WERNSMAN ENGINEERING, INC.

1011 42nd STREET ◆ EVANS, CO 80620
Phone (970) 353-4463 Fax (970) 353-9257

August 7, 2016

Roy Vestal
City of Fort Lupton
130 S. McKinley Ave.
Fort Lupton, CO 80621

RE: Preliminary Drainage Report for Dave Hunt

To whom it may concern;

Attached is the Preliminary Drainage Report and Plan for Dave' Excavation Inc. new facility at 3355 CR 27 in Fort Lupton. This report addresses both the off-site and on-site hydrology that affects or is affected by the proposed development.

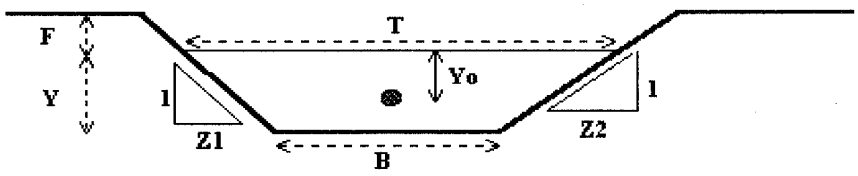
If you have any further questions or comments regarding this matter, please contact this office.

Sincerely,

Eric Wernsman P.E.

Normal Flow Analysis - Trapezoidal Channel

Project: Daves Ex
Channel ID: Sec B-B BASIN 5

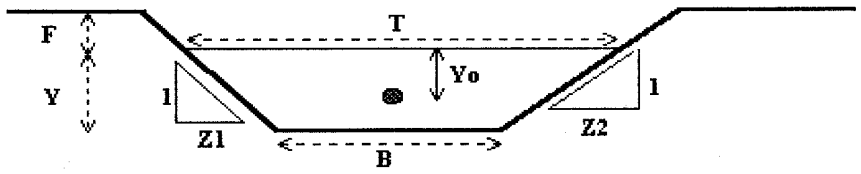


Design Information (Input)			
Channel Invert Slope	So =	0.0085	ft/ft
Manning's n	n =	0.040	
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	4.00	ft/ft
Right Side Slope	Z2 =	4.00	ft/ft
Freeboard Height	F =	1.00	ft
Design Water Depth	Y =	**0.75**	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**3.94**	cfs
Froude Number	**Fr =**	**0.50**	
Flow Velocity	**V =**	**1.75**	fps
Flow Area	A =	2.25	sq ft
Top Width	T =	6.00	ft
Wetted Perimeter	P =	6.18	ft
Hydraulic Radius	R =	0.36	ft
Hydraulic Depth	D =	0.38	ft
Specific Energy	Es =	0.80	ft
Centroid of Flow Area	Yo =	0.25	ft
Specific Force	Fs =	0.05	kip

Normal Flow Analysis - Trapezoidal Channel

Project: Daves Ex
Channel ID: Sec C-C

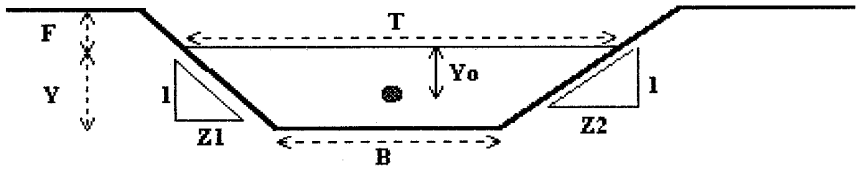


Design Information (Input)			
Channel Invert Slope	So =	0.0050	ft/ft
Manning's n	n =	0.025	
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	42.00	ft/ft
Right Side Slope	Z2 =	33.00	ft/ft
Freeboard Height	F =	1.00	ft
Design Water Depth	Y =	**0.37**	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**7.02**	cfs
Froude Number	**Fr =**	**0.56**	
Flow Velocity	**V =**	**1.37**	fps
Flow Area	A =	5.13	sq ft
Top Width	T =	27.75	ft
Wetted Perimeter	P =	27.76	ft
Hydraulic Radius	R =	0.18	ft
Hydraulic Depth	D =	0.19	ft
Specific Energy	Es =	0.40	ft
Centroid of Flow Area	Yo =	0.12	ft
Specific Force	Fs =	0.06	kip

Normal Flow Analysis - Trapezoidal Channel

Project: Daves Ex
Channel ID: Sec D-D BASIN S8

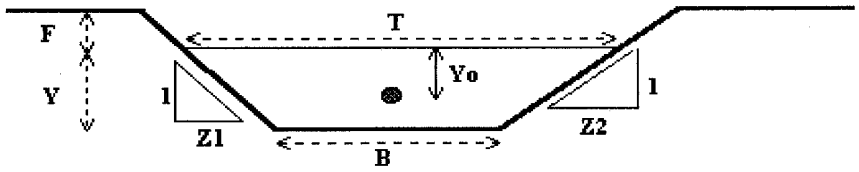


Design Information (Input)			
Channel Invert Slope	So =	0.0040	ft/ft
Manning's n	n =	0.040	
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	4.00	ft/ft
Right Side Slope	Z2 =	33.00	ft/ft
Freeboard Height	F =	1.00	ft
Design Water Depth	Y =	**0.45**	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**3.26**	cfs
Froude Number	**Fr =**	**0.32**	
Flow Velocity	**V =**	**0.87**	fps
Flow Area	A =	3.75	sq ft
Top Width	T =	16.65	ft
Wetted Perimeter	P =	16.71	ft
Hydraulic Radius	R =	0.22	ft
Hydraulic Depth	D =	0.23	ft
Specific Energy	Es =	0.46	ft
Centroid of Flow Area	Yo =	0.15	ft
Specific Force	Fs =	0.04	kip

Normal Flow Analysis - Trapezoidal Channel

Project: Daves Ex
Channel ID: Sec E-E BASIN S8

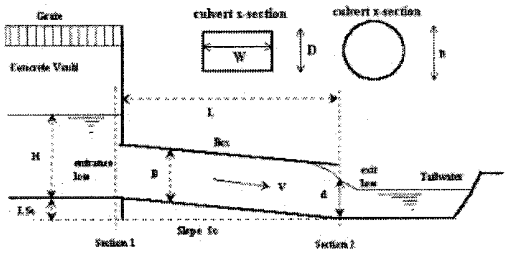


Design Information (Input)			
Channel Invert Slope	So =	0.0100	ft/ft
Manning's n	n =	0.040	
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	4.00	ft/ft
Right Side Slope	Z2 =	4.00	ft/ft
Freeboard Height	F =	1.00	ft
Design Water Depth	Y =	**0.67**	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**3.12**	cfs
Froude Number	**Fr =**	**0.54**	
Flow Velocity	**V =**	**1.76**	fps
Flow Area	A =	1.78	sq ft
Top Width	T =	5.34	ft
Wetted Perimeter	P =	5.50	ft
Hydraulic Radius	R =	0.32	ft
Hydraulic Depth	D =	0.33	ft
Specific Energy	Es =	0.71	ft
Centroid of Flow Area	Yo =	0.22	ft
Specific Force	Fs =	0.04	kip

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

Project: Daves Ex
Basin ID: North Storm Drain CULVERT #1
Status:



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =	24	inches
	Inlet Edge Type (choose from pull-down list)		Square End Projection	
OR:				
Box Culvert:	Barrel Height (Rise) in Feet	Height (Rise) =		ft.
	Barrel Width (Span) in Feet	Width (Span) =		ft.
	Inlet Edge Type (choose from pull-down list)		Square Edge w/ 90-15 Deg. Headwall	
	Number of Barrels	No =	1	
	Inlet Elevation at Culvert Invert	Inlet Elev =	28.5	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Outlet Elev =	27	ft. elev.
	Culvert Length in Feet	L =	814	ft.
	Manning's Roughness	n =	0.012	
	Bend Loss Coefficient	K_b =	0	
	Exit Loss Coefficient	K_x =	1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.50
Friction Loss Coefficient	K_f =	8.56
Sum of All Loss Coefficients	K_s =	10.06
Orifice Inlet Condition Coefficient	C_d =	0.85
Minimum Energy Condition Coefficient	KE_{low} =	0.1121

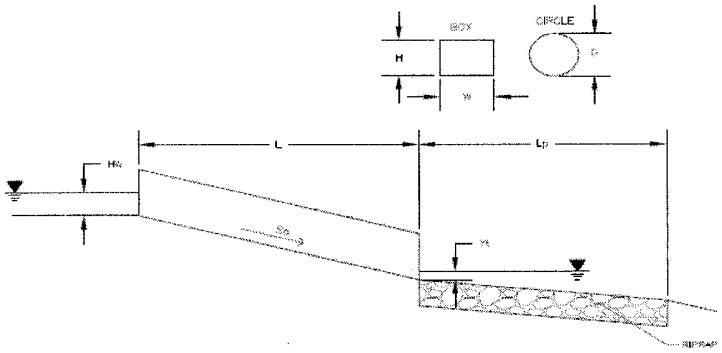
Calculations of Culvert Capacity (output):

Water Surface Elevation (ft., linked)	Tailwater Surface Elevation ft	Culvert Inlet-Control Flowrate cfs	Culvert Outlet-Control Flowrate cfs	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used:	Flow Control Used
31.00	29.00	16.70	11.26	**11.26**	Regression Eqn.	OUTLET
31.25	29.00	18.50	11.94	**11.94**	Regression Eqn.	OUTLET
31.50	29.00	20.10	12.57	**12.57**	Regression Eqn.	OUTLET
31.75	29.00	21.60	13.20	**13.20**	Regression Eqn.	OUTLET
32.00	29.00	23.10	13.78	**13.78**	Regression Eqn.	OUTLET
32.25	29.00	24.40	14.36	**14.36**	Regression Eqn.	OUTLET
32.50	29.00	25.60	14.89	**14.89**	Regression Eqn.	OUTLET
32.75	29.00	26.80	15.41	**15.41**	Regression Eqn.	OUTLET
33.00	29.00	27.90	15.94	**15.94**	Regression Eqn.	OUTLET
33.25	29.00	29.00	16.41	**16.41**	Regression Eqn.	OUTLET
33.50	29.00	30.00	16.89	**16.89**	Regression Eqn.	OUTLET
33.75	29.00	31.00	17.36	**17.36**	Regression Eqn.	OUTLET
34.00	29.00	32.00	17.78	**17.78**	Regression Eqn.	OUTLET
34.25	29.00	32.90	18.25	**18.25**	Regression Eqn.	OUTLET
34.50	29.00	33.80	18.67	**18.67**	Regression Eqn.	OUTLET
34.75	29.00	34.70	19.09	**19.09**	Orifice Eqn.	OUTLET
35.00	29.00	35.50	19.52	**19.52**	Orifice Eqn.	OUTLET
35.25		36.30	19.88	**19.88**	Orifice Eqn.	OUTLET
35.50		37.10	20.30	**20.30**	Orifice Eqn.	OUTLET
35.75		37.80	20.67	**20.67**	Orifice Eqn.	OUTLET
36.00		38.60	21.04	**21.04**	Orifice Eqn.	OUTLET
36.25		39.30	21.41	**21.41**	Orifice Eqn.	OUTLET
36.50		40.00	21.78	**21.78**	Orifice Eqn.	OUTLET
36.75		40.80	22.15	**22.15**	Orifice Eqn.	OUTLET
37.00		41.40	22.51	**22.51**	Orifice Eqn.	OUTLET
37.25		42.10	22.83	**22.83**	Orifice Eqn.	OUTLET
37.50		42.80	23.20	**23.20**	Orifice Eqn.	OUTLET
37.75		43.50	23.51	**23.51**	Orifice Eqn.	OUTLET
38.00		44.10	23.88	**23.88**	Orifice Eqn.	OUTLET
38.25		44.80	24.20	**24.20**	Orifice Eqn.	OUTLET

Processing Time: 00.38 Seconds

Determination of Culvert Headwater and Outlet Protection

Project: DAVES EX
Basin ID: CULVERT #1



Soil Type:
Choose One:
- ○ Sandy
- ◉ Non-Sandy

Design Information (Input):

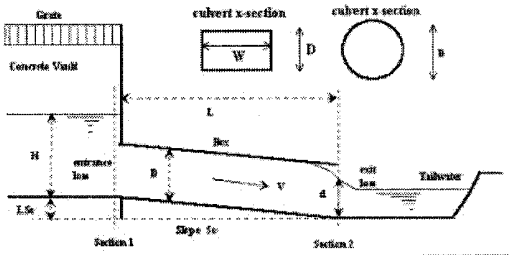
Design Discharge		Q = 11.62	cfs
Circular Culvert:			
Barrel Diameter in Inches		D = 24	inches
Inlet Edge Type (Choose from pull-down list)	Square End Projection		
Box Culvert:		OR	
Barrel Height (Rise) in Feet		Height (Rise) =	ft
Barrel Width (Span) in Feet		Width (Span) =	ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels		No = 1	
Inlet Elevation		Elev IN = 28.5	ft
Outlet Elevation **OR** Slope		Elev OUT = 26.9	ft
Culvert Length		L = 814	ft
Manning's Roughness		n = 0.012	
Bend Loss Coefficient		k_b = 0	
Exit Loss Coefficient		k_x = 1	
Tailwater Surface Elevation		Elev Y_t =	ft
Max Allowable Channel Velocity		V = 7	ft/s

Required Protection (Output):

Tailwater Surface Height		Y_t = 0.80	ft
Flow Area at Max Channel Velocity		A_t = 1.66	ft^2
Culvert Cross Sectional Area Available		A = 3.14	ft^2
Entrance Loss Coefficient		k_e = 0.50	
Friction Loss Coefficient		k_f = 8.57	
Sum of All Losses Coefficients		k_s = 10.07	ft
Culvert Normal Depth		Y_n = 1.80	ft
Culvert Critical Depth		Y_c = 1.22	ft
Tailwater Depth for Design		d = 1.61	ft
Adjusted Diameter **OR** Adjusted Rise		D_a = -	ft
Expansion Factor		1/(2*tan(Θ)) = 5.70	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)		Q/D^2.5 = 2.05	$ft^{0.5}/s$
Froude Number		Fr = 0.43	
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise		Yt/D = 0.40	
Inlet Control Headwater		HW_I = 1.89	ft
Outlet Control Headwater		HW_O = 2.15	
Design Headwater Elevation		**HW =** 30.65	ft
Headwater/Diameter OR Headwater/Rise Ratio		**HW/D =** 1.08	
Minimum Theoretical Riprap Size		d_{50} = 3	in
Nominal Riprap Size		d_{50} = 6	in
UDFCD Riprap Type		**Type =** VL	
Length of Protection		**L_p =** 6	ft
Width of Protection		**T =** 4	ft

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

Project: Daves Ex
Basin ID: Middle Storm Drain culvert #2 18" SECTION
Status:



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =	18	inches
	Inlet Edge Type (choose from pull-down list)		Square End Projection	
OR:				
Box Culvert:	Barrel Height (Rise) in Feet	Height (Rise) =		ft.
	Barrel Width (Span) in Feet	Width (Span) =		ft.
	Inlet Edge Type (choose from pull-down list)		Square Edge w/ 90-15 Deg. Headwall	
	Number of Barrels	No =	1	
	Inlet Elevation at Culvert Invert	Inlet Elev =	31.5	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Outlet Elev =	28	ft. elev.
	Culvert Length in Feet	L =	440	ft.
	Manning's Roughness	n =	0.012	
	Bend Loss Coefficient	K_b =	0	
	Exit Loss Coefficient	K_x =	1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.50
Friction Loss Coefficient	K_f =	6.79
Sum of All Loss Coefficients	K_s =	8.29
Orifice Inlet Condition Coefficient	C_d =	0.85
Minimum Energy Condition Coefficient	KE_{low} =	0.0070

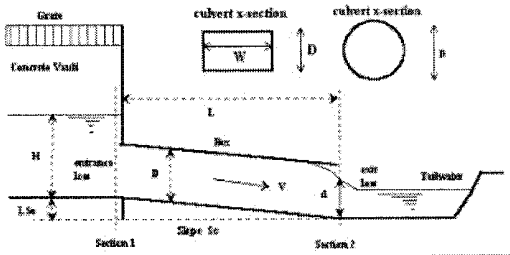
Calculations of Culvert Capacity (output):

Water Surface Elevation (ft., linked)	Tailwater Surface Elevation ft	Culvert Inlet-Control Flowrate cfs	Culvert Outlet-Control Flowrate cfs	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used:	Flow Control Used
34.00	30.00	10.80	9.90	**9.90**	Regression Eqn.	OUTLET
34.25	30.00	11.70	10.20	**10.20**	Regression Eqn.	OUTLET
34.50	30.00	12.50	10.45	**10.45**	Regression Eqn.	OUTLET
34.75	30.00	13.30	10.76	**10.76**	Regression Eqn.	OUTLET
35.00	30.00	14.00	11.01	**11.01**	Regression Eqn.	OUTLET
35.25	30.00	14.70	11.32	**11.32**	Regression Eqn.	OUTLET
35.50	30.00	15.30	11.57	**11.57**	Regression Eqn.	OUTLET
35.75	30.00	15.90	11.82	**11.82**	Regression Eqn.	OUTLET
36.00	30.00	16.50	12.08	**12.08**	Regression Eqn.	OUTLET
36.25		17.10	12.84	**12.84**	Orifice Eqn.	OUTLET
36.50		17.60	13.04	**13.04**	Orifice Eqn.	OUTLET
36.75		18.10	13.30	**13.30**	Orifice Eqn.	OUTLET
37.00		18.60	13.50	**13.50**	Orifice Eqn.	OUTLET
37.25		19.10	13.75	**13.75**	Orifice Eqn.	OUTLET
37.50		19.60	13.96	**13.96**	Orifice Eqn.	OUTLET
37.75		20.00	14.16	**14.16**	Orifice Eqn.	OUTLET
38.00		20.50	14.36	**14.36**	Orifice Eqn.	OUTLET
38.25		20.90	14.62	**14.62**	Orifice Eqn.	OUTLET
38.50		21.40	14.82	**14.82**	Orifice Eqn.	OUTLET
38.75		21.80	15.02	**15.02**	Orifice Eqn.	OUTLET
39.00		22.20	15.22	**15.22**	Orifice Eqn.	OUTLET
39.25		22.60	15.43	**15.43**	Orifice Eqn.	OUTLET
39.50		23.00	15.58	**15.58**	Orifice Eqn.	OUTLET
39.75		23.40	15.78	**15.78**	Orifice Eqn.	OUTLET
40.00		23.80	15.99	**15.99**	Orifice Eqn.	OUTLET
40.25		24.10	16.19	**16.19**	Orifice Eqn.	OUTLET
40.50		24.50	16.34	**16.34**	Orifice Eqn.	OUTLET
40.75		24.90	16.54	**16.54**	Orifice Eqn.	OUTLET
41.00		25.30	16.75	**16.75**	Orifice Eqn.	OUTLET
41.25		25.60	16.90	**16.90**	Orifice Eqn.	OUTLET

Processing Time: 00.38 Seconds

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

Project: Daves Ex
Basin ID: CULVERT #2 24"
Status:



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =	24	inches
	Inlet Edge Type (choose from pull-down list)		Square End Projection	
OR:				
Box Culvert:	Barrel Height (Rise) in Feet	Height (Rise) =		ft.
	Barrel Width (Span) in Feet	Width (Span) =		ft.
	Inlet Edge Type (choose from pull-down list)		Square Edge w/ 90-15 Deg. Headwall	
	Number of Barrels	No =	1	
	Inlet Elevation at Culvert Invert	Inlet Elev =	27.2	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Outlet Elev =	27	ft. elev.
	Culvert Length in Feet	L =	44	ft.
	Manning's Roughness	n =	0.012	
	Bend Loss Coefficient	K_b =	0	
	Exit Loss Coefficient	K_x =	1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.50
Friction Loss Coefficient	K_f =	0.46
Sum of All Loss Coefficients	K_s =	1.96
Orifice Inlet Condition Coefficient	C_d =	0.85
Minimum Energy Condition Coefficient	KE_{low} =	0.1121

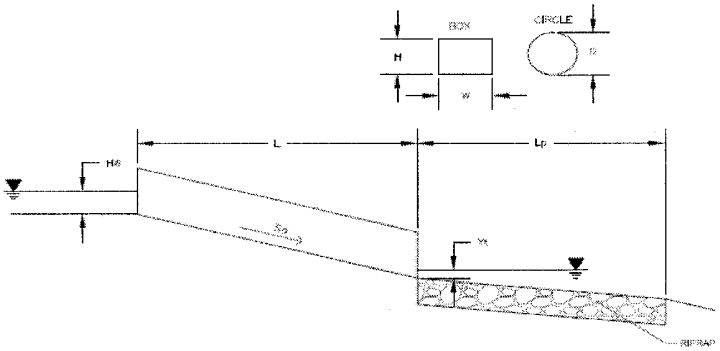
Calculations of Culvert Capacity (output):

Water Surface Elevation (ft., linked)	Tailwater Surface Elevation ft	Culvert Inlet-Control Flowrate cfs	Culvert Outlet-Control Flowrate cfs	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used:	Flow Control Used
33.25	30.00	34.00	32.47	**32.47**	Orifice Eqn.	OUTLET
33.50	30.00	34.80	33.71	**33.71**	Orifice Eqn.	OUTLET
33.75	30.00	35.70	34.86	**34.86**	Orifice Eqn.	OUTLET
34.00	30.00	36.50	36.02	**36.02**	Orifice Eqn.	OUTLET
34.25	30.00	37.20	37.18	**37.18**	Orifice Eqn.	OUTLET
34.50	30.00	38.00	38.25	**38.00**	Orifice Eqn.	INLET
34.75	30.00	38.70	39.24	**38.70**	Orifice Eqn.	INLET
35.00	30.00	39.50	40.32	**39.50**	Orifice Eqn.	INLET
35.25	30.00	40.20	41.31	**40.20**	Orifice Eqn.	INLET
35.50	30.00	40.90	42.22	**40.90**	Orifice Eqn.	INLET
35.75	30.00	41.60	43.21	**41.60**	Orifice Eqn.	INLET
36.00	30.00	42.30	44.12	**42.30**	Orifice Eqn.	INLET
36.25	30.00	42.90	45.03	**42.90**	Orifice Eqn.	INLET
36.50	30.00	43.60	45.93	**43.60**	Orifice Eqn.	INLET
36.75	30.00	44.20	46.76	**44.20**	Orifice Eqn.	INLET
37.00	30.00	44.90	47.67	**44.90**	Orifice Eqn.	INLET
37.25	30.00	45.50	48.50	**45.50**	Orifice Eqn.	INLET
37.50		46.10	52.54	**46.10**	Orifice Eqn.	INLET
37.75		46.80	53.29	**46.80**	Orifice Eqn.	INLET
38.00		47.40	54.03	**47.40**	Orifice Eqn.	INLET
38.25		48.00	54.77	**48.00**	Orifice Eqn.	INLET
38.50		48.60	55.52	**48.60**	Orifice Eqn.	INLET
38.75		49.10	56.26	**49.10**	Orifice Eqn.	INLET
39.00		49.70	56.92	**49.70**	Orifice Eqn.	INLET
39.25		50.30	57.67	**50.30**	Orifice Eqn.	INLET
39.50		50.90	58.33	**50.90**	Orifice Eqn.	INLET
39.75		51.40	59.07	**51.40**	Orifice Eqn.	INLET
40.00		52.00	59.73	**52.00**	Orifice Eqn.	INLET
40.25		52.50	60.39	**52.50**	Orifice Eqn.	INLET
40.50		53.10	61.05	**53.10**	Orifice Eqn.	INLET

Processing Time: 00.38 Seconds

Determination of Culvert Headwater and Outlet Protection

Project: DAVES EX
Basin ID: CULVERT #2 24"



Soil Type:
Choose One:
- ○ Sandy
- ◉ Non-Sandy

Design Information (Input):

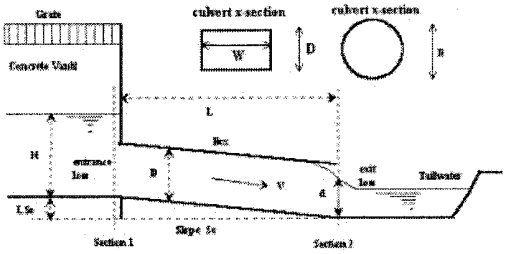
	Design Discharge	Q = 10.94	cfs
Circular Culvert:			
	Barrel Diameter in Inches	D = 24	inches
	Inlet Edge Type (Choose from pull-down list)	Square End Projection	
Box Culvert:		OR	
	Barrel Height (Rise) in Feet	Height (Rise) =	ft
	Barrel Width (Span) in Feet	Width (Span) =	ft
	Inlet Edge Type (Choose from pull-down list)		
	Number of Barrels	No = 1	
	Inlet Elevation	Elev IN = 27.2	ft
	Outlet Elevation **OR** Slope	Elev OUT = 27	ft
	Culvert Length	L = 44	ft
	Manning's Roughness	n = 0.012	
	Bend Loss Coefficient	k_b = 0	
	Exit Loss Coefficient	k_x = 1	
	Tailwater Surface Elevation	Elev Y_t =	ft
	Max Allowable Channel Velocity	V = 7	ft/s

Required Protection (Output):

	Tailwater Surface Height	Y_t = 0.80	ft
	Flow Area at Max Channel Velocity	A_t = 1.56	ft^2
	Culvert Cross Sectional Area Available	A = 3.14	ft^2
	Entrance Loss Coefficient	k_e = 0.50	
	Friction Loss Coefficient	k_f = 0.46	
	Sum of All Losses Coefficients	k_s = 1.96	ft
	Culvert Normal Depth	Y_n = 1.19	ft
	Culvert Critical Depth	Y_c = 1.19	ft
	Tailwater Depth for Design	d = 1.59	ft
	Adjusted Diameter **OR** Adjusted Rise	D_a = -	ft
	Expansion Factor	1/(2*tan(Θ)) = 5.83	
	Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 = 1.93	$ft^{0.5}$/s
	Froude Number	Fr = 1.00	
	Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D = 0.40	
	Inlet Control Headwater	HW_I = 1.81	ft
	Outlet Control Headwater	HW_O = 1.76	
	Design Headwater Elevation	**HW = 29.01**	**ft**
	Headwater/Diameter OR Headwater/Rise Ratio	**HW/D = 0.90**	
	Minimum Theoretical Riprap Size	d_{50} = 3	in
	Nominal Riprap Size	d_{50} = 6	in
	UDFCD Riprap Type	**Type = VL**	
	Length of Protection	**L_p = 6**	**ft**
	Width of Protection	**T = 4**	**ft**

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

Project: Daves Ex
Basin ID: South Storm Drain (CULVERT #3)
Status:



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D = 24	inches
	Inlet Edge Type (choose from pull-down list)	Square End Projection	
OR:			
Box Culvert:	Barrel Height (Rise) in Feet	Height (Rise) =	ft.
	Barrel Width (Span) in Feet	Width (Span) =	ft.
	Inlet Edge Type (choose from pull-down list)	Square Edge w/ 90-15 Deg. Headwall	
	Number of Barrels	No = 1	
	Inlet Elevation at Culvert Invert	Inlet Elev = 29.85	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Outlet Elev = 27	ft. elev.
	Culvert Length in Feet	L = 710	ft.
	Manning's Roughness	n = 0.012	
	Bend Loss Coefficient	K_b = 0	
	Exit Loss Coefficient	K_x = 1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.50
Friction Loss Coefficient	K_f =	7.47
Sum of All Loss Coefficients	K_s =	8.97
Orifice Inlet Condition Coefficient	C_d =	0.85
Minimum Energy Condition Coefficient	KE_{low} =	0.1121

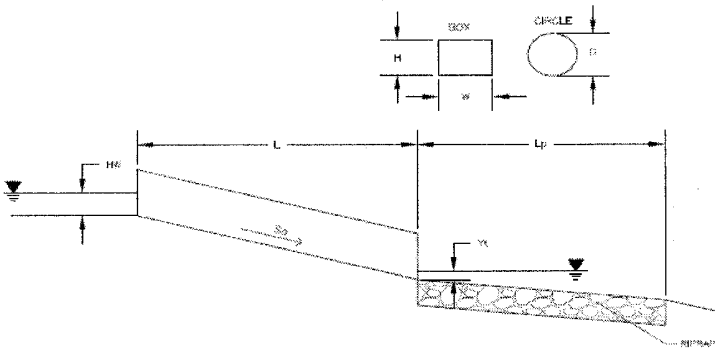
Calculations of Culvert Capacity (output):

Water Surface Elevation (ft., linked)	Tailwater Surface Elevation ft	Culvert Inlet-Control Flowrate cfs	Culvert Outlet-Control Flowrate cfs	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used:	Flow Control Used
31.50	29.00	9.60	13.35	**9.60**	Regression Eqn.	INLET
31.75	29.00	11.80	13.97	**11.80**	Regression Eqn.	INLET
32.00	29.00	14.00	14.60	**14.00**	Regression Eqn.	INLET
32.25	29.00	16.00	15.22	**15.22**	Regression Eqn.	OUTLET
32.50	29.00	17.80	15.76	**15.76**	Regression Eqn.	OUTLET
32.75	29.00	19.50	16.30	**16.30**	Regression Eqn.	OUTLET
33.00	29.00	21.10	16.85	**16.85**	Regression Eqn.	OUTLET
33.25	29.00	22.50	17.39	**17.39**	Regression Eqn.	OUTLET
33.50	29.00	23.90	17.93	**17.93**	Regression Eqn.	OUTLET
33.75	29.00	25.10	18.40	**18.40**	Regression Eqn.	OUTLET
34.00	29.00	26.30	18.87	**18.87**	Regression Eqn.	OUTLET
34.25	29.00	27.50	19.33	**19.33**	Regression Eqn.	OUTLET
34.50	29.00	28.60	19.80	**19.80**	Regression Eqn.	OUTLET
34.75	29.00	29.60	20.19	**20.19**	Regression Eqn.	OUTLET
35.00	29.00	30.60	20.65	**20.65**	Regression Eqn.	OUTLET
35.25	29.00	31.60	21.12	**21.12**	Regression Eqn.	OUTLET
35.50	29.00	32.50	21.51	**21.51**	Regression Eqn.	OUTLET
35.75	29.00	33.40	21.89	**21.89**	Regression Eqn.	OUTLET
36.00	29.00	34.40	22.28	**22.28**	Orifice Eqn.	OUTLET
36.25		35.20	22.67	**22.67**	Orifice Eqn.	OUTLET
36.50		36.00	23.06	**23.06**	Orifice Eqn.	OUTLET
36.75		36.80	23.45	**23.45**	Orifice Eqn.	OUTLET
37.00		37.50	23.83	**23.83**	Orifice Eqn.	OUTLET
37.25		38.30	24.22	**24.22**	Orifice Eqn.	OUTLET
37.50		39.00	24.61	**24.61**	Orifice Eqn.	OUTLET
37.75		39.80	24.92	**24.92**	Orifice Eqn.	OUTLET
38.00		40.50	25.31	**25.31**	Orifice Eqn.	OUTLET
38.25		41.20	25.62	**25.62**	Orifice Eqn.	OUTLET
38.50		41.90	26.01	**26.01**	Orifice Eqn.	OUTLET
38.75		42.50	26.32	**26.32**	Orifice Eqn.	OUTLET

Processing Time: 00.33 Seconds

Determination of Culvert Headwater and Outlet Protection

Project: DAVES EX
Basin ID: CULVERT #3



Soil Type: (Choose One)
- ○ Sandy
- ◉ Non-Sandy

Design Information (Input):

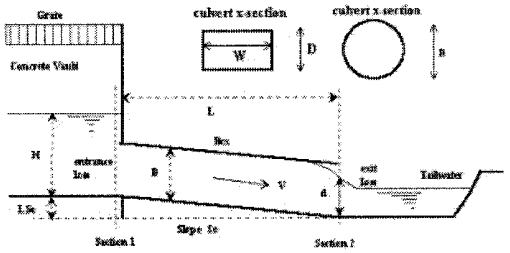
Design Discharge		Q = 11.84	cfs
Circular Culvert:			
Barrel Diameter in Inches		D = 24	inches
Inlet Edge Type (Choose from pull-down list)	Square End Projection		
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet		Height (Rise) =	ft
Barrel Width (Span) in Feet		Width (Span) =	ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels		No = 1	
Inlet Elevation		Elev IN = 29.85	ft
Outlet Elevation **OR** Slope		Elev OUT = 27	ft
Culvert Length		L = 710	ft
Manning's Roughness		n = 0.012	
Bend Loss Coefficient		k_b = 0	
Exit Loss Coefficient		k_x = 1	
Tailwater Surface Elevation		Elev Y_t =	ft
Max Allowable Channel Velocity		V = 7	ft/s

Required Protection (Output):

Tailwater Surface Height		Y_t = 0.80	ft
Flow Area at Max Channel Velocity		A_t = 1.69	ft^2
Culvert Cross Sectional Area Available		A = 3.14	ft^2
Entrance Loss Coefficient		k_e = 0.50	
Friction Loss Coefficient		k_f = 7.47	
Sum of All Losses Coefficients		k_s = 8.97	ft
Culvert Normal Depth		Y_n = 1.30	ft
Culvert Critical Depth		Y_c = 1.24	ft
Tailwater Depth for Design		d = 1.62	ft
Adjusted Diameter **OR** Adjusted Rise		D_a = -	ft
Expansion Factor		1/(2*tan(Θ)) = 5.64	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)		Q/D^2.5 = 2.09	$ft^{0.5}/s$
Froude Number		Fr = 0.90	
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise		Yt/D = 0.40	
Inlet Control Headwater		HW_I = 1.91	ft
Outlet Control Headwater		HW_O = 0.75	
Design Headwater Elevation		**HW = 31.76**	ft
Headwater/Diameter OR Headwater/Rise Ratio		**HW/D = 0.95**	
Minimum Theoretical Riprap Size		d_{50} = 3	in
Nominal Riprap Size		d_{50} = 6	in
UDFCD Riprap Type		**Type = VL**	
Length of Protection		**L_p = 6**	ft
Width of Protection		**T = 4**	ft

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

Project: **Daves Ex**
Basin ID: **West Culvert (#4)**
Status:



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D = 15	inches
	Inlet Edge Type (choose from pull-down list)	Square End Projection	
OR:			
Box Culvert:	Barrel Height (Rise) in Feet	Height (Rise) =	ft.
	Barrel Width (Span) in Feet	Width (Span) =	ft.
	Inlet Edge Type (choose from pull-down list)	Square Edge w/ 90-15 Deg. Headwall	
	Number of Barrels	No = 1	
	Inlet Elevation at Culvert Invert	Inlet Elev = 29	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Outlet Elev = 28.8	ft. elev.
	Culvert Length in Feet	L = 52	ft.
	Manning's Roughness	n = 0.012	
	Bend Loss Coefficient	K_b = 0	
	Exit Loss Coefficient	K_x = 1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.50
Friction Loss Coefficient	K_f =	1.02
Sum of All Loss Coefficients	K_s =	2.52
Orifice Inlet Condition Coefficient	C_d =	0.85
Minimum Energy Condition Coefficient	KE_{low} =	0.0560

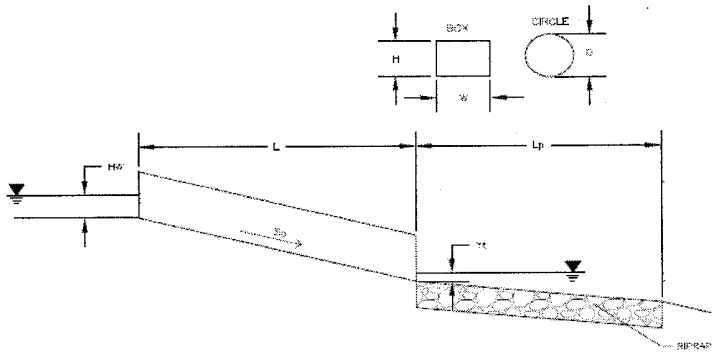
Calculations of Culvert Capacity (output):

Water Surface Elevation (ft., linked)	Tailwater Surface Elevation ft	Culvert Inlet-Control Flowrate cfs	Culvert Outlet-Control Flowrate cfs	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used:	Flow Control Used
29.00	30.00	0.00	0.00	**0.00**	No Flow (WS < inlet)	N/A
29.25	30.00	0.30	0.00	**0.00**	Min. Energy. Eqn.	N/A
29.50	30.00	0.90	0.00	**0.00**	Min. Energy. Eqn.	N/A
29.75	30.00	1.80	0.00	**0.00**	Regression Eqn.	N/A
30.00	30.00	2.80	0.00	**0.00**	Regression Eqn.	N/A
30.25	30.00	4.00	3.10	**3.10**	Regression Eqn.	OUTLET
30.50	30.00	5.00	4.25	**4.25**	Regression Eqn.	OUTLET
30.75	30.00	5.90	5.23	**5.23**	Regression Eqn.	OUTLET
31.00	30.00	6.60	6.05	**6.05**	Regression Eqn.	OUTLET
31.25	30.00	7.30	6.79	**6.79**	Regression Eqn.	OUTLET
31.50	30.00	7.90	7.46	**7.46**	Regression Eqn.	OUTLET
31.75	30.00	8.50	8.09	**8.09**	Regression Eqn.	OUTLET
32.00	30.00	9.10	8.66	**8.66**	Regression Eqn.	OUTLET
32.25	30.00	9.60	9.20	**9.20**	Regression Eqn.	OUTLET
32.50	30.00	10.00	9.72	**9.72**	Regression Eqn.	OUTLET
32.75	30.00	10.50	10.20	**10.20**	Regression Eqn.	OUTLET
33.00	30.00	11.00	10.65	**10.65**	Orifice Eqn.	OUTLET
33.25	30.00	11.40	11.11	**11.11**	Orifice Eqn.	OUTLET
33.50	30.00	11.70	11.52	**11.52**	Orifice Eqn.	OUTLET
33.75	30.00	12.10	11.94	**11.94**	Orifice Eqn.	OUTLET
34.00	30.00	12.50	12.33	**12.33**	Orifice Eqn.	OUTLET
34.25		12.80	12.72	**12.72**	Orifice Eqn.	OUTLET
34.50		13.20	13.09	**13.09**	Orifice Eqn.	OUTLET
34.75		13.50	13.45	**13.45**	Orifice Eqn.	OUTLET
35.00		13.80	13.80	**13.80**	Orifice Eqn.	INLET
35.25		14.10	14.15	**14.10**	Orifice Eqn.	INLET
35.50		14.40	14.47	**14.40**	Orifice Eqn.	INLET
35.75		14.70	14.82	**14.70**	Orifice Eqn.	INLET
36.00		15.00	15.13	**15.00**	Orifice Eqn.	INLET
36.25		15.30	15.45	**15.30**	Orifice Eqn.	INLET

Processing Time: 00.45 Seconds

Determination of Culvert Headwater and Outlet Protection

Project: **DAVES EX**
Basin ID: **CULVERT #4**



Soil Type: Choose One:
- ○ Sandy
- ◉ Non-Sandy

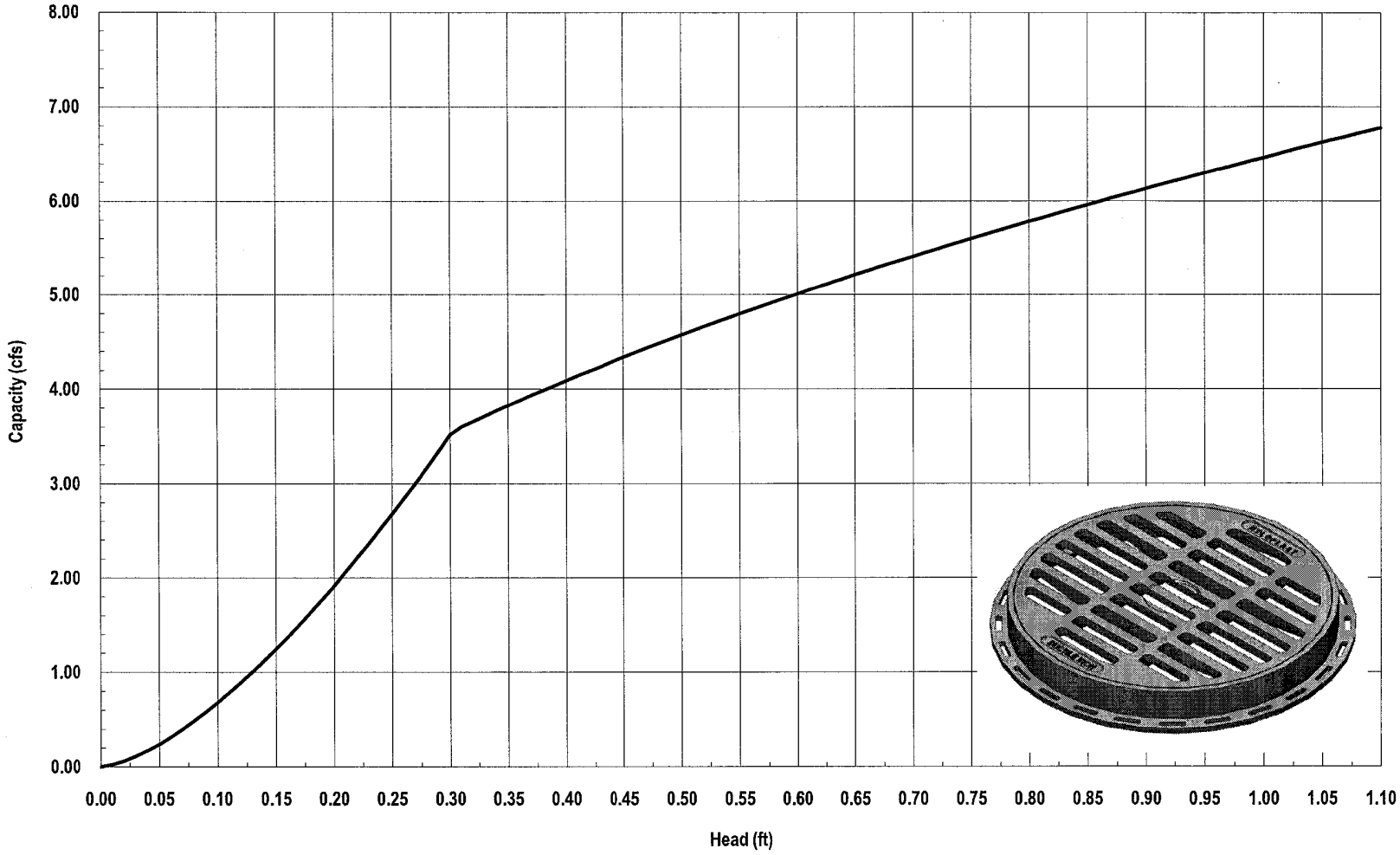
Design Information (Input):

Design Discharge	Q =	3.63	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	15	inches
Inlet Edge Type (Choose from pull-down list)		Square End Projection	
		OR	
Box Culvert:			
Barrel Height (Rise) in Feet	Height (Rise) =		ft
Barrel Width (Span) in Feet	Width (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	No =	1	
Inlet Elevation	Elev IN =	29	ft
Outlet Elevation **OR** Slope	Elev OUT =	28.8	ft
Culvert Length	L =	50	ft
Manning's Roughness	n =	0.012	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	Elev Y_t =		ft
Max Allowable Channel Velocity	V =	7	ft/s

Required Protection (Output):

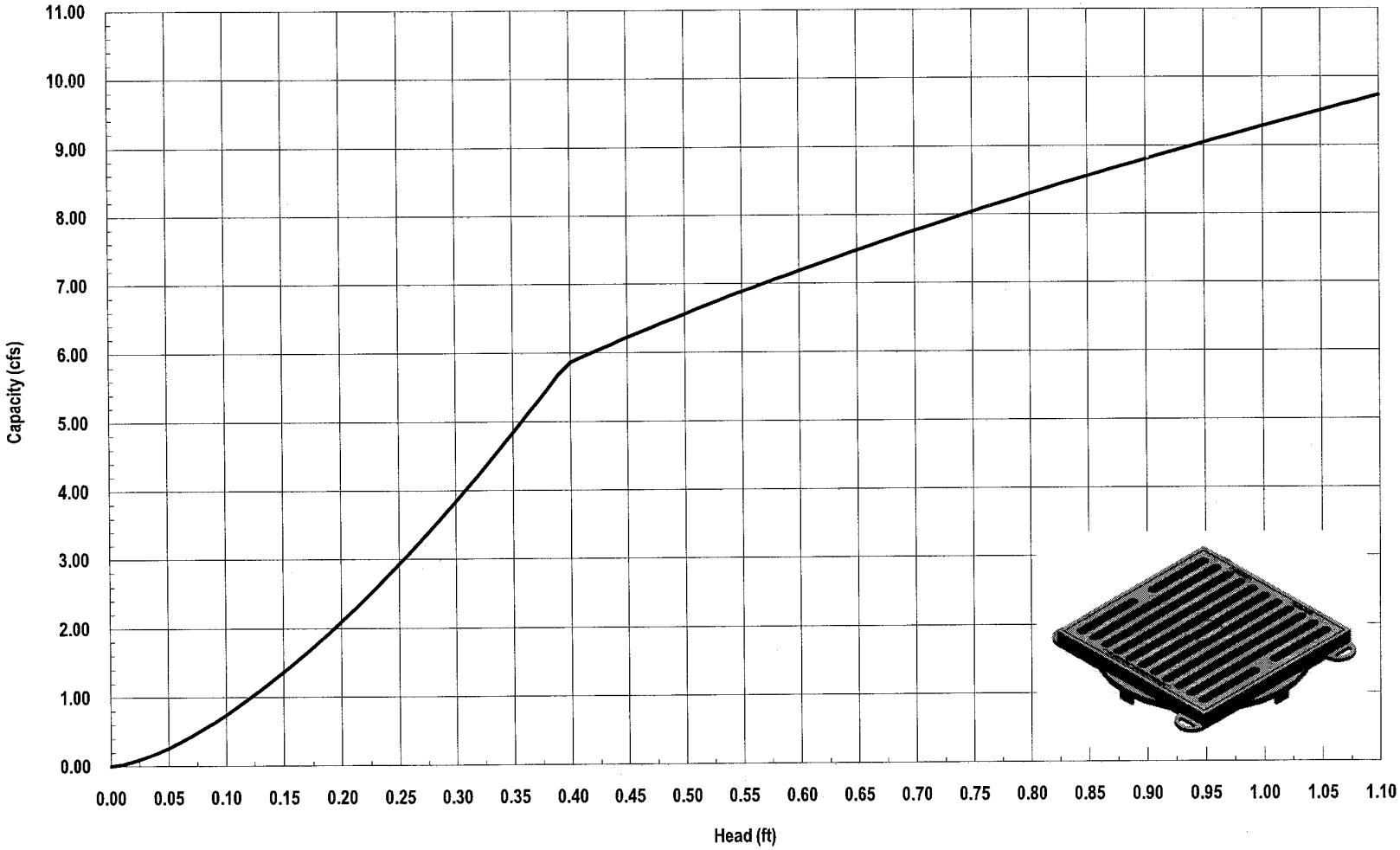
Tailwater Surface Height	Y_t =	0.50	ft
Flow Area at Max Channel Velocity	A_t =	0.52	ft^2
Culvert Cross Sectional Area Available	A =	1.23	ft^2
Entrance Loss Coefficient	k_e =	0.50	
Friction Loss Coefficient	k_f =	0.98	
Sum of All Losses Coefficients	k_s =	2.48	ft
Culvert Normal Depth	Y_n =	0.86	ft
Culvert Critical Depth	Y_c =	0.77	ft
Tailwater Depth for Design	d =	1.01	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	-	ft
Expansion Factor	1/(2*tan(Θ)) =	5.66	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	2.08	$ft^{0.5}/s$
Froude Number	Fr =	0.81	
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.40	
Inlet Control Headwater	HW_I =	1.19	ft
Outlet Control Headwater	HW_O =	1.15	
Design Headwater Elevation	**HW =**	**30.19**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**0.95**	
Minimum Theoretical Riprap Size	d_{50} =	2	in
Nominal Riprap Size	d_{50} =	6	in
UDFCD Riprap Type	**Type =**	VL	
Length of Protection	L_p =	4	ft
Width of Protection	T =	2	ft

Nyloplast 24" Standard Grate Inlet Capacity Chart



Nyloplast®
3130 Verona Avenue • Buford, GA 30518
(866) 888-8479 / (770) 932-2443 • Fax: (770) 932-2490

Nyloplast 2' x 2' Road & Highway Grate Inlet Capacity Chart



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Total Site and Sub-Basin Weighted Imperviousness Calculations

ENTIRE SITE

	AREAS	C VALUE	CXA	I VALUE	I X A
Proposed Building Area	12902	0.9	11611.8	90	1161180
CONCRETE/ASPHALT	29292	0.93	27241.56	100	2929200
GRAVEL	306668	0.65	199334.2	40	12266720
LANDSCAPE	87201	0.3	26160.3	2	174402
TOTAL	436063		264347.9		16531502
		COMP C =	**0.61**	I =	**37.91**
ACRES	10.01				

RETENTION VOLUME WORKSHEET

	TIME minutes	INT(100)	Q(CFS)	STORM VOL	RELEASE VOL	NET VOL.
USE	1440	0.26	1.58	136180.10	0.00	**136,180.10**

Urban Drainage Manual recommends Retention pond sizing for 1.5 times 100-yr 24 hr event

204,270.15 c.f. required

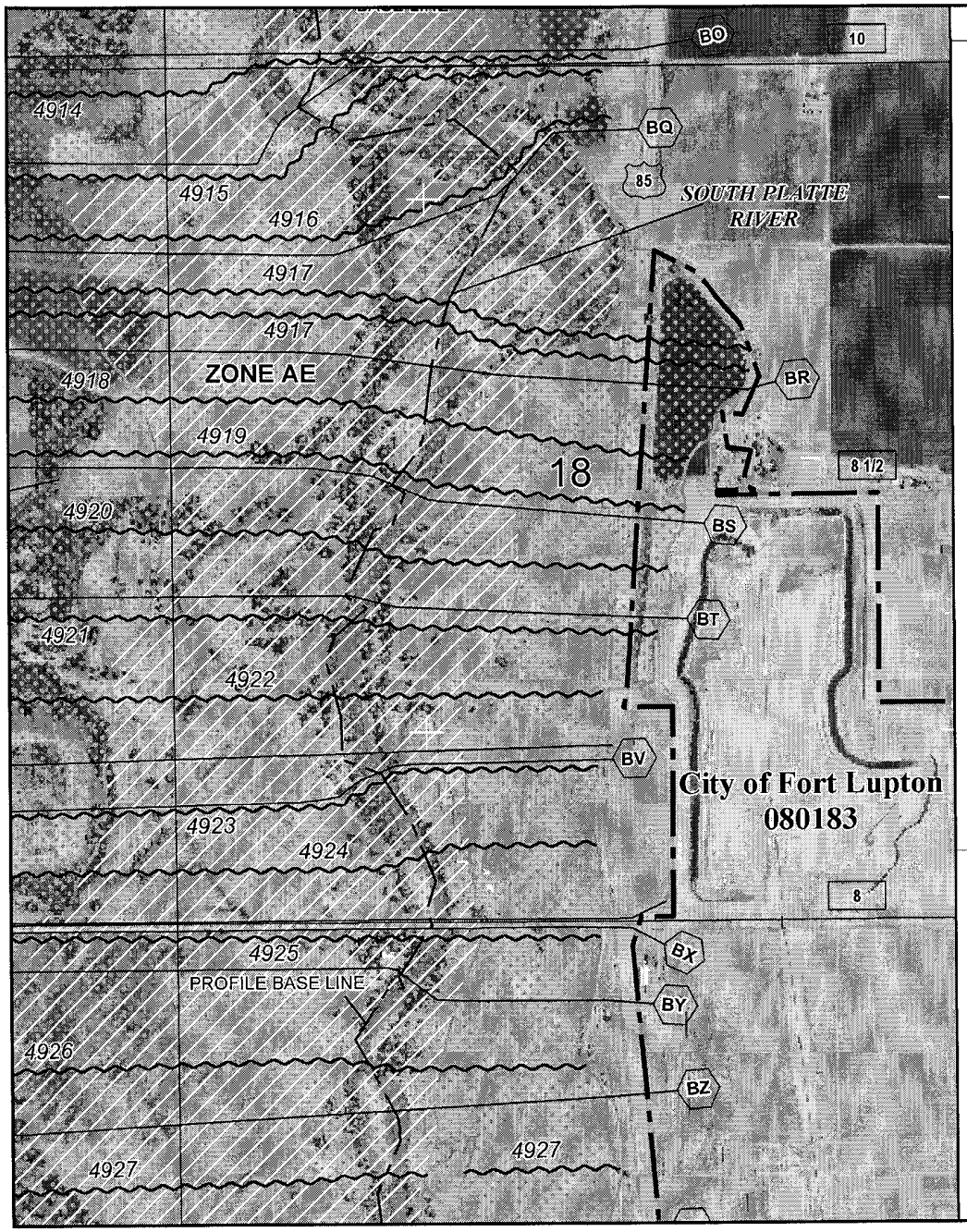
C(100)	0.61
ACRES	10.00
C*A	6.06

hh

CONTOUR ELEVATIONS	AREA	DEPTH	AVG AREA	Volume Provided
25	21613			
		1	22914	22914
26	24215			
		1	25580.5	25580.5
27	26946			
		1	28374.5	28374.5
28	29803			
		1	31296.5	31296.5
29	32790			
		1	34592	34592
30	36394			
		1	41283.5	41283.5
31	46173			
		0.5	47444.5	23722.25
31.5	48716			

TOTAL OF **207763.25** C.F. PROVIDED

45



1265000 F

1260000 F

MAP SCALE 1" = 1000'

500 0 1000 2000

FEET

METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 2115E

FIRM

FLOOD INSURANCE RATE MAP

WELD COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 2115 OF 2250

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
FORT LUPTON, CITY OF	080183	2115	E
WELD COUNTY	080266	2115	E

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
08123C2115E

EFFECTIVE DATE
JANUARY 20, 2016

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

Map Scale: 1:1,680 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 20 40 80 120

Feet
0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

LH

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Weld County, Colorado, Southern Part
Survey Area Data: Version 14, Sep 22, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 16, 2012—Apr 13, 2012

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

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Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Weld County, Colorado, Southern Part (CO618)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1	Altvan loam, 0 to 1 percent slopes	B	1.5	12.5%
21	Dacono clay loam, 0 to 1 percent slopes	C	10.2	87.5%
Totals for Area of Interest			11.7	100.0%

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

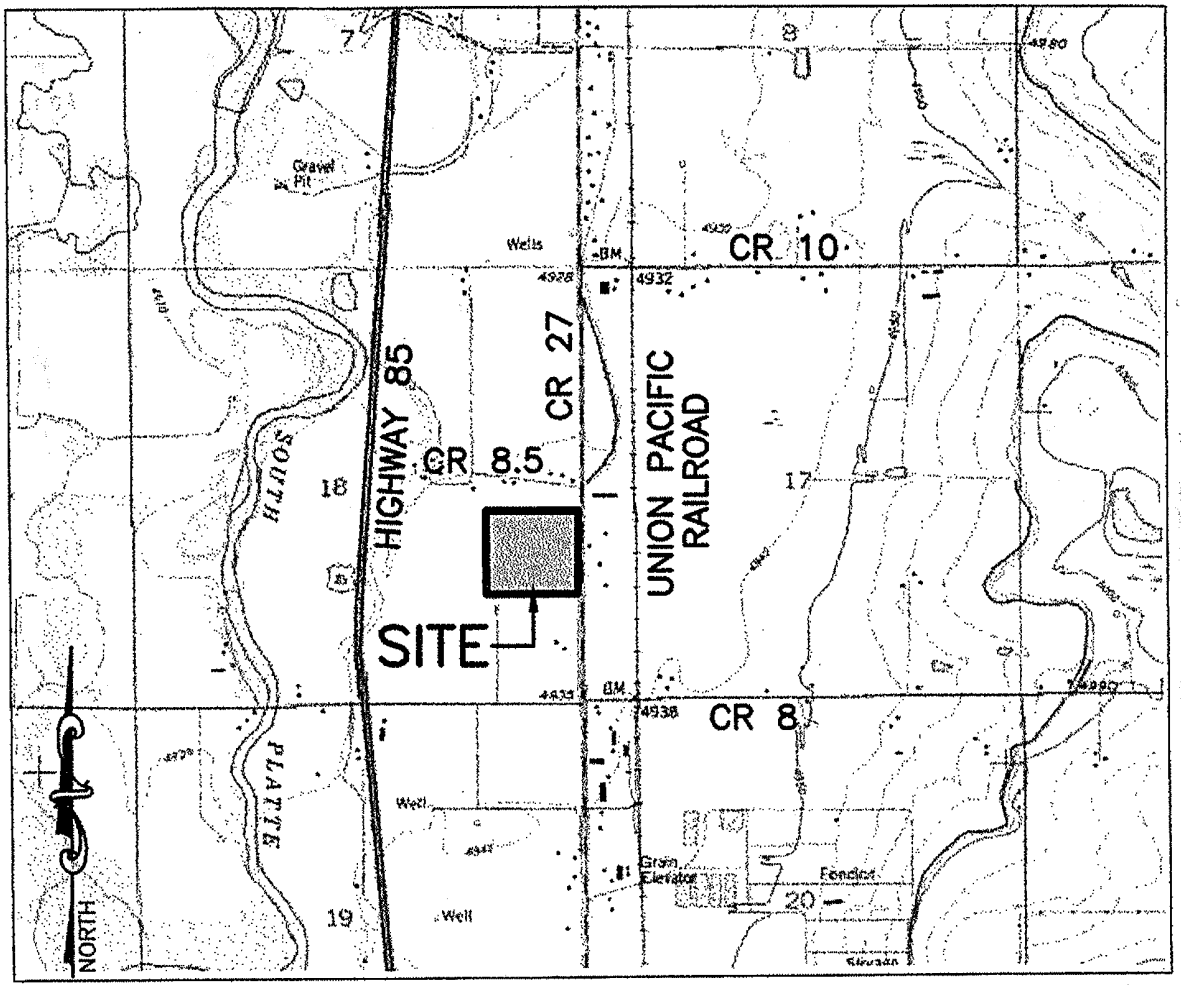
If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

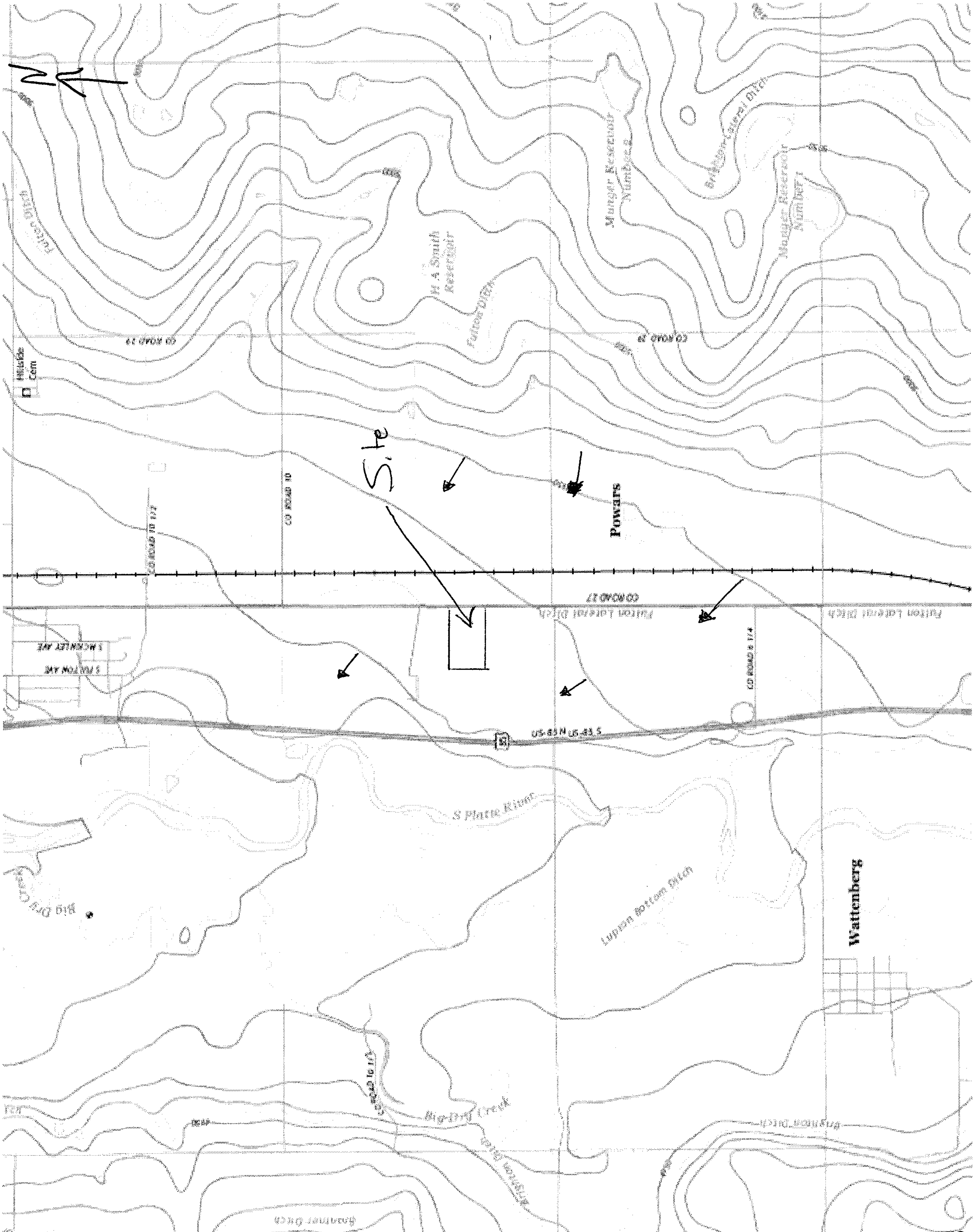
Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher



VICINITY MAP

SCALE: 1" = 2000'



N
Site
Powars
Wattenberg
H A Smith Reservoir
Munger Reservoir Number 2
Munger Reservoir Number 1
Fulton Ditch
Fulton Lateral Ditch
Lupton Bottom Ditch
S Platte River
Big Dry Creek
Hillside Cem
CO ROAD 10
CO ROAD 27
US-85 N US-85 S
S MCKINLEY AVE
S FULTON AVE

REFERENCES

Urban Storm Drainage Criteria Manual, Volumes 1, 2 and 3 (June 2001 and November 2010, Urban Drainage and Flood Control District, Denver, Colorado)

STANDARD FORM SF-1

CHECKLIST

Item	Description	Received or not applicable	To Be Submitted
1.	Typed, Bound Report		
2.	Professional Engineers Certificate		
	Standard Statement 1		
	Standard Statement 2		
	Standard Form 2		
	Standard Form 3		
3.	General Location and Description		
A.	Location Map		
B.	Existing Site Description		
C.	Description of Existing Drainage Patterns and Facilities		
4.	Drainage Basins and Sub-Basins		
A.	Major Basin Description		
B.	Sub-Basin Description		
5.	Design Criteria		
A.	Development Master Plan Discussion		
B.	Hydrologic Criteria Discussion		
C.	Hydraulic Criteria Discussion		
6.	Drainage Facility Design		
A.	Discussion of Proposed Facilities		
B.	Discussion of Drainage Patterns		
C.	Impact on Offsite Facilities		
D.	Impact on Master Plan		
7.	Drainage Plan		
A.	Topographic Contours		
B.	ROW and Easements		
C.	Delineation of Basin and Sub-Basins		
D.	Existing Drainage Patterns & Facilities		
E.	Proposed Drainage Patterns & Facilities		
F.	Proposed Outfall Points		
G.	Routing of Offsite Drainage		
H.	Routing from Site to Major Drainageway		
I.			
J.			
K.			

Standard Statement 1

"I hereby affirm that this report and plan for the Phase ___ drainage design of the development, Dave Hunts, New Facility, was prepared by me (or under my direct supervision) in accordance with the provisions of the City of Fort Lupton Storm Drainage Design and Technical Criteria for the owners thereof. I understand that the City of Fort Lupton does not and will not assume liability for drainage facilities designed by others. I am also aware of the provisions of the City CODE as it pertains to the City's review."

Registered Professional Engineer
State of Colorado No. 33371
(Affix Seal)

Standard Statement 2

_____ hereby affirms that the drainage facilities for the development, _____, shall be constructed according to the design presented in this report. I understand that the City of Fort Lupton does not and will not assume liability for drainage facilities designed and/or certified by my engineer. I understand that the City of Fort Lupton reviews drainage plans but cannot, on behalf of __(Name of Developer)__ and/or their successors and/or assigns assume future liability for improper design. I am also aware of the provisions of the City CODE as it pertains to the City's review."

_____

Name of Developer/Owner

_____

Authorized Signature/Title

STANDARD FORM SF-2

DRAINAGE AGREEMENT DOCUMENT

_____, the owner of the property commonly known as_____, and _____, the owner of property commonly known as _____, do hereby covenant and agree, on with the other that:

WHEREAS, the development known as _____ has developed land from its natural state which may cause alteration of that land's natural drainage; and

WHEREAS, _____has reviewed the Preliminary Drainage Study for _____ and concurs with the content, concept, and design details presented therein; and

WHEREAS, the drainage from _____ will flow onto the _____property in a manner and quantity probably different from natural drainage flow, and _____ is the owner of drainage facilities downstream from _____; and

WHEREAS, the City of Fort Lupton requires alternately detention and release of drainage at historical flows, or acceptance of drainage by the downstream property owner, and holding the City harmless from claims resulting from drainage.

NOW, THEREFORE, in consideration of the sum of Ten Dollars ($10.00), the mutual benefit of the parties, and other good and valuable consideration, the parties agree as follows:

1. That _____ does hereby accept and grant to _____, the right to release all drainage caused by said development, onto and across the property of _____, in accordance with the drainage study done by _____ and concurred in by _____.
2. _____ shall have the right to use the easement premises in any manner that will not prevent the exercise of the rights granted to , and _____ shall have the right to grant other non-exclusive easements over, along, or upon the easement premises, provided, however, that any such other easements shall be subject to the rights granted hereby;
3. That neither _____ nor _____ shall have any right or recourse against the City of Fort Lupton on account of any matter arising out of the subject drainage or the rights granted hereunder.
4. Grantor _____ hereby reserves the right to modify and change the location of the drainage easement premises providing that such relocated

easement shall be of appropriate character and subject to the same uses herein established and equally suitable for the drainage purposes created herein.

5. All rights, title, and privilege herein granted, including all benefits and burdens, shall run with the land and inure to the benefit of the parties and beneficiaries hereto, including the City of Fort Lupton, their respective heirs, executors, administrators, successors, assigns, and legal representatives.

IN WITNESS WHEREOF, the parties hereto have executed or have caused this instrument to be executed by their proper officers duly authorized to create the same.

_____ _____

By: _____ By: _____

ATTEST:

_____

STANDARD FORM SF-3

INDEMNIFICATION STATEMENT

I am the Owner of _____, and as such am preparing to begin construction _____.

I hereby promise to indemnify and hold harmless the City of Fort Lupton for any liability the City may have on account of any change in the nature, direction, quantity, or quality of historical drainage flow resulting from the development of my property or from the construction of streets or storm sewers therein. In addition, I promise to reimburse the City for any and all costs including, but not limited to, attorney's fees, which the City incurs in acquiring or condemning any rights-of-way or easements which the City is required to acquire or condemn or which the City is held to have acquired or condemned, for drainage as a result of the development of my property.

I understand that I will be afforded a full opportunity to participate in the settlement and defense of any claims for which indemnity may be required under this paragraph.

_____

By: _____

ATTEST:

_____

Index

INTRODUCTION

Property Location and Description:

The site is located Lots 2 and 3 Yarbrough Acres Minor Subdivision, City of Fort Lupton which is part of the Northeast quarter of the Southeast quarter of Section 18, Township 1 North, Range 66 West of the 6th Principal Meridian, Fort Lupton, Weld County Colorado. The address for the site is 3355 CR 27, Fort Lupton CO. The site is bordered on the east by Weld County Road 27 which is also known as Denver Ave further north. There is an existing irrigation ditch along the west side of CR 27 (Fulton Lateral Ditch) which will have to be crossed with the access point to the property. The south border is Lot 1 of the same subdivision and it is currently a commercial facility that is mostly developed. The site has an existing retention pond towards the west end of the property. The west side of the lot is bordered by a gravel pit that is owned by the City and County of Denver. The north boundary is a residence that is mainly undeveloped. The project site has an existing barn that will be removed in the future.

The existing vegetation on the site consists of fairly dense weeds and grasses. The exiting soils on the site are classified as Altvan Loam and Dacono Clay Loam. The majority of the soils on the site are Hydrologic group "C". There are no wetlands on the property at this time. This report and design considers on and off-site storm water that is generated by the new construction surfaces. (See Grading and Drainage Plan for location)

The proposed commercial improvements to this project site include 12,800 square foot of metal buildings, concrete and asphalt paving, and gravel driveways. One retention pond will serve the retention requirements for both lots. The 2 lots combined contain 10 acres.

DRAINAGE BASINS AND SUB-BASINS

Major Basin Description

No major drainage ways exist on this property. There is an existing irrigation ditch east of the property (Fulton Lateral Ditch). The site lies within the South Platte River Basin, but does not appear to lie within the floodplain. The FEMA FIRM panel for the property is 08123C2155E . The panel became effective Jan 20, 2016

Existing Drainage Basin Conditions

The existing 10-acre site historically slopes to the northwest at 0.3% slope. Presently the site to the south of the site has a retention facility. The property along the north boundary appears to drain to the west and north west away from the site. The property along the west side of the project drains west towards the South Platte River. The property to the east mainly drains to the west but the combination of CR 27 being slightly elevated and the Fulton Lateral Ditch create a barrier that will in effect prevent offsite flows from entering the site. Therefore the basin considered for this design will consist of the site itself.

Proposed Drainage Basin Conditions

The site flows were calculated using thirteen on-site basins to determine the various requirements of the onsite swales, culverts and inlets.

Sub-Basin S1 which is in the north-east corner of the lot was used to determine the swale capacity along the north side of the property and the requirements of culvert #1 and the inlets. S1 has building, pavement, gravel and landscape surfaces within its boundaries. S1 contains 0.6 acres, has a developed imperviousness of 40% and produces 2.75 cfs in the 100-yr event.

Sub-Basin S2 is directly west of S1 along the north property boundary and was used to determine the swale capacity along the north side of the property and the requirements of culvert #1 and the inlets. S2 has gravel and landscape surfaces within its boundaries. S2 contains 0.79 acres, has a developed imperviousness of 38% and produces 2.55 cfs in the 100-yr event.

Sub-Basin S3 is directly west of S2 along the north property boundary and was used to determine the swale capacity along the north side of the property and the requirements of culvert #1 and the inlets. S3 has gravel and landscape surfaces within its boundaries. S3 contains 0.70 acres, has a developed imperviousness of 38% and produces 2.97 cfs in the 100-yr event.

Sub-Basin S4 is directly west of S3 along the north property boundary and was used to determine the swale capacity along the north side of the property and the requirements of culvert #1 and the inlets. S4 has gravel and landscape surfaces within its boundaries. S4 contains 0.79 acres, has a developed imperviousness of 38% and produces 3.34 cfs in the 100-yr event.

Sub-Basin S5 is directly west of S4 in the north-west corner of the site and was used to determine the swale capacity along the north side of the property and the requirements of the culvert #4 that drains the swale. S5 has gravel and landscape surfaces within its boundaries. S5 contains 0.91 acres, has a developed imperviousness of 32% and produces 3.63 cfs in the 100-yr event.

Sub-Basin S6 which is south of basins S1, S2 and S3 was used to determine the central swale capacity and the requirements of culvert #2 and inlets. S6 has building, pavement, gravel and landscape surfaces within its boundaries. S6 contains 1.57 acres, has a developed imperviousness of 56% and produces 6.92 cfs in the 100-yr event.

Sub-Basin S7 which is south of basins S3, S4 and S5 was used to determine the central swale capacity and the requirements of culvert #2 and inlets. S7 has pavement, gravel and landscape surfaces within its boundaries. S7 contains 0.98 acres, has a developed imperviousness of 41% and produces 4.02 cfs in the 100-yr event.

Sub-Basin S8 which is in the southeast corner of the property was used to determine the central swale capacity and the requirements of culvert #3 and inlets. S has building, pavement, gravel and landscape surfaces within its boundaries. S8 contains 0.7 acres, has a developed imperviousness of 55% and produces 3.09 cfs in the 100-yr event.

Sub-Basin S9 which is west of S8 along the south side of the property was used to determine the southern swale capacity and the requirements of culvert #3 and inlets. S9 has

building, gravel and landscape surfaces within its boundaries. S9 contains 0.49 acres, has a developed imperviousness of 55% and produces 2.05 cfs in the 100-yr event.

Sub-Basin S10 which is west of S9 along the south side of the property was used to determine the southern swale capacity and the requirements of culvert #3 and inlets. S10 has building, gravel and landscape surfaces within its boundaries. S10 contains 0.78 acres, has a developed imperviousness of 38% and produces 3.28 cfs in the 100-yr event.

Sub-Basin S11 which is west of S10 along the south side of the property was used to determine the southern swale capacity and the requirements of culvert #3 and inlets. S11 has gravel and landscape surfaces within its boundaries. S11 contains 0.45 acres, has a developed imperviousness of 37% and produces 1.91 cfs in the 100-yr event.

Sub-Basin S12 which is west of S11 along the south side of the property was used to determine the southern swale capacity and the requirements of culvert #3 and inlets. S12 has gravel and landscape surfaces within its boundaries. S12 contains 0.36 acres, has a developed imperviousness of 37% and produces 1.51 cfs in the 100-yr event.

Sub-Basin S13 which is in the south west corner of the property and west of S12 along the south side of the property. S13 has gravel and landscape surfaces within its boundaries. S13 contains 1.01 acres, has a developed imperviousness of 3% and produces 5.36 cfs in the 100-yr event.

The entire developed site contains 10.01 acres and has an imperviousness of 38%. The 100-yr developed runoff rate is 37.65 cfs.

DRAINAGE DESIGN CRITERIA

Development Criteria Reference and Constraints

The 100-year design rainfalls are used to analyze runoff rates and retention parameters, in accordance with the commercial requirements set forth in the Urban Drainage Manual. Due to the small basin size the Rational Method has been utilized to determine peak runoff rates and required detention pond volumes. The retention pond was designed volume with 150% of the 100-year 24 hour developed storm. The runoff coefficients used in the design are as follows.

SITE IMPERVIOUSNESS / RUNOFF VALUES

	Imperviousness	100 –yr Runoff Coefficient
Landscaping/ Existing	2%	0.3
Building Roofs	90%	0.9
Asphalt and Concrete	100%	0.93
Gravel	40%	0.65

Using the NOAA Atlas 14 Volume 8 Version 2 maps an IDF table was generated. A one hour rainfall depth of 1.31 inches and 2.81 inches was determined for a five-year and 100-year event. The rational method was used to calculate runoff and release rates. The retention pond was sized using the 100-yr 24 hour developed storm. The retention pond volume is required to have the capacity to hold 150% of the 100-yr 24 hour storm. The on site features (swales, culverts etc.) were sized to pass the 100-year events. The runoff for specific design points was calculated by inputting the area, imperviousness, soil type, one hour precipitation values, slope, length of travel and conveyance into the peak runoff spreadsheet. Please see the corresponding peak runoff and feature design for each point. The release rate and developed runoff amounts were calculated using the rational method.

Storm Water Quality Considerations

Storm water quality will be controlled with the installation of the retention pond. Sedimentation from the site to the retention pond is reduced by surfaces of gravel, concrete and asphalt surfaces. These surfaces will mitigate erosion by protecting the soils underneath. The remainder of the site is protected by vegetation, which mitigate erosion and reduce sedimentation.

During construction, erosion control features will be utilized and remain onsite until all surfaces are constructed and vegetation has been established. Structural features include the retention pond, a concrete washout area, a vehicle tracking control pad and silt fence. A concrete washout area will aid in maintaining water quality on-site by containing concrete material. A vehicle tracking control pad is located at the construction entrance to reduce sedimentation into the public right-of-way. Silt Fence is placed at all locations where on-site flows will sheet flow off of the property. Non-structural features, including roughening of soil stockpiles and re-vegetation of disturbed areas will also be included in the construction phase of this project. All stockpiles shall be roughened to reduce erosion and all areas that have been disturbed and aren't protected by solid surfaces shall be seeded and mulched.

DRAINAGE FACILITY DESIGN

The storm water retention is provided in the landscaped area in the south west corner of the property. The required volume was determined by multiplying the volume from the 24 HR 100-yr event by 150%. The retention volume required is 204,270 cubic feet. The retention volume provided will be approximately 207,763 cubic feet. Sheet flow, concrete pans and storm pipe will carry storm water to the retention pond. The elevation around the top of the retention pond shall have a minimum elevation of 4932.5. Once the water reaches an elevation that is higher than the existing ground the storm water will travel along the historical path to the north.

Swale Sec A-A is a typical section that collects flow from basins S1, S2, S3, S4, S5, S9, S10, S11 and S12 and conveys it to inlets and/ or other swale sections . At a minimum slope of

0.8% Sec A-A has the ability to pass 5.11 cfs when the flow depth is 0.5'. The velocity is 1.32 fps, and the Froude number is 0.46 with an "n" value of 0.04. The maximum runoff entering the swale is 3.34 cfs

Swale Sec B-B collects flow from S5 (3.63 cfs) Sec B-B has the ability to pass 3.94 cfs when the flow depth is 0.75'. The velocity is 1.75 fps, and the Froude number is 0.5 with an "n" value of 0.04.

Swale Sec C-C collects flow from S6 and S7 (6.92 cfs max) and empties into storm inlets. Sec C-C has the ability to pass 7.02 cfs when the flow depth is 0.37'. The velocity is 0.55 fps, and the Froude number is 0.56 with an "n" value of 0.025.

Swale Sec D-D collects flow from S8 (3.09 cfs) and empties into a storm inlet on culvert #3. Sec D-D has the ability to pass 3.26 cfs when the flow depth is 0.45'. The velocity is 0.87 fps, and the Froude number is 0.32 with an "n" value of 0.004.

Swale Sec E-E also collects flow from S8 (3.09 cfs) and empties into a storm inlet on culvert #3. Sec E-E has the ability to pass 3.12 cfs when the flow depth is 0.67'. The velocity is 1.76 fps, and the Froude number is 0.54 with an "n" value of 0.004.

Culvert #1 is a 24" ADS pipe that will collect flows from S1, S2, S3 and S4. The total combined flow from these basins is 11.61 cfs. Culvert #1 has the ability to pass this flow when the water elevation reaches 4931.25. This will induce approx. 6.5" of water above the farthest west inlet elevation. The outlet of the pipe is set 2' above the bottom of the retention pond so that in minor events the pipe is cleaned. At the discharge point of the culvert a 22' x 4' x 18" Type "L" rip rap pad is placed to prevent erosion. A single inlet will drain each basin. A 24" Nyoplast inlet Grate has the capacity to accept approximately 4.5 cfs when the sump condition reaches 6".

Culvert #2 is a 18" and a 24" ADS pipe that will collect flows from S6 and S7. The total combined flow from these basins is 10.94 cfs. Culvert #2 is an 18" diameter in between the inlets. The 18" section has the ability to pass this flow from S6 (6.92 cfs) when the water elevation reaches 4934, which is the rim elevation of the inlet. The western section of the pipe has the capacity to pass the combined flows when the elevation reaches 4933.25, which is the rim elevation of the inlet. The outlet of the pipe is set 2' above the bottom of the retention pond so that in minor events the pipe is cleaned. At the discharge point of the culvert a 16' x 4' x 18" Type "L" rip rap pad is placed to prevent erosion. A single inlet will drain each basin. A 2' square Nyoplast Roadway inlet Grate has the capacity to accept approximately 6.9 cfs when the sump condition reaches 6.5".

Culvert #3 is a 24" ADS pipe that will collect flows from S8, S9, S10, S11 and S12. The total combined flow from these basins is 11.84 cfs. Culvert #3 has the ability to pass this flow when the water elevation reaches 4931.75. This will induce approx. 4" of water above the farthest west inlet elevation. The outlet of the pipe is set 2' above the bottom of the retention pond so that in minor events the pipe is cleaned. At the discharge point of the culvert a 18' x 4' x 18" Type "L" rip rap pad is placed to prevent erosion. A single inlet will drain each basin. A

24" Nyoplast inlet Grate has the capacity to accept approximately 4.5 cfs when the sump condition reaches 6".

Culvert #4 is a 15" ADS pipe that will collect flows from S5. The flow from this basin is 3.63 cfs. Culvert #4 has the ability to pass this flow when the water elevation reaches 4930.75. The outlet of the pipe is set 3.8' above the bottom of the retention pond so that in minor events the pipe is cleaned. At the discharge point of the culvert a 17' x 3' x 18" Type "L" rip rap pad is placed to prevent erosion.

CONCLUSION

The attached calculations show that the developed condition imperviousness for the proposed development for a 100-yr storm is 38%. The corresponding runoff coefficient is 0.61. Based on an area of 10.01 Acres, 150% of the 24- hour 100-yr event a storm-volume of 204,270 cubic feet is required. A volume of 204,270 cubic feet is provided.

The project design for Dave Hunt's new facility is completed in compliance with the Urban Storm Drainage Criteria Manual and the City of Fort Lupton.

SITE MAINTENANCE

Drainage/ Site Maintenance Plan for Dave's Excavation

1. At all times any erosion that may occur shall be corrected as soon as possible to mitigate the chance of erosion leaving the site.
2. All culverts shall be inspected regularly and cleaned if necessary.
3. Any seeded areas that are not covered with vegetation shall be re-seeded and irrigated as necessary to establish permanent vegetation.
4. Snow should not be piled in swales or near detention pond outlet.

NOAA Atlas 14, Volume 8, Version 2
Location name: Fort Lupton, Colorado, US*
Latitude: 40.0491°, Longitude: -104.8120°
Elevation: 4936 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.230 (0.177-0.299)	0.281 (0.216-0.365)	0.377 (0.289-0.492)	0.470 (0.358-0.615)	0.617 (0.464-0.859)	0.745 (0.544-1.04)	0.887 (0.627-1.27)	1.04 (0.709-1.53)	1.27 (0.832-1.91)	1.46 (0.925-2.20)
10-min	0.337 (0.259-0.438)	0.411 (0.316-0.535)	0.552 (0.423-0.720)	0.688 (0.524-0.901)	0.903 (0.679-1.26)	1.09 (0.797-1.53)	1.30 (0.918-1.86)	1.53 (1.04-2.24)	1.86 (1.22-2.80)	2.14 (1.35-3.22)
15-min	0.411 (0.316-0.534)	0.501 (0.385-0.652)	0.673 (0.515-0.878)	0.839 (0.639-1.10)	1.10 (0.829-1.53)	1.33 (0.972-1.86)	1.58 (1.12-2.27)	1.86 (1.27-2.73)	2.27 (1.49-3.41)	2.61 (1.65-3.92)
30-min	0.561 (0.432-0.730)	0.680 (0.523-0.885)	0.909 (0.696-1.19)	1.13 (0.862-1.48)	1.48 (1.12-2.07)	1.79 (1.31-2.52)	2.14 (1.51-3.06)	2.52 (1.71-3.69)	3.08 (2.01-4.62)	3.54 (2.24-5.32)
60-min	0.685 (0.527-0.891)	0.829 (0.637-1.08)	1.11 (0.849-1.45)	1.38 (1.05-1.81)	1.82 (1.37-2.54)	2.20 (1.61-3.08)	2.63 (1.86-3.76)	3.10 (2.11-4.55)	3.79 (2.48-5.70)	4.37 (2.77-6.57)
2-hr	0.809 (0.629-1.04)	0.978 (0.759-1.26)	1.31 (1.01-1.69)	1.63 (1.25-2.11)	2.15 (1.64-2.96)	2.60 (1.93-3.61)	3.11 (2.23-4.41)	3.68 (2.53-5.33)	4.51 (2.98-6.68)	5.20 (3.33-7.71)
3-hr	0.875 (0.684-1.12)	1.05 (0.824-1.35)	1.41 (1.09-1.80)	1.75 (1.36-2.25)	2.30 (1.77-3.16)	2.79 (2.08-3.85)	3.34 (2.40-4.69)	3.95 (2.73-5.67)	4.84 (3.22-7.11)	5.58 (3.59-8.20)
6-hr	1.04 (0.819-1.31)	1.23 (0.972-1.56)	1.61 (1.27-2.04)	1.99 (1.55-2.53)	2.59 (2.00-3.50)	3.12 (2.34-4.23)	3.71 (2.69-5.14)	4.37 (3.05-6.19)	5.33 (3.59-7.73)	6.13 (3.99-8.89)
12-hr	1.27 (1.02-1.59)	1.49 (1.19-1.86)	1.90 (1.51-2.38)	2.30 (1.82-2.89)	2.93 (2.29-3.90)	3.49 (2.65-4.66)	4.10 (3.01-5.59)	4.78 (3.38-6.67)	5.77 (3.92-8.24)	6.59 (4.34-9.42)
24-hr	1.52 (1.23-1.88)	1.79 (1.45-2.22)	2.29 (1.84-2.83)	2.74 (2.19-3.40)	3.42 (2.68-4.45)	4.00 (3.05-5.24)	4.62 (3.41-6.17)	5.29 (3.76-7.24)	6.24 (4.28-8.74)	7.01 (4.67-9.88)
2-day	1.73 (1.41-2.10)	2.10 (1.71-2.56)	2.72 (2.21-3.32)	3.25 (2.63-3.99)	4.00 (3.14-5.08)	4.61 (3.54-5.90)	5.22 (3.88-6.84)	5.86 (4.20-7.86)	6.74 (4.65-9.25)	7.42 (5.00-10.3)
3-day	1.88 (1.55-2.28)	2.26 (1.86-2.74)	2.90 (2.37-3.52)	3.44 (2.80-4.19)	4.20 (3.32-5.29)	4.81 (3.72-6.12)	5.43 (4.07-7.06)	6.08 (4.38-8.09)	6.97 (4.84-9.48)	7.65 (5.19-10.5)
4-day	2.01 (1.66-2.42)	2.39 (1.97-2.88)	3.01 (2.48-3.64)	3.55 (2.90-4.31)	4.32 (3.43-5.41)	4.93 (3.83-6.25)	5.57 (4.19-7.19)	6.23 (4.51-8.23)	7.13 (4.98-9.64)	7.83 (5.33-10.7)
7-day	2.31 (1.92-2.75)	2.69 (2.24-3.21)	3.34 (2.77-3.99)	3.89 (3.21-4.67)	4.68 (3.75-5.79)	5.31 (4.16-6.64)	5.95 (4.52-7.60)	6.62 (4.84-8.64)	7.53 (5.31-10.1)	8.24 (5.67-11.1)
10-day	2.56 (2.14-3.03)	2.96 (2.48-3.51)	3.64 (3.03-4.32)	4.21 (3.49-5.02)	5.02 (4.04-6.16)	5.66 (4.46-7.02)	6.31 (4.82-7.99)	6.99 (5.13-9.05)	7.90 (5.60-10.5)	8.61 (5.95-11.5)
20-day	3.27 (2.77-3.83)	3.73 (3.16-4.37)	4.50 (3.79-5.28)	5.13 (4.31-6.05)	6.02 (4.89-7.26)	6.70 (5.34-8.18)	7.39 (5.70-9.21)	8.09 (6.01-10.3)	9.03 (6.47-11.8)	9.74 (6.82-12.9)
30-day	3.83 (3.27-4.46)	4.36 (3.72-5.08)	5.23 (4.44-6.09)	5.94 (5.02-6.95)	6.91 (5.65-8.26)	7.65 (6.13-9.26)	8.39 (6.52-10.4)	9.14 (6.83-11.5)	10.1 (7.29-13.0)	10.8 (7.64-14.2)
45-day	4.51 (3.87-5.20)	5.15 (4.42-5.94)	6.17 (5.28-7.14)	7.00 (5.96-8.13)	8.12 (6.68-9.62)	8.96 (7.22-10.7)	9.79 (7.64-12.0)	10.6 (7.97-13.2)	11.7 (8.46-14.9)	12.4 (8.82-16.1)
60-day	5.06 (4.37-5.81)	5.80 (5.00-6.67)	6.99 (6.00-8.04)	7.94 (6.79-9.17)	9.21 (7.60-10.8)	10.2 (8.21-12.1)	11.1 (8.68-13.4)	12.0 (9.03-14.8)	13.1 (9.53-16.6)	13.9 (9.92-17.9)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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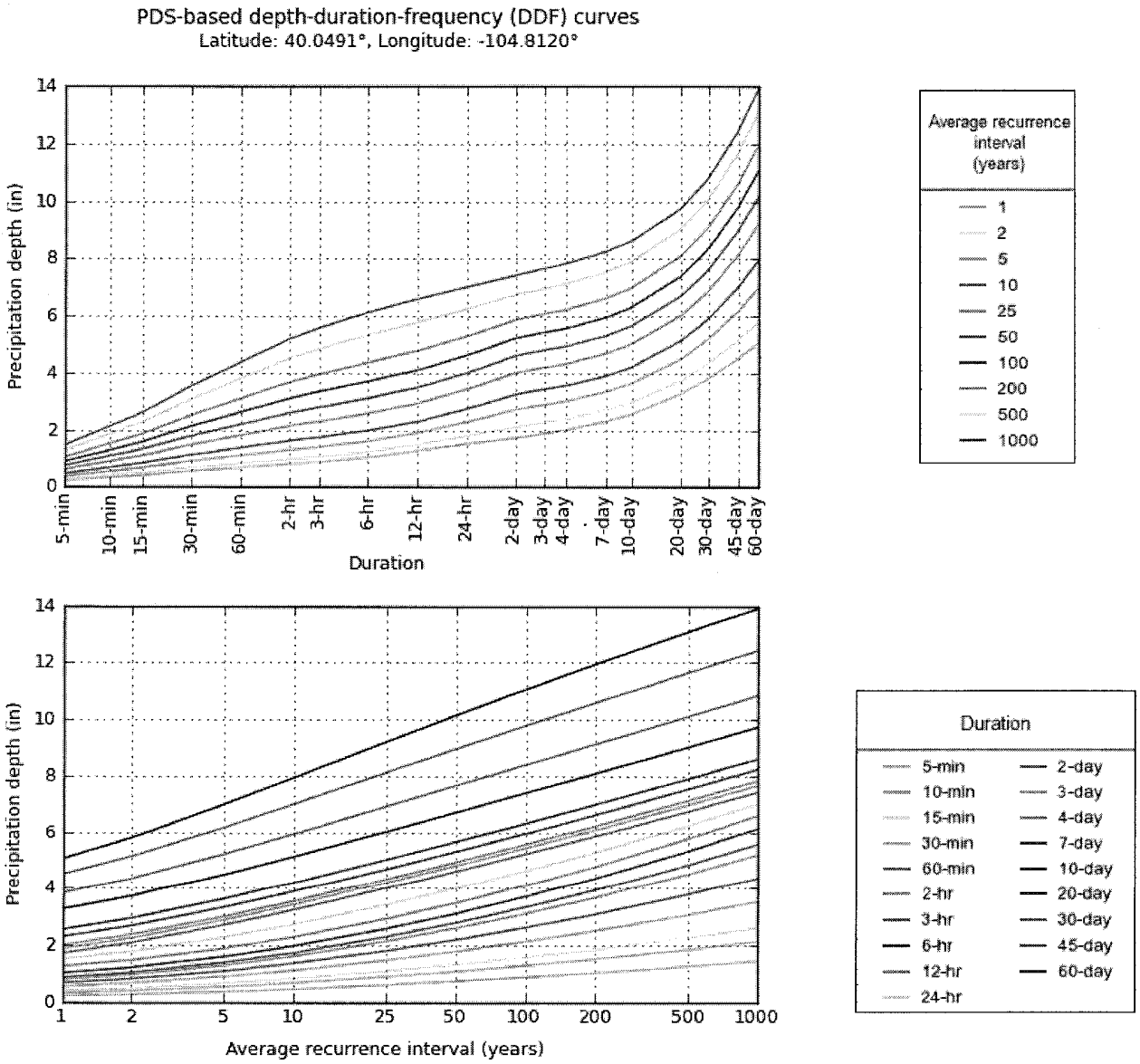
PF graphical



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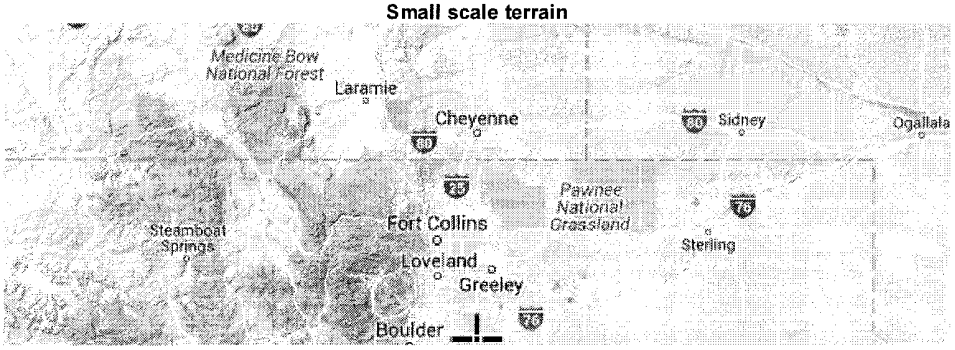
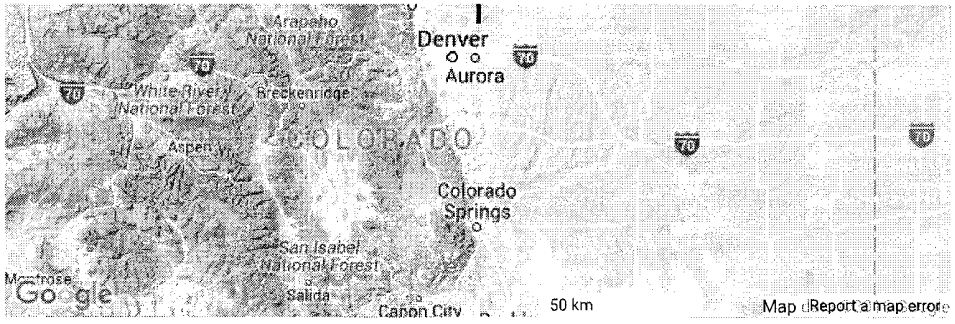
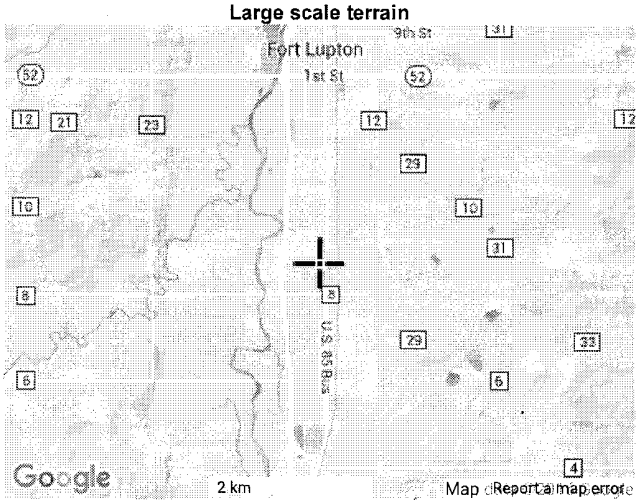
Maps & aerials

Small scale terrain

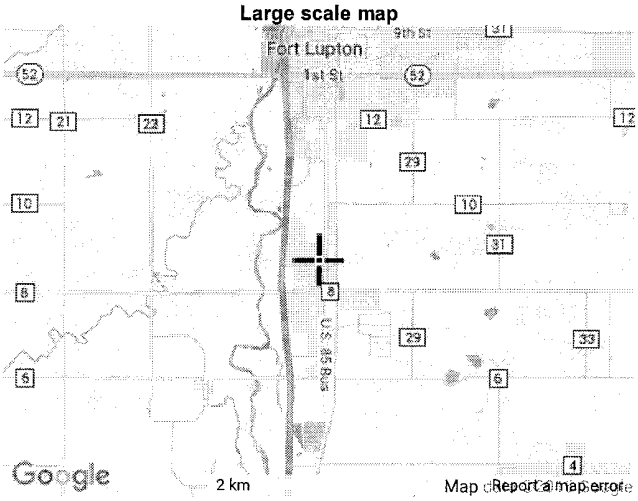




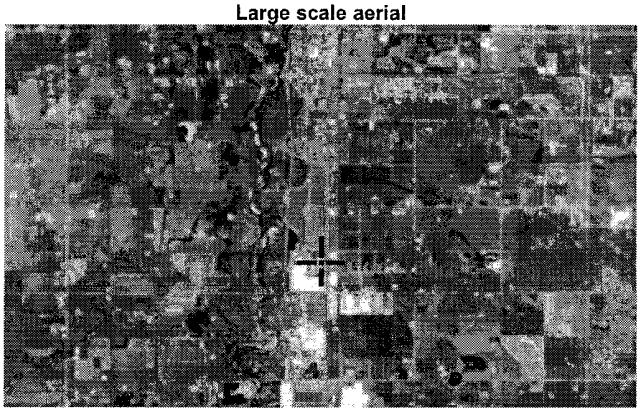
Large scale terrain



Large scale map



Large scale aerial



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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

Depth-Duration-Frequency and Intensity-Duration-Frequency Tables for Colorado Hydrologic Zones 1 through 4

Blue cells are inputs.

Project: Daves

Where is the Watershed Located?

○ Located within UDFCD Boundary

◉ Located outside of UDFCD Boundary

Hydrologic Zone (1, 2, 3, or 4) =	1	(see map)
Elevation at Center of Watershed =	4,936	ft
Watershed Area (Optional) =	N/A	sq. mi.

(Optional) Select a location within the UDFCD boundary:

1. Rainfall Depth-Duration-Frequency Table

If within the UDFCD Boundary, Enter the 1-hour and 6-hour rainfall depths from the USDCM Volume 1.
Otherwise, Enter the 6-hour and 24-hour rainfall depths from the NOAA Atlas 2 Volume III.

Return Period	Rainfall Depth in Inches at Time Duration								
	5-min	*10-min*	*15-min*	*30-min*	*1-hr*	*2-hr*	*3-hr*	*6-hr*	*24-hr*
2-yr	0.23	0.37	0.46	0.54	0.82	0.96	1.06	1.23	1.79
5-yr	0.37	0.59	0.75	0.86	1.31	1.42	1.49	1.61	2.29
10-yr	0.46	0.74	0.93	1.08	1.64	1.76	1.85	1.99	2.74
25-yr	0.58	0.93	1.17	1.35	2.06	2.24	2.37	2.59	3.42
50-yr	0.69	1.10	1.39	1.60	2.44	2.68	2.85	3.12	4.00
100-yr	0.79	1.27	1.59	1.84	2.81	3.12	3.35	3.71	4.62
500-yr	1.02	1.62	2.04	2.36	3.60	3.94	4.20	4.60	5.68

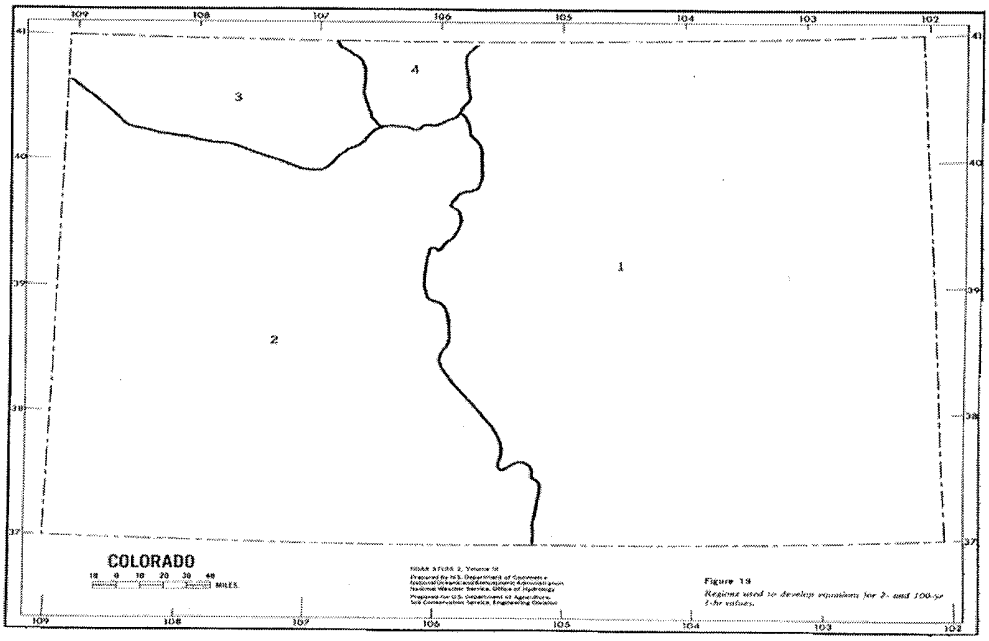
Note: Refer to Figures 4-1 through 4-12 of USDCM Volume 1 for 1-hr and 6-hr rainfall depths.
Refer to NOAA Atlas 2 Volume III isopluvial maps for 6-hr and 24-hr rainfall depths.
Rainfall depths for durations less than 1-hr are calculated using Equation 4-4 in USDCM Volume 1.

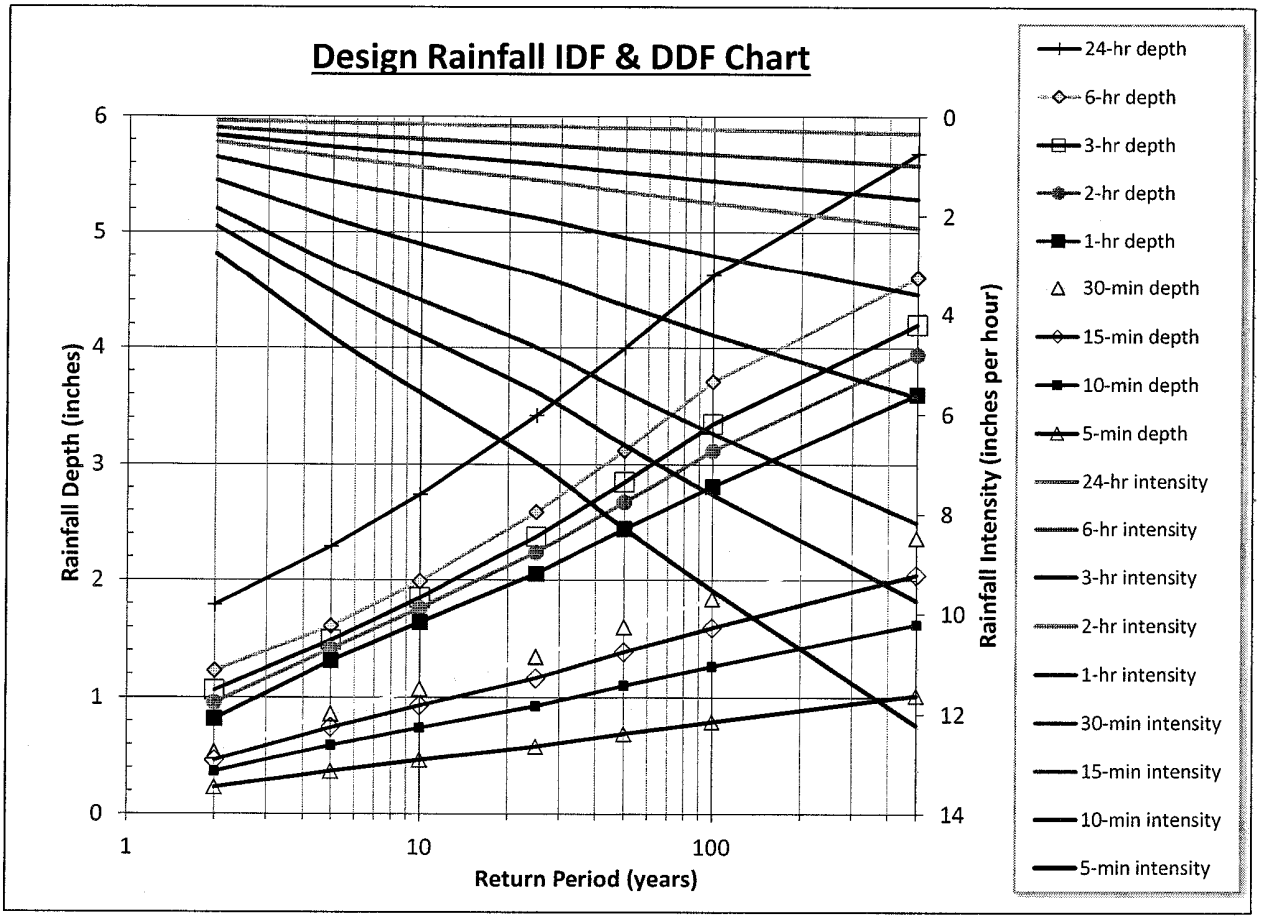
2. Rainfall Intensity-Duration-Frequency Table

Return Period	Rainfall Intensity in Inches Per Hour at Time Duration								
	5-min	*10-min*	*15-min*	*30-min*	*1-hr*	*2-hr*	*3-hr*	*6-hr*	*24-hr*
2-yr	2.77	2.21	1.86	1.28	0.82	0.51	0.38	0.22	0.08
5-yr	4.46	3.56	2.98	2.06	1.31	0.82	0.61	0.36	0.12
10-yr	5.57	4.44	3.73	2.58	1.64	1.02	0.76	0.45	0.15
25-yr	6.97	5.56	4.67	3.22	2.06	1.28	0.95	0.56	0.19
50-yr	8.29	6.61	5.55	3.83	2.44	1.52	1.13	0.67	0.23
100-yr	9.53	7.60	6.38	4.41	2.81	1.75	1.30	0.77	0.26
500-yr	12.21	9.74	8.17	5.65	3.60	2.24	1.66	0.98	0.34

Note: Intensity approximated using 1-hr rainfall depths and Equation 4-3 in USDCM Volume 1.

Depth-Duration-Frequency and Intensity-Duration-Frequency Tables for Colorado Hydrologic Zones 1 through 4





Sub-basin Imperviousness

Daves Earthworks

H1: HISTORIC

Land Use	Area (ft2)	I (%)
Impervious Area, Grass	436063	2
Roofs	0	90
Concrete Surfaces	0	100
Driveways, Gravel	0	40
Wghtd Avg & Total Area	436063	2
Acres	10.01	

ENTIRE SITE

Land Use	Area (ft2)	I (%)
Impervious Area, Grass	87201	2
Roofs	12902	90
Concrete Surfaces	29292	100
Driveways, Gravel	306668	40
Wghtd Avg & Total Area	436063	38
Acres	10.01	

S1

Land Use	Area (ft2)	I (%)
Impervious Area, Grass	4762	2
Roofs	1000	90
Concrete Surfaces	2213	100
Driveways, Gravel	18154	40
Wghtd Avg & Total Area	26129	40
Acres	0.600	

S2

Land Use	Area (ft2)	I (%)
Impervious Area, Grass	1650	2
Roofs	0	90
Concrete Surfaces	0	100
Driveways, Gravel	24591	40
Wghtd Avg & Total Area	26241	38
Acres	0.602	

S3

Land Use	Area (ft2)	I (%)
Impervious Area, Grass	1947	2
Roofs	0	90
Concrete Surfaces	0	100
Driveways, Gravel	28365	40
Wghtd Avg & Total Area	30312	38
Acres	0.696	

S4

Land Use	Area (ft2)	I (%)
Impervious Area, Grass	2244	2
Roofs	0	90
Concrete Surfaces	0	100
Driveways, Gravel	31948	40
Wghtd Avg & Total Area	34192	38
Acres	0.785	

S5

Land Use	Area (ft2)	I (%)
Impervious Area, Grass	8752	2
Roofs	0	90
Concrete Surfaces	0	100
Driveways, Gravel	30858	40
Wghtd Avg & Total Area	39610	32
Acres	0.909	

S6

Land Use	Area (ft2)	I (%)
Impervious Area, Grass	3038	2
Roofs	6392	90
Concrete Surfaces	15351	100
Driveways, Gravel	43561	40
Wghtd Avg & Total Area	68342	56
Acres	1.569	

S7

Land Use	Area (ft2)	I (%)
Impervious Area, Grass	924	2
Roofs	0	90
Concrete Surfaces	1285	100
Driveways, Gravel	40620	40
Wghtd Avg & Total Area	42829	41
Acres	0.983	

S8

Land Use	Area (ft2)	I (%)
Impervious Area, Grass	8718	2
Roofs	3814	90
Concrete Surfaces	10183	100
Driveways, Gravel	7897	40
Wghtd Avg & Total Area	30612	55
Acres	0.703	

S9

Land Use	Area (ft2)	I (%)
Impervious Area, Grass	2547	2
Roofs	1696	90
Concrete Surfaces	0	100
Driveways, Gravel	16930	40
Wghtd Avg & Total Area	21173	39
Acres	0.486	

S10

Land Use	Area (ft2)	I (%)
Impervious Area, Grass	2111	2
Roofs	0	90
Concrete Surfaces	0	100
Driveways, Gravel	31754	40
Wghtd Avg & Total Area	33865	38
Acres	0.777	

S11

Land Use	Area (ft2)	I (%)
Impervious Area, Grass	1302	2
Roofs	0	90
Concrete Surfaces	0	100
Driveways, Gravel	18441	40
Wghtd Avg & Total Area	19743	37
Acres	0.453	

S12

Land Use	Area (ft2)	I (%)
Impervious Area, Grass	2324	2
Roofs	0	90
Concrete Surfaces	0	100
Driveways, Gravel	13549	40
Wghtd Avg & Total Area	15873	34
Acres	0.364	

S13

Land Use	Area (ft2)	I (%)
Impervious Area, Grass	43616	2
Roofs	0	90
Concrete Surfaces	260	100
Driveways, Gravel	0	40
Wghtd Avg & Total Area	43876	3
Acres	1.007	

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Daves Ex
Catchment ID: S1

I. Catchment Hydrologic Data

Catchment ID = S1
Area = 0.60 Acres
Percent Imperviousness = 40.00 %
NRCS Soil Type = C A, B, C, or D

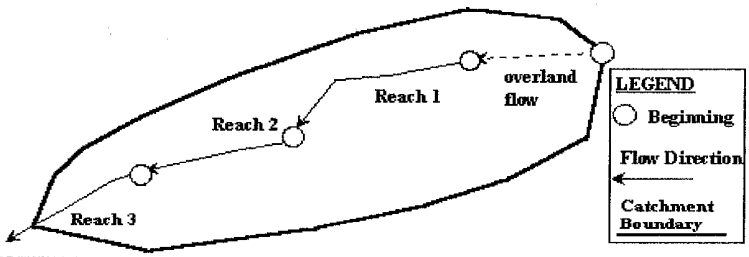
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.81	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.58
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.35
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0190	62	0.35	N/A	0.12	8.64
1	0.0349	109		20.00	3.74	0.49
2						
3						
4						
5						
	Sum	171				

Computed Tc = 9.13
Regional Tc = 10.95
User-Entered Tc = 9.13

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I =	7.87	inch/hr	Peak Flowrate, Qp =	2.75 cfs
Rainfall Intensity at Regional Tc, I =	7.33	inch/hr	Peak Flowrate, Qp =	2.56 cfs
Rainfall Intensity at User-Defined Tc, I =	7.87	inch/hr	Peak Flowrate, Qp =	2.75 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Daves Ex
Catchment ID: S2

I. Catchment Hydrologic Data

Catchment ID = S2
Area = 0.60 Acres
Percent Imperviousness = 38.00 %
NRCS Soil Type = C A, B, C, or D

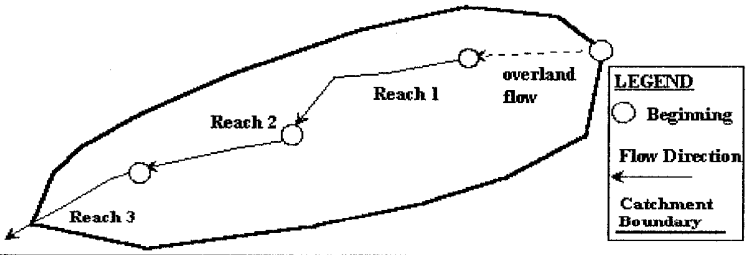
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.81	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.58
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.34
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0230	174	0.34	N/A	0.21	13.76
1						
2						
3						
4						
5						
	Sum	174				

Computed Tc = 13.76
Regional Tc = 10.97
User-Entered Tc = 10.97

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I =	6.64	inch/hr	Peak Flowrate, Qp =	2.31	cfs
Rainfall Intensity at Regional Tc, I =	7.32	inch/hr	Peak Flowrate, Qp =	2.55	cfs
Rainfall Intensity at User-Defined Tc, I =	7.32	inch/hr	Peak Flowrate, Qp =	2.55	cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Daves Ex
Catchment ID: S3

I. Catchment Hydrologic Data

Catchment ID = S3
Area = 0.70 Acres
Percent Imperviousness = 38.00 %
NRCS Soil Type = C A, B, C, or D

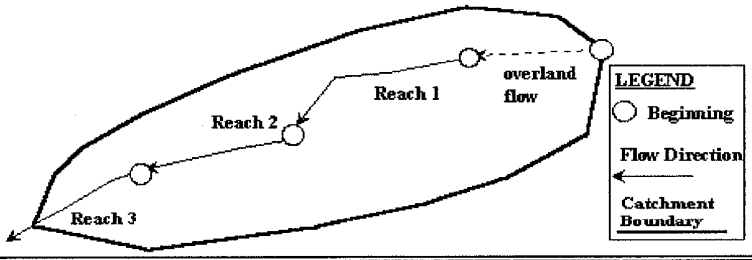
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.81	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.58
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.34
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0240	183	0.34	N/A	0.22	13.91
1						
2						
3						
4						
5						
	Sum	183				

Computed Tc = 13.91
Regional Tc = 11.02
User-Entered Tc = 11.02

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I =	6.61	inch/hr	Peak Flowrate, Qp =	2.68 cfs
Rainfall Intensity at Regional Tc, I =	7.31	inch/hr	Peak Flowrate, Qp =	2.97 cfs
Rainfall Intensity at User-Defined Tc, I =	7.31	inch/hr	Peak Flowrate, Qp =	2.97 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Daves Ex
Catchment ID: S4

I. Catchment Hydrologic Data

Catchment ID = S4
Area = 0.79 Acres
Percent Imperviousness = 38.00 %
NRCS Soil Type = C A, B, C, or D

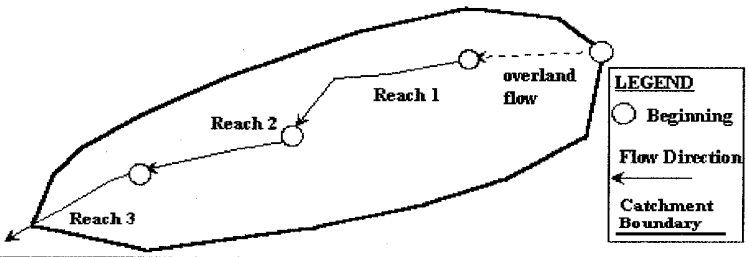
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.81	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.58
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.34
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0280	191	0.34	N/A	0.24	13.51
1						
2						
3						
4						
5						
	Sum	191				

Computed Tc = 13.51
Regional Tc = 11.06
User-Entered Tc = 11.06

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I =	6.69	inch/hr	Peak Flowrate, Qp =	3.06 cfs
Rainfall Intensity at Regional Tc, I =	7.30	inch/hr	Peak Flowrate, Qp =	3.34 cfs
Rainfall Intensity at User-Defined Tc, I =	7.30	inch/hr	Peak Flowrate, Qp =	3.34 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Daves Ex
Catchment ID: S5

I. Catchment Hydrologic Data

Catchment ID = S5
Area = 0.91 Acres
Percent Imperviousness = 32.00 %
NRCS Soil Type = C A, B, C, or D

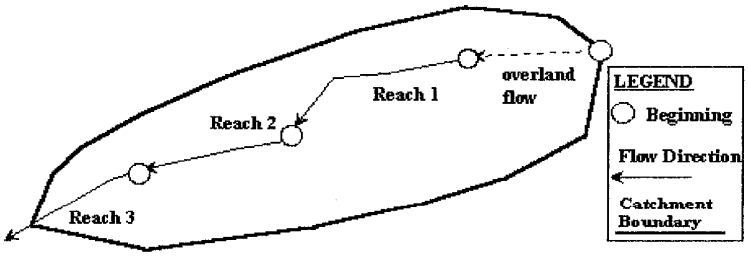
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.81	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.57
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.31
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0170	263	0.31	N/A	0.23	19.33
1	0.0085	135		15.00	1.38	1.63
2						
3						
4						
5						
	Sum	398				

Computed Tc = 20.96
Regional Tc = 12.21
User-Entered Tc = 12.21

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I =	5.39	inch/hr	Peak Flowrate, Qp =	2.80 cfs
Rainfall Intensity at Regional Tc, I =	7.00	inch/hr	Peak Flowrate, Qp =	3.63 cfs
Rainfall Intensity at User-Defined Tc, I =	7.00	inch/hr	Peak Flowrate, Qp =	3.63 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Daves Ex
Catchment ID: S6

I. Catchment Hydrologic Data

Catchment ID = S6
Area = 1.57 Acres
Percent Imperviousness = 56.00 %
NRCS Soil Type = C A, B, C, or D

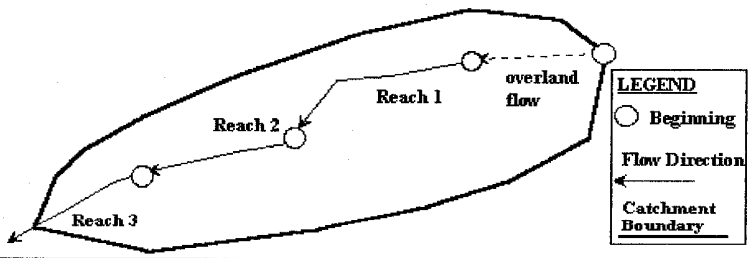
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.81	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.62
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.43
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0050	46	0.43	N/A	0.07	10.29
1	0.0050	270		20.00	1.41	3.18
2						
3						
4						
5						
	Sum	316				

Computed Tc = 13.47
Regional Tc = 11.76
User-Entered Tc = 11.76

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I =	6.70	inch/hr	Peak Flowrate, Qp =	6.52	cfs
Rainfall Intensity at Regional Tc, I =	7.11	inch/hr	Peak Flowrate, Qp =	6.92	cfs
Rainfall Intensity at User-Defined Tc, I =	7.11	inch/hr	Peak Flowrate, Qp =	6.92	cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Daves Ex
Catchment ID: S7

I. Catchment Hydrologic Data

Catchment ID = S7
Area = 0.98 Acres
Percent Imperviousness = 41.00 %
NRCS Soil Type = C A, B, C, or D

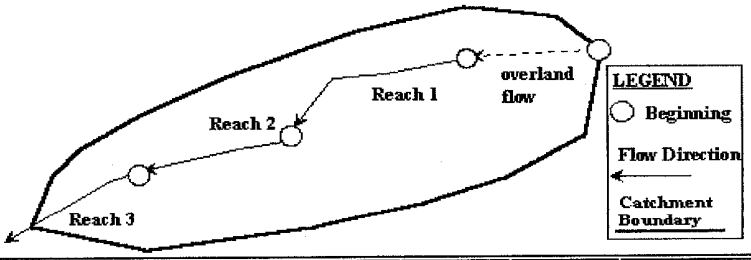
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.81 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.58
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.35
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0200	68	0.35	N/A	0.13	8.84
1	0.0050	313		20.00	1.41	3.69
2						
3						
4						
5						
	Sum	381				

Computed Tc = 12.53
Regional Tc = 12.12
User-Entered Tc = 12.12

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 6.92 inch/hr — Peak Flowrate, Qp = 3.97 cfs
Rainfall Intensity at Regional Tc, I = 7.02 inch/hr — Peak Flowrate, Qp = 4.02 cfs
Rainfall Intensity at User-Defined Tc, I = 7.02 inch/hr — Peak Flowrate, Qp = 4.02 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Daves Ex
Catchment ID: S8

I. Catchment Hydrologic Data

Catchment ID = S8
Area = 0.70 Acres
Percent Imperviousness = 55.00 %
NRCS Soil Type = C A, B, C, or D

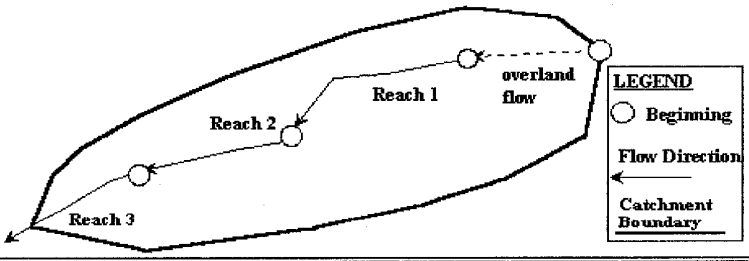
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.81	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.62
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.43
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0200	70	0.43	N/A	0.14	8.10
1	0.0050	75		15.00	1.06	1.18
2	0.0080	102		15.00	1.34	1.27
3	0.0100	100		15.00	1.50	1.11
4						
5						
	Sum	347			Computed Tc =	11.66
					Regional Tc =	11.93
					User-Entered Tc =	11.66

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I =	7.14	inch/hr	Peak Flowrate, Qp =	3.09 cfs
Rainfall Intensity at Regional Tc, I =	7.07	inch/hr	Peak Flowrate, Qp =	3.06 cfs
Rainfall Intensity at User-Defined Tc, I =	7.14	inch/hr	Peak Flowrate, Qp =	3.09 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Daves Ex
Catchment ID: S9

I. Catchment Hydrologic Data

Catchment ID = S9
Area = 0.48 Acres
Percent Imperviousness = 39.00 %
NRCS Soil Type = C A, B, C, or D

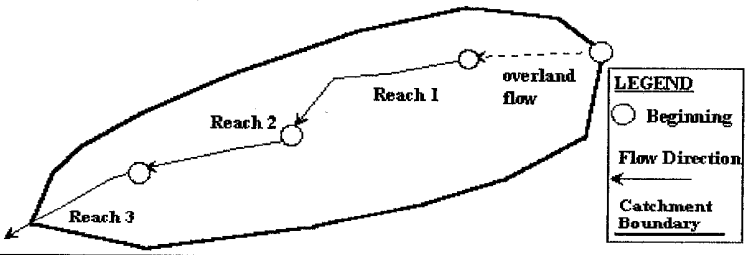
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.81	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.58
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.34
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0250	156	0.34	N/A	0.21	12.60
1						
2						
3						
4						
5						
	Sum	156				

Computed Tc = 12.60
Regional Tc = 10.87
User-Entered Tc = 10.87

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I =	6.91	inch/hr	Peak Flowrate, Qp =	1.93 cfs
Rainfall Intensity at Regional Tc, I =	7.35	inch/hr	Peak Flowrate, Qp =	2.05 cfs
Rainfall Intensity at User-Defined Tc, I =	7.35	inch/hr	Peak Flowrate, Qp =	2.05 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Daves Ex
Catchment ID: S10

I. Catchment Hydrologic Data

Catchment ID = S10
Area = 0.78 Acres
Percent Imperviousness = 38.00 %
NRCS Soil Type = C A, B, C, or D

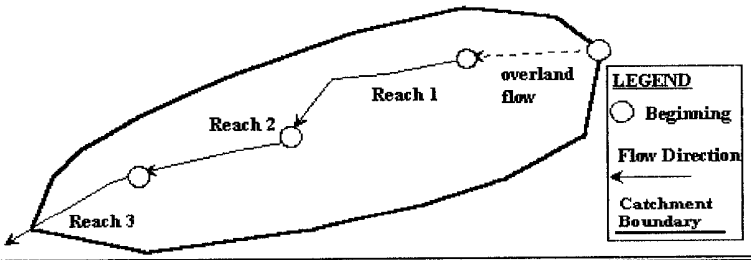
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.81	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.58
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.34
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0200	213	0.34	N/A	0.22	15.94
1						
2						
3						
4						
5						
	Sum	213				

Computed Tc = 15.94
Regional Tc = 11.18
User-Entered Tc = 11.18

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I =	6.20	inch/hr	Peak Flowrate, Qp = 2.80 cfs
Rainfall Intensity at Regional Tc, I =	7.27	inch/hr	Peak Flowrate, Qp = 3.28 cfs
Rainfall Intensity at User-Defined Tc, I =	7.27	inch/hr	Peak Flowrate, Qp = 3.28 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Daves Ex
Catchment ID: S11

I. Catchment Hydrologic Data

Catchment ID = S11
Area = 0.45 Acres
Percent Imperviousness = 37.00 %
NRCS Soil Type = C A, B, C, or D

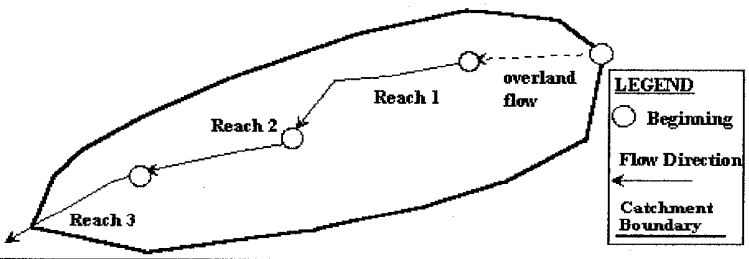
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.81	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.58
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.34
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0230	167	0.34	N/A	0.21	13.56
1						
2						
3						
4						
5						
	Sum	167				

Computed Tc = 13.56
Regional Tc = 10.93
User-Entered Tc = 10.93

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I =	6.68	inch/hr	Peak Flowrate, Qp =	1.74 cfs
Rainfall Intensity at Regional Tc, I =	7.34	inch/hr	Peak Flowrate, Qp =	1.91 cfs
Rainfall Intensity at User-Defined Tc, I =	7.34	inch/hr	Peak Flowrate, Qp =	1.91 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Daves Ex
Catchment ID: S12

I. Catchment Hydrologic Data

Catchment ID = S12
Area = 0.36 Acres
Percent Imperviousness = 34.00 %
NRCS Soil Type = C A, B, C, or D

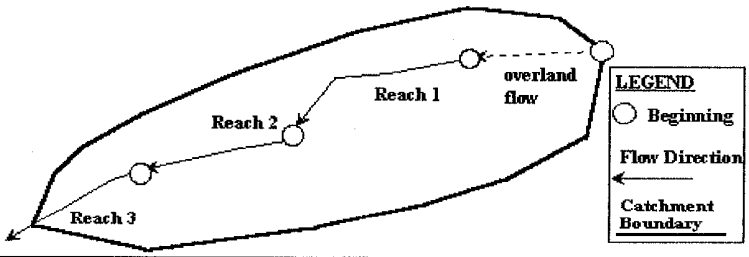
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.81	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.57
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.32
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0210	175	0.32	N/A	0.20	14.55
1						
2						
3						
4						
5						
	Sum	175				

Computed Tc = 14.55
Regional Tc = 10.97
User-Entered Tc = 10.97

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I =	6.47	inch/hr	Peak Flowrate, Qp =	1.34	cfs
Rainfall Intensity at Regional Tc, I =	7.32	inch/hr	Peak Flowrate, Qp =	1.51	cfs
Rainfall Intensity at User-Defined Tc, I =	7.32	inch/hr	Peak Flowrate, Qp =	1.51	cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Daves Ex
Catchment ID: S13

I. Catchment Hydrologic Data

Catchment ID = S13
Area = 1.01 Acres
Percent Imperviousness = 3.00 %
NRCS Soil Type = C A, B, C, or D

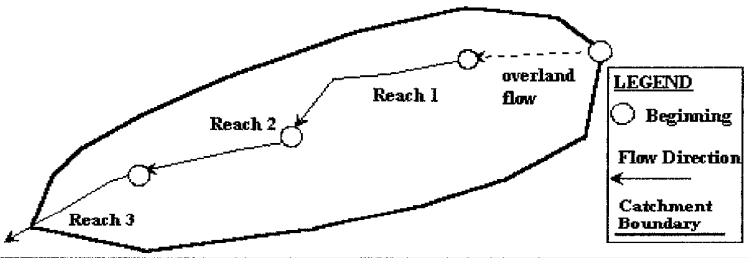
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.81	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.51
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.17
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.2500	35	0.17	N/A	0.17	3.44
1						
2						
3						
4						
5						
	Sum	35				

Computed Tc = 3.44
Regional Tc = 10.19
User-Entered Tc = 5.00

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I =	10.39	inch/hr	Peak Flowrate, Qp = 5.36 cfs
Rainfall Intensity at Regional Tc, I =	7.55	inch/hr	Peak Flowrate, Qp = 3.89 cfs
Rainfall Intensity at User-Defined Tc, I =	9.53	inch/hr	Peak Flowrate, Qp = 4.92 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Daves Excavation
Catchment ID: ENTIRE SITE

I. Catchment Hydrologic Data

Catchment ID = ENTIRE SITE
Area = 10.01 Acres
Percent Imperviousness = 38.00 %
NRCS Soil Type = C A, B, C, or D

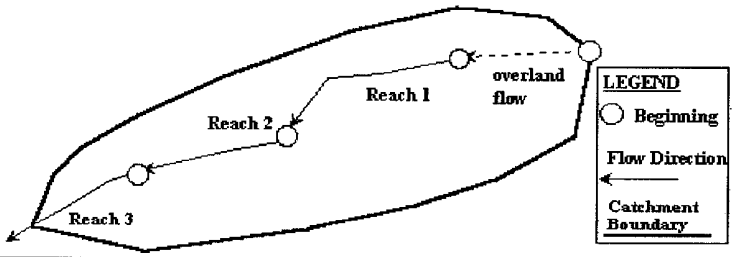
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.81 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.58
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.34
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

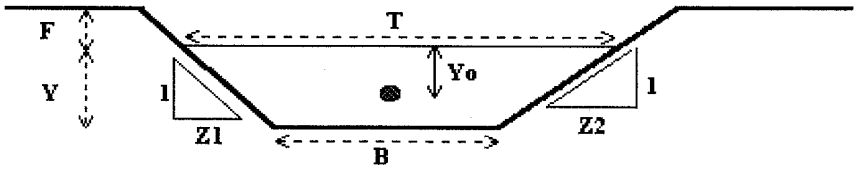
Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0200	37	0.34	N/A	0.09	6.64
1	0.0050	326		20.00	1.41	3.84
2	0.0079	440		20.00	1.78	4.13
3						
4						
5						
	Sum	803				
					Computed Tc =	14.61
					Regional Tc =	14.46
					User-Entered Tc =	14.46

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 6.46 inch/hr — Peak Flowrate, Qp = 37.47 cfs
Rainfall Intensity at Regional Tc, I = 6.49 inch/hr — Peak Flowrate, Qp = 37.65 cfs
Rainfall Intensity at User-Defined Tc, I = 6.49 inch/hr — Peak Flowrate, Qp = 37.65 cfs

Normal Flow Analysis - Trapezoidal Channel

Project: Daves Ex
Channel ID: Sec A-A



Design Information (Input)			
Channel Invert Slope	So =	0.0080	ft/ft
Manning's n	n =	0.040	
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	4.00	ft/ft
Right Side Slope	Z2 =	27.00	ft/ft
Freeboard Height	F =	1.00	ft
Design Water Depth	Y =	**0.50**	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**5.11**	cfs
Froude Number	**Fr =**	**0.46**	
Flow Velocity	**V =**	**1.32**	fps
Flow Area	A =	3.88	sq ft
Top Width	T =	15.50	ft
Wetted Perimeter	P =	15.57	ft
Hydraulic Radius	R =	0.25	ft
Hydraulic Depth	D =	0.25	ft
Specific Energy	Es =	0.53	ft
Centroid of Flow Area	Yo =	0.17	ft
Specific Force	Fs =	0.05	kip