Revisions submitted June 20, 2017 By Steve Howiler (Consultant) for the Design Notes and Drawing 6 of 7

Comments from Mr. Howiler:
Attached is a revised set of design notes. I've corrected the storm flow calculation and plugged new numbers into the rest of the calculations for both stormwater basins. I adjusted the pump on/off setting in Basin #2 to make everything work out and be close to the same. The 25-yr. and 100-yr. storm water levels in both basins changed slightly, as did the maximum basin outflows. Basin #2 also required an increase in outflow structure barrel size from 30" to 36".

My AutoCAD computer has died. I was unable to modify the original drawings, but I have added notes to the Drwg. 6 of 7 PDF showing needed changes and have attached this. Hope this suffices for your records.

Let me know if you see anything else.

Culclasure Farm Tract, LLC
Culclasure Farm Mine
Horsefeathers Lane, NW of Saint Matthews
Calhoun County, SC

Erosion and Sediment Control Design Calculations

For Mine Permit Application - Culclasure Farm Mine
Mine Permit Application #I-002093

January, 2017
REV. 2 - 6/20/17

Submitted to:
S.C. Department of Health & Environmental Control
Bureau of Land and Waste Management
Mining & Reclamation Section

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Howiler & Associates
Designer: Steve Howiler   Date: 1/23/17   Date Revised: 6/20/17 (SW Basins #1 & #2)

Culclasure Farm Tract, LLC - Culclaure Farm Mine - Calhoun County, SC
Mine Permit Application #I-002093

Runoff Calculations and Design of Pit #1 Tailings/Storm Water Sediment Basin, Pit #2 Storm Water Sediment Basin, Stormwater Channels, & Culverts

References: (1) N.C. Erosion and Sediment Control Planning and Design Manual
(2) Stormwater Management and Sediment Control Handbook for Land Disturbance Activities
3) SCDHEC Storm Water Management BMP Handbook

Description of Project:

The subject area consists of 67.98 acres of sandy, mostly cutover, timber lands. The purpose of this exercise is to provide stormwater engineering calculations to SCDHEC as part of a mine permit application for this property to allow the mining of various sand, sand/clay, and clay products. We will use the above-referenced tools in our design and insure that SC sediment control guidelines, which require a soil trapping efficiency of 80% of the d_{15}-size suspended particles in the stormwater at the 25-yr. storm design flow, are met for the release of all stormwater. We will attempt to size the two planned sediment basins to meet this criteria for the 100-yr. storm as well. Principal spillway will be designed to pass the 25-yr storm. It will also pass the 100-yr. storm or an emergency spillway will be provided. The site mining operation will be developed over a period of +/-25 years in two phases. Phase 1 will be the mining of Pit #1 south of Horsefeathers Lane, beginning with the development of the initial plant site, plant, and Pit#1 Tailings/Storm Water Sediment Basin. Phase 2 will consist of development of the Pit#2 Pit Water/Storm Water Sediment Basin as Pit #1 mining is completed and the subsequent mining of the property north of Horsefeathers Lane.

The Pit #1 Tailings/Storm Water Sediment Basin ut waste fine sands, silts, and clays from the plant washing process and will also collect stormwater runoff from the Pit #1 mining area. The plant wash water input will be recycled to the plant for re-use in the wash process. Much of the storm water runoff will be stored and used as makeup water in the plant wash process. The basin will also accept any water generated from required pit dewatering in both Pit #1 and Pit #2, as well as collected stormwater from storm events up to the 25-yr., 24-hr. event from Pit #2 basin. These inputs which will serve as additional makeup water for losses in the fresh water system. The losses in pond evaporation and incorporation into the washed sand products will amount to 15-20% annually of the total +/-400M water used. This basin will discharge to a tributary of Sembly Branch through a primary spillway structure consisting of concrete riser and barrel. An emergency spillway for the 100-yr. storm flow will be provided as well if needed. The Pit #2 Storm Water Sediment Basin will serve as a sediment basin for the storm water runoff from the Pit #2 area. This basin will discharge to a riprap apron in a natural drainage swale through a primary spillway structure consisting of a concrete riser and concrete pipe barrel. Grass-lined channels and culverts designed for the 25-yr. flow will be installed in Pit #2 to direct stormwater runoff from the Phase 2 work to the Pit #2 Sediment Basin. All collected stormwater up to and including the 25-yr., 24-hr. storm event will be pumped to the Pit #1 basin for treatment and discharge. Stormwater from events above the 25-yr. event will be treated and discharged.

I. Design of Pit #1 Tailings/Storm Water Basin (refer to map for location)

Calculate Estimated Volume of Sediment to be Stored Before Cleanout

Minimum required - 1,800 cf/ac x 20.5 acs. = 36900 cf

$V_c = 18*T*A^{0.84}$ where T = Cleanout interval = 180 days
A = disturbed area = 20.5 acres

$V_c =$ 40965 cu. ft

In this basin, we will set maximum allowable level of tailings/sediment build up before basin will need to be expanded to continue functioning properly

I) Design basin based on maintaining trapping efficiency during 25-yr. storm event

A-1) - Calculate Peak Flow, Q_{25}, for the contributing drainage area using SCS TR-55

Base Information for Peak Runoff Calculation
Location: near Columbia in Calhoun County, SC

For worst case scenario as noted above:

Drainage Area =	20.5	acres			
Hydraulic Length =	1250	feet			
% Hydraulic Length modified:			0	%	
Average slope =	5.0	%	(60' fall over 475' & 2' fall over 775')		
Ratio of drainage area to ponded area:			ponded =	2.6	acs.
at design point			Ratio =	7.9	

road - unpaved	0.8	Acres	3.9%
newly graded area - mine area	12.40	Acres	60.5%
plant area	2.50	Acres	12.2%
stockpile area	0.70	Acres	3.4%
overburden/storage/disposal - berms	0.50	Acres	2.4%
sediment basin	2.60	Acres	12.7%
sediment basin assoc. slopes	0.50	Acres	2.4%
undisturbed areas	0.50	Acres	2.4%
	20.5		100%

1) Calculate average curve number (CN)

soil group "B"

	% Area	CN	%Area x CN
road - unpaved, gravel	3.9%	85	3.32
newly graded area-mine area	60.5%	89	53.83
plant area	12.2%	80	9.76
stockpile area	3.4%	60	2.05
berms	2.4%	60	1.46
sediment basin	12.7%	100	12.68
basin assoc. slopes	2.4%	60	1.46
undisturbed	2.4%	60	1.46
	100%		86.03

Therefore, use CN = 86

2) Determine runoff depth

From Appendix "D" (Ref. 2) for Calhoun County, the rainfall amount for the 25-year, 24-hr. storm at site,

P = 6.7 inches

Ultimate Soil Storage Capacity = S = (1000/CN) - 10 = 1.62 inches

Runoff depth, Q_r = $(P-0.2S)^2/(P+0.8S)$ = 5.08 inches

3) Determine peak rate of runoff, Q_1, for the design storm by adjusting for watershed shape

Using the equation $L = 209*a^{0.6}$,where (**L**) is the hydraulic length and (**a**) is the drainage area

the equivalent drainage area is therefore, **a** = 19.7 acres

From figure 8.03p (Ref. 1), 3-8% slope, CN = 86; peak rate of runoff = 23.0 cfs/inch

Q_1 = Peak Rate Runoff * Qr = 116.9 cfs

$Q_2 = Q_1$ * Actual Area/Equiv Area = 121.6 cfs

4) Adjust peak discharge rate Q_2 for percent impervious area (none, therefore factor =1) and percent hydraulic length modified:

From figure 8.03r (Ref 1), for CN = 86 and % length modified = 0

hydraulic length adjustment factor = 1.0

therefore, $Q_3 = Q_2$ * adj factor = 121.6 cfs

5) Adjust peak discharge rate Q_3 for average watershed slope

By interpolation from Table 8.03d (ref 1), for avg. slope = 5.0 and drainage area = 20.5

adjustment factor = 1.05

$Q_4 = Q_3$* adj. Factor = 127.6 cfs

6) Adjust peak discharge Q_4 for surface ponding

From Table 8.03e, for Q_{25} and ponding ratio = 7.9 at design point

Adjustment factor = 0.58

Adjustment factor =

Average factor = 0.58

$Q_{p\ 25,24}$ = Q4 *adj. Factor = 74.0 cfs

B) - Compute time to peak for 25-yr storm

$T_p = (43.5 * Q_r * A) / Q_p$ = 61 min

C) - Develop Hydrograph of inflow for 25-yr storm event

Applying step function, calculate inlet flow to basin for various times using:

for time between zero and 1.25 T_p: $Q = Q_p / 2 *((1-\cos(\pi t / T_p))$

for time > 1.25 T_p: $Q = 4.34 * Q_p \exp((-1.30(t/T_p))$

25-yr. Storm Hydrograph

Known Information

T_p = 61 min

$Q_{p\ 25,24}$ = 74.0 cfs

Time (min)	Flow (cfs)	
4	0.78	
8	3.08	
12	6.80	
16	11.80	
20	17.85	
24	24.71	
28	32.09	
32	39.68	
36	47.15	
40	54.19	
44	60.52	
45	61.96	
48	65.86	
52	69.98	
56	72.72	
61	74.03	**T_p**
64	73.65	
68	71.80	
72	68.49	
76.25	63.53	**1.25T_p**
80	58.74	
84	53.95	
88	49.56	
92	45.52	
96	41.81	
100	38.41	

104	35.28
108	32.40
112	29.76
116	27.34
120	25.11
124	23.07
128	21.19
132	19.46
136	17.88
140	16.42
144	15.08

D) - Determine Stage-Storage Relationship in pond

Dug & dammed pond. Pond bottom elevation = 200 & top bank = 242. Area at each elevation from Dwg. No. 2 of 7. Max. level of allowed tailings/sediment build up will be 230.0. Consider this "bottom" of basin, Area = 90,349 sf.

Contour Elev.	Area (square ft)	Avg. Area (square ft)	Depth (feet)	Volume (cubic feet)	Accumulated Volume (cu ft)	
230	90,349					Pond "bottom" = allowed sediment level
231	93,291	91,820	1	91,820	91,820	= normal operating water level
232	96,233	94,762	1	94,762	186,582	
233	99,372	97,803	1	97,803	284,385	
234	102,511	100,942	1	100,942	385,326	
235	105,960	104,236	1	104,236	489,562	
236	109,410	107,685	1	107,685	597,247	
237	113,281	111,346	1	111,346	708,592	Riser Crest
238	117,152	115,217	1	115,217	823,809	
239	121,361	119,257	1	119,257	943,065	
240	125,571	123,466	1	123,466	1,066,531	
242	129,710	127,641	1	127,641	1,102,352	Top Bank

$S = K_s * Z_b$

Determine K_s and b using known information from two contour levels, near max. water level = 240' and mid-depth, elev. = 235'

$b = \ln(S_2/S_1)/\ln(Z_2/Z_1) =$ ln(1066531/489562) / ln(10/5) = 1.135

$K_s = S_2 / (Z_2)^b$ = 1066531/ (10)^1.135 = 78141

Check constants using $Z = (S/K_s)^{1/b}$

At depth =8', 8' = $(823809/78141)^{1/1.135}$ = 7.97 ft

Therefore, since the result is within 0.2', we can consider the constants valid.

Set 1 - 96" dia. riser bottom elevation = 230 and crest elevation = 237' (8' riser section w/1' set into concrete anti-float/foundation pad)

E) - Check that trapping efficiency of suspended solids >80% based on d_{15} particle

Soils over most of the contributing area will be sand to loamy sand soils to be mined and processed. The native soils in this area are predominantly Troupian sands (TrB) and Ailey-Vaucluse loamy sands (AmE), which, at depths to be encountered will likely consist of only +/-10%-30% particles passing the 200 mesh (as verified by boreholes).

By extrapolation, we estimate the d_{15} size particle to be about 0.064 mm, (use for design)

From Figure 1, (Ref. 2), the V_{15} settling velocity is then = 0.0065 ft/sec.

For 80% trapping efficiency, from Figure 2a (Ref. 2), the ratio Qpo/AV$_{15}$ must be less than 240,000

At spillway crest elevation = 237, for the soils to be encountered:

Qpo = 240,000*A*V$_{15}$ = 4057 cfs *Note: Area (A) is in acres*

Our expected outflow is <74cfs, so limiting outflow is should be no problem; however, we will control water level in basin Qo by putting holes in the riser at level we want to maintain between storm events.

Use 8 - 4" dia. holes at elev. = 234 (Stage=0') to maintain water level between storm events and limit Qo.

Use Short-cut Flood Routing Method to check that 25-yr storm inflow does not cause Qpo to exceed allowable for 80% trapping efficiency at any depth

For Hw = diameter (d) =4" = 0.33' (diameter of drainage orifices, area = 0.088 sq. ft), we find:

$Q = Cd*a*((2g)(stage - d/2))^{0.5}$ = $K*(Hw)^{1.5}$

Hw > diameter Hw < diameter

$Q = (0.6)(0.088)((64.4)(0.167))^{0.5}$ = 0.17 cfs = $K*(0.33)^{1.5}$

K = 0.17 / $(0.33)^{1.5}$ = 0.91 ,so for Hw < 0.33', Q = 0.91*$(Hw)^{1.5}$

$Q = (0.6)(0.022)((64.4)(0.083))^{0.5}$ = 0.03 cfs = $K*(0.167)^{1.5}$

K = 0.03 / $(0.167)^{1.5}$ = 0.45 ,so for Hw < 0.167', Q = 0.45*$(Hw)^{1.5}$

Stage-Storage-Discharge Data by Short-cut Flood Routing Method - based on 25-yr. storm hydrograph. Consider pumped 11.15 cfs input from Pit #2 Basin for worst case scenario.

Assume 96" riser, with riser crest elevation = +/-237.0, Stage 3.0'

Flow over weir = Q = Cw*L*H$^{1.5}$, where Cw is weir coefficient, L is length of weir, and H is height of water above the weir.

Known Information

T_p = 61 min

$Q_{p\ 25,24}$ = 74.0 cfs

K_s = 78141

b = 1.135

Time (min)	Inflow (cfs)	Storage (cu. ft)	Stage (ft)	Outflow (cfs)		Area @ Stage	Allowable Qo
0	0	0	0.00	0.00	Hw < dia 4" drain holes		
		0					
4	0.78	0	0.00	0.00			
		187					
8	3.08	187	0.00	0.00			
		738					

12	6.80	925	0.02	0.02				
		1628						
16	11.80	2553	0.05	0.08				
		2813						
20	17.85	5366	0.09	0.21				
		4234						
24	24.71	9600	0.16	0.46				
		5822						
28	32.09	15422	0.24	0.85				
		7497			Hw > dia 4" holes			
32	39.68	22919	0.34	1.97				
		4524						
34	43.45	27444	0.40	2.14				
		4957						
36	47.15	32400	0.46	2.30				
		10763						
40	65.34	43164	0.59	2.61	PUMP ON in Pit #2 Basin	104546	3744	OK!
		15056						
44	71.67	58220	0.77	2.98				
		16486						
48	77.01	74706	0.96	3.32				
		17684						
52	81.13	92391	1.16	3.65				
		18596						
56	83.87	110987	1.36	3.96				
		4795						
57	84.33	115782	1.41	4.03				
		4818						
58	84.69	120600	1.47	4.10				
		14505						
61	85.18	135105	1.62	4.31	T_p			
		14556						
64	84.80	149661	1.77	4.51				
		19270						
68	82.95	168931	1.97	4.76	$1.25*T_p$	108927	3901	OK!
		18766						
72	79.64	187697	2.16	4.99				
		19037						
76.25	74.68	206733	2.36	5.20				
		15631						
80	69.89	222365	2.51	5.37				
		15483						
84	65.10	237848	2.67	5.53				
		14296						
88	60.71	252144	2.81	5.68				
		13207						
92	56.67	265351	2.94	5.81				
		12207						
96	52.96	277558	3.05	5.92				
		2117						
96.75	52.30	279674	3.08	5.94	Riser Crest @ Stage 3.0 - Elev.=237			
		9040						
100	49.56	288714	3.16	7.02				
		10210						
104	46.43	298924	3.26	8.13		113900	4079	OK!
		9191						
108	43.55	308115	3.35	9.31				
		8218						
112	40.91	316333	3.43	10.49				
		7301						

116	38.49	323634	3.50	11.63				
		6447						
120	36.26	330082	3.56	12.69				
		5658						
124	34.22	335740	3.61	13.67				
		4933						
128	32.34	340672	3.66	14.55				
		4269						
132	30.61	344942	3.70	15.34				
		3666						
136	29.03	348608	3.73	16.03				
		3119						
140	27.57	351727	3.76	16.63				
		2625						
144	26.23	354353	3.79	17.15				
		2181						
148	25.00	356534	3.81	17.58				
		1782						
152	23.88	358316	3.83	17.94				
		1426						
156	22.84	359742	3.84	18.22				
		1108						
160	21.89	360849	3.85	18.45				
		825						
164	21.01	361674	3.86	18.62				
		575						
168	20.21	362249	3.86	18.74				
		354						
172	19.47	362603	3.87	18.81				
		159						
176	18.79	362762	3.87	18.84				
		-11						
180	18.17	362750	3.87	18.84	max. water level and Qo	116455	4171	OK!
		-160						
184	17.60	362590	3.87	18.81				
		-290						
188	17.07	362300	3.86	18.75				
		-401						
192	16.59	361899	3.86	18.66				
		-497						
196	16.15	361401	3.85	18.56				
		-579						
200	15.74	360822	3.85	18.44				
		-649						
204	15.37	360173	3.84	18.31				
		-707						
208	15.02	359466	3.84	18.17				
		-755						
212	14.71	358712	3.83	18.02				
		-14488						
285	11.90	344223	3.69	15.20	PUMP OFF in Pit #2 Basin			
		-2968						
300	0.00	341255	3.66	14.66				
		-69465						
379	0.00	271790	3.00	5.87	Riser Crest @ Stage 3.0 - Elev.=237			
		-42615						
500	0.00	229174	2.58	5.45				
		-163352						
1000	0.00	65822	0.86	3.14				

We see that maximum stage will be 3.87' or elevation = 237.87, 0.87' above riser crest, for the 25-yr storm inflow to the basin. 80% trapping efficiency requirement will be met, as maximum discharge, Q_{po}, will be 17.90 cfs at this elevation which is less than the 4171 cfs allowed at this elevation (240,000 x 2.67 acs. x 0.0065 fps). Top of impoundment elev. = 242.0 gives 4.13' freeboard.

II. Check principal spillway capacity for 100-yr. storm. Provide emergency spillway if necessary.

A) - Calculate $Q_{100,24}$

1) Determine runoff depth

From Appendix "D" (Ref. 2) for Calhoun County, the rainfall amount for the 100-year, 24-hr. storm at site, P = 9.3 inches

Ultimate Soil Storage Capacity = S = (1000/CN) - 10 = 1.62 inches

Runoff depth, Q_r = $(P-0.2S)^2/(P+0.8S)$ = 7.60 inches

2) Determine peak rate of runoff for the design storm by adjusting for watershed shape

Using the equation L = 209*a^0.6 where (**L**) is the hydraulic length and (**a**) is the drainage area

the equiv. drainage area is therefore, **a** = 19.7 acres

From Fig. 8.03p (Ref. 1), 3-8% slope, CN = 86; peak rate of runoff = 23.0 cfs/inch

Q_1 = Peak Rate Runoff * Qr = 174.8 cfs

Q_2 = Q_1 * Actual Area/Equiv Area = 181.8 cfs

3) Adjust peak discharge rate Q_2 for percent impervious area (none, therefore factor =1) and percent hydraulic length modified:

From figure 8.03r (Ref 1), for CN = 86 and % length modified = 0
hydraulic length adjustment factor = 1.0

therefore, Q_3 = Q_2 * adj factor = 181.8 cfs

4) Adjust peak discharge rate Q_3 for average watershed slope

By interpolation from Table 8.03d (ref 1), for avg. slope = 5.0 and drainage area = 20.5
adjustment factor= 1.05

Q_4 = Q_3* adj. Factor = 190.9 cfs

5) Adjust peak discharge Q_4 for surface ponding

From Table 8.03e, for Q_{100} and ponding ratio = 7.9 at design point
Adjustment factor = 0.66
Adjustment factor =
Average factor = **0.66**

$Q_{p\ 100,24}$ = Q4 *adj. Factor = 126.0 cfs

B) - Compute time to peak for 100-yr storm

T_p = (43.5 * Q_r * A) / Q_p = 54 min

C) - Develop Hydrograph of inflow for 100-yr storm event

Applying step function, calculate inlet flow to basin for various times using:

for time between zero and 1.25 T_p: $Q = Q_p / 2 * ((1-\cos(\pi t / T_p))$

for time > 1.25 T_p: $Q = 4.34 * Q_p \exp((-1.30(t/T_p))$

100-yr. Storm Hydrograph

Known Information

T_p =	**54**	**min**
$Q_{p\ 100,24}$ =	**126.0**	**cfs**

	Time (min)	Flow (cfs)
	4	1.71
	8	6.76
	12	14.86
	16	25.57
	20	38.33
	24	52.42
	28	67.09
	32	81.53
	36	94.97
	40	106.68
	44	116.01
	48	122.46
T_p	54	126.01
	56	125.49
	60	121.91
	64	115.12
$1.25*T_p$	67.5	106.85
	72	95.96
	76	87.11
	80	79.09
	84	71.80
	88	65.18
	92	59.17
	96	53.72
	100	48.77
	104	44.27
	108	40.19
	112	36.49
	116	33.13
	120	30.07
	124	27.30
	128	24.79
	132	22.50
	136	20.43
	140	18.55
	144	16.84
	148	15.28
	152	13.88
	156	12.60
	160	11.44

D) - Perform short cut routing method for 100-yr storm event
Principal spillway sized as above, w/orifices and riser crest as above.

Stage-Storage-Discharge Data by Short-cut Flood Routing Method - 100-yr storm. Consider pumped 11.15 cfs input from Pit #2 basin as worst case

Known Information

T_p = 54 min
$Q_{p\ 100,24}$ = 126.0 cfs
K_s = 78141
b = 1.135

Time (min)	Inflow (cfs)	Storage (cu. ft)	Stage (ft)	Outflow (cfs)		Area @ Stage	Allowable Qo	
0	0	0	0.00	0.00	Hw < dia 4" drain holes			
		0			**Elev. =**			
4	1.71	0	0.00	0.00				
		411						
8	6.76	411	0.01	0.01				
		1620						
12	14.86	2031	0.04	0.06				
		3551						
16	25.57	5582	0.10	0.22				
		6084						
20	38.33	11666	0.19	0.59				
		9057						
24	52.42	20723	0.31	1.26				
		12278			Hw > dia 4" holes			
28	67.09	33001	0.47	2.32				
		11658						
31	89.14	44659	0.61	2.65	PUMP ON in Pit #2 Basin			
		25946						
36	106.12	70606	0.91	3.24				
		24692						
40	117.83	95298	1.19	3.70				
		26706						
43.9	126.96	122004	1.48	4.12				
		30217						
48	133.61	152220	1.80	4.55				
		46462						
54	137.16	198682	2.28	5.11	T_p			
		15846						
56	136.64	214528	2.43	5.29				
		31524						
60	133.06	246051	2.75	5.62		112004	4011	OK!
		34408			riser crest @ 3.0			
64.5	125.21	280459	3.08	6.31				
		21403						
67.5	118.00	301862	3.29	8.49	1.25*T_p			
		29566						
72	107.11	331428	3.57	12.92				
		22606						
76	98.26	354034	3.79	17.08				
		19484						
80	90.24	373518	3.97	21.11				
		16590						
84	82.95	390108	4.12	24.82				
		13950						
88	76.33	404058	4.25	28.12				
		11570						
92	70.32	415627	4.36	30.98				

		9443						
96	64.87	425070	4.45	33.38				
		7557						
100	59.92	432627	4.52	35.36				
		5895						
104	55.42	438522	4.57	36.92				
		4441						
108	51.34	442963	4.61	38.12				
		3175						
112	47.64	446138	4.64	38.98				
		2079						
116	44.28	448217	4.66	39.55				
		1136						
120	41.22	449353	4.67	39.86				
		328						
124	38.45	449681	4.67	39.95	high water level & max. Qo	119846	4292	OK!
		-359						
128	35.94	449322	4.67	39.85				
		-939						
132	33.65	448383	4.66	39.59				
		-1425						
136	31.58	446958	4.65	39.20				
		-1829						
140	29.70	445128	4.63	38.70				
		-2162						
144	27.99	442967	4.61	38.12				
		-2431						
148	26.43	440536	4.59	37.46				
		-2646						
152	25.03	437889	4.56	36.75				
		-107637						
305	11.49	330253	3.56	12.72	PUMP OFF in Pit #2 Basin			
		-6973						
400	0.03	323279	3.49	11.57				
		-69205			riser crest @ 3.0			
500	0.00	254075	2.83	5.70				
		-102512						
800	0.00	151563	1.79	4.54				
		-108922						
1200	0.00	42641	0.59	2.60				

High Water Elevation in basin will be 238.67, 1.67' above riser crest and 3.33' below top of dam at 100-yr. storm. Principal spillway riser will carry 100-yr. storm outflow, and provide enough freeboard for safety.
80% trapping efficiency requirement will be met, as maximum discharge, Qpo, will be 39.95 cfs at this elevation which is less than the 4292 cfs allowed at this elevation (240,000 x 2.72 acs. x 0.0065 fps).

E)- Size barrel diameter, using modified orifice equation, inlet controlled to carry the 100-yr basin outflow

Try 24 in. RCP pipe, length = 175 ft
Q = 39.95 cfs
S = 230-218/175 = 0.069 ft/ft

At 0.069 ft/ft grade, 24" RCP will carry 59.4 cfs flowing full and 39.95 cfs @ 0.60 full, or depth = 14.4 in.

Check Available Head for Pipe Flow
Checking for inlet, velocity head, and pipeline friction losses:

Total $H_L = H_e + H_v + h_f = (V^2/2g)(k_e + 1 + ((29n^2L)/R^{1.33}))$

where,	ke =	0.6	for straight pipe inlet
	n=	0.013	
	A=	3.14	sf
	V=Q/A=	12.72	ft/sec
	WP =	3.77	
	R = A/WP =	0.83	
	L =	175	ft

H_L = 6.76 ft

Available H_L = 230 - 218 =12' > 6.76' OK!

Use 175' of 24" RCP

Rip-Rap Apron Design

From Figure 8.06a (Ref. 1) for maximum tailwater condition (midpoint of drain outlet will be at or below flow depth in receiving channel)

d=24":

Entering chart with 39.95 cfs and v=12.72 fps, not on curve. Go to next curve for 30" culvert, which is 50 cfs and v=10 fps, d50 rip rap size = 0.60' = 8". Max. size = d50 x 1.5 = 12".

Min. depth = 1.5 x Dmax = 18".
Min. apron length = 18'. Use 24'
Inlet width = 3 x dia. = 6', Use 8'
outlet width = dia. + L = 20'

III. Design Anti-Float block for Riser

Min. size riser = 1.5 x diameter barrel = 36". This concurs with 96" riser assumed above.

Wt. of water displaced by riser = 3.1416x4^2x7'x62.4 lbs/cf =21956 lbs. Anti-float block should be 1.1 x 21956 lbs = 24152 lbs. Appprox. weight of concrete pipe riser = +/-3000 lbs/ft x 7' = +/-21,000 lbs. Concrete block volume required = 3152/150 = 21cf due to weight of riser. Use concrete slab 12' x 12' x 18" = 216 cf = 8 cy due to size of riser for support.

Use 8' high (1' in concrete foundation) x 96" Dia. RCP riser, w/12'x12'x18" conc. anti-float block, and 175' of 24" RCP barrel.

II. Design of Pit #2 Stormwater Basin (refer to map for location)

Calculate Estimated Volume of Sediment to be Stored Before Cleanout

Minimum required - 1,800 cf/ac x 9.8 acs. = 17640 cf

$V_c = 18*T*A^{0.84}$ where T = Cleanout interval = 230 days

A = disturbed area = 9.8 acres

$V_c =$ 28160 cu. ft greater than as required for cf/ac, so use this number.

I) Design basin based on retaining up to a 25-yr., 24-hr. storm event and pumping this amount of stormwater to Pit #1 stormwater basin for discharge.

A) - Calculate Peak Flow, Q_{25}, for the contributing drainage area using SCS TR-55

Base Information for Peak Runoff Calculation
Location: near Columbia in Calhoun County, SC
For worst case scenario as noted above:

Drainage Area = 9.8 acres
Hydraulic Length = 1150 feet
% Hydraulic Length modified: 30 % - avg. over life of pit operations
Average slope = 4.0 % - avg over life of pit operations
Ratio of drainage area to ponded area: ponded = 0.75 acs.
at design point Ratio = 13.1

road - unpaved	0.30	Acres	3.1%
newly graded areas - mine area	8.10	Acres	82.8%
plant area	0.00	Acres	0.0%
stockpile area	0.00	Acres	0.0%
overburden/storage/disposal-berms	0.40	Acres	4.1%
sediment basin	0.75	Acres	7.7%
sediment basin assoc. slopes	0.20	Acres	2.0%
undisturbed areas	0.00	Acres	0.0%
	9.8		100%

1) Calculate average curve number (CN)

soil group "B" (conservative)

	% Area	CN	%Area x CN
road - unpaved, gravel	3.1%	85	2.60
newly graded areas-mine area	82.8%	89	73.69
plant area	0.0%	80	0.00
stockpile area	0.0%	60	0.00
berms	4.1%	60	2.45
sed.basin	7.7%	100	7.65
sed.basin assoc. slopes	2.0%	60	1.22
undisturbed	0.0%	60	0.00
	100%		87.62

Therefore, use CN = 88

2) Determine runoff depth

From Appendix "D" (Ref. 2) for Calhoun County, the rainfall amount for the 25-year, 24-hr. storm at site,

P = 6.7 inches

Ultimate Soil Storage Capacity = S = (1000/CN) - 10 = 1.41 inches

Runoff depth, $Q_r = (P-0.2S)^2/(P+0.8S) =$ 5.26 inches

3) Determine peak rate of runoff, Q_1, for the design storm by adjusting for watershed shape

Using the equation $L = 209*a^{0.6}$,where (**L)** is the hydraulic length and (**a)** is the drainage area

the equivalent drainage area is therefore, **a** = 17.1 acres

From figure 8.03p (Ref. 1), 3-8% slope, CN = 88; peak rate of runoff = 20.0 cfs/inch

Q_1 = Peak Rate Runoff * Qr = 105.2 cfs

$Q_2 = Q_1$ * Actual Area/Equiv Area = 60.1 cfs

4) Adjust peak discharge rate Q_2 for percent impervious area (none, therefore factor =1) and percent hydraulic length modified:

From figure 8.03r (Ref 1), for CN = 88 and % length modified = 30
hydraulic length adjustment factor = 1.10

therefore, $Q_3 = Q_2$ * adj factor = 66.1 cfs

5) Adjust peak discharge rate Q_3 for average watershed slope
By interpolation from Table 8.03d (ref 1), for avg. slope = 4.0 and drainage area = 9.8
adjustment factor = 1.00

$Q_4 = Q_3$* adj. Factor = 66.1 cfs

6) Adjust peak discharge Q_4 for surface ponding
From Table 8.03e, for Q_{25} and ponding ratio = 13.1 at design point
Adjustment factor = 0.63
Adjustment factor =
Average factor = 0.63

$Q_{p\ 25,24}$ = Q4 *adj. Factor = 41.7 cfs

B) - Compute time to peak for 25-yr storm

$T_p = (43.5 * Q_r * A) / Q_p$ = 54 min

C) - Develop Hydrograph of inflow for 25-yr storm event

Applying step function, calculate inlet flow to basin for various times using:

for time between zero and 1.25 T_p: $Q = Q_p / 2 *((1-\cos(\pi t / T_p))$

for time > 1.25 T_p: $Q = 4.34 * Q_p \exp((-1.30(t/T_p))$

25-yr. Storm Hydrograph

Known Information

T_p = **54** min

$Q_{p\ 25,24}$ = **41.7** cfs

Time (min)	Flow (cfs)	
4	0.57	
8	2.23	
12	4.90	
16	8.44	
20	12.65	
24	17.30	
28	22.15	
32	26.92	
36	31.37	
40	35.24	
44	38.32	
48	40.46	
52	41.54	
54	41.66	T_p
56	41.49	
60	40.32	
64	38.09	
67.5	35.37	$1.25T_p$
72	31.76	
76	28.84	
80	26.18	
84	23.77	
88	21.58	
92	19.60	
96	17.79	
100	16.15	
104	14.66	
108	13.31	
112	12.09	
116	10.98	
120	9.96	
124	9.05	
128	8.21	
132	7.46	
136	6.77	
140	6.15	
144	5.58	
148	5.07	
152	4.60	
156	4.18	

D) - Determine Stage-Storage Relationship in pond

Dug pond. Pond bottom elevation = 262 and top bank = 274.
Area at each level from drawing. Bottom of pond area = 11,767 sf

Contour Elev.	Area (square ft)	Avg. Area (square ft)	Depth (feet)	Volume (cubic feet)	Accumulated Volume (cu ft)	
262	11,767					Pond bottom
263	12,282	12,025		-	-	262-264 for sediment storage
264	12,798	12,540		-	-	Bottom riser to be at elev.=264
265	14,447	13,623	1	13,623	13,623	
266	16,096	15,272	1	15,272	28,894	Pump on/off
267	17,901	16,999	1	16,999	45,893	
268	19,706	18,804	1	18,804	64,696	
269	21,671	20,689	1	20,689	85,385	
270	23,637	22,654	1	22,654	108,039	
271	25,754	24,696	1	24,696	132,734	Approx. Riser Crest
272	27,871	26,813	1	26,813	145,924	Approx. max. water level
273	30,203	29,037	1	29,037	159,690	
274	32,535	31,369	1	31,369	174,060	Top Bank

$S = K_s * Z_b$

Determine K_s and b using known information from two contour levels, near max. water level = 272' and mid-depth, elev. = 268'

$b = \ln(S_2/S_1)/\ln(Z_2/Z_1) =$ ln(145924/64696) / ln(8/4) = 1.173

$K_s = S_2 / (Z_2)^b$ = 145924/ (8)^1.173 = 12717

Check constants using $Z = (S/K_s)^{1/b}$

At depth =6', 6' = $(108039/12717)^{1/1.173}$= 6.19 ft

Therefore, since the result is within 0.2', we can consider the constants valid.

Estimated sediment volume required = 28160 cu. ft

Zsed = $(S/Ks)^{1/b}$ = 28160 /12717^1/1.173 = 2.0 ft.or Elev.= 264.0

Stage-Storage-Discharge Data by Short-cut Flood Routing Method - based on 25-yr. storm hydrograph - pumping collected stormwater to Pit #1 Basin at rate of 5,000 gpm as required to avoid discharge.

Assume 96" riser, with riser crest elevation = +/-271.0, Stage 7'
Assuming Zsed at max. = 264', normal pool = 264', pump on/off @ 266' = Stage 2'(5,000GPM pump flow),

Flow over weir = Q = $Cw*L*H^{1.5}$, where Cw is weir coefficient, L is length of weir, and H is height of water above the weir.

Time (min)	Inflow (cfs)	Storage (cu. ft)	Stage (ft)	Outflow (cfs)	Known Information
					T_p = 54 **min**
					$Q_{p\ 25,24}$ = 41.7 **cfs**
					K_s = 12717
					b = 1.173
0	0	0	0.00	0.00	Elev. = 264 at stage 0
		0			
4	0.57	0	0.00	0.00	
		136			
8	2.23	136	0.02	0.00	

		535			
12	4.90	671	0.08	0.00	
		1177			
16	8.44	1848	0.19	0.00	
		2026			
20	12.65	3873	0.36	0.00	
		3036			
24	17.30	6910	0.59	0.00	
		4153			
28	22.15	11063	0.89	0.00	
		5316			
32	26.92	16379	1.24	0.00	
		6462			
36	31.37	22840	1.65	0.00	
		7528			Elev. = 266 at pond stage 2' - PUMP ON
40	35.24	30368	2.10	11.15	
		5781			
44	38.32	36149	2.44	11.15	
		6522			
48	40.46	42671	2.81	11.15	
		7035			
52	41.54	49706	3.20	11.15	
		3647			
54	41.66	53353	3.39	11.15	T_p
		3661			
56	41.49	57013	3.59	11.15	
		7281			
60	40.32	64295	3.98	11.15	
		7000			
64	38.09	71295	4.35	11.15	
		5657			
67.5	35.37	76952	4.64	11.15	$1.25*T_p$
		6538			
72	31.76	83491	4.97	11.15	
		4947			
76	28.84	88438	5.22	11.15	
		4245			
80	26.18	92683	5.43	11.15	
		3608			
84	23.77	96291	5.61	11.15	
		3029			
88	21.58	99321	5.76	11.15	
		2504			
92	19.60	101825	5.89	11.15	
		2027			
96	17.79	103851	5.99	11.15	
		1594			
100	16.15	105445	6.07	11.15	

		1201			
104	14.66	106646	6.12	11.15	
		844			
108	13.31	107489	6.17	11.15	
		519			
112	12.09	108009	6.19	11.15	
		225			
116	10.98	108234	6.20	11.15	
		-42			
120	9.96	108192	6.20	11.15	max. water level and Qo
		-285			
124	9.05	107907	6.19	11.15	
		-505			
128	8.21	107403	6.16	11.15	
		-705			
132	7.46	106698	6.13	11.15	
		-886			
136	6.77	105812	6.08	11.15	
		-1051			
140	6.15	104761	6.03	11.15	
		-1201			
144	5.58	103560	5.97	11.15	
		-1337			
148	5.07	102223	5.91	11.15	
		-1460			
152	4.60	100763	5.83	11.15	
		-1572			
156	4.18	99191	5.76	11.15	
		-1674			
160	3.79	97518	5.67	11.15	
		-1766			
164	3.44	95752	5.59	11.15	
		-1850			
168	3.13	93902	5.49	11.15	
		-1926			
172	2.84	91976	5.40	11.15	max. water level and Qo
		-1995			
176	2.58	89981	5.30	11.15	
		-2058			
180	2.34	87924	5.20	11.15	
		-2115			
184	2.12	85809	5.09	11.15	
		-2166			
188	1.93	83643	4.98	11.15	
		-2213			
192	1.75	81430	4.87	11.15	
		-52448			
285	0.19	28982	2.02	11.15	On falling water level PUMP OFF @ Elev. = 266 - Pond Stage = 2'

We see that maximum stage will be 6.20' or elevation = 270.2, 0.80' below riser crest, for the 25-yr storm inflow to the basin.

II) Check principal spillway capacity for 100-yr. storm. Provide emergency spillway if necessary.

A) - Calculate $Q_{100,24}$

1) Determine runoff depth

From Appendix "D" (Ref. 2) for Calhoun County, the rainfall amount for the 100-year, 24-hr. storm at site, 9.3 inches

Ultimate Soil Storage Capacity = S = (1000/CN) - 10 = 1.41 inches

Runoff depth, Q_r = $(P-0.2S)^2/(P+0.8S)$ = 7.80 inches

2) Determine peak rate of runoff for the design storm by adjusting for watershed shape

Using the equation L = 209*a^$^{0.6}$ where **(L)** is the hydraulic length and (**a)** is the drainage area

the equiv. drainage area is therefore, **a** = 17.1 acres

From Fig. 8.03p (Ref. 1), 3-8% slope, CN = 88; peak rate of runoff = 20 cfs/inch

Q_1 = Peak Rate Runoff * Qr = 155.9 cfs

$Q_2 = Q_1$ * Actual Area/Equiv Area = 89.1 cfs

3) Adjust peak discharge rate Q_2 for percent impervious area (none, therefore factor =1) and percent hydraulic length modified:

From figure 8.03r (Ref 1), for CN = 88 and % length modified = 30
hydraulic length adjustment factor = 1.10

therefore, $Q_3 = Q_2$ * adj factor = 98.0 cfs

4) Adjust peak discharge rate Q_3 for average watershed slope

By interpolation from Table 8.03d (ref 1), for avg. slope = 4.0 and drainage area = 9.8
adjustment factor = 1.00

$Q_4 = Q_3$* adj. Factor = 98.0 cfs

5) Adjust peak discharge Q_4 for surface ponding

From Table 8.03e, for Q_{100} and ponding ratio = 13.1 at design point
Adjustment factor = 0.70
Adjustment factor =
Average factor = **0.70**

$Q_{p\ 100,24}$ = Q4 *adj. Factor = 68.6 cfs

B) - Compute time to peak for 100-yr storm

T_p = (43.5 * Q_r * A) / Q_p = **48** **min**

C) - Develop Hydrograph of inflow for 100-yr storm event

Applying step function, calculate inlet flow to basin for various times using:

for time between zero and 1.25 T_p: $Q = Q_p / 2 *((1-\cos(\pi t / T_p))$

for time > 1.25 T_p: $Q = 4.34 * Q_p \exp((-1.30(t/T_p))$

100-yr. Storm Hydrograph

Known Information

T_p =	**48**	**min**
$Q_{p\ 100,24}$ =	**68.6**	**cfs**

	Time (min)	Flow (cfs)
	4	1.15
	8	4.51
	12	9.87
	16	16.87
	20	25.03
	24	33.81
	28	42.63
	32	50.88
	36	58.03
	40	63.59
	44	67.19
T_p	48	68.59
	52	67.70
	56	64.57
1.25*T_p	60	59.41
	64	53.45
	68	48.01
	72	43.12
	76	38.73
	80	34.79
	84	31.25
	88	28.07
	92	25.21
	96	22.65
	100	20.34
	104	18.27
	108	16.41
	112	14.74
	116	13.24
	120	11.89

124	10.68
128	9.59
132	8.62
136	7.74
140	6.95
144	6.25
148	5.61
152	5.04
156	4.53
160	4.07

D) - Perform short cut routing method for 100-yr storm event
Principal spillway sized as above, w/orifices and riser crest as above.

Stage-Storage-Discharge Data by Short-cut Flood Routing Method - 100-yr storm

Time (min)	Inflow (cfs)	Storage (cu. ft)	Stage (ft)	Outflow (cfs)	Known Information
					T_p = 48 min
					$Q_{p\ 100,24}$ = 68.6 cfs
					K_s = 12717
					b = 1.173
0	0	0	0.00	0.00	Elev. = 264 at stage 0
		0			
4	1.15	0	0.00	0.00	
		275			
8	4.51	275	0.04	0.00	
		1083			
12	9.87	1359	0.15	0.00	
		2370			
16	16.87	3729	0.35	0.00	
		4048			
20	25.03	7777	0.66	0.00	
		6007			
24	33.81	13784	1.07	0.00	
		8115			
28	42.63	21899	1.59	0.00	
		7673			Elev. = 266 at pond stage 2' - PUMP ON
31	48.90	29572	2.05	11.15	
		11326			
36	58.03	40898	2.71	11.15	
		11252			
40	63.59	52149	3.33	11.15	
		12586			
44	67.19	64736	4.00	11.15	
		13450			
48	68.59	78186	4.70	11.15	T_p
		13786			
52	67.70	91972	5.40	11.15	
		6786			
54	66.40	98758	5.74	11.15	
		6630			
56	64.57	105388	6.06	11.15	
		12820			
60	59.41	118208	6.69	11.15	$1.25*T_p$
		11583			riser crest @7.0' = elev. 271
64	53.45	129791	7.24	31.97	
		5156			
68	48.01	134947	7.48	38.41	

		2303			
72	43.12	137250	7.59	41.46	
		647			
78.5	36.22	137897	7.62	42.34	high water level & max. Qo
		-551			
80	34.79	137346	7.60	41.59	
		-1633			
84	31.25	135714	7.52	39.42	
		-1960			
88	28.07	133753	7.43	36.87	
		-2113			
92	25.21	131640	7.33	34.22	
		-2161			
96	22.65	129479	7.23	31.59	
		-2147			
100	20.34	127332	7.12	29.09	
		-2099			
104	18.27	125232	7.02	26.74	
		-2033			riser crest @7.0' = elev. 271
108	16.41	123199	6.93	11.15	
		1263			
112	14.74	124462	6.99	11.15	
		862			riser crest @7.0' = elev. 271
116	13.24	125323	7.03	26.84	
		-3264			riser crest @7.0' = elev. 271
120	11.89	122059	6.87	11.15	
		178			
124	10.68	122237	6.88	11.15	
		-112			
128	9.59	122125	6.87	11.15	
		-373			
132	8.62	121752	6.86	11.15	
		-608			
136	7.74	121144	6.83	11.15	
		-818			
140	6.95	120326	6.79	11.15	
		-1007			
144	6.25	119319	6.74	11.15	
		-1177			
148	5.61	118142	6.68	11.15	
		-1330			
152	5.04	116812	6.62	11.15	
		-1467			
156	4.53	115345	6.55	11.15	
		-1590			
160	4.07	113755	6.47	11.15	
		-1700			
164	3.65	112055	6.39	11.15	
		-1800			
168	3.28	110255	6.30	11.15	

		-1889			
172	2.95	108367	6.21	11.15	
		-1969			
176	2.65	106398	6.11	11.15	
		-2041			
180	2.38	104357	6.01	11.15	
		-2106			
184	2.13	102251	5.91	11.15	
		-2164			
188	1.92	100087	5.80	11.15	
		-2216			
192	1.72	97872	5.69	11.15	
		-2263			
196	1.55	95609	5.58	11.15	
		-2305			
200	1.39	93304	5.46	11.15	
		-2342			
204	1.25	90962	5.35	11.15	
		-2376			
208	1.12	88585	5.23	11.15	
		-2407			
212	1.01	86178	5.11	11.15	
		-2434			
216	0.90	83744	4.98	11.15	
		-51637			
300	0.09	32107	2.20	11.15	
		-3317			
305	0.08	28790	2.01	11.15	On falling water level - Elev. = 267 at pond stage 2' - PUMP OFF

High Water Elevation in basin will be 271.62, 1.62' above riser crest and 2.38' below top of dam at 100-yr. storm. Principal spillway riser and transfer pump will carry flow well in excess of 100-yr. storm outflow. No emergency spillway needed.

E) - Calculate barrel size for principal spillway, using modified orifice equation, inlet controlled to carry the 100-yr basin outflow

Try 36 in. RCP pipe, length = 148 ft

Q_{100} = 31.19 cfs (42.34 cfs - 11.15 cfs (pumped))

S = 264.0-263.0/148 = 0.007 ft/ft

At 0.007 ft/ft grade, 36" RCP will carry 55.80 cfs flowing full and 31.19 cfs @ 0.54 full, or depth = 19.4 in.

Check Available Head for Pipe Flow

Checking for inlet, velocity head, and pipeline friction losses:

Total $H_L = H_e + H_v + h_f = (V^2/2g)(k_e + 1 + ((29n^2L)/R^{1.33}))$

where,	ke =	0.6	for straight pipe inlet
	n=	0.013	
	A=	7.07	sf
	V=Q/A=	4.41	ft/sec
	WP =	5.09	
	R = A/WP =	1.39	
	L =	148	ft

H_L = 0.63 ft

Available H_L = 264.53 - 263.53 =1' > 0.63' OK!

Principal spillway consists of 96" dia. RCP riser w/36"x148' RCP barrel.

F) Design associated discharge apron for outlet from Pit #2 Sed. Basin:

From Figure 8.06b (Ref. 1) for maximum tailwater condition

d=36":

Entering chart with 31.19 cfs and v=4.41 fps, not on curve. Go to next d=36" and v=10fps, which is 70 cfs d50 rip rap size = 0.35' = 4". Use 6". Max. size = d50 x 1.5 = 9".

Min. depth = 1.5 x Dmax = 12".

Min. apron length = 12'. Use 20'

Inlet width = 3 x dia. = 7.5', Use 24'

outlet width = dia. + L = 14.5'. Use 24'

See Drawing 6 of 7 for detail of apron.

III) Design Anti-Float block for Riser

Min. size riser = 1.5 x diameter barrel = 45". This concurs with 96" riser assumed above.

Wt. of water displaced by riser = 3.1416x4^2x 7' x 62.4 lbs/cf = 21,956 lbs. Anti-float block should be 1.1 x 21,956 lbs = 24,150 lbs. Appprox. weight of concrete pipe riser = +/-3000 lbs/ft x 7' = +/-21,000 lbs. Concrete block volume required = 3150 lbs/(150 lbs/cf - 62.4 lbs/cf) = 36 cf = 1.3 cy. Use concrete slab 12' x 12' x 18" = 216 cf = 8.0 cy due to size of riser.

Use 8' high (1' in concrete foundation) x 96" Dia. RCP riser, w/12'x12'x24" conc. anti-float block, and 175'

III. Design Phase 2-Pit#2 Stormwater Channels (25-yr. design storms as appropriate)

Assume:

Design for 25-yr. storm flow. Using Ref. 1, Appendix 8,
Grass-lined channel (riprap lining as required)
Proposed vegetation: bermudagrass
Soil: TrB & AmE sands (attempt to keep V below 2.5 fps (Table 8.05d))
Permissible velocity, 10-yr storm, (Ref. 1, Table 8.05a): 0-5% slope Vp = 5.0 fps;
5-10% slope Vp = 4.5 fps; >10% slope Vp = 3.5 fps
Retardance Class: design for "D", cut (Ref. 1,Table 8.05c), check for "B", uncut (Table 8.05c)
$V = (1.49/n)R^{2/3}S^{1/2}$

For trapezoidal channel section:
$A = bd + Zd^2$
$P = b + 2d\,(Z^2 + 1)^{0.5}$
$R = A/P$

For v-section channel:
$A = Zd^2$
$P = 2d(z^2 + 1)^{0.5}$
$R = A/P$

I) Stormwater Channel "A"

a) Section from Sta. 2+80 - Sta. 8+20

Q = ciA
c = 0.30 bare packed sandy soil, rough, moderate slope
A = 5.3 acs
height of most remote point above outlet = 22 ft (320'-298')
length of travel = 1000 ft

	Q_{25}	Q_2
From nomograph, Ref. 1, Figure 8.03a, time of concentration, Tc =	7 mins	3.6 mins
if overland flow, grassed surface, multiply Tc by 2 =	mins	7.2 mins
if overland flow, pavement, multiply Tc by 0.4 =	mins	mins
From Ref. 1, Figure 8.03g, i =	6.5 in/hr	4.2 in/hr

Q_{25} = ciA = 0.30 x 6.5 in/hr x 5.3 acs = 10.34 cfs
S = (306-298)/(820-280) 0.015 ft/ft
trapezoidal channel, 3:1 side slopes, Z = 3 b = 3

At low retardance condition (from Ref. 1, Fig. 8.05c, curve D):

d (ft)	A (ft^2)	P	R (ft)	V_t	V_tR	n	V (fps)	Q (cfs)
0.80	4.32	8.06	0.54	2.30	1.23	0.055	2.18	9.40
0.85	4.72	8.38	0.56	2.30	1.30	0.054	2.29	10.80
0.83	4.56	8.25	0.55	2.25	1.24	0.055	2.22	10.11

d will be approx. 0.84' at flow = 10.34 cfs, so ditch depth = 2' is okay
V<Vp - OK.

Ck. Depth required for high retardance (uncut) condition:

d (ft)	A (ft^2)	P	R (ft)	V_t	V_tR	n	V (fps)	Q (cfs)
1.30	8.97	11.22	0.80	1.00	0.80	0.18	0.89	8.01
1.40	10.08	11.85	0.85	1.00	0.85	0.175	0.93	9.38
1.44	10.54	12.11	0.87	1.00	0.87	0.170	0.97	10.25

d will be approx.1.44' at flow = 10.34 cfs, so ditch depth = 2' is okay.
V<Vp - OK.

Ck. Need for temporary lining:
Q_2 = ciA = 0.30 x 4.2 in/hr x 5.3 acs = 6.68 cfs Bare earth channel, n = 0.02

d (ft)	A (ft^2)	P	R (ft)	n	V (fps)	Q (cfs)
0.30	1.17	4.90	0.24	0.02	10.07	11.78
0.23	0.85	4.45	0.19	0.02	8.13	6.90
d =	0.23					

V > 2fps, temporary lining is required

Calculate shear stress, T = yds = 62.4ds

T = 0.21 lb/sf

Use RECP with allowable shear stress > 0.21 lb/sf and allowable velocity > 8.13 fps, such as
North American Green C125 Double Net Blanket, 100% Coconut (s=2.25 psf, Vmax. = 10 fps)

b) Section from Sta. 1+25 to Sta. 2+80

Q = ciA

c = 0.60 bare packed sandy soil, smooth, slight slope (mostly dirt haul road)

A = 1.5 acs

height of most remote point above outlet = 6 ft (312'-306')

length of travel = 360 ft

	Q_{25}	Q_2
From nomograph, Ref. 1, Figure 8.03a, time of concentration, Tc =	3.5 mins	3.5 mins
if overland flow, grassed surface, multiply Tc by 2 =	mins	mins
if overland flow, pavement, multiply Tc by 0.4 =	mins	mins
From Ref. 1, Figure 8.03f, i =	10.0 in/hr	6.0 in/hr

Q_{25} = ciA = 0.60 x 10 in/hr x 1.5 acs = 9.00 cfs

S = 308-306/280-1250 0.013 ft/ft

trapezoidal channel, 3:1 side slopes, Z = 3 b = 2

At low retardance condition (from Ref. 1, Fig. 8.05c, curve D):

d (ft)	A (ft^2)	P	R (ft)	V_t	V_tR	n	V (fps)	Q (cfs)
1.00	5.00	8.32	0.60	2.20	1.32	0.054	2.23	11.15
0.90	4.23	7.69	0.55	2.00	1.10	0.058	1.96	8.28
0.94	4.53	7.95	0.57	2.00	1.14	0.058	2.02	9.17

d will be approx. 0.94' at flow = 9.00 cfs, so ditch depth = 2' is okay

V<Vp - OK.

d (ft)	A (ft^2)	P	R (ft)	V_t	V_tR	n	V (fps)	Q (cfs)
1.50	9.75	11.49	0.85	0.50	0.42	0.28	0.54	5.28
1.60	10.88	12.12	0.90	0.70	0.63	0.21	0.75	8.16
1.64	11.35	12.37	0.92	0.80	0.73	0.190	0.84	9.54

d will be approx. 1.64' at flow = 9.00 cfs, so ditch depth = 2.0' is okay.

Ck. Need for temporary lining:

Q_2 = ciA = 0.60 x 6.0 in/hr x 1.54 acs = 5.40 cfs Bare earth channel, n = 0.02

d (ft)	A (ft^2)	P	R (ft)	n	V (fps)	Q (cfs)
0.20	0.52	3.26	0.16	0.02	5.47	2.85
0.20	0.50	3.23	0.16	0.02	5.36	2.70
d =	0.20					

V > 2fps, temporary lining is required

Calculate shear stress, T = yds = 62.4ds

T = 0.16 lb/sf

Use RECP with allowable shear stress > 0.16 lb/sf and allowable velocity >5.36 fps , such as
North American Green S150 Double Net Straw Blanket (s=1.75 psf, Vmax. = 6 fps)

c) Section from Sta. 0+50 to Sta. 1+25

Q = ciA

c = 0.60 bare packed sandy soil, smooth, slight slope (mostly dirt haul road)

A = 0.4 acs

height of most remote point above outlet = 4 ft (312'-308')

length of travel = 230 ft

	Q_{25}	Q_2
From nomograph, Ref. 1, Figure 8.03a, time of concentration, Tc =	2.5 mins	2.5 mins
if overland flow, grassed surface, multiply Tc by 2 =	mins	mins
if overland flow, pavement, multiply Tc by 0.4 =	mins	mins
From Ref. 1, Figure 8.03f, i =	10.0 in/hr	6.0 in/hr

Q_{25} = ciA = 0.60 x 10 in/hr x 0.4 acs = 2.40 cfs

S = 310-308/125-50 0.027 ft/ft

trapezoidal channel, 3:1 side slopes, Z = 3 b = 2

At low retardance condition (from Ref. 1, Fig. 8.05c, curve D):

d (ft)	A (ft^2)	P	R (ft)	V_t	V_tR	n	V (fps)	Q (cfs)
0.50	1.75	5.16	0.34	1.60	0.54	0.076	1.56	2.72
0.40	1.28	4.53	0.28	1.00	0.28	0.105	1.00	1.28
0.48	1.65	5.04	0.33	1.45	0.48	0.080	1.45	2.39

d will be approx. 0.48' at flow = 2.40 cfs, so ditch depth = 2' is okay

V<Vp - OK.

d (ft)	A (ft^2)	P	R (ft)	V_t	V_tR	n	V (fps)	Q (cfs)
0.80	3.52	7.06	0.50	0.50	0.25	0.32	0.48	1.68
0.90	4.23	7.69	0.55	0.50	0.27	0.315	0.52	2.19
0.93	4.45	7.88	0.57	0.55	0.31	0.310	0.54	2.39

d will be approx. 0.93' at flow = 2.40 cfs, so ditch depth = 2.0' is okay.

Ck. Need for temporary lining:

Q_2 = ciA = 0.60 x 6.0 in/hr x 0.4 acs = 1.44 cfs Bare earth channel, n = 0.02

d (ft)	A (ft^2)	P	R (ft)	n	V (fps)	Q (cfs)
0.20	0.52	3.26	0.16	0.02	7.87	4.09
0.12	0.28	2.76	0.10	0.02	5.24	1.49
d =	0.12					

V > 2fps, temporary lining is required

Calculate shear stress, T = yds = 62.4ds

T = 0.20 lb/sf

Use RECP with allowable shear stress > 0.20 lb/sf and allowable velocity >5.24 fps , such as North American Green S150 Double Net Straw Blanket (s=1.75 psf, Vmax. = 6 fps)

II) Stormwater Channel "B"

Q = ciA

c = 0.30 bare packed sandy soil, rough, moderate slope

A = 0.9 acs

height of most remote point above outlet = 30 ft (340'-310')

length of travel = 420 ft

	Q_{25}	Q_2
From nomograph, Ref. 1, Figure 8.03a, time of concentration, Tc =	2 mins	2.0 mins
if overland flow, grassed surface, multiply Tc by 2 =	mins	mins
if overland flow, pavement, multiply Tc by 0.4 =	mins	mins
From Ref. 1, Figure 8.03g, i =	10.0 in/hr	6.0 in/hr

Q_{25} = ciA = 0.30 x 10 in/hr x 0.9 acs = 2.70 cfs
S = 310-298/150 0.080 ft/ft
trapezoidal channel, 3:1 side slopes, Z = 3 b = 2

At low retardance condition (from Ref. 1, Fig. 8.05c, curve D):

d (ft)	A (ft^2)	P	R (ft)	V_t	V_tR	n	V (fps)	Q (cfs)
0.40	1.28	4.53	0.28	2.50	0.71	0.068	2.67	3.41
0.30	0.87	3.90	0.22	1.90	0.42	0.088	1.76	1.53
0.36	1.11	4.28	0.26	2.50	0.65	0.070	2.45	2.71

d will be approx. 0.36' at flow = 2.70 cfs, so ditch depth = 2.0' is okay
V<Vp - OK.

Ck. Depth required for high retardance (uncut) condition:

d (ft)	A (ft^2)	P	R (ft)	V_t	V_tR	n	V (fps)	Q (cfs)
0.80	3.52	7.06	0.50	1.00	0.50	0.25	1.06	3.73
0.70	2.87	6.43	0.45	0.80	0.36	0.30	0.82	2.35
0.73	3.06	6.62	0.46	0.85	0.39	0.295	0.85	2.61

d will be approx. 0.73' at flow = 2.70 cfs, so ditch depth = 2' is okay.
V<Vp - OK.

Ck. Need for temporary lining:
Q_2 = ciA = 0.30 x 6.5 in/hr x 0.9 acs = 1.62 cfs Bare earth channel, n = 0.02

d (ft)	A (ft^2)	P	R (ft)	n	V (fps)	Q (cfs)
0.10	0.23	2.63	0.09	0.02	7.91	1.82
0.095	0.22	2.60	0.08	0.02	7.61	1.65
d =	0.10					

V > 2fps, temporary lining is required

Calculate shear stress, T = yds = 62.4ds
T = 0.47 lb/sf
Use RECP with allowable shear stress > 0.47 lb/sf and allowable velocity > 7.61, such as North American Green SC150 Double Net Blanket, 70% Straw & 30% Coconut (s=2.00 psf, Vmax. = 8 fps)

III) Stormwater Channel "C"

Q = ciA
c = 0.30 bare packed sandy soil, rough, moderate slope
A = 1.1 acs
height of most remote point above outlet = 30 ft (340'-310')
length of travel = 520 ft

	Q_{25}	Q_2
From nomograph, Ref. 1, Figure 8.03a, time of concentration, Tc =	3 mins	3 mins
if overland flow, grassed surface, multiply Tc by 2 =	mins	mins
if overland flow, pavement, multiply Tc by 0.4 =	mins	mins
From Ref. 1, Figure 8.03g, i =	10.0 in/hr	6.0 in/hr

Q_{25} = ciA = 0.30 x 10 in/hr x 1.1 acs = 3.30 cfs
S = 310-294/230 0.070 ft/ft
trapezoidal channel, 3:1 side slopes, Z = 3 b = 2

At low retardance condition (from Ref. 1, Fig. 8.05c, curve D):

d (ft)	A (ft^2)	P	R (ft)	V_t	V_tR	n	V (fps)	Q (cfs)
0.40	1.28	4.53	0.28	2.40	0.68	0.070	2.42	3.09
0.45	1.51	4.85	0.31	2.50	0.78	0.066	2.73	4.12
0.41	1.32	4.59	0.29	2.55	0.74	0.067	2.56	3.39

d will be approx. 0.41' at flow = 3.30 cfs, so ditch depth = 2' is okay
V= +/-Vp - OK.

Ck. Depth required for high retardance (uncut) condition:

d (ft)	A (ft^2)	P	R (ft)	V_t	V_tR	n	V (fps)	Q (cfs)
0.70	2.87	6.43	0.45	0.70	0.31	0.32	0.72	2.06
0.80	3.52	7.06	0.50	0.90	0.45	0.275	0.90	3.16
0.81	3.59	7.12	0.50	0.90	0.45	0.275	0.90	3.25

d will be approx. 0.81' at flow = 3.30 cfs, so ditch depth = 2' is okay
V<Vp - OK.

Ck. Need for temporary lining:
Q_2 = ciA = 0.30 x 6.5 in/hr x 1.1acs = 1.98 cfs   Bare earth channel, n = 0.02

d (ft)	A (ft^2)	P	R (ft)	n	V (fps)	Q (cfs)
0.10	0.23	2.63	0.09	0.02	7.37	1.70
0.11	0.26	2.70	0.10	0.02	7.92	2.03
d =	0.11					

V > 2fps, temporary lining is required

Calculate shear stress, T = yds = 62.4ds
T = 0.48 lb/sf
Use RECP with allowable shear stress > 0.48 lb/sf and allowable velocity > 7.92 fps, such as North American Green SC150 Double Net Blanket, 70% straw & 30% coconut (s=2.00 psf, Vmax. = 8 fps)

IV) Stormwater Channel "D"

a) Section from Sta. 5+40 to Sta. 8+50

Q = ciA
c = 0.30 bare packed sandy soil, rough, moderate slope
A = 6.8 acs
height of most remote point above outlet = 49 ft   320'-271')
length of travel = 950 ft

	Q_{25}	Q_2
From nomograph, Ref. 1, Figure 8.03a, time of concentration, Tc =	5 mins	5 mins
if overland flow, grassed surface, multiply Tc by 2 =	mins	mins
if overland flow, pavement, multiply Tc by 0.4 =	mins	mins
From Ref. 1, Figure 8.03g, i =	7.2 in/hr	4.8 in/hr

Q_{25} = ciA = 0.30 x 7.2 in/hr x 6.8 acs = 14.69 cfs
S = 276-271/310   0.016 ft/ft
trapezoidal channel, 3:1 side slopes, Z = 3   b = 3

At low retardance condition (from Ref. 1, Fig. 8.05c, curve D):

d (ft)	A (ft^2)	P	R (ft)	V_t	V_tR	n	V (fps)	Q (cfs)
0.80	4.32	8.06	0.54	2.50	1.34	0.052	2.40	10.37
0.90	5.13	8.69	0.59	2.70	1.59	0.049	2.72	13.94
0.92	5.30	8.82	0.60	2.80	1.68	0.049	2.78	14.72

d will be approx. 0.92' at flow = 14.69 cfs, so ditch depth = 2' is okay
V <Vp - OK.

Ck. Depth required for high retardance (uncut) condition:

d (ft)	A (ft^2)	P	R (ft)	V_t	V_tR	n	V (fps)	Q (cfs)
1.50	11.25	12.49	0.90	0.90	0.81	0.18	0.99	11.16
1.60	12.48	13.12	0.95	1.40	1.33	0.13	1.41	17.57
1.53	11.61	12.68	0.92	1.30	1.19	0.135	1.32	15.35

d will be approx.1.53' at flow = 14.69 cfs, so ditch depth = 2' is okay
V <Vp - OK.

Ck. Need for temporary lining:

Q_2 = ciA = 0.30 x 4.8 in/hr x 6.8 acs = 9.79 cfs   Bare earth channel, n = 0.02

d (ft)	A (ft^2)	P	R (ft)	n	V (fps)	Q (cfs)
0.30	1.17	4.90	0.24	0.02	10.51	12.29
0.27	1.03	4.71	0.22	0.02	9.64	9.92
d =	0.27					

V > 2fps, temporary lining is required

Calculate shear stress, T = yds = 62.4ds

T = 0.27 lb/sf

Use RECP with allowable shear stress > 0.27 lb/sf and allowable velocity > 9.64 fps, such as North American Green C125 Double Net Blanket, 100% Coconut (s=2.25 psf, Vmax.=10 fps)

b) Section from Sta. 1+25 to Sta. 5+40

Q = ciA

c = 0.60 bare packed sandy soil, smooth, slight slope (mostly dirt haul road)

A = 3.1 acs

height of most remote point above outlet = 36 ft (312'-276')

length of travel = 650 ft

	Q_{25}	Q_2
From nomograph, Ref. 1, Figure 8.03a, time of concentration, Tc =	3.5 mins	3.5 mins
if overland flow, grassed surface, multiply Tc by 2 =	mins	mins
if overland flow, pavement, multiply Tc by 0.4 =	mins	mins
From Ref. 1, Figure 8.03f, i =	10.0 in/hr	6.0 in/hr

Q_{25} = ciA = 0.60 x 10 in/hr x 3.1 acs = 18.60 cfs

S = 308-276/415 0.077 ft/ft

trapezoidal channel, 3:1 side slopes, Z = 3   b = 3

At low retardance condition (from Ref. 1, Fig. 8.05c, curve D):

d (ft)	A (ft^2)	P	R (ft)	V_t	V_tR	n	V (fps)	Q (cfs)
0.70	3.57	7.43	0.48	6.30	3.03	0.040	6.35	22.65
0.60	2.88	6.79	0.42	5.30	2.25	0.044	5.30	15.28
0.65	3.22	7.11	0.45	5.80	2.62	0.042	5.80	18.68

d will be approx. 0.65' at flow = 6.60 cfs, so ditch depth = 2' is okay

V<Vp - OK.

d (ft)	A (ft^2)	P	R (ft)	V_t	V_tR	n	V (fps)	Q (cfs)
1.00	6.00	9.32	0.64	2.50	1.61	0.12	2.57	15.42
1.10	6.93	9.96	0.70	4.00	2.78	0.082	3.96	27.46
1.01	6.09	9.39	0.65	3.10	2.01	0.099	3.13	19.07

d will be approx. 1.01' at flow = 18.6 cfs, so ditch depth = 2.0' is okay.

Ck. Need for temporary lining:

Q_2 = ciA = 0.60 x 6.0 in/hr x 3.1 acs = 11.16 cfs   Bare earth channel, n = 0.02

d (ft)	A (ft^2)	P	R (ft)	n	V (fps)	Q (cfs)
0.30	1.17	4.90	0.24	0.02	7.96	9.31
0.33	1.32	5.09	0.26	0.02	8.40	11.06
d =	0.33					

V > 2fps, temporary lining is required

Calculate shear stress, T = yds = 62.4ds

T = 1.59 lb/sf

Use RECP with allowable shear stress > 1.59 lb/sf and allowable velocity > 8.40 fps, such as North American Green C125 Double Net Blanket, 100% Coconut (s=2.25 psf, Vmax.=10 fps)

IV. Size various culverts required to carry storm water

PHASE 2 - Pit #2

A. Identify culverts

1) #1 - route drainage from Channels "A" & "B" down slope into Pit #2 Pit Water/Storm Water Sediment Basin

2) #2 - route drainage in Channel "C" down slope into Pit #2 Pit Water/Storm Water Sediment Basin

3) #3 - route drainage in Channel "D" down slope into Pit #2 Pit Water/Storm Water Sediment Basin

B. Calculate required culvert to carry flow at each critical section

I) *Culvert #1 -*

Q_{25} = Q_{25} Channel "A" + Q_{25} Channel "B"
= 10.34 + 2.70 cfs = 13.04 cfs

Critical section is Sta. 0+54 - Sta. 1+14
S = (272.0-263.0)/(114-54) = 0.150 ft/ft

Try 18 in. CPP pipe, length = 60 ft n = 0.022

At 0.150 ft/ft grade, 18" CPP will carry 24.04 cfs flowing full and 13.04 cfs @ 0.53 full, or depth = 9.54 in.

Check Available Head for Pipe Flow

Checking for inlet, velocity head, and pipeline friction losses:

Total $H_L = H_e + H_v + h_f = (V^2/2g)(k_e + 1 + ((29n^2L)/R^{1.33}))$

where, ke = 0.6 for straight pipe inlet
n= 0.022
A= 1.77 sf
V=Q/A= 7.38 ft/sec
WP = 2.50
R = A/WP = 0.71
L = 60 ft

H_L = 2.48 ft
Available H_L = 273 - 264 =9' > 2.48' OK!
Use 114' of 18" Corrugated Plastic Pipe

Design associated discharge apron for outlet from Culvert #1:

From Figure 8.06b (Ref. 1) for maximum tailwater condition

d=18":
Entering chart with 13.04 cfs and v=7.38 fps, D50 rip rap size = 0.35' = 4". Use 6". Max. size = d50 x 1.5 = 9".
Min. depth = 1.5 x Dmax = 12".
Min. apron length = 14'.
Inlet width = 3 x dia. = 4.5', Use 6'
outlet width = dia. + L = 15.5'. Use 18'
See Drawing 6 of 7 for detail of apron.

II) ***Culvert #2*** -

Q_{25} = flow in Channel "C" = 3.30 cfs

Critical section is Sta. 0+58 - Sta. 1+42

S = (280-263)/(142-58) = 0.202 ft/ft

Try 12 in. CPP pipe, length = 84 ft

At 0.202 ft/ft grade, 12" CPP will carry 9.46 cfs flowing full and 3.30 cfs @ 0.41 full, or depth = 4.92 in.

Check Available Head for Pipe Flow

Checking for inlet, velocity head, and pipeline friction losses:

Total $H_L = H_e + H_v + h_f = (V^2/2g)(k_e + 1 + ((29n^2L)/R^{1.33}))$

where, ke = 0.6 for straight pipe inlet

n= 0.022

A= 0.79 sf

V=Q/A= 4.20 ft/sec

WP = 1.29

R = A/WP = 0.61

L = 84 ft

H_L = 1.06 ft

Available H_L = 280.4 - 263.4 = 17' > 1.06' OK!

Use 142' of 12" corrugated plastic pipe

Design associated discharge apron for outlet from Culvert #2:

From Figure 8.06b (Ref. 1) for maximum tailwater condition

d=12":

Entering chart with 3.30 cfs and v=4.20 fps, D50 rip rap size = 0.10' = 4". Use 6". Max. size = d50 x 1.5 = 9".

Min. depth = 1.5 x Dmax = 12".

Min. apron length = 7'.

Inlet width = 3 x dia. = 3', Use 4'

outlet width = dia. + L = 8'. Use 10'

See Drawing 6 of 7 for detail of apron.

III) ***Culvert #3*** -

Q_{25} = flow in Channel "D" = 14.69 cfs

Critical section is Sta. 0+58 - Sta. 1+42

S = (270-263.6)/(64-0) = 0.100 ft/ft

Try 18 in. CPP pipe, length = 64 ft

At 0.100 ft/ft grade, 18" CPP will carry 19.63 cfs flowing full and 14.69 cfs @ 0.65 full, or depth = 11.7 in.

Check Available Head for Pipe Flow
Checking for inlet, velocity head, and pipeline friction losses:

Total $H_L = H_e + H_v + h_f = (V^2/2g)(k_e + 1 + ((29n^2L)/R^{1.33}))$

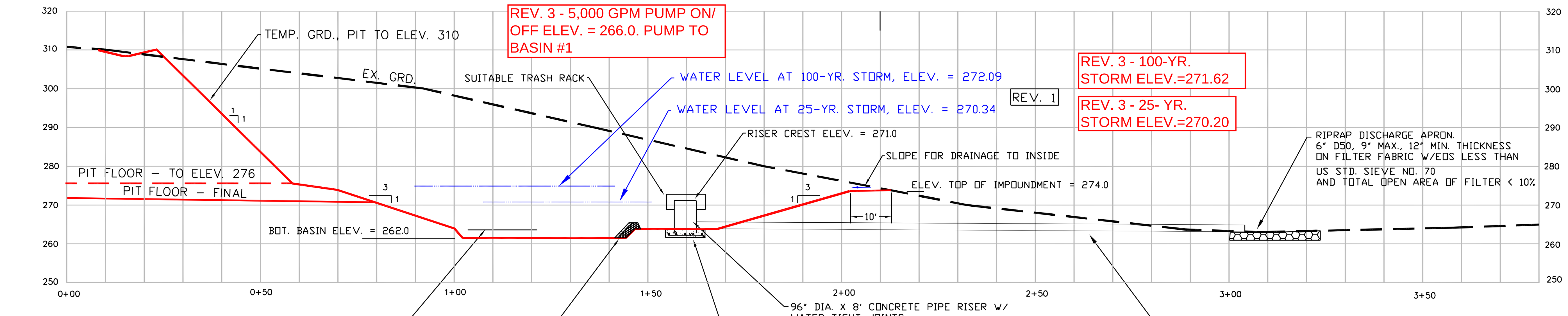
where, ke = 0.6 for straight pipe inlet
n= 0.022
A= 1.77 sf
V=Q/A= 8.31 ft/sec
WP = 3.06
R = A/WP = 0.58
L = 64 ft
H_L = 3.72 ft

Available H_L = 270.6 - 264.2 = 6.40' > 3.72' OK!
Use 64' of 18" corrugated plastic pipe

Design associated discharge apron for outlet from Culvert #3:

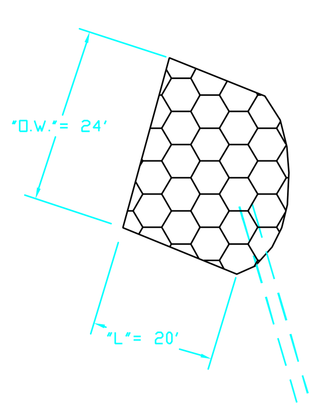
From Figure 8.06b (Ref. 1) for maximum tailwater condition

d=18":
Entering chart with 14.69 cfs and v= 8.31 fps, D50 rip rap size = 0.5' = 6". Use 6". Max. size = d50 x 1.5 = 9".
Min. depth = 1.5 x Dmax = 12".
Min. apron length = 22'.
Inlet width = 3 x dia. = 4.5', Use 6'
outlet width = dia. + L = 23.5'. Use 24'
See Drawing 6 of 7 for detail of apron.

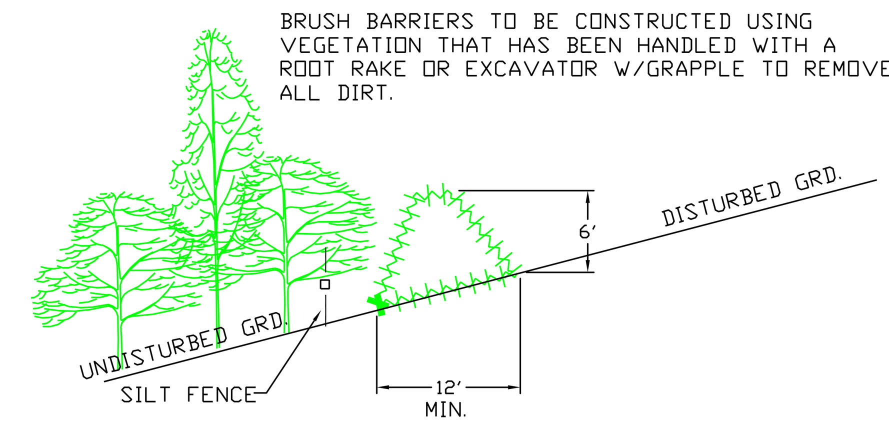


NOTE: SEE DWG. NO. 4 OF 7 FOR PLAN VIEW OF PIT #2 PIT WATER/STORM WATER SEDIMENT BASIN.
SEE ACCOMPANYING PROJECT DESIGN NOTES FOR DESIGN CONSIDERATIONS FOR THIS BASIN AND APPURTENANCES.

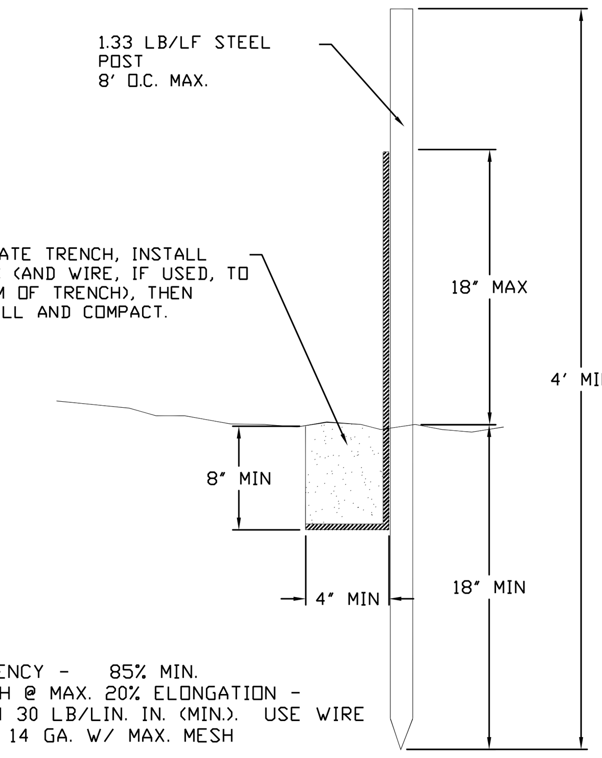
SECTION D–D
PIT #2 STORM WATER SEDIMENT BASIN
SCALE: NTS



RIPRAP DISCHARGE APRON DETAIL

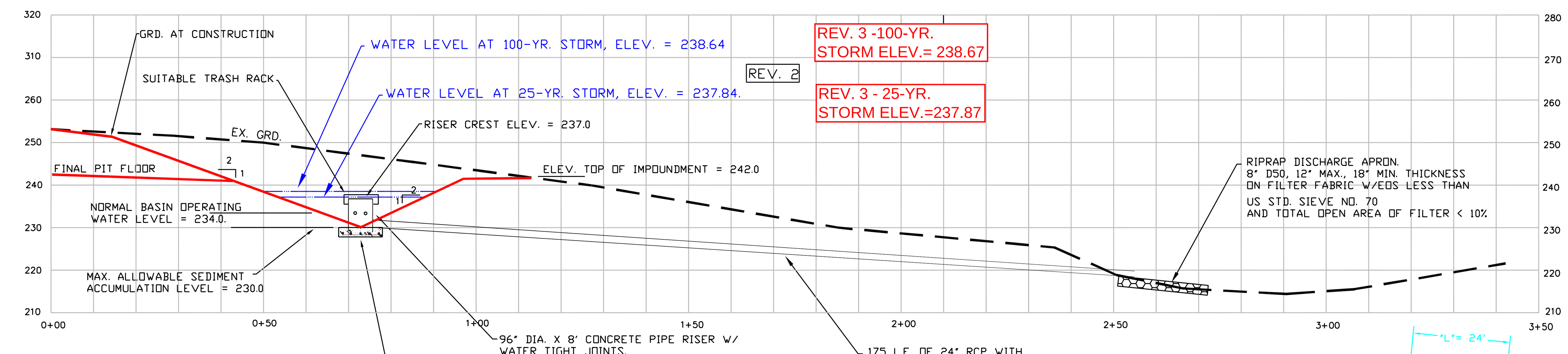


BRUSH BARRIER DETAIL
SCALE: NTS



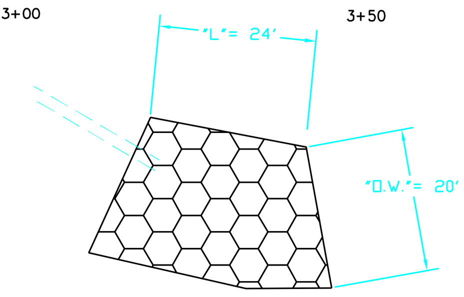
FILTER FABRIC:
1) FILTERING EFFICIENCY - 85% MIN.
2) TENSILE STRENGTH @ MAX. 20% ELONGATION -
A. STD. STRENGTH 30 LB/LIN. IN. (MIN). USE WIRE FENCE BACKING, MIN. 14 GA. W/ MAX. MESH SPACING = 6".
B. EXTRA STRENGTH - 50 LB/ LIN. IN. (MIN)
3) SLURRY FLOW RATE - 0.3 GAL/SQ. FT./MIN (MIN)

SILT FENCE DETAILS
SCALE: NTS



NOTE: SEE DWG. NO. 2 OF 7 FOR PLAN VIEW OF PIT #1 TAILINGS/STORM WATER SEDIMENT BASIN.
SEE ACCOMPANYING PROJECT DESIGN NOTES FOR DESIGN CONSIDERATIONS FOR THIS BASIN AND APPURTENANCES.

SECTION C–C
PIT #1 TAILINGS/STORM WATER SEDIMENT BASIN
SCALE: NTS



RIPRAP DISCHARGE APRON DETAIL

CHANNEL ID	SECTION	INV. EL. IN	INV. EL. OUT	CHANNEL GRADE (ft/ft)	DESIGN FLOW (cfs)	CHANNEL SHAPE	"B" (ft)	"Z"	"D" (ft)	CHANNEL LINING	IF GRASS, TEMPORARY LINING REQUIRED
A	0+00 - 0+50	312.0	310.0	0.040		TRAP.	2	3	2	GRASS	N.A. GREEN S150 DOUBLE NET STRAW BLANKET OR EQUAL, S=1.75PSF, Vmax=6 FPS
	0+50 - 1+25	310.0	308.0	0.027	2.40	TRAP.	2	3	2	GRASS	N.A. GREEN S150 DOUBLE NET STRAW BLANKET OR EQUAL, S=1.75PSF, Vmax=6 FPS
	1+25 - 2+80	308.0	306.0	0.013	9.00	TRAP.	2	3	2	GRASS	N.A. GREEN S150 DOUBLE NET STRAW BLANKET OR EQUAL, S=1.75PSF, Vmax=6 FPS
	2+80 - 8+20	306.0	298.0	0.015	10.34	TRAP.	3	3	2	GRASS	N.A. GREEN C125 DOUBLE NET BLANKET, 100% COCONUT, OR EQUAL, S=2.25PSF, Vmax=10 FPS
B	0+00 - 1+50	310.0	298.0	0.080	2.70	TRAP.	2	3	2	GRASS	N.A. GREEN SC150 DOUBLE NET BLANKET, 70% STRAW & 30% COCONUT, OR EQUAL, S=2.00PSF, Vmax=8 FPS
C	0+00 - 2+30	310.0	294.0	0.070	2.70	TRAP.	2	3	2	GRASS	N.A. GREEN SC150 DOUBLE NET BLANKET, 70% STRAW & 30% COCONUT, OR EQUAL, S=2.00PSF, Vmax=8 FPS
D	1+25 - 5+40	308.0	276.0	0.077	18.60	TRAP.	3	3	2	GRASS	N.A. GREEN C125 DOUBLE NET BLANKET, 100% COCONUT, OR EQUAL, S=2.25PSF, Vmax=10 FPS
	5+40 - 8+50	276.0	271.0	0.016	14.69	TRAP.	3	3	2	GRASS	N.A. GREEN C125 DOUBLE NET BLANKET, 100% COCONUT, OR EQUAL, S=2.25PSF, Vmax=10 FPS

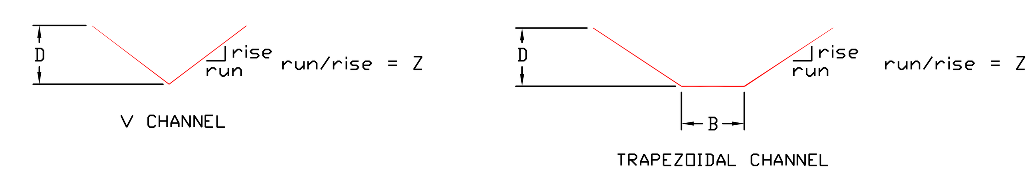
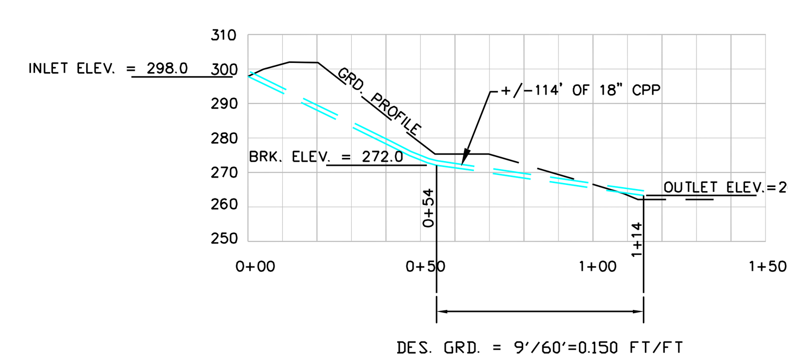
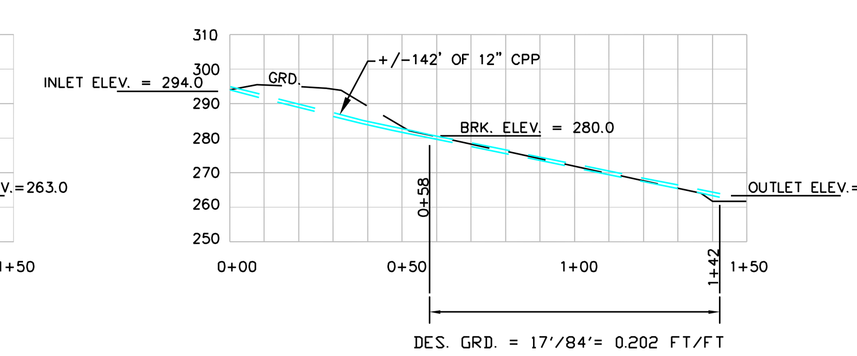


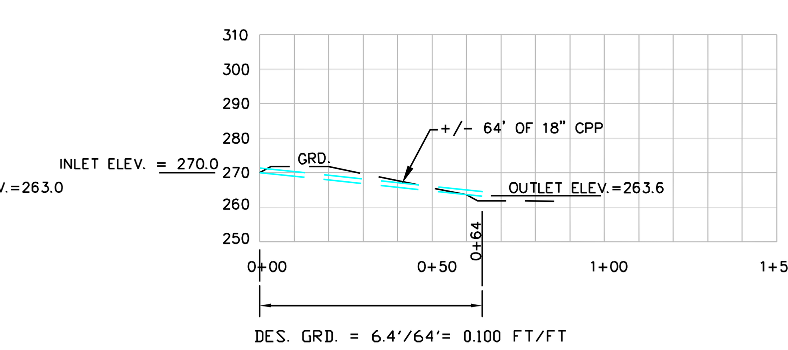
CHART OF STORM WATER CHANNEL DETAILS
SCALE: NTS



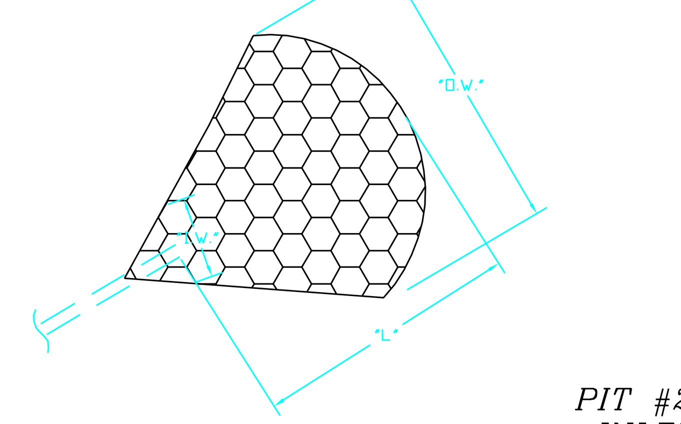
CULVERT #1 INSTALLATION



CULVERT #2 INSTALLATION



CULVERT #3 INSTALLATION



RIPRAP DISCHARGE APRON

		APRON DIMENSIONS			RIPRAP DETAILS		
CULVERT ID	DESIGN FLOW (cfs)	INLET WIDTH "I.W." (ft)	LENGTH "L" (ft)	OUTLET WIDTH "O.W." (ft)	MINIMUM d50c SIZE (in)	MINIMUM dMAX SIZE (in)	MINIMUM THICKNESS (in)
#1	13.04	6	14'	18	6	9	12
#2	3.30	4	7'	10	6	9	12
#3	14.69	6	22'	24	6	9	12

NOTE: USE FILTER FABRIC UNDERNEATH RIPRAP WITH EOS LESS THAN US STD. SIEVE NO. 70 AND TOTAL OPEN AREA OF FILTER < 10%

PIT #2 STORM WATER BASIN INLET CULVERT DETAILS
SCALE: NTS

GENERAL SEDIMENT & EROSION CONTROL AND STORMWATER MGT. NOTES:

1) ALL GENERAL STORM DRAINAGE AND ASSOCIATED SEDIMENT & EROSION AND STORMWATER MANAGEMENT DEVICES ARE TO BE INSTALLED AS SOON AS PRACTICABLE IN CONJUNCTION WITH CLEARING AND/OR ROUGH GRADING AND IN ACCORDANCE WITH THE SC STORMWATER MANAGEMENT AND SEDIMENT CONTROL HANDBOOK AND THE NC EROSION & SEDIMENT CONTROL DESIGN MANUAL.
STABILIZATION MEASURES SHALL BE INITIATED AS SOON AS PRACTICABLE IN PORTIONS OF THE SITE WHERE CONSTRUCTION ACTIVITIES HAVE TEMPORARILY OR PERMANENTLY CEASED, BUT IN NO CASE MORE THAN 14 DAYS AFTER WORK HAS CEASED, UNLESS ACTIVITY IN THAT AREA WILL RESUME WITHIN 21 DAYS.
2) SEDIMENT & EROSION CONTROL AND STORMWATER MANAGEMENT DEVICES ARE TO BE INSPECTED AND MAINTAINED AS REQUIRED AND IN ACCORDANCE WITH THE SC HANDBOOK TO MINIMIZE OFFSITE SILTATION. DEVICES SHALL BE INSPECTED EVERY 7 DAYS OR AFTER EACH RAINFALL OCCURENCE THAT EXCEEDS 1/2-INCH.

CONSTRUCTION/DEVELOPMENT SEQUENCE

INITIAL PLANT AREA INFRASTRUCTURE INSTALLATION AND PIT #1 DEVELOPMENT:
1) CLEARING & GRUBBING AS REQUIRED TO INSTALL PERIMETER SEDIMENT AND EROSION CONTROL MEASURES, I.E. BRUSH BARRIERS, SILT FENCING, TOPSOIL BERMS, ETC.
2) INSTALLATION OF PERIMETER MEASURES.
3) CLEARING & GRUBBING FOR PHASE 1 EARTHWORK.
4) INSTALLATION OF ENTRANCE ROAD.
5) EXCAVATION FROM BORROW AREA AND FILL OF PLANT SITE AND TAILINGS/STORM WATER BASIN IMPOUNDMENT.
6) AFTER FINAL EXCAVATION, INSTALLATION OF TAILINGS/STORM WATER BASIN OVERFLOW STRUCTURE.
7) TOPSOIL AND GRASS ALL PLANT SITE AND TAILINGS/STORM WATER BASIN SLOPES.
8) REMOVE SILT FENCING AFTER SATISFACTORY VEGETATION HAS BEEN ESTABLISHED ON ALL CONTRIBUTARY AREAS.
9) MINE PIT #1, MAINTAINING ALL PERIMETER CONTROLS AND PIT #1 TAILINGS/STORM WATER BASIN

PIT #2 PIT WATER/STORM WATER SEDIMENT BASIN AND PIT #2 DEVELOPMENT:
10) CLEARING & GRUBBING AS REQUIRED TO INSTALL PERIMETER SEDIMENT AND EROSION CONTROL MEASURES.
11) INSTALLATION OF PERIMETER MEASURES.
12) CLEARING AND GRUBBING FOR PHASE 2 EARTHWORK.
13) INSTALLATION OF HAUL ROAD
14) EXCAVATION OF PIT #2 PIT WATER/STORM WATER SEDIMENT BASIN.
15) INSTALLATION OF PIT #2 PIT WATER/STORM WATER SEDIMENT BASIN OVERFLOW STRUCTURES.
16) INSTALLATION OF TEMPORARY STORM WATER CHANNEL #1 AND BASIN INLET CULVERT #1 FOR CONTROL OF STORM WATER RUNOFF DURING FIRST PHASE OF PIT DEVELOPMENT DOWN TO ELEVATION = +/-310'
17) PIT #2 DEVELOPMENT AND MINING TO ELEVATION +/-310', MAINTAINING ALL STORM WATER RUNOFF PROTECTION MEASURES.
18) INSTALLATION OF TEMPORARY STORM WATER CHANNEL #2 AND BASIN INLET CULVERT #2 FOR CONTROL OF STORM WATER RUNOFF DURING FIRST PHASE OF PIT DEVELOPMENT DOWN TO ELEVATION = +/-276'.
19) MINING PIT #2 DOWN TO ELEVATION = +/-276', MAINTAINING ALL STORM WATER PROTECTION MEASURES.
20) MINING PIT #2 DOWN TO ELEVATION = +/-257', MAINTAINING ALL STORM WATER PROTECTION MEASURES..

GRASSING SPECIFICATIONS
SEEDING NOTES:

1) SOIL PREPARATION SHALL BE IN ACCORDANCE WITH NC EROSION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL, SECTIONS 6.10 & 6.11.
2) COMPACTED SOILS WILL BE SCARIFIED TO DEPTH OF AT LEAST 4" USING SUITABLE EQUIPMENT BEFORE TOPSOIL IS APPLIED. IF TOPSOIL BECOMES COMPACTED, IT TOO WILL BE SCARIFIED BEFORE SEEDING.
3) TOPSOIL, AS PROVIDED BY THE OWNER, SHALL BE APPLIED 4" MINIMUM DEPTH TO ALL AREAS THAT WILL BE PERMANENTLY GRASSED, EITHER IMMEDIATELY OR EVENTUALLY.
4) LIME SHALL BE APPLIED AT A RATE OF 1 TON/ACRE MINIMUM OR AS RECOMMENDED BY SOIL TEST TO BE PAID FOR BY CONTRACTOR, WITH COST INCLUDED IN GRASSING BID. INCORPORATE LIME UNIFORMLY INTO TOPSOIL.
5) FERTILIZER APPLICATION RATES SHALL BE BASED ON SOIL TEST TO BE PAID FOR BY CONTRACTOR WITH COST INCLUDED IN GRASSNG BID. MINIMUM APPLICATION WILL CONSIST OF 10-10-10 FERTILIZER AT RATE OF 300 LBS/AC.
6) TEMPORARY SEEDING SHALL BE APPLIED TO ALL AREAS THAT ARE BROUGHT TO FINAL GRADE AND WHERE PERMANENT GRASSING WILL NOT BE DONE WITHIN THIRTY WORKING DAYS.
7) TEMPORARY SEEDING SHALL BE AS FOLLOWS:
SEPT. 1 – MAR. 15 – RYE GRAIN (60 #/AC.)
MAR. 15 – SEPT. 1 – BROWN TOP MILLET (40 #/AC.)
8) PERMANENT GRASS SHALL BE ESTABLISHED AS SOON AS PRACTICABLE.
9) PERMANENT SEEDING SHALL BE AS FOLLOWS:
MAR. 15 – SEPT. 1 – BAHIAGRASS (30 #/AC); SERICEA LESPEDEZA (40 #/AC); BROWNTOP MILLET (10 #/AC)
SEPT. 1 – MAR. 15 – SERICEA LESPEDEZA-UNHULLED (50#/AC); RYE GRAIN (10 #/AC)
10) SEED SHALL BE UNIFORMLY BROADCAST, COVERED BY RAKING OR CHAIN DRAGGING TO THE DEPTH APPROPRIATE FOR THE TYPE OF GRASS BEING PLANTED, AND LIGHTLY ROLLED TO ACHIEVE GOOD SOIL CONTACT.
11) A SUITABLE MULCH SHALL BE USED AS REQUIRED FOR THE PARTICULAR AREA, BASED ON GRADE AND THE AMOUNT OF RUNOFF ACROSS THE LOCATION.
12) THESE ARE MINIMUM GUIDELINES AND OTHER METHODS (SUCH AS HYDRO-SEEDING) AND SEED MIXTURES (AS RECOMMENDED AND INCLUDED IN GRASSING SUBCONTRACTOR'S GUARANTEE) WILL BE CONSIDERED AS PRESENTED TO THE ENGINEER AND OWNER BY THE CONTRACTOR.

MAINTENANCE:

ONGOING MAINTENANCE OF GRADED AND SEEDED AREAS WILL BE PERFORMED UNTIL 80% COVERAGE OF PERMANENT GRASS IS ACHIEVED. LIME AND FERTILIZER WILL BE APPLIED ANNUALLY AT RATES AS INDICATED BY SOIL TEST BUT GENERALLY AT MINIMUM RATES OF 500 LBS/AC LIME AND 200 LBS/AC OF 10-10-10 FERTILIZER. ANY EROSION ISSUES WILL BE CORRECTED AND AREAS RE-TOPSOILED, LIMED AND FERTILIZED, SEEDED, AND MULCHED AS REQUIRED.

REV NO:	DESCRIPTION OF REVISION:	BY:	DATE:
3	PIT SW BASINS 1 & 2 - REVISE 25-YR. & 100-YR. STORM EVENT WATER LEVELS. REV. OUTLET PIPE SIZE BASIN #2. ADD NOTE REG. PUMP FOR X-FER S'WATER BASIN 2 TO 1.	SFH	6/20/17
2	PIT BASIN #1 – REVISE 25-YR. & 100-YR. STORM EVENT WATER LEVELS	SFH	4/13/17
1	REMOVE DRAINAGE HOLES IN PIT #2 RISER – NO STORMWATER DISCHARGE AT < 25-YR. STORM EVENT. REVISE 25-YR. & 100-YR. STORM EVENT WATER LEVELS. REVISE DISCHARGE BARREL TO 30".	SFH	4/13/17

STEPHEN F. HOWILER
SC PE#7006
1/31/2017
HOWILER & ASSOCIATES
599 WALLACE RD.
CHERAW, SC 29520 843-537-4784

SOUTH CAROLINA PROFESSIONAL ENGINEER SEAL 7006 STEPHEN F. HOWILER

SCALE: NTS
DESIGNED: SFH
DRAWN: SFH
CHECKED: SFH
DATE: JANUARY 20, 2017
DRAWING PROJECT: ATC-CULCLASURE
DRAWING FILE: MINE PERMIT DRAWINGS
DRAWING NO.: 6 OF 7

CULCLASURE FARM TRACT LLC
CULCLASURE FARM MINE
MINE PERMIT APPLICATION I-002093
CALHOUN COUNTY, SC

EROSION & SEDIMENTATION CONTROL DETAILS