follows:

Areas Requiring Final Cover (acres)	
Phase 1, Modules 1- 3	12.9
Phase 1, Modules 4-6	12.0
Phase 2, Modules 10-11	7.3
Total	**32.2**

6.0 SCHEDULE OF SEQUENTIAL CLOSURE ACTIVITIES

40 CFR 257.102(b)(1)(vi) *"A schedule for completing all activities necessary to satisfy the closure criteria in this section, including an estimate of the year in which all closure activities for the CCR unit will be completed."*

NR 514.07(10)(c)(6) *"A schedule for completion of all closure activities, including an estimate of the year in which all closure activities for the CCR landfill will be completed."*

CCR placement is anticipated to permanently end at this facility following retirement of the Columbia Generating Station by June 2026, as announced by WPL. Some CCR disposal activity may be necessary following retirement of Columbia as part of decommissioning efforts (for example, cleaning of ducts and other equipment that may contain CCR following retirement). Closure activities are expected to be complete by the end of 2027.The potential schedule for closure of the existing CCR modules is provided in **Appendix B.**

7.0 COMPLETION OF CLOSURE ACTIVITIES

40 CFR 257.102(f)(1) *"Except as provided for in paragraph (f)(2) of this section, the owner or operator must complete closure of the CCR unit:*

(i) For existing and new CCR landfills and any lateral expansion of a CCR landfill, within six months of commencing closure activities."

NR 506.083(3)(a) *"The owner or operator shall complete closure of the CCR landfill within 6 months of commencing closure activities."*

As shown on the enclosed schedule, closure of each CCR unit will be completed within 6 months of commencing closure activities.

40 CFR 257.102(f)(3) *"Upon completion, the owner or operator of the CCR unit must obtain a certification from a qualified professional engineer verifying that closure has been completed in accordance with the closure plan specified in paragraph (b) of this section and the requirements of this section."*

NR 506.083(1)(b) *"Within 30 days following completion of closure of a CCR landfill under sub. (3), the owner or operator shall prepare and submit a notification of closure to the department and place a copy in the facility's operating record. The notification shall include the certification required under s. NR 516.04(3)(d)."*

A qualified licensed engineer will oversee the final cover construction. The engineer will verify final cover materials and methods and oversee material testing. At the end of construction, the engineer will provide a report summarizing and documenting construction and will certify compliance with the requirements.

8.0 CERTIFICATION

40 CFR 257.102(b)(4) *"The owner or operator of the CCR unit must obtain a written certification from a qualified professional engineer that the initial and any amendment of the written closure plan meets the requirement of this section."*

NR 500.05 *"Unless otherwise specified, all submittals for review and approval of any initial site report, feasibility report, plan of operation site investigation report, remedial action options report, construction documentation report, or closure plan, or any modifications to those plans, shall include all of the following:*

(4) CERTIFICATION. (a) The reports and plan sheets shall be under the seal of a licensed professional engineer."

Phillip Gearing, PE, a licensed professional engineer in the State of Wisconsin has overseen the preparation of this Closure Plan. A certification statement is provided on **page iii** of this plan.

40 CFR 257.102(d)(2)(iii) *"The owner or operator of the CCR unit must obtain a written certification from a qualified professional engineer that the design of the final cover system meets the requirement of this section."*

Phillip Gearing, PE, a licensed professional engineer in the State of Wisconsin has overseen the design of the final cover system and certifies that the design meets the requirements of 40 CFR 257.102(d). The certification statement is provided on **page iii** of this plan.

9.0 RECORDKEEPING AND REPORTING

40 CFR 257.102(b)(vi)(2)(iii) *"The owner or operator has completed the written closure plan when the plan including the certification required by paragraph (b)(4) of this section, has been placed in the facility's operating record as required by Section 257.105(i)(4)."*

NR 506.17(2)(e) *"The written operating record shall contain the plan of operation, plan modifications, construction documentation, department approvals, annual reports, inspection records, monitoring and corrective action records, notifications to the department, and records of public comments received during any public comment period."*

The Closure Plan will be placed in the facility's operating record and on Alliant Energy's CCR Rule Compliance Data and Information website.

Amendments to the written Closure Plan will be done when a new module is constructed, when there is a change in the operation of the CCR unit that affects the plan, or when unanticipated events warrant revision to the written Closure Plan as required by 40 CFR 257.102(b)(3) and NR 514.07(10)(c)(7).

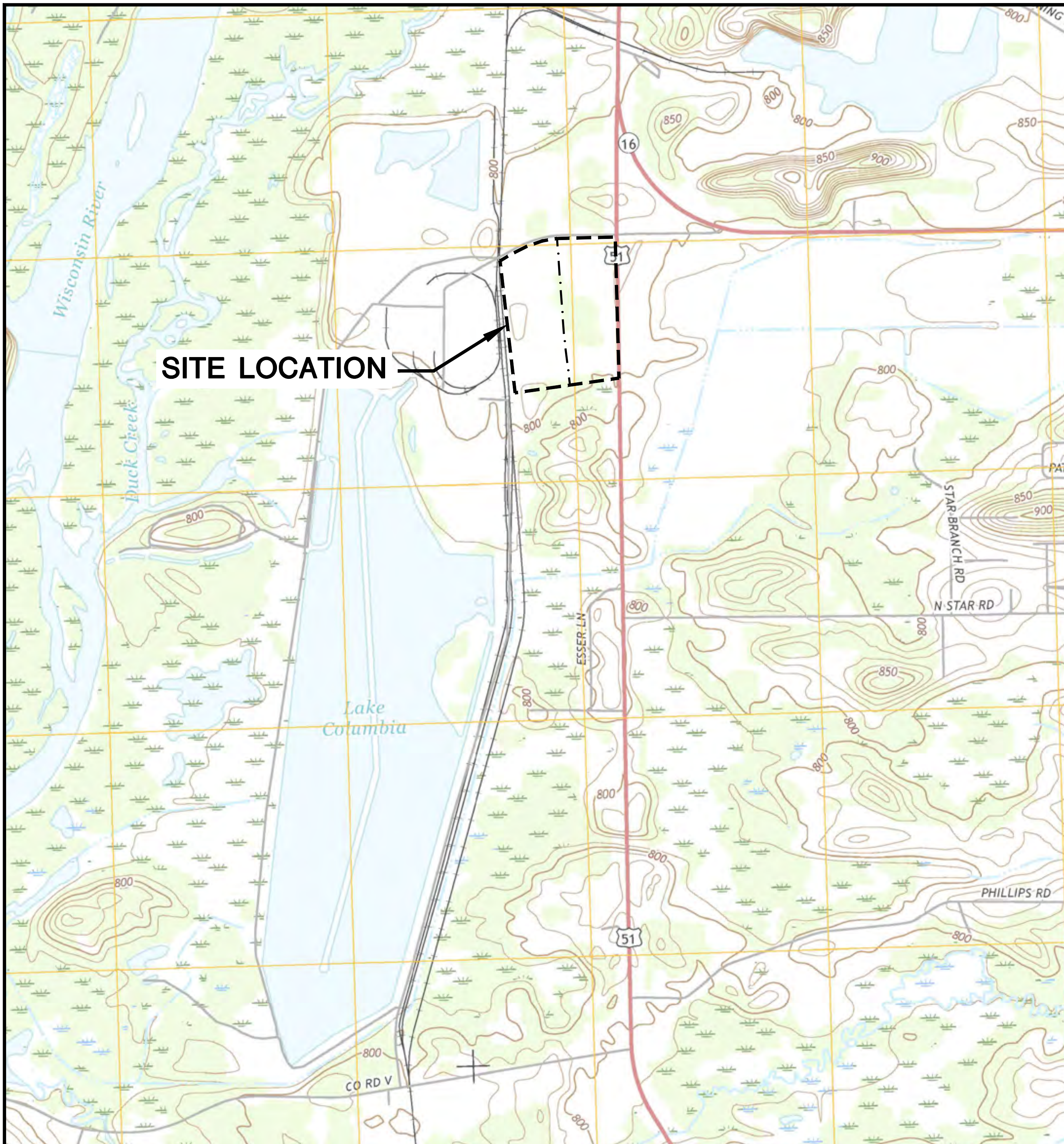
WPL will provide notification as follows:

- Intent to initiate closure
- Closure completion

- Availability of the written Closure Plan and any amendments

All notifications will be placed in the facility's operating record and on the website per 40 CFR 257.105(i), 257.106(i), 257.107(i), and NR 506.17(2).

Figures



POYNETTE QUADRANGLE
WISCONSIN–COLUMBIA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
2016
SCALE: 1" = 2,000'

CLIENT	SITE	
WISCONSIN POWER AND LIGHT COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WISCONSIN 53954	CLOSURE PLAN COLUMBIA DRY ASH DISPOSAL FACILITY TOWN OF PACIFIC, WISCONSIN	SITE LOCATION MAP

				ENGINEER	FIGURE
PROJECT NO.	25222260.00	DRAWN BY:	AHB	SCS ENGINEERS 2830 DAIRY DRIVE MADISON, WI 53718-6751 PHONE: (608) 224-2830	1
DRAWN:	08/09/2016	CHECKED BY:	RJG		
REVISED:	12/28/2022	APPROVED BY:	PEG 01/31/23		

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LEGEND

- ASH DISPOSAL FACILITY LIMITS
- APPROVED LIMITS OF ASH FILL
- PHASE/MODULE LIMIT
- 810 EXISTING GRADE (5' CONTOUR)
- EXISTING GRADE (1' CONTOUR)
- PAVED ROAD
- UNPAVED ROAD
- RAILROAD TRACKS
- VEGETATION
- FENCE
- SWALE
- EDGE OF WATER
- APPROXIMATE LIMITS OF EXISTING LEACHATE/SURFACE WATER POND LINER
- CULVERT
- TRANSMISSION TOWER
- WATER SUPPLY WELL
- STAFF GAUGE
- WATER TABLE WELL
- PIEZOMETER
- SURFACE WATER SAMPLE LOCATION
- LYSIMETER
- ABANDONED WATER TABLE WELL
- ABANDONED PIEZOMETER
- BENCHMARK
- PROPOSED FINAL GRADE (2' CONTOUR)
- 820 PROPOSED FINAL GRADE (10' CONTOUR)
- ACTIVE LANDFILL AREA
- PROPOSED DIVERSION BERM
- PROPOSED DOWNSLOPE CHANNEL
- PROPOSED DOWNSLOPE FLUME
- CLOSED AREA
- AREA TO BE CLOSED WITH FINAL COVER (SAND DRAINAGE LAYER)
- AREA TO BE CLOSED WITH FINAL COVER (GEOCOMPOSITE DRAINAGE LAYER)
- AREA WITH HIGH CAPACITY GEOCOMPOSITE

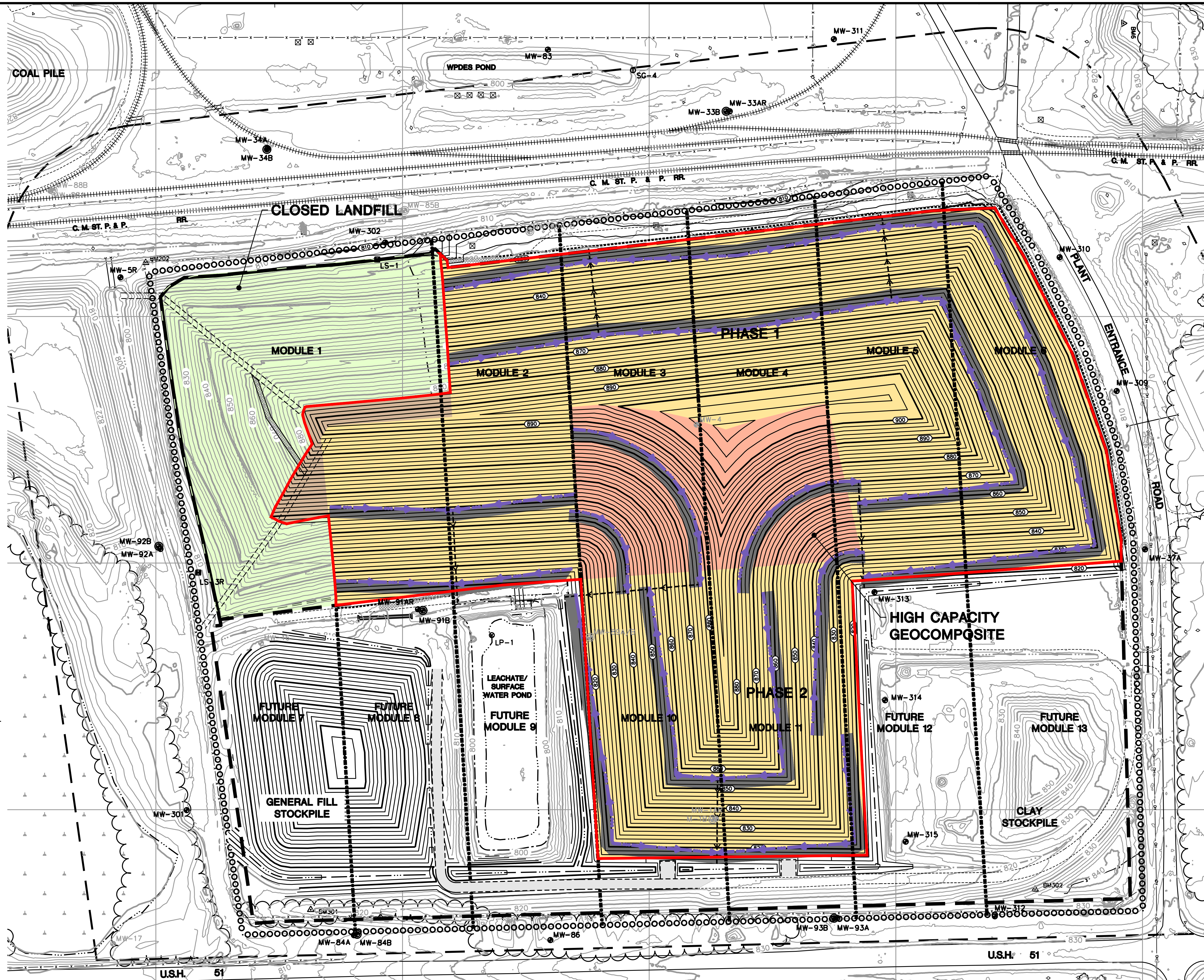
NOTES:

1. BASE MAP CREATED FROM AERIAL SURVEY BY KBM, FLOWN DECEMBER 1, 2014, AND GROUND SURVEY BY SCS ENGINEERS IN DECEMBER 2020, AND BY DRONE SURVEY BY AMES ON JANUARY 17, 2023.
2. MONITORING WELL LOCATIONS AND ELEVATIONS SURVEYED BY WISCONSIN POWER AND LIGHT, INC. IN DECEMBER 1994, NOVEMBER 1996, APRIL 2003, AUGUST 2012, JANUARY 2016, AND BY SCS ENGINEERS IN MAY 2019.

N

200 0 200

SCALE: 1" = 200'



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CLIENT: WISCONSIN POWER AND LIGHT
COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

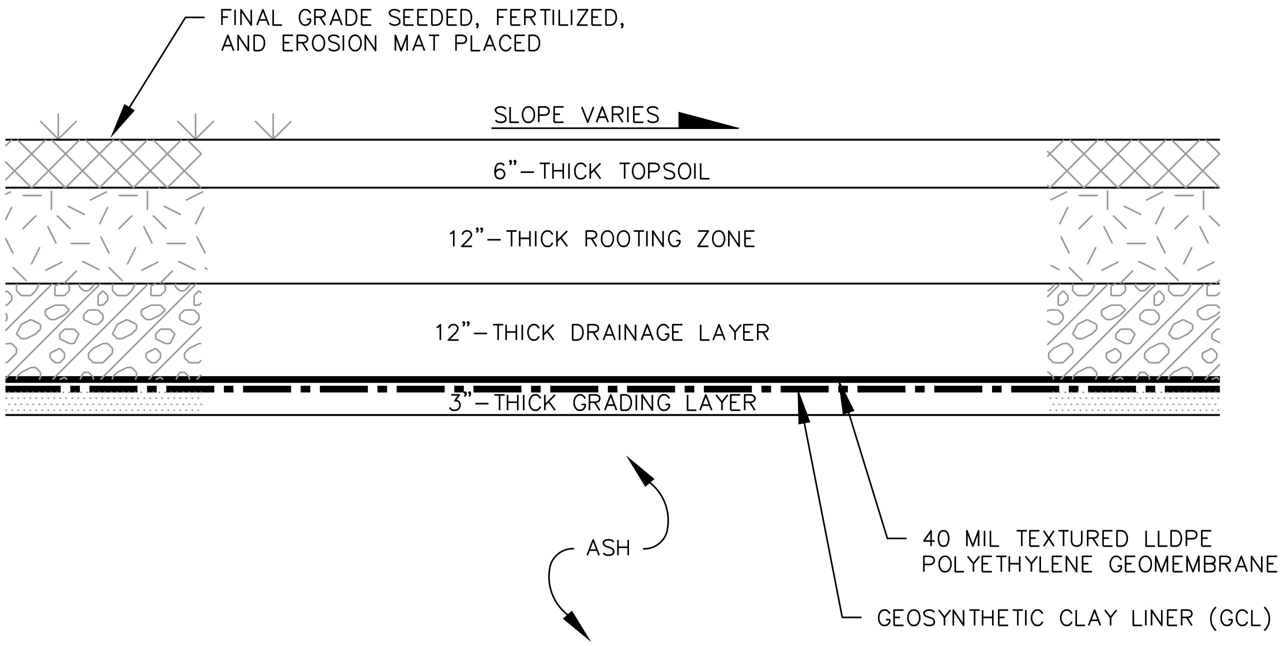
SITE: CLOSURE PLAN
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

PROJECT NO. 25222260.00	DRAWN BY: KP/MJT		
DRAWN: 11/30/2021	CHECKED BY: RJG		
REVISED: 01/25/2023	APPROVED BY: PEG 01/31/23		

ENGINEER: SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

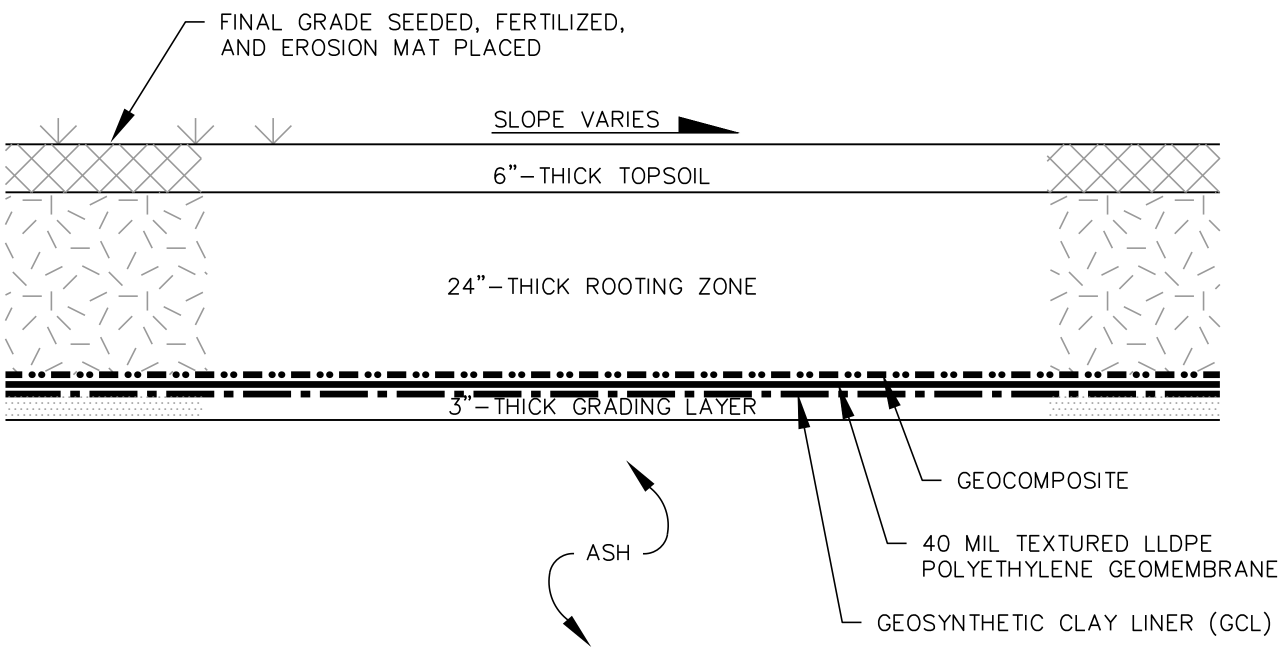
CLOSURE PLAN

FIGURE 2



FINAL COVER SYSTEM (SAND DRAINAGE LAYER)

SCALE: 1" = 2'



FINAL COVER SYSTEM (GEOCOMPOSITE DRAINAGE LAYER)

SCALE: 1" = 2'

CLIENT	SITE	
WISCONSIN POWER AND LIGHT COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WISCONSIN 53954	CLOSURE PLAN COLUMBIA DRY ASH DISPOSAL FACILITY TOWN OF PACIFIC, WISCONSIN	FINAL COVER SYSTEM

				ENGINEER	FIGURE
PROJECT NO.	25222260.00	DRAWN BY:	KP/MJT	SCS ENGINEERS 2830 DAIRY DRIVE MADISON, WI 53718-6751 PHONE: (608) 224-2830	3
DRAWN:	08/17/2016	CHECKED BY:	RJG		
REVISED:	01/25/2023	APPROVED BY:	PEG 01/31/23		

Appendix A

Stability Calculations

Appendix A1

Existing Final Cover Stability Calculations

BT SQUARED
CIVIL & ENVIRONMENTAL ENGINEERING

		Sheet No. 1	
		Calc. No.	
		Rev. No.	
Job No. 4071	Job: Columbia Ash Generation Landfill	By: PEG	Date 9/23/10
Client: Alliant	Subject: Liner Side Slope Drainage Layer Stability	Chk'd: DLN	Date 9/24/10

EVALUATION:

Evaluate the Phase 1 landfill liner side slope drainage layer for static veneer slope stability.

The side slope on the modules base runs at a 3:1 slope for an approximate maximum of 80 feet.

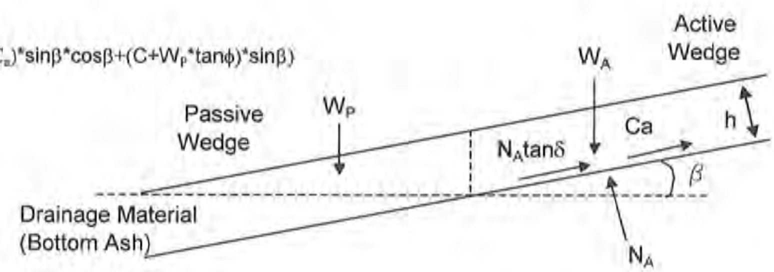
The following calculations evaluate the static veneer slope stability of the 3:1 slope.

REFERENCES:

1.) Koerner, Robert M. & Te-Yang Soong, Analysis and Design of Veneer Cover Soils, Geosynthetic Research Institute.
2.) U.S. Department of Transportation - Federal Highway Administration Recycled Materials, Coal Bottom Ash User's Guide

EQUATIONS:

$FS = (-b+(b^2-4*a*c)^{1/2})/(2*a)$
$a = (W_A-N_A*\cos\beta)*\cos\beta$
$b = -((W_A-N_A*\cos\beta)*\sin\beta*\tan\phi+(N_A*\tan\delta+C_a)*\sin\beta*\cos\beta+(C+W_P*\tan\phi)*\sin\beta)$
$c = (N_A*\tan\delta+C_a)*(\sin\beta)^2*\tan\phi$
$N_A = W_A*\cos\beta$
$W_A = \gamma*h^2*(L/h-1/\sin\beta-\tan\beta/2)$
$W_P = (\gamma*h^2)/\sin 2\beta$
$C_a = c_a(L-h/\sin\beta)$



DEFINITIONS OF VARIABLES:

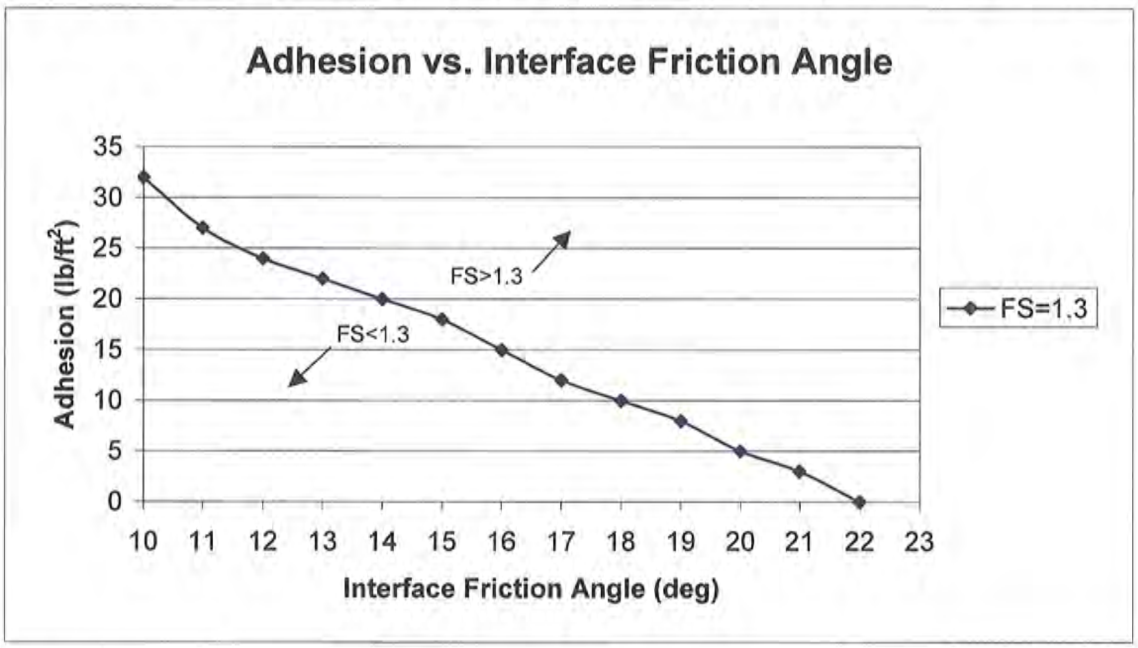
FS = Factor of Safety
a, b, & c = intermediate variables (= calculated variable)
N_A = Effective force normal to the failure plane of the active wedge (= calculated variable)
W_A = Total weight of active wedge (= calculated variable)
W_P = Total weight of passive wedge (= calculated variable)
β = Soil slope angle beneath the geomembrane (= 18.42 degrees or 0.322 radians
based on liner slope of 3 to 1)
ϕ = Friction angle of the drainage layer material (= 35 degrees 0.611 radians based on Ref #2)
δ = Interface friction angle for liner system geosynthetics (to be determined)
c_a = Adhesion for liner system geosynthetics at active wedge (to be determined) , Variable
γ = Unit weight of the drainage layer material (= 135 pcf based on conservative wet density of bottom ash).
C = Cohesive force along the failure plane of the passive wedge (assumed 0 for drainage layer material)
C_a = Adhesive force of the active wedge for the liner system geosynthetics
h = Thickness of the drainage layer material(= 1.0 foot based on base design)
L = Length of slope measured along the geomembrane (= 80 feet based on base design)

BT SQUARED
CIVIL & ENVIRONMENTAL ENGINEERING

		Sheet No. 2	
		Calc. No.	
		Rev. No.	
Job No. 4071	Job: Columbia Ash Generation Landfill	By: PEG	Date 9/23/10
Client: Alliant	Subject: Liner Side Slope Drainage Layer Stability	Chk'd: DLN	Date 9/24/10

CALCULATIONS:

δ		c_a	W_A	W_P	N_A	C_a	a	b	c	FS
(deg)	(rad)	(lb/ft^2)	(lb/ft)	(lb/ft)	(lb/ft)	(lb/ft)	(lb/ft)	(lb/ft)	(lb/ft)	
10	0.175	32	10,350	225	9,820	2,459	981	-1,535	293	**1.3**
11	0.192	27	10,350	225	9,820	2,075	981	-1,473	279	**1.3**
12	0.209	24	10,350	225	9,820	1,844	981	-1,457	275	**1.3**
13	0.227	22	10,350	225	9,820	1,690	981	-1,465	277	**1.3**
14	0.244	20	10,350	225	9,820	1,537	981	-1,473	279	**1.3**
15	0.262	18	10,350	225	9,820	1,383	981	-1,482	281	**1.3**
16	0.279	15	10,350	225	9,820	1,153	981	-1,468	277	**1.3**
17	0.297	12	10,350	225	9,820	922	981	-1,455	274	**1.3**
18	0.314	10	10,350	225	9,820	768	981	-1,465	277	**1.3**
19	0.332	8	10,350	225	9,820	615	981	-1,477	279	**1.3**
20	0.349	5	10,350	225	9,820	384	981	-1,465	277	**1.3**
21	0.367	3	10,350	225	9,820	231	981	-1,478	280	**1.3**
22	0.384	0	10,350	225	9,820	0	981	-1,468	277	**1.3**



CONCLUSION:

The landfill liner side slope drainage layer was evaluated for static veneer slope stability along its longest slope. Calculations were performed to determine the minimum adhesion necessary for a range of interface friction angles to reach a FS of 1.3 or greater. Each interface friction angle and the coinciding adhesion was graphed in order to easily determine if a material interface is acceptable along the side slope.

Purpose: Determine the maximum shear stress acting on a Geosynthetic Clay Liner (GCL) and the GCL internal shear strength required to provide a minimum slope stability safety factor (FS) of 1.5 for the liner system.

Approach: Use maximum shear stress formula and assumed values.

References: **Design of GCL Barrier for Final Cover Side Slope Applications Gregory N. Richardson, Ph.D., P.E. Geosynthetics '97 - 541**

Calculation: The maximum shear stress acting on the GCL can be calculated as follows:

$$\tau_{act} = W_T \sin \beta$$

$$\beta = 18.4^\circ$$

$$W_T = \gamma * h$$

Where,

γ = Ash Unit Weight = 135 pcf

h = drainage layer thickness = 1 ft

$$W_T = 135 \text{ psf}$$

$$\tau_{act} = 42.6 \text{ psf}$$

$$FS = \frac{\tau_{resist}}{\tau_{act}} = 1.5$$

$$\tau_{resist} = FS * \tau_{act} = 1.5 * 42.6 = 64 \text{ psf}$$

Assumptions: 1. Slope angle, β=18.4° (3:1 horizontal/vertical liner side slope).

2. Ash unit weight, γ = 135 pcf

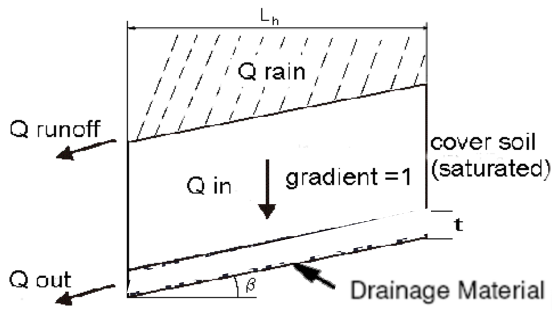
Conclusions: For a total weight of the leachate drainage layer of 135 psf and a slope angle of 3:1, the maximum shear stress will be 42.6 psf. A minimum GCL internal shear strength of 64 psf is required to provide a slope stability safety factor of 1.5.

Purpose: To determine the maximum length of slope that the final cover drainage layer (sand) can carry infiltrating water and remain stable.

Approach: Use the unit gradient method to determine the maximum slope length.

References:

1. Landfilldesign.com
2. "GRI-GC8, Determination of the Allowable Flow Rate of a Drainage Geocomposite". Geosynthetics Research Institute, 2001
3. "Beyond a factor-of-safety value, i.e., the proabability of failure". GRI Newsletter/Report, Vol. 15, no. 3
4. "Designing with Geosynthetics". R.M. Koerner, Prentice Hall Publishing Co., Englewood Cliffs, NJ, 1998
5. "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers". J. P. Giroud, J. G. Zornberg and A. Zhao, Geosynthetics International, Vol. 7, Nos 4-5
6. "Lateral Drainage Design update - part 2". G. N. Richardson, J. P. Giroud and A. Zhao, Geotechnical Fabrics Report, March 2002
7. HELP Model "User's Guide", Table 4: Default Soil, Waste, and Geosynthetic Characteristics
8. SCS Engineers, Plan Modification Request/Plan of Operation Update, Dry Ash Disposal Facility, COL Energy Center, Final Grades Plan Sheet, May 2022



With Darcy's Law:

$$Q = k \times i \times A$$

Inflow of water in the Drainage Material

$$Q_{in} = k_{veg} \times i \times A = k_{veg} \times 1 \times L_h \times 1$$

Outflow of water from the geocomposite at the toe of the slope

$$Q_{out} = k_{drain} \times i \times A = k_{drain} \times t \times \sin\beta$$

This results in a required k_{drain} of:

$$k_{drain} = \frac{k_{veg} \times L_h}{t \times \sin\beta} \times FS$$

Assumptions: 1. Soil hydraulic gradient *i* = 1.0.

2. Top soil will be clay. Soil permeability is 4.2 x 10^{-5} cm/sec for a CL clay from HELP model user's guide.
3. Drainage Layer hydraulic gradient = sinβ where β=14° (4:1 horizontal/vertical final cover slope).
4. Maximum horizontal final cover slope length from crest to toe drain is 368 feet as shown in Module 1 on the final grades plan sheet.
5. The minimum hydraulic conductivity ($k_{drain,ave}$) is 1.0 x 10^{-2} cm/s for the sand.
6. Cover drainage layer thickness t = 1 foot.

Calculation: Constants

L_h	=	Drainage pipe spacing or length of slope measured horizontally	=	See Below	
k_{veg}	=	Permeability of the vegetative supporting soil	=	0.000042	cm/sec
S	=	The liner's slope, **S** = tan **b**	=	25%	b = 14°
FS_{slope}	=	Minimum factor of safety against sliding, for drainage layer/geomembrane interface	=	1.5	
$\delta_{req'd}$	=	Minimum interface friction angle = $\tan^{-1}$(FS*tan(b))	=	20.6	degrees

Determine the maximum slope length for the given minimum required drainage layer permeability

L_h (feet)	L_h (meter)	$k_{drain, req}$ (cm/s)	
30	9.1	7.69E-03	Design

Conclusions: The design has an intermediate pipe every 30 feet spaced evenly up the slope. The intermediate pipe spacing design with the sand material has a factor of safety of 1.95.

SCS ENGINEERS

		Sheet No.	1 of 1
		Calc. No.	
		Rev. No.	
Job No. 25220183.00	Job: Columbia Dry Ash Disposal Facility	By: MJT	Date: 04/25/22
Client: WPL	Subject: GCL Internal Shear on Final Cover	Chk'd: DLN	Date: 04/26/22

Purpose: Determine the maximum shear stress acting on a Geosynthetic Clay Liner (GCL) and the GCL internal shear strength required to provide a minimum slope stability safety factor (FS) of 1.5 for the final cover.

Approach: Use maximum shear stress formula and assumed values.

References: Design of GCL Barrier for Final Cover Side Slope Applications, Gregory N. Richardson, Ph.D., P.E., Geosynthetics '97-541

Calculation: The maximum shear stress acting on the GCL can be calculated as follows:

$$\tau_{act} = W_T \sin\beta$$

$$\beta = 14^\circ$$

$$W_T = \gamma \times h$$

Where: γ = Soil Unit Weight = 120 pcf

h = Cover Thickness = 2.5 ft

$$W_T = 300 \text{ psf}$$

$$\tau_{act} = 72.6 \text{ psf}$$

$$FS = \frac{\tau_{resist}}{\tau_{act}} = 1.5$$

$$\tau_{resist} = FS \times \tau_{act} = 1.5 \times 72.6 = 109 \text{ psf}$$

Assumptions: Slope angle, $\beta = 14^\circ$ (4:1 horizontal / vertical final cover slope)

Soil unit weight, $\gamma = 120$ pcf

Conclusion: For a total weight of the final cover system of 300 psf and a slope angle of 4:1, the maximum shear stress will be 72.6 psf. A minimum GCL internal shear strength of 109 psf is required to provide a slope stability safety factor of 1.5.

Appendix A2

Alternative Final Cover Stability Calculations

Purpose: Evaluate the Module 10 and 11 landfill liner side slope drainage layer for static veneer slope stability. The following calculations evaluate the static veneer slope stability of the 3:1 slope.

References: 1. Koerner, Robert M. & Te-Yang Soong, Analysis and Design of Veneer Cover Soils, Geosynthetic Research Institute.
2. U.S. Department of Transportation - Federal Highway Administration Recycled Materials, Coal Bottom Ash User's Guide

Calculation:

$FS = (-b + (b^2 - 4 * a * c)^{1/2}) / (2 * a)$

$a = (W_A - N_A * \cos\beta) * \cos\beta$

$b = -((W_A - N_A * \cos\beta) * \sin\beta * \tan\phi + (N_A * \tan\delta + C_a) * \sin\beta * \cos\beta + (C + W_P * \tan\phi) * \sin\beta)$

$c = (N_A * \tan\delta + C_a) * (\sin\beta)^2 * \tan\phi$

$N_A = W_A * \cos\beta$

$W_A = \gamma * h^2 * (L / h - 1 / \sin\beta - \tan\beta / 2)$

$W_P = (\gamma * h^2) / \sin 2\beta$

$C_a = c_a (L - h / \sin\beta)$

Where:

FS = Factor of Safety

a, b, & c = intermediate variables (calculated variable)

N_A = Effective force normal to the failure plane of the active wedge (calculated variable)

W_A = Total weight of active wedge (calculated variable)

W_P = Total weight of passive wedge (calculated variable)

β = Soil slope angle beneath the geomembrane = 18.421 degrees = 0.3215 radians
based on liner slope of 3 to 1

ϕ = Friction angle of the sand drainage layer material = 30 degrees = 0.5236 radians
based on experience

δ = Interface friction angle for liner system geosynthetics (to be determined)

c_a = Adhesion for liner system geosynthetics at active wedge (to be determined), Variable

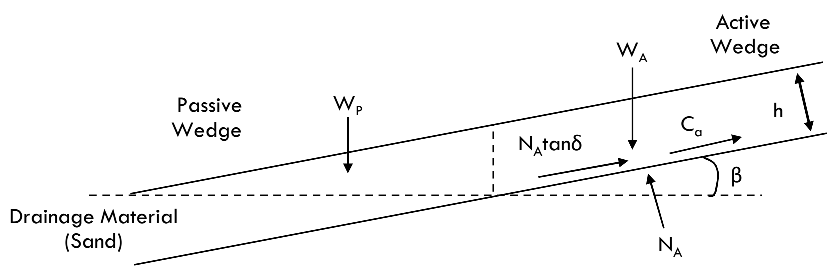
γ = Unit weight of the drainage layer material = 125 pcf
based on conservative wet density of sand

C = Cohesive force along the failure plane of the passive wedge, assumed
= 0 for drainage layer material

C_a = Adhesive force of the active wedge for the liner system geosynthetics

h = Thickness of the drainage layer material = 1 foot, based on base design

L = Length of slope measured along the geomembrane = 49 feet, based on base design



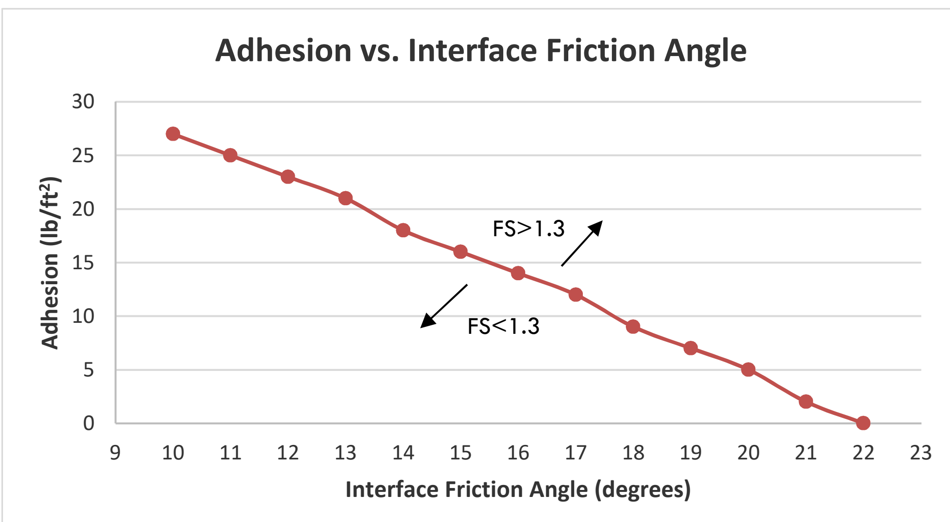
SCS ENGINEERS

		Sheet No.	2 of 2
		Calc. No.	
		Rev. No.	
Job No. 25220183.00	Job: Columbia Dry Ash Disposal Facility	By: MJT	Date: 04/04/22
Client: WPL	Subject: Liner Side Slope Drainage Layer Stability	Chk'd: DLN	Date: 04/13/22

Calculation:

(cont.)

δ		c_a	W_A	W_P	N_A	C_a	a	b	c	FS
(deg)	(rad)	(lb/ft^2)	(lb/ft)	(lb/ft)	(lb/ft)	(lb/ft)	(lb/ft)	(lb/ft)	(lb/ft)	
10	0.1745	27	5,709	208	5,416	1237.6	541	-799	126	1.3
11	0.192	25	5,709	208	5,416	1,146	541	-801	127	1.3
12	0.2094	23	5,709	208	5,416	1,054	541	-803	127	1.3
13	0.2269	21	5,709	208	5,416	963	541	-805	128	1.3
14	0.2443	18	5,709	208	5,416	825	541	-794	125	1.3
15	0.2618	16	5,709	208	5,416	733	541	-797	126	1.3
16	0.2793	14	5,709	208	5,416	642	541	-800	127	1.3
17	0.2967	12	5,709	208	5,416	550	541	-803	127	1.3
18	0.3142	9	5,709	208	5,416	413	541	-793	125	1.3
19	0.3316	7	5,709	208	5,416	321	541	-797	126	1.3
20	0.3491	5	5,709	208	5,416	229	541	-802	127	1.3
21	0.3665	2	5,709	208	5,416	92	541	-793	125	1.3
22	0.384	0	5,709	208	5,416	0	541	-798	126	1.3



Conclusion: The landfill liner side slope drainage layer was evaluated for static veneer slope stability along its longest slope. Calculations were performed to determine the minimum adhesion necessary for a range of interface friction angles to reach a FS of 1.3 or greater. Each interface friction angle and the coinciding adhesion was graphed in order to easily determine if a material interface is acceptable along the side slope.

SCS ENGINEERS

		Sheet No.	1 of 1
		Calc. No.	
		Rev. No.	
Job No. 25220183.00	Job: Columbia Dry Ash Disposal Facility	By: MJT	Date: 03/02/22
Client: WPL	Subject: GCL Internal Shear for Liner System	Chk'd: DLN	Date: 04/13/22

Purpose: Determine the maximum shear stress acting on a Geosynthetic Clay Liner (GCL) and the GCL internal shear strength required to provide a minimum slope stability safety factor (FS) of 1.5 for the liner system.

Approach: Use maximum shear stress formula and assumed values.

References: Design of GCL Barrier for Final Cover Side Slope Applications, Gregory N. Richardson, Ph.D., P.E., Geosynthetics '97-541

Calculation: The maximum shear stress acting on the GCL can be calculated as follows:

$$\tau_{act} = W_T \sin\beta$$

$$\beta = 18.4^\circ$$

$$W_T = \gamma \times h$$

Where: γ = Sand Unit Weight = 125 pcf

h = Drainage Layer Thickness = 1 ft

$$W_T = 125 \text{ psf}$$

$$\tau_{act} = 39.5 \text{ psf}$$

$$FS = \frac{\tau_{resist}}{\tau_{act}} = 1.5$$

$$\tau_{resist} = FS \times \tau_{act} = 1.5 \times 39.5 = 59 \text{ psf}$$

Assumptions: Slope angle, $\beta = 18.4^\circ$ (3:1 horizontal / vertical liner side slope

Sand unit weight, $\gamma = 125$ pcf

Conclusion: For a total weight of the leachate drainage layer of 125 psf and a slope angle of 3:1, the maximum shear stress will be 39.46 psf. A minimum GCL internal shear strength of 59.19 psf is required to provide a slope stability safety factor of 1.5.

Purpose: To determine the maximum length of slope that the final cover drainage geocomposite can carry infiltrating water and remain stable. Also determine the recommended minimum friction angle for final cover side slope stability. Note: This calculation does not include the flow convergence areas where a separate calculation is required.

Approach: Use the unit gradient method to determine the maximum slope length.

References:

1. Landfilldesign.com - Lateral Drainage System - Single Slope, Unit Gradient Method

2. "GRI-GC8, Determination of the Allowable Flow Rate of a Drainage Geocomposite". Geosynthetics Research Institute, 2001.

3. "Beyond a factor-of-safety value, i.e., the proabability of failure". GRI Newsletter/Report, Vol. 15, no. 3.

4. "Designing with Geosynthetics". R.M. Koerner, Prentice Hall Publishing Co., Englewood Cliffs, NJ, 1998.

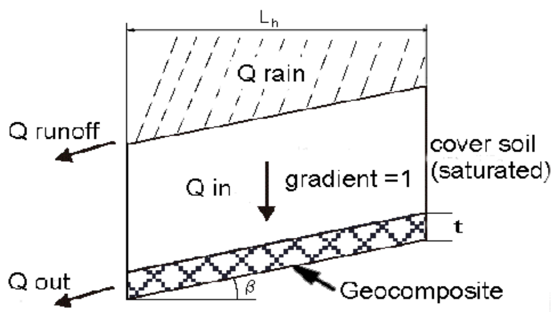
5. "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers". J. P. Giroud, J. G. Zornberg and A. Zhao, Geosynthetics International, Vol. 7, Nos 4-5.

6. "Lateral Drainage Design update - part 2". G. N. Richardson, J. P. Giroud and A. Zhao, Geotechnical Fabrics Report, March 2002.

7. Giroud, Zornberg, and Zhao, 2000, "Hydraulic Design of Liquid Collection Layers", Geosynthetics International

8. SCS Engineers, Plan Modification Request/Plan of Operation Update, Dry Ash Disposal Facility, COL Energy Center, Final Grades Plan Sheet, May 2022

9. HELP Model "User's Guide" in conjunction with GRI report #19, pages 34-37 (Leachate Collection System)



With Darcy's law:

$$Q = k * i * A$$

Inflow of water in the geocomposite

$$Q_{in} = k_{veg} * i * A = k_{veg} * 1 * L_h * 1$$

Outflow of water from the geocomposite at the toe of the slope

$$Q_{out} = k_{comp} * i * A = k_{comp} * i * t * 1 = \theta_{required} * \sin\beta$$ = θ*j*1 where θ = k_{comp} * t

Inflow equals outflow (Factor of Safety = 1)

$$Q_{in} = Q_{out}$$

This results in a required transmissivity of the geocomposite of:

$$\theta_{required} = \frac{k_{veg} * L_h}{\sin\beta}$$

Which results in the ultimate transmissivity after multiplying by the Total Serviceability Factor (TSF)

$$\theta_{ultimate} = \theta_{required} * FS_d * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

Assumptions: 1. Soil hydraulic gradient *i* = 1.0.

2. Top soil will be clay. Soil permeability is 4.2×10^{-5} cm/sec for a CL clay from HELP model user's guide.
3. Geocomposite hydraulic gradient = sinβ where β=14° (4:1 horizontal/vertical final cover slope).
4. Factor of safety and transmissivity reduction factors are from recommended values in GRI report #19 (Leachate collection system example) and HELP model "Users Guide"
5. Maximum horizontal final cover slope length from crest to toe drain is 397 feet as shown on Module 10 and 11 Final Grades plan sheet. This includes 58' of 10:1 slope length at the peak.

Calculation: Constants

L_h	=	Drainage pipe spacing or length of slope measured horizontally	=	See Below	
k_{veg}	=	Permeability of the vegetative supporting soil	=	0.000042	cm/sec
S	=	The liner's slope, **S** = tan **b**	=	25%	b = 14°
FS_{slope}	=	Minimum factor of safety against sliding, for soil/geocomposite or geocomposite/geomembrane interfaces	=	1.5	
$\delta_{req'd}$	=	Minimum interface friction angle = $\tan^{-1}$(FS*tan(b))	=	20.6	degrees
FS_d	=	Overall factor of safety for drainage	=	2.0	
RF_{in}	=	Intrusion Reduction Factor	=	1.1	
RF_{cr}	=	Creep Reduction Factor	=	1.2	
RF_{cc}	=	Chemical Clogging Reduction Factor	=	1.1	
RF_{bc}	=	Biological Clogging Reduction Factor	=	1.4	

Determine the maximum slope length for a given ultimate transmissivity

Θ_{ult} (m^2/sec)	L_h (meter)	L_h (feet)
1.00E-03	141.7	465

Determine the ultimate transmissivity based on a given slope length

L_h (feet)	L_h (meter)	Θ_{ult} (m^2/sec)	
397	121.0	8.55E-04	~ Total slope length
199	60.5	4.27E-04	~ 1/2 of total slope length
132	40.3	2.85E-04	~ 1/3 of total slope length

Conclusions: If no intermediate drainage outlets were constructed on the final cover, a minimum transmissivity of 8.55×10^{-4} m^2/sec would need to be obtained.

A minimum interface friction angle of 20.6 degrees between cover soil and geocomposite is required to achieve a minimum recommended final cover slope stability safety factor of 1.5.

Purpose: To determine the geocomposite drainage requirements in the final cover where flow converges in the north and south corners of Modules 10 and 11so the final cover drainage geocomposite can carry infiltrating water and remain stable. Also to determine the recommended minimum interface friction angle for final cover stability.

Approach: Use the unit gradient method and flow path geometry to determine the geocomposite transmissivity required at locations within the converging flow area.

References:

1. Landfilldesign.com - Lateral Drainage System - Single Slope, Unit Gradient Method

2. "GRI-GC8, Determination of the Allowable Flow Rate of a Drainage Geocomposite". Geosynthetics Research Institute, 2001.

3. "Beyond a factor-of-safety value, i.e., the proabability of failure". GRI Newsletter/Report, Vol. 15, no. 3.

4. "Designing with Geosynthetics". R.M. Koerner, Prentice Hall Publishing Co., Englewood Cliffs, NJ, 1998.

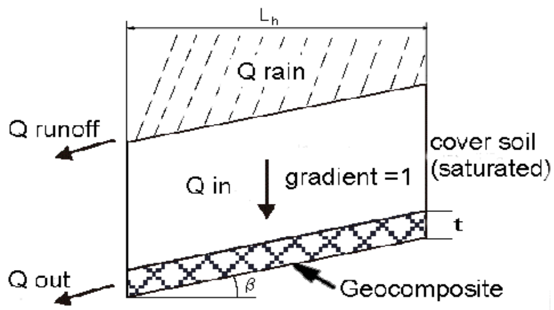
5. "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers". J. P. Giroud, J. G. Zornberg and A. Zhao, Geosynthetics International, Vol. 7, Nos 4-5.

6. "Lateral Drainage Design update - part 2". G. N. Richardson, J. P. Giroud and A. Zhao, Geotechnical Fabrics Report, March 2002.

7. Giroud, Zornberg, and Zhao, 2000, "Hydraulic Design of Liquid Collection Layers", Geosynthetics International

8. SCS Engineers, Plan Modification Request/Plan of Operation Update, Dry Ash Disposal Facility, COL Energy Center, Final Grades Plan Sheet, April 2022

9. HELP Model "User's Guide" in conjunction with GRI report #19, pages 34-37 (Leachate Collection System)



With Darcy's law:

$$Q = k * i * A$$

Inflow of water in the geocomposite

$$Q_{in} = k_{veg} * i * A = k_{veg} * 1 * L_h * 1$$

Outflow of water from the geocomposite at the toe of the slope

$$Q_{out} = k_{comp} * i * A = k_{comp} * i * t * 1 = \theta_{required} * \sin\beta$$

= θ*i*1 where θ = k_{comp} * t
(minimum allowable outflow to keep head within geocomposite)

Inflow equals outflow (Factor of Safety = 1)

$$Q_{in} = Q_{out}$$

This results in a required transmissivity of the geocomposite of

$$\theta_{required} = \frac{k_{veg} * L_h}{\sin\beta}$$

Which results in the ultimate transmissivity after multiplying by the Total Serviceability Factor (TSF)

$$\theta_{ultimate} = \theta_{required} * FS_d * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

Assumptions: 1. Soil hydraulic gradient i = 1.0.

2. Top soil will be clay. Soil permeability is 4.2 x 10^{-5} cm/sec for a CL clay from HELP model user's guide.
3. Geocomposite hydraulic gradient = sinβ where β=14˚ (4:1 horizontal/vertical final cover slope).
4. Factor of safety and transmissivity reduction factors are from recommended values in GRI report #19 (Leachate collection system example) and HELP model "Users Guide"
5. Flow paths A-E and F-J are as shown on attached drawing. Assume circular arc with radius measured from the corner of the toe drain.
6. Intermediate drainage piping will be used at 3 locations along the slope in each area to divert flow from the drainage layer to the diversion berms and downslope flume.

Calculation: Constants

L_h	=	Drainage pipe spacing or length of slope measured horizontally	=	See Below	
k_{veg}	=	Permeability of the vegetative supporting soil	=	0.000042	cm/sec
S	=	The liner's slope, **S** = tan **b**	=	25%	b = 14˚
FS_{slope}	=	Minimum factor of safety against sliding, for soil/geocomposite or geocomposite/geomembrane interfaces	=	1.5	
$\delta_{req'd}$	=	Minimum interface friction angle = $\tan^{-1}$(FS*tan(b))	=	20.6	degrees
FS_d	=	Overall factor of safety for drainage	=	2.0	
RF_{in}	=	Intrusion Reduction Factor	=	1.1	
RF_{cr}	=	Creep Reduction Factor	=	1.2	
RF_{cc}	=	Chemical Clogging Reduction Factor	=	1.1	
RF_{bc}	=	Biological Clogging Reduction Factor	=	1.4	
w	=	Geocomposite width at drainage outlet			
A	=	Final cover plan area upslope of geocomposite drainage outlet			

Determine the maximum slope length for a given ultimate transmissivity

Min. Θ_{req} = A X k_{veg} / (w X sinβ)

For the outlet at the corner, use minimum 5 foot width and 2 foot width of geocomposite to connect the toe drain to drain the converging flow area:

Area	A (sq. feet)	w (feet)	w (meter)	Min. Θ_{ult} (m^2/sec)	Proposed Θ_{ult} (m^2/sec)
1	420	5	1.52	1.81E-04	1.00E-03
4	70	2	0.61	7.53E-05	1.00E-03

The toe drainage areas, Area 1 and Area 4, include only converging flow below the lowest intermediate drainage piping, as flow above this area is diverted. There are intermediate drainage pipes in Areas 1 and 4 which divert flow from the outlet corner to the downslope flume.

For converging flow in a circular arc, from radius R-top to radius R-bottom:

L = R-top - R-bottom

w-bot = w-top * (R-bot/R-top)

A = L* (1+ (R-bot/R-top))/2 (assuming unit width at top and trapezoid vs arc to simplify)

Θult-bot = (Θult calculated for L) * R-top/R-bot * (1+ (R-bot/R-top))/2

Calculation: (Cont.) For the southern convergence area, flow paths A-E, calculate Θult for selected R-bot values to determine appropriate geocomposite products as flow converges down the slope:

Flow Path	R-top (feet)	R-bot (feet)	L_h (feet)	L_h (meters)	Θ_{ult} (m^2/sec)	Proposed Θ_{ult} (m^2/sec)
Area 1						
A1	138	26	112	34	7.57E-04	1.00E-03
B1	132	24	108	32	7.34E-04	1.00E-03
C1	129	23	106	32	7.47E-04	1.00E-03
D1	126	21	105	32	7.91E-04	1.00E-03
E1	122	20	102	31	7.77E-04	1.00E-03
Area 2						
A2	306	138	168	51	5.79E-04	1.00E-03
B2	294	132	162	49	5.58E-04	1.00E-03
C2	286	129	157	47	5.34E-04	1.00E-03
D2	278	126	152	46	5.21E-04	1.00E-03
E2	270	122	148	45	5.11E-04	1.00E-03
Area 3						
A3	328	306	22	6	4.39E-05	1.00E-03
B3	357	294	63	19	1.49E-04	1.00E-03
C3	419	286	133	40	3.48E-04	1.00E-03
D3	319	278	41	12	9.10E-05	1.00E-03
E3	285	270	15	4	2.91E-05	1.00E-03

Conclusions: For the southern area proposed design with intermediate slope outlets and a toe-of-slope drainage outlet, placement of geocomposite with the required transmissivities to the minimum lengths/areas shown in the table above and on the attached drawing will provide adequate drainage for the converging flow.

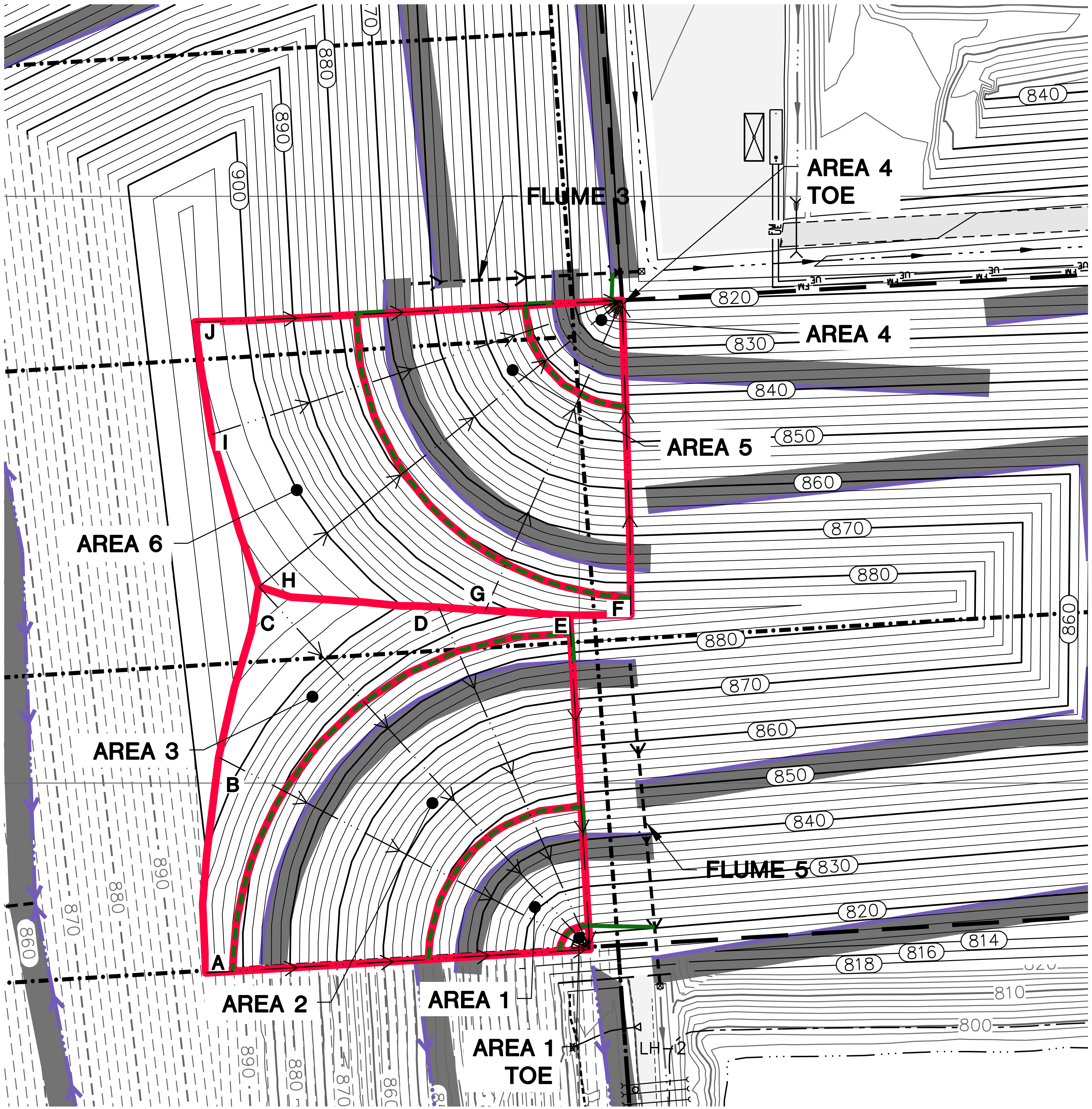
A minimum interface friction angle of 20.6 degrees for the geocomposite, geomembrane, and GCL interfaces is required to achieve a minimum recommended final cover slope stability safety factor of 1.5.

Calculation: (Cont.) For the northern convergence area, flow paths F-J, calculate θult for selected R-bot values to determine appropriate geocomposite products as flow converges down the slope:

Flow Path	R-top (feet)	R-bot (feet)	L_h (feet)	L_h (meters)	θ_{ult} (m^2/sec)	Proposed θ_{ult} (m^2/sec)
Area 4						
F4	91	11	80	24	7.86E-04	1.00E-03
G4	87	10	77	23	7.88E-04	1.00E-03
H4	86	9	77	23	8.57E-04	1.00E-03
I4	84	9	75	22	8.03E-04	1.00E-03
J4	83	9	74	22	7.94E-04	1.00E-03
Area 5						
F5	254	91	163	49	6.56E-04	1.00E-03
G5	245	87	158	48	6.47E-04	1.00E-03
H5	237	86	151	46	6.10E-04	1.00E-03
I5	231	84	147	44	5.83E-04	1.00E-03
J5	227	83	144	43	5.67E-04	1.00E-03
Area 6						
F6	268	254	14	4	2.90E-05	1.00E-03
G6	289	245	44	13	1.00E-04	1.00E-03
H6	395	237	158	48	4.52E-04	1.00E-03
I6	368	231	137	41	3.75E-04	1.00E-03
J6	365	227	138	42	3.87E-04	1.00E-03

Conclusions: For the northern area proposed design with intermediate slope outlets and a toe-of-slope drainage outlet, placement of geocomposite with the required transmissivities to the minimum lengths/areas shown in the table above and on the attached drawing will provide adequate drainage for the converging flow.

A minimum interface friction angle of 20.6 degrees for the geocomposite, geomembrane, and GCL interfaces is required to achieve a minimum recommended final cover slope stability safety factor of 1.5.



LEGEND

	LIMITS OF WASTE
	LINER PHASE/MODULE LIMIT
810	EXISTING GRADE (10' INTERVAL)
	EXISTING GRADE (2' INTERVAL)
	SWALE
	EDGE OF WATER
	WETLAND
840	PROPOSED PHASE 1 FINAL GRADE (10' INTERVAL)
	PROPOSED PHASE 1 FINAL GRADE (2' INTERVAL)
840	PROPOSED GRADE (10' INTERVAL)
	PROPOSED GRADE (2' INTERVAL)
	PROPOSED PERIMETER ROAD
	PROPOSED SWALE
	PROPOSED CULVERT
	PROPOSED LEACHATE COLLECTION SYSTEM CLEANOUT
	PROPOSED LEACHATE VAULT
FM	PROPOSED LEACHATE FORCEMAIN
UE	PROPOSED UNDERGROUND ELECTRIC
	PROPOSED DIVERSION BERM
	PROPOSED DOWNSLOPE FLUME
	PROPOSED ENERGY DISSIPATOR
	PROPOSED RIPRAP
	CONVERGENCE FLOW PATH
	PERFORATED SUBSURFACE PIPING
	SOLID SUBSURFACE PIPING

N

10 0 10

SCALE: 1" = 10'

GEOTECHNICAL CALCULATION – FLOW CONVERGENCE

FIGURE 1

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

ENGINEER

SITE: PLAN OF OPERATION 2022 UPDATE
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

CLIENT: WISCONSIN POWER AND LIGHT
COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

PROJECT NO.	25220183.00
DRAWN:	01/25/2022
REVISED:	05/02/2022
DRAWN BY:	KP/MJT
CHECKED BY:	DN
APPROVED BY:	

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SCS ENGINEERS

Sheet No.	1 of 1
Calc. No.	
Rev. No.	

Job No. 25220183.00	Job: Columbia Dry Ash Disposal Facility	By: MJT	Date: 04/25/22
Client: WPL	Subject: GCL Internal Shear on Final Cover	Chk'd: DLN	Date: 04/26/22

Purpose: Determine the maximum shear stress acting on a Geosynthetic Clay Liner (GCL) and the GCL internal shear strength required to provide a minimum slope stability safety factor (FS) of 1.5 for the final cover.

Approach: Use maximum shear stress formula and assumed values.

References: Design of GCL Barrier for Final Cover Side Slope Applications, Gregory N. Richardson, Ph.D., P.E., Geosynthetics '97-541

Calculation: The maximum shear stress acting on the GCL can be calculated as follows:

$$\tau_{act} = W_T \sin \beta$$

$$\beta = 14^\circ$$

$$W_T = \gamma \times h$$

Where:

γ	=	Soil Unit Weight	=	120	pcf
h	=	Cover Thickness	=	2.5	ft

$$W_T = 300 \text{ psf}$$

$$\tau_{act} = 72.6 \text{ psf}$$

$$FS = \frac{\tau_{resist}}{\tau_{act}} = 1.5$$

$$\tau_{resist} = FS \times \tau_{act} = 1.5 \times 72.6 = 109 \text{ psf}$$

Assumptions: Slope angle, $\beta = 14^\circ$ (4:1 horizontal / vertical final cover slope)

Soil unit weight, $\gamma = 120$ pcf

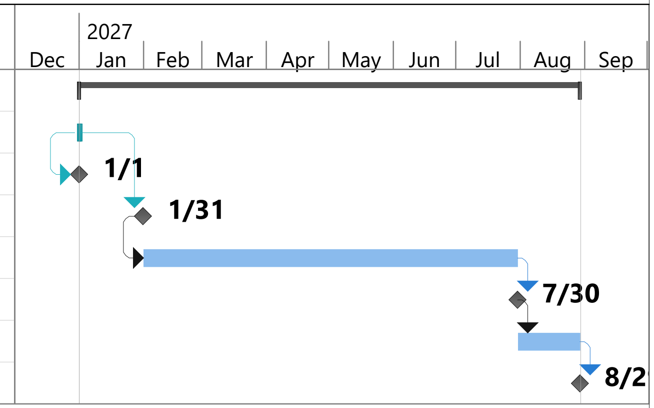
Conclusion: For a total weight of the final cover system of 300 psf and a slope angle of 4:1, the maximum shear stress will be 72.6 psf. A minimum GCL internal shear strength of 109 psf is required to provide a slope stability safety factor of 1.5.

Appendix B

Schedule

Closure Plan - Columbia Ash Disposal Facility

ID	Task Name	Duration	Start	Finish
1	**Closure of Columbia Ash Disposal Facility**	**241 days**	**Fri 1/1/27**	**Sun 8/29/27**
2	Ash Filling Ceases	1 day	Fri 1/1/27	Fri 1/1/27
3	Other Regulatory Permits - None	0 days	Fri 1/1/27	Fri 1/1/27
4	Notification of Intent to Close	0 days	Sun 1/31/27	Sun 1/31/27
5	Construction Activities	180 days	Mon 2/1/27	Fri 7/30/27
6	Notification of Closure Completion	0 days	Fri 7/30/27	Fri 7/30/27
7	Documentation of Closure	30 days	Sat 7/31/27	Sun 8/29/27
8	State Submittal of Documentation Report	0 days	Sun 8/29/27	Sun 8/29/27



Date: Tue 1/31/23

Task		Inactive Summary		External Tasks	
Split		Manual Task		External Milestone	
Milestone		Duration-only		Deadline	
Summary		Manual Summary Rollup		Progress	
Project Summary		Manual Summary		Manual Progress	
Inactive Task		Start-only			
Inactive Milestone		Finish-only			

Appendix C4

Written Long–Term Care Plan

Post-Closure Care Plan

Columbia Dry Ash Disposal Facility

Phase 1 Module 1
Phase 1 Module 2
Phase 1 Module 3
Phase 1 Module 4
Phase 1 Module 5
Phase 1 Module 6
Phase 2 Module 10
Phase 2 Module 11

Prepared for:

Wisconsin Power and Light Company
Columbia Energy Center
W8375 Murray Road
Pardeeville, Wisconsin 53954

SCS ENGINEERS

25222260.00 | February 1, 2023

2830 Dairy Drive
Madison, WI 53718-6751
608-224-2830

Table of Contents

Figures

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PE CERTIFICATION

I, Phillip Gearing, hereby certify that I am a licensed professional engineer in the State of Wisconsin in accordance with the requirements of ch. A–E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A–E 8, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 500 to 538, Wis. Adm. Code.

Specifically,

- This Post-Closure Care Plan was prepared by me or under my direct supervision and meets the requirements of 40 CFR 257.104(d) and NR 514.07(10)(d)

February 1, 2023

(signature) (date)

Phillip E. Gearing

(printed or typed name)

License number E-45115

My license renewal date is July 31, 2024.

Pages or sheets covered by this seal:

ALL

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1.0 INTRODUCTION AND PROJECT SUMMARY

On behalf of Wisconsin Power and Light Company (WPL), SCS Engineers (SCS) has prepared this Post-Closure Care Plan for the Columbia (COL) Dry Ash Disposal Facility Phase 1, Modules 1 through 6 and Phase 2, Modules 10 and 11 as required by 40 Code of Federal Regulations (CFR) 257.104 and Wisconsin Administrative Code NR 514.07(10)(d), as stated below.

40 CFR 257.104(d). *"Written post-closure plan – (1) Content of the plan. The owner or operator of a CCR unit must prepare a written post-closure plan that includes, as a minimum, the information specified in paragraphs (d)(1)(i) through (iii) of this section."*

NR 517.07 (10)(d). *"A written long–term care plan that addresses all of the following: 1. A description of the monitoring and maintenance activities and the frequency at which those activities will be performed. The activities shall include, at a minimum, all of the following:"*

The COL facility includes an active coal combustion residual (CCR) landfill, which currently consists of the following modules, located in Phase 1 and Phase 2 of the facility.

- **Phase 1, Module 1** – This module has received final cover over outer sideslope areas that will no longer receive additional CCR; intermediate cover has been placed over remaining areas. The final cover placed complies with the CCR Rule.

- **Phase 1, Module 2** – This module has received intermediate cover over a majority of the in-place CCR.

- **Phase 1, Module 3** – This module has received intermediate cover over a majority of the in-place CCR.

- **Phase 1, Module 4** – This module is currently being filled.

- **Phase 1, Module 5** – This module is currently being filled.

- **Phase 1, Module 6** – This module is currently being filled.

- **Phase 2, Module 10** – Construction of the Module 10 liner began in 2022. The new module will be used for disposal following approval of the liner Construction Documentation Report, which will be submitted for Wisconsin Department of Natural Resources (WDNR) review early in 2023. Filling is anticipated to begin in 2023.

- **Phase 2, Module 11** – Construction of the Module 11 liner began in 2022. The new module will be used for disposal following approval of the liner Construction Documentation Report, which will be submitted for WDNR review early in 2023. Filling is anticipated to begin in 2023.

Phase 1, Modules 1-3 were previously described as separate existing CCR landfills although they are contiguous and are managed as a single landfill by the facility and by the WDNR. WPL has clarified in the operating record for the Columbia facility that Modules 1-3 are one existing CCR landfill as defined in 40 CFR 257.53 of the federal CCR Rule. Phase 1, Modules 4-6 are considered to be a new CCR landfill that initiated construction after October 19, 2015, and is therefore managed as a separate CCR unit under the CCR Rule even though they are contiguous to the existing CCR landfill

(Modules 1-3). In addition, the new CCR landfill will include Phase 2, Modules 10 and 11, once the liner construction documentation is approved by the WDNR in 2023. Construction of additional modules is not currently planned prior to retirement of the Columbia Energy Center, which is currently scheduled to occur no later than June 1, 2026.

The site location is shown on **Figure 1**. **Figure 2** shows proposed final cover grades and monitoring locations.

Phase 1, Module 1 has been partially closed with a final cover as described in the Closure Plan for the existing CCR landfill. The remaining open areas of this module will be closed when CCR materials reach final waste grades, as described in the Plan of Operations approved by the WDNR. The future final cover system is planned to differ from the existing final cover system, as explained in the Closure Plan. Following the closure of the CCR units at COL, WPL will conduct post-closure care in accordance with 40 CFR 257.104(b) for the required 30 years and with NR 514.07(10)(d) for the required 40 years per NR 506.084(2).

2.0 MONITORING AND MAINTENANCE ACTIVITIES

40 CFR 257.104(d)(1)(i). *"A description of the monitoring and maintenance activities required in paragraph (b) of this section for the CCR unit, and the frequency at which these activities will be performed."*

NR 514.07(10)(d)(1). *"A description of the monitoring and maintenance activities and the frequency at which those activities will be performed."*

Monitoring and Maintenance Activities	Frequency
Mowing	Semi-Annually
Inspections by Owner/Operator	Quarterly
Repair to Final Cover for Erosion Concerns	As needed, determined by inspection
Sedimentation Basin Cleaning	As needed, determined by inspection
Leachate Collection Line Cleaning	Annually
Environmental Monitoring (groundwater, leachate)	Semi-Annually

The owner/operator will perform quarterly inspections of the landfill surface, leachate control system, and groundwater monitoring systems. If issues are noticed during the inspection, action will be taken to remedy the situation. Eroded areas will be repaired and reseeded. Repairs or replacement will be performed on the groundwater monitoring system as needed.

2.1 FINAL COVER MAINTENANCE

Mowing will be performed semi-annually during the growing season unless additional mowing is required in response to the vegetation growth rate. During quarterly inspections, if eroded areas are noted, WPL will repair and reseed the area.

2.2 LEACHATE COLLECTION AND REMOVAL SYSTEM MAINTENANCE

The leachate collection and removal system for the existing CCR landfill and existing / future units will be maintained to meet state requirements including leachate collection line cleaning, leachate collection video inspection, and any needed repairs to the existing system.

Phase 1, Module 4 was constructed and opened in 2018. Module 4 is a new CCR landfill as defined in 40 CFR 257.53. Phase 1, Modules 5 and 6 were constructed in 2021. Phase 2, Modules 10 and 11 began construction in 2022. These modules are defined as lateral expansions of the new CCR landfill. Phase 1, Modules 4, 5, and 6 and Phase 2, Modules 10 and 11 are in compliance with the requirements of 40 CFR 257.70, as demonstrated in the Liner and Leachate Collection System Design Compliance Demonstrations. Phase 1, Modules 4, 5, and 6 and Phase 2, Modules 10 and 11 are in compliance with the requirements of NR 504.12, as demonstrated in the Plan of Operation Modification Request WDNR CCR Code Update Report.

2.3 GROUNDWATER MONITORING AND SYSTEM MAINTENANCE

All CCR Wells, as defined by NR 500.03(26y) and approved by the Department, will be maintained and sampled semi-annually for the parameters listed in Appendix III to Part 257 and listed in Appendix I, Table 1A to NR 507, and in accordance with 40 CFR 257.90-98 and NR 507.15 (3).

Non-CCR monitoring wells at the site will be maintained and sampled as approved by the Department in writing.

3.0 POST-CLOSURE PERIOD CONTACTS

40 CFR 257.104(d)(1)(ii). *"The name, address, telephone number, and email address of the person or office to contact about the facility during the post-closure period."*

NR 514.07(10)(d)(2). *"The name, address, telephone number, and email address of the person or office to contact about the facility during long–term care."*

Currently, the contact information for COL during the post-closure/long-term care period is as follows:

Columbia Energy Center
Attn: Plant Manager
W8375 Murray Road
Pardeeville, WI 53954
(608) 742-0711
CCRProgram@alliantenergy.com

4.0 POST-CLOSURE PERIOD SITE USE

40 CFR 257.104(d)(1)(iii). *"A description of the planned uses of the property during the post-closure period. Post-closure use of the property shall not disturb the integrity of the final cover, liner(s), or any other component of the containment system or the function of the monitoring systems unless necessary to comply with the requirements of the subpart..."*

NR 514.07(10)(d)(3). *"A description of the planned uses of the property during long–term care. Post–closure uses may not disturb the integrity of the final cover, liner, or any other component of* *the landfill, or the function of the monitoring systems unless approved in writing by the department....”*

The final use of the COL Dry Ash Disposal Facility will be privately owned green space. With this use, there will be no disturbance of the final cover or any other landfill-related components.

5.0 CERTIFICATIONS

40 CFR 257.104(d)(4). *“The owner or operator of the CCR unit must obtain a written certification from a qualified professional engineer that the initial and any amendment of the written post-closure plan meets the requirements of this section.”*

NR 500.05. *“Unless otherwise specified, all submittals for review and approval of any initial site report, feasibility report, plan of operation site investigation report, remedial action options report, construction documentation report, or closure plan, or any modifications to those plans, shall include all of the following:*

(4) CERTIFICATION. (a) The reports and plan sheets shall be under the seal of a licensed professional engineer.”

Phillip Gearing, PE, a licensed profession engineer in the State of Wisconsin, has overseen the preparation of this Post-Closure Care Plan. A certification statement is provided on page iii of this plan.

6.0 RECORDKEEPING AND REPORTING

40 CFR 257.104(b)(2)(iii). *“The owner or operator has completed the written post-closure plan when the plan including the certification required by paragraph (d)(4) of this section, has been placed in the facility’s operating record as required by Section 257.105(i)(4).”*

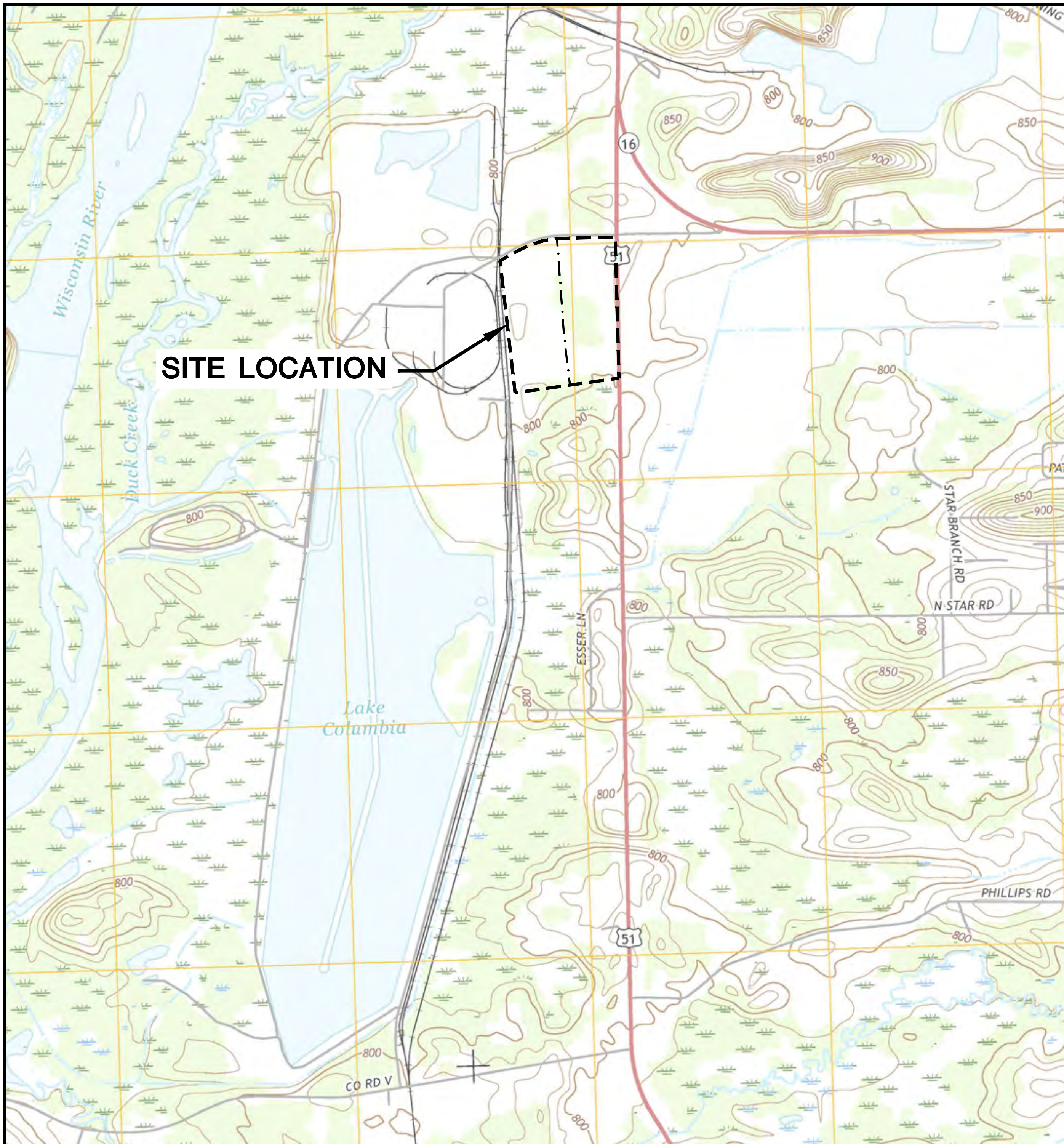
NR 506.17(2)(e). *“The written operating record shall contain the plan of operation, plan modifications, construction documentation, department approvals, annual reports, inspection records, monitoring and corrective action records, notifications to the department, and records of public comments received during any public comment period.”*

The Post-Closure Care Plan will be placed in the facility’s operating record and on Alliant Energy’s CCR Rule Compliance Data and Information website, as will all amendments.

WPL will amend the Post-Closure Care Plan if there is a change in operation of the CCR unit that affects the written Post-Closure Care Plan or, if after post-closure activities have started, unexpected events cause a revision of the plan.

WPL will provide notification of completion of the post-closure care no later than 60 days following the completion of the post-closure care period. The notification will include certification by a qualified professional engineer verifying that post-closure care has been completed in accordance with the plan. The notification will be placed in the facility’s operating record and on the website.

Figures



N

POYNETTE QUADRANGLE
WISCONSIN–COLUMBIA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
2016
SCALE: 1" = 2,000'

CLIENT	SITE	
WISCONSIN POWER AND LIGHT COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WISCONSIN 53954	POST CLOSURE CARE PLAN COLUMBIA DRY ASH DISPOSAL FACILITY TOWN OF PACIFIC, WISCONSIN	SITE LOCATION MAP

PROJECT NO.	25222260.00	DRAWN BY:	AHB	ENGINEER	SCS ENGINEERS 2830 DAIRY DRIVE MADISON, WI 53718-6751 PHONE: (608) 224-2830	FIGURE
DRAWN:	08/09/2016	CHECKED BY:	RJG			1
REVISED:	12/28/2022	APPROVED BY:	PEG 01/31/23			

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LEGEND

- ASH DISPOSAL FACILITY LIMITS
- APPROVED LIMITS OF ASH FILL
- PHASE/MODULE LIMIT
- 810 EXISTING GRADE (10' CONTOUR)
- EXISTING GRADE (2' CONTOUR)
- PAVED ROAD
- UNPAVED ROAD
- RAILROAD TRACKS
- VEGETATION
- FENCE
- SWALE
- EDGE OF WATER
- APPROXIMATE LIMITS OF EXISTING LEACHATE/SURFACE WATER POND LINER
- CULVERT
- TRANSMISSION TOWER
- WATER SUPPLY WELL
- WATER TABLE WELL
- PIEZOMETER
- SURFACE WATER SAMPLE LOCATION
- LYSIMETER
- LEACHATE HEADWELL
- BENCHMARK
- 820 PROPOSED FINAL GRADES (10' CONTOUR)
- PROPOSED FINAL GRADES (2' CONTOUR)

NOTES:

1. BASE MAP CREATED FROM AERIAL SURVEY BY KBM, FLOWN DECEMBER 1, 2014, AND GROUND SURVEY BY SCS ENGINEERS IN DECEMBER 2020, AND BY DRONE SURVEY BY AMES ON JANUARY 17, 2023.
2. MONITORING WELL LOCATIONS AND ELEVATIONS SURVEYED BY WISCONSIN POWER AND LIGHT, INC. IN DECEMBER 1994, NOVEMBER 1996, APRIL 2003, AUGUST 2012, JANUARY 2016, AND BY SCS ENGINEERS IN MAY 2019.

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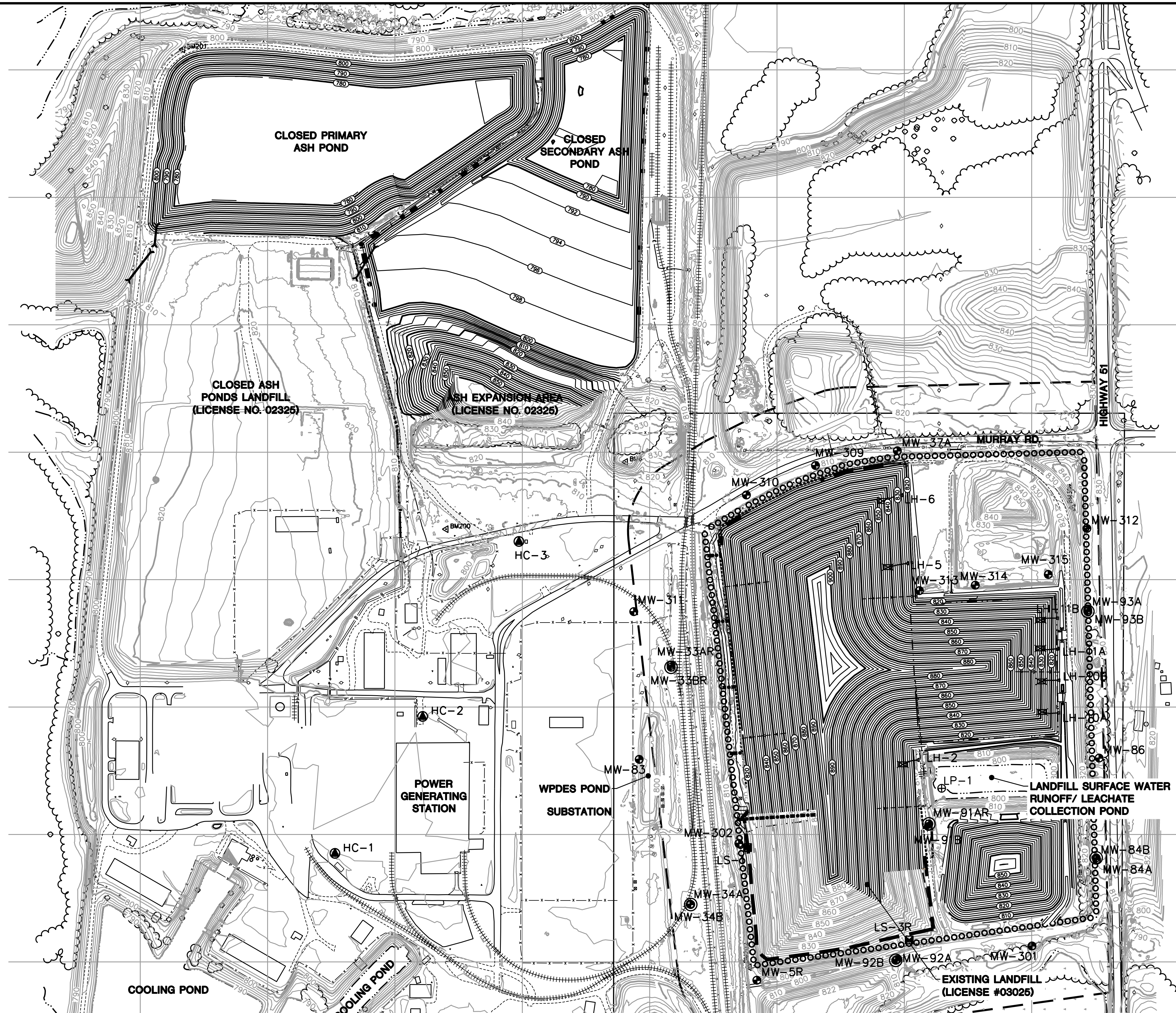
400 0 400

SCALE: 1" = 400'



POST-CLOSURE CARE PLAN

FIGURE 2

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

ENGINEER

SITE
POST-CLOSURE CARE PLAN
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

CLIENT
WISCONSIN POWER AND LIGHT
COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

PROJECT NO.	25222260.00	DRAWN BY:	BJM/KP
DRAWN:	12/18/2017	CHECKED BY:	PEG
REVISED:	1/25/2023	APPROVED BY:	PEG 01/31/23

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