PRELIMINARY/FINAL DRAINAGE REPORT

FOR

SOUTH ACADEMY BUSINESS CENTER

Prepared For:
10230 Hall Boulevard, LLC
PO Box 38014
Colorado Springs, CO 80937

Prepared By:
Associated Design Professionals, Inc.
3520 Austin Bluffs Parkway, Suite 102
Colorado Springs, CO 80918
(719) 266-5212

Project No. 161103
2/27/18
PCD Project No 17-004

COLORADO REGISTERED
23329
3/15/18
PROFESSIONAL ENGINEER

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ENGINEER'S STATEMENT:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the city/county for drainage reports, and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

Michael A. Bartusek, P.E. #23329

COLORADO REGISTERED
MICHAEL A. BARTUSEK
23329
3/15/18
PROFESSIONAL ENGINEER

DEVELOPER'S STATEMENT:

I, the Developer, have read and will comply with all of the requirements specified in this drainage report and plan.

By: _____
Mr Michael Turley

Title: Manager

Address: 10230 Hall Boulevard, LLC
PO Box 38014
Colorado Springs, CO 80937

EL PASO COUNTY:

Filed in accordance with the El Paso County Land Development Code; the Drainage Criteria Manual, Volumes 1 and 2; and the Engineering Criteria Manual, as amended.

Approved
by Elizabeth Nijkamp
El Paso County Planning and Community Development
on behalf of Jennifer Irvine, County Engineer, ECM Administrator
04/02/2018 9:33:41 AM

Jennifer Irvine, P.E., County Engineer / ECM Administrator — Date

Conditions:

PROJECT DESCRIPTION

This proposed project is contained within a new subdivision named the South Academy Business Center. This currently vacant lot consists of 7.60 acres. It is located in the Southeast Quarter of Section 3, Township 15 South, Range 66 West of the Sixth Principal Meridian, County of El Paso, State of Colorado. The site is located on a narrow strip of land which is bordered on the west by State Highway 85/87 and on the east by the Denver and Rio Grande Western Railroad. Its northern boundary is situated on the south boundary line of the South Academy Boulevard right-of-way.

FLOODPLAIN STATEMENT

This site does not lie within a designated 100-year floodplain as delineated on LOMR No. 03-08-0318P, dated April 9, 2004. It is located within the West Little Johnson drainage basin. The drainage basin map shows a split in the property between the Little Johnson and West Little Johnson Basins. However, field verification revealed that all of the property was located within the West Little Johnson Basin.

SOILS

The soils on the northern site are classified as Blakeland loamy sand by the USDA Soil Conservation Service. This soil is further classified as Hydrologic Soil Group "A". The soils on the proposed site are classified as Nunn clay loam by the USDA Soil Conservation Service. This soil is further classified as Hydrologic Soil Group "C".

METHOD OF COMPUTATION

The methodology utilized for this report is in accordance with *City/County Drainage Criteria Manual.* The Rational Method for computation of runoff was used for determining on-site flows.

$Q = cia$

Where
- Q = maximum rate of runoff in cubic feet per second
- c = runoff coefficient representing drainage area characteristics
- i = average rainfall intensity, in inches per hour, for the duration required for the runoff to become established
- a = drainage basin size in acres

Off-site flows were determined using the TR20 hydrologic program for project hydrology by the Soil Conservation Service.

EXISTING DRAINAGE CHARACTERISTICS

This previously unplatted site was included in the *Little Johnson/West Little Johnson Drainage Basin Planning Study* prepared by Simons, Li & Associates in 1987. Much of the land north of the proposed project lies within either the Rocky Mountain Materials property or the Stephen Schnurr Living Trust. The Rocky Mountain property encompasses approximately 42 acres of the 54.5-acre basin. The Stephen Schnurr Living Trust owns the 4.6 acres just north of the site. Flows from these properties are released at historic levels onto the site to its south. This vacant land is just north of the proposed project and is covered with rangeland grasses. The tributary area slopes generally southwest at an average slope of one percent. The existing runoff is contained within a broad drainage swale located near the existing railroad tracks.

According to the analysis performed by Simons, Li & Associates, the runoff produced by the entire drainage basin along SH 85/87 would result in no flow for the ten-year storm event and one cfs for the 100-year storm event. The low runoff amounts were due to the Type "A" soils and the long overland flow times. These off-site flows travel to the southeast and are currently directed toward the railroad ditch east of the parcel and do not enter the parcel.

An analysis of the South Academy Business Center site using the Rational Method produced the following flow rates: Sub-Basin A, which drains toward the interior of the parcel and produces 1.6 cfs for the five-year storm and 9.2 cfs for the 100-year storm; Sub-Basin B, which drains to a ditch along SH 85/87 produces a flow of 0.4 cfs for the five-year storm and 2.1 cfs for the 100-year storm. The total flow tributary to the site is 1.9 cfs for the five-year storm and 11.1 cfs for the 100-year storm.

DEVELOPED DRAINAGE CHARACTERISTICS

The proposed development of 7.6 acres will be storage facility comprised of 8' x 40' trailers placed on the site with loose gravel placed over the site.

Runoff from Sub-Basin A will be directed in a southeasterly direction toward the south property line. Based on the proposed developed conditions, Sub-Basin A will produce flows of 4.7 cfs for the five-year storm and 14.3 cfs for the 100-year storm. The detained flows from the Water Quality/Detention Basin will be 1.0 cfs for the five-year storm and 5.0 cfs for the 100-year storm. These detained flows will be directed into an existing grass swale just east of the basin. The existing broad, grassed swale continues flowing to the east at a 0.7% slope with 10:1 side slopes. The 100 year outflow will produce a flow depth of 0.6 ft and a velocity of 1.5 fps.

Runoff from Sub-Basin B will increase slightly to 0.4 cfs for the five-year storm and 2.3 cfs for the 100-year storm. The total flow tributary to the site is 1.4 cfs for the five-year storm and 7.2 cfs for the 100-year storm.

WATER QUALITY/DETENTION REQUIREMENTS

In accordance with current NPDES, stormwater quality BMPs will be provided for this site when it is developed. Based on actual calculations, the commercial development of the site will produce an imperviousness of 48 percent. The water quality component is accomplished by a 2.42' deep 0.703 acre foot private extended detention facility located at the south end of the project. The facility will be maintained by the owner

DRAINAGE BASIN FEE

The proposed development is located within the West Little Johnson drainage basin. The 2017 drainage basin fee calculation is as follows:

Impervious Coverage	=	48%
Area Subject to Fee	=	0.48 x 7.6 acres = 3.648 acre
West Little Johnson Basin Fee	=	$1,072/acre
Drainage Basin Fee	=	$1,072 x 3.648 = $3,911

There are no associated Bridge Fees for the West Little Johnson drainage basin.

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PRIVATE DRAINAGE FACILITIES

Item	Unit	Quantity	Unit Cost	Total Cost
18" RCP FES	EA	1	$500	$ 600
18" HDPE	LF	15	$84	$ 1,260
Detention Outlet Structure	EA	1	$3,000	$ 5,000
Emergency Spillway	EA	1	$1,000	$ 1,500
			Sub-Total	$8,360
			15% Contingency & Engineering	$ 1,254
			TOTAL	$9,614

CONCLUSION

Storm runoff from this property will not adversely affect downstream properties or facilities. Grading will take place on the property; therefore, appropriate erosion control measures will be implemented to will include a water quality basin. An on-site detention basin will be incorporated into the parcel to reduce developed flows to historic levels.

Step 1: Runoff has been reduced by disconnecting impervious areas where possible, eliminating "unnecessary" impervious areas and encouraging infiltration into suitable soils.
Step 2: All drainageways, ditches and channels have been stabilized by the following methods:

- New swales within the site are broad and covered with gravel and with a slope of about 0.7% no erosion will take place
- An existing roadside ditch will be enhanced as part of the proposed development.

Step 3: The proposed development will disturb approximately 7.6 acres.
Step 4: The development of this project will not affect sensitive waters.

The development of this site will have little impact on downstream properties once the water quality/detention basin is constructed.

REFERENCES

1. City of Colorado Springs and El Paso County (1994). ***Drainage Criteria Manual Volume 1*** (DCM).

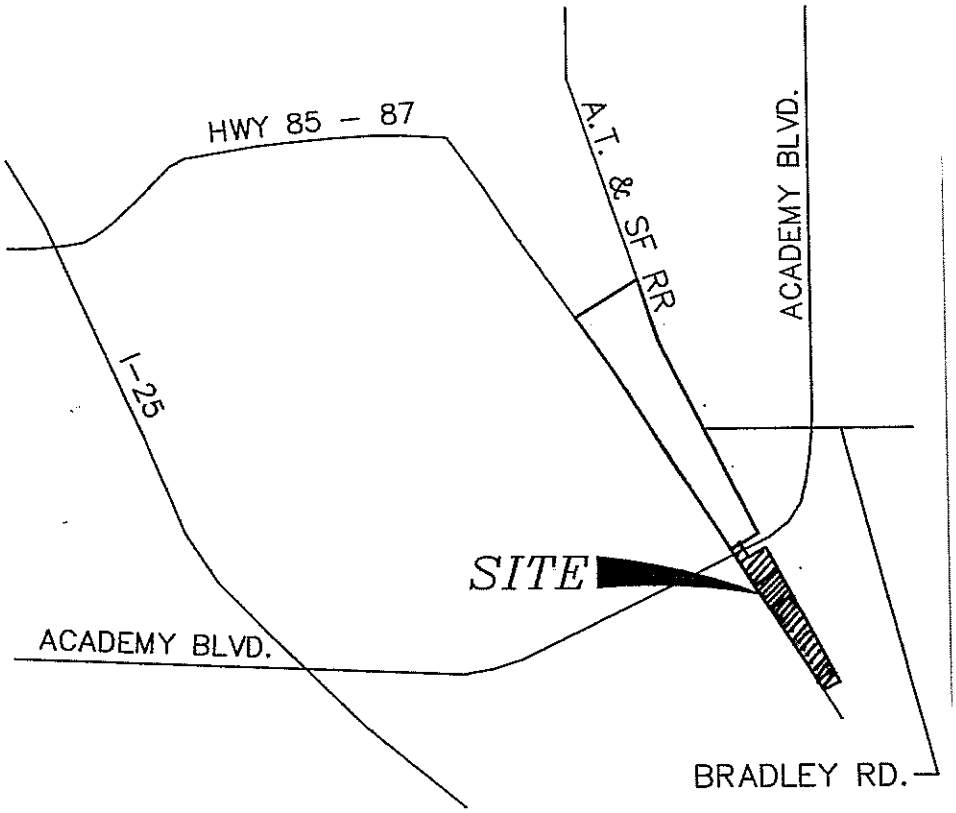
2. City of Colorado Springs and El Paso County (1994). ***Drainage Criteria Manual Volume II*** (DCM).

3. Soil Survey of El Paso County Area, Colorado by USDA, NRCS.

4. ***El Paso County (January 2006) Engineering Criteria Manual.***

5. Urban Drainage and Flood Control District (June 2011). ***Urban Storm Drainage Criteria Manual, Volume 1-3.***

APPENDIX A
MAPS & EXHIBITS



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VICINITY MAP

N.T.S.

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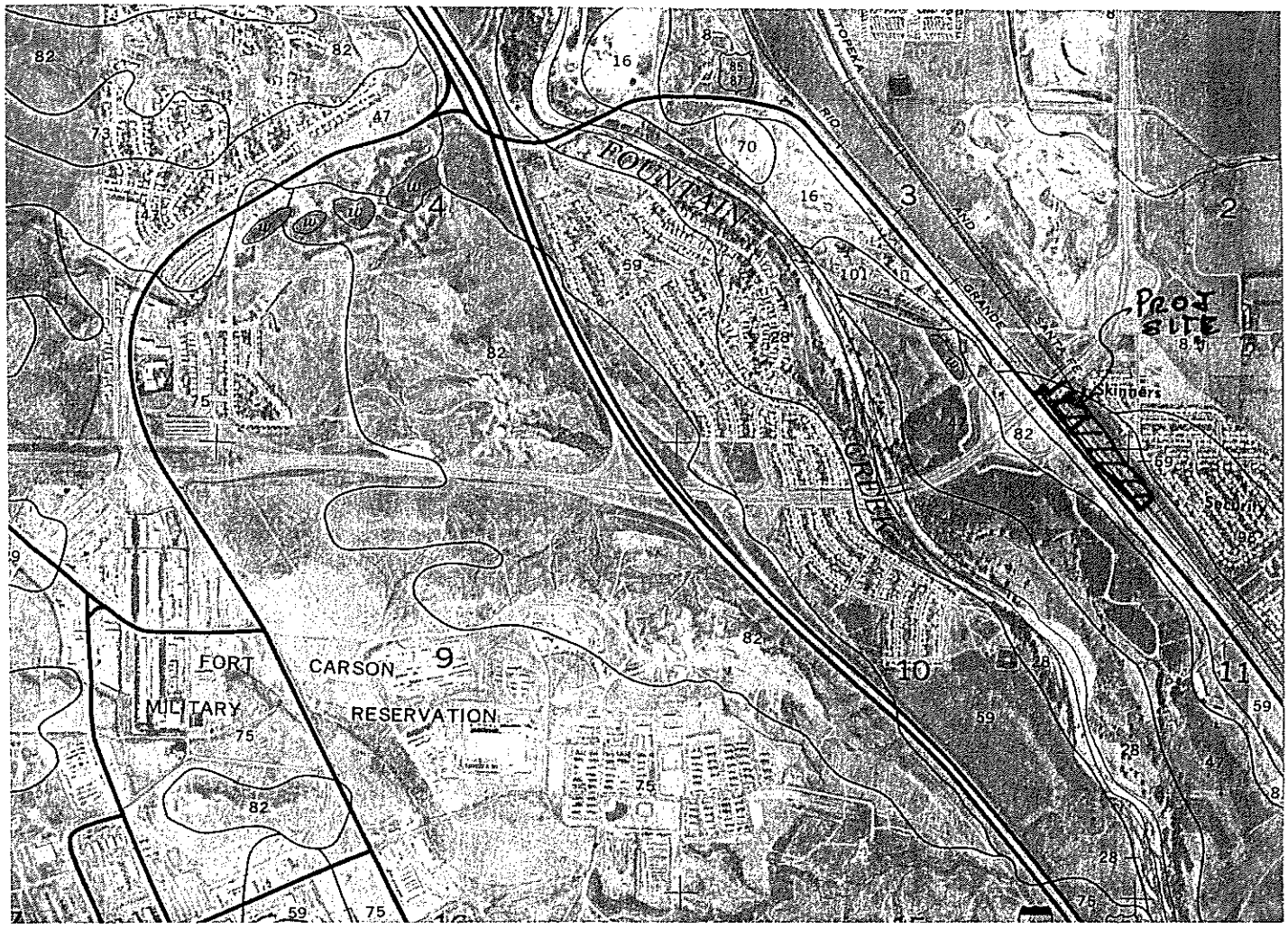

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SOILS MAP

N.T.S.

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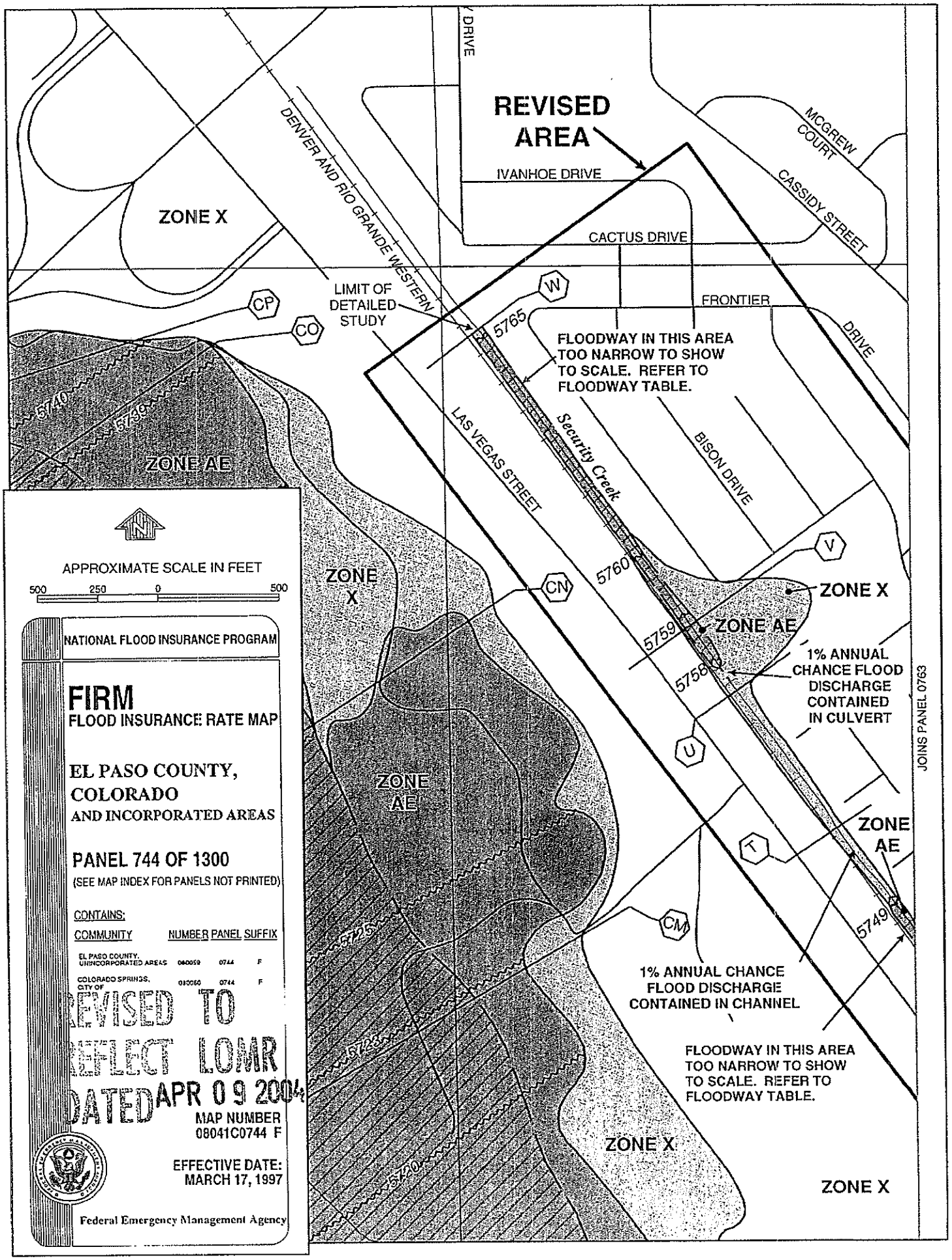

REVISED AREA
IVANHOE DRIVE
CACTUS DRIVE
FRONTIER DRIVE
MCGREW COURT
CASSIDY STREET
DENVER AND RIO GRANDE WESTERN
LIMIT OF DETAILED STUDY
ZONE X
ZONE AE
CP
CO
W
V
CN
U
T
CM
5765
5760
5759
5756
5749
5740
5739
5725
5723
5720
FLOODWAY IN THIS AREA TOO NARROW TO SHOW TO SCALE. REFER TO FLOODWAY TABLE.
LAS VEGAS STREET
Security Creek
BISON DRIVE
1% ANNUAL CHANCE FLOOD DISCHARGE CONTAINED IN CULVERT
1% ANNUAL CHANCE FLOOD DISCHARGE CONTAINED IN CHANNEL
JOINS PANEL 0763
APPROXIMATE SCALE IN FEET
500 250 0 500
NATIONAL FLOOD INSURANCE PROGRAM
FIRM
FLOOD INSURANCE RATE MAP
EL PASO COUNTY, COLORADO
AND INCORPORATED AREAS
PANEL 744 OF 1300
(SEE MAP INDEX FOR PANELS NOT PRINTED)
CONTAINS:
COMMUNITY NUMBER PANEL SUFFIX
EL PASO COUNTY, UNINCORPORATED AREAS 080059 0744 F
COLORADO SPRINGS, CITY OF 080060 0744 F
REVISED TO REFLECT LOMR DATED APR 09 2004
MAP NUMBER 08041C0744 F
EFFECTIVE DATE: MARCH 17, 1997
Federal Emergency Management Agency

APPENDIX B
DRAINAGE CALCULATIONS

SOUTH ACADEMY BUSINESS CENTER						
C FACTOR CALCULATION SHEET						
RUNOFF COEFICIENT						
TYPE C SOILS						
LAND USE			5 YR	100 YR		
UNDEV & LOOSE GRAVEL			0.15	0.5		
STREETS/PARKING GRAVEL			0.63	0.74		
ROOFS/ PAVED AREAS			0.75	0.83		
Historic Conditions						
	TOTAL	**SURFACE CONDITION AREAS**			**CALCULATED C**	
AREA	**AREA**	**UNDEV**	**STREETS/**	**ROOFS/**	**5**	**100**
			PARKING	**PAVED**		
DESIG.	**(acre)**		**GRAVEL**	**AREAS**	**YR**	**YR**
Aex	6.40	6.40			**0.15**	**0.50**
Bex	1.30	1.30			**0.15**	**0.50**
RUNOFF COEFICIENT						
TYPE C SOILS						
LAND USE			5 YR	100 YR		
UNDEV & LOOSE GRAVEL			0.15	0.5		
STREETS/PARKING GRAVEL			0.63	0.74		
ROOFS/ PAVED AREAS			0.75	0.83		
Developed Conditions						
	TOTAL	**SURFACE CONDITION AREAS**			**CALCULATED C**	
AREA	**AREA**	**UNDEV**	**LOOSE**	**ROOFS/**	**5**	**100**
			GRAVEL	**PAVED**		
DESIG.	**(acre)**			**AREAS**	**YR**	**YR**
A	7.30	1.80	2.90	2.60	**0.36**	**0.62**
B	0.30	0.30			**0.15**	**0.50**
IMPERVIOUS						
COVERAGE	ACREAGE	% IMP				
Undev	1.80	0	0			
Loose Grav	2.90	0.4	1.16			
Trailers	2.60	0.9	2.34			
	7.30		3.50			
		TOTAL IMP	**47.95%**			

SOUTH ACADEMY BUSINESS CENTER
DRAINAGE CALCULATION SHEET
file:lock - load dr
06/09/17 Rev 2/27/18

AREA DESIG.	AREA (acre)	C5 (5 yr)	C100 (100 yr)	C5 X A	C100 X A	L (ft)	Initial Tci Slope (%)	ti (min)	L (ft)	Travel Time Slope (%)	V (fps)	Tt (min)	TC (min)	I5 (in/hr)	I100 (in/hr)	Q5 (cfs)	Q100 (cfs)	AREA DESIG.
CURRENT CONDITIONS																		
OS1	54.50					Flows from this off-site are drain into the railroad ditch and by-pass the proposed development												
Aex	6.30	0.15	0.50	0.95	3.15	100	1.50	15.54	1900	0.70	0.90	35.19	50.73	1.67	2.91	1.58	9.18	Aex
Bex	1.30	0.15	0.50	0.20	0.65	15	1.00	6.88	1900	0.70	0.90	35.19	42.07	1.88	3.29	0.37	2.14	Bex
DP1	7.60			1.14	3.80								50.73	1.67	2.91	1.90	11.07	DP1
DEVELOPED CONDITIONS																		
OS1	54.50					Flows from this off-site are drain into the railroad ditch and by-pass the proposed development												
A	7.30	0.36	0.62	2.63	4.53	50	1.00	9.78	1900	0.70	0.90	35.19	44.97	1.80	3.15	4.74	14.26	A
				0.56	1.59								44.97	1.80	3.15	1.00	5.00	
B	1.37	0.15	0.50	0.21	0.69	12	2.00	4.90	1900	0.70	0.90	35.19	40.08	1.94	3.39	0.40	2.32	B
DP1	8.67			0.77	2.28								44.97	1.80	3.15	1.38	7.17	DP1

ti = (0.395*(1.1-C5)*L^0.5)/S^0.33 (EQ 6-8)
V from Fig 6-25
Tt = L/V/60
TC = ti+Tt

DITCH CAPACITY CALCULATION SHEET

Swale Location	Q5 cfs	Q100 cfs	S %	B ft	Z	d100 ft	V fps	Froude #	Riprap Size
Outlet Swale	1.00	5.00	0.70	0.00	10:1	0.60	1.50	0.52	
Spillway	4.70	14.30	1.00	10.00	4:1	0.50	2.20	0.57	0.03
									Use 6" Rock

FOREBAY CALCULATION SHEET
(Per Table EDB-4)

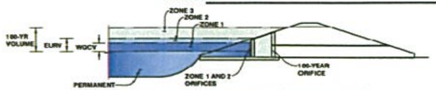
RELEASE RATE	OPENING	VOLUME	FOREBAY DEPTH	TRICKLE CHAN CAP
2% 100 yr stm	Q = C x D^3/2	2% WQCV	D = 6"	OUTLET Q = 0.28 cfs
0.02 X 14.3 = 0.28 cfs	@W = 0.26'	0.02 X 0.122 ac ft = 0.002 ac ft		@d = 4", b= 1', s =0.5%
	Q = 0.28 cfs	0.002 ac ft x 43560 = 87.1 cf		MAX Q = 0.79 cfs

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: S Academy Business Ctr

Basin ID: A



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB	
Watershed Area =	7.30	acres
Watershed Length =	1,900	ft
Watershed Slope =	0.007	ft/ft
Watershed Imperviousness =	48.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Desired WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Denver - Capitol Building	
Water Quality Capture Volume (WQCV) =	0.122	acre-feet
Excess Urban Runoff Volume (EURV) =	0.330	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.310	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	0.464	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	0.601	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	0.830	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	1.003	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	1.218	acre-feet
500-yr Runoff Volume (P1 = 3.01 in.) =	1.579	acre-feet
Approximate 2-yr Detention Volume =	0.291	acre-feet
Approximate 5-yr Detention Volume =	0.437	acre-feet
Approximate 10-yr Detention Volume =	0.499	acre-feet
Approximate 25-yr Detention Volume =	0.541	acre-feet
Approximate 50-yr Detention Volume =	0.561	acre-feet
Approximate 100-yr Detention Volume =	0.642	acre-feet

Note: L / W Ratio > 8

L / W Ratio = 11.4

Optional User Override 1-hr Precipitation

1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
3.01	inches

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.122	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.208	acre-feet
Zone 3 (100yr + 1 / 2 WQCV - Zones 1 & 2) =	0.373	acre-feet
Total Detention Basin Volume =	0.703	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

Depth Increment = 0.25 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	6,500	0.149		
	--	0.35	--	--	--	7,500	0.172	2,375	0.055
	--	0.60	--	--	--	7,875	0.181	4,293	0.099
	--	0.85	--	--	--	8,250	0.189	6,305	0.145
	--	1.10	--	--	--	9,590	0.220	8,522	0.196
	--	1.35	--	--	--	10,130	0.233	10,981	0.252
	--	1.60	--	--	--	11,070	0.254	13,622	0.313
	--	1.85	--	--	--	12,010	0.276	16,498	0.379
	--	2.10	--	--	--	16,700	0.383	20,206	0.464
	--	2.35	--	--	--	21,390	0.491	24,967	0.573
	--	2.60	--	--	--	26,100	0.599	30,904	0.709
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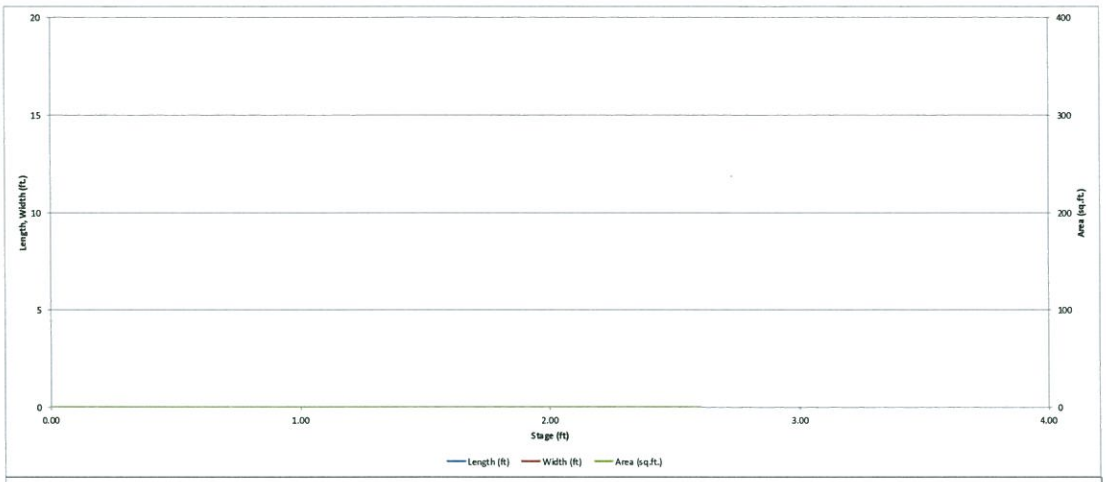
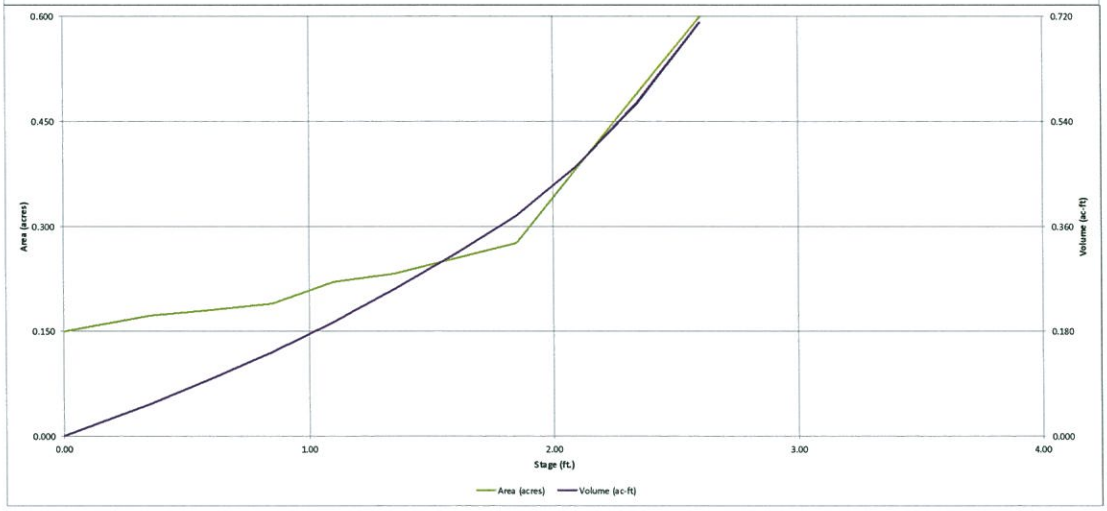
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)



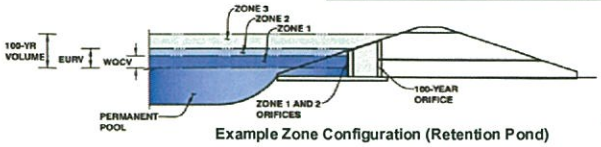


Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: s Academy Business Ctr

Basin ID: A



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.65	0.122	Orifice Plate
Zone 2 (EURV)	1.50	0.208	Orifice Plate
i (100+1/2WQCV)	2.42	0.373	Weir&Pipe (Restrict)
		0.703	Total

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	1.50	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	6.00	inches
Orifice Plate: Orifice Area per Row =	2.45	sq. inches (diameter = 1-3/4 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row =	1.701E-02	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.50	1.00					
Orifice Area (sq. inches)	2.45	2.45	2.45					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.50	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	3.00	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	3.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	1.50	N/A	feet
Over Flow Weir Slope Length =	3.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	6.93	N/A	should be $\geq$ 4
Overflow Grate Open Area w/o Debris =	6.30	N/A	ft^2
Overflow Grate Open Area w/ Debris =	3.15	N/A	ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.00	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	9.20		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.91	N/A	ft^2
Outlet Orifice Centroid =	0.44	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.59	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	2.42	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	8.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

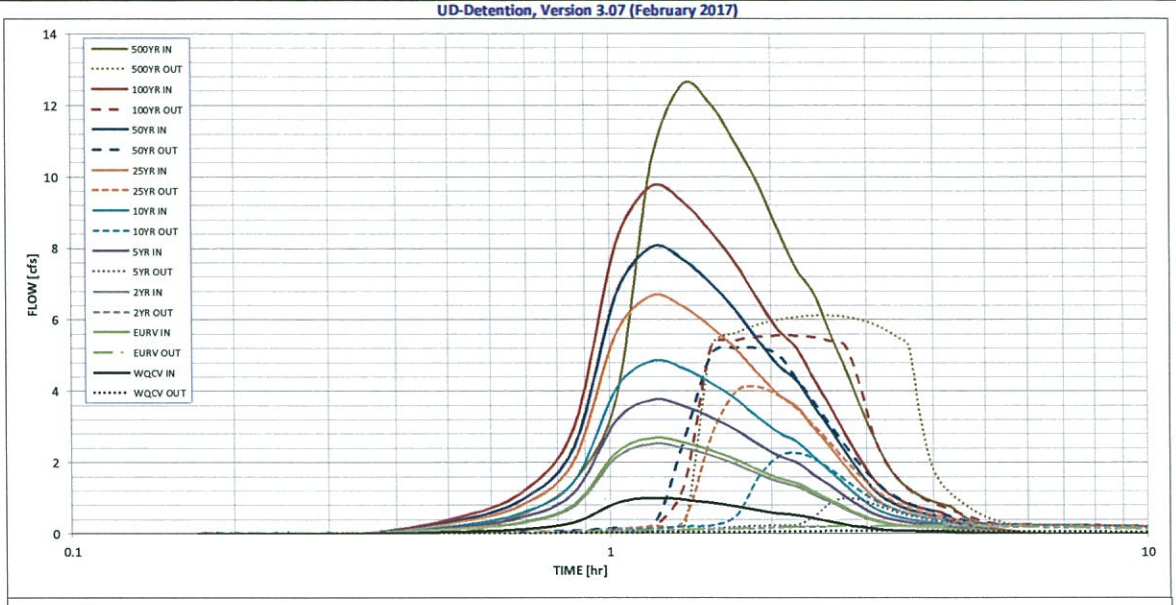
Spillway Design Flow Depth=	0.48	feet
Stage at Top of Freeboard =	3.90	feet
Basin Area at Top of Freeboard =	0.60	acres

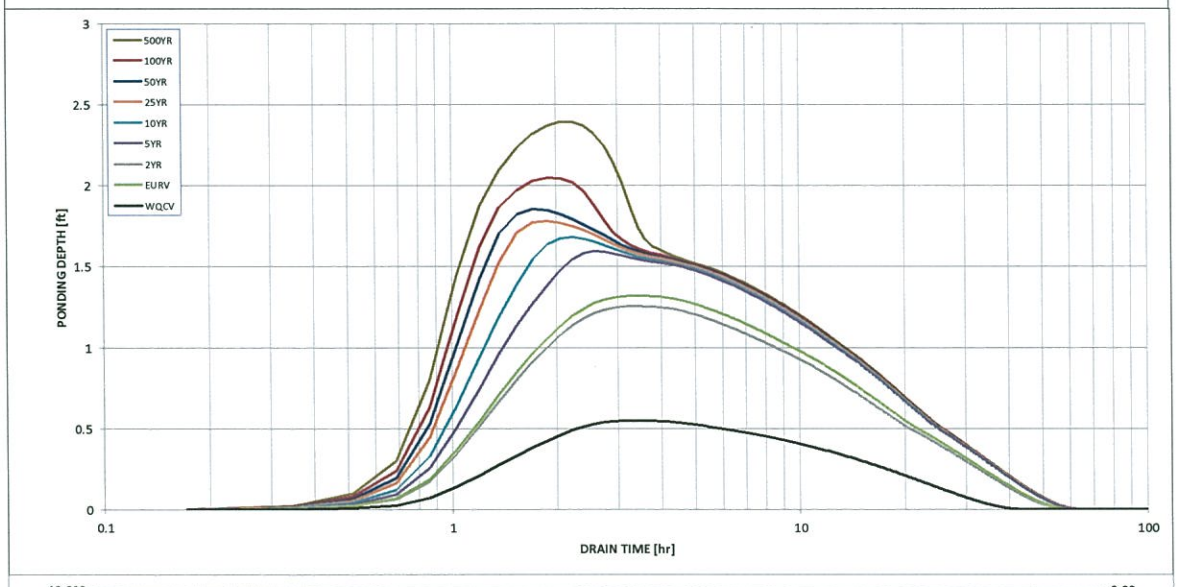
Routed Hydrograph Results

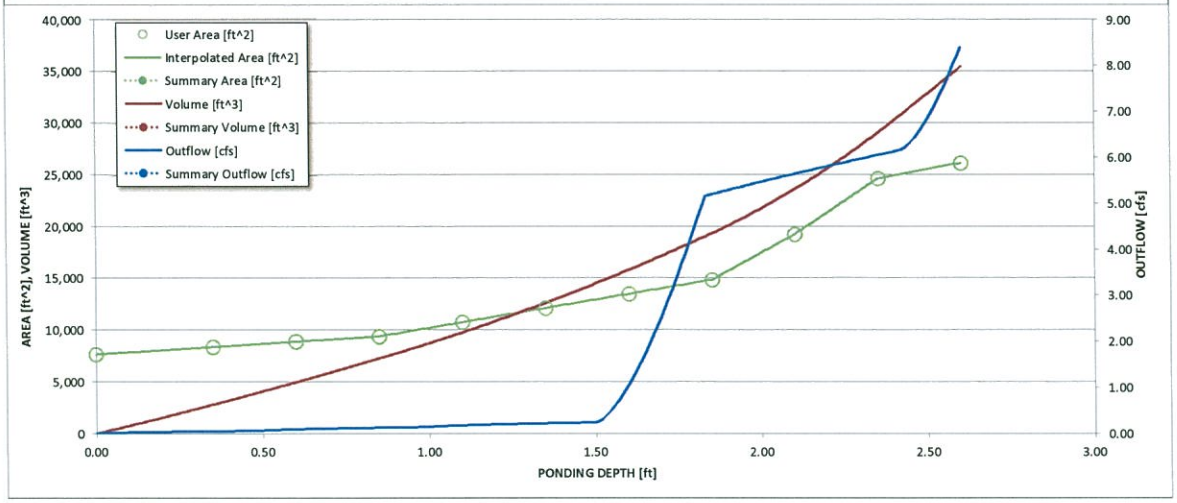
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.01
Calculated Runoff Volume (acre-ft) =	0.122	0.330	0.310	0.464	0.601	0.830	1.003	1.218	1.579
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.121	0.330	0.310	0.463	0.600	0.830	1.002	1.217	1.578
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.07	0.19	0.47	0.62	0.82	1.15
Predevelopment Peak Q (cfs) =	0.0	0.0	0.1	0.5	1.4	3.4	4.5	6.0	8.4
Peak Inflow Q (cfs) =	1.0	2.7	2.5	3.7	4.8	6.7	8.0	9.7	12.6
Peak Outflow Q (cfs) =	0.1	0.2	0.2	1.0	2.3	4.1	5.2	5.5	6.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.0	1.6	1.2	1.2	0.9	0.7
Structure Controlling Flow =	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.1	0.3	0.6	0.8	0.8	0.9
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	37	48	47	49	47	44	42	40	37
Time to Drain 99% of Inflow Volume (hours) =	40	53	52	55	54	52	51	50	49
Maximum Ponding Depth (ft) =	0.55	1.32	1.25	1.59	1.68	1.78	1.85	2.05	2.39
Area at Maximum Ponding Depth (acres) =	0.20	0.27	0.27	0.31	0.32	0.33	0.34	0.42	0.57
Maximum Volume Stored (acre-ft) =	0.102	0.278	0.262	0.359	0.388	0.417	0.444	0.516	0.690

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename:

Storm Inflow Hydrographs **UD-Detention, Version 3.07 (February 2017)**

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
10.31 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrograph	0:20:37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Constant	0:30:56	0.05	0.12	0.11	0.17	0.21	0.29	0.35	0.42	0.54
0.485	0:41:14	0.12	0.32	0.30	0.45	0.58	0.79	0.95	1.15	1.48
	0:51:33	0.31	0.83	0.78	1.15	1.48	2.04	2.45	2.96	3.81
	1:01:52	0.86	2.28	2.14	3.17	4.08	5.59	6.72	8.12	10.45
	1:12:10	1.00	2.68	2.52	3.74	4.84	6.66	8.03	9.72	12.58
	1:22:29	0.95	2.55	2.40	3.57	4.62	6.36	7.67	9.30	12.04
	1:32:47	0.86	2.32	2.18	3.25	4.20	5.79	6.98	8.46	10.96
	1:43:06	0.76	2.07	1.94	2.90	3.75	5.18	6.25	7.58	9.83
	1:53:25	0.65	1.78	1.67	2.49	3.24	4.48	5.41	6.57	8.53
	2:03:43	0.57	1.55	1.46	2.18	2.82	3.90	4.71	5.72	7.41
	2:14:02	0.51	1.40	1.32	1.97	2.56	3.54	4.27	5.18	6.72
	2:24:20	0.42	1.15	1.08	1.62	2.11	2.92	3.54	4.30	5.59
	2:34:39	0.33	0.93	0.88	1.32	1.72	2.39	2.90	3.53	4.60
	2:44:58	0.25	0.71	0.67	1.01	1.32	1.85	2.25	2.75	3.60
	2:55:16	0.18	0.52	0.49	0.75	0.98	1.38	1.69	2.07	2.73
	3:05:35	0.13	0.38	0.36	0.54	0.71	1.00	1.22	1.51	2.00
	3:15:53	0.11	0.30	0.28	0.42	0.55	0.77	0.94	1.16	1.52
	3:26:12	0.09	0.25	0.23	0.35	0.46	0.64	0.77	0.95	1.24
	3:36:31	0.07	0.21	0.20	0.30	0.39	0.54	0.65	0.80	1.05
	3:46:49	0.07	0.18	0.17	0.26	0.34	0.47	0.57	0.70	0.92
	3:57:08	0.06	0.17	0.16	0.23	0.31	0.43	0.52	0.63	0.82
	4:07:26	0.06	0.15	0.14	0.22	0.28	0.39	0.48	0.58	0.76
	4:17:45	0.04	0.11	0.11	0.16	0.21	0.29	0.35	0.43	0.56
	4:28:04	0.03	0.08	0.08	0.12	0.15	0.21	0.26	0.31	0.41
	4:38:22	0.02	0.06	0.06	0.09	0.11	0.15	0.19	0.23	0.30
	4:48:41	0.02	0.04	0.04	0.06	0.08	0.11	0.14	0.17	0.22
	4:58:59	0.01	0.03	0.03	0.04	0.06	0.08	0.10	0.12	0.16
	5:09:18	0.01	0.02	0.02	0.03	0.04	0.06	0.07	0.09	0.11
	5:19:37	0.01	0.02	0.01	0.02	0.03	0.04	0.05	0.06	0.08
	5:29:55	0.00	0.01	0.01	0.01	0.02	0.03	0.03	0.04	0.06
	5:40:14	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03
	5:50:32	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02
	6:00:51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	6:11:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:21:28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:31:47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:42:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:52:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:02:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:13:01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:23:20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:33:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:43:57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:54:16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	8:04:34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	8:14:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	8:25:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	8:35:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	8:45:49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	8:56:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	9:06:26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	9:16:44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	9:27:03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	9:37:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	9:47:40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	9:57:59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	10:08:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	10:18:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	10:28:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	10:39:13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	10:49:32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	10:59:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	11:10:09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	11:20:28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	11:30:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	11:41:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	11:51:23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	12:01:42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	12:12:01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	12:22:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

APPENDIX C
DESIGN CHARTS

Table 6-6. Runoff Coefficients for Rational Method
(Source: UDFCD 2001)

Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.60	0.65	0.62	0.68
Residential													
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.57	0.62	0.59	0.65
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.43	0.52	0.47	0.57
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.41	0.51	0.46	0.56
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.40	0.50	0.44	0.55
Industrial													
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Heavy Areas	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
Undeveloped Areas													
Historic Flow Analysis-- Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59
Streets													
Paved	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Drive and Walks	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Roofs	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

Figure 6-25. Estimate of Average Concentrated Shallow Flow

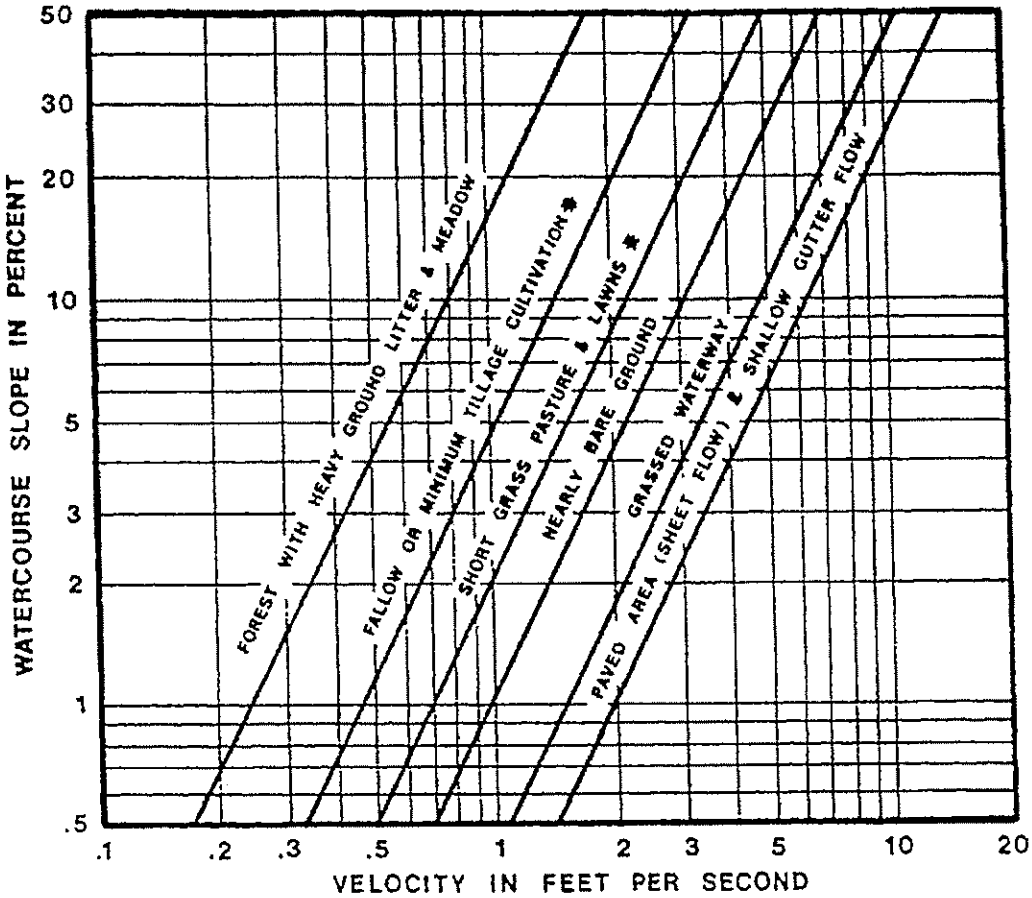
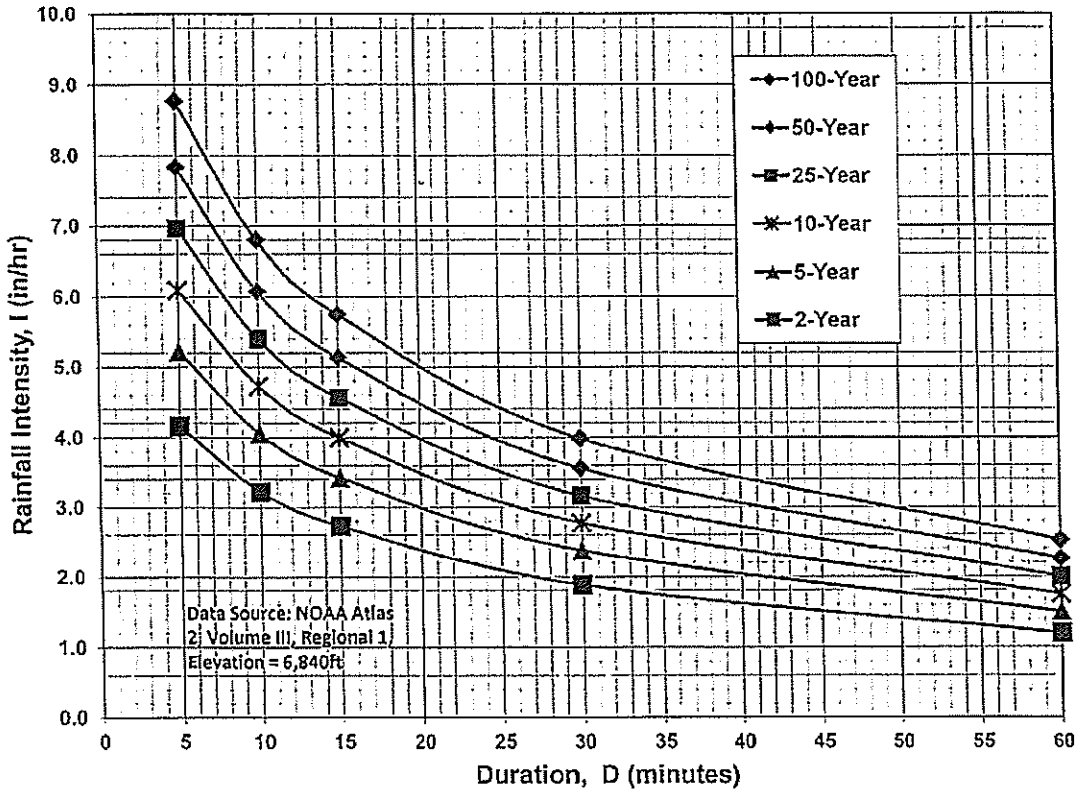


Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

$I_{100} = -2.52 \ln(D) + 12.735$

$I_{50} = -2.25 \ln(D) + 11.375$

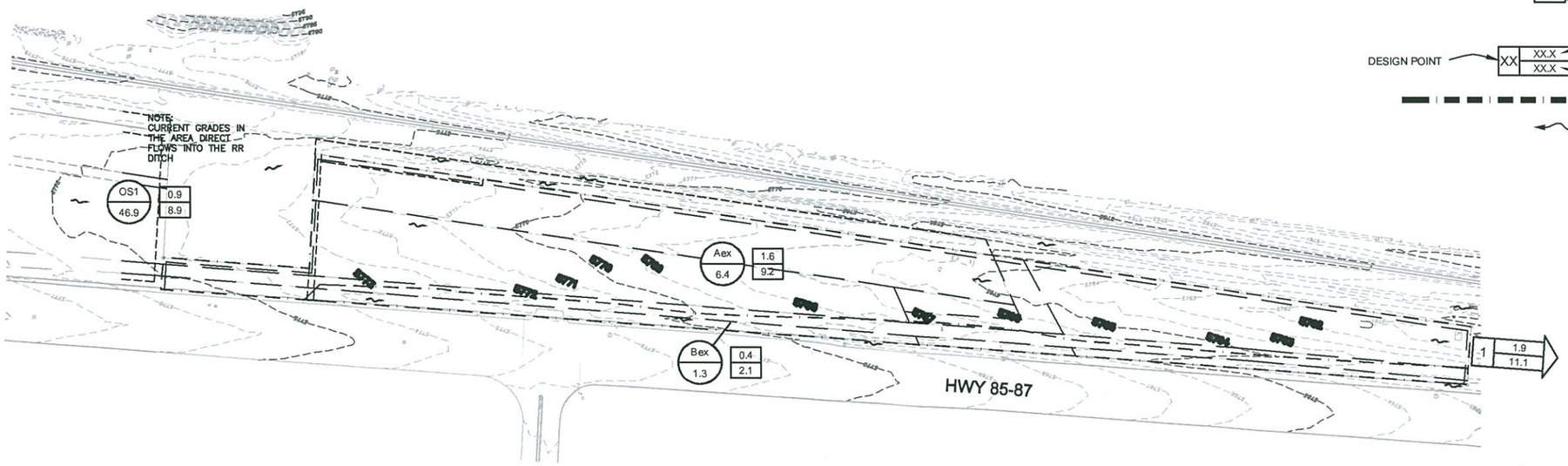
$I_{25} = -2.00 \ln(D) + 10.111$

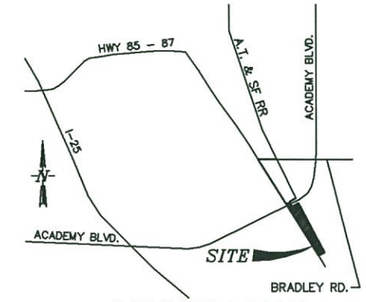
$I_{10} = -1.75 \ln(D) + 8.847$

$I_{5} = -1.50 \ln(D) + 7.583$

$I_{2} = -1.19 \ln(D) + 6.035$

Note: Values calculated by equations may not precisely duplicate values read from figure.





VICINITY MAP
NOT TO SCALE

LEGEND

A1A — BASIN DESIGNATION
XX — BASIN AREA, ACRES

XX — 5 YEAR STORM, CFS
XX — 100 YEAR STORM, CFS

DESIGN POINT — XX — XX.X — 5 YEAR ACCUMULATED FLOW, CFS
XX.X — 100 YEAR ACCUMULATED FLOW, CFS

SUB-BASIN BOUNDARY

DIRECTION OF DRAINAGE FLOW

GRAPHIC SCALE
100 0 50 100 200 300
(IN FEET)
1 inch = 100 ft.

ASSOCIATED DESIGN PROFESSIONALS

PREPARED UNDER MY DIRECT SUPERVISION FOR AND ON THE BEHALF OF ASSOCIATED DESIGN PROFESSIONALS, INC.

MICHAEL BARTUSEK, COLORADO P.E. #23329 — DATE 3/15/18

COLORADO REGISTERED MICHAEL A. BARTUSEK 23329 PROFESSIONAL ENGINEER

DESIGNED BY MAB
PROJECT ENGINEER MAB
PROJECT MANAGER MAB
SCALE: HORZ. 1"=100' VERT. N/A
DATE: 12/28/17
JOB NO. 161103
CAD FILE NO. 161103-Drainage
DRAWN BY HJS

PREPARED BY:
ADP CIVIL ENGINEERING FOR THE FUTURE
3520 Austin Bluffs Parkway
Suite 102
Colorado Springs, CO 80918
(719) 266-5212
fax: (719) 266-5341

NO.	DATE	REVISION	BY

SOUTH ACADEMY BUSINESS CENTER
4425 HWY 85-87
EL PASO COUNTY, COLORADO
DRAINAGE PLAN - EXISTING CONDITIONS

SHEET 1 of 2

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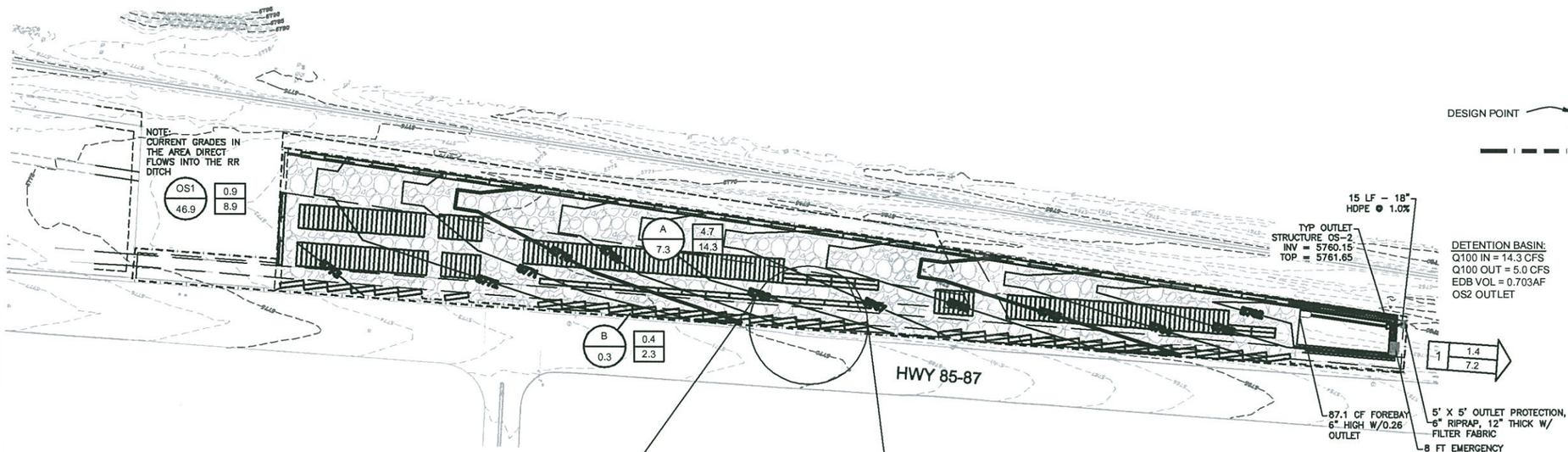
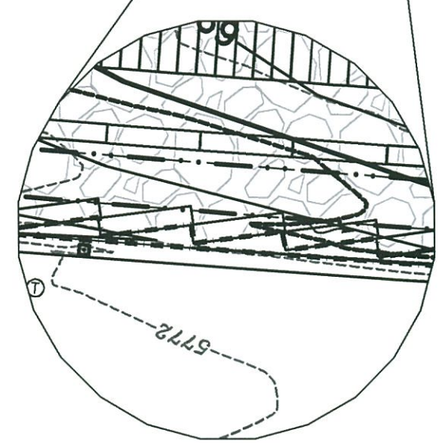
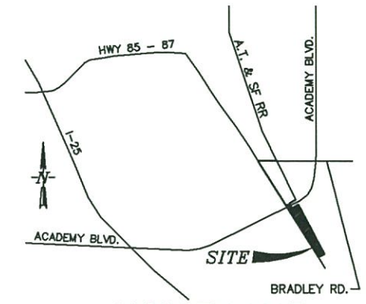




DETAIL - DRAINAGE AREA 'B'



VICINITY MAP
NOT TO SCALE

LEGEND

- A1A / XX — BASIN DESIGNATION; BASIN AREA, ACRES
- XX / XX — 5 YEAR STORM, CFS; 100 YEAR STORM, CFS
- DESIGN POINT — XX | XX.X / XX.X — 5 YEAR ACCUMULATED FLOW, CFS; 100 YEAR ACCUMULATED FLOW, CFS
- SUB-BASIN BOUNDARY
- DIRECTION OF DRAINAGE FLOW

GRAPHIC SCALE

100 0 80 100 200 300

(IN FEET)
1 inch = 100 ft.

NOTE:
DETENTION POND AREA TO BE UTILIZED AS A SEDIMENTATION BASIN UNTIL EARTH MOVING IS COMPLETED AND THE GROUND STABILIZED, AT WHICH TIME IT WILL BE CLEANED OUT AND THE DETENTION POND STRUCTURES ADDED.

ASSOCIATED DESIGN PROFESSIONALS

PREPARED UNDER MY DIRECT SUPERVISION FOR AND ON THE BEHALF OF ASSOCIATED DESIGN PROFESSIONALS, INC.

MICHAEL BARTUSEK COLORADO P.E. #23329

DATE 3/15/18

COLORADO REGISTERED MICHAEL A. BARTUSEK 23329 PROFESSIONAL ENGINEER

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SOUTH ACADEMY BUSINESS CENTER
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EL PASO COUNTY, COLORADO
DRAINAGE PLAN - PROPOSED CONDITIONS

SHEET 2 of 2

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