E&S WORKSHEET # 11
Channel Design Data

PROJECT NAME: ATLANTIC SUNRISE PROJECT - COMPRESSOR STATION 610

LOCATION: ORANGE TOWNSHIP, COLUMBIA COUNTY, PENNSYLVANIA

PREPARED BY: AOE   DATE: 03/07/16

CHECKED BY: AJB   DATE: 03/07/16

CHANNEL OR CHANNEL SECTION		DITCH 1 R-4 RIP RAP LINING	DITCH 2A R-4 RIP RAP LINING	DITCH 2B R-4 RIP RAP LINING	DITCH 3 R-4 RIP RAP LINING	DITCH 4 R-4 RIP RAP LINING
TEMPORARY OR PERMANENT?	(T OR P)	P	P	P	P	P
DESIGN STORM	(2, 5, OR 10 YR)	10	10	10	10	10
ACRES	(AC)	0.36	1.83	1.34	0.35	1.00
MULTIPLIER[1]	(1.6, 2.25, or 2.75)[1]	2.75	2.75	2.75	2.75	2.75
Q_r (REQUIRED CAPACITY)	(CFS)	0.99	5.03	3.69	0.96	2.75
Q (CALCULATED AT FLOW DEPTH d)	(CFS)	1.00	5.06	3.72	1.00	2.77
PROTECTIVE LINING[2]		R-4 RIP RAP	R-4 RIP RAP	R-4 RIP RAP	R-4 RIP RAP	R-4 RIP RAP
n (MANNING'S COEFFICIENT)[2]		0.064	0.059	0.063	0.064	0.064
V_a (ALLOWABLE VELOCITY)	(FPS)	9	9	9	9	9
V (CALCULATED AT FLOW DEPTH d)	(FPS)	0.99	2.64	2.42	1.76	2.55
τ_a (MAX ALLOWABLE SHEAR STRESS)	(LB/FT^2)	N/A	N/A	N/A	N/A	N/A
τ_d (CALC'D SHEAR STRESS AT FLOW DEPTH d)	(LB/FT^2)	0.23	1.35	1.30	0.78	1.53
CHANNEL BOTTOM WIDTH	(FT)	2	2	2	2	2
CHANNEL SIDE SLOPES	(H:V)	2	2	2	2	2
D (TOTAL DEPTH)	(FT)	2.0	2.0	2.0	2.0	2.0
CHANNEL TOP WIDTH @ D	(FT)	10	10	10	10	10
d (CALCULATED FLOW DEPTH)	(FT)	0.37	0.60	0.51	0.23	0.39
CHANNEL TOP WIDTH @ FLOW DEPTH d	(FT)	3.48	4.40	4.04	2.92	3.56
BOTTOM WIDTH: FLOW DEPTH RATIO	(12:1 MAX)	5.41	3.33	3.92	8.70	5.13
d50 STONE SIZE	(IN)	6	6	6	6	6
A (CROSS-SECTIONAL AREA)	(SQ. FT.)	1.01	1.92	1.54	0.57	1.08
R (HYDRAULIC RADIUS)		0.28	0.41	0.36	0.19	0.29
S (BED SLOPE)[3]	(FT/FT)	0.01	0.036	0.041	0.054	0.063
S_c (CRITICAL SLOPE)	(FT/FT)	0.115	0.076	0.091	0.115	0.098
.7S_c	(FT/FT)	0.081	0.053	0.064	0.081	0.069
1.3S_c	(FT/FT)	0.150	0.099	0.118	0.150	0.127
STABLE FLOW?	(Y/N)	Y	Y	Y	Y	Y
FREEBOARD BASED ON UNSTABLE FLOW	(FT)	0.03	0.12	0.09	0.03	0.07
FREEBOARD BASED ON STABLE FLOW	(FT)	0.50	0.50	0.50	0.50	0.50
MINIMUM REQUIRED FREEBOARD[4]	(FT)	0.50	0.50	0.50	0.50	0.50
DESIGN METHOD FOR PROTECTIVE LINING [5] PERMISSIBLE VELOCITY (V) OR SHEAR STRESS	(S)	V	V	V	V	V

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A" and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A" and attach appropriate Worksheets.

2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufactured linings without vegetation and with vegetation in separate columns.

3. Slopes may not be averaged.

4. Minimum Freeboard is 0.5 ft. or ¼ Total Channel Depth, whichever is greater

5. Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

Source: 363-2134-008 / March 31, 2012 / Page 382

E&S WORKSHEET # 11
Channel Design Data

PROJECT NAME: ATLANTIC SUNRISE PROJECT - COMPRESSOR STATION 610

LOCATION: ORANGE TOWNSHIP, COLUMBIA COUNTY, PENNSYLVANIA

PREPARED BY: AOE   DATE: 02/05/17

CHECKED BY: AJB   DATE: 02/05/17

CHANNEL OR CHANNEL SECTION		DITCH 5 R-4 RIP RAP LINING	DITCH 6 R-4 RIP RAP LINING	DITCH 7 R-4 RIP RAP LINING	DITCH 8 R-4 RIP RAP LINING	
TEMPORARY OR PERMANENT?	(T OR P)	P	P	P	P	
DESIGN STORM	(2, 5, OR 10 YR)	10	10	10	10	
ACRES	(AC)	0.40	7.59	0.10	0.42	
MULTIPLIER[1]	(1.6, 2.25, or 2.75)[1]	2.75	2.75	2.75	2.75	
Q_r (REQUIRED CAPACITY)	(CFS)	1.10	20.87	0.28	1.16	
Q (CALCULATED AT FLOW DEPTH d)	(CFS)	1.15	20.91	0.21	1.19	
PROTECTIVE LINING[2]		R-4 RIP RAP	R-4 RIP RAP	R-4 RIP RAP	R-4 RIP RAP	
n (MANNING'S COEFFICIENT)[2]		0.064	0.045	0.064	0.064	
V_a (ALLOWABLE VELOCITY)	(FPS)	9	9	9	9	
V (CALCULATED AT FLOW DEPTH d)	(FPS)	0.99	3.04	1.20	1.52	
τ_a (MAX ALLOWABLE SHEAR STRESS)	(LB/FT^2)	N/A	N/A	N/A	N/A	
τ_d (CALC'D SHEAR STRESS AT FLOW DEPTH d)	(LB/FT^2)	0.23	0.97	0.44	0.56	
CHANNEL BOTTOM WIDTH	(FT)	2	2	2	2	
CHANNEL SIDE SLOPES	(H:V)	2	2	2	2	
D (TOTAL DEPTH)	(FT)	2.0	2.0	2.0	2.0	
CHANNEL TOP WIDTH @ D	(FT)	10	10	10	10	
d (CALCULATED FLOW DEPTH)	(FT)	0.41	1.42	0.08	0.30	
CHANNEL TOP WIDTH @ FLOW DEPTH d	(FT)	3.64	7.68	2.32	3.20	
BOTTOM WIDTH: FLOW DEPTH RATIO	(12:1 MAX)	4.88	1.41	25.00	6.67	
d50 STONE SIZE	(IN)	6	6	6	6	
A (CROSS-SECTIONAL AREA)	(SQ. FT.)	1.16	6.87	0.17	0.78	
R (HYDRAULIC RADIUS)		0.30	0.82	0.07	0.23	
S (BED SLOPE)[3]	(FT/FT)	0.009	0.011	0.088	0.030	
Sc (CRITICAL SLOPE)	(FT/FT)	0.112	0.037	0.145	0.111	
.7Sc	(FT/FT)	0.078	0.026	0.101	0.078	
1.3Sc	(FT/FT)	0.146	0.048	0.188	0.144	
STABLE FLOW?	(Y/N)	Y	Y	Y	Y	
FREEBOARD BASED ON UNSTABLE FLOW	(FT)	0.03	0.32	0.01	0.03	
FREEBOARD BASED ON STABLE FLOW	(FT)	0.50	0.50	0.50	0.50	
MINIMUM REQUIRED FREEBOARD[4]	(FT)	0.50	0.50	0.50	0.50	
DESIGN METHOD FOR PROTECTIVE LINING [5] PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)		V	V	V	V	

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A" and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A" and attach appropriate Worksheets.

2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufactured linings without vegetation and with vegetation in separate columns.

3. Slopes may not be averaged.

4. Minimum Freeboard is 0.5 ft. or ¼ Total Channel Depth, whichever is greater

5. Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

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LOCATION: ___ORANGE TOWNSHIP, COLUMBIA COUNTY, PENNSYLVANIA___

PREPARED BY: ___AOE___   DATE: ___02/05/17___

CHECKED BY: ___AJB___   DATE: ___02/05/17___

CHANNEL OR CHANNEL SECTION		DITCH 9A R-4 RIP RAP LINING				
TEMPORARY OR PERMANENT?	(T OR P)	P				
DESIGN STORM	(2, 5, OR 10 YR)	10				
ACRES	(AC)	4.03				
MULTIPLIER[1]	(1.6, 2.25, or 2.75)[1]	2.75				
Qr (REQUIRED CAPACITY)	(CFS)	11.08				
Q (CALCULATED AT FLOW DEPTH d)	(CFS)	11.07				
PROTECTIVE LINING[2]		R-4 RIP RAP				
n (MANNING'S COEFFICIENT)[2]		0.051				
Va (ALLOWABLE VELOCITY)	(FPS)	9				
V (CALCULATED AT FLOW DEPTH d)	(FPS)	3.78				
τa (MAX ALLOWABLE SHEAR STRESS)	(LB/FT^2)	N/A				
τd (CALC'D SHEAR STRESS AT FLOW DEPTH d)	(LB/FT^2)	2.02				
CHANNEL BOTTOM WIDTH	(FT)	2				
CHANNEL SIDE SLOPES	(H:V)	2				
D (TOTAL DEPTH)	(FT)	2.0				
CHANNEL TOP WIDTH @ D	(FT)	10				
d (CALCULATED FLOW DEPTH)	(FT)	0.81				
CHANNEL TOP WIDTH @ FLOW DEPTH d	(FT)	5.24				
BOTTOM WIDTH: FLOW DEPTH RATIO	(12:1 MAX)	2.47				
d50 STONE SIZE	(IN)	6				
A (CROSS-SECTIONAL AREA)	(SQ. FT.)	2.93				
R (HYDRAULIC RADIUS)		0.52				
S (BED SLOPE)[3]	(FT/FT)	0.040				
Sc (CRITICAL SLOPE)	(FT/FT)	0.050				
.7Sc	(FT/FT)	0.035				
1.3Sc	(FT/FT)	0.066				
STABLE FLOW?	(Y/N)	N				
FREEBOARD BASED ON UNSTABLE FLOW	(FT)	0.23				
FREEBOARD BASED ON STABLE FLOW	(FT)	0.50				
MINIMUM REQUIRED FREEBOARD[4]	(FT)	0.50				
DESIGN METHOD FOR PROTECTIVE LINING [5] PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)		V				

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A" and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A" and attach appropriate Worksheets.

2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufactured linings without vegetation and with vegetation in separate columns.

3. Slopes may not be averaged.

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