

# FINAL DRAINAGE REPORT FOR COLORADO CENTRE METROPOLITAN DISTRICT ADMINISTRATION BUILDING

PCD FILE # PPR-21-51

**PREPARED BY**

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**PREPARED FOR**

Colorado Centre Metropolitan District  
4770 Horizonview Drive  
Colorado Springs, CO 80925

January 2023

Project 247.07





## ENGINEER'S STATEMENT

This report and plan for the drainage design of Colorado Centre Metropolitan District Administration Building, was prepared by me (or under my direct supervision) and is correct to the best of my knowledge and belief. Said report and plan has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the master plan of the drainage basin. I understand that El Paso County does not, and will not, assume liability for drainage facilities designed by others. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

Richard Gallegos, P.E.

Registered Professional Engineer State of Colorado No. 36247

1/3/2023

Date



## OWNER/DEVELOPER'S STATEMENT

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

Jackie McClintock, President  
Colorado Centre Metropolitan District  
4770 Horizonview Drive,  
Colorado Springs, CO 80925

1/4/2023

Date

## EL PASO COUNTY STATEMENT

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

Joshua Palmer, P.E.  
County Engineer/ECM Administrator

Date



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## 1.0 PURPOSE

This drainage report is for the design of the Colorado Centre Metropolitan District Administration Building. The site is located at 9696 Flagstone Street, Colorado Springs, Colorado in central El Paso County. See Vicinity Map in the Appendix below for reference. It is further described as the Northeast One-Quarter of the Southwest One-Quarter of Section 3, Township 15 South, Range 65 West of the 6<sup>th</sup> P.M.

One County-approved Drainage Report was found within the County's files that included the project site:

- *Drainage Report for Colorado Centro Metropolitan District Water Treatment Facility* by JDS-Hydro Consultants Inc. approved in August 2015.

This 7.73-acre site is located within the Jimmy Camp Creek – FOFO2000 basin. Work will include the construction of a 4,542 square foot (sf) administration building, asphalt driveway, and a parking lot. In order to accommodate an area of disturbance greater than 1 acre, a 0.137-acre-foot detention basin will be constructed in the southwest portion of the site to detain all flows directed to the south. No portion of the site is located within a FEMA designated 100-year floodplain per Map No. 08041C0769G that was effective on December 7<sup>th</sup>, 2018.

## 2.0 SOIL CONDITIONS

According to the El Paso County Area Soil Survey, the soil on the site is classified as follows:

SOIL #	SOIL TYPE	HYDROLOGIC CLASSIFICATION	PERCENT OF SITE
28	Ellicot Loamy Coarse Sand, 0 to 5 Percent Slopes	A	0.0%
101	Ustic Torrfluvents, Loamy	B	100.0%

The Ustic Torrfluvents soil can be described as having a high permeability, low surface runoff, and slight hazard of erosion. The Ellicot soils is described as having very high permeability and very low surface runoff. The hydrologic soil classification used for this study is 'B'. See Soils Map in the Appendix for reference.

## 3.0 HYDROLOGIC CRITERIA

The methodology utilized for this report is in accordance with the *El Paso County Drainage Criteria Manual*. All references from the *El Paso County Drainage Criteria Manual* can be found in Appendix C. The Rational Method for computation of runoff was used.



$Q = c ia$

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

The storm recurrence intervals used for this study were the 5-year storm and the 100-year storm. The detention discharge for the proposed 0.137-acre-foot Full Spectrum Extended Detention Basin is 0.4 cfs for the 5-year storm and 3.6 cfs for the 100-year storm. The Colorado Urban Hydrograph Procedure (CUHP) was used to route flows through the proposed private detention basin. This procedure is described in more detail in the *Mile High Flood District Urban Storm Drainage Criteria Manual Volume 1*, shown below in Appendix C – Colorado Urban Hydrograph Procedure Summary.

The Mile High Flood District – Detention Version 4.05 (January 2022) spreadsheet was used to determine the required detention basin storage volume and outlet structure design. ManningSolver Version 1.019, also, was used in this analysis to calculate the Manning's normal depth within the pond inlet channel.

## 4.0 EXISTING DRAINAGE CONDITIONS

The overall site consists of 7.73 acres. The site includes an existing 3725 sf water treatment plant and an asphalt driveway. The areas of the site not covered by the water treatment plant or asphalt driveway are covered with nearly bare ground. These undeveloped areas include slopes that range from 0.5% to 19.3%. The overall existing site is 5.6% impervious. See Existing Drainage Map in the Back Pocket for reference.

Flows from Sub-basin Aex through Sub-basin Dex are tributary to the Jimmy Camp Creek (FOFO2000) basin.

Sub-basin Aex contains 2.55 acres and drains south towards a grated inlet in the southwest corner of the site. This sub-basin produces existing flows of 0.6 cfs for the 5-year storm and 4.3 cfs for the 100-year storm. These flows sheetflow to the south.

Sub-basin Bex contains 0.17 acres and drains south along East Anvil Drive. This sub-basin produces existing flows of 1.0 cfs for the 5-year storm and 1.8 cfs for the 100-year storm. These flows move south into and along curb and gutter as channelized flow.

Sub-basin Cex contains 2.87 acres and drains east towards Jimmy Camp Creek. This sub-basin produces existing flows of 1.0 cfs for the 5-year storm and 5.4 cfs for the 100-year storm. These flows sheetflow to the east.



Sub-basin Dex contains 0.71 acres and drains east towards Jimmy Camp Creek. It produces flows of 0.2 cfs for the 5-year storm and 1.5 cfs for the 100-year storm. These flows sheetflow to the east, ultimately ending up in Jimmy Camp Creek.

Sub-basin Eex contains 1.65 acres and drains east towards Jimmy Camp Creek. It produces flows of 0.4 cfs for the 5-year storm and 2.8 cfs for the 100-year storm. These flows sheetflow to the east into Jimmy Camp Creek.

Sub-basin Fex contains 0.09 acres and drains northeast into Jimmy Camp Creek. It produces flows of less than 0.1 cfs for the 5-year storm and 0.3 cfs for the 100-year storm. These flows sheetflow to the east into Jimmy Camp Creek.

Sub-basin Gex contains 0.07 acres and drains south towards Flagstone Street. It produces flows of less than 0.1 cfs for the 5-year storm and 0.2 cfs for the 100-year storm. These flows sheetflow to the south onto Flagstone Street.

Sub-basin OS1 contains 0.50 acres and drains southwest towards Sub-basin Aex. It produces flows of 0.1 cfs for the 5-year storm and 0.9 cfs for the 100-year storm. These flows sheetflow to the southwest into Sub-basin Aex.

Sub-basin OS2 contains 0.50 acres and drains southeast towards Sub-basin Eex. It produces flows of 0.1 cfs for the 5-year storm and 0.8 cfs for the 100-year storm. These flows sheetflow to the southeast into Sub-basin Eex.

Sub-basin OS3 contains 0.01 acres and drains east towards Sub-basin Aex. It produces flows of less than 0.1 cfs for the 5-year storm and less than 0.1 cfs for the 100-year storm. These flows sheetflow to the east into Sub-basin Aex.

The estimated runoff amounts produced for the project under Existing Conditions are shown in Table 1 below.

TABLE 1 – EXISTING CONDITIONS		
Sub-basin	Q <sub>5</sub> (CFS)	Q <sub>100</sub> (CFS)
Aex	0.6	4.3
Bex	1.0	1.8
Cex	1.0	5.4
Dex	0.2	1.5
Eex	0.4	2.8
Fex	<0.1	0.3
Gex	<0.1	0.2
OS1	0.1	0.9
OS2	0.1	0.8
OS3	<0.1	<0.1



## 5.0 DEVELOPED DRAINAGE CONDITIONS

The overall site consists of 7.73 acres, of which 2.65 acres will be disturbed as part of this project. A 4,542 sf administration building and asphalt driveway is proposed on the west side of the site. A 0.137-acre-foot Full Spectrum Extended Detention basin size will accommodate the area of disturbance greater than 1 acre. Proposed Conditions Map is located below in the Back Pocket for reference. Proposed site imperviousness is 20.0%, versus 5.8% in the existing conditions. Proposed flows are tributary to the Jimmy Camp Creek Basin (FOFO2000).

2.78

Sub-basin A contains 3.28 acres and south towards a 0.137-acre-foot Full Spectrum Extended Detention Basin located in the southwest corner of the site. It produces flows of 4.4 cfs for the 5-year storm and 11.7 cfs for the 100-year storm. These flows sheetflow to the south into the proposed 0.137-acre-foot Full Spectrum Extended Detention Basin. A portion of these flows drain through an existing 4' wide curb opening located on the along East Anvil Drive. A conservative approach was used in calculating the curb opening capacity and the total 100-year flow of 11.7 cfs was used. The 11.7 cfs accounts for 0.308 feet of depth, with approximately 0.192 of freeboard. No flows will bypass the existing curb opening. More details on this calculation can be found in Appendix B below.

Sub-basin B contains 0.17 acres and drains south along East Anvil Drive. This sub-basin produces flows of 1.0 cfs for the 5-year storm and 1.8 cfs for the 100-year storm. These flows move south into and along curb and gutter as channelized flow. No water quality control measures are proposed within Sub-basin B per the El Paso County Engineering Criteria Manual (ECM) Section I.7.1.C.1., which allows for the County to exclude up to 20 percent when the County has determined that it is not practicable to capture runoff from portions of the site that will not drain towards control measures. Sub-basin B is to remain the same as existing conditions.

Sub-basin C contains 2.14 acres and drains east towards Jimmy Camp Creek. This sub-basin produces flows of 0.8 cfs for the 5-year storm and 4.2 cfs for the 100-year storm. These flows sheetflow to the east. Similar to Sub-basin B, no water quality control measures are proposed within Sub-basin C per the El Paso County Engineering Criteria Manual (ECM) Section I.7.1.C.1., which allows for the County to exclude up to 20 percent when the County has determined that it is not practicable to capture runoff from portions of the site that will not drain towards control measures. this is more than 20%. just consider this are undeveloped land to remain undeveloped.

Sub-basin D contains 0.65 acres and drains east towards Jimmy Camp Creek. It produces flows of 0.2 cfs for the 5-year storm and 1.4 cfs for the 100-year storm. These flows sheetflow to the east, draining into Jimmy Camp Creek. No water quality control measures are proposed within Sub-basin D because the land is to remain undeveloped. Water quality is not required for this sub-basin per El Paso County ECM Section I.7.1.B.7.

Sub-basin E contains 1.65 acres and drains east towards Jimmy Camp Creek. It produces flows of 0.4 cfs for the 5-year storm and 2.8 cfs for the 100-year storm. These flows sheetflow to the east into Jimmy Camp Creek. No water quality control measures are proposed within Sub-basin E because the land is to remain undeveloped. Water quality is not required for this sub-basin per El Paso County ECM Section I.7.1.B.7.



Sub-basin F contains 0.09 acres and drains northeast into Jimmy Camp Creek. It produces flows of less than 0.1 cfs for the 5-year storm and 0.3 cfs for the 100-year storm. These flows sheetflow to the east into Jimmy Camp Creek. No water quality control measures are proposed within Sub-basin F because the land is to remain undeveloped. Water quality is not required for this sub-basin per El Paso County ECM Section I.7.1.B.7.

Sub-basin OS1 contains 0.50 acres and drains southwest towards Sub-basin A. It produces flows of 0.1 cfs for the 5-year storm and 0.9 cfs for the 100-year storm. These flows sheetflow to the southwest into Sub-basin A. Flows combine with flows from Sub-basin A at Design Point 1 (DP1) to produce total flows of 5.1 cfs for the 5-year storm and 13.7 cfs for the 100-year storm. Flows were computed at this point to determine the capacity and freeboard within the proposed swale and trickle channel.

0.37

Sub-basin OS2 contains 0.50 acres and drains southeast towards Sub-basin E. It produces flows of 0.1 cfs for the 5-year storm and 0.8 cfs for the 100-year storm. These flows sheetflow to the southeast into Sub-basin E.

Sub-basin OS3 contains 0.01 acres and drains east towards Sub-basin A. It produces flows of less than 0.1 cfs for the 5-year storm and less than 0.1 cfs for the 100-year storm. These flows sheetflow to the east into Sub-basin A.

rock check dam is shown as to be removed on the GEC

Existing rock check dams are to remain onsite. The removal of the rock check dams is deemed unnecessary, and therefore, should remain as to slow runoff.

The estimated runoff amounts produced for the project under Proposed Conditions are shown in Table 2 below. The proposed design point information for the project are shown in Table 3 below.

flows do not match proposed conditions figure

TABLE 2 - PROPOSED CONDITIONS		
Sub-basin	Q <sub>5</sub> (CFS)	Q <sub>100</sub> (CFS)
A*	4.4	11.7
B	1.0	1.8
C	0.8	4.2
D	0.2	1.4
E	0.4	2.8
F*	<0.1	0.3
OS1	0.1	0.9
OS2	0.1	0.8
OS3	<0.1	<0.1

\*Note that detained flows are 0.6 cfs for the 5-year event and 3.0 cfs for the 100-year event

TABLE 3 - DESIGN POINTS		
DESIGN POINT	Q <sub>5</sub> (CFS)	Q <sub>100</sub> (CFS)
DP1 (A + OS1)	5.1	13.7



## 6.0 FOUR STEP PROCESS

The proposed development follows the "Four Step Process" as mandated by the *El Paso County Drainage Criteria Manual* as follows:

Step 1: Reduce runoff by disconnecting impervious area, eliminating "unnecessary" impervious area and encouraging infiltration into soils that are suitable.

Runoff has been reduced by disconnecting impervious areas where possible, eliminating "unnecessary" impervious areas and encouraging infiltration into suitable soils. IRF Spreadsheets utilized for design.

Step 2: Treat and slowly release the WQCV.

- All new developed flows have been routed to the water quality basin with impervious area less than one acre.
- Drain time for the water quality basin is as follows: Full Spectrum Extended Detention Basin (EDB) is 40 hours.

Step 3: Stabilize stream channels.

Although Jimmy Camp Creek drainageway is adjacent to the project, no work will be done in the drainageway.

- Site flows from the project have been directed to the concrete curb and gutters along the roadways and transported to public drainage facilities which direct them into the water quality/detention facility.
- All new and re-developed projects are required to construct or participate in the funding of channel stabilization measures. Drainage basin fees paid at the time of platting go towards channel stabilization within the drainage basin.

Step 4: Implement source controls.

Erosion control measures will be in place during initial construction to provide source control of sediment with landscaping placed within the proposed development and permanent seeding of all disturbed areas. No other potential pollutants are anticipated with this site post construction. The development of this site will have no adverse impact on downstream properties.

## 7.0 DETENTION BASIN

To accommodate the area of disturbance greater than 1 acre, a private 0.137-acre-foot Full Spectrum Detention Basin is proposed on the southwest corner of the site (See Proposed Drainage Plan in the Back Pocket). An existing swale beginning in the west end of Sub-basin A will direct flows towards the proposed private detention basin in the southwest corner of the site, as seen in Back Pocket – Proposed Drainage Plan. The detention basin, with a depth of 5.17ft and a volume of 0.137 acre-feet, will detain a flow of 1.3 cfs for the 5-year storm and 4.2 cfs for the 100-year storm in Sub-basin A (according to the CUHP procedure), seen below in Appendix B – Developed Detention for Colorado Centre.



A trapezoidal channel located on the west end of the site discharges flows into the 0137-acre-foot Full Spectrum Extended Detention Basin. These flows produce a velocity of 2.86 feet per second (fps) and a depth of 0.253 feet for the 5-year storm and a velocity of 4.01 fps and a depth of 0.452 feet for the 100-year storm within the channel. This is 2.2 feet of freeboard for the 5-year storm and 2.0 feet of freeboard for the 100-year storm within the channel. More details on the Manning's normal depth calculation for the inlet channel are provided below in Appendix B.

The detention basin will have post-detention peak flows of 0.6 cfs for the 5-year storm and 3.0 cfs for the 100-year storm. This detention basin will outlet 5-year flows through a series of orifices spaced at 0, 1, and 1.5 feet above the bottom of the basin. The detention basin will, conversely, outlet 100-year flows through a proposed Type OS2 outlet structure and tied into an existing 24" diameter outlet pipe with a flow restrictor plate set at 4.7" above the pipe invert. More details can be found in the Appendix B – Outlet Structure Design. Basin drain times and stage versus volume figures are shown below in Appendix B – Developed Detention for Colorado Centre.

## 8.0 WATER QUALITY

Water quality for the site will be achieved through a 0.137-acre-foot proposed private Full Spectrum Extended Detention Basin (FS/EDB). A 2' wide trickle channel located in the detention basin will carry flows towards a private 'Type OS2' Outlet Structure tied into an existing private 24" corrugated metal pipe outlet (See *MHFD Detention Basin Stage-Storage Table Builder* in Appendix B for reference). The existing grated inlet located in Sub-basin Aex will be removed during construction. The outlet pipe to be tied into is in a stable and working condition, flowing and outfalling east into Flagstone Channel (See the Proposed Drainage Plan in the Back Pocket for reference). The outfall is protected with existing riprap and vegetation, which is seen below in a provided photo found in Appendix A. For these reasons, no improvements to the existing pipe are proposed. The private EDB drains an area of 3.35 acres that is 32.80% impervious and will have a volume of 0.137-acre-ft. The Water Quality capture volume will be 0.036 acre- ft. Calculations for the private EDB and outlet structure design are included in Appendix B of this report.

## 9.0 EROSION CONTROL PLAN

The site construction consists of constructing a new administration building and asphalt drive, disturbing 2.65 acres of area. This requires an Erosion and Stormwater Quality Control Permit. The Grading and Erosion Control Plan will be submitted in separate Construction Plans.

## 10.0 FLOODPLAIN STATEMENT

No portion of the developed site is located within a designated FEMA 100-year floodplain according to the information published in the Federal Emergency Management Agency Flood Plain Map No. 08041C0769G dated December 7<sup>th</sup>, 2018.



## 11.0 DRAINAGE BASIN FEES

The proposed development is located within the Jimmy Camp Creek Drainage Basin.

### 2022 Jimmy Camp Creek Drainage Fees

Drainage fees are waived because Colorado Centre Metropolitan District owns and maintains the drainage infrastructure within its boundaries.

### 2022 Jimmy Camp Creek Bridge Fees

Bridge fees are waived because Colorado Centre Metropolitan District owns and maintains the bridges within its boundaries.

## 12.0 CONSTRUCTION COST OPINION

The private, non-reimbursable Control Measures (CM) Financial Assurances costs of construction are as follows:

Description	Quantity	Unit Cost	Amount
OUTLET STRUCTURE	1 EA	\$3,000	\$3,000
CONCRETE FOREBAY	1 LS	\$500	\$500
2' CONC. PAN	120 LF	\$20	\$2,400
FSD/EDB GRADING	1350 CY	\$10	\$13,500
CONCRETE STILLING BASIN	1 EA	\$2,500	\$2,500
RETAINING WALL	90 SF	\$20	\$1,800
		Sub-Total	\$23,700
		Engineering & Contingencies 10%	<u>\$2,370</u>
		Total	\$26,070

## 13.0 CONCLUSIONS

For this 7.73-acre site, work will include constructing a 4,542 sf administration building and asphalt driveway. Proposed detention allows flows to remain unchanged for the 5-year storm and decrease from 3.4 cfs to 3.0 cfs for the 100-year storm within Sub-basin A. In order to accommodate an area of disturbance greater than 1 acre, a 0.137-acre-foot Full Spectrum Extended Detention Basin is proposed that detains flows from Sub-basin A and releases 5-year storm and 100-year storm flows through a Type OS2 Outlet Structure that is tied into an existing 24" corrugated metal pipe.

All areas disturbed by construction will be repaired, and erosion control measures will be installed during construction of the proposed site per the approved Grading and Erosion Control Plan to be submitted separately for review and approval. Site runoff, storm drains, and appurtenances associated with the development of the Colorado Centre Metropolitan District Administration building will not

adversely affect the downstream and surrounding developments.

## 14.0 REFERENCES

*Drainage Report for Colorado Centre Metropolitan District Water Treatment Facility*, prepared by JDS-Hydro Consultants Inc in August 2015.

*Flood Insurance Rate Map Number 08041C0769G*, Federal Emergency Management Agency Floodplain Data, revised December 7, 2018

Municipal Code Corporation (2018). *Drainage Criteria Manual of El Paso County, Colorado (DPM)*

Urban Drainage and Flood Control District (June 2017). *Urban Storm Drainage Criteria Manual, Volume 1-3*.

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





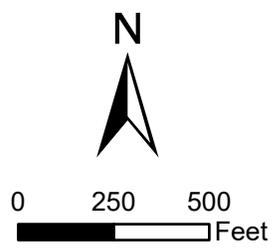
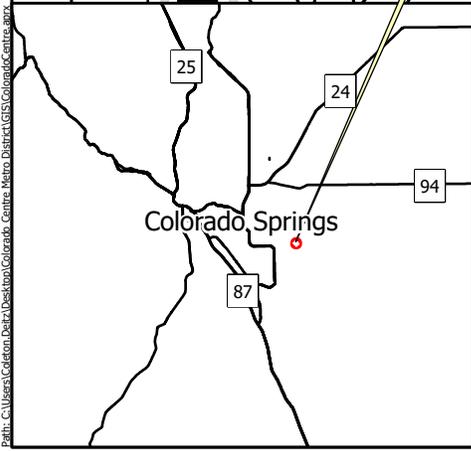
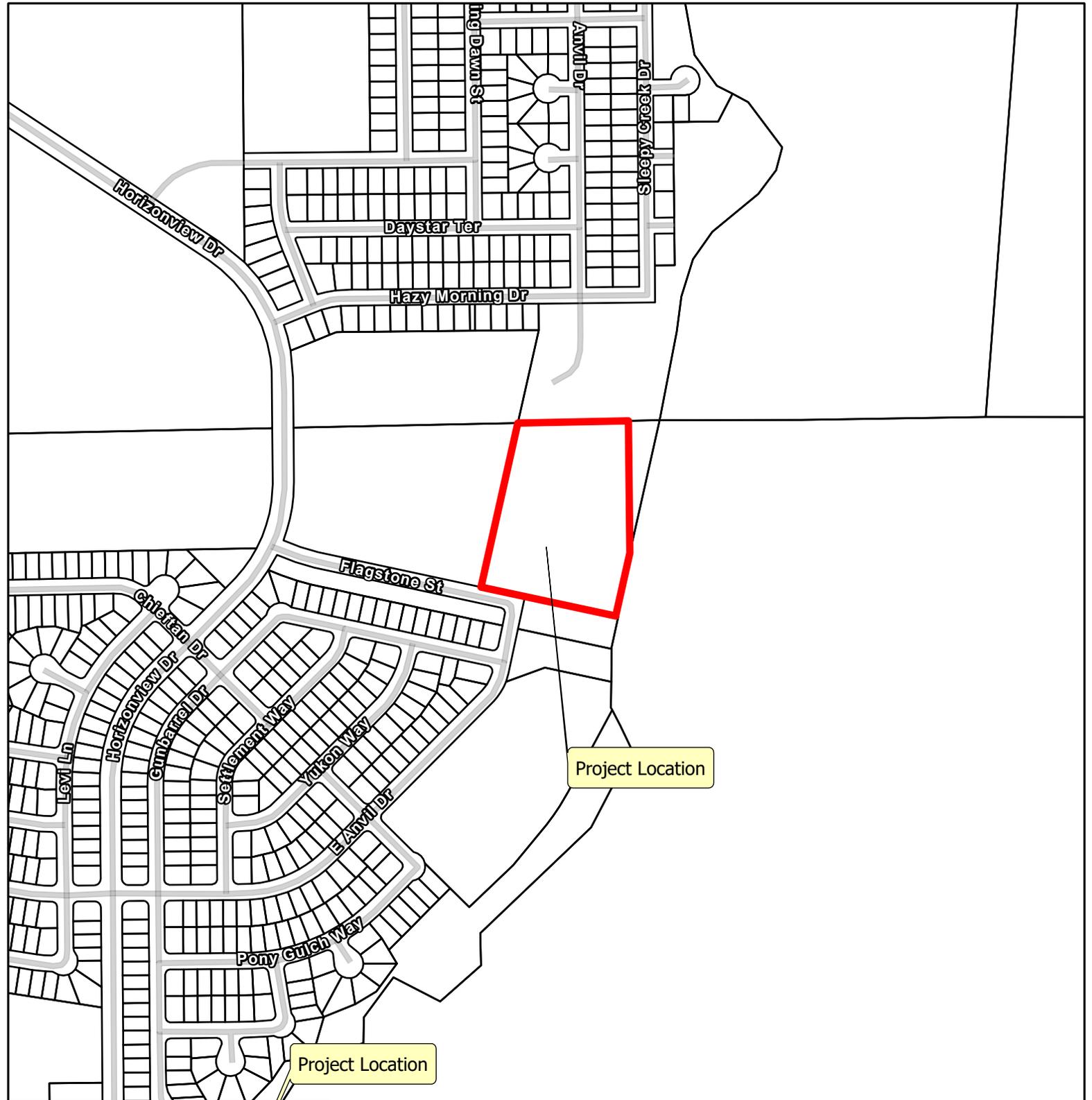
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# APPENDIX A

## MAPS

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Prepared by:



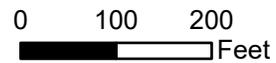
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COLORADO CENTRE METROPOLITAN DISTRICT  
 ADMINISTRATION BUILDING

**VICINITY MAP**

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Path: C:\Users\Colson\Desktop\Colorado\_Centre\_Metro\_District\GIS\Colorado\_Centre.aprx



Map Unit Symbol	Map Unit Name	Rating	Percent of Site, %
28	Ellicot loamy coarse sand, 0 to 5 percent slopes	A	0
101	Ustic Torrfluvents, loamy	B	100.0

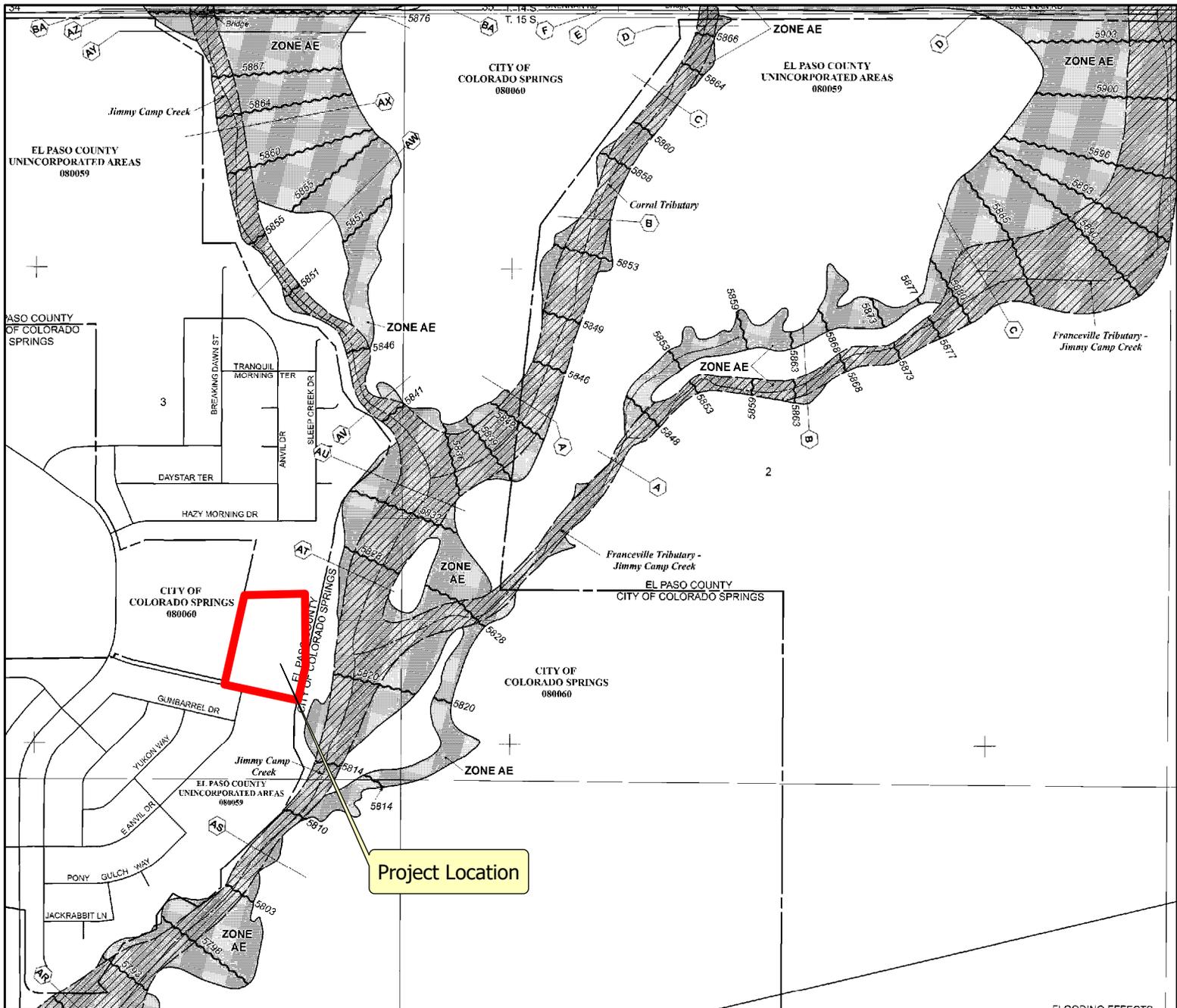
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COLORADO CENTRE METROPOLITAN DISTRICT  
 ADMINISTRATION BUILDING

**SOILS MAP**



Project Location

FLOODING EFFECTS FROM JIMMY CAMP CREEK - EAST TRIBUTARY



0 500 1,000 Feet

**NFP**

**PANEL 0769G**

**FIRM**  
FLOOD INSURANCE RATE MAP  
EL PASO COUNTY,  
COLORADO  
AND INCORPORATED AREAS

PANEL 769 OF 1300  
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0769	G
EL PASO COUNTY	080059	0769	G

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

**MAP NUMBER**  
08041C0769G

**MAP REVISED**  
DECEMBER 7, 2018

Federal Emergency Management Agency



Prepared by:



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**RESPEC**

COLORADO CENTRE METROPOLITAN DISTRICT  
ADMINISTRATION BUILDING

**FIRM MAP**

Esri Community Maps Contributors, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, Esri, NASA, NGA, USGS, FEMA, Maxar



**Image taken looking southeast at the existing outfall configuration of the 24" CMP storm sewer line beginning onsite and terminating in Flagstone Channel.**

Sediment and vegetation should be removed and riprap re-established. Confirm riprap pad sizing and gradation is meets calculated requirements.



# APPENDIX B

## CALCULATIONS

Colorado Centre Metropolitan District Administration Building									
PROJ.247.07									
C FACTOR CALCULATION SHEET									
EXISTING CONDITIONS									
RUNOFF COEFFICIENT									
TYPE A/B SOILS									
LAND USE		Imperv %	5 YR	100 YR					
UNDEV		0	0.08	0.35					
GRAVEL ROAD		80	0.59	0.7					
ASPHALT ROAD		100	0.9	0.96					
ROOFS		90	0.73	0.81					
EXISTING CONDITIONS									
	TOTAL	SURFACE CONDITION AREAS				CALCULATED C			
AREA	AREA	UNDEV	GRAVEL	ASPHALT	ROOFS	5	100	% IMPERVIOUS	
DESIG.	(acre)		ROAD	ROAD		YR	YR		
Aex	2.05	2.01	0.00	0.04	0.00	0.09	0.36		1.80
Bex	0.17	0.00	0.00	0.17	0.00	0.90	0.96		100.00
Cex	2.87	2.72	0.00	0.07	0.08	0.12	0.38		4.95
Dex	0.71	0.71	0.00	0.00	0.00	0.08	0.35		0.00
Eex	1.65	1.65	0.00	0.00	0.00	0.08	0.35		0.00
Fex	0.09	0.09	0.00	0.00	0.00	0.08	0.35		0.00
Gex	0.07	0.07	0.00	0.00	0.00	0.08	0.35		0.00
OS1	0.50	0.50	0.00	0.00	0.00	0.08	0.35		0.00
OS2	0.37	0.37	0.00	0.00	0.00	0.08	0.35		0.00
OS3	0.01	0.01	0.00	0.00	0.00	0.08	0.35		0.00
Site Percent Impervious, %		4.59							

<b>PROPOSED CONDITIONS</b>									
<b>RUNOFF COEFFICIENT</b>									
<b>TYPE A/B SOILS</b>									
<b>LAND USE</b>		<b>Imperv %</b>	<b>5 YR</b>	<b>100 YR</b>					
UNDEV		0	0.08	0.35					
GRAVEL ROAD		80	0.59	0.7					
ASPHALT ROAD		100	0.9	0.96					
ROOFS		90	0.73	0.81					

**PROPOSED CONDITIONS**

	TOTAL	SURFACE CONDITION AREAS				CALCULATED C			
AREA	AREA	UNDEV	GRAVEL	ASPHALT	ROOFS	5	100	% IMPERVIOUS	
DESIG.	(acre)		ROAD	ROAD		YR	YR		
A	2.78	1.61	0.00	1.05	0.12	<b>0.42</b>	<b>0.60</b>		<b>41.75</b>
B	0.17	0.00	0.00	0.17	0.00	<b>0.90</b>	<b>0.96</b>		<b>100.00</b>
C	2.14	1.99	0.00	0.07	0.08	<b>0.13</b>	<b>0.39</b>		<b>6.85</b>
D	0.65	0.65	0.00	0.00	0.00	<b>0.08</b>	<b>0.35</b>		<b>0.00</b>
E	1.65	1.65	0.00	0.00	0.00	<b>0.08</b>	<b>0.35</b>		<b>0.00</b>
F	0.09	0.09	0.00	0.00	0.00	<b>0.08</b>	<b>0.35</b>		<b>0.00</b>
G	0.07	0.07	0.00	0.00	0.00	<b>0.08</b>	<b>0.35</b>		<b>0.00</b>
OS1	0.50	0.50	0.00	0.00	0.00	<b>0.08</b>	<b>0.35</b>		<b>0.00</b>
OS2	0.37	0.37	0.00	0.00	0.00	<b>0.08</b>	<b>0.35</b>		<b>0.00</b>
OS3	0.01	0.01	0.00	0.00	0.00	<b>0.08</b>	<b>0.35</b>		<b>0.00</b>
Site Percent Impervious, %		19.57							



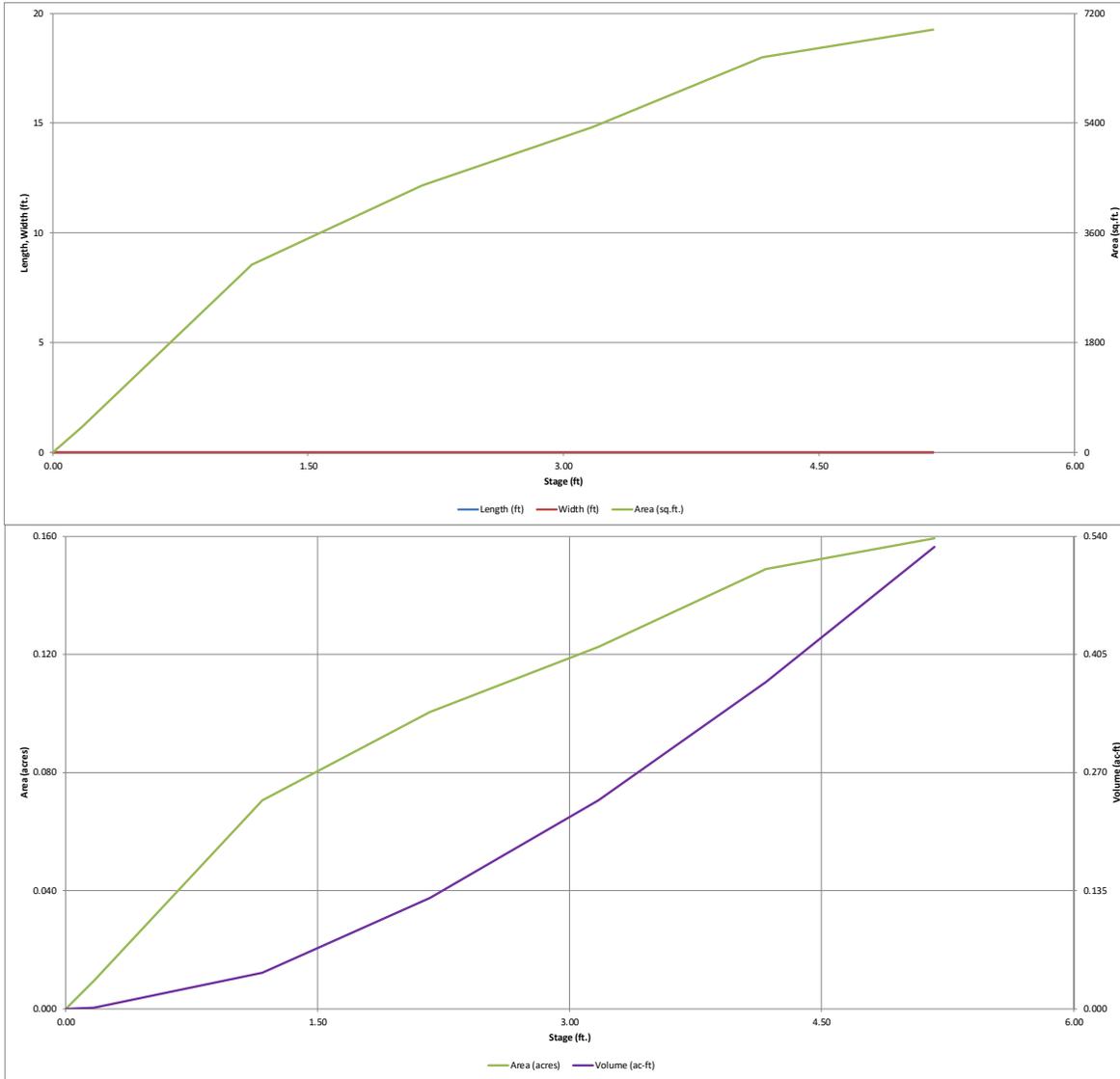
**Colorado Centre Metropolitan District  
Proposed Full Spectrum Detention Basin  
Stage-Area Curve**

<b>Elevation (ft)</b>	<b>Depth (ft)</b>	<b>Area (sf)</b>	<b>Area (ac)</b>	<b>Inc. Vol. (ac-ft)</b>	<b>Total Vol. (ac-ft)</b>
5818.83	0	0	0	0.00	0.00
5819	5819	419	0.01	0.00	0.00
5820	5820	3075	0.07	0.04	0.04
5821	5821	4378	0.10	0.09	0.13
5822	5822	5338	0.12	0.11	0.24
5823	5823	6484	0.15	0.14	0.37
5824	5824	6940	0.16	0.15	0.53



# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

*MHFD-Detention, Version 4.05 (January 2022)*

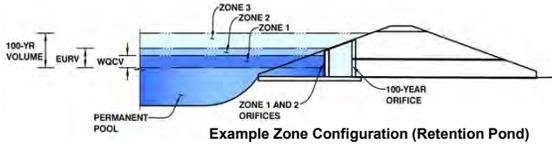


# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD- Detention, Version 4.05 (January 2022)

Project: Colorado Centre Metro District Building

Basin ID: A



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.10	0.036	Orifice Plate
Zone 2 (EURV)	1.66	0.043	Orifice Plate
Zone 3 (100-year)	2.77	0.111	Weir & Pipe (Restrict)
Total (all zones)		0.190	

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

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

Calculated Parameters for Underdrain  
 Underdrain Orifice Area =  ft<sup>2</sup>  
 Underdrain Orifice Centroid =  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)

Centroid of Lowest Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
 Depth at top of Zone using Orifice Plate =  ft (relative to basin bottom at Stage = 0 ft)  
 Orifice Plate: Orifice Vertical Spacing =  inches  
 Orifice Plate: Orifice Area per Row =  sq. inches (diameter = 5/8 inch)

Calculated Parameters for Plate  
 WQ Orifice Area per Row =  ft<sup>2</sup>  
 Elliptical Half-Width =  feet  
 Elliptical Slot Centroid =  feet  
 Elliptical Slot Area =  ft<sup>2</sup>

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	0.55	1.11					
Orifice Area (sq. inches)	0.30	0.30	0.30					

	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)

Invert of Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
 Depth at top of Zone using Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
 Vertical Orifice Diameter =  inches

Calculated Parameters for Vertical Orifice  
 Vertical Orifice Area =  ft<sup>2</sup>  
 Vertical Orifice Centroid =  feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

Overflow Weir Front Edge Height, H<sub>o</sub> =  ft (relative to basin bottom at Stage = 0 ft)  
 Overflow Weir Front Edge Length =  feet  
 Overflow Weir Grate Slope =  H:V  
 Horiz. Length of Weir Sides =  feet  
 Overflow Grate Type =   
 Debris Clogging % =

Calculated Parameters for Overflow Weir  
 Height of Grate Upper Edge, H<sub>u</sub> =  feet  
 Overflow Weir Slope Length =  feet  
 Grate Open Area / 100-yr Orifice Area =   
 Overflow Grate Open Area w/o Debris =  ft<sup>2</sup>  
 Overflow Grate Open Area w/ Debris =  ft<sup>2</sup>

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

Depth to Invert of Outlet Pipe =  ft (distance below basin bottom at Stage = 0 ft)  
 Outlet Pipe Diameter =  inches  
 Restrictor Plate Height Above Pipe Invert =  inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate  
 Outlet Orifice Area =  ft<sup>2</sup>  
 Outlet Orifice Centroid =  feet  
 Half-Central Angle of Restrictor Plate on Pipe =  radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway  
 Spillway Design Flow Depth =  feet  
 Stage at Top of Freeboard =  feet  
 Basin Area at Top of Freeboard =  acres  
 Basin Volume at Top of Freeboard =  acre-ft

orifice plate?

## Routed Hydrograph Results

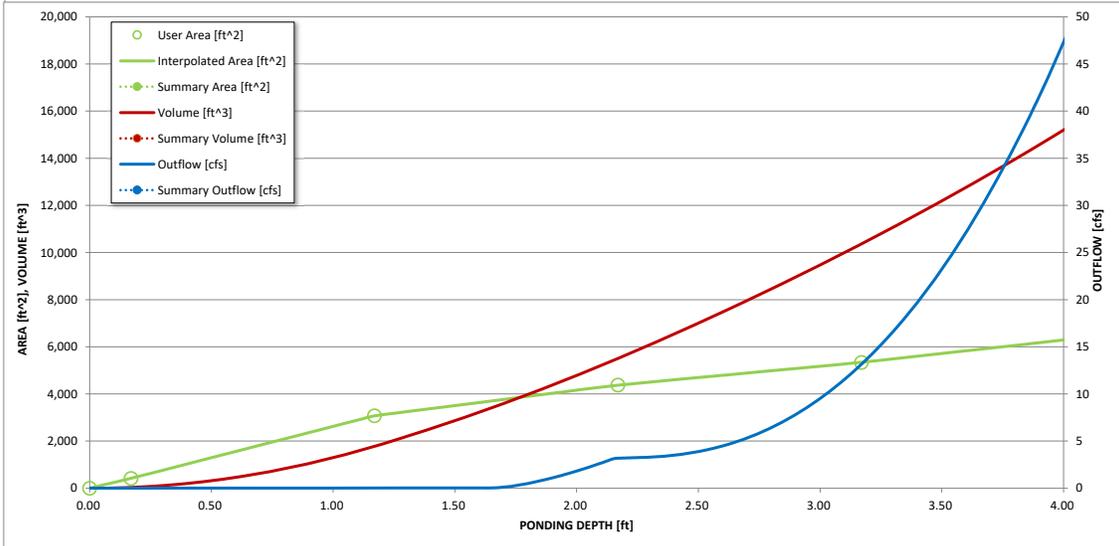
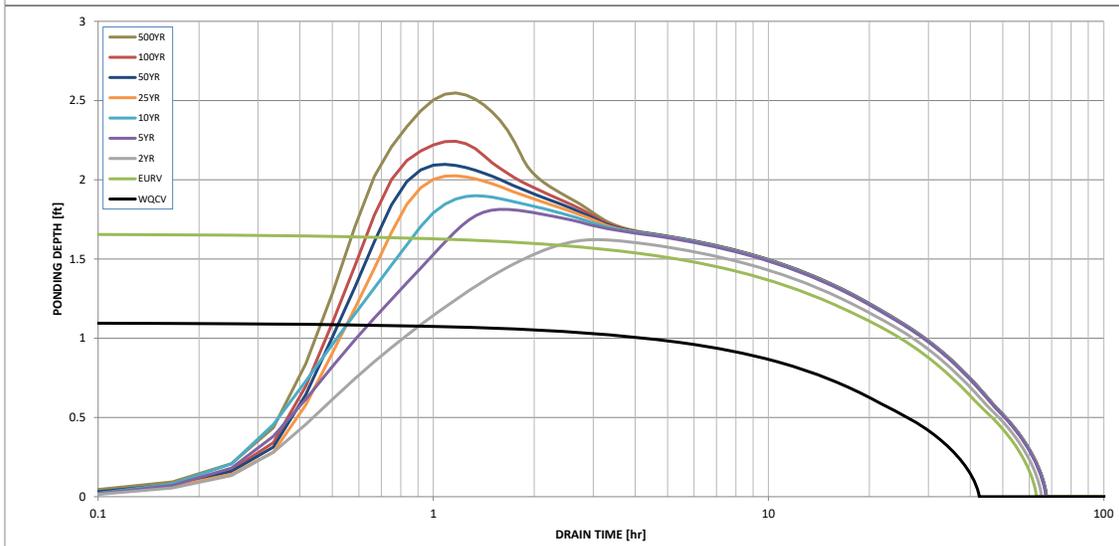
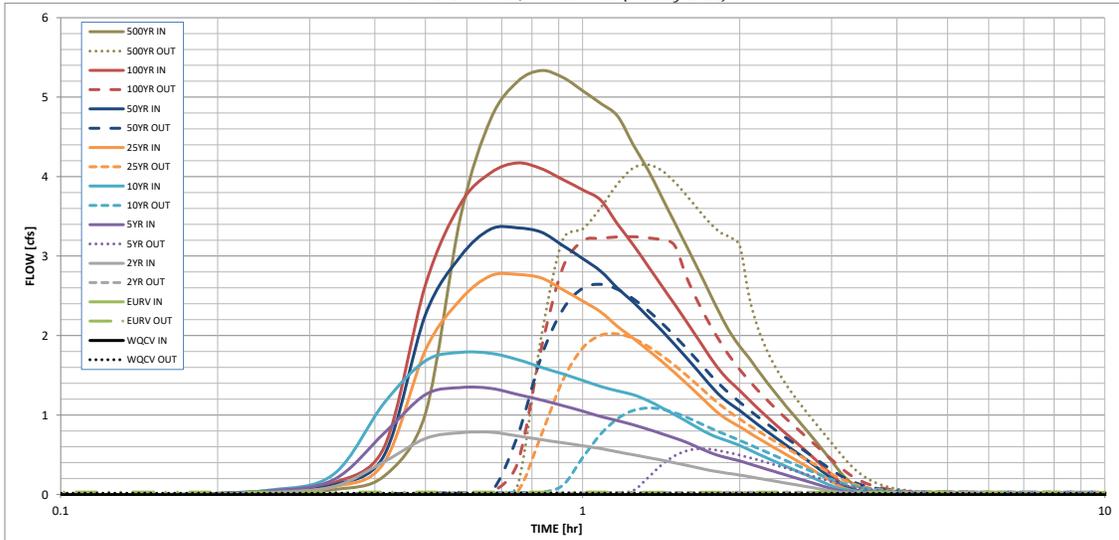
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period									
One-Hour Rainfall Depth (in)	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.01
CUHP Runoff Volume (acre-ft)	0.036	0.079	0.082	0.143	0.199	0.289	0.354	0.444	0.577
Inflow Hydrograph Volume (acre-ft)	N/A	N/A	0.082	0.143	0.199	0.289	0.354	0.444	0.577
CUHP Predevelopment Peak Q (cfs)	N/A	N/A	0.3	0.8	1.2	2.1	2.7	3.4	4.5
OPTIONAL Override Predevelopment Peak Q (cfs)	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre)	N/A	N/A	0.08	0.23	0.35	0.64	0.81	1.04	1.36
Peak Inflow Q (cfs)	N/A	N/A	0.8	1.3	1.8	2.8	3.4	4.2	5.3
Peak Outflow Q (cfs)	0.0	0.0	0.0	0.0	1.1	2.0	2.6	3.2	4.2
Ratio Peak Outflow to Predevelopment Q	N/A	N/A	N/A	0.8	0.9	1.0	1.0	1.0	0.9
Structure Controlling Flow	Plate	Overflow Weir 1	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
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)	39	56	58	56	53	49	46	43	39
Time to Drain 99% of Inflow Volume (hours)	41	60	62	62	61	59	58	56	54
Maximum Ponding Depth (ft)	1.10	1.66	1.62	1.81	1.90	2.03	2.10	2.24	2.55
Area at Maximum Ponding Depth (acres)	0.07	0.09	0.08	0.09	0.09	0.10	0.10	0.10	0.11
Maximum Volume Stored (acre-ft)	0.036	0.079	0.076	0.092	0.099	0.112	0.118	0.134	0.165

flows do not match proposed flows on figure

# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.05 (January 2022)*



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: \_\_\_\_\_

## Inflow Hydrographs

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

Time Interval	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
	TIME	WOCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	0:15:00	0.00	0.00	0.03	0.04	0.06	0.04	0.05	0.05	0.06
	0:20:00	0.00	0.00	0.10	0.19	0.26	0.10	0.12	0.15	0.23
	0:25:00	0.00	0.00	0.41	0.77	1.15	0.40	0.50	0.60	1.02
	0:30:00	0.00	0.00	0.71	1.26	1.68	1.82	2.27	2.64	3.49
	0:35:00	0.00	0.00	0.78	1.35	1.79	2.45	3.00	3.66	4.72
	0:40:00	0.00	0.00	0.79	1.34	1.78	2.75	3.34	4.05	5.20
	0:45:00	0.00	0.00	0.74	1.26	1.70	2.77	3.36	4.17	5.34
	0:50:00	0.00	0.00	0.69	1.19	1.60	2.73	3.30	4.10	5.25
	0:55:00	0.00	0.00	0.65	1.12	1.52	2.58	3.13	3.96	5.08
	1:00:00	0.00	0.00	0.61	1.05	1.44	2.44	2.97	3.83	4.92
	1:05:00	0.00	0.00	0.58	0.98	1.36	2.30	2.81	3.70	4.76
	1:10:00	0.00	0.00	0.54	0.93	1.30	2.11	2.60	3.40	4.40
	1:15:00	0.00	0.00	0.50	0.88	1.26	1.97	2.42	3.14	4.09
	1:20:00	0.00	0.00	0.47	0.82	1.18	1.82	2.24	2.88	3.75
	1:25:00	0.00	0.00	0.43	0.77	1.09	1.68	2.07	2.63	3.42
	1:30:00	0.00	0.00	0.40	0.71	1.01	1.53	1.89	2.40	3.12
	1:35:00	0.00	0.00	0.37	0.66	0.92	1.39	1.72	2.17	2.82
	1:40:00	0.00	0.00	0.34	0.59	0.84	1.26	1.55	1.95	2.54
	1:45:00	0.00	0.00	0.31	0.53	0.76	1.12	1.39	1.74	2.27
	1:50:00	0.00	0.00	0.28	0.49	0.71	1.01	1.24	1.56	2.04
	1:55:00	0.00	0.00	0.26	0.45	0.66	0.92	1.14	1.42	1.86
	2:00:00	0.00	0.00	0.25	0.42	0.62	0.85	1.06	1.31	1.72
	2:05:00	0.00	0.00	0.23	0.39	0.56	0.78	0.97	1.19	1.56
	2:10:00	0.00	0.00	0.21	0.35	0.51	0.71	0.88	1.08	1.42
	2:15:00	0.00	0.00	0.19	0.32	0.46	0.65	0.80	0.98	1.29
	2:20:00	0.00	0.00	0.17	0.29	0.42	0.59	0.72	0.89	1.16
	2:25:00	0.00	0.00	0.15	0.26	0.37	0.53	0.65	0.80	1.05
	2:30:00	0.00	0.00	0.14	0.23	0.33	0.47	0.58	0.72	0.94
	2:35:00	0.00	0.00	0.12	0.20	0.29	0.42	0.52	0.64	0.83
	2:40:00	0.00	0.00	0.10	0.17	0.25	0.37	0.45	0.56	0.73
	2:45:00	0.00	0.00	0.09	0.15	0.22	0.32	0.39	0.48	0.62
	2:50:00	0.00	0.00	0.07	0.12	0.18	0.26	0.33	0.40	0.52
	2:55:00	0.00	0.00	0.06	0.10	0.14	0.21	0.26	0.32	0.42
	3:00:00	0.00	0.00	0.05	0.07	0.11	0.16	0.20	0.25	0.32
	3:05:00	0.00	0.00	0.03	0.05	0.08	0.12	0.14	0.18	0.23
	3:10:00	0.00	0.00	0.02	0.04	0.07	0.08	0.10	0.12	0.16
	3:15:00	0.00	0.00	0.02	0.03	0.05	0.06	0.07	0.09	0.12
	3:20:00	0.00	0.00	0.02	0.03	0.04	0.04	0.06	0.06	0.09
	3:25:00	0.00	0.00	0.01	0.02	0.04	0.03	0.04	0.05	0.07
	3:30:00	0.00	0.00	0.01	0.02	0.03	0.03	0.03	0.03	0.05
	3:35:00	0.00	0.00	0.01	0.02	0.02	0.02	0.03	0.02	0.03
	3:40:00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.02	0.02
	3:45:00	0.00	0.00	0.01	0.01	0.02	0.01	0.02	0.01	0.02
	3:50:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02
	3:55:00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
	4:00:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
	4:05:00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00





Project: Colorado Centre Admin Building



Water Quality Capture Volume (WQCV) Calculator

Drain Time (hrs)	40
Coefficient, a	1.0
Imperviousness, I	35.4%
WQCV (watershed inches)	0.17
WQCV (ft)	0.01
Watershed Area (ac)	3.3
WQCV (ac-ft)	0.046



Forebay Calculator

WQCV (ac-ft)	0.046
2% of WQCV (ac-ft)	0.0009
2% of WQCV (cf)	40
Depth (ft)	1.00
Width (ft)	6
Length (ft)	8
Volume (cf)	48
Is Volume greater than 2% of WQCV?	YES



Forebay Notch Calculator

Q <sub>100</sub> (cfs)	13.7
2% of Q <sub>100</sub> (cfs)	0.27
D (ft)	1
<b>W (ft)</b>	<b>0.09</b>

$$W = \frac{2\% \text{ of } Q}{D^{1.5} * C}$$



### Trickle Channel Calculator

Q <sub>100</sub> (cfs)	13.7
2% of Q <sub>100</sub> (cfs)	0.27
Slope (ft/ft)	0.005
<b>Bottom Width (ft)</b>	<b>2</b>
Side Slopes (Vertical)	0
<b>Depth of Trickle Channel (ft)</b>	<b>0.5</b>
Depth of 2% of 100-Year (ft)	0.09
Velocity (ft/s)	1.52
Froude Number	0.9
Type of Flow (Subcritical/Supercritical)	Subcritical

Project: Colorado Centre Admin Building



**Proposed Detention Basin Spillway**

Slope (ft/ft)	0.2	
Cf	2	
Q <sub>100</sub> (cfs)	13.7	
Width (ft)	15	doesn't match MHFD
q (cfs/ft)	0.91	Detention form
Calculated D <sub>50</sub> (in)	4.3	
D <sub>50</sub> used (in)	6.0	



**Detention Basin Outlet**

100-Year Peak Outflow (cfs)	3.0
Y <sub>t</sub> (ft)	0.59
D <sub>c</sub> (ft)	2.0
D <sub>50</sub> (ft)	0.1
D <sub>50</sub> Used (ft)	6.0

**Manning Formula:** Trickle Channel - 2% of 100 Year Flow

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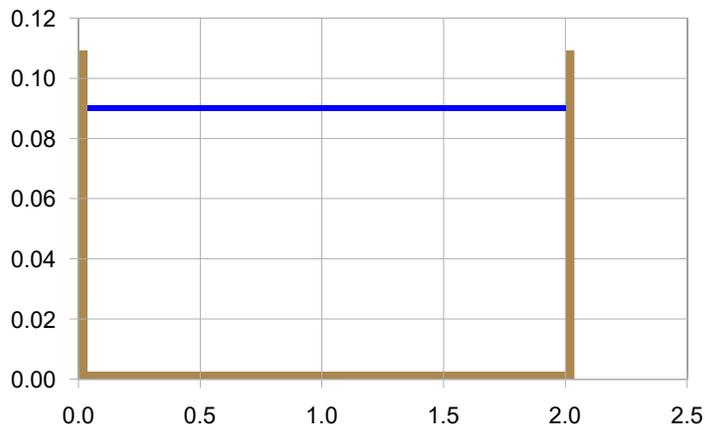
**Rectangular Channel**

**Input**

Flow	0.27 cfs
Slope	0.005 ft/ft
Manning's n	0.013
Base Width	2 ft
Right Side Slope	0:1
Left Side Slope	0:1

**Output**

Depth	0.089 ft
Flow Area	0.178 sf
Velocity	1.52 fps
Velocity Head	0.0359 ft
Top Width	2.00 ft
Froude Number	0.899
Critical Depth	0.083 ft
Critical Slope	0.00628 ft/ft



**Manning Formula:** Curb Opening - 100 Year Flow

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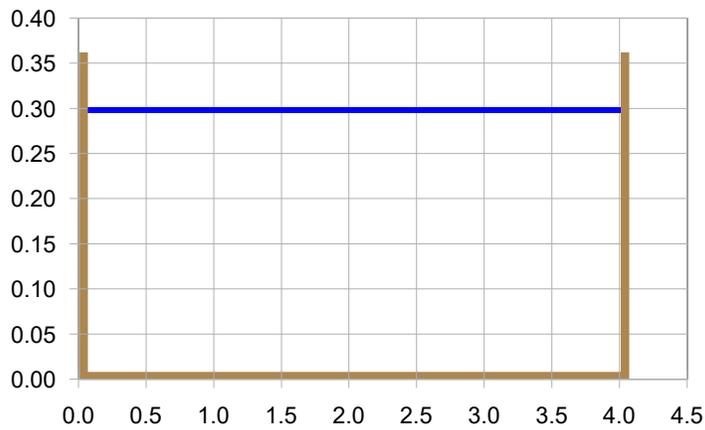
**Rectangular Channel**

**Input**

Flow	10.9 cfs
Slope	0.04 ft/ft
Manning's n	0.013
Base Width	4 ft
Right Side Slope	0:1
Left Side Slope	0:1

**Output**

Depth	0.295 ft
Flow Area	1.18 sf
Velocity	9.24 fps
Velocity Head	1.33 ft
Top Width	4.00 ft
Froude Number	3.00
Critical Depth	0.613 ft
Critical Slope	0.00414 ft/ft



**Manning Formula:** Pond Inlet Channel - 5 Year Flow

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**Irregular Section**

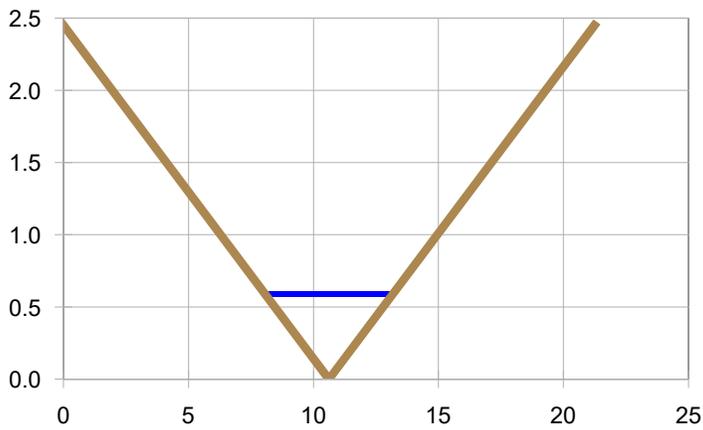
**Input**

Flow 5.1 cfs  
Slope 0.044 ft/ft

Sta	Elev	n	Sta	Elev	n	Sta	Elev	n	Sta	Elev	n
0	2.45	0.04	10.62	0	0.04	21.24	2.45	0.04			

**Output**

WSElev 0.589 ft  
Flow Area 1.50 sf  
Velocity 3.39 fps  
Velocity Head 0.179 ft  
Top Width 5.11 ft  
Froude Number 1.10  
Critical WSElev 0.612 ft  
Critical Slope ft/ft



## Manning Formula: Pond Inlet Channel - 100 Year Flow

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### Irregular Section

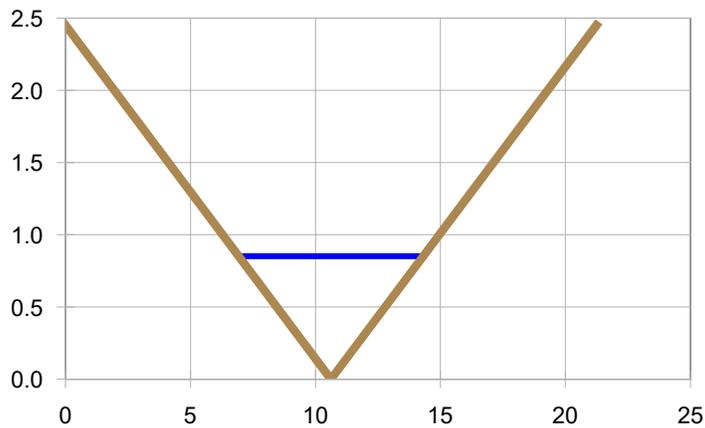
#### Input

Flow 13.7 cfs  
Slope 0.044 ft/ft

Sta	Elev	n	Sta	Elev	n	Sta	Elev	n	Sta	Elev	n
0	2.45	0.04	10.62	0	0.04	21.24	2.45	0.04			

#### Output

WSElev 0.853 ft  
Flow Area 3.16 sf  
Velocity 4.34 fps  
Velocity Head 0.293 ft  
Top Width 7.40 ft  
Froude Number 1.17  
Critical WSElev 0.909 ft  
Critical Slope ft/ft





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# APPENDIX C

## DESIGN CHARTS

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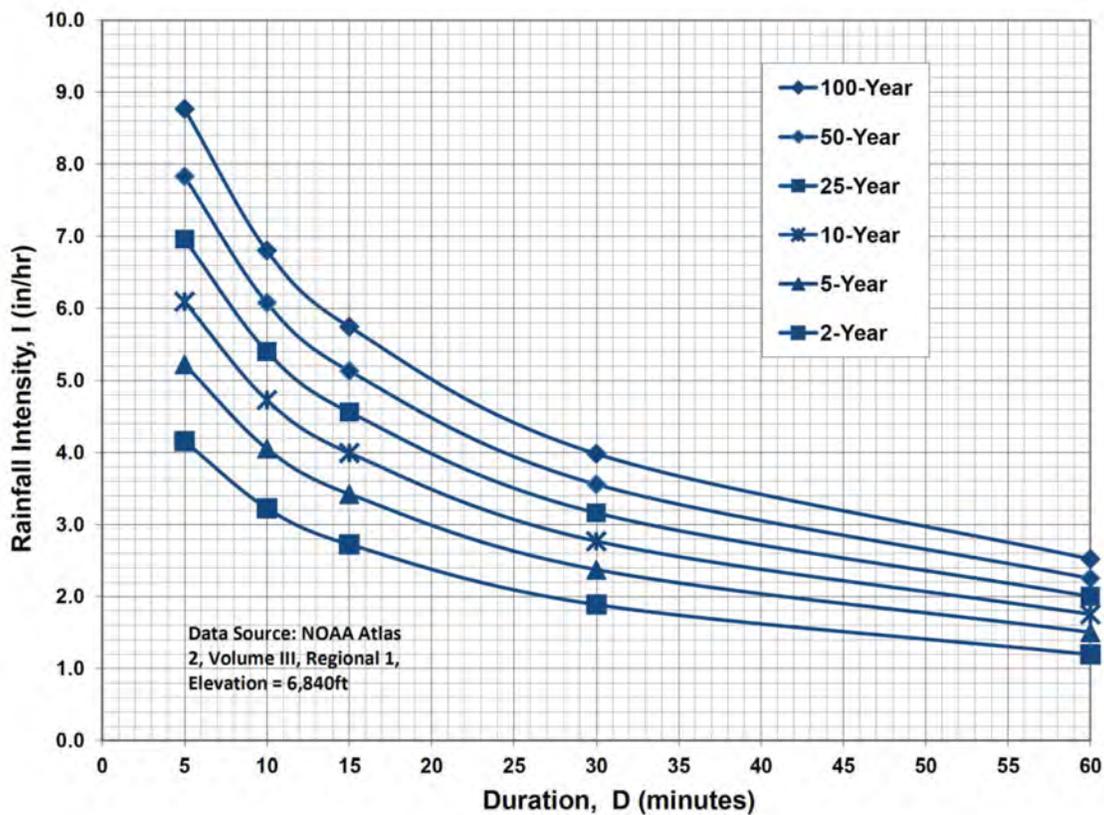






Historic Flow Analysis—Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	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 6-5. Colorado Springs Rainfall Intensity Duration Frequency



**IDF Equations**

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

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

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

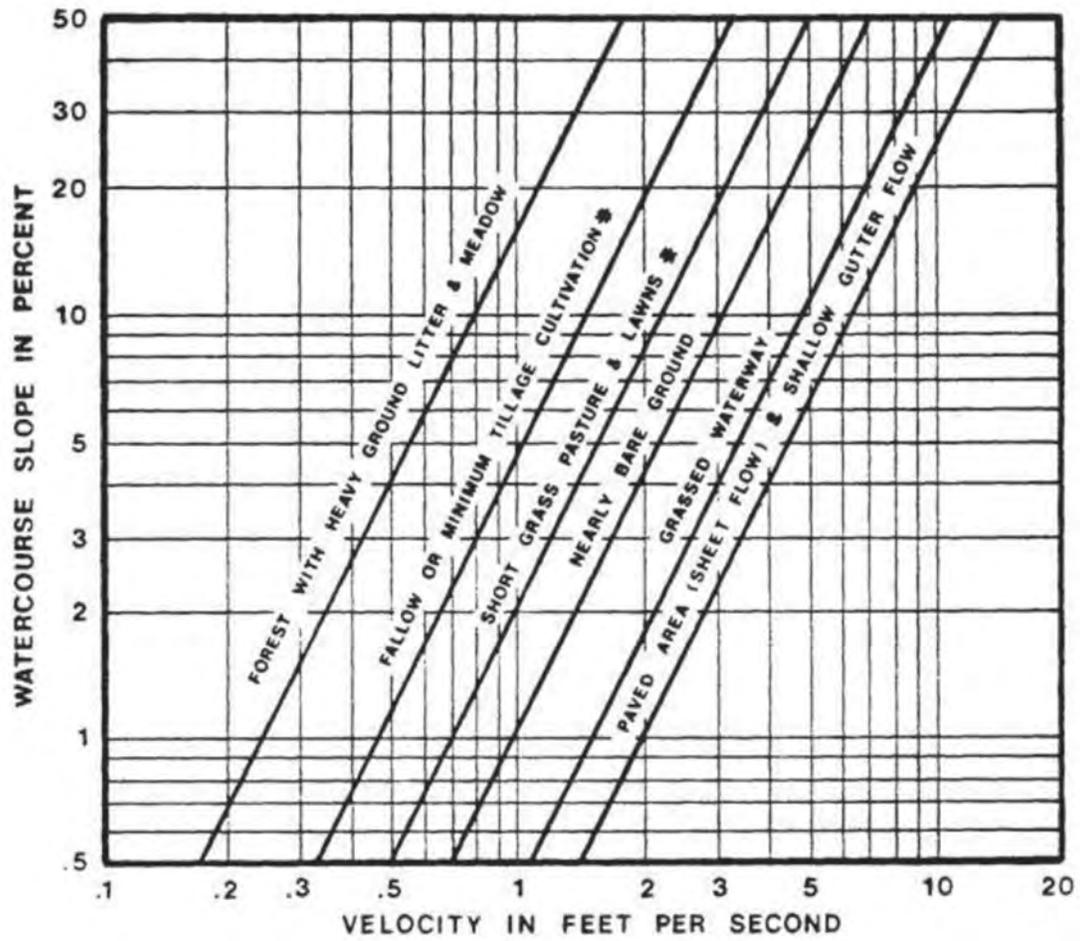
$$I_{10} = -1.75 \ln(D) + 8.847$$

$$I_5 = -1.50 \ln(D) + 7.583$$

$$I_2 = -1.19 \ln(D) + 6.035$$

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

Figure 6-25. Estimate of Average Concentrated Shallow Flow



## 3.0 Colorado Urban Hydrograph Procedure

### 3.1 Background

The Colorado Urban Hydrograph Procedure (CUHP) is a method of hydrologic analysis based upon the unit hydrograph principle. A unit hydrograph is defined as the hydrograph of one inch of direct runoff from the tributary area resulting from a storm of a given duration. The unit hydrograph thus represents the integrated effects of factors such as tributary area, shape, street pattern, channel capacities, and street and land slopes. The basic premise of the unit hydrograph is that individual hydrographs resulting from the successive increments of excess rainfall that occur throughout a storm period will be proportional in discharge throughout their runoff period. Thus, the hydrograph of total storm discharge is obtained by summing the ordinates of the individual sub-hydrographs.

CUHP has been developed and calibrated using rainfall-runoff data collected in Colorado (mostly in the Denver/Boulder metropolitan area). This section provides a general background in the use of the computer version of CUHP to perform stormwater runoff calculations. A detailed description of the CUHP method and the assumptions and equations used, including a hand calculation example, are provided in the CUHP User Manual. The latest version of the CUHP 2005 macro-enabled Excel workbook and User Manual are available for download from [www.udfed.org](http://www.udfed.org).

### 3.2 Effective Rainfall for CUHP

Effective rainfall is that portion of precipitation during a storm event that runs off the land to streams. Those portions of precipitation that do not reach a stream are called abstractions and include interception by vegetation, evaporation, infiltration, storage in all surface depressions, and extended duration surface retention. The total design rainfall depth for use with CUHP should be obtained from the *Rainfall* chapter of the USDCM. This chapter illustrates a method for estimating the amount of rainfall that actually becomes surface runoff whenever a design rainstorm is used.

#### 3.2.1 Pervious-Impervious Areas

As described in Section 2.5.1, the urban landscape is comprised of pervious and impervious surfaces. The degree of imperviousness is the primary variable that affects the volumes and rates of runoff calculated using CUHP. When analyzing a watershed for design purposes, the probable future percent of impervious area must first be estimated. A complete tabulation of recommended values of total percentage imperviousness is provided in Table 6-3 and Figures 6-1 through 6-3. References to impervious area and all calculations in this chapter are based on the input of total impervious areas. The pervious-impervious area relationship can be further refined for use in CUHP as follows:

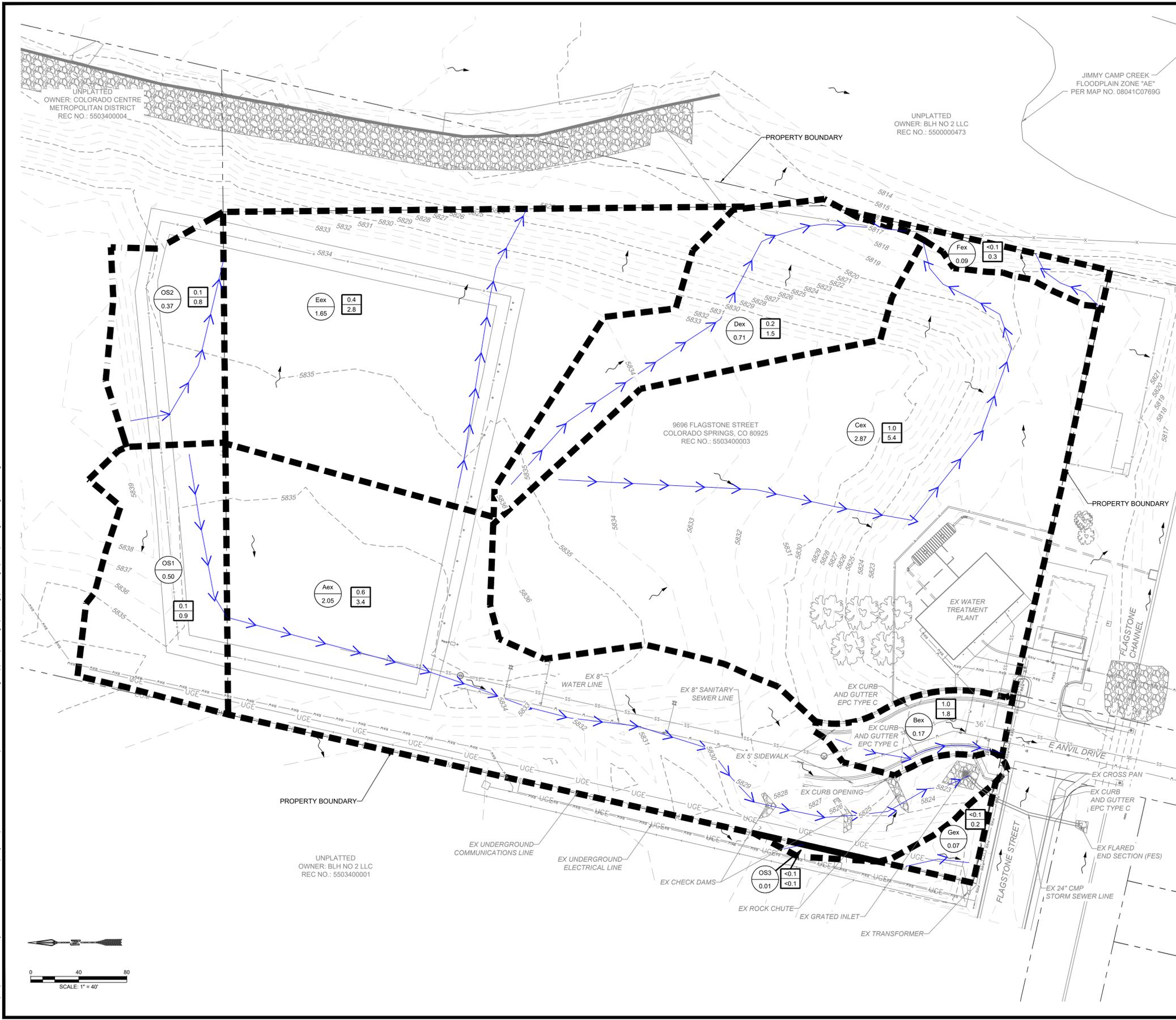
- **DCIA:** Impervious area portion directly connected to the drainage system.
- **UIA:** Impervious area portion that drains onto or across pervious surfaces.
- **RPA:** The portion of pervious area receiving runoff from impervious portions.
- **SPA:** The separate pervious area portion not receiving runoff from impervious surfaces.

This further refinement is explained in more detail in the CUHP User Manual and in Chapter 3 of the USDCM Volume 3.



# BACK POCKET

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- BENCHMARKS**
1. SURVEY CONTROL POINT AS SHOWN HERON. ELEVATIONS ARE BASED UPON CITY OF COLORADO SPRINGS "FIMS" VERTICAL DATUM. FIMS MONUMENT "TM\_5" ELEVATION = 5824.02 (NGVD 29). "FIMS" ALUMINUM CAP STAMPED "TM-5" IN A ROAD BOX ON THE EAST SIDE OF MARKSHEFFEL ROAD, ABOUT 1/2 MILE SOUTH OF DRENNAN ROAD.
  2. SURVEY CONTROL POINT AS SHOWN HERON. ELEVATIONS ARE BASED UPON CITY OF COLORADO SPRINGS "FIMS" VERTICAL DATUM. FIMS MONUMENT "TM\_4" ELEVATION = 5856.50 (NGVD 29). "FIMS" ALUMINUM CAP STAMPED "TM-4" IN A ROAD BOX 26 FEET NORTH OF A FENCE CORNER AT THE SOUTHEAST CORNER OF MARKSHEFFEL ROAD AND DRENNAN ROAD.

- LEGEND**
- A1A EXIST BASIN DESIGNATION
  - XX EXIST BASIN AREA, ACRES
  - XX EXIST 5 YEAR STORM, CFS
  - XX EXIST 100 YEAR STORM, CFS
  - XX EXIST DESIGN POINT
  - XX.X EXIST 5 YEAR ACCUMULATED FLOW, CFS
  - XXX.X EXIST 100 YEAR ACCUMULATED FLOW, CFS
  - EXISTING DIRECTION OF DRAINAGE FLOW
  - EXISTING SUB-BASIN BOUNDARY
  - EXISTING MAJOR CONTOUR
  - EXISTING MINOR CONTOUR
  - EXISTING TIME OF CONCENTRATION PATH
  - EXISTING WATER MAIN
  - EXISTING SANITARY MAIN SEWER
  - EXISTING NON-POTABLE WATERLINE
  - EXISTING UNDERGROUND ELECTRIC
  - EXISTING TELECOMMUNICATION LINE
  - EXISTING FENCE
  - EXISTING PROPERTY BOUNDARY

**NOTE:**  
 1. THERE IS NO FEMA FLOODPLAIN WITHIN THE PROPOSED SITE.  
 FEMA MAP: 08041C0769G  
 EFFECTIVE: 12/7/2018

EXISTING CONDITIONS			
SUB-BASIN	ACRES	Q5 (CFS)	Q100 (CFS)
Aex	2.05	0.6	3.4
Bex	0.17	1.0	1.8
Cex	2.87	1.0	5.4
Dex	0.71	0.2	1.5
Eex	1.65	0.4	2.8
Fex	0.09	<0.1	0.3
Gex	0.07	<0.1	0.2
OS1	0.50	0.1	0.9
OS2	0.37	0.1	0.8
OS3	0.01	<0.1	<0.1

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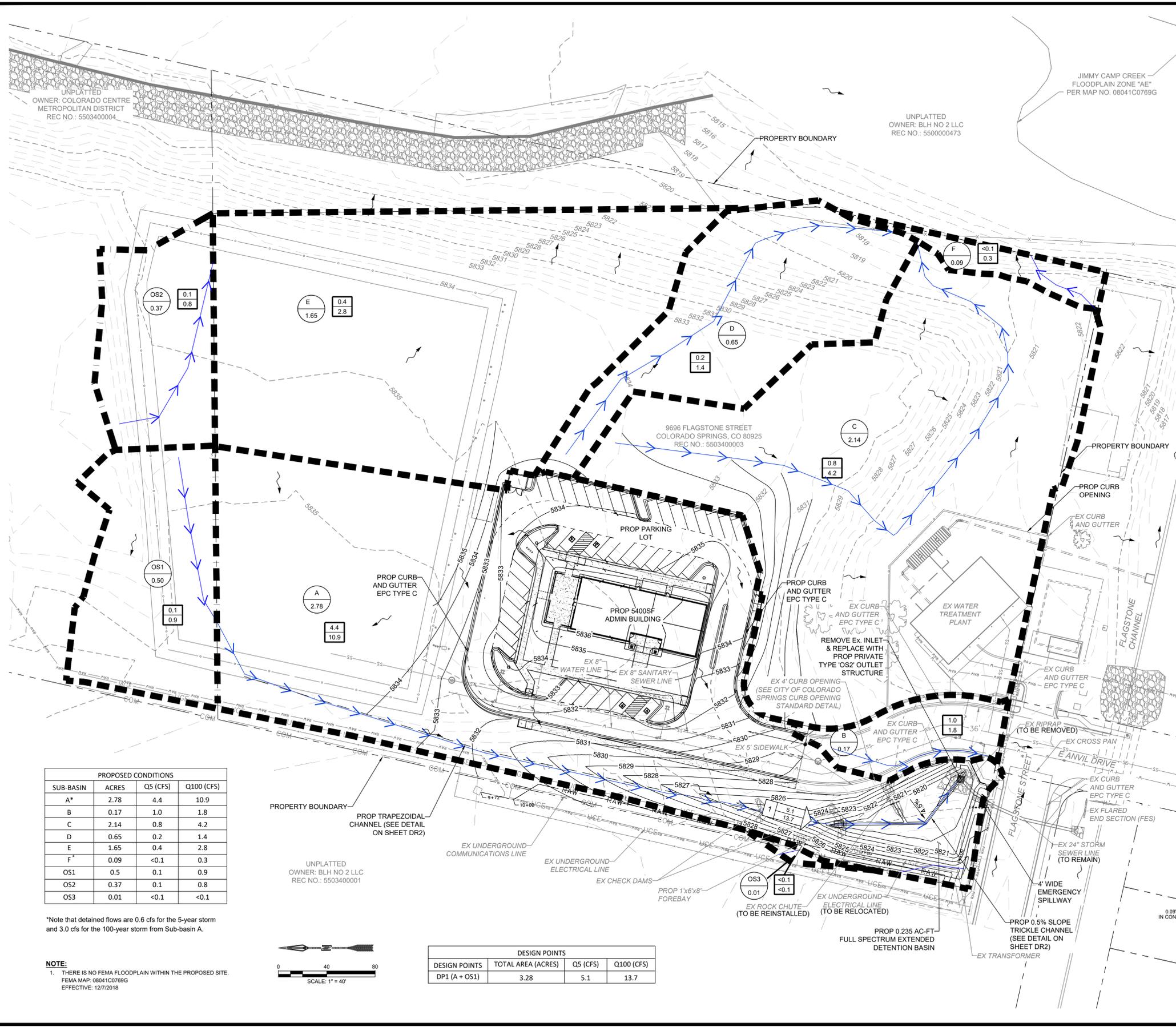
COLORADO CENTRE METROPOLITAN DISTRICT  
 ADMINISTRATION BUILDING  
 EXISTING DRAINAGE PLAN

NO.	DESCRIPTION	BY	APP.	DATE
1				
2				
3				
4				
5				
6				
7				

Project No.: 247.07  
 Date: 09/2022  
 Design: CTD  
 Drawn: CTD  
 Check: RGG

**DR1**  
 SHEET 1 OF 2

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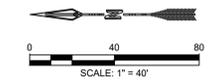


- BENCHMARKS**
- SURVEY CONTROL POINT AS SHOWN HEREON. ELEVATIONS ARE BASED UPON CITY OF COLORADO SPRINGS "FIMS" VERTICAL DATUM, FIMS MONUMENT "TM\_5" ELEVATION = 5824.02' (NGVD 29). "FIMS" ALUMINUM CAP STAMPED "TM-5" IN A ROAD BOX ON THE EAST SIDE OF MARKSHEFFEL ROAD, ABOUT 1/2 MILE SOUTH OF DRENNAN ROAD.
  - SURVEY CONTROL POINT AS SHOWN HEREON. ELEVATIONS ARE BASED UPON CITY OF COLORADO SPRINGS "FIMS" VERTICAL DATUM, FIMS MONUMENT "TM\_4" ELEVATION = 5856.50' (NGVD 29). "FIMS" ALUMINUM CAP STAMPED "TM-4" IN A ROAD BOX 26 FEET NORTH OF A FENCE CORNER AT THE SOUTHEAST CORNER OF MARKSHEFFEL ROAD AND DRENNAN ROAD.
- LEGEND**
- (A1A) PROPOSED BASIN DESIGNATION
  - (XX) PROPOSED BASIN AREA, ACRES
  - [XX] PROPOSED 5 YEAR STORM, CFS
  - [XX] PROPOSED 100 YEAR STORM, CFS
  - XX.XX.XX PROPOSED 5 YEAR ACCUMULATED FLOW, CFS
  - XX.XX.XX PROPOSED 100 YEAR ACCUMULATED FLOW, CFS
  - PROPOSED DIRECTION OF DRAINAGE FLOW
  - PROPOSED SUB-BASIN BOUNDARY
  - 7290--- PROPOSED MAJOR CONTOUR
  - 7291--- PROPOSED MINOR CONTOUR
  - 7290--- EXISTING MAJOR CONTOUR
  - 7291--- EXISTING MINOR CONTOUR
  - PROPOSED TIME OF CONCENTRATION PATH
  - PROPOSED CHANNEL FLOWLINE
  - RAW --- PROPOSED NON-POTABLE WATERLINE
  - W --- EXISTING WATER MAIN
  - SS --- EXISTING SANITARY MAIN SEWER
  - EAB --- EXISTING NON-POTABLE WATERLINE
  - UGE --- EXISTING UNDERGROUND ELECTRIC
  - COM --- EXISTING TELECOMMUNICATION LINE
  - EXISTING FENCE
  - EXISTING PROPERTY BOUNDARY

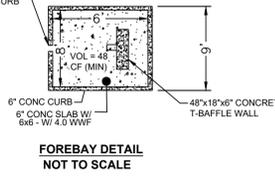
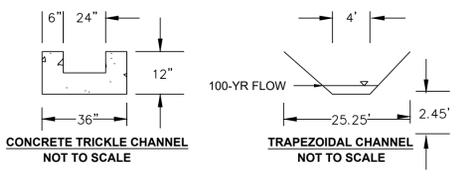
PROPOSED CONDITIONS			
SUB-BASIN	ACRES	Q5 (CFS)	Q100 (CFS)
A*	2.78	4.4	10.9
B	0.17	1.0	1.8
C	2.14	0.8	4.2
D	0.65	0.2	1.4
E	1.65	0.4	2.8
F*	0.09	<0.1	0.3
OS1	0.5	0.1	0.9
OS2	0.37	0.1	0.8
OS3	0.01	<0.1	<0.1

\*Note that detained flows are 0.6 cfs for the 5-year storm and 3.0 cfs for the 100-year storm from Sub-basin A.

**NOTE:**  
1. THERE IS NO FEMA FLOODPLAIN WITHIN THE PROPOSED SITE.  
FEMA MAP: 08041C0769G  
EFFECTIVE: 12/7/2016



DESIGN POINTS			
DESIGN POINTS	TOTAL AREA (ACRES)	Q5 (CFS)	Q100 (CFS)
DP1 (A + OS1)	3.28	5.1	13.7



make details larger and add all details to GEC. Include forebay, forebay notch, and forebay riprap protection, trickle channel, channel, pond bottom, riprap chute, outlet structure (including orifice hole size/elevation, micropool screen, outlet pipe elevation, micropool, WQCV, EURV, 100yr elevations, trash rack, etc.), and curb cut. unresolved.

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COLORADO CENTRE METROPOLITAN DISTRICT  
ADMINISTRATION BUILDING  
PROPOSED DRAINAGE PLAN

NO.	DESCRIPTION	BY	APP.	DATE
1				
2				
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4				
5				
6				
7				

Project No.: 247.07  
Date: 09/2022  
Design: CTD  
Drawn: CTD  
Check: RGG

**DR2**  
SHEET 2 OF 2