

Appendix 11

King II

June 1, 2020 (TR-29 AR #2)

King II Appendix 11 - Hydrologic Designs	
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Appendix 11(1)

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June 1, 2020 (TR-29 AR #2)

Engineering, Testing & Surveying

Date: June 30, 2015

To: Marcia L. Talvitie, P.E.
Environmental Protection Specialist II
DRMS-Durango Field Office
691 Co. Rd. 233, Suite A-2
Durango, CO 81301

From: Ryan Griglak, P.E.
Stoner Engineering & Surveying

Re: King Coal II – Preliminary “As-Built” Hydrology Analysis Permit C-1981-035

Enclosed is the preliminary “as-built” hydrological analysis for GCC Energy, LLC’s King II Mine located at 6473 County Road 120, Hesperus, Colorado 81326. The analysis includes all the drainage control structures located on the site. The computer modeling was done with SEDCAD version 4.0. The information for the analysis was obtained from aerial topography supplemented with a detailed field survey.

The aerial topography has a much greater degree of accuracy than what was available for the original study. The basin size was slightly reduced and the soil properties modified to more accurately reflect the actual site conditions included the original report. Please see the enclosed information for the actual values. These changes resulted in an increase in the amount of run-off the East and West Clear Water Ditches experience during the design event. The increased flows do not exceed the capacity of either of the clear water ditches.

The minimum culvert installed on-site is a 16-inch CMP due to maintenance considerations. This results in the internal culverts being generally oversized from the results of the SEDCAD modeling. The detention pond has the necessary volume available to store the 25-year, 24-hour storm event.

Please let me know if you have any questions or comments in regards to the information provided.

Sincerely,



Ryan M. Griglak, P.E.

Appendix 11(1A)

King II

June 1, 2020 (TR-29 AR #2)

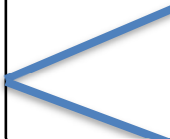
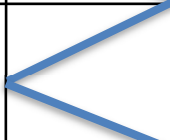
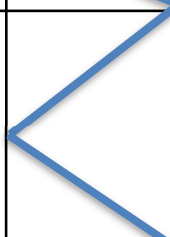
Basin ID Table								
Disturbed Area Basins	Square Feet	Acres	Slope	Vertical Distance	Horizontal (Length)	Hydrologic Soil Group	Soil Cover	Curve
A	204,384	4.69	39.49	312.0	790	D	Forest with Litter	80
B1	50,984	1.17	45.77	292.0	638	D	Forest with Litter	80
B2	33,579	0.77	32.54	68.0	209	D	Forest with Litter	80
C1	128,278	2.94	42.41	268.0	632	D	Forest with Litter	80
C2	29,112	0.67	8.70	18.0	207	D	Forest with Litter	80
D	187,351	4.30	36.23	288.0	795	D	Forest with Litter	85
D1A	46,761	1.07	13.60	68.0	500	D	Forest with Litter	85
D1B	28,578	0.66	37.50	45.0	120	D	Forest with Litter	85
E-1	98,687	2.27	1.91	9.0	470	D	Short Grass Pature	77
E-2	38,069	0.87	7.03	18.0	256	D	Short Grass Pature	77
F1	23,070	0.53	36.36	44.0	121	D	Forest with Litter	80
F2	70,918	1.63	7.06	53.0	751	D	Gravel Road/Parking	85
F3	57,084	1.31	4.21	32.0	760	D	Gravel Road/Parking	85
F4	33,950	0.78	39.66	46.0	116	D	Nearly Bare	85
G	42,209	0.97	18.01	58.0	322	D	Nearly Bare	87
H	64,469	1.48	5.34	14.0	262	D	Nearly Bare	85
I	79,657	1.83	0.63	4.0	633	D	Short Grass Pature	77
Ramp	15,853	0.36	1.22	5.5	450	D	Nearly Bare	85
J	144,975	3.33	47.96	235.0	490	D	Forest with Litter	80
Portals	21,149	0.49	6.09	28.5	468	D	Nearly Bare	85
Totals	1,217,140	32.12						

Contributing Area Basins								
UD-4 West	4098996	94.10	8.00	660.0	8250	D	Forest with Litter	80
UD-4 East	3031776	69.60	8.00	660.0	8250	D	Forest with Litter	80
UD-4 Section A	1287198	29.55	40.29	309.0	767	D	Forest with Litter	80
UD-4 Section B	163786	3.76	33.01	207.0	627	D	Forest with Litter	80
UD-4 Cemetary	213444	4.90	24.00	210.0	875	D	Minimum Tillage	80
UD-4 Road	19602	0.45	14.88	32.0	215	D	Forest with Litter	80
UD-2	227819	5.23	39.78	354.0	890	D	Forest with Litter	80
UD-1 West	43265970	993.25	7.40	950.0	12830	C	Forest with Litter	73
UD-1a East	225368	5.17	42.37	250.0	590	C	Forest with Litter	73
UD-1b East	254783	5.85	49.89	232.0	465	C	Forest with Litter	73
Totals	52,788,742	1211.86						

Culvert ID	SEDCAD STRUCTURE	Description	Material	Linear Feet	Diameter (Inches)	SEDCAD Req' Size (inches Dia.)	Elev. In (Feet)	Elev. Out (Feet)	Drop	Slope (%)	Manning's "n"	Req'd Flow (CFS)
C-1		Under C.R. 120	CMP	82	48	42	7202.50	7200.72	1.78	2.17%	0.015	85.86
C-2	#3	Under Haul Road	CMP	48	24	12	7215.94	7214.70	1.24	2.58%	0.024	4.38
C-3	SC2 - #11	Double Under Haul Road	CMP	49	2 x 24	36	7229.95	7227.78	2.17	4.43%	0.015	24.17
C-4A		Pond Emerg. Spillway-Top = 7233.64'	CMP	119	24	24	7227.85	7225.33	2.52	2.12%	0.024	1.244
C-4B		Pond Spillway-Top = 7232.73'	CMP	119	24	24	7227.85	7225.33	2.52	2.12%	0.024	15.647
C-5		Under Haul Road	CMP	118	24	N/A	7241.37	7238.74	2.63	2.23%	0.024	N/A
C-6	#22	West Pond Inlet	CMP	99	24	18	7238.74	7236.60	2.14	2.16%	0.015	10.83
C-7	#30	Connection Structure to East Pond Inlet	ADS-SMOOTH	265	24	24	7238.20	7237.03	1.17	0.44%	0.015	11.88
C-8	#29	Screen Drop to Connection Structure	ADS-SMOOTH	60	24	15	7239.60	7238.30	1.30	2.17%	0.015	7.04
C-9	#38	Yard Drop to Connection Structure	ADS-SMOOTH	202	24	15	7246.45	7238.30	8.15	4.03%	0.015	4.84
C-10	#35	Substation Drop to Screen Drop	ADS-SMOOTH	167	24	15	7243.07	7241.00	2.07	1.24%	0.015	4.85
C-11		Scale House to Ditch D	CMP	40	16	N/A	7247.50	7243.72	3.78	9.45%	0.024	0
C-12	#20	Stacker 1 to Ditch D	CMP	74	24	18	7245.16	7241.69	3.47	4.69%	0.015	9.30
C-13	#39	Parking Lot to Stacker 1	CMP	60	18	10	7260.41	7258.04	2.37	3.95%	0.024	2.04
C-14	#14	Upper Parking Lot to Lower Parking Lot	CMP	223	16	15	7280.77	7270.08	10.69	4.79%	0.024	5.28
C-15	#12	Under Belt Portal Road	CMP	40	16	15	7284.22	7282.10	2.12	5.30%	0.024	5.28
C-16	#5	3-Sided Building	CMP	100	16	10	7286.94	7283.61	3.33	3.14%	0.024	2.76
C-17	#2	Shop to 3-Sided Building	CMP	100	18	12	7290.09	7286.62	3.47	3.47%	0.024	2.14
C-17A	#42	Basin B1 & B2 to ID 00	HDPE	43	12	10	7287.40	7286.62	0.78	2.00%	0.024	1.4
C-18	SC2 - #12	West Clearwater Shop Bypass	ADS- CORRUGATED	255	24	21	7301.45	7290.63	10.82	4.24%	0.011	15.2
C-19		Pad 2 Culverts	CMP	20	24_x2	6	7256.00	7255.60	0.40	2.00%	0.024	1.19
C-20		Belt Galley	CMP	9	24	0	7306.00	7305.80	0.20	2.35%	0.024	0
C-21	#49	Under King III Ramp	CMP	40	24	15	7260.00	7259.20	0.80	2.00%	0.024	3.85
C-22		Clear Water Ditch UD West of King III Ramp	CMP or ADS	397	30" _x2 or 36"	36	7260.00	7250.38	9.62	2.42%	0.024	35.64

Ditch ID	Station (also in SEDCAD)	Soil Type	STRUCT. No.	Bottom Width (Ft)	Linear Ft.	Slope	Hydraulic Radius	Manning's "n"	Req'd Flow (CFS)	Velocity	Req'd Depth	Actual Depth	Type	Ditch Material
CWD-1A	0+00 to 0+32 (A')	Unbarg Loam	#3	3.6	32	6.90%	0.387	N/A	15.2	4.08	0.68	4.4	Trapezoidal	Grass Mixture
	0+32 to 1+18 (B')	Unbarg Loam	#4	3.5	86	2.90%	0.44	N/A	15.2	2.66	1.17	3.5	Trapezoidal	Grass Mixture
	1+18 to 1+80 (C')	Unbarg Loam	#5	3.3	62	6.80%	0.46	N/A	15.2	5.09	0.73	2.0	Trapezoidal	Grass Mixture
	1+80 to 2+37 (D')	Unbarg Loam	#6	0.0	57	0.20%	1.14	N/A	15.2	1.11	2.27	2.6	Trapezoidal	Grass Mixture
	4+90 to 8+38 (E')	Unbarg Loam	#13	4.3	348	4.20%	0.594	0.040	24.17	5.42	0.78	1.9	Trapezoidal	Rip Rap
	8+38 to 10+81 (F')	Unbarg Loam	#8	2.2	243	3.70%	0.64	n/a	24.17	5.61	1.02	2.1	Trapezoidal	Rip Rap
	10+81 to 12+40 (G')	Unbarg Loam	#9	1.6	159	6.10%	0.548	0.038	24.17	6.48	0.93	2.1	Trapezoidal	Rip Rap
	12+40 to 18+95 (H')	Unbarg Loam	#10	1.0	655	3.60%	0.675	0.036	24.17	6.07	1.29	2.1	Trapezoidal	Rip Rap
CWD-1B	18+95 to 24+01 (I')	Unbarg Loam	#2	2.3	506	4.10%	0.275	0.03	4.38	4.23	0.35	3.0	Trapezoidal	Graded Loam to Cobbles when noncolloidal
CWD-1C	24+01 to 27+58 (J')	Unbarg Loam	#2	2.7	357	4.30%	0.221	0.03	3.23	3.74	0.27	3.0	Trapezoidal	Graded Loam to Cobbles when noncolloidal
CWD-1D	27+58 to 24+01 (J')	Unbarg Loam	#4	2.7	12	13.40%	0.049	0.03	0.33	2.43	0.05	3.0	Trapezoidal	Graded Loam to Cobbles when noncolloidal
Cattle Guard	Cattle Guard	Steel	#3	6.5	35	0.50%	0.183	0.013	3.37	2.61	0.19	3.0	Trapezoidal	Steel
CWD-2	0+00 to 0+05 (A')	Unbarg Loam	#2	3.8	5	19.10%	0.11	0.03	2.38	4.98	0.12	3.0	Trapezoidal	Graded Loam to Cobbles when noncolloidal
	0+05 to 0+70 (B')	Unbarg Loam	#3	5.79	65	17.70%	0.09	0.03	2.38	4.19	0.39	1.26	Trapezoidal	Graded Loam to Cobbles when noncolloidal
	0+70 to 1+60 (C')	Unbarg Loam	#4	3.91	90	6.20%	0.142	0.03	2.38	3.37	0.16	1.02	Trapezoidal	Graded Loam to Cobbles when noncolloidal
	1+60 to 4+70 (D')	Unbarg Loam	#5	4.79	310	1.70%	0.193	0.03	2.38	2.16	0.21	2.05	Trapezoidal	Graded Loam to Cobbles when noncolloidal
	4+70 to 6+12 (E')	Unbarg Loam	#6	3.11	142	0.60%	0.990	0.03	35.64	3.82	1.60	1.90	Trapezoidal	Graded Loam to Cobbles when noncolloidal
	6+12 to 7+90 (F')	Unbarg Loam	#7	7.23	178	0.90%	0.774	0.03	35.64	3.97	0.98	2.98	Trapezoidal	Graded Loam to Cobbles when noncolloidal
	7+90 to 10+00 (G')	Unbarg Loam	#8	7.62	210	3.00%	0.610	N/A	35.64	4.27	1.25	2.68	Trapezoidal	Bermuda Grass
	CULVERT INTERRUPT													
	13+93 to 14+56 (H')	Unbarg Loam	#9	5.34	63	1.80%	0.787	N/A	35.71	4.21	1.66	1.99	Trapezoidal	Grass Mixture
	14+56 to 18+00 (I')	Unbarg Loam	#10	5.84	344	2.60%	0.698	N/A	35.71	4.64	1.44	1.79	Trapezoidal	Grass Mixture
	18+00 to 20+84 (J')	Unbarg Loam	#11	6.18	284	2.90%	0.777	N/A	35.71	4.05	1.37	3.82	Trapezoidal	Grass Mixture
	20+84 to 22+20 (K')	Unbarg Loam	#12	3.94	136	3.10%	0.477	N/A	35.71	3.09	1.3	1.6	Trapezoidal	Grass Mixture
	22+20 to 25+95 (L')	Unbarg Loam		1.98	375	1.50%	0.888	N/A	76.82	4.35	2.28	2.60	Trapezoidal	Grass Mixture
	25+95 to 26+61 (M')	Unbarg Loam		3.84	66	15.90%	0.814	0.3	76.82	9.25	1.53	7.29	Trapezoidal	Rip Rap
	26+61 to 31+87 (N')	Unbarg Loam		8.34	526	2.30%	0.495	0.03	85.86	4.75	1.11	6.21	Trapezoidal	Graded Loam to Cobbles when noncolloidal
ID 00	Minimum	Unbarg Loam	#43	2.00	9	2.10%	0.26	0.03	2.76	2.95	0.35	0.8	Trapezoidal	Graded Silts to Cobbles when noncolloidal
ID 0	Minimum	Unbarg Loam	#44	2.00	210	10.00%	0.13	0.03	1.40	4.03	0.15	0.8	Trapezoidal	Graded Silts to Cobbles when noncolloidal
ID 1A	Minimum	Unbarg Loam	#45	2.00	260	7.64%	0.17	0.03	2.14	4.25	0.21	0.8	Trapezoidal	Graded Loam to Cobbles when noncolloidal
ID 1B	Minimum	Unbarg Loam	#46	2.00	9	2.20%	0.35	0.03	5.28	3.64	0.49	0.8	Trapezoidal	Graded Loam to Cobbles when noncolloidal
ID 1C	Minimum	Unbarg Loam	#47	2.00	20	3.50%	0.31	0.03	5.28	4.29	0.43	0.8	Trapezoidal	Graded Loam to Cobbles when noncolloidal
ID 1D	Minimum	Unbarg Loam	#13	2.00	136	2.70%	0.353	0.03	6.46	4.89	0.48	0.8	Trapezoidal	Shales and Hardpans
ID 1E	Minimum	Unbarg Loam	#19	8.3	274	6.60%	0.222	0.03	9.30	4.66	0.23	0.8	Trapezoidal	Graded Loam to Cobbles when noncolloidal
ID-2A	Minimum	Unbarg Loam	#41	1.25	187	2.00%	0.21	0.030	1.11	2.47	0.28	0.6	Trapezoidal	Graded Loam to Cobbles when noncolloidal
ID-2B	Minimum	Unbarg Loam	#18	0.66	265	4.20%	0.23	0.03	2.04	3.86	0.39	0.7	Trapezoidal	Graded Silts to Cobbles when noncolloidal
ID-3A	Minimum	Unbarg Loam	#48	1.75	9	7.10%	0.20	0.03	2.52	4.52	0.25	0.8	Trapezoidal	Graded Loam to Cobbles when noncolloidal
ID-3	Minimum	Unbarg Loam	#11	1.00	424	10.00%	0.2	0.03	2.52	5.4	0.29	0.8	Trapezoidal	Graded Siltsto Cobbles when noncolloidal
ID 4	Minimum	Unbarg Loam	#21	4.00	128	5.30%	0.368	0.03	10.83	5.30	0.45	0.8	Trapezoidal	Cobbles and Shingles
ID-5	Minimum	Unbarg Loam	#28	4.00	75	1.90%	0.205	N/A	0.88	0.66	0.60	0.90	Trapezoidal	Grass Mixture
ID-5A	Minimum	Unbarg Loam	#50	0.00	305	1.90%	0.29	0.03	4.84	2.97	0.58	0.9	Triangular	Grass Mixture
ID 5B	Minimum	Unbarg Loam	#32	3.00	329	2.00%	0.10	0.025	0.68	1.84	0.11	0.4	Trapezoidal	Shales and Hardpans
ID 5C	Minimum	Unbarg Loam	#34	0.00	182	2.00%	0.35	0.025	4.18	4.21	1.00	1.3	Triangular	Shales and Hardpans
ID-6	Minimum	Unbarg Loam	#15	2.00	160	12.00%	0.062	0.025	0.41	3.16	0.36	0.80	Trapezoidal	Course Gravel noncollidal
ID-7	Minimum	Unbarg Loam	#52	0	450	1.20%	0.147	0.025	0.37	1.83	0.34	0.64	Triangular	Course Gravel noncollidal
ID-8	Minimum	Unbarg Loam	#53	0	173	1.00%	0.338	0.025	3.07	2.89	0.78	1.08	Triangular	Course Gravel noncollidal
ID-9	Minimum	Unbarg Loam	#51	0	470	7.50%	0.290	0.039	3.11	4.59	0.82	1.12	Triangular	Rip-Rap

Utility Runs

Utility Run	Flow		Individual Runs Included in Utility Run	cfs
CWD-2 Station 22+20 to 25+95 (L') As-Built	76.82 cfs		Pond Discharge	16.89
			CWD-2 Start to Station 22+20	35.76
			Culvert C-3 (CWD-1A)	24.17
			Total	76.82
CWD-2 Station 25+95 to 26+61 (M') As-Built	76.82 cfs		Pond Discharge	16.89
			CWD-2 Start to Station 22+20	35.76
			Culvert C-3 (CWD-1A)	24.17
			Total	76.82
CWD-2 Station 26+61 to 31+87 (N') As-Built	84.57 cfs		Pond Discharge	16.89
			CWD-2 Start to Station 22+20	35.76
			Culvert C-3 (CWD-1A)	24.17
			Culvert C-2 (CWD-1B)	4.38
			Cattle Guard (CWD -1C & CWD -1D)	3.37
			Total	84.57
<i>Notes: The flows shown are from King II Appendix 11(1F) June 1, 2020 (TR-29 AR #2), 'Design Discharge w/o Freeboard' for CWD-2 Station 22+20 to 25+95 (L') As-Built and CWD-2 Station 25+95 to 26+61 (M') As-Built Sedcad models (originally printed 06-29-2015) and CWD-2 Station 26+61 to 31+87 (N') As-Built (Printed 05-19-2020). The utility runs were not modified for TR-29 because the flow from CWD-2 above station 22+20 decreased and the maximum discharge from the pond was considered. The peak stage of the "Drainage Basin A to Pond 1 Flows modified for King III Portals" resulted in no discharge from the pond during a 10yr 24hr event. "Pond Discharge" in the above table is derived from the Stucture #37 (Pond) -- Pond Flows to Outlet -- Pond Results: 'Elevation-Capacity-Discharge Table (King II Appendix 11(1G), June 1, 2020 (TR-29 AR #2), originally printed 06-29-2015), which represents maximum discharge at the maximum pond elevation of 7233.80'</i>				

Appendix 11(1B)

King II

June 1, 2020 (TR-29 AR #2)

Drainage Basin A to Pond 1 Flows **modified for King III Portals**

JANUARY 2020:

SEDCAD model reproduced by GEOMAT from supplied PDF of Report dated 12-03-2015. All input variables for the model are assumed correct as supplied in the information and remain the sole responsibility of GCC.

Bob Flegal

GEOMAT Inc

April 2020 Joel Riggins updated F2 & F3 CN values and changed description on structure #50, 49, 51,32,34 and others for clarity. Changed #34 from a null structure to ditch ID-5C.

Bob Flegal

General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	10 yr - 24 hr
Rainfall Depth:	2.200 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#45	0.000	0.000	Basin A flows to Ditch ID-1A
Culvert	#2	==>	#43	0.000	0.000	Culvert C-17 flows to ID -00
Null	#3	==>	#4	0.000	0.000	Basin B1 flow to Basin B2
Null	#4	==>	#44	0.000	0.000	Basin B2 flows Culvert C-17A
Culvert	#5	==>	#46	0.000	0.000	Culvert C-16 flow to Ditch ID-1B
Null	#9	==>	#48	0.000	0.000	Basin C1 flows to Ditch 3
Null	#10	==>	#48	0.000	0.000	Basin C2 flows to Ditch 3
Channel	#11	==>	#46	0.000	0.000	Ditch ID-3 flow to Ditch ID-1B
Culvert	#12	==>	#47	0.000	0.000	Culvert C-15 Flows into Ditch 1C
Channel	#13	==>	#19	0.000	0.000	Ditch 1D flows to Ditch 1E
Culvert	#14	==>	#13	0.000	0.000	Culvert C-14 flow to Ditch 1D
Channel	#15	==>	#13	0.000	0.000	Ditch ID 6 (F1) Flows Into Ditch 1D
Null	#16	==>	#13	0.000	0.000	Basin F2 Flows into Ditch 1C Null
Null	#17	==>	#18	0.000	0.000	Basin F3 Flows into Ditch 2
Channel	#18	==>	#39	0.000	0.000	Ditch 2B Flows Into Culvert C-13
Channel	#19	==>	#20	0.000	0.000	Ditch 1E Flows into Culvert C-12
Culvert	#20	==>	#21	0.000	0.000	Culvert C-12 Flows into Ditch 4
Channel	#21	==>	#22	0.000	0.000	Ditch ID-4 (Includes Basin H) flows into Culvert 6
Culvert	#22	==>	#37	0.000	0.000	Culvert 6 Flows into Pond 1
Null	#25	==>	#28	0.000	0.000	Basin E-1 Flows Into Ditch 5
Channel	#28	==>	#49	0.000	0.000	Ditch 5 Flows into C-21
Culvert	#29	==>	#30	0.000	0.000	Basin G into Culvert C-8 into Culvert C-7
Culvert	#30	==>	#37	0.000	0.000	Culvert C-7 Flows into Pond 1
Null	#31	==>	#53	0.000	0.000	Basin D flows to Ditch ID-5C via ID-8
Channel	#32	==>	#35	0.000	0.000	ID-5B Basin D1B to C-10 via ID-5B
Channel	#34	==>	#35	0.000	0.000	ID-5C Basin D1A into C-10 via ID-5C
Culvert	#35	==>	#29	0.000	0.000	Culvert C-10 Flows into Culvert C-8
Pond	#37	==>	End	0.000	0.000	Pond 1 Flows to Outlet
Culvert	#38	==>	#30	0.000	0.000	Culvert C-9 Flows into Culvert C-7
Culvert	#39	==>	#19	0.000	0.000	Culvert C-13 to Ditch 1E
Channel	#41	==>	#18	0.000	0.000	Ditch 2A Flows into Ditch 2B
Culvert	#42	==>	#43	0.000	0.000	Culvert 17A flow to ID-00
Channel	#43	==>	#5	0.000	0.000	ID-00 flow to Culvert C-16
Channel	#44	==>	#42	0.000	0.000	ID-0 Flows to Culvert C-17A
Channel	#45	==>	#2	0.000	0.000	ID-1A flows to Culvert C-17
Channel	#46	==>	#12	0.000	0.000	Ditch 1B flows into Culver C-15
Channel	#47	==>	#14	0.000	0.000	Ditch 1C flows into Culvert C-14
Channel	#48	==>	#11	0.000	0.000	Ditch 3A flows into Ditch ID-3
Culvert	#49	==>	#50	0.000	0.000	C-21 into ID-5A
Channel	#50	==>	#38	0.000	0.000	ID-5A into Culvert C-9

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#51	==>	#49	0.000	0.000	ID-9 Portals and Basin J to Drop to C-21
Channel	#52	==>	#53	0.000	0.000	Road ID-7 (& basin) into ID-8
Channel	#53	==>	#34	0.000	0.000	ID-8 Flows into ID-5C

		#51 Chan'l	
			#25 Null
		#28 Chan'l	
		#49 Culvert	
		#50 Chan'l	
	#38 Culvert		
			#52 Chan'l
			#31 Null
		#53 Chan'l	
		#34 Chan'l	
		#32 Chan'l	
		#35 Culvert	
	#29 Culvert		
	#30 Culvert		
			#41 Chan'l
			#17 Null
			#18 Chan'l
		#39 Culvert	
			#16 Null

	#15 Chan'l				
			#10 Null		
			#9 Null		
			#48 Chan'l		
		#11 Chan'l			
					#3 Null
					#4 Null
				#44 Chan'l	
			#42 Culvert		
					#1 Null
				#45 Chan'l	
				#2 Culvert	
			#43 Chan'l		
			#5 Culvert		
			#46 Chan'l		
			#12 Culvert		
			#47 Chan'l		
			#14 Culvert		
			#13 Chan'l		
			#19 Chan'l		
			#20 Culvert		
		#21 Chan'l			

 #22 <i>Culvert</i>
#37 <i>Pond</i>

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#51	3.814	3.814	3.11	0.23
#25	2.266	2.266	0.88	0.09
#28	0.000	2.266	0.88	0.09
#49	0.000	6.080	3.85	0.31
#50	0.874	6.954	4.84	0.39
#38	0.000	6.954	4.84	0.39
#52	0.364	0.364	0.37	0.02
#31	4.301	4.301	2.93	0.27
#53	0.000	4.665	3.07	0.30
#34	1.073	5.738	4.18	0.38
#32	0.656	0.656	0.68	0.05
#35	0.000	6.394	4.85	0.43
#29	2.799	9.193	7.04	0.59
#30	0.000	16.147	11.88	0.98
#41	0.898	0.898	1.11	0.09
#17	0.898	0.898	0.92	0.07
#18	0.000	1.796	2.04	0.16
#39	0.000	1.796	2.04	0.16
#16	1.628	1.628	0.94	0.10
#15	0.530	0.530	0.41	0.03
#10	0.668	0.668	0.52	0.04
#9	2.945	2.945	2.08	0.17
#48	0.000	3.613	2.52	0.21
#11	0.000	3.613	2.52	0.21
#3	1.170	1.170	0.83	0.07
#4	0.771	1.941	1.40	0.11
#44	0.000	1.941	1.40	0.11
#42	0.000	1.941	1.40	0.11
#1	4.692	4.692	2.14	0.22
#45	0.000	4.692	2.14	0.22
#2	0.000	4.692	2.14	0.22
#43	0.000	6.633	2.76	0.33
#5	0.000	6.633	2.76	0.33
#46	0.000	10.246	5.28	0.54
#12	0.000	10.246	5.28	0.54
#47	0.000	10.246	5.28	0.54
#14	0.000	10.246	5.28	0.54
#13	0.000	12.404	6.46	0.67
#19	0.779	14.979	9.30	0.89

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#20	0.000	14.979	9.30	0.89
#21	1.480	16.459	10.83	1.00
#22	0.000	16.459	10.83	1.00
#37 In	0.000	32.606	22.71	1.98
Out			0.00	0.00

Structure Detail:

Structure #51 (Riprap Channel)

ID-9 Portals and Basin J to Drop to C-21

Triangular Riprap Channel Inputs:

Material: Riprap

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
1.0:1	1.0:1	7.5	0.30		

Riprap Channel Results:

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	3.11 cfs	
Depth:	0.82 ft	1.12 ft
Top Width:	1.64 ft	2.24 ft
Velocity:	4.59 fps	
X-Section Area:	0.68 sq ft	
Hydraulic Radius:	0.291 ft	
Froude Number:	1.26	
Manning's n:	0.0390	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

Structure #25 (Null)

Basin E-1 Flows Into Ditch 5

Structure #28 (Vegetated Channel)

Ditch 5 Flows into C-21

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
4.00	1.8:1	7.8:1	1.9	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	0.88 cfs		0.88 cfs	
Depth:	0.26 ft	0.56 ft	0.60 ft	0.90 ft
Top Width:	6.45 ft	9.33 ft	9.78 ft	12.66 ft
Velocity:	0.66 fps		0.21 fps	
X-Section Area:	1.33 sq ft		4.15 sq ft	
Hydraulic Radius:	0.205 ft		0.419 ft	
Froude Number:	0.26		0.06	
Roughness Coefficient:	0.1072		0.5390	

Structure #49 (Culvert)

C-21 into ID-5A

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
40.00	2.00	0.0240	2.00	0.00	0.90

Culvert Results:

Design Discharge = 3.85 cfs

Minimum pipe diameter: 1 - 15 inch pipe(s) required

Structure #50 (Erodible Channel)

ID-5A into Culvert C-9

Triangular Erodible Channel Inputs:

Material: Graded loam to cobbles when noncolloidal

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.8:1	7.8:1	1.9	0.0300	0.30			5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	4.84 cfs	
Depth:	0.58 ft	0.88 ft
Top Width:	5.60 ft	8.48 ft
Velocity:	2.97 fps	
X-Section Area:	1.63 sq ft	
Hydraulic Radius:	0.285 ft	
Froude Number:	0.97	

Structure #38 (Culvert)

Culvert C-9 Flows into Culvert C-7

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
202.00	4.03	0.0150	3.00	0.00	0.90

Culvert Results:

Design Discharge = 4.84 cfs

Minimum pipe diameter: 1 - 12 inch pipe(s) required

Structure #52 (Erodible Channel)

Road ID-7 (& basin) into ID-8

Triangular Erodible Channel Inputs:

Material: Coarse gravel noncolloidal

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.0:1	1.5:1	1.2	0.0250	0.30			4.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.37 cfs	
Depth:	0.34 ft	0.64 ft
Top Width:	1.19 ft	2.24 ft
Velocity:	1.83 fps	
X-Section Area:	0.20 sq ft	
Hydraulic Radius:	0.147 ft	
Froude Number:	0.79	

Structure #31 (Null)

Basin D flows to Ditch ID-5C via ID-8

Structure #53 (Erodible Channel)

ID-8 Flows into ID-5C

Triangular Erodible Channel Inputs:

Material: Coarse gravel noncolloidal

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.0:1	1.5:1	1.0	0.0250	0.30			4.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	3.07 cfs	
Depth:	0.78 ft	1.08 ft
Top Width:	2.73 ft	3.78 ft
Velocity:	2.89 fps	
X-Section Area:	1.06 sq ft	
Hydraulic Radius:	0.338 ft	
Froude Number:	0.82	

Structure #34 (Erodible Channel)

ID-5C Basin D1A into C-10 via ID-5C

Triangular Erodible Channel Inputs:

Material: Shales and hardpans

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.0:1	1.0:1	2.0	0.0250	0.30			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	4.18 cfs	
Depth:	1.00 ft	1.30 ft
Top Width:	1.99 ft	2.59 ft
Velocity:	4.21 fps	
X-Section Area:	0.99 sq ft	
Hydraulic Radius:	0.353 ft	
Froude Number:	1.05	

Structure #32 (Erodible Channel)*ID-5B Basin D1B to C-10 via ID-5B*

Trapezoidal Erodible Channel Inputs:

Material: Shales and hardpans

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.00	2.0:1	3.0:1	2.0	0.0250	0.30			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.68 cfs	
Depth:	0.11 ft	0.41 ft
Top Width:	3.56 ft	5.06 ft
Velocity:	1.84 fps	
X-Section Area:	0.37 sq ft	
Hydraulic Radius:	0.102 ft	
Froude Number:	1.01	

Structure #35 (Culvert)*Culvert C-10 Flows into Culvert C-8*

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
167.00	1.24	0.0150	2.50	0.00	0.90

Culvert Results:

Design Discharge = 4.85 cfs

Minimum pipe diameter: 1 - 15 inch pipe(s) required

Structure #29 (Culvert)*Basin G into Culvert C-8 into Culvert C-7*

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
60.00	2.17	0.0150	2.50	0.00	0.90

Culvert Results:

Design Discharge = 7.04 cfs

Minimum pipe diameter: 1 - 15 inch pipe(s) required

Structure #30 (Culvert)

Culvert C-7 Flows into Pond 1

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
265.00	0.44	0.0150	2.50	0.00	0.90

Culvert Results:

Design Discharge = 11.88 cfs

Minimum pipe diameter: 1 - 24 inch pipe(s) required

Structure #41 (Erodible Channel)

Ditch 2A Flows into Ditch 2B

Trapezoidal Erodible Channel Inputs:

Material: Graded loam to cobbles when noncolloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.25	1.3:1	1.3:1	2.0	0.0300	0.30			5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.11 cfs	
Depth:	0.28 ft	0.58 ft
Top Width:	1.98 ft	2.76 ft
Velocity:	2.47 fps	
X-Section Area:	0.45 sq ft	
Hydraulic Radius:	0.208 ft	
Froude Number:	0.91	

Structure #17 (Null)

Basin F3 Flows into Ditch 2

Structure #18 (Erodible Channel)

Ditch 2B Flows Into Culvert C-13

Trapezoidal Erodible Channel Inputs:

Material: Graded silts to cobbles when colloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
0.66	1.8:1	1.8:1	4.2	0.0300	0.30			5.5

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.04 cfs	
Depth:	0.39 ft	0.69 ft
Top Width:	2.06 ft	3.14 ft
Velocity:	3.86 fps	
X-Section Area:	0.53 sq ft	
Hydraulic Radius:	0.234 ft	
Froude Number:	1.34	

Structure #39 (Culvert)

Culvert C-13 to Ditch 1E

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
60.00	3.95	0.0240	2.50	0.00	0.90

Culvert Results:

Design Discharge = 2.04 cfs

Minimum pipe diameter: 1 - 10 inch pipe(s) required

Structure #16 (Null)

Basin F2 Flows into Ditch 1C Null

Structure #15 (Erodible Channel)

Ditch ID 6 (F1) Flows Into Ditch 1D

Trapezoidal Erodible Channel Inputs:

Material: Coarse gravel noncolloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.00	1.0:1	1.0:1	12.0	0.0250	0.30			4.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.41 cfs	
Depth:	0.06 ft	0.36 ft
Top Width:	2.13 ft	2.73 ft
Velocity:	3.16 fps	
X-Section Area:	0.13 sq ft	
Hydraulic Radius:	0.060 ft	
Froude Number:	2.25	

Structure #10 (Null)

Basin C2 flows to Ditch 3

Structure #9 (Null)

Basin C1 flows to Ditch 3

Structure #48 (Erodible Channel)

Ditch 3A flows into Ditch ID-3

Trapezoidal Erodible Channel Inputs:

Material: Graded loam to cobbles when noncolloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.75	1.8:1	1.8:1	7.1	0.0300	0.30			5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.52 cfs	
Depth:	0.25 ft	0.55 ft
Top Width:	2.66 ft	3.74 ft
Velocity:	4.52 fps	
X-Section Area:	0.56 sq ft	
Hydraulic Radius:	0.200 ft	
Froude Number:	1.74	

Structure #11 (Erodible Channel)

Ditch ID-3 flow to Ditch ID-1B

Trapezoidal Erodible Channel Inputs:

Material: Graded silts to cobbles when colloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.00	2.0:1	2.0:1	10.0	0.0300	0.30			5.5

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.52 cfs	
Depth:	0.29 ft	0.59 ft
Top Width:	2.18 ft	3.38 ft
Velocity:	5.40 fps	
X-Section Area:	0.47 sq ft	
Hydraulic Radius:	0.202 ft	
Froude Number:	2.05	

Structure #3 (Null)

Basin B1 flow to Basin B2

Structure #4 (Null)

Basin B2 flows Culvert C-17A

Structure #44 (Erodible Channel)

ID-0 Flows to Culvert C-17A

Trapezoidal Erodible Channel Inputs:

Material: Graded silts to cobbles when colloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.00	2.0:1	2.0:1	10.0	0.0300	0.30			5.5

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	1.40 cfs	
Depth:	0.15 ft	0.45 ft
Top Width:	2.60 ft	3.80 ft
Velocity:	4.03 fps	
X-Section Area:	0.35 sq ft	
Hydraulic Radius:	0.130 ft	
Froude Number:	1.94	

Structure #42 (Culvert)

Culvert 17A flow to ID-00

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
43.00	2.00	0.0240	2.00	0.00	0.90

Culvert Results:

Design Discharge = 1.40 cfs

Minimum pipe diameter: 1 - 10 inch pipe(s) required

Structure #1 (Null)

Basin A flows to Ditch ID-1A

Structure #45 (Erodible Channel)

ID-1A flows to Culvert C-17

Trapezoidal Erodible Channel Inputs:

Material: Graded loam to cobbles when noncolloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.00	2.0:1	2.0:1	7.6	0.0300	0.30			5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.14 cfs	
Depth:	0.21 ft	0.51 ft
Top Width:	2.84 ft	4.04 ft
Velocity:	4.25 fps	
X-Section Area:	0.51 sq ft	
Hydraulic Radius:	0.173 ft	
Froude Number:	1.77	

Structure #2 (Culvert)

Culvert C-17 flows to ID -00

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
100.00	3.47	0.0240	2.50	2.50	0.90

Culvert Results:

Design Discharge = 2.14 cfs

Minimum pipe diameter: 1 - 12 inch pipe(s) required

Structure #43 (Erodible Channel)

ID-00 flow to Culvert C-16

Trapezoidal Erodible Channel Inputs:

Material: Graded silts to cobbles when colloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.00	2.0:1	2.0:1	2.1	0.0300	0.30			5.5

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.76 cfs	
Depth:	0.35 ft	0.65 ft
Top Width:	3.39 ft	4.59 ft
Velocity:	2.96 fps	
X-Section Area:	0.93 sq ft	
Hydraulic Radius:	0.263 ft	
Froude Number:	0.99	

Structure #5 (Culvert)

Culvert C-16 flow to Ditch ID-1B

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
100.00	3.14	0.0240	2.50	3.00	0.90

Culvert Results:

Design Discharge = 2.76 cfs

Minimum pipe diameter: 1 - 12 inch pipe(s) required

Structure #46 (Erodible Channel)

Ditch 1B flows into Culver C-15

Trapezoidal Erodible Channel Inputs:

Material: Graded loam to cobbles when noncolloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.00	2.0:1	2.0:1	2.2	0.0300	0.30			5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	5.28 cfs	
Depth:	0.49 ft	0.79 ft
Top Width:	3.95 ft	5.15 ft
Velocity:	3.64 fps	
X-Section Area:	1.45 sq ft	
Hydraulic Radius:	0.347 ft	
Froude Number:	1.06	

Structure #12 (Culvert)

Culvert C-15 Flows into Ditch 1C

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
40.00	5.30	0.0240	2.50	2.00	0.90

Culvert Results:

Design Discharge = 5.28 cfs

Minimum pipe diameter: 1 - 15 inch pipe(s) required

Structure #47 (Erodible Channel)

Ditch 1C flows into Culvert C-14

Trapezoidal Erodible Channel Inputs:

Material: Graded loam to cobbles when noncolloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.00	2.0:1	2.0:1	3.5	0.0300	0.30			5.5

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	5.28 cfs	
Depth:	0.43 ft	0.73 ft
Top Width:	3.72 ft	4.92 ft

	w/o Freeboard	w/ Freeboard
Velocity:	4.29 fps	
X-Section Area:	1.23 sq ft	
Hydraulic Radius:	0.314 ft	
Froude Number:	1.31	

Structure #14 (Culvert)

Culvert C-14 flow to Ditch 1D

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
223.00	4.79	0.0240	2.52	0.00	0.90

Culvert Results:

Design Discharge = 5.28 cfs

Minimum pipe diameter: 1 - 15 inch pipe(s) required

Structure #13 (Erodible Channel)

Ditch 1D flows to Ditch 1E

Trapezoidal Erodible Channel Inputs:

Material: Shales and hardpans

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.00	1.5:1	1.5:1	2.7	0.0250	0.30			6.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	6.46 cfs	
Depth:	0.48 ft	0.78 ft
Top Width:	3.45 ft	4.35 ft
Velocity:	4.89 fps	
X-Section Area:	1.32 sq ft	
Hydraulic Radius:	0.353 ft	
Froude Number:	1.39	

Structure #19 (Erodible Channel)

Ditch 1E Flows into Culvert C-12

Trapezoidal Erodible Channel Inputs:

Material: Graded loam to cobbles when noncolloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.30	1.3:1	1.3:1	6.6	0.0300	0.30			5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	9.30 cfs	
Depth:	0.23 ft	0.53 ft
Top Width:	8.90 ft	9.68 ft
Velocity:	4.66 fps	
X-Section Area:	2.00 sq ft	
Hydraulic Radius:	0.221 ft	
Froude Number:	1.73	

Structure #20 (Culvert)*Culvert C-12 Flows into Ditch 4*

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
74.00	4.69	0.0150	3.00	0.00	0.90

Culvert Results:

Design Discharge = 9.30 cfs

Minimum pipe diameter: 1 - 18 inch pipe(s) required

Structure #21 (Erodible Channel)*Ditch ID-4 (Includes Basin H) flows into Culvert 6*

Trapezoidal Erodible Channel Inputs:

Material: Cobbles and shingles

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
4.00	1.8:1	1.8:1	5.3	0.0350	0.30			5.5

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	10.83 cfs	
Depth:	0.45 ft	0.75 ft

	w/o Freeboard	w/ Freeboard
Top Width:	5.61 ft	6.69 ft
Velocity:	5.03 fps	
X-Section Area:	2.15 sq ft	
Hydraulic Radius:	0.368 ft	
Froude Number:	1.43	

Structure #22 (Culvert)

Culvert 6 Flows into Pond 1

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
99.00	2.16	0.0150	4.00	0.00	0.90

Culvert Results:

Design Discharge = 10.83 cfs

Minimum pipe diameter: 1 - 18 inch pipe(s) required

Structure #37 (Pond)

Pond 1 Flows to Outlet

Pond Inputs:

Initial Pool Elev:	7,227.00 ft
Initial Pool:	0.07 ac-ft

Drop Inlet

Riser Diameter (in)	Riser Height (ft)	Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)
24.00	7.17	24.00	119.00	2.12	0.0240	7,233.64

Drop Inlet

Riser Diameter (in)	Riser Height (ft)	Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)
24.00	6.56	24.00	119.00	2.12	0.0240	7,232.73

Pond Results:

Peak Elevation:	7,230.88 ft
Dewater Time:	0.00 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
7,226.17	0.025	0.000	0.000	
7,226.67	0.097	0.029	0.000	
7,227.00	0.164	0.071	0.000	
7,227.17	0.201	0.102	0.000	
7,227.67	0.295	0.225	0.000	
7,228.17	0.407	0.400	0.000	
7,228.67	0.499	0.626	0.000	
7,229.17	0.599	0.900	0.000	
7,229.67	0.644	1.211	0.000	
7,230.17	0.690	1.544	0.000	
7,230.67	0.721	1.897	0.000	
7,230.88	0.735	2.054	0.000	0.00 Peak Stage
7,231.17	0.753	2.266	0.000	
7,231.67	0.787	2.651	0.000	
7,232.17	0.822	3.053	0.000	
7,232.67	0.860	3.474	0.000	
7,232.73	0.865	3.526	0.000	Spillway #2
7,233.00	0.886	3.762	2.733	
7,233.17	0.899	3.914	5.684	
7,233.64	0.920	4.341	14.431	Spillway #1
7,233.67	0.921	4.369	14.766	
7,233.80	0.927	4.489	16.889	

Detailed Discharge Table

Elevation (ft)	Drop Inlet (cfs)	Drop Inlet (cfs)	Combined Total Discharge (cfs)
7,226.17	0.000	0.000	0.000
7,226.67	0.000	0.000	0.000
7,227.00	0.000	0.000	0.000
7,227.17	0.000	0.000	0.000
7,227.67	0.000	0.000	0.000
7,228.17	0.000	0.000	0.000
7,228.67	0.000	0.000	0.000
7,229.17	0.000	0.000	0.000
7,229.67	0.000	0.000	0.000
7,230.17	0.000	0.000	0.000
7,230.67	0.000	0.000	0.000
7,231.17	0.000	0.000	0.000

Elevation (ft)	Drop Inlet (cfs)	Drop Inlet (cfs)	Combined Total Discharge (cfs)
7,231.67	0.000	0.000	0.000
7,232.17	0.000	0.000	0.000
7,232.67	0.000	0.000	0.000
7,232.73	0.000	0.000	0.000
7,233.00	0.000	2.733	2.733
7,233.17	0.000	5.684	5.684
7,233.64	0.000	14.431	14.431
7,233.67	0.100	14.665	14.766
7,233.80	1.243	15.646	16.889

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#51	1	3.328	0.077	0.000	0.000	80.000	M	2.61	0.191
	2	0.486	0.052	0.000	0.000	85.000	M	0.50	0.035
	Σ	3.814						3.11	0.225
#25	1	2.266	0.136	0.000	0.000	77.000	M	0.88	0.086
	Σ	2.266						0.88	0.086
#28	Σ	2.266						0.88	0.086
#49	Σ	6.080						3.85	0.311
#50	1	0.874	0.070	0.000	0.000	87.000	M	0.99	0.077
	Σ	6.954						4.84	0.388
#38	Σ	6.954						4.84	0.388
#52	1	0.364	0.113	0.000	0.000	85.000	M	0.37	0.024
	Σ	0.364						0.37	0.024
#31	1	4.301	0.145	0.000	0.000	85.000	M	2.93	0.275
	Σ	4.301						2.93	0.275
#53	Σ	4.665						3.07	0.299
#34	1	1.073	0.037	0.000	0.000	85.000	M	1.10	0.084
	Σ	5.738						4.18	0.383
#32	1	0.656	0.005	0.000	0.000	85.000	M	0.68	0.051
	Σ	0.656						0.68	0.051
#35	Σ	6.394						4.85	0.435
#29	1	0.969	0.021	0.000	0.000	80.000	M	0.76	0.055
	2	1.830	0.120	0.000	0.000	80.000	M	1.43	0.105
	Σ	9.193						7.04	0.595
#30	Σ	16.147						11.88	0.983
#41	1	0.898	0.096	0.000	0.000	89.000	M	1.11	0.089
	Σ	0.898						1.11	0.089
#17	1	0.898	0.102	0.000	0.000	85.000	M	0.92	0.070
	Σ	0.898						0.92	0.070
#18	Σ	1.796						2.04	0.159
#39	Σ	1.796						2.04	0.159

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#16	1	1.628	0.311	0.000	0.000	85.000	M	0.94	0.102
	Σ	1.628						0.94	0.102
#15	1	0.530	0.022	0.000	0.000	80.000	M	0.41	0.027
	Σ	0.530						0.41	0.027
#10	1	0.668	0.077	0.019	0.317	80.000	M	0.52	0.038
	Σ	0.668						0.52	0.038
#9	1	2.945	0.107	0.107	0.246	80.000	M	2.31	0.169
	Σ	2.945						2.08	0.169
#48	Σ	3.613						2.52	0.207
#11	Σ	3.613						2.52	0.207
#3	1	1.170	0.103	0.103	0.251	80.000	M	0.92	0.067
	Σ	1.170						0.83	0.067
#4	1	0.771	0.040	0.040	0.229	80.000	M	0.60	0.044
	Σ	1.941						1.40	0.111
#44	Σ	1.941						1.40	0.111
#42	Σ	1.941						1.40	0.111
#1	1	4.692	0.138	0.138	0.241	80.000	M	2.31	0.219
	Σ	4.692						2.14	0.219
#45	Σ	4.692						2.14	0.219
#2	Σ	4.692						2.14	0.219
#43	Σ	6.633						2.76	0.329
#5	Σ	6.633						2.76	0.329
#46	Σ	10.246						5.28	0.536
#12	Σ	10.246						5.28	0.536
#47	Σ	10.246						5.28	0.536
#14	Σ	10.246						5.28	0.536
#13	Σ	12.404						6.46	0.666
#19	1	0.779	0.005	0.000	0.000	85.000	M	0.80	0.061
	Σ	14.979						9.30	0.885
#20	Σ	14.979						9.30	0.885
#21	1	1.480	0.031	0.000	0.000	85.000	M	1.52	0.116

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
	Σ	16.459						10.83	1.002
#22	Σ	16.459						10.83	1.002
#37	Σ	32.606						22.71	1.984

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	1. Forest with heavy ground litter	39.49	312.00	790.00	1.580	0.138
#1	1	Time of Concentration:					0.138
#3	1	1. Forest with heavy ground litter	45.77	292.00	638.00	1.710	0.103
#3	1	Time of Concentration:					0.103
#4	1	1. Forest with heavy ground litter	32.54	68.00	209.00	1.440	0.040
#4	1	Time of Concentration:					0.040
#9	1	1. Forest with heavy ground litter	42.40	268.00	632.00	1.640	0.107
#9	1	Time of Concentration:					0.107
#10	1	1. Forest with heavy ground litter	8.70	18.00	207.00	0.740	0.077
#10	1	Time of Concentration:					0.077
#15	1	1. Forest with heavy ground litter	36.36	44.00	121.00	1.520	0.022
#15	1	Time of Concentration:					0.022
#16	1	1. Forest with heavy ground litter	7.06	53.00	751.00	0.670	0.311
#16	1	Time of Concentration:					0.311
#17	1	5. Nearly bare and untilled, and alluvial valley fans	4.21	32.00	760.02	2.050	0.102
#17	1	Time of Concentration:					0.102
#19	1	5. Nearly bare and untilled, and alluvial valley fans	39.66	46.00	116.00	6.290	0.005
#19	1	Time of Concentration:					0.005
#21	1	5. Nearly bare and untilled, and alluvial valley fans	5.34	14.00	262.00	2.310	0.031
#21	1	Time of Concentration:					0.031
#25	1	3. Short grass pasture	3.88	30.00	773.01	1.570	0.136
#25	1	Time of Concentration:					0.136
#29	1	5. Nearly bare and untilled, and alluvial valley fans	18.01	58.00	322.00	4.240	0.021
#29	1	Time of Concentration:					0.021
#29	2	6. Grassed waterway	1.33	10.00	750.00	1.730	0.120
#29	2	Time of Concentration:					0.120
#31	1	1. Forest with heavy ground litter	36.23	288.00	795.00	1.520	0.145
#31	1	Time of Concentration:					0.145
#32	1	5. Nearly bare and untilled, and alluvial valley fans	37.50	45.00	120.00	6.120	0.005
#32	1	Time of Concentration:					0.005

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#34	1	5. Nearly bare and untilled, and alluvial valley fans	13.60	68.00	499.99	3.680	0.037
#34	1	Time of Concentration:					0.037
#41	1	5. Nearly bare and untilled, and alluvial valley fans	2.02	10.00	495.00	1.420	0.096
#41	1	Time of Concentration:					0.096
#50	1	5. Nearly bare and untilled, and alluvial valley fans	0.85	2.00	235.01	0.920	0.070
#50	1	Time of Concentration:					0.070
#51	1	1. Forest with heavy ground litter	47.96	235.00	490.00	1.750	0.077
#51	1	Time of Concentration:					0.077
#51	2	5. Nearly bare and untilled, and alluvial valley fans	6.09	28.50	468.00	2.460	0.052
#51	2	Time of Concentration:					0.052
#52	1	5. Nearly bare and untilled, and alluvial valley fans	1.22	5.50	450.00	1.100	0.113
#52	1	Time of Concentration:					0.113

Subwatershed Muskingum Routing Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	1. Forest with heavy ground litter	39.49	312.00	790.00	1.580	0.138
#1	1	Muskingum K:					0.138
#3	1	1. Forest with heavy ground litter	45.77	292.00	638.00	1.710	0.103
#3	1	Muskingum K:					0.103
#4	1	1. Forest with heavy ground litter	32.54	68.00	209.00	1.440	0.040
#4	1	Muskingum K:					0.040
#9	1	1. Forest with heavy ground litter	42.40	268.00	632.00	1.640	0.107
#9	1	Muskingum K:					0.107
#10	1	5. Nearly bare and untilled, and alluvial valley fans	8.70	18.00	207.00	2.940	0.019
#10	1	Muskingum K:					0.019

Appendix 11(1C)

King II

June 1, 2020 (TR-29 AR #2)

Ditch CWD-1A SEDCad As-Built **(Stations 0+00 to 18+95 (Culvert C-** **3 to CWD-2)**

Upstream flows into CWD-1A to CWD-2

Joshua Chlopek

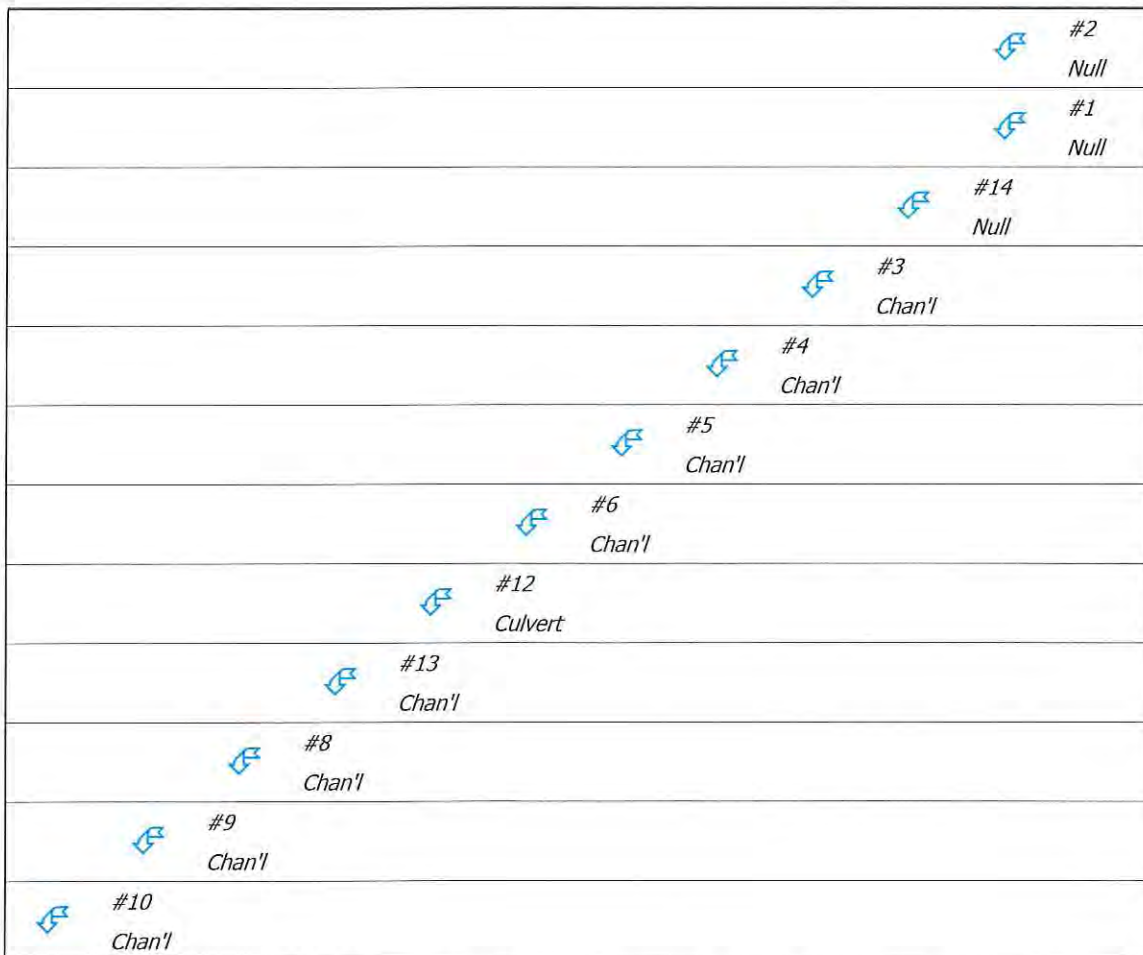
General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	10 yr - 24 hr
Rainfall Depth:	2.200 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#14	0.000	0.000	Basin West
Null	#2	==>	#14	0.000	0.000	Basin East
Channel	#3	==>	#4	0.000	0.000	Station 0+00 to Station 0+32 (A')
Channel	#4	==>	#5	0.000	0.000	Station 0+32 to Station 1+18 (B')
Channel	#5	==>	#6	0.000	0.000	Station 1+18 to Station 1+80 (C')
Channel	#6	==>	#12	0.000	0.000	Station 1+80 to Station 2+37 (D')
Channel	#8	==>	#9	0.000	0.000	Station 8+38 to Station 10+81 (F')
Channel	#9	==>	#10	0.000	0.000	Station 10+81 to Station 12+40 (G')
Channel	#10	==>	#11	0.000	0.000	Station 12+40 to Station 18+95 (H')
Culvert	#11	==>	End	0.000	0.000	Culvert C-3 to CWD-2
Culvert	#12	==>	#13	0.000	0.000	Culvert C-18 to Station 4+95
Channel	#13	==>	#8	0.000	0.000	Station 4+90 to 8+38 (E')
Null	#14	==>	#3	0.000	0.000	Flows Basin West and Basin East



#11

Culvert

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#2	69.600	69.600	6.46	3.18
#1	94.100	94.100	8.74	4.29
#14	0.000	163.700	15.20	7.47
#3	0.000	163.700	15.20	7.47
#4	0.000	163.700	15.20	7.47
#5	0.000	163.700	15.20	7.47
#6	0.000	163.700	15.20	7.47
#12	0.000	163.700	15.20	7.47
#13	29.550	193.250	24.17	9.86
#8	0.000	193.250	24.17	9.86
#9	0.000	193.250	24.17	9.86
#10	0.000	193.250	24.17	9.86
#11	0.000	193.250	24.17	9.86

Structure Detail:***Structure #2 (Null)****Basin East****Structure #1 (Null)****Basin West****Structure #14 (Null)****Flows Basin West and Basin East****Structure #3 (Vegetated Channel)****Station 0+00 to Station 0+32 (A')*

Trapezoidal Vegetated Channel Inputs:

Material: Bermuda grass

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.60	2.1:1	8.3:1	6.9	D, C	0.30			7.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class C w/o Freeboard	Capacity Class C w/ Freeboard
Design Discharge:	15.20 cfs		15.20 cfs	
Depth:	0.57 ft	0.87 ft	0.68 ft	0.98 ft
Top Width:	9.52 ft	12.65 ft	10.65 ft	13.78 ft
Velocity:	4.08 fps		3.16 fps	
X-Section Area:	3.73 sq ft		4.82 sq ft	
Hydraulic Radius:	0.387 ft		0.447 ft	
Froude Number:	1.15		0.83	
Roughness Coefficient:	0.0507		0.0722	

Structure #4 (Vegetated Channel)*Station 0+32 to Station 1+18 (B')*

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.50	5.6:1	7.7:1	2.9	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	15.20 cfs		15.20 cfs	
Depth:	0.70 ft	1.00 ft	1.17 ft	1.47 ft
Top Width:	12.82 ft	16.81 ft	19.03 ft	23.03 ft
Velocity:	2.66 fps		1.16 fps	
X-Section Area:	5.71 sq ft		13.15 sq ft	
Hydraulic Radius:	0.442 ft		0.685 ft	
Froude Number:	0.70		0.25	
Roughness Coefficient:	0.0555		0.1710	

Structure #5 (Vegetated Channel)

Station 1+18 to Station 1+80 (C')

Trapezoidal Vegetated Channel Inputs:

Material: Bermuda grass

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.30	2.2:1	2.7:1	6.8	D, C	0.30			7.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class C w/o Freeboard	Capacity Class C w/ Freeboard
Design Discharge:	15.20 cfs		15.20 cfs	
Depth:	0.62 ft	0.92 ft	0.73 ft	1.03 ft
Top Width:	6.36 ft	7.84 ft	6.92 ft	8.40 ft
Velocity:	5.09 fps		4.07 fps	
X-Section Area:	2.99 sq ft		3.74 sq ft	
Hydraulic Radius:	0.453 ft		0.519 ft	
Froude Number:	1.31		0.97	
Roughness Coefficient:	0.0452		0.0618	

Structure #6 (Vegetated Channel)

Station 1+80 to Station 2+37 (D')

Parabolic Vegetated Channel Inputs:

Material: Grass mixture

Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
0.2	D, C	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class C w/o Freeboard	Capacity Class C w/ Freeboard
Design Discharge:	15.20 cfs		15.20 cfs	
Depth:	1.99 ft	2.29 ft	2.27 ft	2.57 ft
Top Width:	7.94 ft	8.52 ft	9.08 ft	9.67 ft
Velocity:	1.45 fps		1.11 fps	
X-Section Area:	10.52 sq ft		13.75 sq ft	
Hydraulic Radius:	1.135 ft		1.298 ft	
Froude Number:	0.22		0.16	
Roughness Coefficient:	0.0501		0.0717	

Structure #12 (Culvert)

Culvert C-18 to Station 4+95

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
255.00	4.24	0.0110	3.00	0.00	0.90

Culvert Results:

Design Discharge = 15.20 cfs

Minimum pipe diameter: 1 - 21 inch pipe(s) required

Structure #13 (Riprap Channel)

Station 4+90 to 8+38 (E')

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
4.30	2.0:1	1.5:1	4.2	0.30		

Riprap Channel Results:

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	24.17 cfs	
Depth:	0.78 ft	1.08 ft
Top Width:	7.10 ft	8.17 ft
Velocity:	5.42 fps	
X-Section Area:	4.46 sq ft	
Hydraulic Radius:	0.594 ft	
Froude Number:	1.21	
Manning's n:	0.0400	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

Structure #8 (Riprap Channel)

Station 8+38 to Station 10+81 (F')

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
2.20	2.3:1	1.6:1	3.7	0.30		

Riprap Channel Results:

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	24.17 cfs	
Depth:	1.02 ft	1.32 ft
Top Width:	6.25 ft	7.44 ft
Velocity:	5.61 fps	
X-Section Area:	4.31 sq ft	
Hydraulic Radius:	0.640 ft	
Froude Number:	1.19	

	w/o Freeboard	w/ Freeboard
Manning's n:	0.0380	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

Structure #9 (Riprap Channel)

Station 10+81 to Station 12+40 (G')

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
1.60	1.7:1	3.6:1	6.1	0.30		

Riprap Channel Results:

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	24.17 cfs	
Depth:	0.93 ft	1.23 ft
Top Width:	6.47 ft	8.04 ft
Velocity:	6.48 fps	
X-Section Area:	3.73 sq ft	
Hydraulic Radius:	0.548 ft	
Froude Number:	1.50	
Manning's n:	0.0380	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

Structure #10 (Riprap Channel)

Station 12+40 to Station 18+95 (H')

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult, x (VxD)
1.00	0.5:1	2.7:1	3.6	0.30		

Riprap Channel Results:

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	24.17 cfs	
Depth:	1.29 ft	1.59 ft
Top Width:	5.17 ft	6.14 ft
Velocity:	6.07 fps	
X-Section Area:	3.98 sq ft	
Hydraulic Radius:	0.675 ft	
Froude Number:	1.22	
Manning's n:	0.0360	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

Structure #11 (Culvert)

Culvert C-3 to CWD-2

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
49.00	4.43	0.0150	2.50	0.00	0.90

Culvert Results:

Design Discharge = 24.17 cfs

Minimum pipe diameter: 1 - 36 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#2	1	69.600	3.227	3.227	0.147	80.000	M	6.68	3.176
	Σ	69.600						6.46	3.176
#1	1	94.100	3.227	3.227	0.147	80.000	M	9.03	4.294
	Σ	94.100						8.74	4.294
#14	Σ	163.700						15.20	7.470
#3	Σ	163.700						15.20	7.470
#4	Σ	163.700						15.20	7.470
#5	Σ	163.700						15.20	7.470
#6	Σ	163.700						15.20	7.470
#12	Σ	163.700						15.20	7.470
#13	1	29.550	0.133	0.133	0.242	89.000	M	25.22	2.393
	Σ	193.250						24.17	9.863
#8	Σ	193.250						24.17	9.863
#9	Σ	193.250						24.17	9.863
#10	Σ	193.250						24.17	9.863
#11	Σ	193.250						24.17	9.863

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	1. Forest with heavy ground litter	8.00	660.00	8,250.00	0.710	3.227
#1	1	Time of Concentration:					3.227
#2	1	1. Forest with heavy ground litter	8.00	660.00	8,250.00	0.710	3.227
#2	1	Time of Concentration:					3.227
#13	1	1. Forest with heavy ground litter	40.29	309.00	767.00	1.600	0.133
#13	1	Time of Concentration:					0.133

Subwatershed Muskingum Routing Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	1. Forest with heavy ground litter	8.00	660.00	8,250.00	0.710	3.227
#1	1	Muskingum K:					3.227
#2	1	1. Forest with heavy ground litter	8.00	660.00	8,250.00	0.710	3.227
#2	1	Muskingum K:					3.227
#13	1	1. Forest with heavy ground litter	40.29	309.00	767.00	1.600	0.133
#13	1	Muskingum K:					0.133

Appendix 11(1D)

King II

June 1, 2020 (TR-29 AR #2)

Ditch CWD-1B SedCAD As-Built **(Stations 18+95 to 24+01)**

Upstreams flows from CWD-1B to CWD-2 via Culvert C-2

Joshua Chlopek

GCC Energy
6473 CR 120
Hesperus, CO 81326

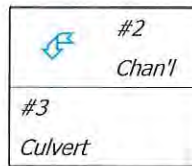
General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	2 yr - 24 hr
Rainfall Depth:	2.200 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#2	==>	#3	0.000	0.000	Station 18+95 to 23+90
Culvert	#3	==>	End	0.000	0.000	Culvert C-2 to CWD-2



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#2	3.760	3.760	4.38	0.37
#3	0.000	3.760	4.38	0.37

Structure Detail:

Structure #2 (Erodible Channel)

Station 18+95 to 23+90

Trapezoidal Erodible Channel Inputs:

Material: Graded loam to cobbles when noncolloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.30	1.5:1	2.1:1	4.1	0.0300	0.30			5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	4.38 cfs	
Depth:	0.35 ft	0.65 ft
Top Width:	3.58 ft	4.67 ft
Velocity:	4.23 fps	
X-Section Area:	1.04 sq ft	
Hydraulic Radius:	0.275 ft	
Froude Number:	1.39	

Structure #3 (Culvert)

Culvert C-2 to CWD-2

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
48.00	2.58	0.0150	3.00	0.00	0.90

Culvert Results:

Design Discharge = 4.38 cfs

Minimum pipe diameter: 1 - 12 inch pipe(s) required

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#2	1	3.760	0.120	0.120	0.230	89.000	M	4.66	0.374
	Σ	3.760						4.38	0.374
#3	Σ	3.760						4.38	0.374

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#2	1	1. Forest with heavy ground litter	33.01	207.00	627.00	1.450	0.120
#2	1	Time of Concentration:					0.120

Subwatershed Muskingum Routing Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#2	1	1. Forest with heavy ground litter	32.96	207.00	628.00	1.450	0.120
#2	1	Muskingum K:					0.120

Appendix 11(1E)

King II

June 1, 2020 (TR-29 AR #2)

CWD-1C and CWD-1D As-Built to CWD-2 via cattle guard

Joshua Chlopek

GCC Energy
6473 CR 120
Hesperus, CO 81326

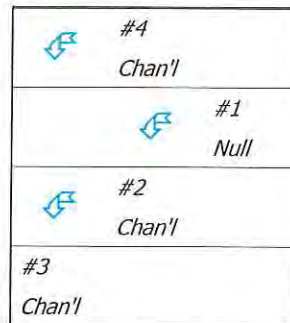
General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	2 yr - 24 hr
Rainfall Depth:	2.200 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#2	0.000	0.000	Cementary Basin Flows in to CWD-1c
Channel	#2	==>	#3	0.000	0.000	CWD-1C to Cattle Guard
Channel	#3	==>	End	0.000	0.000	Cattle Guard to CWD-2 Station 31+12
Channel	#4	==>	#3	0.000	0.000	CWD-1D to Cattle Guard



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#4	0.450	0.450	0.33	0.02
#1	4.900	4.900	3.23	0.28
#2	0.000	4.900	3.23	0.28
#3	0.000	5.350	3.37	0.30

Structure Detail:

Structure #4 (Erodible Channel)

CWD-1D to Cattle Guard

Trapezoidal Erodible Channel Inputs:

Material: Graded loam to cobbles when noncolloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.70	1.3:1	1.6:1	13.4	0.0300	0.30			5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.33 cfs	
Depth:	0.05 ft	0.35 ft
Top Width:	2.85 ft	3.74 ft
Velocity:	2.43 fps	
X-Section Area:	0.14 sq ft	
Hydraulic Radius:	0.049 ft	
Froude Number:	1.93	

Structure #1 (Null)

Cementary Basin Flows in to CWD-1c

Structure #2 (Erodible Channel)

CWD-1C to Cattle Guard

Trapezoidal Erodible Channel Inputs:

Material: Graded loam to cobbles when noncolloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.70	1.3:1	2.7:1	4.3	0.0300	0.30			5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	3.23 cfs	
Depth:	0.27 ft	0.57 ft

	w/o Freeboard	w/ Freeboard
Top Width:	3.77 ft	4.98 ft
Velocity:	3.74 fps	
X-Section Area:	0.86 sq ft	
Hydraulic Radius:	0.221 ft	
Froude Number:	1.38	

Structure #3 (Nonerodible Channel)

Cattle Guard to CWD-2 Station 31+12

Trapezoidal Nonerodible Channel Inputs:

Material: Metal, Smooth (Flume)

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
6.50	1.0:1	1.0:1	0.5	0.0130	0.30		

Nonerodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	3.37 cfs	
Depth:	0.19 ft	0.49 ft
Top Width:	6.89 ft	7.49 ft
Velocity:	2.61 fps	
X-Section Area:	1.29 sq ft	
Hydraulic Radius:	0.183 ft	
Froude Number:	1.06	

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#4	1	0.450	0.061	0.061	0.182	80.000	M	0.35	0.022
	Σ	0.450						0.33	0.022
#1	1	4.900	0.099	0.197	0.210	80.000	M	3.84	0.281
	Σ	4.900						3.23	0.281
#2	Σ	4.900						3.23	0.281
#3	Σ	5.350						3.37	0.302

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	2. Minimum tillage cultivation	24.00	210.00	875.00	2.440	0.099
#1	1	Time of Concentration:					0.099
#4	1	1. Forest with heavy ground litter	14.88	32.00	215.00	0.970	0.061
#4	1	Time of Concentration:					0.061

Subwatershed Muskingum Routing Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	1. Forest with heavy ground litter	24.00	210.00	875.00	1.230	0.197
#1	1	Muskingum K:					0.197
#4	1	1. Forest with heavy ground litter	14.88	32.00	215.00	0.970	0.061
#4	1	Muskingum K:					0.061

Appendix 11(1F)

King II

June 1, 2020 (TR-29 AR #2)

Revised East Clearwater Diversion (CWD-2): Modified for 2020 Portal

JANUARY 2020:

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Bob Flegal

GEOMAT Inc

Bob Flegal

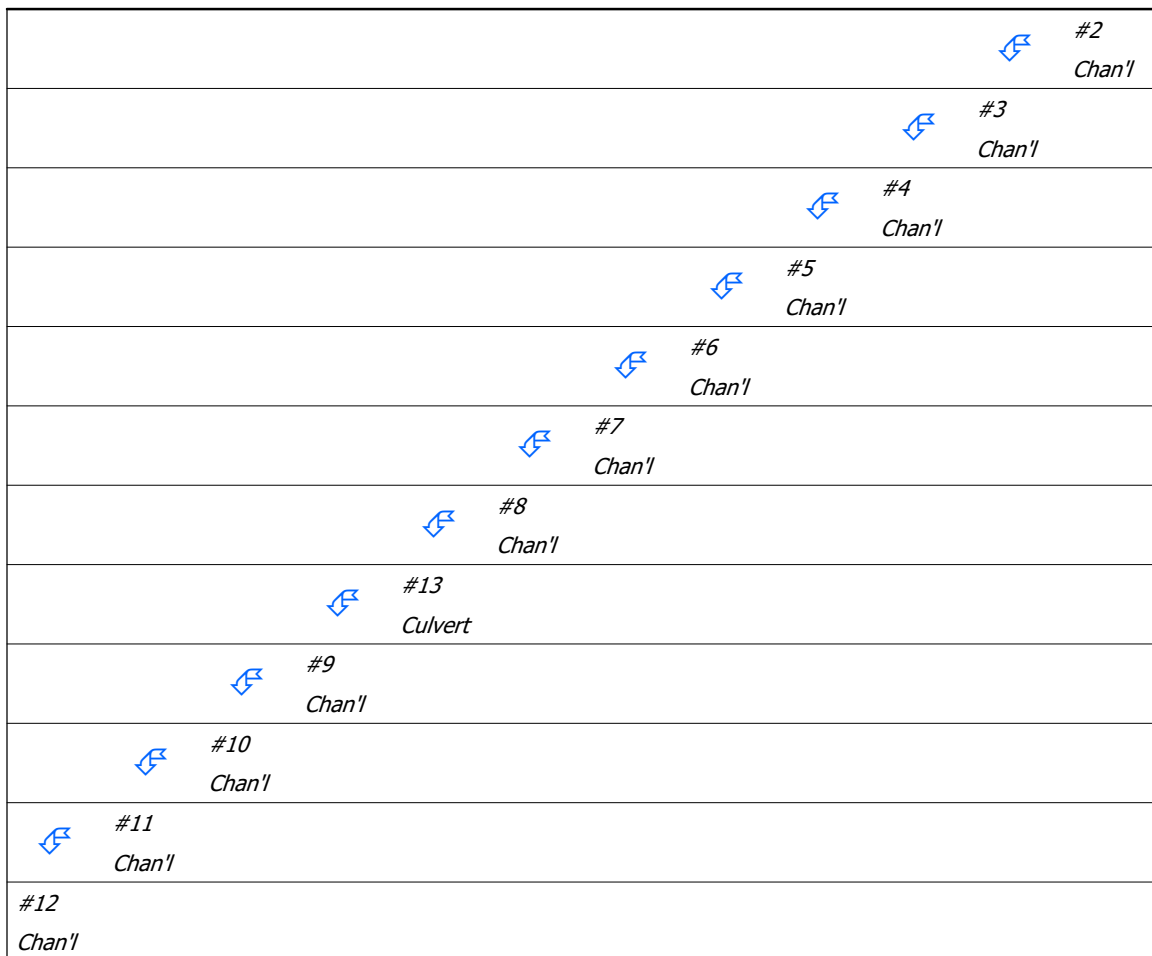
General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	10 yr - 24 hr
Rainfall Depth:	2.200 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#2	==>	#3	0.000	0.000	Station 0+00 to 0+05 (A')
Channel	#3	==>	#4	0.000	0.000	Station 0+05 to 0+70 (B')
Channel	#4	==>	#5	0.000	0.000	Station 0+70 to 1+60 (C')
Channel	#5	==>	#6	0.000	0.000	Station 1+60 to 4+70 (D')
Channel	#6	==>	#7	0.000	0.000	Station 4+70 to 6+12 (E')
Channel	#7	==>	#8	0.000	0.000	Station 6+12 to 7+90 (F')
Channel	#8	==>	#13	0.000	0.000	Station 7+90 to 9+95 (G')
Channel	#9	==>	#10	0.000	0.000	Station 13+92 to 14+56 (H')
Channel	#10	==>	#11	0.000	0.000	Station 14+56 to 18+00 (I')
Channel	#11	==>	#12	0.000	0.000	Station 18+00 to 20+84 (J')
Channel	#12	==>	End	0.000	0.000	Station 20+84 to 22+20 (K')
Culvert	#13	==>	#9	0.000	0.000	Culvert C-22 CDW-2 through disturbance



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#2	5.230	5.230	2.38	0.24
#3	0.000	5.230	2.38	0.24
#4	0.000	5.230	2.38	0.24
#5	0.000	5.230	2.38	0.24
#6	998.420	1,003.650	35.64	27.65
#7	0.000	1,003.650	35.64	27.65
#8	0.000	1,003.650	35.64	27.65
#13	0.000	1,003.650	35.64	27.65
#9	5.850	1,009.500	35.71	27.85
#10	0.000	1,009.500	35.71	27.85
#11	0.000	1,009.500	35.71	27.85
#12	0.000	1,009.500	35.71	27.85

Structure Detail:

Structure #2 (Erodible Channel)

Station 0+00 to 0+05 (A')

Trapezoidal Erodible Channel Inputs:

Material: Graded loam to cobbles when noncolloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.80	2.3:1	1.8:1	19.1	0.0300	0.30			5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.38 cfs	
Depth:	0.12 ft	0.42 ft
Top Width:	4.28 ft	5.51 ft
Velocity:	4.98 fps	
X-Section Area:	0.48 sq ft	
Hydraulic Radius:	0.110 ft	
Froude Number:	2.63	

Structure #3 (Erodible Channel)

Station 0+05 to 0+70 (B')

Trapezoidal Erodible Channel Inputs:

Material: Graded loam to cobbles when noncolloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
5.79	2.0:1	3.1:1	17.7	0.0300	0.30			5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.38 cfs	
Depth:	0.09 ft	0.39 ft
Top Width:	6.27 ft	7.80 ft
Velocity:	4.19 fps	
X-Section Area:	0.57 sq ft	
Hydraulic Radius:	0.090 ft	

w/o Freeboard	w/ Freeboard
Froude Number:	2.46

Structure #4 (Erodible Channel)

Station 0+70 to 1+60 (C')

Trapezoidal Erodible Channel Inputs:

Material: Graded loam to cobbles when noncolloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.91	2.6:1	3.7:1	6.2	0.0300	0.30			5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.38 cfs	
Depth:	0.16 ft	0.46 ft
Top Width:	4.92 ft	6.81 ft
Velocity:	3.37 fps	
X-Section Area:	0.71 sq ft	
Hydraulic Radius:	0.142 ft	
Froude Number:	1.57	

Structure #5 (Erodible Channel)

Station 1+60 to 4+70 (D')

Trapezoidal Erodible Channel Inputs:

Material: Graded loam to cobbles when noncolloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
4.79	1.7:1	2.2:1	1.7	0.0300	0.30			5.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.38 cfs	
Depth:	0.21 ft	0.51 ft
Top Width:	5.62 ft	6.79 ft
Velocity:	2.16 fps	
X-Section Area:	1.10 sq ft	
Hydraulic Radius:	0.193 ft	

w/o Freeboard	w/ Freeboard
Froude Number:	0.86

Structure #6 (Erodible Channel)

Station 4+70 to 6+12 (E')

Trapezoidal Erodible Channel Inputs:

Material: Graded loam to cobbles when noncolloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.11	1.6:1	1.8:1	0.6	0.0300	0.30			5.0

Erodible Channel Results:

w/o Freeboard	w/ Freeboard
Design Discharge:	35.64 cfs
Depth:	1.60 ft 1.90 ft
Top Width:	8.55 ft 9.57 ft
Velocity:	3.82 fps
X-Section Area:	9.33 sq ft
Hydraulic Radius:	0.990 ft
Froude Number:	0.64

Structure #7 (Erodible Channel)

Station 6+12 to 7+90 (F')

Trapezoidal Erodible Channel Inputs:

Material: Graded loam to cobbles when noncolloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
7.23	2.0:1	2.0:1	0.9	0.0300	0.30			5.0

Erodible Channel Results:

w/o Freeboard	w/ Freeboard
Design Discharge:	35.64 cfs
Depth:	0.98 ft 1.28 ft
Top Width:	11.14 ft 12.34 ft
Velocity:	3.97 fps
X-Section Area:	8.98 sq ft
Hydraulic Radius:	0.774 ft

w/o Freeboard	w/ Freeboard
Froude Number:	0.78

Structure #8 (Vegetated Channel)

Station 7+90 to 9+95 (G')

Trapezoidal Vegetated Channel Inputs:

Material: Bermuda grass

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
7.62	2.3:1	5.1:1	3.0	D, B	0.30			8.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	35.64 cfs		35.64 cfs	
Depth:	0.79 ft	1.09 ft	1.25 ft	1.55 ft
Top Width:	13.48 ft	15.70 ft	16.90 ft	19.12 ft
Velocity:	4.27 fps		2.32 fps	
X-Section Area:	8.36 sq ft		15.37 sq ft	
Hydraulic Radius:	0.610 ft		0.892 ft	
Froude Number:	0.95		0.43	
Roughness Coefficient:	0.0435		0.1031	

Structure #13 (Culvert)

Culvert C-22 CDW-2 through disturbance

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
397.00	2.42	0.0240	3.50	0.00	0.90

Culvert Results:

Design Discharge = 35.64 cfs

Minimum pipe diameter: 1 - 36 inch pipe(s) required

Structure #9 (Vegetated Channel)

Station 13+92 to 14+56 (H')

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
5.34	2.8:1	1.8:1	1.8	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	35.71 cfs		35.71 cfs	
Depth:	1.08 ft	1.38 ft	1.66 ft	1.96 ft
Top Width:	10.32 ft	11.70 ft	12.97 ft	14.35 ft
Velocity:	4.21 fps		2.35 fps	
X-Section Area:	8.48 sq ft		15.19 sq ft	
Hydraulic Radius:	0.787 ft		1.112 ft	
Froude Number:	0.82		0.38	
Roughness Coefficient:	0.0404		0.0912	

Structure #10 (Vegetated Channel)

Station 14+56 to 18+00 (I')

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
5.84	2.9:1	2.3:1	2.6	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	35.71 cfs		35.71 cfs	
Depth:	0.93 ft	1.23 ft	1.43 ft	1.73 ft
Top Width:	10.69 ft	12.25 ft	13.30 ft	14.86 ft
Velocity:	4.64 fps		2.60 fps	
X-Section Area:	7.70 sq ft		13.72 sq ft	
Hydraulic Radius:	0.698 ft		0.992 ft	
Froude Number:	0.96		0.45	
Roughness Coefficient:	0.0407		0.0918	

Structure #11 (Vegetated Channel)

Station 18+00 to 20+84 (J')

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
6.18	1.7:1	2.9:1	2.9	C, B	0.30			5.0

Vegetated Channel Results:

	Stability Class C w/o Freeboard	Stability Class C w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	35.71 cfs		35.71 cfs	
Depth:	1.03 ft	1.33 ft	1.37 ft	1.67 ft
Top Width:	10.93 ft	12.31 ft	12.46 ft	13.84 ft
Velocity:	4.05 fps		2.81 fps	
X-Section Area:	8.83 sq ft		12.72 sq ft	
Hydraulic Radius:	0.777 ft		0.977 ft	
Froude Number:	0.79		0.49	
Roughness Coefficient:	0.0530		0.0889	

Structure #12 (Vegetated Channel)

Station 20+84 to 22+20 (K')

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.94	2.5:1	22.1:1	3.1	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	35.71 cfs		35.71 cfs	
Depth:	0.82 ft	1.12 ft	1.30 ft	1.60 ft
Top Width:	24.19 ft	31.57 ft	35.85 ft	43.23 ft
Velocity:	3.09 fps		1.38 fps	
X-Section Area:	11.57 sq ft		25.80 sq ft	
Hydraulic Radius:	0.477 ft		0.718 ft	
Froude Number:	0.79		0.29	

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Roughness Coefficient:	0.0518		0.1517	

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#2	1	5.230	0.155	0.155	0.242	80.000	M	2.57	0.244
	Σ	5.230						2.38	0.244
#3	Σ	5.230						2.38	0.244
#4	Σ	5.230						2.38	0.244
#5	Σ	5.230						2.38	0.244
#6	1	993.250	5.241	5.241	0.143	73.000	M	35.98	27.226
	2	5.170	0.099	0.099	0.246	73.000	M	2.49	0.178
	Σ	1,003.650						35.64	27.648
#7	Σ	1,003.650						35.64	27.648
#8	Σ	1,003.650						35.64	27.648
#13	Σ	1,003.650						35.64	27.648
#9	1	5.850	0.091	0.000	0.000	73.000	M	2.81	0.201
	Σ	1,009.500						35.71	27.849
#10	Σ	1,009.500						35.71	27.849
#11	Σ	1,009.500						35.71	27.849
#12	Σ	1,009.500						35.71	27.849

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#2	1	1. Forest with heavy ground litter	39.78	354.00	890.00	1.590	0.155
#2	1	Time of Concentration:					0.155
#6	1	1. Forest with heavy ground litter	7.40	950.00	12,830.03	0.680	5.241
#6	1	Time of Concentration:					5.241
#6	2	1. Forest with heavy ground litter	42.37	250.00	590.00	1.640	0.099
#6	2	Time of Concentration:					0.099
#9	1	1. Forest with heavy ground litter	40.00	210.00	525.00	1.600	0.091
#9	1	Time of Concentration:					0.091

Subwatershed Muskingum Routing Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#2	1	1. Forest with heavy ground litter	39.78	354.00	890.00	1.590	0.155
#2	1	Muskingum K:					0.155
#6	1	1. Forest with heavy ground litter	7.40	950.00	12,830.00	0.680	5.241
#6	1	Muskingum K:					5.241
#6	2	1. Forest with heavy ground litter	42.37	250.00	590.00	1.640	0.099
#6	2	Muskingum K:					0.099

CWD-2 Station 22+20 to 25+95 (L') As-Built

Material: Grass mixture

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.98	3.2:1	7.6:1	1.5	D, B	0.30			5.0

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	76.82 cfs		76.82 cfs	
Depth:	1.64 ft	1.94 ft	2.28 ft	2.58 ft
Top Width:	19.58 ft	22.80 ft	26.49 ft	29.72 ft
Velocity:	4.35 fps		2.37 fps	
X-Section Area:	17.65 sq ft		32.46 sq ft	
Hydraulic Radius:	0.888 ft		1.206 ft	
Froude Number:	0.81		0.38	
Roughness Coefficient:	0.0386		0.0871	

CWD-2 Station 25+95 to 26+61 (M') As-Built

Material: Riprap

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.84	3.3:1	1.5:1	15.9	0.30		

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	76.82 cfs	
Depth:	1.23 ft	1.53 ft
Top Width:	9.71 ft	11.15 ft
Velocity:	9.25 fps	
X-Section Area:	8.31 sq ft	
Hydraulic Radius:	0.814 ft	
Froude Number:	1.76	
Manning's n:	0.0560	
Dmin:	5.00 in	
D50:	9.00 in	
Dmax:	12.00 in	

CWD-2 Station 26+61 to 31+87 (N') As-Built

Material: Graded loam to cobbles when noncolloidal

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.34	1.5:1	33.4:1	2.3	0.0300	0.30			5.0

	w/o Freeboard	w/ Freeboard
Design Discharge:	84.57 cfs	
Depth:	0.80 ft	1.10 ft
Top Width:	36.39 ft	46.86 ft
Velocity:	4.70 fps	
X-Section Area:	17.98 sq ft	
Hydraulic Radius:	0.493 ft	
Froude Number:	1.18	

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
82.00	2.17	0.0150	8.00	0.00	0.90

Culvert Results:

Minimum pipe diameter: 1 - 36 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 84.57 cfs

Maximum Headwater = 8.00 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (30 in)	Discharge (cfs) (36 in)	Discharge (cfs) (42 in)
0.80	3.75	4.50	5.25
1.60	10.59	12.71	14.83
2.40	19.47	23.36	27.25
3.20	28.89	35.96	41.95
4.00	36.22	47.70	58.63
4.80	42.30	57.14	72.28
5.60	47.60	65.22	84.01
6.40	52.38	72.42	94.26
7.20	56.75	78.95	103.54
8.00	60.81	84.99	112.05
8.80	64.62	90.63	119.94
9.60	68.21	95.90	127.37
10.40	71.62	100.93	134.36
11.20	74.88	105.72	141.01
12.00	78.00	110.29	147.39

Appendix 11(1G)

King II

June 1, 2020 (TR-29 AR #2)

Structure Detail:

Structure #37 (Pond)

Pond 1 Flows to Outlet

Pond Inputs:

Initial Pool Elev:	7,232.73 ft
Initial Pool:	3.52 ac-ft

Drop Inlet

Riser Diameter (in)	Riser Height (ft)	Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)
24.00	7.17	24.00	119.00	2.12	0.0110	7,233.64

Drop Inlet

Riser Diameter (in)	Riser Height (ft)	Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)
24.00	6.56	24.00	119.00	2.12	0.0110	7,232.73

Pond Results:

Peak Elevation:	7,233.43 ft
Dewater Time:	0.70 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
7,226.17	0.025	0.000	0.000	
7,226.67	0.092	0.028	0.000	
7,227.17	0.201	0.099	0.000	
7,227.67	0.295	0.222	0.000	
7,228.17	0.407	0.397	0.000	
7,228.67	0.499	0.623	0.000	
7,229.17	0.599	0.898	0.000	
7,229.67	0.644	1.208	0.000	
7,230.17	0.690	1.541	0.000	
7,230.67	0.721	1.894	0.000	
7,231.17	0.753	2.263	0.000	
7,231.67	0.787	2.648	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
7,232.17	0.822	3.050	0.000	
7,232.67	0.860	3.471	0.000	
7,232.73	0.865	3.523	0.000	Spillway #2
7,233.00	0.886	3.759	2.733	14.95
7,233.17	0.899	3.911	5.684	1.05
7,233.43	0.909	4.145	10.477	0.90 Peak Stage
7,233.64	0.920	4.338	14.431	Spillway #1
7,233.67	0.921	4.366	14.766	
7,233.80	0.927	4.486	16.889	

Detailed Discharge Table

Elevation (ft)	Drop Inlet (cfs)	Drop Inlet (cfs)	Combined Total Discharge (cfs)
7,226.17	0.000	0.000	0.000
7,226.67	0.000	0.000	0.000
7,227.17	0.000	0.000	0.000
7,227.67	0.000	0.000	0.000
7,228.17	0.000	0.000	0.000
7,228.67	0.000	0.000	0.000
7,229.17	0.000	0.000	0.000
7,229.67	0.000	0.000	0.000
7,230.17	0.000	0.000	0.000
7,230.67	0.000	0.000	0.000
7,231.17	0.000	0.000	0.000
7,231.67	0.000	0.000	0.000
7,232.17	0.000	0.000	0.000
7,232.67	0.000	0.000	0.000
7,232.73	0.000	0.000	0.000
7,233.00	0.000	2.733	2.733
7,233.17	0.000	5.684	5.684
7,233.64	0.000	14.431	14.431
7,233.67	0.100	14.665	14.766
7,233.80	1.243	15.646	16.889