EPC STORMWATER REVIEW COMMENTS ARE SHOWN IN ORANGE BOXES WITH BLACK TEXT

LOTS 3, 4, AND 5 NORTHCREST CENTER FILING NO 2
PHASE 1 SUBDIVISION
REFERRED TO AS: "NORTHCREST CENTER"
FINAL DRAINAGE REPORT

2510 & 2522 CANADA DRIVE
COLORADO SPRINGS, COLORADO
80922

PREPARED FOR: LEISURE CONSTRUCTION
3443 TAMPA ROAD, SUITE B
PALM HARBOR, FL 34684
(727) 242-5121

PCD FILE NO. PPR-21-036

November 8, 2021

Prepared by
Scott Marvel, P.E.
Rocky Mountain Group
2910 Austin Bluffs Blvd. | Colorado Springs, CO 80918 | 719-434-5638

SIGNATURE PAGE

LOTS 3, 4, AND 5 NORTHCREST CENTER FILING NO 2 PHASE 1 SUBDIVISION

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 County for drainage reports and said report is in conformity with the applicable master plan of the drainage basin. I accept responsibility for any liability caused by negligent acts, errors or omissions on my part in preparing this report.

SIGNATURE (Affix Seal): ____

Scott Marvel, P.E. No.: 52138 Date:

DEVELOPER'S STATEMENT

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

____

Name of Developer

____

Authorized Signature   Date

____

Printed Name

____

Title

____

Address

EL PASO COUNTY:

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.

________________________________ ________

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

Conditions:

Table of Contents

Appendices

I. PURPOSE

This report is a Final Drainage Report for Lots 3, 4 & 5 Northcrest Center Subdivision, a currently unaddressed set of lots, for the development for a multi-unit commercial development, Northcrest Center.

The purpose of this report is to identify on-site and off-site drainage patterns, assess stormwater conditions per delineated basin and sub-basins, demonstrate adequate design standards for storm water flow and release into the existing storm water system or right-of-way, and provide a narrative for any other drainage considerations related to the development of this parcel.

II. GENERAL LOCATION AND DESCRIPTION

A. LOCATION

The proposed development of thirteen 2,280 square foot commercial buildings, is located at the address of Northcrest Center (formerly Lots 3, 4, & 5) in the City of Colorado Springs, Colorado in El Paso County within the Northcrest Center Subdivision. The parcel schedule numbers are 5332309004, 5332309006, and 5332309005 and the legal descriptions are Lot 3 Northcrest Center, A Vacation & Replat Of Tract B Northcrest Fil No 2 Phase 1, Lot 5 Northcrest Center, A Vacation & Replat Of Tract B Northcrest Fil No 2 Phase 1, and Lot 4 Northcrest Center, A Vacation & Replat Of Tract B Northcrest Fil No 2 Phase 1. The parcel is located to the north of Constitution Avenue, west of Canada Drive, east of Peterson Road, and south of Bismark Road.

The surrounding parcels are as follows:

North of Lots 3, 4 & 5 Northcrest Center, A Vacation & Replat of Tract B Northcrest Fil No 2 Phase 1 (Northcrest Center (formerly Lots 3, 4, & 5)) from west to east:

2508 Weyburn Way, Schedule No. 5332308031, Zoning RS-6000 CAD-O, Plat No. 10281, Lot 15 Constitution Hills Fil No 8

2507 Weyburn Way, Schedule No. 5332308032, Zoning RS-6000 CAD-O, Plat No. 10281, Lot 14 Constitution Hills Fil No 8

2630 Tibburn Way, Schedule No. 5332308040, Zoning RS-6000 CAD-O, Plat No. 10281, Lot 6 Constitution Hills Fil No 8

2610 Tibburn Way, Schedule No. 5332308041, Zoning RS-6000 CAD-O, Plat No. 10281, Lot 5 Constitution Hills Fil No 8

2605 Tibburn Way, Schedule No. 5332308042, Zoning RS-6000 CAD-O, Plat No. 10281, Lot 4 Constitution Hills Fil No 8

2624 Tibburn Way, Schedule No. 5332308043, Zoning RS-6000 CAD-O, Plat No. 10281, Lot 3 Constitution Hills Fil No 8

East of Lots 3, 4 & 5 Northcrest Center, A Vacation & Replat of Tract B Northcrest Fil No 2 Phase 1 (Northcrest Center (formerly Lots 3, 4, & 5)) from north to south:

2535 Canada Drive, Schedule No. 5332310002, Zoning RS-6000 CAD-O, Plat No. 8956, Lot 1 Living Waters Sub

2525 Canada Drive, Schedule No. 5332310003, Zoning PUD CAD-O, Plat No. 8956, Lot 2 Living Waters Sub

2455 Canada Drive, Schedule No. 5405207050, Zoning RM-30 CAD-O, Plat No. 7588, Lot 2 Northcrest Fil No 4

South of Lots 3, 4 & 5 Northcrest Center, A Vacation & Replat of Tract B Northcrest Fil No 2 Phase 1 (Northcrest Center (formerly Lots 3, 4, & 5)) from west to east:

6855 Constitution Avenue, Schedule No. 5405218002, Zoning CC CAD-O, Plat No. 9808, Lot 1 Eight Line Sub

West of Lots 3, 4 & 5 Northcrest Center, A Vacation & Replat of Tract B Northcrest Fil No 2 Phase 1 (Northcrest Center (formerly Lots 3, 4, & 5)) from north to south:

6805 Bismark Road, Schedule No. 5332309007, Zoning CC CAD-O, Plat No. 7776, Lots 1 & 2 Northcrest Center, A Vacation & Replat of Tract B Northcrest Fil No 2 Phase 1

B. Description of Property – Existing Conditions

Lots 3, 4, and 5 (Northcrest Center (formerly Lots 3, 4, & 5)) is approximately 144,776 square feet combined (3.32 acres) and is located on the north side of Constitution Avenue, east side of Peterson Road, West of Canada Drive, and south of Bismark Road. The parcels fall within the SW 1/4 of Section 32, Township 13 South, Range 65 West of the 6th P.M. of Colorado Springs, El Paso County, Colorado.

The property currently consists of undeveloped natural vegetation. There is existing curb and gutter along Bismark Drive, Canada Drive, and Constitution Avenue.

The existing percent imperviousness is approximately 1.5 percent on Lots 3, 4, and 5.

The existing topography consists of grades between 5.3 and 19.17 percent. Drainage patterns sheet flow across the parcel southeasterly to the corner of Canada Drive and Constitution Avenue.

C. Existing Soils

The soils indicative to the site are classified as Truckton sandy loam by the USDA Soil Conservation Service and are listed as NRCS (National Resources Conservation Service) Hydrologic Soil Group A. A USDA Soil Map is provided in the Appendix.

A subsurface soils investigation was conducted for Commercial Development Site Constitution and Peterson, with a letter entitled *Geotechnical Report* by RMG – Rocky Mountain Group dated

February 23, 2021. The investigation "revealed similar substance subsurface soil conditions across the site, being primarily silty sand extending from the ground surface to the extent of the test borings. Neither expansive clay soil not bedrock were encountered in the borings."

The study found that "groundwater was not encountered in the test borings during field exploration."

D. Existing Drainage

The existing topography consists of grades between 5.3 and 19.17 percent within the entire parcel that ultimately flows southeast. The existing imperviousness of the lot is approximately 1.5 percent. The existing vegetation consists of native grasses and has been identified via site visits and aerial photography as well as survey data and pictures.

The existing drainage pattern from storm runoff is generally characterized as overland flow to the southeast of the parcel across pervious landscaped yard. The runoff from this parcel and the surrounding neighborhood flows via curb and gutter in the public right of way of Bismark Road, Constitution Avenue, and Canada Drive. The runoff flows south on Canada Drive into the existing Public 15' CDOT Type R Curb Inlet located at the northwest corner of the intersection of Canada Drive and Constitution Avenue. This Public Storm Inlet is a branch of the Public 24" RCP Storm Main that flows west to east along the north side of Constitution Avenue and ultimately outfalls into Jimmy Camp Creek.

Lots 3, 4, and 5 do not lie within a designated floodplain according to information published in the Federal Emergency Management Agency Floodplain Map No. 08041C0752G, dated December 7, 2018. The FEMA Floodplain map is provided in Appendix C showing it lies within Zone X, a minimal flood hazard area.

There are no known non-stormwater discharges that contribute to the storm water systems on site and downstream, both private and public.

E. Description of Property – Proposed Conditions

The proposed development consists of thirteen 2,280 square foot commercial units and 68,606 square feet of concrete and asphalt pavement for drive accesses, sidewalks, and curb and gutter. Other on-site features include 29,020 square feet of landscaping, 756 linear feet of retaining wall, and 2,432 square feet for a full spectrum detention pond.

There is no existing access point to the property. Two new curb cuts are proposed along Canada Drive.

III. DRAINAGE BASINS AND SUB-BASINS

A. EXISTING MAJOR DRAINAGE BASIN AND SUB-BASINS

The parcel is delineated into sub-basins according to the existing and proposed grading for existing and developed conditions.

Basin E is the entirety of the parcel representing existing conditions and consists of one on-site sub-basin. There are no off-site flows that enter the property due to the slope of the existing drive aisle between this lot and the neighboring lot.

Sub-basin E-1 (3.24 ac.; Q_5 = 0.81 cfs, Q_{100} = 5.27 cfs) is the entirety of Lots 3, 4, and 5 to be replatted via vacation into a single lot which contains natural vegetation that flows to the right of ways of Bismark Road, Canada Drive, and Constitution Ave. Those right of ways have curb and gutter directly adjacent to the lot that flow to a Public 15' CDOT Type R Curb Inlet. This public stormwater system is connected to a Public 24" RCP Storm Main that runs west to east along the south side of the lot within Constitution Avenue. The Public 15' & 5' CDOT Type R Curb Inlets located at the northwest and northeast corners, respectively, of the intersection of Canada Drive and Constitutions Avenue are branches that connect to the public stormwater main within Constitution Avenue. The public stormwater system ultimately flows to the East Fork Sand Creek.

EP1 is the existing conditions design point representing the Public 15' CDOT Type R Curb Inlet at the northwest corner at the intersection of Canada Drive and Constitution Avenue where sub-basin E-1 flows over the pervious lot containing native grasses and vegetation to the public roadways. The emergency flow route of this public storm inlet is due east along the north side of Constitution Avenue.

B. DEVELOPED MAJOR DRAINAGE BASIN AND SUB-BASINS

Basin D is the entirety of the developed parcel representing developed conditions and consists of eight sub-basins. There are no off-site flows that enter the property due to grading of the drive accesses to divert storm water away from the property near the property boundary.

Sub-basin D-1 (0.32 ac. ; Q_5 = 0.70 cfs, Q_{100} = 1.58 cfs) is the northwestern area of the development consisting of an asphalt drive access off of the common drive access for this property and the neighboring lot from Bismark Road as well as enclosed storage and large vehicle parking area that consists of compacted gravel. The sub-basin is sloped southeast and overland flow is directed to a concrete drainage pan within the drive aisle and channeled to a Private 3'x3' CDOT Type C Depressed Inlet with Grate.

DP1 is the Design Point representing the Private 3'x3' CDOT Type C Depressed Inlet with Grate for Sub-basin D-1. The Private Storm Inlet flows downstream to subsequent Design Points via the Private Storm Sewer system. The emergency flow route for DP1 is an overflow condition of the Private Storm Inlet that would cause storm water pooling within the northern drive aisle and would flow due east into Canada Drive and ultimately to the Public 15' CDOT Type R Curb Inlet at the northwest corner of the intersection of Canada Drive and Constitution Avenue.

Sub-basin D-2 (0.41 ac. ; Q_5 = 0.88 cfs, Q_{100} = 2.00 cfs) is the middle-north area of the development consisting of an asphalt drive access off of the common drive access for this property as well as enclosed storage and large vehicle parking area that consists of compacted gravel. The sub-basin is sloped southeast and overland flow is directed to the concrete drain pan within the drive aisle and channeled to a Private 3'x3' CDOT Type C Depressed Inlet with Grate, the second in a series of storm inlets in the northern area.

DP2 is the Design Point representing the Private 3'x3' CDOT Type C Depressed Inlet with Grate for Sub-basin D-2. The Private Storm Inlet flows downstream to subsequent Design Points via the Private Storm Sewer system. The emergency flow route for DP2 is an overflow condition of the Private Storm Inlet that would cause storm water pooling within the northern drive aisle and would flow due east into Canada Drive and ultimately to the Public 15' CDOT Type R Curb Inlet at the northwest corner of the intersection of Canada Drive and Constitution Avenue.

Sub-basin D-3 (0.52 ac. ; Q_5 = 0.93 cfs, Q_{100} = 2.29 cfs) is the northeast area of the development consisting of an asphalt drive access off of the common drive access for this property as well as enclosed storage and large vehicle parking area that consists of compacted gravel. The sub-basin is sloped southeast and overland flow is directed to the concrete drain pan within the drive aisle and channeled to a Private 3'x3' CDOT Type C Depressed Inlet with Grate, the third and last in a series of storm inlets in the northern area that conveys storm water via the Private Storm system south and toward a Full Spectrum Extended Detention Basin.

DP3 is the Design Point representing the Private 3'x3' CDOT Type C Depressed Inlet with Grate for Sub-basin D-3. The Private Storm Inlet flows downstream to subsequent Design Points via the Private Storm Sewer system. The emergency flow route for DP3 is an overflow condition of the Private Storm Inlet that would cause storm water pooling within the northern drive aisle and would flow due east into Canada Drive and ultimately to the Public 15' CDOT Type R Curb Inlet at the northwest corner of the intersection of Canada Drive and Constitution Avenue.

Sub-basin D-4 (0.46 ac. ; Q_5 = 1.64 cfs, Q_{100} = 3.01 cfs) is the southeast area of the development consisting of roof runoff from Units 9 through 13 as well as the south frontage parking lot. The sub-basin is generally sloped southeast within the parking lot, with other storm water conveyances via roof drains and curb and gutter. The sub-basin flows to a low point in the south parking curb and gutter where a proposed Private 10' CDOT Type R Curb Inlet collects storm water and conveys it to the Full Spectrum Extended Detention Basin via the Private Storm Sewer system.

DP4 is the Design Point representing the Private 10' CDOT Type R Curb Inlet for Sub-basin D-4. The Private Storm Inlet flows downstream to the Full Spectrum Extended Detention Basin via the Private Storm Sewer system. The emergency flow route for DP4 is an overflow condition of the Private Storm Inlet that would cause storm water pooling within the southern drive aisle indicated as a right turn only exit aisle and would flow due east into Canada Drive and ultimately to the Public 15' CDOT Type R Curb Inlet at the northwest corner of the intersection of Canada Drive and Constitution Avenue.

Sub-basin D-5 (0.79 ac. ; Q_5 = 2.86 cfs, Q_{100} = 5.22 cfs) is the southwest and middle-south area of the development consisting of roof runoff from Units 1 through 8 as well as the south frontage parking lot. The sub-basin is generally sloped southeast within the parking lot with other storm water conveyances via roof drains and curb and gutter. The sub-basin flows to a low point in the south parking curb and gutter just west of the proposed EDB where a proposed Private 20' CDOT Type R Curb Inlet collects storm water and conveys it to the Full Spectrum Extended Detention Basin via the Private Storm Sewer system.

DP5 is the Design Point representing the Private 20' CDOT Type R Curb Inlet for Sub-basin D-5. The Private Storm Inlet flows downstream to the Full Spectrum Extended Detention Basin via the Private Storm Sewer system. The emergency flow route for DP4 is an overflow condition of the Private Storm Inlet that would cause storm water pooling within the southern parking lot area and would pool for 6" before spilling into the landscaping area surrounding the EDB and ultimately entering the EDB.

Based on proposed contours, water will spill onto sidewalk before entering EDB.

Sub-basin D-6 (0.07 ac. ; Q_5 = 0.08 cfs, Q_{100} = 0.26 cfs) accounts for the tributary area of the development that consists of the Full Spectrum Extended Detention Basin footprint. Runoff in this area is directly collected by the basin.

DP6 is the Design Point representing the Full Spectrum Extended Detention Basin that is designed to detain a major storm event for the developed lot and provide Water Quality. The EDB is proposed to consist of 6-foot high Redirock structural walls with a detention volume of 16,500 cubic feet. The EDB consists of concrete trickle channel, micropool, and outlet structure with an engineered orifice plate to comply with release rates for Water Quality Capture Volume, Excess Urban Runoff Volume, and the 100-Year Major Storm Event. The emergency spillway of the Design Point results in storm water spilling over the walls and flowing due south to Constitution Avenue, ultimately flowing into the existing Public 15' CDOT Type R Curb Inlet (DP7) at the northwest corner of the intersection of Canada Drive and Constitution Avenue.

Sub-basin D-7 (0.54 ac. ; Q_5 = 0.55 cfs, Q_{100} = 1.87 cfs) is the tributary area within the property boundary that flows toward the adjacent right of ways of Bismark Road, Canada Drive, and Constitution Avenue. The sub-basin consists mostly of proposed landscaped areas, public concrete sidewalk, and ingress/egress curb cuts. The sub-basin flows to Design Point 7 via the adjacent roadways' curb and gutter, ultimately to the Public 15' CDOT Type R Curb Inlet at the northwest corner of the intersection of Canada Drive and Constitution Avenue.

DP7 is the Design Point representing the Public 15' CDOT Type R Curb Inlet at the northwest corner of the intersection of Canada Drive and Constitution Avenue. This Public Storm Inlet is a branch line of the Public Storm Main that runs west to east within Constitution Avenue and is the ultimate recipient of storm water flow from the developed lot as it is proposed to be connected to the outlet structure of the EDB (DP6). The emergency flow route of this public storm inlet is due east along the north side of Constitution Avenue.

Appropriate spillway needs to be constructed, cannot just overflow sidewalls of pond

Engineer must confirm in the Drainage Report that the existing pond is functioning as intended.

Sub-basin D-8 (0.10 ac. ; Q_5 = 0.40 cfs, Q_{100} = 0.74 cfs) is the tributary area within the property boundary that consists of the common drive access off of Bismark Road to be extended to the south parking lot frontage of the development as well as a small landscaped portion at the south side of the lot. This sub-basin previously flowed southeast to the public storm system and is proposed to flow to the existing water quality control measure constructed for the neighboring lot. If existing drainage patterns were adhered to at the west property boundary, the new development would take on excess storm water runoff from the neighboring parcel. Grading of the extended drive aisle due south is to create a slight slope due west as originally intended to keep storm water of the respective lots directed toward their respective control measures.

confirm that this offsite WQ Pond was sized for inflow from the Site. Provide UD Detention Form

DP8 is the Design Point representing the Water Quality Capture Volume BMP/control measure constructed for the neighboring lot (Northcrest Center Fil No 2 Lots 1 & 2). The emergency overflow of DP8 is via a sidewalk chase directly south to the curb and gutter of Constitution Avenue and ultimately to the existing Public 15' CDOT Type R Curb Inlet (DP7) at the northwest corner of the intersection of Canada Drive and Constitution Avenue.

The difference between Basin E and Basin D results in an overall increase of the 100-year storm water volume overall due to increased impervious surfaces.

The total storm water flow generated from the entirety of the 3.24 acre lot for the major (100-year) storm event for existing conditions, with an effective imperviousness of 1.5 percent, is 5.27 cfs. The major storm event runoff for developed conditions, with an effective imperviousness of 62.5 percent, is 16.97 cfs.

Of the total 3.24-acre lot, a tributary area of 2.59 acres with an effective imperviousness of 68.1 percent drains to the Full Spectrum Detention Basin, totaling 14.36 cfs, 87 percent of the total site runoff.

The remaining 0.65 acres has an effective 29.8 percent imperviousness and flows over mostly landscaped area and public concrete sidewalk to the respective roadways, ultimately to the public storm system. The combined 3.24-acre lot has a composite imperviousness of 62.6%. The developed conditions yield a major storm runoff of 2.61 cfs that flows directly to the public storm system for the 100yr storm. This is directly comparable to the existing drainage condition that yielded 5.27 cfs of storm water runoff for a major storm event. This is an approximately 50 percent decrease in runoff directly captured by the existing drainage system.

A Full Spectrum Extended Detention Basin is proposed for the site to provide water quality and detention prior to attenuated storm water release to the public storm system.

It is anticipated that there will be no negative impact to downstream developments or infrastructure as a result of this development.

IV. DRAINAGE DESIGN CRITERIA

A. REGULATIONS

The hydrological and hydraulic calculations and design of the site conform to the City of Colorado Springs Drainage Criteria Manuals I and II (latest revision, May 2014) as well as the Mile High Flood District Drainage Criteria manuals revised August 2018.

B. DEVELOPMENT CRITERIA REFERENCE AND CONSTRAINTS

The parcel falls within the Sand Creek major drainage basin (East Fork Sand Creek) designated by the City of Colorado Springs Water Resources Engineering Department with the ultimate receiving waters of Arkansas River. The drainage on this parcel will have no effect on downstream infrastructure or facilities, streets, utilities, transit, or further development of adjacent lots. Relevant criteria for the calculations shown further include equations and design criteria for the rational method, volumes and runoff of carious storm events.

C. HYDROLOGICAL CRITERIA

The rational method was used to calculate the peak runoff of the delineated sub-basins using the manuals referenced prior with the C, I, and P1 values from the Design Criteria Manual Volume I, Chapter 6 as well as the Colorado Springs designated IDF curve values. Specific calculations and tables are provided further with inputs including design rainfall, sub-basin acreage and percent imperviousness, runoff coefficients, one-hour rainfall depths, rainfall intensities, time of concentration, and peak discharge of various storm events. The default rainfall intensities and volumes use runoff coefficients based on soil types. Weighted runoff coefficients were calculated for each basin and sub-basin due to the mix of impervious surfaces, shown in the Appendix exhibits.

D. FOUR-STEP PROCESS

The selection of appropriate control measures is based on the characteristics of the site and potential pollutants. The Four-Step Process provides a method of going through the selection process. The following applies the four-step process to the Development Plan for the Northcrest Center.

Step 1: Employ Runoff Reduction Practices

The Development Plan including the Landscape Plan utilizes landscaping areas for plantings and grass or mulch wherever possible without obstructing utilities or drainageways. Given the proposed land use, the majority of the site is to be paved for vehicular use. Within the mostly-impervious site, the storm water runoff is kept to the site limits by use of grading, a private storm system and all other areas are to be landscaped, including the right of way landscape buffer areas.

Step 2: Provide Water Quality Capture Volume

The Development Plan and Final Drainage Report indicate the use of a storm water detention pond as a control measure for capturing storm water runoff and properly treating the storm water prior to release either via percolation into the soil or attenuated to the public storm system. The detention pond is to be installed and the configuration is sized for capture of the WQCV as well as the EURV and full-spectrum detention, and 100-year detention.

Step 3: Stabilize Drainageways

The drainage within the site is stabilized by way of pavement with features such as drainage pans, curb and gutter, and sloped pavement to direct storm water to the private storm system. There are no unpaved or unstabilized drainageways on this site.

Step 4: Implement Site Specific and Other Source Control BMPs

No control measures beyond the Full Spectrum Extended Detention Basin are proposed as there are no unusual land uses that would result in the need for other source control BMPs.

V. Drainage Infrastructure Costs and Fees

A. Drainage and Bridge Fees

The development falls within the Sand Creek drainage basin (FOFO4000) which has a drainage basin fee of $20,387 per impervious acre and a bridge fee of $8,339 per impervious acre according to the 2021 El Paso County Drainage Basin Fees document. The development has a total impervious acreage of 2.03acres (3.24acres * 62.6% imperviousness).

Drainage Basin Fee: $20,387/impervious acre * 2.03 impervious acres = $41,385.61

Bridge Fee: $8,339/impervious acre * 2.03 impervious acres = $16,928.17

Since the site is already platted, drainage fees are assumed to have already been paid. Since this development is increasing imperviousness, the County shall review their records and make a decision on fee requirements.

Any outstanding fees must be paid prior to plat recordation.

B. Storm Drain System Quantities and Costs Estimate

The following summarizes the Engineer's Opinion of Probable Cost for the proposed storm facilities for the development (installation plus materials).

Private System

Description	Quantity	Unit	Unit Price	Cost
Earthwork for cut of Pond (Less than 1,000)	612	CY	$ 8	$ 4,896
Concrete Drainage Channel	2	CY	$ 590	$ 1,180
12" RCP	230	LF	$ 55	$ 12,650
18" RCP	226	LF	$ 65	$ 14,690
24" RCP	74	LF	$ 78	$ 5,772
Curb Inlet (Type R) L=10' 5' ≤ Depth < 10'	1	EA	$ 8,136	$ 8,136
Curb Inlet (Type R) L=20' 5' ≤ Depth < 10'	1	EA	$ 11,005	$ 11,005
Pond Outlet Structure	1	EA	$ 10,000	$ 10,000
Grated Inlet (Type C) Depth < 5'	3	EA	$ 4,802	$ 14,406
Storm Sewer Manhole, Box Base	1	EA	$ 12,034	$ 12,034

Total Cost	**$ 94,769.0**
Engineering Contingency (10%)	**$ 9,476.9**
Grand Total (w/ Contingency)	**$ 104,245.9**
Non-Reimbursable	**$ 104,245.9**

VI. Conclusions

A. Compliance with Standards

The criteria used to design the storm water runoff volumes are formulas and figures within the City of Colorado Springs Drainage Manuals as well as the Mile High Flood District Drainage Criteria manual. Grading practices for optimal drainage shall comply with the geotechnical investigative report and City standards. The development of Lots 3-5 is within compliance and standards and meets the requirements for the Northcrest Center.

The proposed grading and drainage is within substantial conformance for the master drainage plan for the Subdivision and Drainage Basin. There is no impact on major drainageway planning studies within the larger drainage basin. This development will not adversely affect downstream development.

VII. REFERENCES

Colorado Springs Drainage Manual Volumes I & II (May 2014)

Colorado Urban Drainage and Flood Control District Drainage Criteria Manual, Volume I (August 2018)

Colorado Urban Drainage and Flood Control District Drainage Criteria Manual, Volume III (April 2018)

Urban Storm Drainage Criteria Manual, Volume III (November, 2015)

FEMA Flood Map Service Center

United States Department of Agriculture National Resources Conservation Service

Subsurface Soil Investigation prepared by RMG-Rocky Mountain Group Engineers dated February 23, 2021

VIII. Appendices

APPENDIX A – VICINITY MAP

VICINITY MAP

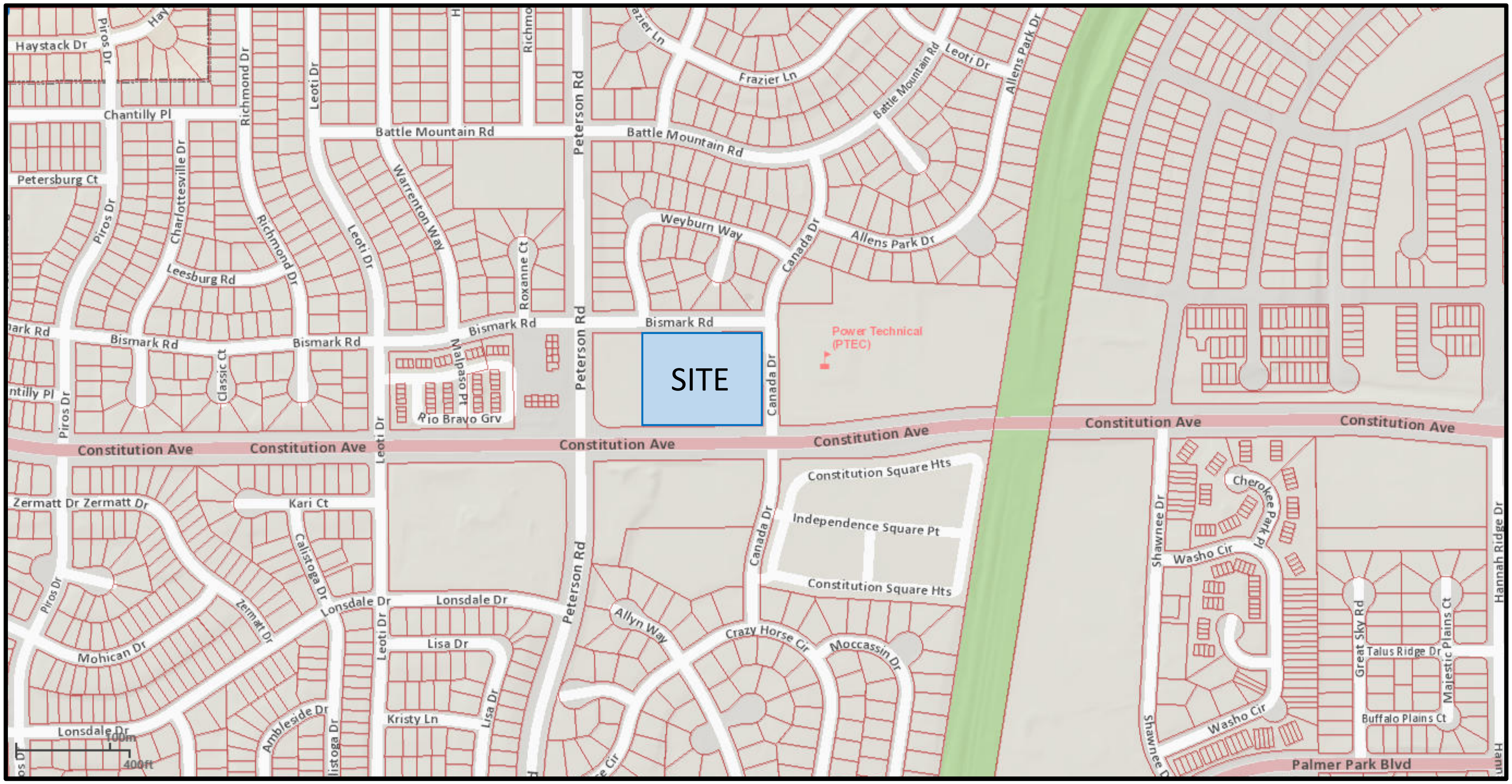
NORTHCREST CENTER

TBD BISMARK ROAD

COLORADO SPRINGS, COLORADO 80922

EL PASO COUNTY

N



APPENDIX B – HYDROLOGIC AND HYDRAULIC COMPUTATIONS

Project: Northcrest Center PEMBs Development - EXISTING CONDITIONS
Engineer: Scott Marvel, PE
Date: 10/18/2021
Address: TBD Bismark Rd. Colorado Springs, Colorado

Sub-Basin:	**E-1**	**(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)**			
t_t Duration:	**26.01**				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
2.157273203	2.69510908	3.1444606	3.5938121	4.0431636	4.5233433

Hydrologic Soil Type:	**A**

Coefficient (Table 6-6)

Land Use or Surface Characteristic	Square Feet	Acreage	$Coefficient_2$	$Coefficient_5$	$Coefficient_{10}$	$Coefficient_{25}$	$Coefficient_{50}$	$Coefficient_{100}$
Roof	0	0.000	0.71	0.73	0.75	0.78	0.80	0.81
Pavement	2155	0.049	0.89	0.90	0.92	0.94	0.95	0.96
Lawn	139193	3.195	0.02	0.08	0.15	0.25	0.30	0.35
A_t:	141348.11	3.245						

Land Use or Surface Characteristic	2 Yr: $C_i * A_i$	5 Yr: $C_i * A_i$	10 Yr: $C_i * A_i$	25 Yr: $C_i * A_i$	50 Yr: $C_i * A_i$	100 Yr: $C_i * A_i$
Roof	0.000	0.000	0.000	0.000	0.000	0.000
Pavement	0.044	0.045	0.046	0.047	0.047	0.047
Lawn	0.064	0.256	0.479	0.799	0.959	1.118
A_t:						

2 Yr C_c	5 Yr C_c	10 Yr C_c	25 Yr C_c	50 Yr C_c	100 Yr C_c
0.033	**0.093**	**0.162**	**0.261**	**0.310**	**0.359**

Q Peak Flow (cfs)

2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
0.23	**0.81**	**1.65**	**3.04**	**4.07**	**5.27**

Design Points

Design Point	Q_5	Q_{10}	Q_{100}
EX DP1	0.81	1.65	5.27
Total Site	**0.81**	**1.65**	**5.27**

Time of Concentration $t_c = t_i + t_t$

3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \quad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

Sub-Basin or DP:	E-1	
C_5:	0.09	[Table 6-6. Runoff Coefficients for Rational Method]
L:	550	ft
S:	0.045	ft/ft

Composite Runoff Coefficient Calculation:

$C_c = (C_1A_1 + C_2A_2 + C_3A_3 + \ldots C_iA_i) / A_t$

Land Use or Surface Characteristic	Square Feet	Acreage	C_5
Roof	0	0.00	0.73
Pavement	2155	0.05	0.90
Lawn	139193	3.20	0.08
A_t :	141348	3.24	

*C_c = (0.90*0.04 + 0.08*3.20) / 3.24 =* **0.09**

t_i = (0.395(1.1-C_5)*sqrt(L))/(S^0.33)*
t_i = (0.395(1.1-0.09)*sqrt(550))/(* ***0.045*** *^0.33) =* **25.96** mins

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \quad \text{(Eq. 6-9)}$$

Where:

V = velocity (ft/s)
C_v = conveyance coefficient (from Table 6-7)
S_w = watercourse slope (ft/ft)

$V = C_v S_w^{0.5}$
$V = (20)(0.006)^{0.5}$ = **1.55** ft/s

Flow Distance: **5.00** ft

t_t = L/V = 3.23 sec.
0.05 min.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

*For buried riprap, select C_v value based on type of vegetative cover.

$t_c = t_i + t_t$ = **26.01** min.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

Final t_c: **26.01** min.

Project: Northcrest Center PEMBs Commercial Development - DEVELOPED CONDITIONS
Engineer: Scott Marvel, PE
Date: 10/18/2021
Address: TBD Bismark Road

Sub-Basin:	D-1	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_t Duration:	7.83				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
3.585515386	4.495414352	5.2448167	5.9942191	6.7436215	7.5478561

Hydrologic Soil Type:	A

Coefficient (Table 6-6)

Land Use or Surface Characteristic	Square Feet	Acreage	$Coefficient_2$	$Coefficient_5$	$Coefficient_{10}$	$Coefficient_{25}$	$Coefficient_{50}$	$Coefficient_{100}$	2 Yr: $C_i * A_i$	5 Yr: $C_i * A_i$	10 Yr: $C_i * A_i$	25 Yr: $C_i * A_i$	50 Yr: $C_i * A_i$	100 Yr: $C_i * A_i$	2 Yr C_c	5 Yr C_c	10 Yr C_c	25 Yr C_c	50 Yr C_c	100 Yr C_c
Roof	0	0.000	0.71	0.73	0.75	0.78	0.80	0.81	0.000	0.000	0.000	0.000	0.000	0.000	**0.447**	**0.482**	**0.528**	**0.588**	**0.619**	**0.649**
Pavement	6964	0.160	0.89	0.90	0.92	0.94	0.95	0.96	0.142	0.144	0.147	0.150	0.152	0.153						
Lawn & Gravel	7240	0.166	0.02	0.08	0.15	0.25	0.30	0.35	0.003	0.013	0.025	0.042	0.050	0.058						
A_t:	14204	0.326																		

Q Peak Flow (cfs)

2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
0.52	**0.70**	**0.89**	**1.14**	**1.35**	**1.58**

Sub-Basin:	D-2	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_t Duration:	8.08				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
3.548739946	4.449058756	5.1907352	5.9324117	6.6740881	7.4699787

Hydrologic Soil Type:	A

Coefficient (Table 6-6)

Land Use or Surface Characteristic	Square Feet	Acreage	$Coefficient_2$	$Coefficient_5$	$Coefficient_{10}$	$Coefficient_{25}$	$Coefficient_{50}$	$Coefficient_{100}$	2 Yr: $C_i * A_i$	5 Yr: $C_i * A_i$	10 Yr: $C_i * A_i$	25 Yr: $C_i * A_i$	50 Yr: $C_i * A_i$	100 Yr: $C_i * A_i$	2 Yr C_c	5 Yr C_c	10 Yr C_c	25 Yr C_c	50 Yr C_c	100 Yr C_c
Roof	0	0.000	0.71	0.73	0.75	0.78	0.80	0.81	0.000	0.000	0.000	0.000	0.000	0.000	**0.446**	**0.482**	**0.527**	**0.588**	**0.618**	**0.649**
Pavement	8793	0.202	0.89	0.90	0.92	0.94	0.95	0.96	0.180	0.182	0.186	0.190	0.192	0.194						
Lawn	9159	0.210	0.02	0.08	0.15	0.25	0.30	0.35	0.004	0.017	0.032	0.053	0.063	0.074						
A_t:	17952	0.412																		

Q Peak Flow (cfs)

2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
0.65	**0.88**	**1.13**	**1.44**	**1.70**	**2.00**

Sub-Basin:	D-3	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_t Duration:	10.08				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
3.284994319	4.116606284	4.802874	5.4891417	6.1754094	6.9114586

Hydrologic Soil Type:	A

Coefficient (Table 6-6)

Land Use or Surface Characteristic	Square Feet	Acreage	$Coefficient_2$	$Coefficient_5$	$Coefficient_{10}$	$Coefficient_{25}$	$Coefficient_{50}$	$Coefficient_{100}$	2 Yr: $C_i * A_i$	5 Yr: $C_i * A_i$	10 Yr: $C_i * A_i$	25 Yr: $C_i * A_i$	50 Yr: $C_i * A_i$	100 Yr: $C_i * A_i$	2 Yr C_c	5 Yr C_c	10 Yr C_c	25 Yr C_c	50 Yr C_c	100 Yr C_c
Roof	0	0.000	0.71	0.73	0.75	0.78	0.80	0.81	0.000	0.000	0.000	0.000	0.000	0.000	**0.362**	**0.402**	**0.452**	**0.521**	**0.555**	**0.589**
Pavement	8902	0.204	0.89	0.90	0.92	0.94	0.95	0.96	0.182	0.184	0.188	0.192	0.194	0.196						
Lawn	13776	0.316	0.02	0.08	0.15	0.25	0.30	0.35	0.006	0.025	0.047	0.079	0.095	0.111						
A_t:	22678	0.521																		

Q Peak Flow (cfs)

2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
0.67	**0.93**	**1.22**	**1.61**	**1.93**	**2.29**

Sub-Basin:	D-4	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_t Duration:	5.00				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
4.119768884	5.168843131	6.0304837	6.8921242	7.7537647	8.6792165

Hydrologic Soil Type:	A

Coefficient (Table 6-6)

Land Use or Surface Characteristic	Square Feet	Acreage	$Coefficient_2$	$Coefficient_5$	$Coefficient_{10}$	$Coefficient_{25}$	$Coefficient_{50}$	$Coefficient_{100}$	2 Yr: $C_i * A_i$	5 Yr: $C_i * A_i$	10 Yr: $C_i * A_i$	25 Yr: $C_i * A_i$	50 Yr: $C_i * A_i$	100 Yr: $C_i * A_i$	2 Yr C_c	5 Yr C_c	10 Yr C_c	25 Yr C_c	50 Yr C_c	100 Yr C_c
Roof	12040	0.276	0.71	0.73	0.75	0.78	0.80	0.81	0.196	0.202	0.207	0.216	0.221	0.224	**0.781**	**0.797**	**0.817**	**0.843**	**0.859**	**0.869**
Pavement	8104	0.186	0.89	0.90	0.92	0.94	0.95	0.96	0.166	0.167	0.171	0.175	0.177	0.179						
Lawn	45	0.001	0.02	0.08	0.15	0.25	0.30	0.35	0.000	0.000	0.000	0.000	0.000	0.000						
A_t:	20189	0.463																		

Q Peak Flow (cfs)

2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
1.28	**1.64**	**1.97**	**2.32**	**2.66**	**3.01**

Sub-Basin:	D-5	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_t Duration:	8.50				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
3.488148863	4.372683441	5.1016307	5.8305779	6.5595252	7.3416682

Hydrologic Soil Type:	A

Coefficient (Table 6-6)

Land Use or Surface Characteristic	Square Feet	Acreage	$Coefficient_2$	$Coefficient_5$	$Coefficient_{10}$	$Coefficient_{25}$	$Coefficient_{50}$	$Coefficient_{100}$	2 Yr: $C_i * A_i$	5 Yr: $C_i * A_i$	10 Yr: $C_i * A_i$	25 Yr: $C_i * A_i$	50 Yr: $C_i * A_i$	100 Yr: $C_i * A_i$	2 Yr C_c	5 Yr C_c	10 Yr C_c	25 Yr C_c	50 Yr C_c	100 Yr C_c
Roof	17775	0.408	0.71	0.73	0.75	0.78	0.80	0.81	0.290	0.298	0.306	0.318	0.326	0.331	**0.793**	**0.809**	**0.829**	**0.854**	**0.870**	**0.880**
Pavement	16645	0.382	0.89	0.90	0.92	0.94	0.95	0.96	0.340	0.344	0.352	0.359	0.363	0.367						
Lawn	175	0.004	0.02	0.08	0.15	0.25	0.30	0.35	0.000	0.000	0.001	0.001	0.001	0.001						
A_t:	34595	0.794																		

Q Peak Flow (cfs)

2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
2.24	**2.86**	**3.42**	**4.03**	**4.61**	**5.22**

Sub-Basin:	D-6	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_c Duration:	5.00				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
4.119768884	5.168843131	6.0304837	6.8921242	7.7537647	8.6792165

Hydrologic Soil Type:	A

Coefficient (Table 6-6)

Land Use or Surface Characteristic	Square Feet	Acreage	Coefficient $_2$	Coefficient $_5$	Coefficient $_{10}$	Coefficient $_{25}$	Coefficient $_{50}$	Coefficient $_{100}$	2 Yr: $C_i * A_i$	5 Yr: $C_i * A_i$	10 Yr: $C_i * A_i$	25 Yr: $C_i * A_i$	50 Yr: $C_i * A_i$	100 Yr: $C_i * A_i$	2 Yr C_c	5 Yr C_c	10 Yr C_c	25 Yr C_c	50 Yr C_c	100 Yr C_c
Roof	0	0.000	0.71	0.73	0.75	0.78	0.80	0.81	0.000	0.000	0.000	0.000	0.000	0.000	**0.201**	**0.251**	**0.310**	**0.394**	**0.435**	**0.477**
Pavement	654	0.015	0.89	0.90	0.92	0.94	0.95	0.96	0.013	0.014	0.014	0.014	0.014	0.014						
Lawn	2487	0.057	0.02	0.08	0.15	0.25	0.30	0.35	0.001	0.005	0.009	0.014	0.017	0.020						
A_t:	3141	0.072																		

Q Peak Flow (cfs)

2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
0.05	**0.08**	**0.12**	**0.17**	**0.21**	**0.26**

Sub-Basin:	D-7	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_c Duration:	9.60				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
3.343994973	4.190976856	4.8896397	5.5883025	6.2869653	7.0364011

Hydrologic Soil Type:	A

Coefficient (Table 6-6)

Land Use or Surface Characteristic	Square Feet	Acreage	Coefficient $_2$	Coefficient $_5$	Coefficient $_{10}$	Coefficient $_{25}$	Coefficient $_{50}$	Coefficient $_{100}$	2 Yr: $C_i * A_i$	5 Yr: $C_i * A_i$	10 Yr: $C_i * A_i$	25 Yr: $C_i * A_i$	50 Yr: $C_i * A_i$	100 Yr: $C_i * A_i$	2 Yr C_c	5 Yr C_c	10 Yr C_c	25 Yr C_c	50 Yr C_c	100 Yr C_c
Roof	0	0.000	0.71	0.73	0.75	0.78	0.80	0.81	0.000	0.000	0.000	0.000	0.000	0.000	**0.174**	**0.225**	**0.286**	**0.372**	**0.415**	**0.458**
Pavement	4220	0.097	0.89	0.90	0.92	0.94	0.95	0.96	0.086	0.087	0.089	0.091	0.092	0.093						
Lawn	19604	0.450	0.02	0.08	0.15	0.25	0.30	0.35	0.009	0.036	0.068	0.113	0.135	0.158						
A_t:	23824	0.547																		

Q Peak Flow (cfs)

2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
0.34	**0.55**	**0.81**	**1.21**	**1.52**	**1.87**

Sub-Basin:	D-8	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_c Duration:	5.00				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
4.119768884	5.168843131	6.0304837	6.8921242	7.7537647	8.6792165

Hydrologic Soil Type:	A

Coefficient (Table 6-6)

Land Use or Surface Characteristic	Square Feet	Acreage	Coefficient $_2$	Coefficient $_5$	Coefficient $_{10}$	Coefficient $_{25}$	Coefficient $_{50}$	Coefficient $_{100}$	2 Yr: $C_i * A_i$	5 Yr: $C_i * A_i$	10 Yr: $C_i * A_i$	25 Yr: $C_i * A_i$	50 Yr: $C_i * A_i$	100 Yr: $C_i * A_i$	2 Yr C_c	5 Yr C_c	10 Yr C_c	25 Yr C_c	50 Yr C_c	100 Yr C_c
Roof	0	0.000	0.71	0.73	0.75	0.78	0.80	0.81	0.000	0.000	0.000	0.000	0.000	0.000	**0.808**	**0.823**	**0.848**	**0.875**	**0.889**	**0.903**
Pavement	4304	0.099	0.89	0.90	0.92	0.94	0.95	0.96	0.088	0.089	0.091	0.093	0.094	0.095						
Lawn	446	0.010	0.02	0.08	0.15	0.25	0.30	0.35	0.000	0.001	0.002	0.003	0.003	0.004						
A_t:	4750	0.109																		

Q Peak Flow (cfs)

2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
0.31	**0.40**	**0.48**	**0.57**	**0.65**	**0.74**

Design Points			Cumulative Flows (Series)		
Design Point	Q_5	Q_{100}	Design Point	Q_5	Q_{100}
DP1	0.70	1.58	DP1	0.70	1.58
DP2	0.88	2.00	DP2	1.58	3.58
DP3	0.93	2.29	DP3	2.51	5.87
DP4	1.64	3.01	DP4	4.16	8.88
DP5	2.86	5.22	DP5	2.86	5.22
DP6	0.08	0.26	DP6	7.09	14.36
DP7	0.55	1.87	DP7	0.55	1.87
DP8	0.40	0.74	DP8	0.40	0.74
TOTAL	8.04	16.96			
TOTAL ON-SITE	7.09	14.36			
TOTAL OFF-SITE	0.95	2.61			

SITE IMPERVIOUSNES COMPOSITE CALCULATION

	ACREAGE	% OF TOTAL AREA	COEFFICIENT, MINOR STORM (5-YR)	$C_5 * A_i$	COMPOSITE IMPERVIOUSNESS (5-YR)	COEFFICIENT, MAJOR STORM (100-YR)	$C_{100} * A_i$	COMPOSITE IMPERVIOUSNESS (100-YR)
Roof	0.684	21.10%	0.73	0.500	15.40%	0.81	0.554	17.09%
Pavement	1.345	41.45%	0.90	1.210	37.31%	0.96	1.291	39.79%
Lawn	1.215	37.45%	0.08	0.097	3.00%	0.35	0.425	13.11%
TOTAL	3.245	100.00%						
	IMPERVIOUSNESS:	62.55%	COMPOSITE IMPERVIOUSNESS:		55.70%			69.99%

SEE IRF CALCULATIONS FOR FINAL EFFECTIVE IMPERVIOUSNESS FOR EACH RESPECTIVE SUB-BASIN & BMP

Time of Concentration $t_c = t_i + t_t$

3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \qquad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

Sub-Basin or DP:	D-1	
C_5:	0.48	[Table 6-6. Runoff Coefficients for Rational Method]
L:	145	ft
S:	0.055	ft/ft

Composite Runoff Coefficient Calculation:

$C_c = (C_1A_1 + C_2A_2 + C_3A_3 + ...C_iA_i) / A_t$

Land Use or Surface Characteristic	Square Feet	Acreage	C_5
Roof	0	0.00	0.73
Pavement	6964	0.16	0.90
Lawn	7240	0.17	0.08
A_t :	14204	0.33	

C_c = (0.90*0.16 + 0.08*0.17) / 0.33 = **0.48**

t_i = (0.395*(1.1-C_5)*sqrt(L))/(S^0.33)

t_i = (0.395*(1.1-0.48)*sqrt(145))/(**0.055** ^0.33) = **7.71** mins

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \qquad \text{(Eq. 6-9)}$$

Where:

V = velocity (ft/s)
C_v = conveyance coefficient (from Table 6-7)
S_w = watercourse slope (ft/ft)

$V = C_v S_w^{0.5}$

$V = (20)(0.041)^{0.5}$ = **4.05** ft/s

Flow Distance: **30.00** ft

t_t = L/V = 7.41 sec.
0.12 min.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

*For buried riprap, select C_v value based on type of vegetative cover.

$t_c = t_i + t_t$ = **7.83** min.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

Final t_c: **7.83** min.

Time of Concentration $t_c = t_i + t_t$

3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \qquad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

Sub-Basin or DP:	D-2	
C_5:	0.48	[Table 6-6. Runoff Coefficients for Rational Method]
L:	135	ft
S:	0.05	ft/ft

Composite Runoff Coefficient Calculation:

$C_c = (C_1 A_1 + C_2 A_2 + C_3 A_3 + ...C_i A_i) / A_t$

Land Use or Surface Characteristic	Square Feet	Acreage	C_5
Roof	0	0.00	0.73
Pavement	8793	0.20	0.90
Lawn	9159	0.21	0.08
A_t :	17952	0.41	

$C_c = (0.90*0.20 + 0.08*0.21) / 0.41 =$ **0.48**

$t_i = (0.395*(1.1-C_5)*sqrt(L))/(S\text{^}0.33)$

$t_i = (0.395*(1.1-0.48)*sqrt(135))/($ **0.05** $\text{^}0.33) =$ **7.65** mins

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \qquad \text{(Eq. 6-9)}$$

Where:

V = velocity (ft/s)
C_v = conveyance coefficient (from Table 6-7)
S_w = watercourse slope (ft/ft)

$V = C_v S_w^{0.5}$

$V = (20)(0.041)^{0.5} =$ **4.05** ft/s

Flow Distance: **105.00** ft

$t_t = L/V =$ 25.93 sec.
0.43 min.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

*For buried riprap, select C_v value based on type of vegetative cover.

$t_c = t_i + t_t$ = **8.08** min.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

Final t_c: **8.08** min.

Time of Concentration $t_c = t_i + t_t$

3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \quad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft <u>maximum</u> for non-urban land uses, 100 ft <u>maximum</u> for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

Sub-Basin or DP:	D-3	
C_5:	0.40	[Table 6-6. Runoff Coefficients for Rational Method]
L:	155	ft
S:	0.043	ft/ft

Composite Runoff Coefficient Calculation:

$C_c = (C_1A_1 + C_2A_2 + C_3A_3 + ...C_iA_i) / A_t$

Land Use or Surface Characteristic	Square Feet	Acreage	C_5
Roof	0	0.00	0.73
Pavement	8902	0.20	0.90
Lawn	13776	0.32	0.08
A_t :	22678	0.52	

$C_c = (0.90*0.20 + 0.08*0.32) / 0.52 =$ **0.40**

$t_i = (0.395*(1.1-C_5)*sqrt(L))/(S^{0.33})$

$t_i = (0.395*(1.1-0.40)*sqrt(155))/($ **0.043** $^{0.33}) =$ **9.79** mins

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \quad \text{(Eq. 6-9)}$$

Where:

V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

$V = C_v S_w^{0.5}$

$V = (20)(0.02)^{0.5} =$ **4.05** ft/s

Flow Distance: **72.00** ft

$t_t = L/V =$ 17.78 sec.

0.30 min.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

*For buried riprap, select C_v value based on type of vegetative cover.

$t_c = t_i + t_t =$ 10.08 min.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

Final t_c: 10.08 min.

Time of Concentration $t_c = t_i + t_t$

3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \quad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

Sub-Basin or DP:	D-4	
C_5:	0.82	[Table 6-6. Runoff Coefficients for Rational Method]
L:	90	ft
S:	0.04	ft/ft

Composite Runoff Coefficient Calculation:

$C_c = (C_1 A_1 + C_2 A_2 + C_3 A_3 + ...C_i A_i) / A_t$

Land Use or Surface Characteristic	Square Feet	Acreage	C_5
Roof	12040	0.28	0.73
Pavement	8104	0.19	0.90
Lawn	45	0.001	0.08
A_t :	20189	0.46	

C_c = (0.73*0.28 + 0.90*0.19 + 0.08*0.001) / 0.46 = **0.82**

t_i = (0.395*(1.1-C_5)*sqrt(L))/(S^0.33)

t_i = (0.395*(1.1- **0.82**)*sqrt(90))/(**0.04** ^0.33) = **3.08** mins

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \quad \text{(Eq. 6-9)}$$

Where:

V = velocity (ft/s)
C_v = conveyance coefficient (from Table 6-7)
S_w = watercourse slope (ft/ft)

$V = C_v S_w^{0.5}$

$V = (20)(0.013)^{0.5}$ = **4.15** ft/s

Flow Distance: **130.00** ft

t_t = L/V = 31.35 sec.
0.52 min.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

*For buried riprap, select C_v value based on type of vegetative cover.

$t_c = t_i + t_t$ = 3.60 min.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

Final t_c: 5.00 min.

Time of Concentration $t_c = t_i + t_t$

3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \quad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

Sub-Basin or DP:	D-5	
C_5:	0.47	[Table 6-6. Runoff Coefficients for Rational Method]
L:	125	ft
S:	0.046	ft/ft

Composite Runoff Coefficient Calculation:

$C_c = (C_1 A_1 + C_2 A_2 + C_3 A_3 + \ldots C_i A_i) / A_t$

Land Use or Surface Characteristic	Square Feet	Acreage	C_5
Roof	17775	0.41	0.73
Pavement	16645	0.38	0.90
Lawn	175	0.004	0.08
A_t :	34595	0.794	

C_c = (0.73*0.41 + 0.90*0.38 + 0.08*0.004) / 0.794 = **0.47**

t_i = (0.395*(1.1-C_5)*sqrt(L))/(S^0.33)

t_i = (0.395*(1.1- **0.47**)*sqrt(125))/(**0.046** ^0.33) = **7.70** mins

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \quad \text{(Eq. 6-9)}$$

Where:

V = velocity (ft/s)
C_v = conveyance coefficient (from Table 6-7)
S_w = watercourse slope (ft/ft)

$V = C_v S_w^{0.5}$

$V = (20)(0.055)^{0.5}$ = **4.47** ft/s

Flow Distance: **215.00** ft

t_t = L/V = 48.08 sec.
0.80 min.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

* For buried riprap, select C_v value based on type of vegetative cover.

$t_c = t_i + t_t$ = **8.50** min.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

Final t_c: **8.50** min.

Time of Concentration $t_c = t_i + t_t$

3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \quad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft <u>maximum</u> for non-urban land uses, 100 ft <u>maximum</u> for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

Sub-Basin or DP:	D-6	
C_5:	0.33	[Table 6-6. Runoff Coefficients for Rational Method]
L:	7	ft
S:	10	ft/ft

Composite Runoff Coefficient Calculation:

$C_c = (C_1A_1 + C_2A_2 + C_3A_3 + ...C_iA_i) / A_t$

Land Use or Surface Characteristic	Square Feet	Acreage	C_5
Roof	0	0.00	0.73
Pavement	654	0.02	0.90
Lawn	2487	0.06	0.08
A_t :	3141	0.07	

*C_c = (0.90*0.02 + 0.08*0.06) / 0.07 =* **0.33**

t_i = (0.395(1.1-C_5)*sqrt(L))/(S^0.33)*

t_i = (0.395(1.1- **0.33**)*sqrt(7))/(**0.1** ^0.33) =* **0.38** mins

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \quad \text{(Eq. 6-9)}$$

Where:

V = velocity (ft/s)
C_v = conveyance coefficient (from Table 6-7)
S_w = watercourse slope (ft/ft)

$V = C_v S_w^{0.5}$

$V = (20)(0.02)^{0.5}$ = **6.32** ft/s

Flow Distance: **10.00** ft

t_t = L/V = 1.58 sec.
0.03 min.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

* For buried riprap, select C_v value based on type of vegetative cover.

$t_c = t_i + t_t$ = **0.40** min.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

Final t_c: **5.00** min.

Time of Concentration $t_c = t_i + t_t$

3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}}$$ (Eq. 6-8)

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

Sub-Basin or DP:	D-7	
C_5:	0.42	[Table 6-6. Runoff Coefficients for Rational Method]
L:	46	ft
S:	0.02	ft/ft

Composite Runoff Coefficient Calculation:

$C_c = (C_1A_1 + C_2A_2 + C_3A_3 + ...C_iA_i) / A_t$

Land Use or Surface Characteristic	Square Feet	Acreage	C_5
Roof	0	0.00	0.73
Pavement	4220	0.097	0.90
Lawn	19604	0.450	0.08
A_t :	23824	0.547	

*C_c = (0.73*0.0 + 0.90*0.018 + 0.08*0.027) / 0.044 =* **0.42**

t_i = (0.395(1.1-C_5)*sqrt(L))/(S^0.33)*

t_i = (0.395(1.1- **0.42**)*sqrt(24))/(**0.07** ^0.33) =* **6.65** mins

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5}$$ (Eq. 6-9)

Where:

V = velocity (ft/s)
C_v = conveyance coefficient (from Table 6-7)
S_w = watercourse slope (ft/ft)

$V = C_v S_w^{0.5}$

$V = (20)(0.033)^{0.5}$ = **3.63** ft/s

Flow Distance: **642.00** ft

t_t = L/V = 176.70 sec.

2.95 min.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

* For buried riprap, select C_v value based on type of vegetative cover.

$t_c = t_i + t_t$ = **9.60** min.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

Final t_c: **9.60** min.

Time of Concentration $t_c = t_i + t_t$

3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}}$$ (Eq. 6-8)

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

Sub-Basin or DP:	D-8	
C_5:	0.41	[Table 6-6. Runoff Coefficients for Rational Method]
L:	10	ft
S:	0.02	ft/ft

Composite Runoff Coefficient Calculation:

$C_c = (C_1 A_1 + C_2 A_2 + C_3 A_3 + \ldots C_i A_i) / A_t$

Land Use or Surface Characteristic	Square Feet	Acreage	C_5
Roof	0	0.00	0.73
Pavement	4304	0.099	0.90
Lawn	446	0.010	0.08
A_t :	4750	0.109	

C_c = (0.73*0.0 + 0.90*0.027 + 0.08*0.039) / 0.067 = **0.41**

t_i = (0.395*(1.1-C_5)*sqrt(L))/(S^0.33)

t_i = (0.395*(1.1- **0.41**)*sqrt(25))/(**0.02** ^0.33) = **3.14** mins

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5}$$ (Eq. 6-9)

Where:

V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

$V = C_v S_w^{0.5}$

$V = (20)(0.038)^{0.5}$ = **3.90** ft/s

Flow Distance: **360.00** ft

t_t = L/V = 92.34 sec.
1.54 min.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

* For buried riprap, select C_v value based on type of vegetative cover.

$t_c = t_i + t_t$ = 4.68 min.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

Final t_c: 5.00 min.

Site-Level Low Impact Development (LID) Design Effective Impervious Calculator

LID Credit by Impervious Reduction Factor (IRF) Method

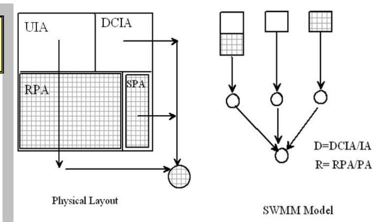
UD-BMP (Version 3.06, November 2016)

User Input

Calculated cells

***Design Storm: 1-Hour Rain Depth	WQCV Event	0.60	inches
***Minor Storm: 1-Hour Rain Depth	2-Year Event	1.19	inches
***Major Storm: 1-Hour Rain Depth	100-Year Event	2.52	inches
Optional User Defined Storm	CUHP		
(CUHP) NOAA 1 Hour Rainfall Depth and Frequency for User Defined Storm	100-Year Event		
Max Intensity for Optional User Defined Storm	0		

Designer: Scott Marvel, PE
Company: RMG - Rocky Mountain Group
Date: November 8, 2021
Project: Northcrest Center PEMBs Development
Location: TBD Bismark Road Colorado Springs, CO - El Paso County



Provide a figure showing all proposed UIA and RPA areas to be utilized for runoff reduction. All RPA areas will need to be within a no build/drainage easement and discussed in the maintenance agreement and O&M Manual.

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	D-1	D-2	D-3	D-4	D-5	D-6
Receiving Pervious Area Soil Type	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	0.320	0.410	0.520	0.460	0.790	0.070
Directly Connected Impervious Area (DCIA, acres)	0.150	0.177	0.203	0.449	0.756	0.015
Unconnected Impervious Area (UIA, acres)	0.000	0.000	0.000	0.000	0.000	0.000
Receiving Pervious Area (RPA, acres)	0.000	0.000	0.000	0.011	0.000	0.000
Separate Pervious Area (SPA, acres)	0.170	0.233	0.317	0.000	0.034	0.055
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	V	V	V	V	V	V

CALCULATED RESULTS (OUTPUT)

Total Calculated Area (ac, check against input)	0.320	0.410	0.520	0.460	0.790	0.070
Directly Connected Impervious Area (DCIA, %)	47.0%	43.2%	39.1%	97.5%	95.7%	21.4%
Unconnected Impervious Area (UIA, %)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Receiving Pervious Area (RPA, %)	0.0%	0.0%	0.0%	2.5%	0.0%	0.0%
Separate Pervious Area (SPA, %)	53.0%	56.8%	60.9%	0.0%	4.3%	78.6%
A_R (RPA / UIA)	0.000	0.000	0.000	0.000	0.000	0.000
I_a Check	1.000	1.000	1.000	1.000	1.000	1.000
f / I for WQCV Event:	1.7	1.7	1.7	1.7	1.7	1.7
f / I for 2-Year Event:	0.5	0.5	0.5	0.5	0.5	0.5
f / I for 100-Year Event:	0.3	0.3	0.3	0.3	0.3	0.3
f / I for Optional User Defined Storm CUHP:						
IRF for WQCV Event:	0.00	0.00	0.00	0.00	0.00	0.00
IRF for 2-Year Event:	1.00	1.00	1.00	1.00	1.00	1.00
IRF for 100-Year Event:	1.00	1.00	1.00	1.00	1.00	1.00
IRF for Optional User Defined Storm CUHP:						
Total Site Imperviousness: I_{total}	47.0%	43.2%	39.1%	97.5%	95.7%	21.4%
Effective Imperviousness for WQCV Event:	47.0%	43.2%	39.1%	97.5%	95.7%	21.4%
Effective Imperviousness for 2-Year Event:	47.0%	43.2%	39.1%	97.5%	95.7%	21.4%
Effective Imperviousness for 100-Year Event:	47.0%	43.2%	39.1%	97.5%	95.7%	21.4%
Effective Imperviousness for Optional User Defined Storm CUHP:						

LID / EFFECTIVE IMPERVIOUSNESS CREDITS

WQCV Event CREDIT: Reduce Detention By:	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
This line only for 10-Year Event	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100-Year Event CREDIT**: Reduce Detention By:	0.0%	0.1%	0.1%	0.0%	0.0%	1.4%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
User Defined CUHP CREDIT: Reduce Detention By:														

Total Site Imperviousness:	**68.1%**
Total Site Effective Imperviousness for WQCV Event:	**68.1%**
Total Site Effective Imperviousness for 2-Year Event:	**68.1%**
Total Site Effective Imperviousness for 100-Year Event:	**68.1%**
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	

Notes:

* Use Green-Ampt average infiltration rate values from Table 3-3.

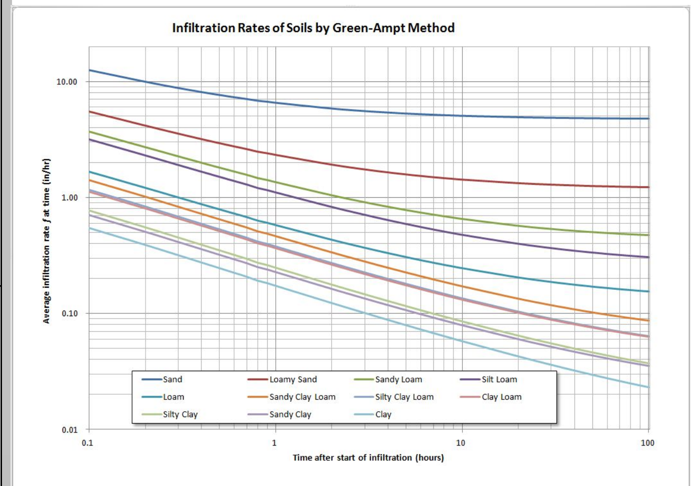
** Flood control detention volume credits based on empirical equations from Storage Chapter of USDCM.

*** Method assumes that 1-hour rainfall depth is equivalent to 1-hour intensity for calculation purposed

Table 3-3. Infiltration Rates (*f*) for IRF Calculations[1]

Soil Type	Hydrologic Soil Group	WQCV Event	Minor Storm Event	Major Storm Event	Optional User Defined Event
		(in/hr)	(in/hr)	(in/hr)	(in/hr)
Clay	D	0.12	0.22	0.23	#N/A
Sandy Clay	D	0.16	0.25	0.29	#N/A
Silty Clay	D	0.18	0.29	0.29	#N/A
Clay Loam	D	0.26	0.29	0.29	#N/A
Silty Clay Loam	D	0.27	0.39	0.40	#N/A
Sandy Clay Loam	D	0.34	0.38	0.38	#N/A
Loam	C	0.43	0.42	0.47	#N/A
Silt Loam	C	0.83	0.51	0.76	#N/A
Sandy Loam	C	1.04	0.51	0.78	#N/A
Loamy Sand	B	1.92	0.67	0.98	#N/A
Sand	A	5.85	0.67	1.44	#N/A

[1] Infiltration Rates are based on the Green-Ampt method and are calculated as the average infiltration rate over the duration of the storm.

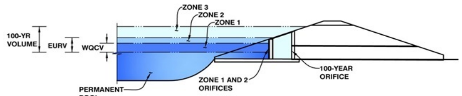


DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: **Northcrest Center PEMBs Development**

Basin ID: **EDB for DP6 - Sub-Basins DP-1 through DP-6, Full Spectrum Extended Detention Basin**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**			
Watershed Area =	2.59	acres		
Watershed Length =	400	ft		
Watershed Length to Centroid =	175	ft		
Watershed Slope =	0.050	ft/ft		
Watershed Imperviousness =	68.10%	percent		
Percentage Hydrologic Soil Group A =	100.0%	percent		
Percentage Hydrologic Soil Group B =	0.0%	percent		
Percentage Hydrologic Soil Groups C/D =	0.0%	percent		
Target WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.058	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.222	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.148	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.193	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.229	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.276	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.321	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.376	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.48 in.) =	0.564	acre-feet	3.48	inches
Approximate 2-yr Detention Volume =	0.144	acre-feet		
Approximate 5-yr Detention Volume =	0.189	acre-feet		
Approximate 10-yr Detention Volume =	0.227	acre-feet		
Approximate 25-yr Detention Volume =	0.272	acre-feet		
Approximate 50-yr Detention Volume =	0.299	acre-feet		
Approximate 100-yr Detention Volume =	0.327	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.058	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.164	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.105	acre-feet
Total Detention Basin Volume =	0.327	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 = 0.50 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	--	--	--	2,750	0.063		
	--	0.50	--	--	--	2,750	0.063	1,375	0.032
	--	1.00	--	--	--	2,750	0.063	2,750	0.063
	--	1.50	--	--	--	2,750	0.063	4,125	0.095
	--	2.00	--	--	--	2,750	0.063	5,500	0.126
	--	2.50	--	--	--	2,750	0.063	6,875	0.158
	--	3.00	--	--	--	2,750	0.063	8,250	0.189
	--	3.50	--	--	--	2,750	0.063	9,625	0.221
	--	4.00	--	--	--	2,750	0.063	11,000	0.253
	--	4.50	--	--	--	2,750	0.063	12,375	0.284
	--	5.00	--	--	--	2,750	0.063	13,750	0.316
	--	5.50	--	--	--	2,750	0.063	15,125	0.347
	--	6.00	--	--	--	2,750	0.063	16,500	0.379
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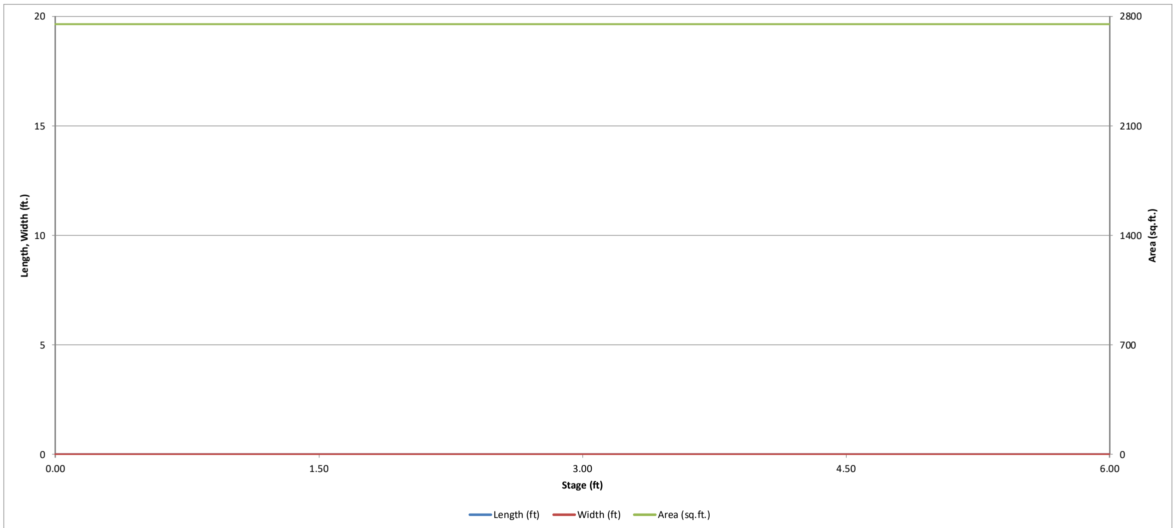
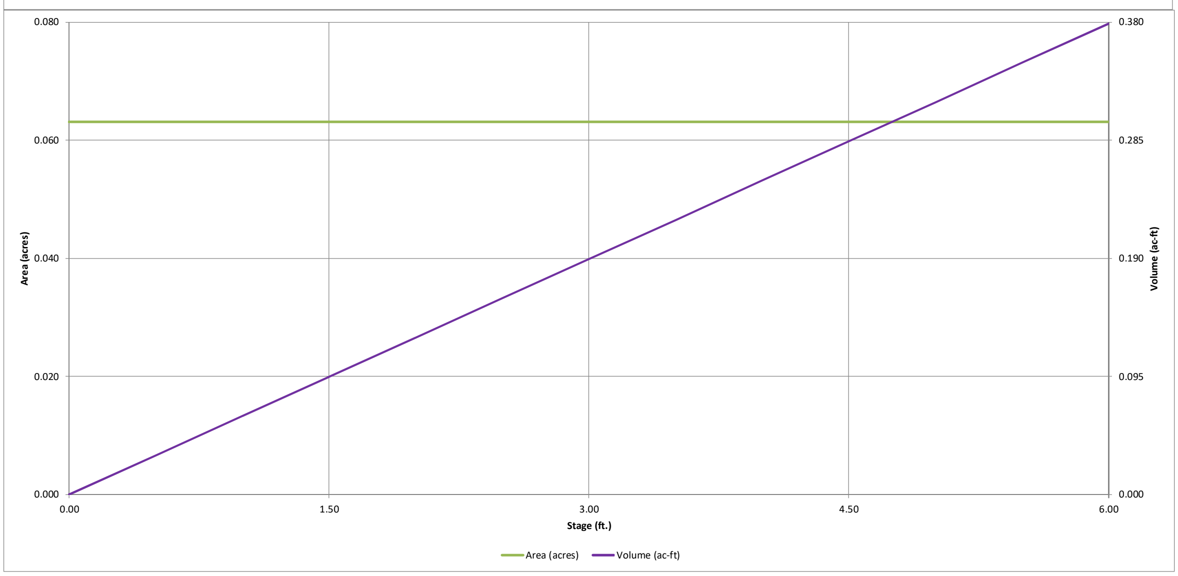

Length, Width (ft.)
Area (sq.ft.)
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

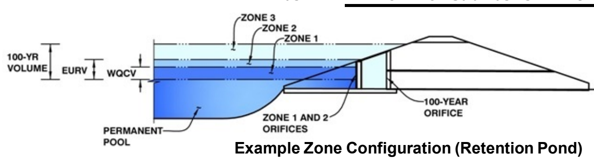

Area (acres)
Volume (ac-ft)
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: **Northcrest Center PEMBs Development**

Basin ID: **EDB for DP6 - Sub-Basins DP-1 through DP-6, Full Spectrum Extended Detention Basin**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.92	0.058	Orifice Plate
Zone 2 (EURV)	3.52	0.164	Orifice Plate
Zone 3 (100-year)	5.18	0.105	Weir&Pipe (Restrict)
Total (all zones)		0.327	

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 =	3.55	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	9.00	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	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	0.80	1.60	2.40	3.20			
Orifice Area (sq. inches)	0.75	1.00	1.25					

	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 Orif

	Not Selected	Not Selected
Vertical Orifice Area =	N/A	N/A
Vertical Orifice Centroid =	N/A	N/A

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.75	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	3.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	3.00	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	0%	N/A	%

Calculated Parameters for Overflow W

	Zone 3 Weir	Not Selected
Height of Grate Upper Edge, H_t =	3.75	N/A
Overflow Weir Slope Length =	3.00	N/A
Grate Open Area / 100-yr Orifice Area =	13.21	N/A
Overflow Grate Open Area w/o Debris =	6.26	N/A
Overflow Grate Open Area w/ Debris =	6.26	N/A

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 =	2.00	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	24.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	5.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Pla

	Zone 3 Restrictor	Not Selected
Outlet Orifice Area =	0.47	N/A
Outlet Orifice Centroid =	0.25	N/A
Half-Central Angle of Restrictor Plate on Pipe =	0.95	N/A

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.20	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	3.00	feet
Spillway End Slopes =	0.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.98	feet
Stage at Top of Freeboard =	7.18	feet
Basin Area at Top of Freeboard =	0.06	acres
Basin Volume at Top of Freeboard =	0.38	acre-ft

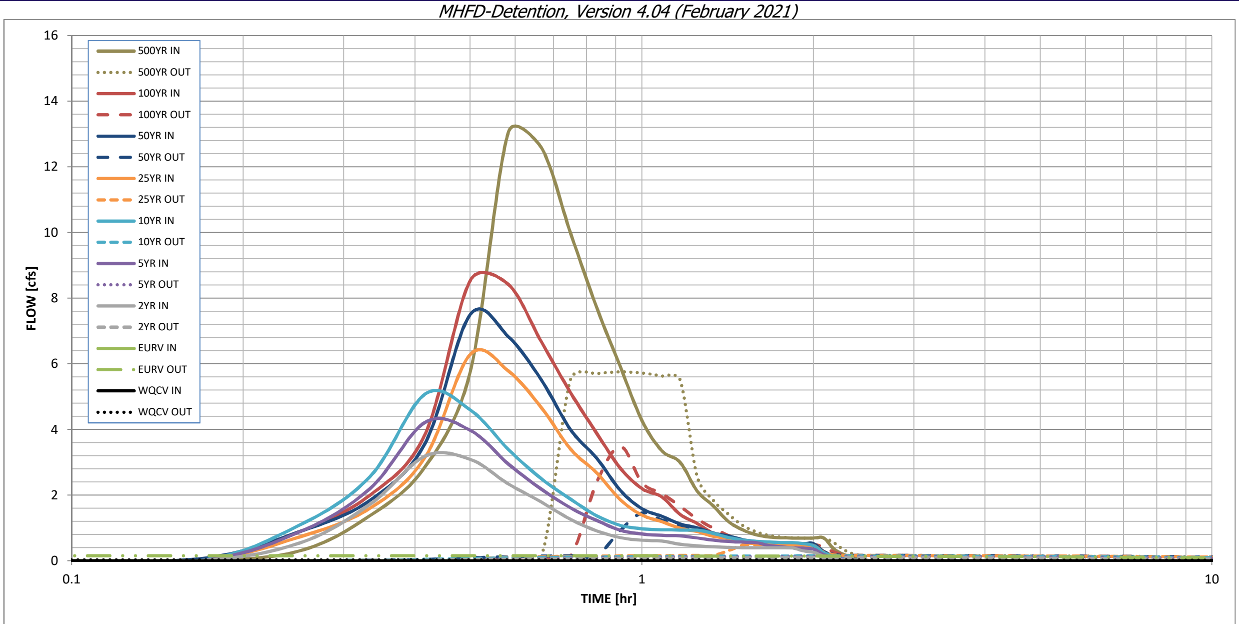
Routed Hydrograph Results

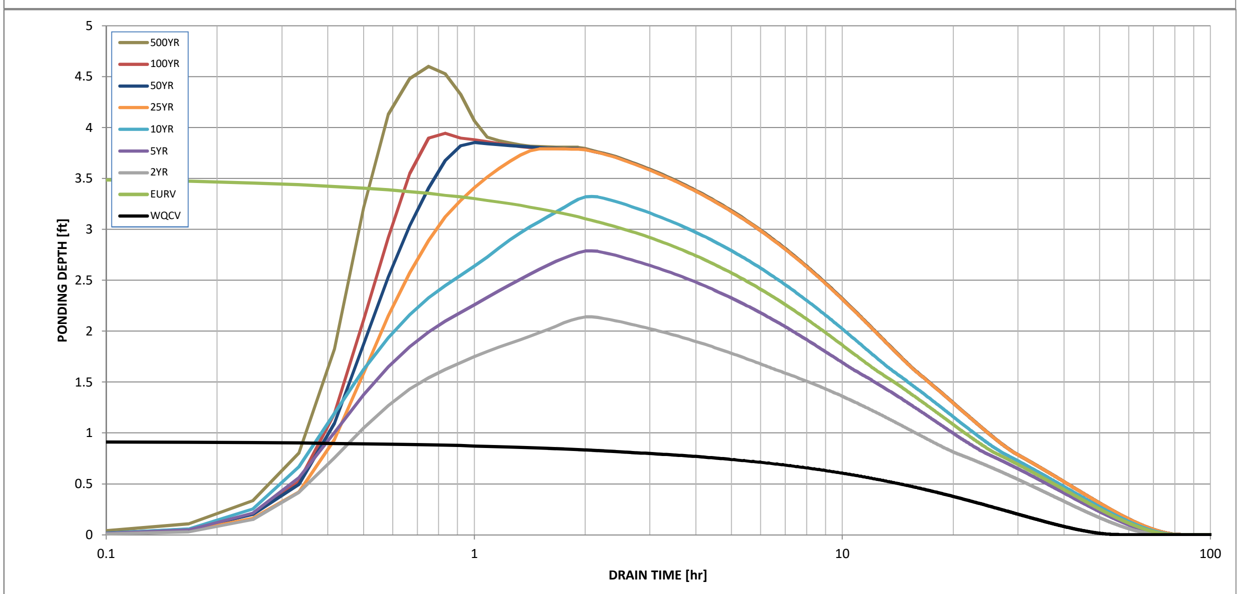
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through A

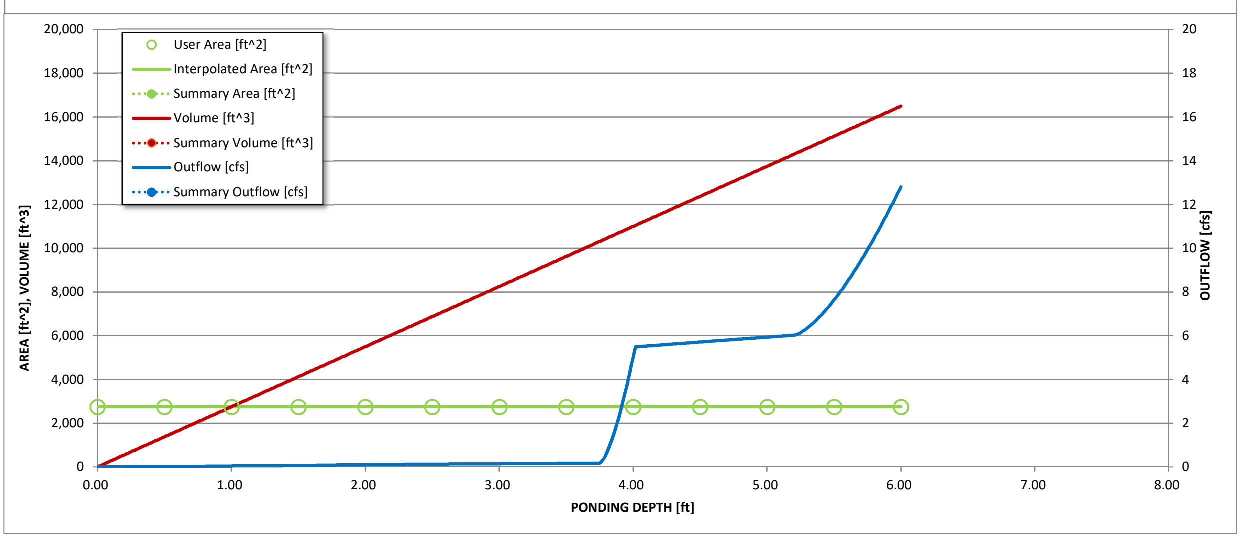
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52
CUHP Runoff Volume (acre-ft) =	0.058	0.222	0.148	0.193	0.229	0.276	0.321	0.376
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.148	0.193	0.229	0.276	0.321	0.376
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.0	0.1	0.1	0.7	1.4	2.3
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A	0.2	0.8	1.7	3.0	4.1	5.3
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.09	0.31	0.64	1.17	1.57	2.04
Peak Inflow Q (cfs) =	N/A	N/A	3.2	4.2	5.1	6.3	7.5	8.5
Peak Outflow Q (cfs) =	0.0	0.2	0.1	0.1	0.2	0.5	1.5	3.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.1	0.2	0.4	0.7
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.0	0.2	0.5
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	47	61	59	61	62	62	60	58
Time to Drain 99% of Inflow Volume (hours) =	**52**	69	66	69	70	71	70	69
Maximum Ponding Depth (ft) =	0.92	3.52	2.14	2.79	3.32	3.79	3.85	3.94
Area at Maximum Ponding Depth (acres) =	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Maximum Volume Stored (acre-ft) =	0.058	0.222	0.134	0.176	0.210	0.239	0.243	0.249

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







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.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
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]
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	0.06	0.01	0.30
	0:15:00	0.00	0.00	0.54	0.87	1.08	0.72	0.88	0.88	1.37
	0:20:00	0.00	0.00	1.72	2.20	2.56	1.60	1.84	2.00	2.87
	0:25:00	0.00	0.00	3.19	4.22	5.08	3.16	3.59	3.86	5.77
	0:30:00	0.00	0.00	3.09	3.98	4.60	6.29	7.51	8.54	13.06
	0:35:00	0.00	0.00	2.34	2.95	3.39	5.78	6.83	8.42	12.58
	0:40:00	0.00	0.00	1.79	2.18	2.50	4.66	5.50	6.66	9.97
	0:45:00	0.00	0.00	1.26	1.61	1.88	3.40	3.99	5.12	7.71
	0:50:00	0.00	0.00	0.91	1.23	1.37	2.68	3.13	3.88	5.91
	0:55:00	0.00	0.00	0.71	0.93	1.08	1.86	2.15	2.83	4.28
	1:00:00	0.00	0.00	0.63	0.82	0.98	1.40	1.59	2.20	3.35
	1:05:00	0.00	0.00	0.60	0.78	0.95	1.19	1.36	1.95	3.00
	1:10:00	0.00	0.00	0.51	0.76	0.94	0.99	1.13	1.42	2.13
	1:15:00	0.00	0.00	0.46	0.70	0.94	0.89	1.01	1.14	1.68
	1:20:00	0.00	0.00	0.43	0.63	0.84	0.75	0.85	0.84	1.21
	1:25:00	0.00	0.00	0.41	0.59	0.71	0.68	0.77	0.67	0.95
	1:30:00	0.00	0.00	0.40	0.57	0.64	0.58	0.65	0.57	0.80
	1:35:00	0.00	0.00	0.40	0.56	0.60	0.52	0.59	0.53	0.73
	1:40:00	0.00	0.00	0.40	0.47	0.57	0.49	0.55	0.51	0.71
	1:45:00	0.00	0.00	0.40	0.43	0.56	0.48	0.54	0.50	0.70
	1:50:00	0.00	0.00	0.40	0.40	0.56	0.47	0.53	0.50	0.70
	1:55:00	0.00	0.00	0.31	0.39	0.53	0.47	0.53	0.50	0.70
	2:00:00	0.00	0.00	0.26	0.36	0.46	0.47	0.53	0.50	0.70
	2:05:00	0.00	0.00	0.14	0.19	0.25	0.26	0.29	0.28	0.38
	2:10:00	0.00	0.00	0.07	0.11	0.14	0.14	0.16	0.15	0.21
	2:15:00	0.00	0.00	0.03	0.05	0.07	0.07	0.08	0.08	0.11
	2:20:00	0.00	0.00	0.01	0.02	0.03	0.03	0.04	0.03	0.05
	2:25:00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
	2:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	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

Hydraulic Grade Line and Pipe Capacity

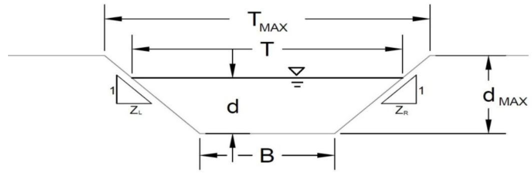
100-YEAR EVENT											
Pipe	**Design Flow Rate**	**Proposed Pipe Diameter**	**Slope**	**80% of Proposed Pipe Diameter**	**Manning Coefficient**	**Full Pipe Cross Sectional Area**	**Full Pipe Flow Rate**	**Q Design / Q Full**	**d/D**	**Hydraulic Grade Line (Depth of Flow)**	**Depth of Flow Less Than 80% of Pipe Diameter**
	Qdes (ft3/sec)	**Dpro(in)**	**S (%)**	**Dpro*.8 (in)**	**n**	**A (ft) = π (Dpro/2)2**	**Qfull (ft3/s) = A(1.49/n)((Dpro/ 48)2/3)S1/2**	**Qdes/Qfull**	**(from Chart)**	**d (in) = (d/D)*Dpro**	**(Yes/No)**
1-2	1.58	12.0	2.08%	9.6	0.013	0.785	5.150	0.31	0.43	5.16	Yes
2-3	3.58	12.0	2.08%	9.6	0.013	0.785	5.150	0.70	0.68	8.10	Yes
3-4	5.87	18.0	2.08%	14.4	0.013	1.766	15.183	0.39	0.49	8.73	Yes
4-6	8.88	18.0	2.08%	14.4	0.013	1.766	15.183	0.58	0.62	11.07	Yes
5-6	5.22	18.0	2.08%	14.4	0.013	1.766	15.183	0.34	0.45	8.10	Yes
OUTLET	14.36	24.0	2.08%	19.2	0.013	3.140	32.698	0.44	0.52	12.36	Yes

5-YEAR EVENT											
Pipe	**Design Flow Rate**	**Proposed Pipe Diameter**	**Slope**	**80% of Proposed Pipe Diameter**	**Manning Coefficient**	**Full Pipe Cross Sectional Area**	**Full Pipe Flow Rate**	**Q Design / Q Full**	**d/D**	**Hydraulic Grade Line (Depth of Flow)**	**Depth of Flow Less Than 80% of Pipe Diameter**
	Qdes (ft3/sec)	**Dpro(in)**	**S (%)**	**Dpro*.8 (in)**	**n**	**A (ft) = π (Dpro/2)2**	**Qfull (ft3/s) = A(1.49/n)((Dpro/ 48)2/3)S1/2**	**Qdes/Qfull**	**(from Chart)**	**d (in) = (d/D)*Dpro**	**(Yes/No)**
1-2	0.70	12.0	2.08%	9.6	0.013	0.785	5.150	0.14	0.28	3.30	Yes
2-3	1.58	12.0	2.08%	9.6	0.013	0.785	5.150	0.31	0.43	5.16	Yes
3-4	2.51	18.0	2.08%	14.4	0.013	1.766	15.183	0.17	0.31	5.63	Yes
4-6	4.15	18.0	2.08%	14.4	0.013	1.766	15.183	0.27	0.38	6.84	Yes
5-6	2.86	18.0	2.08%	14.4	0.013	1.766	15.183	0.19	0.34	6.03	Yes
OUTLET	7.09	18.0	2.08%	14.4	0.013	1.766	15.183	0.47	0.53	9.54	Yes

AREA INLET IN A SWALE

NORTHCREST CENTER PEMBs - EL PASO COUNTY

DP1



This worksheet uses the NRCS vegetal retardance method to determine Manning's n.

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

	NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D, or E =		
	Manning's n (Leave cell D16 blank to manually enter an n value)	n =	0.012	
	Channel Invert Slope	S_O =	0.0410	ft/ft
	Bottom Width	B =	4.00	ft
Warning 01	Left Side Slope	Z1 =	0.02	ft/ft
Warning 01	Right Side Sloe	Z2 =	0.02	ft/ft

Check one of the following soil types:

Soil Type:	Max. Velocity (V_{MAX})	Max Froude No. (F_{MAX})
Non-Cohesive	5.0 fps	0.60
Cohesive	7.0 fps	0.80
Paved	N/A	N/A

Choose One:
- ☐ **Non-Cohesive**
- ☐ **Cohesive**
- ☐ **Paved**

		Minor Storm	Major Storm	
Maximum Allowable Top Width of Channel for Minor & Major Storm	T_{MAX} =	**55.00**	**55.00**	**ft**
Maximum Allowable Water Depth in Channel for Minor & Major Storm	d_{MAX} =	**2.00**	**2.00**	**ft**

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**204.5**	**204.5**	**cfs**
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	**2.00**	**2.00**	**ft**

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	**0.7**	**1.6**	**cfs**
Water Depth	d =	**0.05**	**0.08**	**ft**

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

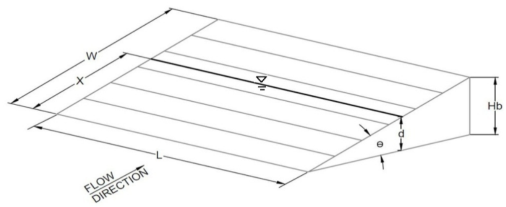
AREA INLET IN A SWALE

NORTHCREST CENTER PEMBs - EL PASO COUNTY

DP1

Inlet Design Information (Input)

Type of Inlet	CDOT Type C (Depressed)	Inlet Type =	CDOT Type C (Depressed)
Angle of Inclined Grate (must be <= 30 degrees)	θ =	1.19	degrees
Width of Grate	W =	3.00	ft
Length of Grate	L =	3.00	ft
Open Area Ratio	A_{RATIO} =	0.70	
Height of Inclined Grate	H_B =	0.06	ft
Clogging Factor	C_f =	0.50	
Grate Discharge Coefficient	C_d =	0.79	
Orifice Coefficient	C_o =	0.52	
Weir Coefficient	C_w =	1.68	



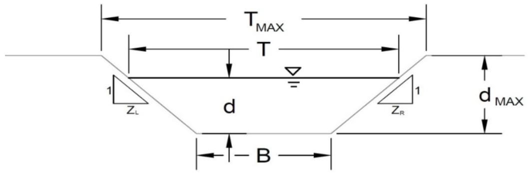
		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	1.05	1.08	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**15.9**	**16.6**	**cfs**
Bypassed Flow	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Qa/Qo	**C% =**	**100**	**100**	**%**

Warning 01: Sideslope steepness exceeds USDCM Volume I recommendation.

Warning 02: Depth (d) exceeds USDCM Volume I recommendation.

AREA INLET IN A SWALE

NORTHCREST CENTER PEMBs - EL PASO COUNTY
DP2



This worksheet uses the NRCS vegetal retardance method to determine Manning's n.

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

	NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D, or E =		
	Manning's n (Leave cell D16 blank to manually enter an n value)	n =	0.012	
	Channel Invert Slope	S_O =	0.0410	ft/ft
	Bottom Width	B =	4.00	ft
Warning 01	Left Side Slope	Z1 =	0.05	ft/ft
Warning 01	Right Side Sloe	Z2 =	0.05	ft/ft

Check one of the following soil types:

Soil Type:	Max. Velocity (V_{MAX})	Max Froude No. (F_{MAX})
Non-Cohesive	5.0 fps	0.60
Cohesive	7.0 fps	0.80
Paved	N/A	N/A

Choose One:
- ☐ Non-Cohesive
- ☐ Cohesive
- ☒ Paved

		Minor Storm	Major Storm	
Maximum Allowable Top Width of Channel for Minor & Major Storm	T_{MAX} =	**55.00**	**55.00**	**ft**
Maximum Allowable Water Depth in Channel for Minor & Major Storm	d_{MAX} =	**2.00**	**2.00**	**ft**

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**209.5**	**209.5**	**cfs**
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	**2.00**	**2.00**	**ft**

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	**0.9**	**2.0**	**cfs**
Water Depth	d =	**0.06**	**0.10**	**ft**

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

AREA INLET IN A SWALE

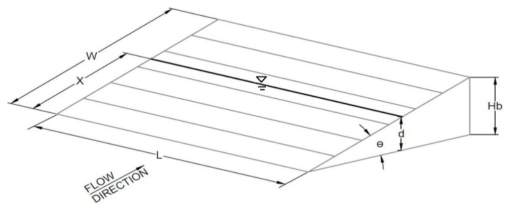
NORTHCREST CENTER PEMBs - EL PASO COUNTY

DP2

Inlet Design Information (Input)

Type of Inlet: CDOT Type C (Depressed)

Inlet Type = CDOT Type C (Depressed)



Angle of Inclined Grate (must be <= 30 degrees)	θ =	1.19	degrees
Width of Grate	W =	3.00	ft
Length of Grate	L =	3.00	ft
Open Area Ratio	A_{RATIO} =	0.70	
Height of Inclined Grate	H_B =	0.06	ft
Clogging Factor	C_f =	0.50	
Grate Discharge Coefficient	C_d =	0.79	
Orifice Coefficient	C_o =	0.52	
Weir Coefficient	C_w =	1.68	

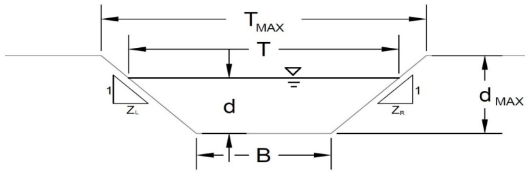
		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	1.06	1.10	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**16.1**	**16.9**	**cfs**
Bypassed Flow	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Qa/Qo	**C% =**	**100**	**100**	**%**

Warning 01: Sideslope steepness exceeds USDCM Volume I recommendation.
Warning 02: Depth (d) exceeds USDCM Volume I recommendation.

AREA INLET IN A SWALE

NORTHCREST CENTER PEMBs - EL PASO COUNTY

DP3



This worksheet uses the NRCS vegetal retardance method to determine Manning's n.

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

	NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D, or E =		
	Manning's n (Leave cell D16 blank to manually enter an n value)	n =	0.012	
	Channel Invert Slope	S_O =	0.0410	ft/ft
	Bottom Width	B =	4.00	ft
Warning 01	Left Side Slope	Z1 =	0.05	ft/ft
Warning 01	Right Side Sloe	Z2 =	0.05	ft/ft

Check one of the following soil types:

Soil Type:	Max. Velocity (V_{MAX})	Max Froude No. (F_{MAX})
Non-Cohesive	5.0 fps	0.60
Cohesive	7.0 fps	0.80
Paved	N/A	N/A

Choose One:
- ☐ **Non-Cohesive**
- ☐ **Cohesive**
- ☒ **Paved**

		Minor Storm	Major Storm	
Maximum Allowable Top Width of Channel for Minor & Major Storm	T_{MAX} =	**55.00**	**55.00**	**ft**
Maximum Allowable Water Depth in Channel for Minor & Major Storm	d_{MAX} =	**2.00**	**2.00**	**ft**

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**209.5**	**209.5**	**cfs**
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	**2.00**	**2.00**	**ft**

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	**0.9**	**2.3**	**cfs**
Water Depth	d =	**0.06**	**0.11**	**ft**

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

MHFD-Inlet, Version 5.01 (April 2021)

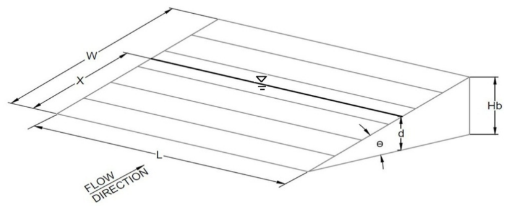
AREA INLET IN A SWALE

NORTHCREST CENTER PEMBs - EL PASO COUNTY

DP3

Inlet Design Information (Input)

Type of Inlet	CDOT Type C (Depressed)	Inlet Type =	CDOT Type C (Depressed)
Angle of Inclined Grate (must be <= 30 degrees)	θ =	1.19	degrees
Width of Grate	W =	3.00	ft
Length of Grate	L =	3.00	ft
Open Area Ratio	A_{RATIO} =	0.70	
Height of Inclined Grate	H_B =	0.06	ft
Clogging Factor	C_f =	0.50	
Grate Discharge Coefficient	C_d =	0.79	
Orifice Coefficient	C_o =	0.52	
Weir Coefficient	C_w =	1.68	



		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	1.06	1.11	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**16.1**	**17.1**	**cfs**
Bypassed Flow	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Qa/Qo	**C% =**	**100**	**100**	**%**

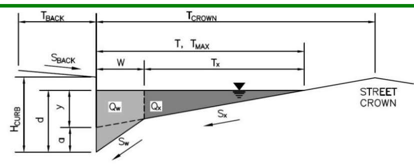
Warning 01: Sideslope steepness exceeds USDCM Volume I recommendation.
Warning 02: Depth (d) exceeds USDCM Volume I recommendation.

MHFD-Inlet, Version 5.01 (April 2021)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: **NORTHCREST CENTER PEMBs - EL PASO COUNTY**
Inlet ID: **DP4**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	12.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.040	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.020	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

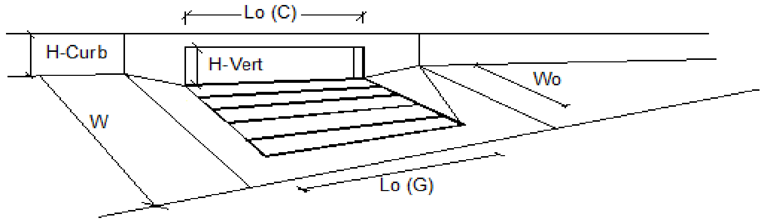
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	10.0	10.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**11.8**	**11.8**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



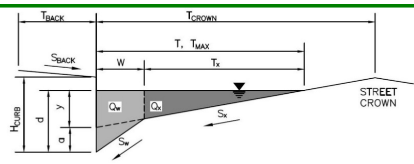
Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity'			MINOR	MAJOR	
Total Inlet Interception Capacity		**Q =**	**1.6**	**3.0**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)		**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o =		**C% =**	**100**	**100**	**%**

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: **NORTHCREST CENTER PEMBs - EL PASO COUNTY**

Inlet ID: **DP5**



Gutter Geometry:

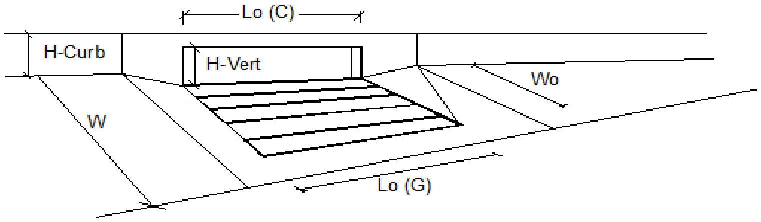
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	60.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.040		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.020		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	48.0	48.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**12.8**	**12.8**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



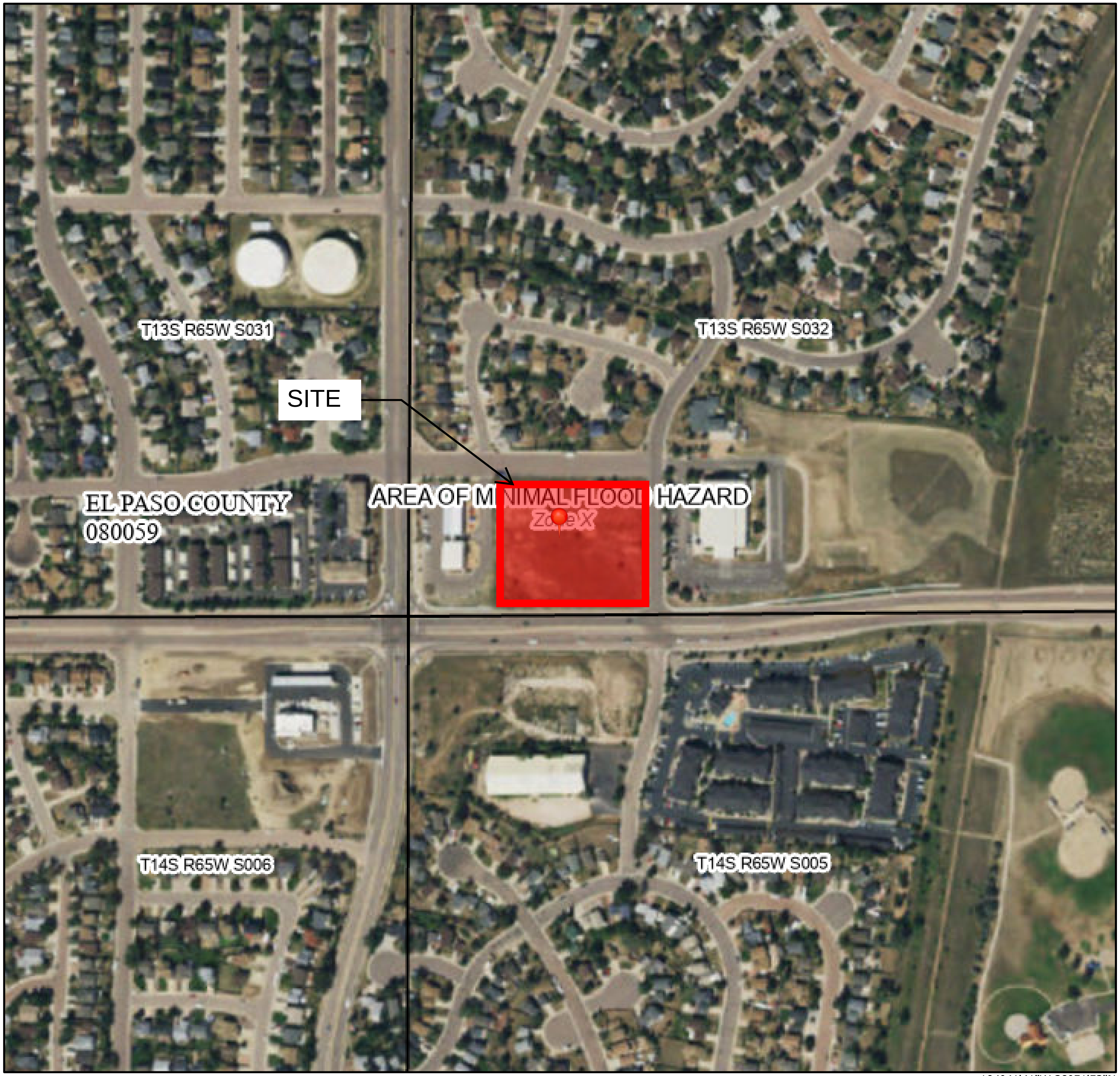
Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	4	4	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity'			MINOR	MAJOR	
Total Inlet Interception Capacity		**Q =**	**2.9**	**5.2**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)		**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o =		**C% =**	**100**	**100**	**%**

APPENDIX C – FEMA FLOODPLAIN MAP

National Flood Hazard Layer FIRMette

FEMA

104°42'18"W 38°52'21"N



104°41'41"W 38°51'53"N

Feet

0 250 500 1,000 1,500 2,000

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) *Zone A, V, A99*
		With BFE or Depth *Zone AE, AO, AH, VE, AR*
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
		Future Conditions 1% Annual Chance Flood Hazard *Zone X*
		Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
		Area with Flood Risk due to Levee *Zone D*
OTHER AREAS	NO SCREEN	Area of Minimal Flood Hazard *Zone X*
		Effective LOMRs
		Area of Undetermined Flood Hazard *Zone D*
GENERAL STRUCTURES		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES	B 20.2 / 17.5	Cross Sections with 1% Annual Chance Water Surface Elevation
	8	Coastal Transect
	513	Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
		Coastal Transect Baseline
		Profile Baseline
		Hydrographic Feature
MAP PANELS		Digital Data Available
		No Digital Data Available
		Unmapped

N

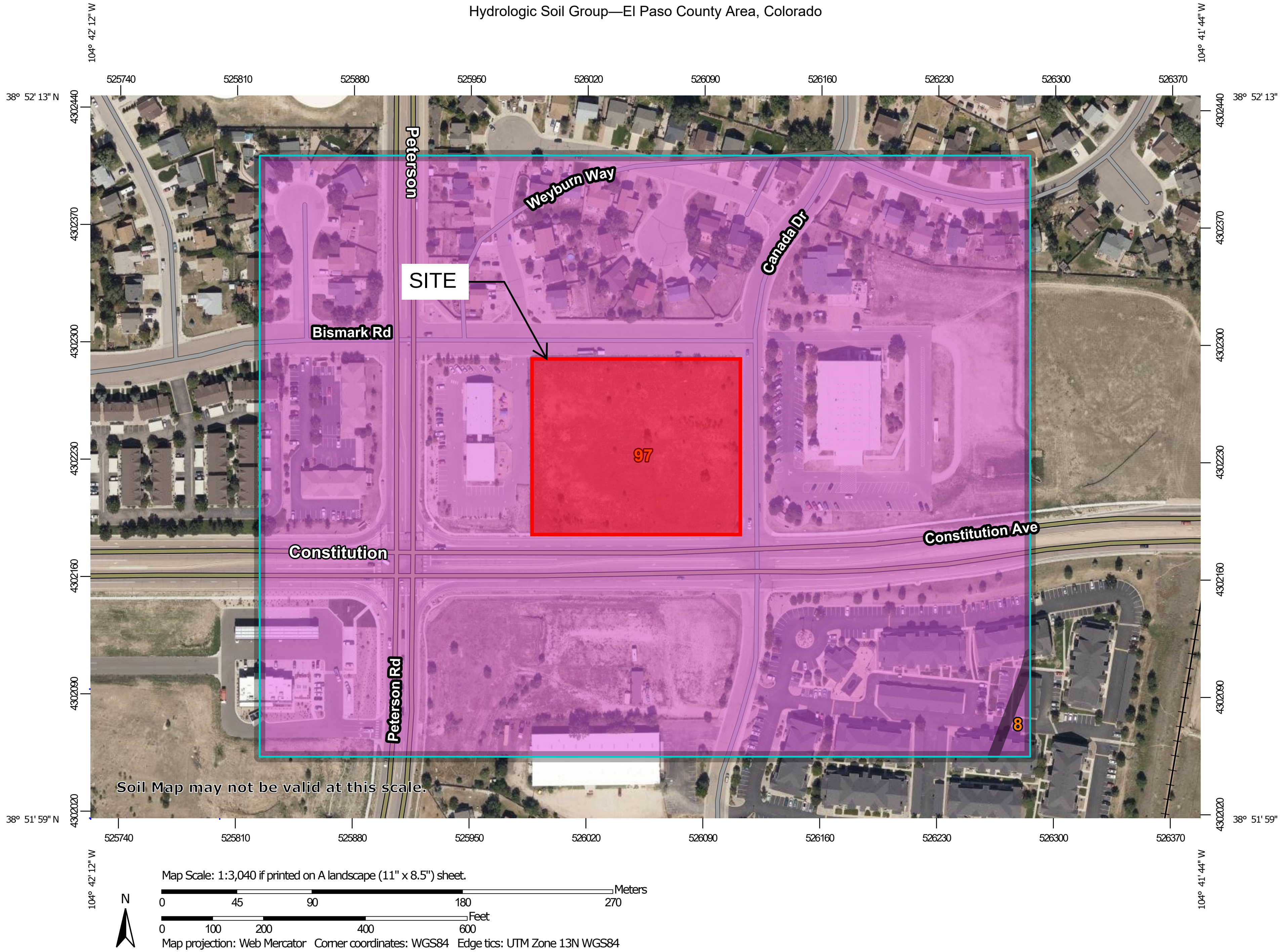
The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 3/17/2021 at 3:21 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

APPENDIX D – USGS SOILS SURVEY MAP


104° 42' 12" W
104° 41' 44" W
38° 52' 13" N
38° 51' 59" N
525740
525810
525880
525950
526020
526090
526160
526230
526300
526370
4302440
4302370
4302300
4302230
4302160
4302090
4302020
Peterson
Weyburn Way
Canada Dr
SITE
Bismark Rd
97
Constitution Ave
Constitution
Peterson Rd
8
Soil Map may not be valid at this scale.
Map Scale: 1:3,040 if printed on A landscape (11" x 8.5") sheet.
N
0
45
90
180
270
Meters
0
100
200
400
600
Feet
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

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:
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: El Paso County Area, Colorado
Survey Area Data: Version 18, Jun 5, 2020

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

Date(s) aerial images were photographed: Aug 19, 2018—Sep 23, 2018

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.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
8	Blakeland loamy sand, 1 to 9 percent slopes	A	0.2	0.4%
97	Truckton sandy loam, 3 to 9 percent slopes	A	40.9	99.6%
Totals for Area of Interest			**41.1**	**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

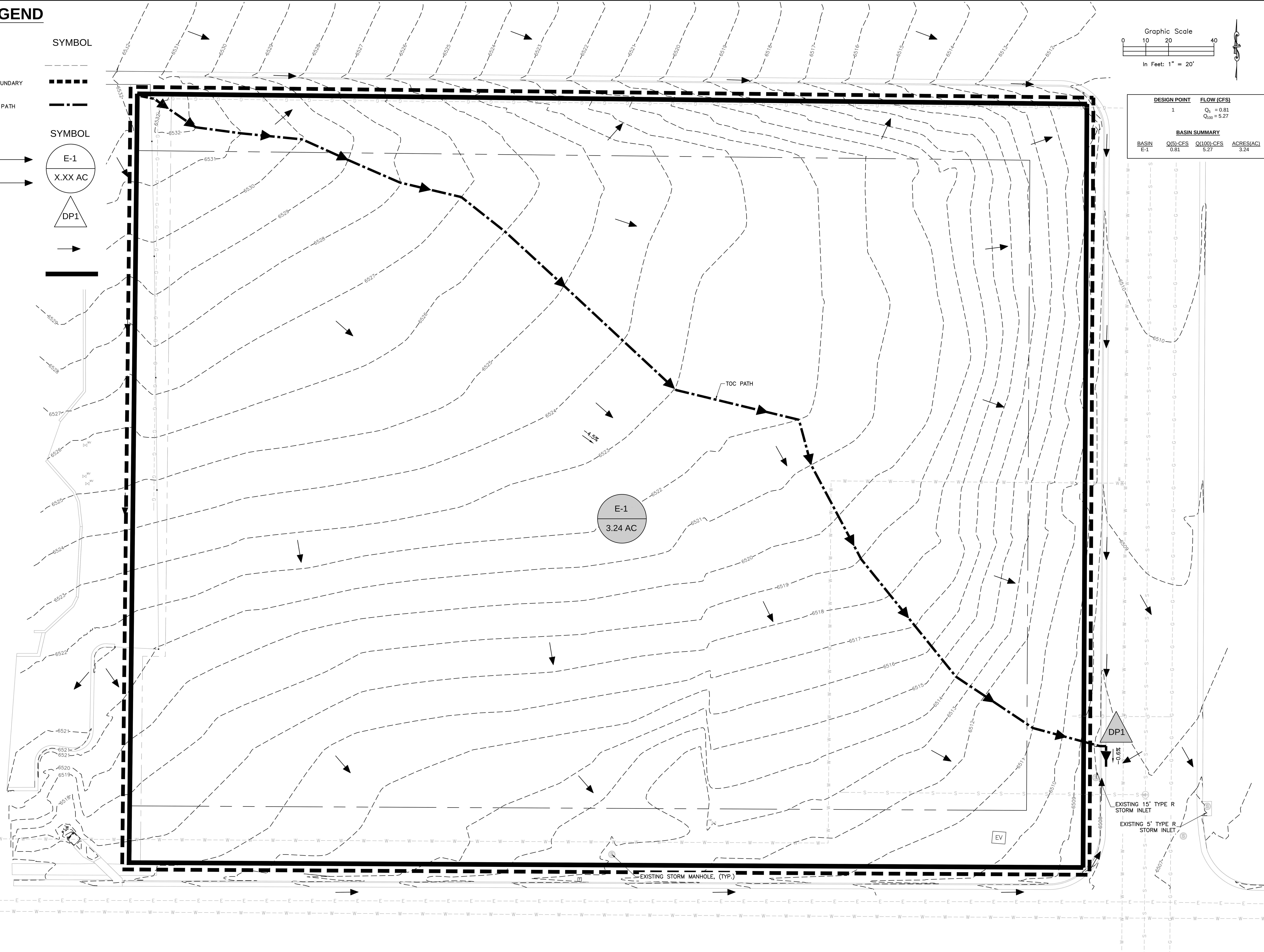
Tie-break Rule: Higher

APPENDIX E – DRAINAGE PLANS

LEGEND

DESCRIPTION	SYMBOL
EX. CONTOUR	
DRAINAGE SUB-BASIN BOUNDARY	
TIME OF CONCENTRATION PATH	

DESCRIPTION	SYMBOL
BASIN IDENTIFIER	E-1
AREA IN ACRES	X.XX AC
DESIGN POINT ID	DP1
FLOW ARROW	
PROPERTY LINE	



DESIGN POINT	FLOW (CFS)
1	Q_5 = 0.81 Q_{100} = 5.27

BASIN SUMMARY

BASIN	Q(5)-CFS	Q(100)-CFS	ACRES(AC)
E-1	0.81	5.27	3.24

ROCKY MOUNTAIN GROUP
ARCHITECTS RMG ENGINEERS
Architectural
Structural
Forensics
Geotechnical
Materials, Testing
Civil, Planning
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(719) 548-0600 ~ WWW. RMGENGINEERS.COM
SOUTHERN COLORADO, DENVER METRO, NORTHERN COLORADO

NOT FOR CONSTRUCTION
FOR CIVIL ONLY

NORTHCREST PEMB DEVELOPMENT
PETERSON ROAD AND CONSTITUTION AVENUE
COLORADO SPRINGS, COLORADO
LEISURE CONSTRUCTION

SHEET NAME
EXISTING CONDITIONS
SUB-BASIN HYDROLOGY

PROJECT STATUS
DESIGN DEVELOPMENT

ENG: SAM
DRAWN: ARP
CHECKED: SAM
DATE
10/13/2021

#	REVISION	DATE
	—	—
	—	—
	—	—
	—	—
	—	—
	—	—
	—	—

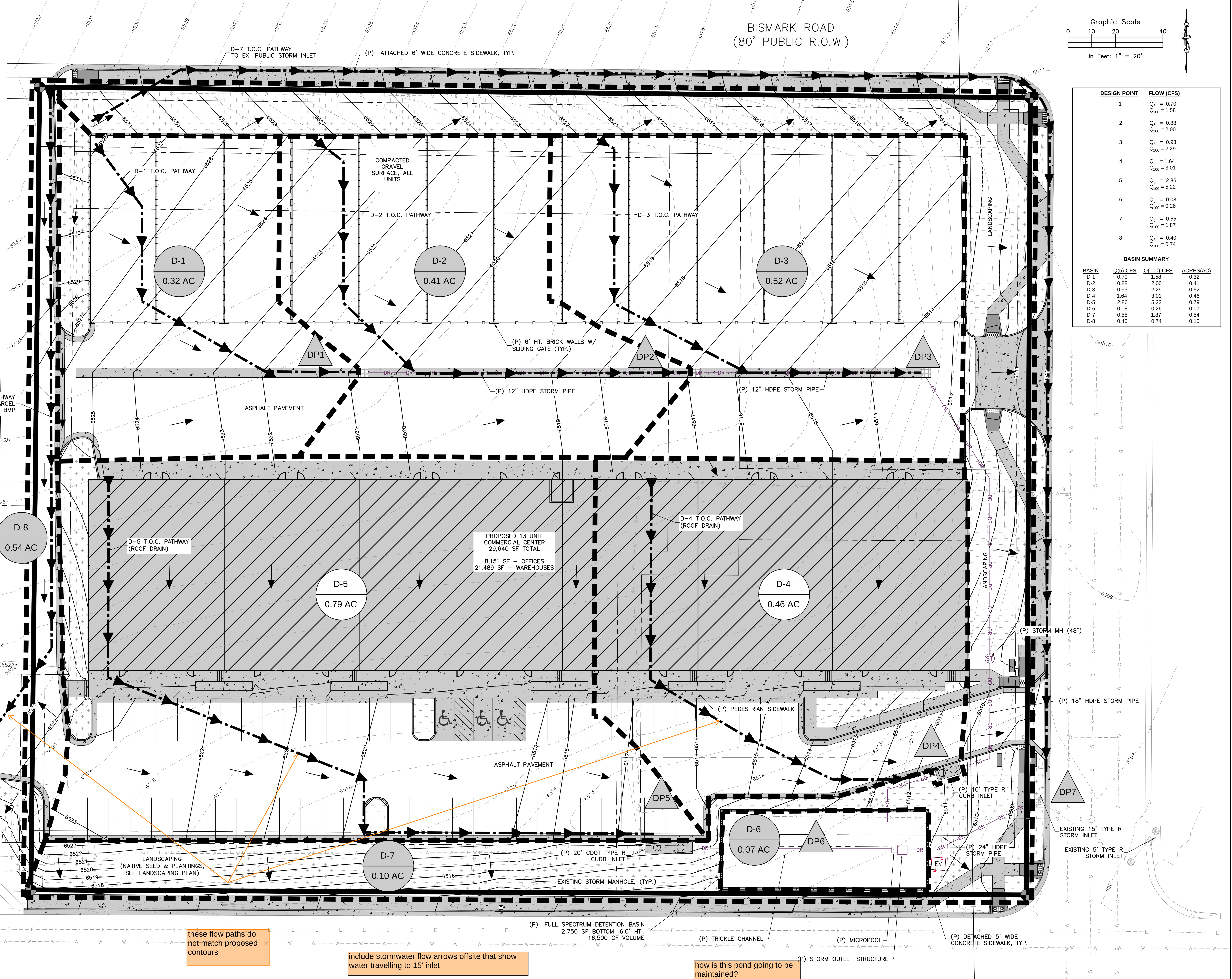
JOB NO.
180649

SHEET NO.
C-EX-01

LEGEND

DESCRIPTION	SYMBOL
PROP. STRUCTURE/BUILDING	
TIME OF CONCENTRATION PATH	
EX. CONTOUR	
PROP. CONTOUR	
DRAINAGE SUB-BASIN BOUNDARY	

DESCRIPTION	SYMBOL
BASIN IDENTIFIER	D-1
AREA IN ACRES	X.XX AC
DESIGN POINT ID	DP1
FLOW ARROW	
PROPERTY LINE	



DESIGN POINT	FLOW (CFS)
1	Q_5 = 0.70 Q_{100} = 1.58
2	Q_5 = 0.88 Q_{100} = 2.00
3	Q_5 = 0.93 Q_{100} = 2.29
4	Q_5 = 1.64 Q_{100} = 3.01
5	Q_5 = 2.86 Q_{100} = 5.22
6	Q_5 = 0.08 Q_{100} = 0.26
7	Q_5 = 0.55 Q_{100} = 1.87
8	Q_5 = 0.40 Q_{100} = 0.74

BASIN SUMMARY

BASIN	Q(5)-CFS	Q(100)-CFS	ACRES(AC)
D-1	0.70	1.58	0.32
D-2	0.88	2.00	0.41
D-3	0.93	2.29	0.52
D-4	1.64	3.01	0.46
D-5	2.86	5.22	0.79
D-6	0.08	0.26	0.07
D-7	0.55	1.87	0.54
D-8	0.40	0.74	0.10

Any green infrastructure that would be used to meet the runoff reduction requirements is required to be in a drainage easement. And a maintenance agreement would also be required.

these flow paths do not match proposed contours

include stormwater flow arrows offsite that show water travelling to 15' inlet

how is this pond going to be maintained?

ROCKY MOUNTAIN GROUP
RMG ARCHITECTS ENGINEERS
Architectural Structural Forensics
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NORTHCREST PEMB DEVELOPMENT

2510 & 2522 CANADA DRIVE
COLORADO SPRINGS, COLORADO
LEISURE CONSTRUCTION

SHEET NAME: DEVELOPED CONDITIONS SUB-BASINS HYDROLOGY

PROJECT STATUS: DESIGN DEVELOPMENT

ENG: SAM
DRAWN: ARP
CHECKED: SAM
DATE: 11/08/2021

#	REVISION	DATE
	—	—

JOB NO.: 180649

SHEET NO.: C-EX-02