Master Development Drainage Plan Update
Falcon Commerce Center
Monument, Colorado

Prepared for:
Forest Lakes, LLC
1123 Emerson Ave, Suite 204
Evanston, Illinois 60201

Prepared by:

Kiowa Engineering Corporation
1604 South 21st Street
Colorado Springs, Colorado 80904
Ph: (719)630-7342

Kiowa Project No. 21057

May 17, 2022

TABLE OF CONTENTS

STATEMENTS AND APPROVALS

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

_____

Matthew W. Erichsen, PE (PE #36713) Seal

For and on Behalf of Kiowa Engineering Corporation

DEVELOPER'S STATEMENT:

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

Business Name: _____

Authorized Signature: _____ Date: _____

Title: _____

Address:

Town of Monument:

Filed in accordance with Section 17.45 of the Zoning Ordinance for the Town of Monument, and Section 16.12.060 of the Subdivision Code for the Town of Monument, revised February, 2007.

_____ _____

Director of Development Services Date

Conditions:

I. GENERAL DESCRIPTION

The purpose of this Master Development Drainage Plan (MDDP) Update is to update the Original MDDP with the southern portion of the Falcon Commerce Center (FCC) property and revise a couple drainage patterns for the northern portion of the FCC development. The Falcon Commerce Center site is located to the west of Interstate 25, south of Baptist Road, east of Woodcarver Road, Santa Fe trail and the Union Pacific Railroad; and north of the United States Air Force Academy (USAFA). This report will focus on updates to the MDDP and revisions to the Original MDDP, refer to the Original MDDP (dated October 13, 2020) for additional information.

The total area of the property is 213.82 acres. The original MDDP analyzed the north portion of the property (approximately 136 acres) located to the north of Jackson Creek and south of Baptist Road. The property to the south of Jackson Creek encompasses the remaining area of the property and is part of this update.

The overall site is planned to be developed with mixed use of commercial, industrial and the option for residential/apartment properties to the south of Jackson Creek. Each individual development will be required to submit a drainage report with drainage calculations to analyze site specific details and design the specific drainage improvements for each individual lot/site. The drainage patterns and calculations provided in this report include an evaluation of the drainage impact and improvements associated with the overall development and only provide a preliminary design of the public and major drainage facilities.

There are no irrigation facilities located within the property.

II. SOIL CONDITIONS

Soils within the property are classified to be within Hydrologic Soils Group B based on the NRCS Soil Survey for the El Paso County area. Soils on the site are predominantly Pring coarse sandy loam and Peyton-Pring complex (Soil Group B). A small portion of Tomah-Crowfoot complex boarders Jackson Creek (Soil Group B) and a small portion of Kettle-Rock outcrop complex is present on the west side of the site (Soil Group B). For the site drainage calculations, the soils were assumed to be Hydrologic Soil Group B. The existing vegetative cover within the development is in fair condition with mostly native grasses and scattered trees throughout the site. The existing ground slopes within a majority of the property range from 2 to 8 percent. Steeper slopes occur near Jackson Creek. The steepest slopes occur along the abandoned railroad embankment and Jackson Creek.

III. DRAINAGE CRITERIA

Hydrologic and hydraulic calculations for the site were performed using the methods outlined in the *City of Colorado Springs Drainage Criteria Manual Volumes 1 and 2*. Topography for the site was compiled using two-foot contour interval and is presented on the Drainage Plans. The hydrological calculations were made for the existing and proposed site conditions. The Drainage Plan – Proposed Condition presents the proposed drainage patterns for the site, including the sub-basins. The peak flow rates for the sub-basins were estimated using the Rational Method. The 5-year (Minor Storm) and 100-year (Major Storm) recurrence intervals were determined. The one-hour rainfall depths were determined from Table 6-2 of the City's Drainage Criteria Manual, Volume 1.

Hydraulic calculations will be provided in the future as part of the Final Drainage Report for the individual developments. MHFD-Detention workbook was used for the preliminary sizing and design of the water quality and detention facilities.

IV. EXISTING DRAINAGE CONDITIONS

The area to the north of Jackson Creek is described in the Original MDDP. The area to the south of Jackson Creek drains by sheet flow and drainage swale flow south-southwest to the south property line with Air Force Academy and the west property line with the railroad right of way. Basin EX-M from the Original MDDP describes the portion of area to the south of Jackson Creek that drains north into the Creek. That basin is not impacted by this Update. In the existing condition, runoff from the south portion of the property leaves the site in three locations (1) southwest corner of the property thru an existing 12-inch CMP under the Santa Fe trail into the railroad ROW, (2) on the south end of the site thru an existing 12-inch CMP under the Santa Fe trail and into the Air Force Academy and (3) at the southeast corner of the site by sheet flow across the Santa Fe trail into the Air Force Academy (AFA). A description of the existing drainage basins is included below.

A Habitat Conservation Area exists along Jackson Creek within the overall property and to the east of the property. The area/property to the east is owned and monitored by the Colorado Department of Transportation. The proposed improvements will not impact this area. For the development of the subject site, a 300-ft buffer is shown along both sides of Jackson Creek for the Preble's Meadow Jumping Mouse (PMJM).

Sub-Basin EX-N: The drainage basin is located to the south of Jackson Creek. The basin consists of grassed areas, a drainage swale and portions of the old Denver and Santa Fe Railroad. Off site flows enter this basin from the east via a 60-inch RCP storm sewer under Interstate 25 and into a drainage swale. A 24-inch culvert conveys the flows under the old Denver and Santa Fe Railroad embankment and into the property. This undersized culvert will provide some inadvertent flow attenuation before releasing the flows into the existing drainage swale that flows through the property to the southwest corner. The runoff from the basin generally sheet flows south to the existing drainage swale which conveys flows to the southwest corner of the property. At the downstream end, a 12-inch culvert is located under the Santa Fe trail to convey flows under the trail and into the railroad right of way. The runoff appears to continue south along the east side of the railroad tracks into the Air Force Academy property. A culvert under the railroad tracks was not visible from the FCC property.

Sub-Basin EX-O: The drainage basin is located in the southeast corner of the property. The basin consists of grassed areas, a drainage swale and portions of the old Denver and Santa Fe Railroad. Off site flows enter this basin from the east via a 42-inch RCP storm sewer under Interstate 25 and into detention basin with outlet structure in the CDOT ROW. A 24-inch culvert conveys the flows from the CDOT ROW under the old Denver and Santa Fe Railroad embankment into the property. An existing drainage swale conveys the flows west and south to the property line with the Air Force Academy. The runoff from the basin generally sheet flows to the existing drainage swale which conveys flows to the south property line. At the downstream end, an existing 12-inch culvert is located under the Santa Fe trail to convey flows under the trail and into the AFA property.

Sub-Basin EX-P: The drainage basin is located in the southeast corner of the property. The basin consists of grassed areas. The runoff from the basin generally sheet flows southwest to the south property line and over the Santa Fe trail to the AFA property.

V. PROPOSED DRAINAGE CONDITIONS

The drainage patterns for the proposed development will generally include sheet flow, gutter flow to proposed inlets which will collect the flows. Storm sewer systems will be installed to convey these flows to the south end of the site to the proposed stormwater quality and detention basin. The detention basins will be Full Spectrum Detention (FSD) basins including forebays, trickle channel, FSD outlet structure, emergency spillway and outlet pipe. The Drainage Plan – Proposed Condition for the site (Exhibit B) is provided at the end of this report.

This MDDP provides an evaluation of the overall drainage impact of the development and preliminary design of the public and major drainage facilities. Detailed drainage report(s) and construction plans are required for the public and major drainage improvements including the sub-regional stormwater quality and detention facility.

The proposed development will include both public and private facilities. The public drainage facilities are planned to be maintained by the Town and include the inlets within the public roadways, the storm sewer system downstream of those inlets and the detention basins. The detention basins will be initially maintained by the Forest Lakes Metro District and then turned over to the Town after the period of time agreed to between the two entities. The private facilities will be the inlets and storm sewers for each individual lot. These private facilities will be maintained privately. Refer to the Original MDDP for a description of the on-site storm sewer systems. Following is a description of the drainage basins.

Sub-Basin OS-2: The Pilot Travel Center detention basin provides both stormwater quality improvement and detention to the developed runoff with a Full Spectrum Detention basin. The outlet pipe from the detention basin will be routed into the proposed FCC storm sewer system, specifically Storm Sewer System 2 to drain to the regional detention basin at the southwest corner of the north portion of the site. The peak flow rates from the detention basin are Q5=0.4 cfs and Q100=20.8 cfs. The downstream storm sewer system and the Falcon Commerce Center Full Spectrum Detention basin (FSD 1) have been sized to accept, convey and treat these flows. Specifically, the regional detention basin has been sized to provide additional water quality and detention for the Basin OS-2 flows. The emergency spillway for the PTC detention basin is located at the southwest corner of the detention basin. The flows from the emergency spillway will need to be accounted for by the areas downstream of the detention basin or modify the existing spillway location.

Sub-Basin C-50: The drainage basin is located to the south of Jackson Creek and includes the area planned to be developed in the future. The planned development may include industrial, commercial or apartments. The runoff from the site will drain southwest and be captured by inlets connected to storm sewer system which will drain to the proposed Full Spectrum Detention basin (FSD 2). Inlets and storm sewer will be sized to capture and convey the 100-year storm event to FSD 2.

Sub-Basin C51: The drainage basin includes the area associated with the proposed FSD 2. The runoff from this basin will sheet flow into the detention basin. Refer to the following section for a description of the FSD 2. The outlet pipe for the detention basin will drain into the existing drainage swale to the south before leaving the property at Design Point 61.

Sub-Basin C52: The drainage basin is located along the southwest side of the south site. It includes an existing drainage swale which conveys off-site flows through the property from under Interstate 25. The area associated with the drainage swale is planned to be left undeveloped. The flows in that swale will be piped from the east end of the site, under Basin C50 and discharge back into the existing drainage swale within this basin. A preliminary size of the storm sewer pipe has been provided on the Drainage Plan. Outlet protection with a flow dissipation structure will be provided at the end of the pipe, however no other improvements are planned to the portion of swale within the basin. The

Sub-Basin C53: The drainage basin is located along the south side of the south site. It includes an existing drainage swale which conveys off-site flows through the property from under Interstate 25. The basin is planned to be left undeveloped. The flows in the swale will be piped from the east end of the site, under Basin C50 and discharge back into the existing drainage swale within this basin. A preliminary size of the storm sewer pipe has been provided on the Drainage Plan. Outlet protection with flow dissipation will be provided at the end of the pipe. No other improvements are planned to the portion of swale within the basin.

Sub-Basin C54: The drainage basin is located in the southeast corner of the south site and includes the area planned to be developed in the future. The planned development may include industrial, commercial or apartments. The runoff from the site will be captured by a storm sewer system and routed to Full Spectrum Detention basin FSD 2. Inlets and storm sewer will be sized to capture and convey the 100-year storm event to FSD 2. There is a possibility future development will not develop the edges of this drainage basin. If that occurs, the runoff released onto the adjacent property shall be kept to historic flow rates.

Jackson Creek Crossing: The development of the south portion of the site will necessitate the use or replacement of the existing bridge crossing Jackson Creek to access the south side of the creek. The bridge will be analyzed to verify sufficient flow capacity and structural integrity as part of the development of the south side of the creek. The Fire District is requiring two points of access into the south area, so a second bridge is planned to be constructed parallel with the existing bridge.

VI. WATER QUALITY AND DETENTION DESIGN

The development of the property will include construction of two storm water quality and detention facilities (one on each side of the creek) meeting the requirements of the Town of Monument and the City of Colorado Spring's Drainage Criteria Manual (Volume 1 and 2). A Full Spectrum Detention (FSD) basin will be constructed in the southwest corner of the site for the north area (FSD 1) and the southwest corner of the site for the south area (FSD 2), to provide both stormwater quality and detention improvements for the proposed runoff from the site. FSD 2 is planned to be located adjacent to the existing drainage swale that conveys off-site flows through the property. The off-site flows are not planned to go through FSD 2. The FSD's will include forebays, trickle channel, FSD outlet structure, emergency spillway and outlet pipe. The outlet structure has been designed to control the release the of the WQCV, EURV and multiple storm return periods up to the 100 year event at a flow rate equal to or less than the calculated existing condition flows into Jackson Creek for the north area and to the southwest corner of the property for the south area. The water quality orifice plate will be sized to drain the WQCV in approximately 40 hours and to drain the EURV in approximately 72 hours. The emergency spillway will be constructed along the south side of the detention area to release flows in excess of the 100-year event and in an emergency situation to the existing grassed area to the south of the site. The UD-Detention workbook along with Mile High Flood District equations have been used to design the facility. Refer to the Appendix for the preliminary calculations and for a detailed summary of the maximum allowable detention release rates. The specific design of the detention basins will be provided in a Final Drainage Report. The design of the north FSD (FSD 1) is provided in the Final Drainage Report for Falcon Commerce Center Filing No. 1.

For the north area (FSD 1), the maximum allowable detention release rates were calculated to result in a proposed condition flow at Jackson Creek at the existing railroad tracks which is equal to or less than the existing condition. The common Design Points between the existing and proposed conditions are DP E4 and DP 42 respectively. This meant the need to over detain to account for the runoff from Basins EX-D and EX-E which flow directly to Monument Creek. In the proposed condition, the runoff from those basins will be routed through the sub-regional detention basin and into Jackson Creek. This results in a lower overall flow reaching Monument Creek than in the existing condition.

For the south area (FSD 2), the maximum allowable detention release rates were calculated to result in a proposed condition flow at the southwest corner of the property to be equal to or less than the existing condition. The existing condition design point is DP 62. Refer to the Drainage Plan – Proposed Condition for a comparison.

The detailed final design of the FSD detention basins will require a separate drainage report and construction documents.

VII. FLOODPLAIN

A portion of the subject property along Jackson Creek is located within a Zone A FEMA regulated floodplain based on Flood Insurance Rate Map 08041C0286 G (effective date of December 7, 2018). The area included in the Zone A floodplain is located within the Prebles Meadow Jumping Mouse habitat buffer area and will not be impacted as part of the Falcon Commerce Center development. The remainder of the property is located in an unshaded Zone X area which is described as "Areas determined to be outside 500-year floodplain".

The proposed lots in the subdivision will be located more than 300-ft from the existing Zone A FEMA regulated floodplain, due to the PMJM habitat buffer area. A crossing of the creek and floodplain is planned to develop the area to the south of Jackson Creek. Prior to Final Plat and development of the Terrazzo Drive extension and crossing of Jackson Creek, a floodplain study will be required to determine base flood elevations and detailed flood boundaries. A Conditional Letter of Map Revision will be submitted for review and approval prior to Final Plat of areas within 300-ft of Jackson Creek.

VIII. ENVIRONMENTAL

An Environmental Assessment Report was completed for the property by Bristlecone Ecology in April 2020. The report provides documentation of the natural resources and existing site conditions to identify potential environmental constraints that may affect the development of the project. It provides guidance on regulatory issues that could influence site development in accordance with development planning.

As part of the first phase of the overall project, FSD 1 was constructed and the storm sewer outfall to the creek was installed. Wetland impacts along Jackson Creek were authorized by the Army Corps of Engineers and work within the PMJM habitat area was authorized by the United States Fish and Wildlife. Prior to constructing the Terrazzo Drive crossing of Jackson Creek an assessment will be required to determine the wetland, PMJM and environmental impacts associated with the construction. Permits and authorization will be required through these entities prior to construction.

For the remainder of the site, a jurisdictional determination was received from USACE, confirming isolated wetlands in swales separate from Jackson Creek are non-jurisdictional and do not require authorization. There have been no changes since those authorizations were received.

IX. SUMMARY

This Master Development Drainage Plan has been prepared in general conformance with the Town of Monument standards and the *City of Colorado Springs Drainage Criteria Manual Volumes 1 and 2*. The proposed stormwater management design for the subject site has been designed to properly convey and treat stormwater based on the requirements and guidance provided in the criteria manuals.

X. REFERENCES

1) Master Development Drainage Plan, Falcon Commerce Center, prepared by Kiowa Engineering Corporation, dated October 13, 2020.

2) Final Drainage Report, Falcon Commerce Center Filing No. 1, prepared by Kiowa Engineering Corporation, dated December 7, 2020.

3) City of Colorado Springs, Drainage Criteria Manual, Volumes 1 and 2 dated May 2014.

4) Urban Storm Drainage Criteria Manual, Vol. 1, 2 and 3, and Design Workbooks/Spreadsheets, Urban Drainage and Flood Control District, latest revisions.

5) Monument Creek Drainage Basin Planning Study, City of Colorado Springs and El Paso County, prepared by CH2M Hill and Kiowa Engineering Corporation.

6) Final Drainage Report for Baptist Road West, prepared by Felsburg Holt & Ullevig, dated March 19, 2015.

7) Preliminary and Final Drainage Report for Pilot Travel Center Filing No. 1, prepared by Drexel, Barrell & Co. dated July 13, 2017.

8) Hydrology Report I-25 North Design Build, prepared by RESPEC Consulting & Services, dated August 2012, revised September 14, 2012.

9) Environmental Assessment Report for Falcon Commerce Center, prepared by Bristlecone Ecology, LLC, dated April 2020.

APPENDIX TABLE OF CONTENTS

APPENDIX A

Figure 1: Vicinity Map

Soils Map

FEMA Flood Insurance Rate Map

Floodplain Letter for Zone A Floodplain

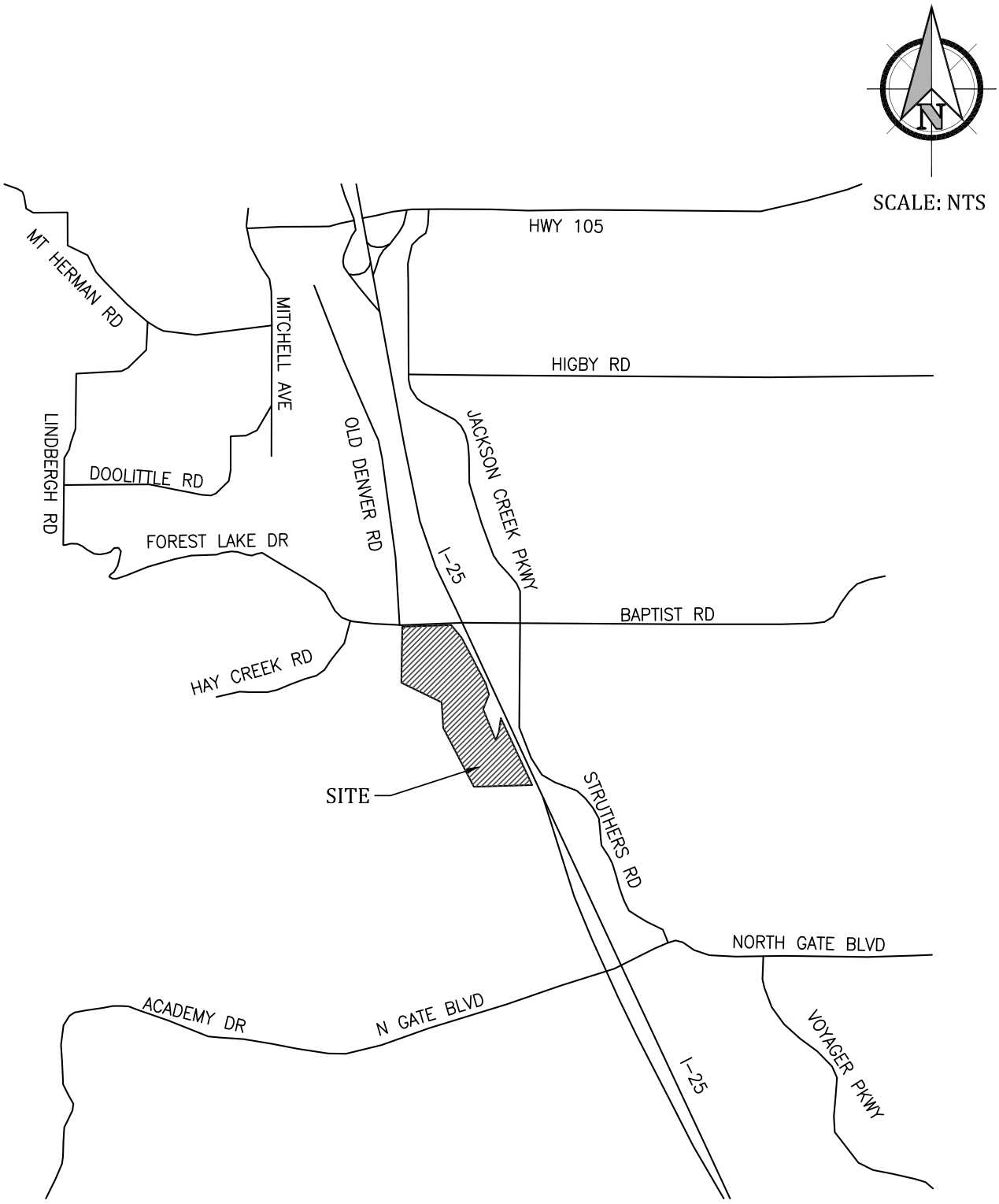
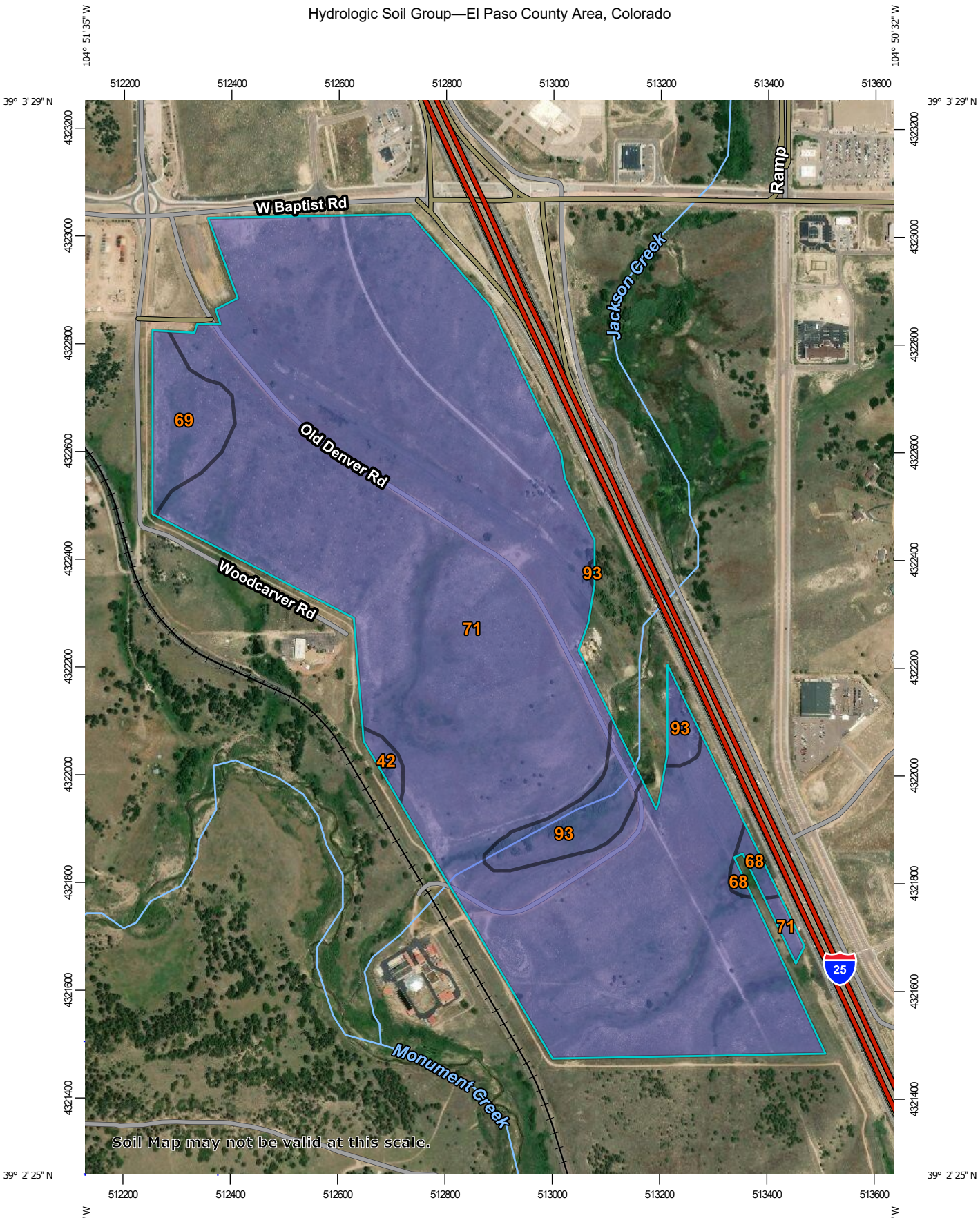


FIGURE 1
VICINITY MAP
FALCON COMMERCE CENTER



Map Scale: 1:9,720 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 100 200 400 600

Feet: 0 450 900 1800 2700

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 16, Sep 10, 2018

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

Date(s) aerial images were photographed: Jul 4, 2010—Oct 16, 2017

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
42	Kettle-Rock outcrop complex	B	1.1	0.5%
68	Peyton-Pring complex, 3 to 8 percent slopes	B	1.3	0.6%
69	Peyton-Pring complex, 8 to 15 percent slopes	B	7.8	3.5%
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	205.4	91.5%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	B	8.7	3.9%
Totals for Area of Interest			**224.4**	**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

National Flood Hazard Layer FIRMette

FEMA

Feet

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

1:6,000

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
- 20.2 / 17.5 Cross Sections with 1% Annual Chance / Water Surface Elevation
- 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.

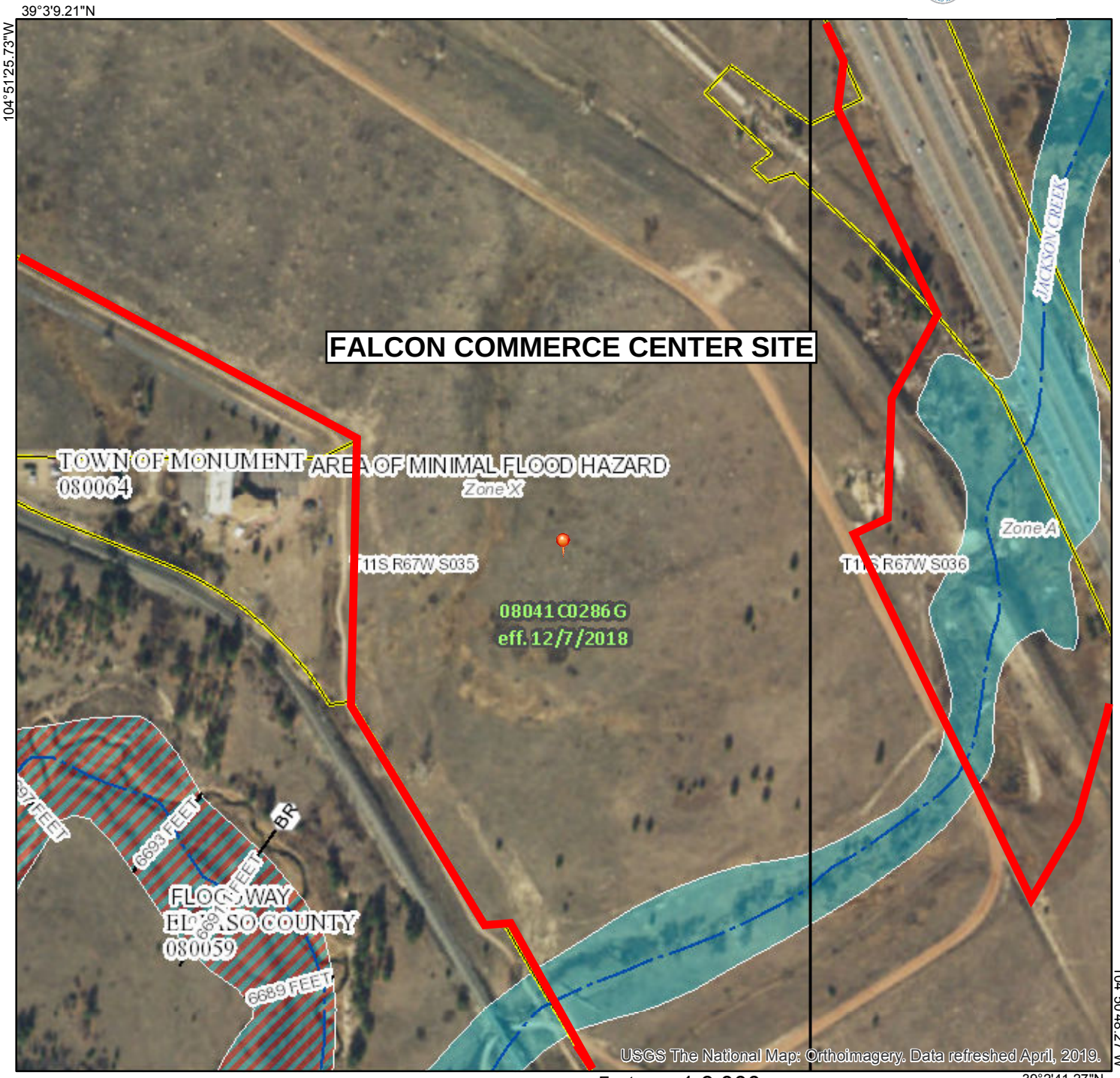
This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 7/18/2019 at 11:07:10 AM 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.

National Flood Hazard Layer FIRMette

FEMA



Feet

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1:6,000

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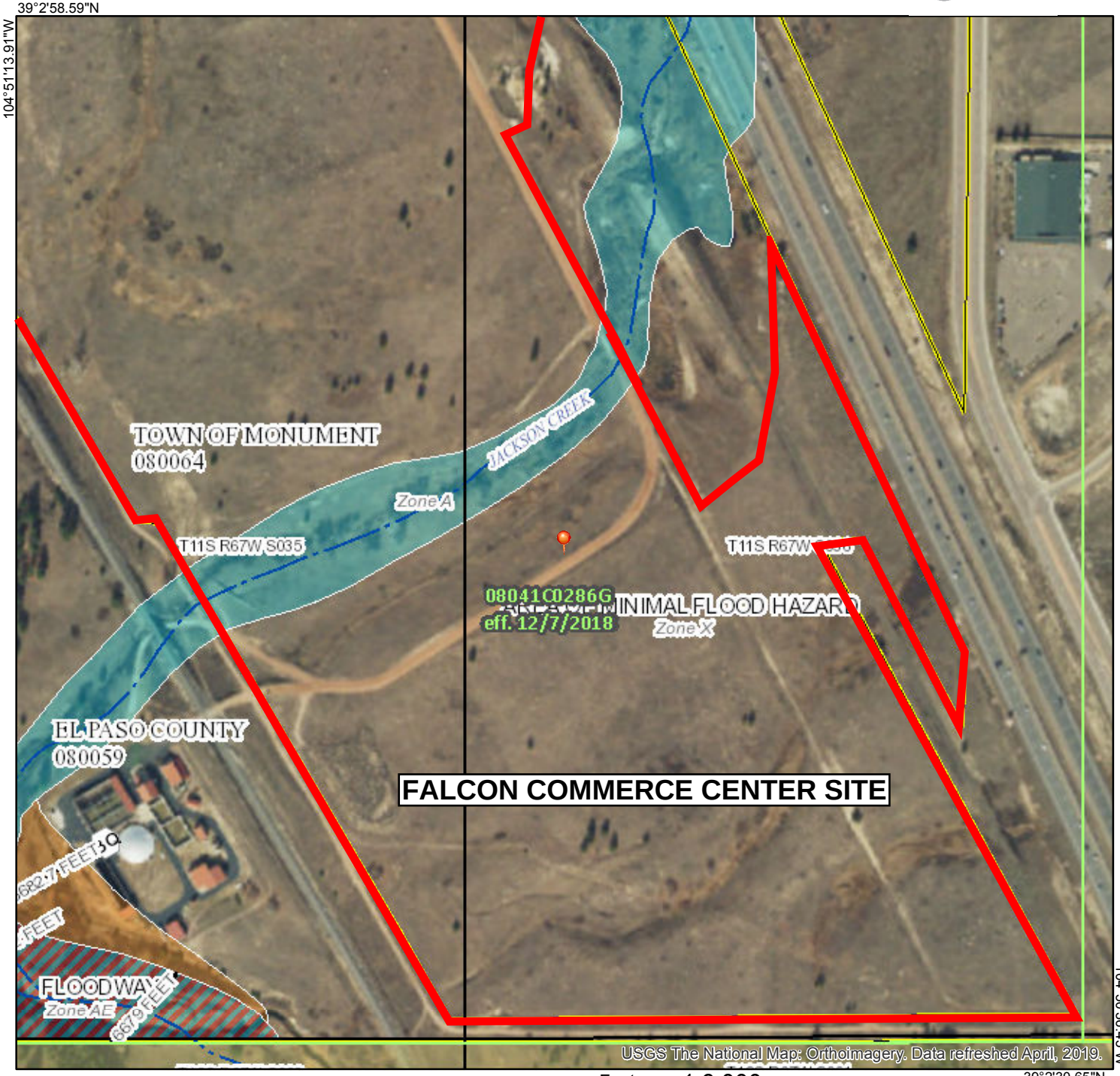
National Flood Hazard Layer FIRMette

FEMA



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- 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 7/18/2019 at 10:50:32 AM 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.

Kiowa
Engineering Corporation

June 16, 2020

Keith Curtis
Floodplain Administrator
Pikes Peak Regional Building Department
2880 International Circle
Colorado Springs, CO 80910

RE: Falcon Commerce Center Sketch Plan – Jackson Creek Zone A Floodplain
Kiowa Project Number 19036

Dear Mr. Curtis:

The lots in the proposed development will be located more than 300-ft from the existing Zone A FEMA regulated floodplain, due in part to the PMJM habitat buffer area. When this area is platted the property within the Special Flood Hazard Area will be dedicated as a tract.

Based on field verified characteristics of the property, the property is reasonably safe from flooding and to the best of the engineer's knowledge if the 100-year floodplain were studied it would not enter the property in question.

Please feel free to contact me if there are any questions or if I may be of further assistance.

Sincerely,
Kiowa Engineering Corporation

COLORADO REGISTERED
MATTHEW W. ERICHSEN
6/16/2020
36713
PROFESSIONAL ENGINEER

Matthew Erichsen, P.E., CFM
Project Manager

APPENDIX B

Hydrologic Calculations – Existing Conditions

Runoff Coefficient and Percent Impervious Calculations
Time of Concentration and Drainage Basin Runoff Calculations

Falcon Commerce Canter

Runoff Coeficient and Percent Impervious Calculation - Existing Condition

Basin / DP	Basin or DP Area (DP contributing basins)		Soil Type	HI	Area 1 Land Use			GR	Area 2 Land Use			PV	Area 3 Land Use			RO	Area 4 Land Use			RO	Area 5 LandUse			Basin % Imperv	Basin Runoff Coef	
				% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp		C_5	C_{100}
EX-B	768,579 sf	17.64ac	AB	2%	17.42ac	99%	2%	80%	0.22ac	1%	1%	100%		0%	0%	90%		0%	0%	90%		0%	0%	**3.0%**	**0.08**	**0.37**
EX-C	1,343,182 sf	30.84ac	AB	2%	29.95ac	97%	2%	80%	0.89ac	3%	2%	100%		0%	0%	90%		0%	0%	90%		0%	0%	**4.2%**	**0.09**	**0.37**
EX-D	895,524 sf	20.56ac	AB	2%	20.32ac	99%	2%	80%	0.24ac	1%	1%	100%		0%	0%	90%		0%	0%	90%		0%	0%	**2.9%**	**0.08**	**0.37**
EX-E	1,064,100 sf	24.43ac	AB	2%	21.49ac	88%	2%	80%	2.93ac	12%	10%	100%		0%	0%	90%		0%	0%	90%		0%	0%	**11.4%**	**0.15**	**0.41**
EX-F	306,301 sf	7.03ac	AB	2%	6.71ac	95%	2%	80%	0.32ac	5%	4%	100%		0%	0%	90%		0%	0%	90%		0%	0%	**5.6%**	**0.10**	**0.38**
EX-H	1,357,365 sf	31.16ac	AB	2%	28.19ac	90%	2%	80%	1.79ac	6%	5%	100%	1.18ac	4%	4%	90%		0%	0%	90%		0%	0%	**10.2%**	**0.14**	**0.40**
EX-I	685,988 sf	15.75ac	AB	2%	12.95ac	82%	2%	80%	0.14ac	1%	1%	100%	2.66ac	17%	17%	90%		0%	0%	90%		0%	0%	**19.2%**	**0.19**	**0.44**
EX-J	334,995 sf	7.69ac	AB	2%	6.65ac	86%	2%	80%	1.04ac	14%	11%	100%		0%	0%	90%		0%	0%	90%		0%	0%	**12.5%**	**0.15**	**0.41**
EX-K	745,032 sf	17.10ac	AB	2%	15.62ac	91%	2%	80%	0.57ac	3%	3%	100%	0.91ac	5%	5%	90%		0%	0%	90%		0%	0%	**9.8%**	**0.14**	**0.40**
EX-L	625,730 sf	14.36ac	AB	2%	13.98ac	97%	2%	80%	0.39ac	3%	2%	100%		0%	0%	90%		0%	0%	90%		0%	0%	**4.1%**	**0.09**	**0.37**
EX-M	556,530 sf	12.78ac	AB	2%	11.48ac	90%	2%	80%	1.29ac	10%	8%	100%		0%	0%	90%		0%	0%	90%		0%	0%	**9.9%**	**0.14**	**0.40**
EX-N	1,697,774 sf	38.98ac	AB	2%	38.98ac	100%	2%	80%		0%	0%	100%		0%	0%	90%		0%	0%	90%		0%	0%	**2.0%**	**0.08**	**0.36**
EX-O	413,100 sf	9.48ac	AB	2%	9.48ac	100%	2%	80%		0%	0%	100%		0%	0%	90%		0%	0%	90%		0%	0%	**2.0%**	**0.08**	**0.36**
OS-1	211,991 sf	4.87ac	AB	2%	3.57ac	73%	1%	80%	0.35ac	7%	6%	100%	0.95ac	20%	20%	90%		0%	0%	90%		0%	0%	**26.7%**	**0.23**	**0.46**
OS-2Hist	551,783 sf	12.67ac	AB	2%	12.67ac	100%	2%	80%		0%	0%	100%		0%	0%	90%		0%	0%	90%		0%	0%	**2.0%**	**0.08**	**0.36**
OS-2	551,784 sf	12.67ac	AB	2%	4.59ac	36%	1%	80%		0%	0%	100%	7.76ac	61%	61%	90%	0.31ac	2%	2%	90%		0%	0%	**64.2%**	**0.44**	**0.59**
E4	EX-H,I,J,K,L, OS-2Hist	111.51ac	AB	2%	101.54ac	91%	2%	80%	5.22ac	5%	4%	100%	4.75ac	4%	4%	90%	0.00ac	0%	0%	90%		0%	0%	**9.8%**	**0.14**	**0.40**

Basin Runoff Coef is based on % Impervious Calculation

Based on Table 6-6: Runoff Coefficients for Rational Method from City of Colo Springs DCM

Runoff Coefficients and Percents Impervious						
Hydrologic Soil Type:	**AB**	**Runoff Coef Method**			%Imp	
Land Use	Abb	%	C_5	C_{10}	C_{100}	Weighted
Commercial Area	CO	95%	0.81	0.83	0.88	%Imp
Drives and Walks	DR	100%	0.90	0.92	0.96	A
Streets - Gravel (Packed)	GR	80%	0.59	0.63	0.70	AB
Historic Flow Analysis	HI	2%	0.09	0.17	0.36	CD
Lawns	LA	0%	0.08	0.15	0.35	D
Off-site flow-Undeveloped	OF	45%	0.32	0.38	0.51	
Park	PA	7%	0.12	0.20	0.39	
Streets - Paved	PV	100%	0.90	0.92	0.96	
Roofs	RO	90%	0.73	0.75	0.81	
User Input 1	US1	40%	0.30	0.36	0.50	
User Input 2	US2	65%	0.45	0.49	0.59	

Falcon Commerce Center
Time of Concentration Calculation - Existing Condition

Sub-Basin Data				Time of Concentration Estimate											
Basin / Design Point	Contributing Basins	Area	C_5	Initial/Overland Time (t_i)			Travel Time (t_t)						Comp.		Final t_c
				Length	Slope	t_i	Length	Slope	Land Type	Cv	Velocity	t_t	t_c		
EX-B		17.64ac	0.08	300lf	2.3%	24.6 min.	1500lf	3.3%	SP	7	1.3 ft/sec	19.8 min.	44.4 min.		**44.4 min.**
EX-C		30.84ac	0.09	300lf	2.0%	25.3 min.	1425lf	3.4%	GW	15	2.8 ft/sec	8.6 min.	33.9 min.		**33.9 min.**
EX-D		20.56ac	0.08	300lf	4.0%	20.3 min.	675lf	3.4%	SP	7	1.3 ft/sec	8.8 min.	29.1 min.		**29.1 min.**
EX-E		24.43ac	0.15	300lf	2.8%	21.6 min.	1475lf	2.5%	SP	7	1.1 ft/sec	22.1 min.	43.7 min.		**43.7 min.**
EX-F		7.03ac	0.10	300lf	4.0%	19.9 min.	1075lf	2.0%	SP	7	1.0 ft/sec	17.9 min.	37.8 min.		**37.8 min.**
EX-H		31.16ac	0.14	300lf	3.5%	20.1 min.	1375lf	2.0%	GW	15	2.1 ft/sec	10.8 min.	30.9 min.		**30.9 min.**
EX-I		15.75ac	0.19	300lf	8.5%	14.1 min.	1800lf	2.8%	GW	15	2.5 ft/sec	12.0 min.	26.1 min.		**26.1 min.**
EX-J		7.69ac	0.15	300lf	4.3%	18.5 min.	1140lf	3.4%	GW	15	2.8 ft/sec	6.9 min.	25.4 min.		**25.4 min.**
EX-K		17.10ac	0.14	300lf	8.0%	15.3 min.	470lf	6.0%	GW	15	3.7 ft/sec	2.1 min.	17.4 min.		**17.4 min.**
EX-L		14.36ac	0.09	300lf	6.3%	17.3 min.	1050lf	1.8%	GW	15	2.0 ft/sec	8.7 min.	26.0 min.		**26.0 min.**
EX-M		12.78ac	0.14	300lf	12.0%	13.4 min.	980lf	1.8%	GW	15	2.0 ft/sec	8.1 min.	21.5 min.		**21.5 min.**
EX-N		38.98ac	0.08	300lf	4.0%	20.4 min.	2100lf	3.0%	GW	15	2.6 ft/sec	13.5 min.	33.8 min.		**33.8 min.**
EX-O		9.48ac	0.08	300lf	4.0%	20.4 min.	600lf	4.3%	GW	15	3.1 ft/sec	3.2 min.	23.6 min.		**23.6 min.**
OS-1		4.87ac	0.23	170lf	5.9%	11.5 min.	460lf	1.7%	SP	7	0.9 ft/sec	8.4 min.	19.9 min.		**19.9 min.**
OS-2Hist		12.67ac	0.08	60lf	5.0%	8.4 min.	600lf	3.5%	SP	7	1.3 ft/sec	7.6 min.	16.1 min.		**16.1 min.**

Equations:

t_i (Overland) = $0.395(1.1-C_5)L^{0.5} S^{-0.333}$

C_5 = Runoff coefficient for 5-year

L = Length of overland flow (ft)

S = Slope of flow path (ft/ft)

tc Check = (L/180)+10 (Developed Cond. Only)

L = Overall Length

Velocity (Travel Time) = $CvS^{0.5}$

Cv = Conveyance Coef (see table)

S = Watercourse slope (ft/ft)

Table 6-7: Conveyance Coef (City CS DCM, Vol 1)

Type of Land Surface	Land Type	Cv
Grassed Waterway	GW	15
Heavy Meadow	HM	2.5
Nearly Bare Ground	NBG	10
Paved Area	PV	20
Riprap (Not Buried)	RR	6.5
Short Pasture/Lawns	SP	7
Tillage/Fields	TF	5

Falcon Commerce Center
Runoff Calculation - Existing Condition

Design Storm: 5 Year

		Direct Runoff							Total Runoff				Street/Chan		Pipe			Travel Time			
Street	**Design Point**	Area Designation	Area	C	T_c	C*A (acre)	i (in/hr)	Q	T_c	Sum C*A	i (in/hr)	Q	Slope	Q	Q	Slope	Pipe Size	L (ft)	Vel (ft/s)	T_t	Remarks
		EX-B	17.64 ac	0.08	44.4min	1.50	1.9	2.8 cfs			---	---								---	
		EX-C	30.84 ac	0.09	33.9min	2.92	2.3	6.7 cfs			---	---								---	
		EX-D	20.56 ac	0.08	29.1min	1.74	2.5	4.4 cfs			---	---								---	
		EX-E	24.43 ac	0.15	43.7min	3.55	1.9	6.8 cfs			---	---								---	
		EX-F	7.03 ac	0.10	37.8min	0.74	2.1	1.6 cfs			---	---	3.2%	1.6 cfs				1600'	1.8	14.7min	To DP E7
		EX-H	31.16 ac	0.14	30.9min	4.29	2.4	10.4 cfs			---	---	3.1%	10.4 cfs				460'	4.6	1.7min	To DP E2
		EX-I	15.75 ac	0.19	26.1min	3.04	2.7	8.2 cfs			---	---								---	
		EX-J	7.69 ac	0.15	25.4min	1.18	2.7	3.2 cfs			---	---								---	
		EX-K	17.10 ac	0.14	17.4min	2.31	3.3	7.6 cfs			---	---								---	
		EX-L	14.36 ac	0.09	26.0min	1.35	2.7	3.6 cfs			---	---								---	
		EX-M	12.78 ac	0.14	21.5min	1.73	3.0	5.2 cfs			---	---								---	
		EX-N	38.98 ac	0.08	33.8min	3.18	2.3	7.3 cfs			---	---								---	
		EX-O	9.48 ac	0.08	23.6min	0.77	2.8	2.2 cfs			---	63.2 cfs	+I-25, South Flows							---	
		OS-1	4.87 ac	0.23	19.9min	1.13	3.1	3.5 cfs			---	---								---	
		OS-2Hist	12.67 ac	0.08	16.1min	1.03	3.4	3.5 cfs			---	---								---	
		OS-2						0.4 cfs	Detention outlet flow, See PTC FDR											---	
	I-25, North							60.0 cfs	10yr Flow under I-25, See I25 North Hydro Report												
	I-25, South							61.0 cfs	10yr Flow under I-25, See I25 North Hydro Report												
	DP E1	OS-2,EX-H							30.9min	4.29	2.4	10.8 cfs	Added flow out of PTC detention basin							---	To DP E2
	DP E2	DPE1+EX-I							32.6min	7.32	2.4	17.7 cfs	0.8%	17.7 cfs				880'	2.3	6.3min	To DP E3
	DP E3	DPE2, EX-J,K							38.9min	10.82	2.1	23.0 cfs	1.8%	23.0 cfs				1500'	3.3	7.6min	To DP E4
	DP E4	DPE3, EX-L,M							46.5min	13.89	1.8	25.8 cfs								---	
	DP E4Hist	DP E4Hist	Uses Historic flow from OS-2						46.5min	14.93	1.8	27.2 cfs								---	
	DP E7	EX-B,C,F							52.5min	5.15	1.6	8.5 cfs								---	
	DP E10	EX-N. I-25, North										67.3 cfs	Includes I-25 North Flows							---	
	DP E11	EX-N										7.3 cfs	On-Site Flows Only							---	
	DP E12	EX-O+I-25 South										63.2 cfs	Includes I-25 South Flows							---	

NOTE: "PTC FDR" is Pilot Travel Center Final Drainage Report, prepared by Drexel, Barrell & Co, dated July 13, 2017.

Equations (taken from Fig 6-5, City of Colorado Springs DCM):

$i_2 = -1.19 \ln(T_c) + 6.035$

$i_5 = -1.50 \ln(T_c) + 7.583$

$i_{10} = -1.75 \ln(T_c) + 8.847$

$i_{100} = -2.52 \ln(T_c) + 12.735$

Q = CiA

Q = Peak Runoff Rate (cubic feet/second)

C = Runoff coef representing a ration of peak runoff rate to ave rainfall intensity for a duration equal to the runoff time of concentration.

i = average rainfall intensity in inches per hour

A = Drainage area in acres

Falcon Commerce Center
Runoff Calculation - Existing Condition

Design Storm: 100 Year

		Direct Runoff							Total Runoff				Street/Chan		Pipe			Travel Time			
Street	**Design Point**	Area Designation	Area	C	T_c	C*A (acre)	i (in/hr)	Q	T_c	Sum C*A	i (in/hr)	Q	Slope	Q	Q	Slope	Pipe Size	L (ft)	Vel (ft/s)	T_t	Remarks
		EX-B	17.64 ac	0.37	44.4min	6.49	3.2	20.6 cfs			---	---								---	
		EX-C	30.84 ac	0.37	33.9min	11.56	3.9	44.6 cfs			---	---								---	
		EX-D	20.56 ac	0.37	29.1min	7.55	4.2	32.1 cfs			---	---								---	
		EX-E	24.43 ac	0.41	43.7min	10.00	3.2	32.2 cfs			---	---								---	
		EX-F	7.03 ac	0.38	37.8min	2.69	3.6	9.6 cfs			---	---	3.2%	9.6 cfs				1600'	3.9	6.9min	To DPE7
		EX-H	31.16 ac	0.40	30.9min	12.60	4.1	51.5 cfs			---	---	3.1%	72.3 cfs				460'	7.5	1.0min	To DPE2
		EX-I	15.75 ac	0.44	26.1min	6.91	4.5	31.2 cfs			---	---								---	
		EX-J	7.69 ac	0.41	25.4min	3.19	4.6	14.6 cfs			---	---								---	
		EX-K	17.10 ac	0.40	17.4min	6.89	5.5	38.1 cfs			---	---								---	
		EX-L	14.36 ac	0.37	26.0min	5.38	4.5	24.3 cfs			---	---								---	
		EX-M	12.78 ac	0.40	21.5min	5.15	5.0	25.8 cfs			---	---								---	
		EX-N	38.98 ac	0.36	33.8min	14.12	3.9	54.5 cfs			---	---								---	
		EX-O	9.48 ac	0.36	23.6min	3.44	4.8	16.4 cfs			---	209.4 cfs	+I-25, South Flows							---	
		OS-1	4.87 ac	0.46	19.9min	2.24	5.2	11.7 cfs			---	---								---	
		OS-2Hist	12.67 ac	0.36	16.1min	4.59	5.7	26.3 cfs			---	---								---	
		OS-2						20.8 cfs	Detention outlet flow, See PTC FDR											---	
	I-25, North							276.0 cfs	Flow under I-25, See I25 North Hydro Report												
	I-25, South							193.0 cfs	Flow under I-25, See I25 North Hydro Report												
	DP E1	OS-2,EX-H							30.9min	12.60	4.1	72.3 cfs	Added flow out of PTC detention basin							---	To DP E2
	DP E2	DPE1+EX-I							31.9min	19.50	4.0	98.9 cfs	0.8%	98.9 cfs				880'	4.0	3.7min	To DP E3
	DP E3	DPE2, EX-J,K							35.6min	29.57	3.7	131.1 cfs	1.8%	131.1 cfs				1500'	5.7	4.4min	To DP E4
	DP E4	DPE3, EX-L,M							40.0 min	40.10	3.4	158.8 cfs								---	
	DP E4Hist	DP E4Hist	Uses Historic flow from OS-2						40.0min	44.69	3.4	153.8 cfs								---	
	DP E7	EX-B,C,F							44.7min	20.74	3.2	65.6 cfs								---	
	DP E10	EX-N. I-25, North										330.5 cfs	Includes I-25 North Flows							---	
	DP E11	EX-N										54.5 cfs	On-Site Flows Only							---	
	DP E12	EX-O+I-25 South										209.4 cfs	Includes I-25 North Flows							---	

NOTE: "PTC FDR" is Pilot Travel Center Final Drainage Report, prepared by Drexel, Barrell & Co, dated July 13, 2017.

Equations (taken from Fig 6-5, City of Colorado Springs DCM):

i_2=-1.19 ln(T_c) + 6.035

i_5=-1.50 ln(T_c) + 7.583

i_{10}=-1.75 ln(T_c) + 8.847

i_{100}=-2.52 ln(T_c) + 12.735

Q = CiA

Q = Peak Runoff Rate (cubic feet/second)

C = Runoff coef representing a ration of peak runoff rate to ave rainfall intensity for a duration equal to the runoff time of concentration.

i = average rainfall intensity in inches per hour

A = Drainage area in acres

APPENDIX B.1

Hydrologic Calculations – Proposed Conditions

Runoff Coefficient and Percent Impervious Calculations
Time of Concentration and Drainage Basin Runoff Calculations

Falcon Commerce Canter - MDDP

Runoff Coeficient and Percent Impervious Calculation - Proposed Condition

				US1	Area 1 Land Use			US2	Area 2 Land Use			GR	Area 3 Land Use			PV	Area 4 Land Use			HI	Area 5 LandUse					
Basin / DP	**Basin or DP Area (DP contributing basins)**		Soil Type	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	**Basin % Imperv**	**Basin Runoff Coef** C_5	**Basin Runoff Coef** C_{100}
C-1	422,482 sf	9.70ac	AB	85%	0.00ac	0%	0%	75%		0%	0%	80%		0%	0%	100%		0%	0%	2%	9.70ac	100%	2%	**2.0%**	**0.08**	**0.36**
C-2	516,368 sf	11.85ac	AB	85%	11.85ac	100%	85%	75%		0%	0%	80%		0%	0%	100%		0%	0%	2%		0%	0%	**85.0%**	**0.66**	**0.75**
C-3	442,716 sf	10.16ac	AB	85%	10.16ac	100%	85%	75%		0%	0%	80%		0%	0%	100%		0%	0%	2%		0%	0%	**85.0%**	**0.66**	**0.75**
C-4	121,502 sf	2.79ac	AB	85%	1.29ac	46%	39%	75%		0%	0%	80%		0%	0%	100%		0%	0%	2%	1.50ac	54%	1%	**40.4%**	**0.30**	**0.50**
C-5	381,247 sf	8.75ac	AB	85%	8.75ac	100%	85%	75%		0%	0%	80%		0%	0%	100%		0%	0%	2%		0%	0%	**85.0%**	**0.66**	**0.75**
C-6	255,584 sf	5.87ac	AB	85%	5.87ac	100%	85%	75%		0%	0%	80%		0%	0%	100%		0%	0%	2%		0%	0%	**85.0%**	**0.66**	**0.75**
C-7	356,419 sf	8.18ac	AB	85%	8.18ac	100%	85%	75%		0%	0%	80%		0%	0%	100%		0%	0%	2%		0%	0%	**85.0%**	**0.66**	**0.75**
C-8	123,101 sf	2.83ac	AB	85%	2.33ac	82%	70%	75%		0%	0%	80%		0%	0%	100%		0%	0%	2%	0.50ac	18%	0%	**70.3%**	**0.49**	**0.62**
C-9	138,561 sf	3.18ac	AB	85%	3.18ac	100%	85%	75%		0%	0%	80%		0%	0%	100%		0%	0%	2%		0%	0%	**85.0%**	**0.66**	**0.75**
C-10	302,974 sf	6.96ac	AB	85%	6.96ac	100%	85%	75%		0%	0%	80%		0%	0%	100%		0%	0%	2%		0%	0%	**85.0%**	**0.66**	**0.75**
C-11	148,880 sf	3.42ac	AB	85%	3.42ac	100%	85%	75%		0%	0%	80%		0%	0%	100%		0%	0%	2%		0%	0%	**85.0%**	**0.66**	**0.75**
C-12	7,016 sf	0.16ac	AB	85%	0.00ac	0%	0%	75%	0.16ac	100%	75%	80%		0%	0%	100%		0%	0%	2%		0%	0%	**75.0%**	**0.54**	**0.66**
C-13	16,061 sf	0.37ac	AB	85%	0.00ac	0%	0%	75%	0.37ac	100%	75%	80%		0%	0%	100%		0%	0%	2%		0%	0%	**75.0%**	**0.54**	**0.66**
C-14	87,402 sf	2.01ac	AB	85%	0.00ac	0%	0%	75%	1.69ac	84%	63%	80%	0.32ac	16%	13%	100%		0%	0%	2%		0%	0%	**75.8%**	**0.55**	**0.66**
C-15	32,492 sf	0.75ac	AB	85%	0.00ac	0%	0%	75%	0.75ac	100%	75%	80%		0%	0%	100%		0%	0%	2%		0%	0%	**75.0%**	**0.54**	**0.66**
C-16	556,153 sf	12.77ac	AB	85%	12.77ac	100%	85%	75%		0%	0%	80%		0%	0%	100%		0%	0%	2%		0%	0%	**85.0%**	**0.66**	**0.75**
C-20	26,181 sf	0.60ac	AB	85%	0.00ac	0%	0%	75%	0.60ac	100%	75%	80%		0%	0%	100%		0%	0%	2%		0%	0%	**75.0%**	**0.54**	**0.66**
C-21	25,273 sf	0.58ac	AB	85%	0.00ac	0%	0%	75%	0.58ac	100%	75%	80%		0%	0%	100%		0%	0%	2%		0%	0%	**75.0%**	**0.54**	**0.66**
C-22	452,831 sf	10.40ac	AB	85%	10.40ac	100%	85%	75%		0%	0%	80%		0%	0%	100%		0%	0%	2%		0%	0%	**85.0%**	**0.66**	**0.75**
C-23	322,059 sf	7.39ac	AB	85%	7.39ac	100%	85%	75%		0%	0%	80%		0%	0%	100%		0%	0%	2%		0%	0%	**85.0%**	**0.66**	**0.75**
C-24	30,959 sf	0.71ac	AB	85%	0.00ac	0%	0%	75%	0.71ac	100%	75%	80%		0%	0%	100%		0%	0%	2%		0%	0%	**75.0%**	**0.54**	**0.66**
C-25	32,412 sf	0.74ac	AB	85%	0.00ac	0%	0%	75%	0.74ac	100%	75%	80%		0%	0%	100%		0%	0%	2%		0%	0%	**75.0%**	**0.54**	**0.66**
C-26	287,907 sf	6.61ac	AB	85%	6.61ac	100%	85%	75%		0%	0%	80%		0%	0%	100%		0%	0%	2%		0%	0%	**85.0%**	**0.66**	**0.75**
C-27	301,760 sf	6.93ac	AB	85%	6.93ac	100%	85%	75%		0%	0%	80%		0%	0%	100%		0%	0%	2%		0%	0%	**85.0%**	**0.66**	**0.75**
C-30	69,388 sf	1.59ac	AB	85%	0.00ac	0%	0%	75%	1.59ac	100%	75%	80%		0%	0%	100%		0%	0%	2%		0%	0%	**75.0%**	**0.54**	**0.66**
C-31	70,441 sf	1.62ac	AB	85%	0.00ac	0%	0%	75%	1.62ac	100%	75%	80%		0%	0%	100%		0%	0%	2%		0%	0%	**75.0%**	**0.54**	**0.66**
C-32	350,897 sf	8.06ac	AB	85%	8.06ac	100%	85%	75%		0%	0%	80%		0%	0%	100%		0%	0%	2%		0%	0%	**85.0%**	**0.66**	**0.75**
C-40	359,359 sf	8.25ac	AB	85%		0%	0%	75%	2.17ac	26%	20%	80%		0%	0%	100%		0%	0%	2%	6.08ac	74%	1%	**21.2%**	**0.20**	**0.44**
C-41	967,143 sf	22.20ac	AB	85%		0%	0%	75%	1.27ac	6%	4%	80%	0.70ac	3%	3%	100%		0%	0%	2%	20.23ac	91%	2%	**8.6%**	**0.13**	**0.40**
C-42	1,166,143 sf	26.77ac	AB	85%		0%	0%	75%		0%	0%	80%	1.55ac	6%	5%	100%		0%	0%	2%	25.22ac	94%	2%	**6.5%**	**0.11**	**0.39**
C-50	1,566,200 sf	35.96ac	AB	85%	30.82ac	86%	73%	75%		0%	0%	80%		0%	0%	100%		0%	0%	2%	5.13ac	14%	0%	**73.2%**	**0.52**	**0.64**
C-51	106,587 sf	2.45ac	AB	85%		0%	0%	75%		0%	0%	80%		0%	0%	100%		0%	0%	2%	2.45ac	100%	2%	**2.0%**	**0.08**	**0.36**
C-52	75,600 sf	1.74ac	AB	85%		0%	0%	75%		0%	0%	80%		0%	0%	100%		0%	0%	2%	1.74ac	100%	2%	**2.0%**	**0.08**	**0.36**
C-53	17,300 sf	0.40ac	AB	85%		0%	0%	75%		0%	0%	80%		0%	0%	100%		0%	0%	2%	0.40ac	100%	2%	**2.0%**	**0.08**	**0.36**
C-54	400,100 sf	9.19ac	AB	85%	7.69ac	84%	71%	75%		0%	0%	80%		0%	0%	100%		0%	0%	2%	1.50ac	16%	0%	**71.4%**	**0.50**	**0.63**
D-1	51,488 sf	1.18ac	AB	85%		0%	0%	75%		0%	0%	80%		0%	0%	100%		0%	0%	2%	1.18ac	100%	2%	**2.0%**	**0.08**	**0.36**
D-2	241,038 sf	5.53ac	AB	85%		0%	0%	75%		0%	0%	80%		0%	0%	100%		0%	0%	2%	5.53ac	100%	2%	**2.0%**	**0.08**	**0.36**

Falcon Commerce Canter - MDDP
Runoff Coeficient and Percent Impervious Calculation - Proposed Condition

Basin / DP	Basin or DP Area (DP contributing basins)		Soil Type	US1 % Imperv	Area 1 Land Use Land Use Area	Area 1 Land Use % Area	Area 1 Land Use Comp Land Use % Imp	US2 % Imperv	Area 2 Land Use Land Use Area	Area 2 Land Use % Area	Area 2 Land Use Comp Land Use % Imp	GR % Imperv	Area 3 Land Use Land Use Area	Area 3 Land Use % Area	Area 3 Land Use Comp Land Use % Imp	PV % Imperv	Area 4 Land Use Land Use Area	Area 4 Land Use % Area	Area 4 Land Use Comp Land Use % Imp	HI % Imperv	Area 5 LandUse Land Use Area	Area 5 LandUse % Area	Area 5 LandUse Comp Land Use % Imp	**Basin % Imperv**	**Basin Runoff Coef C_5**	**Basin Runoff Coef C_{100}**
OS-1	182,538 sf	4.19ac	AB	85%		0%	0%	75%		0%	0%	80%	0.32ac	8%	6%	100%		0%	0%	2%	3.87ac	92%	2%	**8.0%**	**0.12**	**0.39**
OS-3	15,284 sf	0.35ac	AB																					**100.0%**	**0.90**	**0.96**
OS-4	16,899 sf	0.39ac	AB																					**100.0%**	**0.90**	**0.96**
OS-2	551,784 sf	12.67ac	AB	85%	0.32ac	3%	2%	75%		0%	0%	80%		0%	0%	100%	7.75ac	61%	61%	2%	4.60ac	36%	1%	**64.0%**	**0.44**	**0.58**
DP13	C1-C32, OS-2	147.63ac	AB	85%	114.45ac	78%	66%	75%	8.81ac	6%	4%	80%	0.32ac	0%	0%	100%	7.75ac	5%	5%	2%	16.30ac	11%	0%	**76.0%**	**0.55**	**0.67**
DP60	C50,C51,C54	47.59ac	AB	85%	38.51ac	81%	69%	75%	0.00ac	0%	0%	80%	0.00ac	0%	0%	100%	0.00ac	0%	0%	2%	9.08ac	19%	0%	**69.2%**	**0.48**	**0.62**
DP42	C-40,41,42	57.22ac	AB	85%	0.00ac	0%	0%	75%	3.44ac	6%	5%	80%	2.25ac	4%	3%	100%	0.00ac	0%	0%	2%	51.53ac	90%	2%	**9.5%**	**0.13**	**0.40**

Basin Runoff Coef is based on % Impervious Calculation

Runoff Coefficients and Percents Impervious

Hydrologic Soil Type:	**AB**	**Runoff Coef Method**			%Imp
Land Use	Abb	%	C_5	C_{10}	C_{100}	Weighted %Imp
Commercial Area	CO	95%	0.81	0.83	0.88	AB
Streets - Gravel (Packed)	GR	80%	0.59	0.63	0.70	CD
Historic Flow Analysis	HI	2%	0.09	0.17	0.36	D
Lawns	LA	0%	0.08	0.15	0.35	
Off-site flow-Undeveloped	OF	45%	0.32	0.38	0.51	
Park	PA	7%	0.12	0.20	0.39	
Streets - Paved	PV	100%	0.90	0.92	0.96	
Roofs	RO	90%	0.73	0.75	0.81	
User Input 1	US1	85%	0.66	0.69	0.75	
User Input 2	US2	75%	0.54	0.58	0.66	

Based on Table 6-6: Runoff Coefficients for Rational Method from City of Colo Springs DCM

*Planned commercial areas are assumed to be 85% impervious

*Street right of way areas are planned to have an average impervious area of 75% based on the typical street section.

Falcon Commerce Center - MDDP
Time of Concentration Calculation - Proposed Condition

Sub-Basin Data				Time of Concentration Estimate												
Basin / Design Point	Contributing Basins	Area	C_5	Initial/Overland Time (t_i)			Travel Time (t_t)						Comp.			Final t_c
				Length	Slope	t_i	Length	Slope	Land Type	Cv	Velocity	t_t	t_c			
C-1		9.70ac	0.08	50lf	25.0%	4.5 min.	100lf	25.0%	PV	20	10.0 ft/sec	0.2 min.	5.0 min.			**5.0 min.**
C-2		11.85ac	0.66	50lf	3.0%	4.0 min.	960lf	2.8%	PV	20	3.3 ft/sec	4.8 min.	8.8 min.			**8.8 min.**
C-3		10.16ac	0.66	50lf	12.0%	2.5 min.	650lf	2.8%	PV	20	3.3 ft/sec	3.2 min.	5.7 min.			**5.7 min.**
C-4		2.79ac	0.30	50lf	3.0%	7.2 min.	600lf	2.7%	PV	20	3.3 ft/sec	3.1 min.	10.2 min.			**10.2 min.**
C-5		8.75ac	0.66	50lf	2.8%	4.1 min.	850lf	2.8%	PV	20	3.3 ft/sec	4.2 min.	8.3 min.			**8.3 min.**
C-6		5.87ac	0.66	50lf	2.6%	4.2 min.	680lf	2.6%	PV	20	3.2 ft/sec	3.5 min.	7.7 min.			**7.7 min.**
C-7		8.18ac	0.66	50lf	25.0%	2.0 min.	750lf	3.5%	PV	20	3.7 ft/sec	3.3 min.	5.3 min.			**5.3 min.**
C-8		2.83ac	0.49	50lf	4.0%	4.9 min.	250lf	4.0%	PV	20	4.0 ft/sec	1.0 min.	6.0 min.			**6.0 min.**
C-9		3.18ac	0.66	40lf	1.5%	4.5 min.	250lf	2.6%	PV	20	3.2 ft/sec	1.3 min.	5.8 min.			**5.8 min.**
C-10		6.96ac	0.66	25lf	2.5%	3.0 min.	1100lf	3.5%	PV	20	3.7 ft/sec	4.9 min.	7.9 min.			**7.9 min.**
C-11		3.42ac	0.66	25lf	2.5%	3.0 min.	300lf	4.0%	PV	20	4.0 ft/sec	1.3 min.	5.0 min.			**5.0 min.**
C-12		0.16ac	0.54	25lf	2.5%	3.8 min.	100lf	1.0%	PV	20	2.0 ft/sec	0.8 min.	5.0 min.			**5.0 min.**
C-13		0.37ac	0.54	25lf	2.5%	3.8 min.	900lf	2.8%	PV	20	3.3 ft/sec	4.5 min.	8.3 min.			**8.3 min.**
C-14		2.01ac	0.55	25lf	2.5%	3.7 min.	1050lf	3.2%	PV	20	3.6 ft/sec	4.9 min.	8.6 min.			**8.6 min.**
C-15		0.75ac	0.54	25lf	2.5%	3.8 min.	560lf	1.7%	PV	20	2.6 ft/sec	3.6 min.	7.4 min.			**7.4 min.**
C-16		12.77ac	0.66	50lf	2.4%	4.3 min.	980lf	2.5%	PV	20	3.2 ft/sec	5.2 min.	9.5 min.			**9.5 min.**
C-20		0.60ac	0.54	25lf	2.5%	3.8 min.	620lf	1.0%	PV	20	2.0 ft/sec	5.2 min.	8.9 min.			**8.9 min.**
C-21		0.58ac	0.54	25lf	2.5%	3.8 min.	600lf	1.0%	PV	20	2.0 ft/sec	5.0 min.	8.8 min.			**8.8 min.**
C-22		10.40ac	0.66	50lf	2.2%	4.4 min.	770lf	2.2%	PV	20	3.0 ft/sec	4.3 min.	8.7 min.			**8.7 min.**
C-23		7.39ac	0.66	50lf	2.2%	4.4 min.	800lf	1.0%	PV	20	2.0 ft/sec	6.7 min.	11.1 min.			**11.1 min.**
C-24		0.71ac	0.54	25lf	2.5%	3.8 min.	725lf	4.0%	PV	20	4.0 ft/sec	3.0 min.	6.8 min.			**6.8 min.**
C-25		0.74ac	0.54	25lf	2.5%	3.8 min.	700lf	4.0%	PV	20	4.0 ft/sec	2.9 min.	6.7 min.			**6.7 min.**
C-26		6.61ac	0.66	50lf	3.0%	4.0 min.	650lf	2.8%	PV	20	3.3 ft/sec	3.2 min.	7.2 min.			**7.2 min.**
C-27		6.93ac	0.66	50lf	4.0%	3.6 min.	630lf	3.2%	PV	20	3.6 ft/sec	2.9 min.	6.6 min.			**6.6 min.**
C-30		1.59ac	0.54	25lf	2.5%	3.8 min.	1500lf	2.5%	PV	20	3.2 ft/sec	7.9 min.	11.7 min.			**11.7 min.**
C-31		1.62ac	0.54	25lf	2.5%	3.8 min.	1550lf	2.5%	PV	20	3.2 ft/sec	8.2 min.	11.9 min.			**11.9 min.**
C-32		8.06ac	0.66	50lf	4.0%	3.6 min.	840lf	2.2%	PV	20	3.0 ft/sec	4.7 min.	8.3 min.			**8.3 min.**
C-40		8.25ac	0.20	300lf	3.0%	19.7 min.	1515lf	2.2%	GW	15	2.2 ft/sec	11.3 min.	31.1 min.			**31.1 min.**
C-41		22.20ac	0.13	300lf	2.5%	22.7 min.	1150lf	2.4%	GW	15	2.3 ft/sec	8.2 min.	31.0 min.			**31.0 min.**
C-42		26.77ac	0.11	300lf	2.0%	24.9 min.	1300lf	2.5%	GW	15	2.4 ft/sec	9.1 min.	34.0 min.			**34.0 min.**
C-50		35.96ac	0.52	50lf	2.0%	5.9 min.	1500lf	2.5%	PV	20	3.2 ft/sec	7.9 min.	13.9 min.			**13.9 min.**
C-51		2.45ac	0.08	50lf	25.0%	4.5 min.	250lf	1.0%	PV	20	2.0 ft/sec	2.1 min.	6.6 min.			**6.6 min.**
C-52		1.74ac	0.08	130lf	3.0%	14.7 min.	310lf	3.0%	SP	7	1.2 ft/sec	4.3 min.	19.0 min.			**19.0 min.**
C-53		0.40ac	0.08	80lf	3.0%	11.6 min.	130lf	2.0%	SP	7	1.0 ft/sec	2.2 min.	13.8 min.			**13.8 min.**
C-54		9.19ac	0.50	100lf	2.7%	7.8 min.	700lf	3.0%	PV	20	3.5 ft/sec	3.4 min.	11.2 min.			**11.2 min.**

Falcon Commerce Center - MDDP
Time of Concentration Calculation - Proposed Condition

Sub-Basin Data				Time of Concentration Estimate											
Basin / Design Point	Contributing Basins	Area	C_5	Initial/Overland Time (t_i)			Travel Time (t_t)						Comp.		Final t_c
				Length	Slope	t_i	Length	Slope	Land Type	Cv	Velocity	t_t	t_c		
D-1		1.18ac	0.08	40lf	5.0%	6.9 min.	800lf	2.6%	GW	15	2.4 ft/sec	5.5 min.	12.4 min.		**12.4 min.**
D-2		5.53ac	0.08	40lf	5.0%	6.9 min.	900lf	4.0%	GW	15	3.0 ft/sec	5.0 min.	11.9 min.		**11.9 min.**
OS-1		4.87ac	0.12	170lf	5.9%	12.9 min.	460lf	1.7%	SP	7	0.9 ft/sec	8.4 min.	21.3 min.		**21.3 min.**
OS-3		0.35ac	0.90	30lf	2.0%	1.6 min.	840lf	2.9%	PV	20	3.4 ft/sec	4.1 min.	5.7 min.		**5.7 min.**
OS-4		0.39ac	0.90	30lf	2.0%	1.6 min.	900lf	2.9%	PV	20	3.4 ft/sec	4.4 min.	6.0 min.		**6.0 min.**

Equations:

t_i (Overland) = $0.395(1.1-C_5)L^{0.5} S^{-0.333}$

C_5 = Runoff coefficient for 5-year

L = Length of overland flow (ft)

S = Slope of flow path (ft/ft)

tc Check = (L/180)+10 (Developed Cond. Only)

L = Overall Length

Velocity (Travel Time) = $CvS^{0.5}$

Cv = Conveyance Coef (see table)

S = Watercourse slope (ft/ft)

Table 6-7: Conveyance Coef (City CS DCM, Vol 1)

Type of Land Surface	Land Type	Cv
Grassed Waterway	GW	15
Heavy Meadow	HM	2.5
Nearly Bare Ground	NBG	10
Paved Area	PV	20
Riprap (Not Buried)	RR	6.5
Short Pasture/Lawns	SP	7
Tillage/Fields	TF	5

Falcon Commerce Center - MDDP
Runoff Calculation - Proposed Condition

Design Stm: 5 Year

		Direct Runoff							Total Runoff				Street/Chan		Pipe			Travel Time			
	Design Point	Area Designation	Area	C	T_c	C*A (acre)	i (in/hr)	Q	T_c	Sum C*A	i (in/hr)	Q	Slope	Q	Q	Slope	Pipe Size	L (ft)	Vel (ft/s)	T_t	Remarks
		C-1	9.70 ac	0.08	5.0min	0.79	5.2	4.1 cfs			---	---								---	
		C-2	11.85 ac	0.66	8.8min	7.78	4.3	33.7 cfs			---	---								---	
		C-3	10.16 ac	0.66	5.7min	6.67	5.0	33.1 cfs			---	---								---	
		C-4	2.79 ac	0.30	10.2min	0.83	4.1	3.4 cfs			---	---								---	
		C-5	8.75 ac	0.66	8.3min	5.74	4.4	25.3 cfs			---	---								---	
		C-6	5.87 ac	0.66	7.7min	3.85	4.5	17.4 cfs			---	---								---	
		C-7	8.18 ac	0.66	5.3min	5.37	5.1	27.3 cfs			---	---								---	
		C-8	2.83 ac	0.49	6.0min	1.40	4.9	6.8 cfs			---	---								---	
		C-9	3.18 ac	0.66	5.8min	2.09	5.0	10.3 cfs			---	---								---	
		C-10	6.96 ac	0.66	7.9min	4.57	4.5	20.5 cfs			---	---								---	
		C-11	3.42 ac	0.66	5.0min	2.24	5.2	11.6 cfs			---	---								---	
		C-12	0.16 ac	0.54	5.0min	0.09	5.2	0.4 cfs			---	---								---	
		C-13	0.37 ac	0.54	8.3min	0.20	4.4	0.9 cfs			---	---								---	
		C-14	2.01 ac	0.55	8.6min	1.10	4.4	4.8 cfs			---	---			4.8 cfs	1.0%	18-in	42'	5.96	0.1min	to DP3
		C-15	0.75 ac	0.54	7.4min	0.40	4.6	1.8 cfs			---	---	2.8%	1.8 cfs				690'	3.3	3.5min	to DP1
		C-16	12.77 ac	0.66	9.5min	8.38	4.2	35.3 cfs			---	---								---	
		C-20	0.60 ac	0.54	8.9min	0.32	4.3	1.4 cfs			---	---								---	
		C-21	0.58 ac	0.54	8.8min	0.31	4.3	1.4 cfs			---	---								---	
		C-22	10.40 ac	0.66	8.7min	6.82	4.3	29.6 cfs			---	---								---	
		C-23	7.39 ac	0.66	11.1min	4.85	4.0	19.3 cfs			---	---						550'	10	0.9min	to DP23
		C-24	0.71 ac	0.54	6.8min	0.38	4.7	1.8 cfs			---	---								---	
		C-25	0.74 ac	0.54	6.7min	0.40	4.7	1.9 cfs			---	---								---	
		C-26	6.61 ac	0.66	7.2min	4.34	4.6	20.0 cfs			---	---								---	
		C-27	6.93 ac	0.66	6.6min	4.55	4.8	21.7 cfs			---	---						710'	10	1.2min	to DP20
		C-30	1.59 ac	0.54	11.7min	0.86	3.9	3.3 cfs			---	---								---	
		C-31	1.62 ac	0.54	11.9min	0.87	3.9	3.4 cfs			---	---								---	
		C-32	8.06 ac	0.66	8.3min	5.29	4.4	23.3 cfs			---	---			23.3 cfs	1.8%	30-in	730'	11.2	1.1min	to DP30
		C-40	8.25 ac	0.20	31.1min	1.68	2.4	4.1 cfs			---	---						1310'	4	5.5min	to DP41
		C-41	22.20 ac	0.13	31.0min	2.82	2.4	6.9 cfs			---	---								---	
		C-42	26.77 ac	0.11	34.0min	3.00	2.3	6.9 cfs			---	---								---	
		C-50	35.96 ac	0.52	13.9min	18.74	3.6	68.2 cfs			---	---						300'	5	1.0min	to DP60
		C-51	2.45 ac	0.08	6.6min	0.20	4.8	0.9 cfs			---	---								---	
		C-52	1.74 ac	0.08	19.0min	0.14	3.2	0.4 cfs			---	---								---	
		C-53	0.40 ac	0.08	13.8min	0.03	3.7	0.1 cfs			---	61.1 cfs	Includes I-25 South Flows							---	
		C-54	9.19 ac	0.50	11.2min	4.64	4.0	18.4 cfs			---	---								---	
		D-1	1.18 ac	0.08	12.4min	0.10	3.8	0.4 cfs			---	---								---	
		D-2	5.53 ac	0.08	11.9min	0.45	3.9	1.7 cfs			---	---								---	
		OS-1	4.19 ac	0.12	21.3min	0.51	3.0	1.5 cfs			---	---								---	
		OS-3	0.35 ac	0.90	5.7min	0.31	5.0	1.6 cfs			---	---								---	
		OS-4	0.39 ac	0.90	6.0min	0.35	4.9	1.7 cfs			---	---								---	
		OS-2	12.67 ac					0.4 cfs	Detention outlet flow, See PTC FDR											---	to DP20
		I-25, North						60.0 cfs	Flow under I-25, See I25 North Hydro Report											---	to C-52
		I-25, South						61.0 cfs	Flow under I-25, See I25 North Hydro Report											---	to C-53
		FSD 2						1.1 cfs	Detention outlet flow											---	to DP61

Falcon Commerce Center - MDDP
Runoff Calculation - Proposed Condition

Design Stm: 5 Year

	Direct Runoff							Total Runoff				Street/Chan		Pipe			Travel Time			
	Design Point	Area Designation	Area	C	T_c	C*A (acre)	i (in/hr)	Q	T_c	Sum C*A	i (in/hr)	Q	Slope	Q	Q	Slope	Pipe Size	L (ft)	Vel (ft/s)	T_t	Remarks
	DP1	C-15+C-16	13.51 ac						10.9min	8.78	4.0	35.2 cfs			35.2 cfs	1.5%	36-in	290'	7.3	0.7min	to DP2
	DP2	DP1+C-13	13.88 ac						11.5min	8.98	3.9	35.2 cfs			35.2 cfs	1.8%	36-in	108'	12.7	0.1min	to DP4
	DP3	C-12+C-14	2.17 ac						8.7min	1.19	4.3	5.1 cfs								---	
	DP4	DP2+DP3	16.05 ac						11.7min	10.17	3.9	39.6 cfs			39.6 cfs	2.5%	36-in	290'	15.9	0.3min	to DP5
	DP5	DP4+C-11	19.47 ac						12.0min	12.41	3.9	47.9 cfs			47.9 cfs	1.0%	42-in	433'	13.6	0.5min	to DP6
	DP6	DP5+C-10	26.42 ac						12.5min	16.98	3.8	64.4 cfs			64.4 cfs	2.3%	42-in	295'	8.4	0.6min	to DP7
	DP7	DP6+C-9	29.60 ac						13.1min	19.06	3.7	71.1 cfs			71.1 cfs	1.2%	54-in	663'	15.0	0.7min	to DP8
	DP8	DP7+C-7+C-8	40.61 ac						13.8min	25.83	3.6	94.2 cfs			94.2 cfs	0.5%	60-in	266'	10.8	0.4min	to DP9
	DP9	DP8+C-6	46.48 ac						14.2min	29.68	3.6	106.9 cfs			106.9 cfs	1.2%	72-in	430'	10.8	0.7min	to DP10
	DP10	DP9+C-5	55.23 ac						14.9min	35.43	3.5	125.1 cfs			125.1 cfs	1.6%	72-in	101'	20.2	0.1min	to DP11
	DP11	DP10+DP26+C-4	104.65 ac						15.0min	58.25	3.5	205.7 cfs	+PTC Det flows*		205.7 cfs	1.0%	72-in	88'	5.0	0.3min	to DP12
	DP12	DP11+C-3	114.81 ac						15.3min	64.92	3.5	227.3 cfs	+PTC Det flows*		227.3 cfs	1.3%	36-in	547'	13.4	0.7min	to FB/DP13
	DP13	DP12+DP30+C1+C2	147.63 ac						15.9min	80.51	3.4	276.5 cfs	+PTC Det flows*							---	to JC
	DP20	C-27+C-26+OS2	26.20 ac						7.7min	8.89	4.5	40.5 cfs	+PTC Det flows*							---	to DP21
	DP21	DP20+C-25	26.95 ac						7.7min	9.29	4.5	42.3 cfs	+PTC Det flows*		42.3 cfs	2.0%	36-in	37'	12.4	0.0min	to DP22
	DP22	DP21+C-24	27.66 ac						7.8min	9.67	4.5	44.0 cfs	+PTC Det flows*							---	to DP25
	DP23	C-22+C-23	17.79 ac						12.0min	11.68	3.9	45.0 cfs								---	to DP24
	DP24	DP23+C-21	18.37 ac						12.0min	11.99	3.9	46.2 cfs			46.2 cfs	1.4%	42-in	37'	16.2	0.0min	to DP25
	DP25	DP22+DP24	46.03 ac						12.0min	21.66	3.9	83.8 cfs	+PTC Det flows*		83.8 cfs	2.0%	48-in	13'	16.2	0.0min	to DP26
	DP26	DP25+C-20	46.63 ac						12.1min	21.98	3.8	85.0 cfs	+PTC Det flows*		85.0 cfs	2.0%	48-in	710'	16.2	0.7min	to DP11
	DP30	C-30+C-31+C-32	11.27 ac						11.9min	7.02	3.9	27.1 cfs			27.1 cfs	1.5%	32-in	328'	10.7	0.5min	to FB/DP13
	DP41	C-40+C-41	30.45 ac						36.5min	4.50	2.2	10.2 cfs						1280'	4.0	5.3min	
	DP42	DP41+C-42	57.22 ac						41.9min	7.50	2.0	15.3 cfs								---	
	DP50	E-18+OS-1	4.54 ac						21.3min	0.83	3.0	2.5 cfs								---	
	DP60	C-50, C-51, C-54	47.59 ac						14.9min	23.58	3.5	83.4 cfs								---	to FSD 2
	DP61	FSD 2+C-52+I-25, North	49.32 ac									61.5 cfs	Includes I-25 North Flows							---	
	DP62	FSD2+C-52	49.32 ac									1.5 cfs	On-Site Flows Only								

NOTE: PTC FDR is Pilot Travel Center Final Drainage Report, prepared by Drexel, Barrell & Co. July 13, 2017.
*Added flow out of PTC detention basin

Equations (taken from Fig 6-5, City of Colorado Springs DCM):

i_2=-1.19 ln(T_c) + 6.035

i_5=-1.50 ln(T_c) + 7.583

i_{10}=-1.75 ln(T_c) + 8.847

i_{100}=-2.52 ln(T_c) + 12.735

Q = CiA

Q = Peak Runoff Rate (cubic feet/second)

C = Runoff coef representing a ration of peak runoff rate to ave rainfall intensity for a duration equal to the runoff time of concentration.

i = average rainfall intensity in inches per hour

A = Drainage area in acres

*Area Designation for Direct Runoff is Direct Runoff Drainage Basin and if it combines with other basins, those basin names are added after (i.e. B+A where Basin B is Direct Runoff and Basin A is combining with Basin B).

Falcon Commerce Center - MDDP
Runoff Calculation - Proposed Condition

Design Storm: 100 Year

		Direct Runoff							Total Runoff				Street/Chan		Pipe			Travel Time			
Street	**Design Point**	Area Designation	Area	C	T_c	C*A (acre)	i (in/hr)	Q	T_c	Sum C*A	i (in/hr)	Q	Slope	Q	Q	Slope	Pipe Size	L (ft)	Vel (ft/s)	T_t	Remarks
		C-1	9.70 ac	0.36	5.0min	3.51	8.7	30.5 cfs			---	---								---	
		C-2	11.85 ac	0.75	8.8min	8.90	7.3	64.7 cfs			---	---								---	
		C-3	10.16 ac	0.75	5.7min	7.63	8.3	63.6 cfs			---	---								---	
		C-4	2.79 ac	0.50	10.2min	1.38	6.9	9.5 cfs			---	---								---	
		C-5	8.75 ac	0.75	8.3min	6.57	7.4	48.6 cfs			---	---								---	
		C-6	5.87 ac	0.75	7.7min	4.41	7.6	33.5 cfs			---	---								---	
		C-7	8.18 ac	0.75	5.3min	6.14	8.5	52.4 cfs			---	---								---	
		C-8	2.83 ac	0.62	6.0min	1.76	8.2	14.5 cfs			---	---								---	
		C-9	3.18 ac	0.75	5.8min	2.39	8.3	19.9 cfs			---	---								---	
		C-10	6.96 ac	0.75	7.9min	5.22	7.5	39.3 cfs			---	---								---	
		C-11	3.42 ac	0.75	5.0min	2.57	8.7	22.3 cfs			---	---								---	
		C-12	0.16 ac	0.66	5.0min	0.11	8.7	0.9 cfs			---	---								---	
		C-13	0.37 ac	0.66	8.3min	0.24	7.4	1.8 cfs			---	---								---	
		C-14	2.01 ac	0.66	8.6min	1.33	7.3	9.7 cfs			---	---			9.7 cfs	1.0%	18-in	42'	5.96	0.1min	to DP3
		C-15	0.75 ac	0.66	7.4min	0.49	7.7	3.8 cfs			---	---	2.8%	3.8 cfs				690'	3.3	3.5min	to DP1
		C-16	12.77 ac	0.75	9.5min	9.59	7.1	67.8 cfs			---	---								---	
		C-20	0.60 ac	0.66	8.9min	0.39	7.2	2.8 cfs			---	---								---	
		C-21	0.58 ac	0.66	8.8min	0.38	7.3	2.8 cfs			---	---								---	
		C-22	10.40 ac	0.75	8.7min	7.81	7.3	56.8 cfs			---	---								---	
		C-23	7.39 ac	0.75	11.1min	5.55	6.7	37.0 cfs			---	---						550'	10	0.9min	to DP23
		C-24	0.71 ac	0.66	6.8min	0.47	7.9	3.7 cfs			---	---								---	
		C-25	0.74 ac	0.66	6.7min	0.49	7.9	3.9 cfs			---	---								---	
		C-26	6.61 ac	0.75	7.2min	4.96	7.8	38.5 cfs			---	---								---	
		C-27	6.93 ac	0.75	6.6min	5.20	8.0	41.6 cfs			---	---						710'	10	1.2min	to DP20
		C-30	1.59 ac	0.66	11.7min	1.05	6.5	6.8 cfs			---	---								---	
		C-31	1.62 ac	0.66	11.9min	1.06	6.5	6.9 cfs			---	---								---	
		C-32	8.06 ac	0.75	8.3min	6.05	7.4	44.7 cfs			---	---			44.7 cfs	1.8%	30-in	730'	11.2	1.1min	to DP30
		C-40	8.25 ac	0.44	31.1min	3.67	4.1	15.0 cfs			---	---						1310'	4	5.5min	to DP41
		C-41	22.20 ac	0.40	31.0min	8.82	4.1	36.0 cfs			---	---								---	
		C-42	26.77 ac	0.39	34.0min	10.36	3.8	39.9 cfs			---	---								---	
		C-50	35.96 ac	0.64	13.9min	23.12	6.1	141.3 cfs			---	---						300'	5	1.0min	to DP60
		C-51	2.45 ac	0.36	6.6min	0.89	8.0	7.1 cfs			---	---								---	
		C-52	1.74 ac	0.36	19.0min	0.63	5.3	3.3 cfs			---	---								---	
		C-53	0.40 ac	0.36	13.8min	0.14	6.1	0.9 cfs			---	193.9 cfs	+I-25, South Flows							---	
		C-54	9.19 ac	0.63	11.2min	5.79	6.6	38.5 cfs			---	---								---	
		D-1	1.18 ac	0.36	12.4min	0.43	6.4	2.7 cfs			---	---								---	
		D-2	5.53 ac	0.36	11.9min	2.00	6.5	13.0 cfs			---	---								---	
		OS-1	4.19 ac	0.39	21.3min	1.65	5.0	8.3 cfs			---	---								---	
		OS-3	0.35 ac	0.96	5.7min	0.34	8.3	2.8 cfs			---	---								---	
		OS-4	0.39 ac	0.96	6.0min	0.37	8.2	3.0 cfs			---	---								---	
		OS-2	12.67 ac					20.8 cfs	Detention outlet flow, See PTC FDR											---	to DP20
		I-25, North						276.0 cfs	Flow under I-25, See I25 North Hydro Report											---	to C-52
		I-25, South						193.0 cfs	Flow under I-25, See I25 North Hydro Report											---	to C-53

Falcon Commerce Center - MDDP
Runoff Calculation - Proposed Condition

Design Storm: 100 Year

		Direct Runoff							Total Runoff				Street/Chan		Pipe			Travel Time			
Street	**Design Point**	Area Designation	Area	C	T_c	C*A (acre)	i (in/hr)	Q	T_c	Sum C*A	i (in/hr)	Q	Slope	Q	Q	Slope	Pipe Size	L (ft)	Vel (ft/s)	T_t	Remarks
		FSD 2						51.1 cfs	Detention outlet flow											---	to DP61
	DP1	C-15+C-16	13.51 ac						10.9min	10.08	6.7	67.8 cfs			67.8 cfs	1.5%	36-in	290'	7.3	0.7min	to DP2
	DP2	DP1+C-13	13.88 ac						11.5min	10.32	6.6	67.9 cfs			67.9 cfs	1.8%	36-in	108'	12.7	0.1min	to DP4
	DP3	C-12+C-14	2.17 ac						8.7min	1.44	7.3	10.5 cfs								---	
	DP4	DP2+DP3	16.05 ac						11.7min	11.76	6.5	77.0 cfs			77.0 cfs	2.5%	36-in	290'	15.9	0.3min	to DP5
	DP5	DP4+C-11	19.47 ac						12.0min	14.32	6.5	92.8 cfs			92.8 cfs	1.0%	42-in	433'	13.6	0.5min	to DP6
	DP6	DP5+C-10	26.42 ac						12.5min	19.55	6.4	124.5 cfs			124.5 cfs	2.3%	42-in	295'	8.4	0.6min	to DP7
	DP7	DP6+C-9	29.60 ac						13.1min	21.93	6.3	137.2 cfs			137.2 cfs	1.2%	54-in	663'	15.0	0.7min	to DP8
	DP8	DP7+C-7+C-8	40.61 ac						13.8min	29.84	6.1	182.6 cfs			182.6 cfs	0.5%	60-in	266'	10.8	0.4min	to DP9
	DP9	DP8+C-6	46.48 ac						14.2min	34.24	6.0	207.0 cfs			207.0 cfs	1.2%	72-in	430'	10.8	0.7min	to DP10
	DP10	DP9+C-5	55.23 ac						14.9min	40.82	5.9	262.8 cfs			262.8 cfs	1.6%	72-in	101'	20.2	0.1min	to DP11
	DP11	DP10+DP26+C-4	104.65 ac						15.0min	67.45	5.9	419.8 cfs	+PTC Det flows*	419.8 cfs	419.8 cfs	1.0%	72-in	88'	5.0	0.3min	to DP12
	DP12	DP11+C-3	114.81 ac						15.3min	75.09	5.9	461.3 cfs	+PTC Det flows*	461.3 cfs	461.3 cfs	1.3%	36-in	547'	13.4	0.7min	to FB/DP13
	DP13	DP12+DP30+C1+C2	147.63 ac						15.9min	95.66	5.8	571.5 cfs	+PTC Det flows*							---	to JC
	DP20	C-27+C-26+OS2	26.20 ac						7.7min	10.16	7.6	97.8 cfs	+PTC Det flows*							---	to DP21
	DP21	DP20+C-25	26.95 ac						7.7min	10.65	7.6	101.5 cfs	+PTC Det flows*	101.5 cfs	101.5 cfs	2.0%	36-in	37'	13.4	0.0min	to DP22
	DP22	DP21+C-24	27.66 ac						7.8min	11.12	7.6	104.9 cfs	+PTC Det flows*							---	to DP25
	DP23	C-22+C-23	17.79 ac						12.0min	13.36	6.5	86.5 cfs								---	to DP24
	DP24	DP23+C-21	18.37 ac						12.0min	13.74	6.5	88.9 cfs			88.9 cfs	1.4%	42-in	37'	12.4	0.0min	to DP25
	DP25	DP22+DP24	46.03 ac						12.0min	24.86	6.5	181.5 cfs	+PTC Det flows*	181.5 cfs	181.5 cfs	2.0%	48-in	13'	16.2	0.0min	to DP26
	DP26	DP25+C-20	46.63 ac						12.1min	25.25	6.5	183.9 cfs	+PTC Det flows*	183.9 cfs	183.9 cfs	2.0%	48-in	710'	16.2	0.7min	to DP11
	DP30	C-30+C-31+C-32	11.27 ac						11.9min	8.16	6.5	52.9 cfs			52.9 cfs	1.5%	32-in	328'	10.7	0.5min	to FB/DP13
	DP41	C-40+C-41	30.45 ac						36.5min	12.49	3.7	45.8 cfs						1280'	5.0	4.3min	
	DP42	DP41+C-42	57.22 ac						40.8min	22.85	3.4	77.4 cfs								---	
	DP50	E-18+OS-1	4.54 ac						21.3min	1.99	5.0	10.0 cfs								---	
	DP60	C-50, C-51, C-54	47.59 ac						14.9min	29.79	5.9	176.8 cfs								---	to FSD 2
	DP61	FSD 2+C-52+I-25, North	49.32 ac									330.4 cfs	Includes I-25 North Flows							---	
	DP62	FSD2+C-52	49.32 ac									54.4 cfs	On-Site Flows Only								

NOTE: PTC FDR is Pilot Travel Center Final Drainage Report, prepared by Drexel, Barrell & Co. July 13, 2017.

*Added flow out of PTC detention basin

Equations (taken from Fig 6-5, City of Colorado Springs DCM):

i_2=-1.19 ln(T_c) + 6.035

i_5=-1.50 ln(T_c) + 7.583

i_{10}=-1.75 ln(T_c) + 8.847

i_{100}=-2.52 ln(T_c) + 12.735

Q = CiA

Q = Peak Runoff Rate (cubic feet/second)

C = Runoff coef representing a ration of peak runoff rate to ave rainfall intensity for a duration equal to the runoff time of concentration.

i = average rainfall intensity in inches per hour

A = Drainage area in acres

*Area Designation for Direct Runoff is the Direct Runoff Drainage Basin and if it combines with other basins, those basin names are added after (i.e. B+A where Basin B is Direct Runoff and Basin A is combining with Basin B).

APPENDIX B.2

Supporting Hydrologic Tables and Figures

For Colorado Springs and much of the Fountain Creek watershed, the 1-hour depths are fairly uniform and are summarized in Table 6-2. Depending on the location of the project, rainfall depths may be calculated using the described method and the NOAA Atlas maps shown in Figures 6-6 through 6-17.

Table 6-2. Rainfall Depths for Colorado Springs

Return Period	1-Hour Depth	6-Hour Depth	24-Hour Depth
2	1.19	1.70	2.10
5	1.50	2.10	2.70
10	1.75	2.40	3.20
25	2.00	2.90	3.60
50	2.25	3.20	4.20
100	2.52	3.50	4.60

Where Z= 6,840 ft/100

These depths can be applied to the design storms or converted to intensities (inches/hour) for the Rational Method as described below. However, as the basin area increases, it is unlikely that the reported point rainfalls will occur uniformly over the entire basin. To account for this characteristic of rain storms an adjustment factor, the Depth Area Reduction Factor (DARF) is applied. This adjustment to rainfall depth and its effect on design storms is also described below. The UDFCD UD-Rain spreadsheet, available on UDFCD's website, also provides tools to calculate point rainfall depths and Intensity-Duration-Frequency curves[2] and should produce similar depth calculation results.

2.2 Design Storms

Design storms are used as input into rainfall/runoff models and provide a representation of the typical temporal distribution of rainfall events when the creation or routing of runoff hydrographs is required. It has long been observed that rainstorms in the Front Range of Colorado tend to occur as either short-duration, high-intensity, localized, convective thunderstorms (cloud bursts) or longer-duration, lower-intensity, broader, frontal (general) storms. The significance of these two types of events is primarily determined by the size of the drainage basin being studied. Thunderstorms can create high rates of runoff within a relatively small area, quickly, but their influence may not be significant very far downstream. Frontal storms may not create high rates of runoff within smaller drainage basins due to their lower intensity, but tend to produce larger flood flows that can be hazardous over a broader area and extend further downstream.

- **Thunderstorms**: Based on the extensive evaluation of rain storms completed in the Carlton study (Carlton 2011), it was determined that typical thunderstorms have a duration of about 2 hours. The study evaluated over 300,000 storm cells using gage-adjusted NEXRAD data, collected over a 14-year period (1994 to 2008). Storms lasting longer than 3 hours were rarely found. Therefore, the results of the Carlton study have been used to define the shorter duration design storms.

  To determine the temporal distribution of thunderstorms, 22 gage-adjusted NEXRAD storm cells were studied in detail. Through a process described in a technical memorandum prepared by the City of Colorado Springs (City of Colorado Springs 2012), the results of this analysis were interpreted and normalized to the 1-hour rainfall depth to create the distribution shown in Table 6-3 with a 5 minute time interval for drainage basins up to 1 square mile in size. This distribution represents the rainfall

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

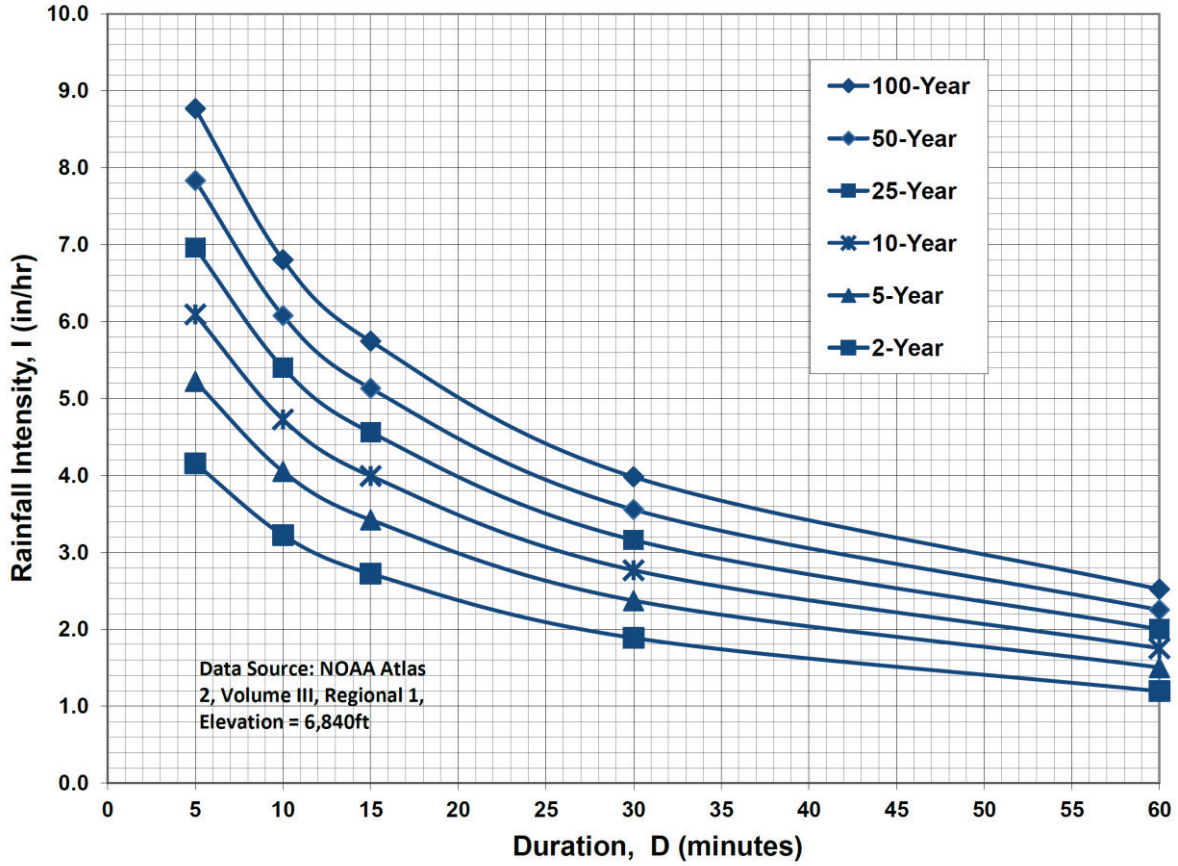
Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82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

3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration (t_c) consists of an initial time or overland flow time (t_i) plus the travel time (t_t) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time (t_i) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion (t_t) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

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

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

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

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

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

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

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

APPENDIX C

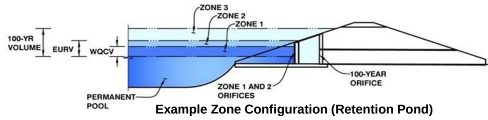
Water Quality and Detention Calculations

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.03 (May 2020)

Project: **Falcon Commerce Center MDDP**

Basin ID: **FSD-1 (DP 13) Sub-Regional Detention Basin**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	147.63	acres
Watershed Length =	3,500	ft
Watershed Length to Centroid =	1,800	ft
Watershed Slope =	0.028	ft/ft
Watershed Imperviousness =	76.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	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) =	3.751	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	12.403	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	11.311	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	14.993	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	18.111	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	21.657	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	24.893	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	28.648	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.1 in.) =	36.289	acre-feet	3.10	inches
Approximate 2-yr Detention Volume =	9.775	acre-feet		
Approximate 5-yr Detention Volume =	12.936	acre-feet		
Approximate 10-yr Detention Volume =	16.160	acre-feet		
Approximate 25-yr Detention Volume =	17.331	acre-feet		
Approximate 50-yr Detention Volume =	18.011	acre-feet		
Approximate 100-yr Detention Volume =	19.099	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	3.751	acre-feet
Zone 2 Volume (EURV - Zone 1) =	8.652	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	6.696	acre-feet
Total Detention Basin Volume =	19.099	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 = 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	--	--	--	475	0.011		
	--	1.00	--	--	--	475	0.011	475	0.011
	--	1.50	--	--	--	969	0.022	836	0.019
	--	2.50	--	--	--	3,106	0.071	2,873	0.066
	--	3.50	--	--	--	30,331	0.696	19,592	0.450
	--	4.50	--	--	--	77,105	1.770	73,310	1.683
	--	5.50	--	--	--	139,514	3.203	181,619	4.169
	--	6.50	--	--	--	183,893	4.222	343,322	7.882
	--	7.50	--	--	--	200,343	4.599	535,440	12.292
	--	8.50	--	--	--	211,770	4.862	741,497	17.022
	--	9.50	--	--	--	223,259	5.125	959,011	22.016
	--	10.50	--	--	--	234,311	5.379	1,187,796	27.268
	--	11.50	--	--	--	244,670	5.617	1,427,287	32.766
	--	12.50	--	--	--	243,497	5.590	1,671,370	38.369
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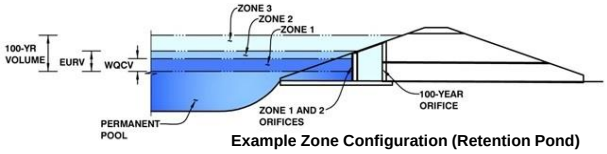
DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.03 (May 2020)

Project: **Falcon Commerce Center MDDP**

Basin ID: **FSD-1 (DP 13) Sub-Regional Detention Basin**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	5.37	3.751	Orifice Plate
Zone 2 (EURV)	7.53	8.652	Orifice Plate
Zone 3 (100-year)	8.93	6.696	Weir&Pipe (Restrict)
Total (all zones)		19.099	

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

Underdrain Orifice Invert Depth = [ ] ft (distance below the filtration media surface)

Underdrain Orifice Diameter = [ ] inches

Calculated Parameters for Underdrain

Underdrain Orifice Area = [ ] ft²

Underdrain Orifice Centroid = [ ] feet

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

Invert of Lowest Orifice = 0.00 ft (relative to basin bottom at Stage = 0 ft)

Depth at top of Zone using Orifice Plate = 8.10 ft (relative to basin bottom at Stage = 0 ft)

Orifice Plate: Orifice Vertical Spacing = N/A inches

Orifice Plate: Orifice Area per Row = N/A inches

Calculated Parameters for Plate

WQ Orifice Area per Row = N/A ft²

Elliptical Half-Width = N/A feet

Elliptical Slot Centroid = N/A feet

Elliptical Slot Area = N/A ft²

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	2.00	3.50	5.00	6.50			
Orifice Area (sq. inches)	7.00	7.00	18.00	34.00	36.00			

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft²
Vertical Orifice Centroid =	N/A	N/A	feet

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 =	8.30	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	10.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Open Area % =	65%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	8.30	N/A	feet
Overflow Weir Slope Length =	4.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	5.01	N/A	
Overflow Grate Open Area w/o Debris =	26.00	N/A	ft²
Overflow Grate Open Area w/ Debris =	13.00	N/A	ft²

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.84	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	36.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	24.80		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	5.19	N/A	ft²
Outlet Orifice Centroid =	1.16	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.96	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage= 9.70 ft (relative to basin bottom at Stage = 0 ft)

Spillway Crest Length = 100.00 feet

Spillway End Slopes = 4.00 H:V

Freeboard above Max Water Surface = 0.00 feet

Calculated Parameters for Spillway

Spillway Design Flow Depth= 1.48 feet

Stage at Top of Freeboard = 11.18 feet

Basin Area at Top of Freeboard = 5.54 acres

Basin Volume at Top of Freeboard = 30.98 acre-ft

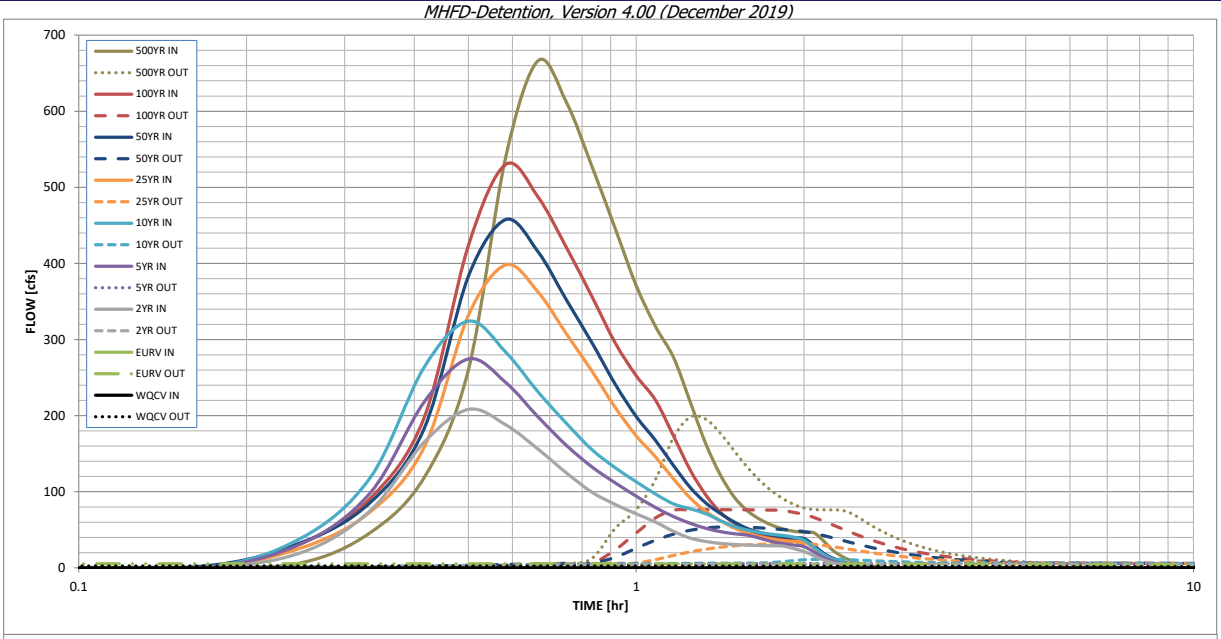
Routed Hydrograph Results

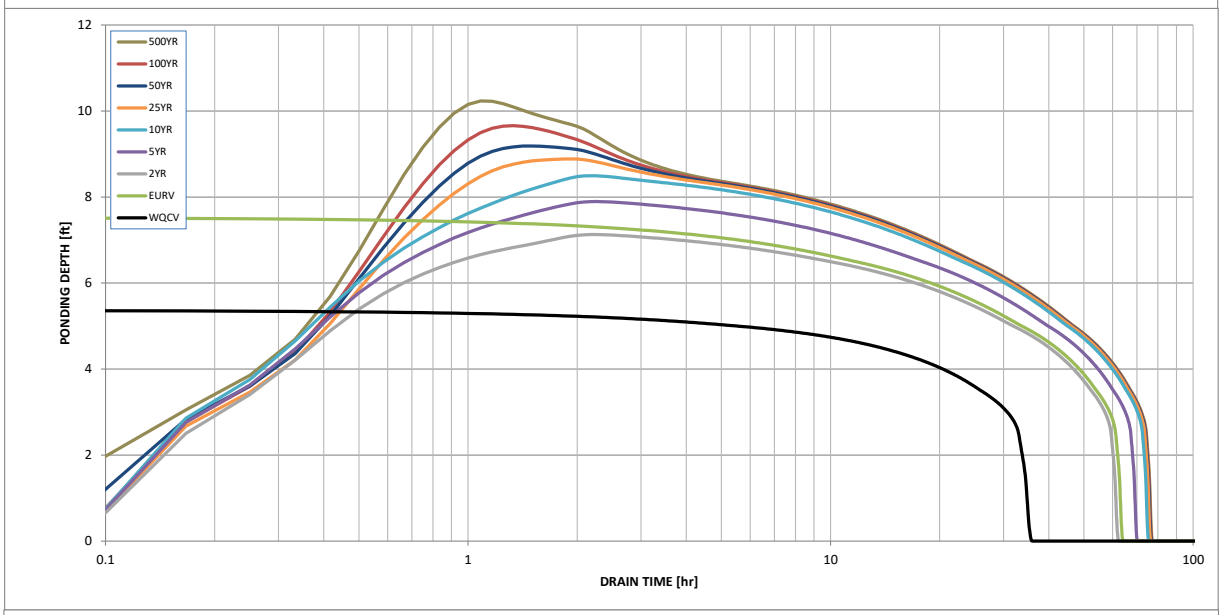
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

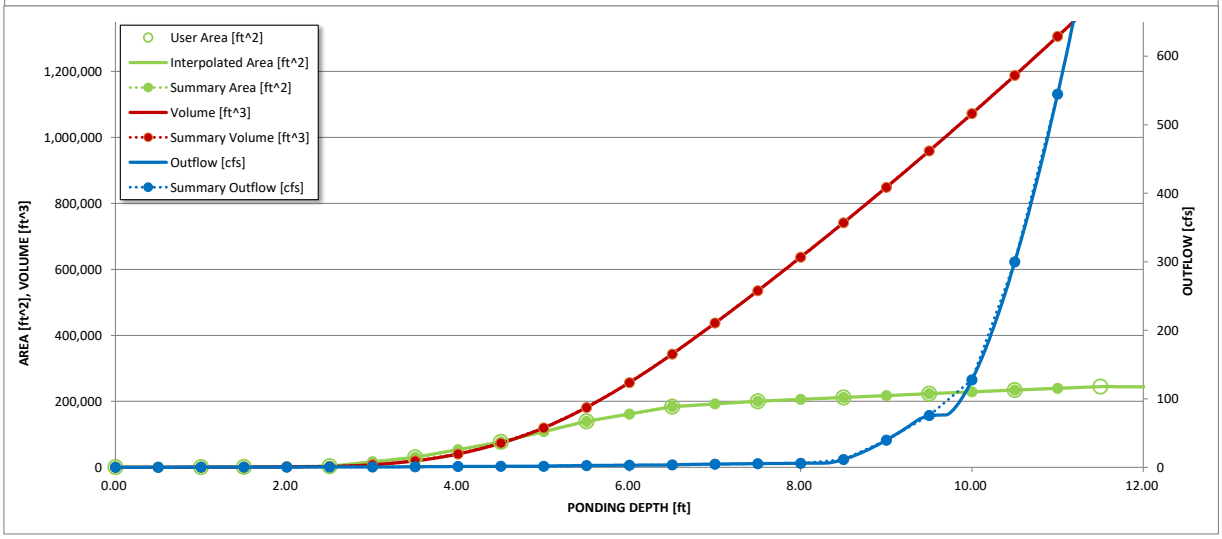
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.10
CUHP Runoff Volume (acre-ft) =	3.751	12.403	11.311	14.993	18.111	21.657	24.893	28.648	36.289
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	11.311	14.993	18.111	21.657	24.893	28.648	36.289
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	16.0	45.4	69.0	122.7	154.2	195.3	267.9
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.11	0.31	0.47	0.83	1.04	1.32	1.81
Peak Inflow Q (cfs) =	N/A	N/A	208.2	274.4	324.2	398.0	457.7	530.1	666.4
Peak Outflow Q (cfs) =	2.5	5.4	4.9	5.8	11.3	32.0	53.9	76.4	198.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.2	0.3	0.3	0.4	0.7
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.2	1.0	1.8	2.7	2.7
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	32	56	54	60	64	64	63	62	60
Time to Drain 99% of Inflow Volume (hours) =	**34**	60	58	66	70	71	70	70	69
Maximum Ponding Depth (ft) =	5.37	7.53	7.13	7.90	8.50	8.89	9.19	9.66	10.23
Area at Maximum Ponding Depth (acres) =	3.02	4.61	4.46	4.70	4.86	4.96	5.04	5.16	5.31
Maximum Volume Stored (acre-ft) =	3.765	12.430	10.572	14.106	16.974	18.889	20.389	22.788	25.825

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)







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	2.16	0.22	6.50
	0:15:00	0.00	0.00	19.74	31.29	38.69	25.95	32.96	31.63	46.22
	0:20:00	0.00	0.00	75.09	98.47	118.49	73.54	85.82	91.33	118.75
	0:25:00	0.00	0.00	165.23	218.01	263.82	158.63	183.26	197.57	259.90
	0:30:00	0.00	0.00	208.23	274.44	324.17	331.70	383.05	423.39	539.57
	0:35:00	0.00	0.00	188.03	243.66	283.52	398.05	457.66	530.07	666.40
	0:40:00	0.00	0.00	156.05	198.38	231.28	362.56	415.43	487.46	611.51
	0:45:00	0.00	0.00	124.67	160.79	189.72	307.24	351.83	420.75	527.38
	0:50:00	0.00	0.00	99.40	132.58	155.24	258.38	295.71	356.35	446.45
	0:55:00	0.00	0.00	83.36	111.83	131.67	211.04	241.64	295.91	371.16
	1:00:00	0.00	0.00	71.01	94.23	113.20	173.54	199.00	252.61	317.13
	1:05:00	0.00	0.00	60.11	79.31	97.00	145.81	167.41	220.28	276.65
	1:10:00	0.00	0.00	47.98	67.43	84.07	117.02	134.45	173.39	218.26
	1:15:00	0.00	0.00	39.06	58.59	77.63	91.90	105.70	128.62	162.98
	1:20:00	0.00	0.00	34.61	51.99	71.11	74.11	85.29	95.80	121.90
	1:25:00	0.00	0.00	32.16	47.58	61.94	62.00	71.30	72.91	92.86
	1:30:00	0.00	0.00	30.78	44.82	54.51	52.50	60.24	58.86	75.01
	1:35:00	0.00	0.00	29.97	42.99	49.69	45.27	51.77	50.09	63.83
	1:40:00	0.00	0.00	29.35	38.90	46.37	40.80	46.52	44.15	56.26
	1:45:00	0.00	0.00	28.91	34.67	44.15	37.86	43.07	40.23	51.26
	1:50:00	0.00	0.00	28.67	31.90	42.59	35.88	40.73	37.74	48.07
	1:55:00	0.00	0.00	25.32	29.99	40.36	34.74	39.39	36.69	46.70
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	2:25:00	0.00	0.00	2.70	3.60	4.78	4.70	5.31	5.06	6.42
	2:30:00	0.00	0.00	1.54	2.22	2.87	2.92	3.30	3.14	3.98
	2:35:00	0.00	0.00	0.74	1.17	1.45	1.57	1.76	1.68	2.12
	2:40:00	0.00	0.00	0.28	0.46	0.54	0.63	0.70	0.67	0.84
	2:45:00	0.00	0.00	0.05	0.08	0.09	0.10	0.11	0.11	0.13
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	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
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	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
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	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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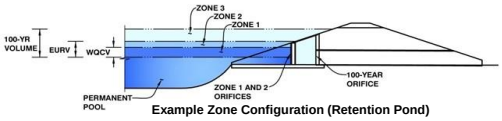
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	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

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)

Project: **Falcon Commerce Center MDDP**

Basin ID: **FSD 2 (DP 60)**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	47.59	acres
Watershed Length =	1,950	ft
Watershed Length to Centroid =	720	ft
Watershed Slope =	0.030	ft/ft
Watershed Imperviousness =	69.20%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	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) =	1.077	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	3.613	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.9 in.) =	2.281	acre-feet	0.90	inches
5-yr Runoff Volume (P1 = 1.19 in.) =	3.222	acre-feet	1.19	inches
10-yr Runoff Volume (P1 = 1.45 in.) =	4.180	acre-feet	1.45	inches
25-yr Runoff Volume (P1 = 1.85 in.) =	5.904	acre-feet	1.85	inches
50-yr Runoff Volume (P1 = 2.17 in.) =	7.192	acre-feet	2.17	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	8.723	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.42 in.) =	12.461	acre-feet	3.42	inches
Approximate 2-yr Detention Volume =	2.128	acre-feet		
Approximate 5-yr Detention Volume =	2.984	acre-feet		
Approximate 10-yr Detention Volume =	3.940	acre-feet		
Approximate 25-yr Detention Volume =	4.728	acre-feet		
Approximate 50-yr Detention Volume =	5.129	acre-feet		
Approximate 100-yr Detention Volume =	5.704	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	1.077	acre-feet
Zone 2 Volume (EURV - Zone 1) =	2.537	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	2.091	acre-feet
Total Detention Basin Volume =	5.704	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 = ft

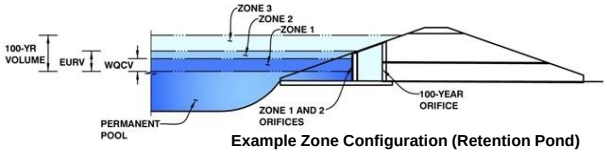
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	300	0.007		
	--	1.00	--	--	--	300	0.007	300	0.007
	--	2.00	--	--	--	1,600	0.037	1,250	0.029
	--	3.00	--	--	--	22,000	0.505	13,050	0.300
	--	4.00	--	--	--	55,000	1.263	51,550	1.183
	--	5.00	--	--	--	60,000	1.377	109,050	2.503
	--	6.00	--	--	--	65,000	1.492	171,550	3.938
	--	7.00	--	--	--	70,000	1.607	239,050	5.488
	--	8.00	--	--	--	75,000	1.722	311,550	7.152
	--	9.00	--	--	--	80,000	1.837	389,050	8.931

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Project: **Falcon Commerce Center MDDP**

Basin ID: **FSD 2 (DP 60)**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.92	1.077	Orifice Plate
Zone 2 (EURV)	5.79	2.537	Orifice Plate
Zone 3 (100-year)	7.14	2.091	Weir&Pipe (Restrict)
Total (all zones)		5.704	

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

Calculated Parameters for Underdrain

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	5.90	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	sq. inches	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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	2.00	4.00					
Orifice Area (sq. inches)	3.00	4.20	15.00					

	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			Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

Calculated Parameters for Vertical Orifice

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			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	5.90	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	5.90	N/A	feet
Overflow Weir Front Edge Length =	13.00	N/A	feet	Overflow Weir Slope Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	8.74	N/A	
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	36.19	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	18.10	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	4.14	N/A	ft^2
Outlet Pipe Diameter =	30.00	N/A	inches	Outlet Orifice Centroid =	1.08	N/A	feet
Restrictor Plate Height Above Pipe Invert =	23.60		inches	Half-Central Angle of Restrictor Plate on Pipe =	2.18	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	7.50	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	1.06	feet
Spillway Crest Length =	40.00	feet	Stage at Top of Freeboard =	8.56	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	1.79	acres
Freeboard above Max Water Surface =	0.00	feet	Basin Volume at Top of Freeboard =	8.13	acre-ft

Calculated Parameters for Spillway

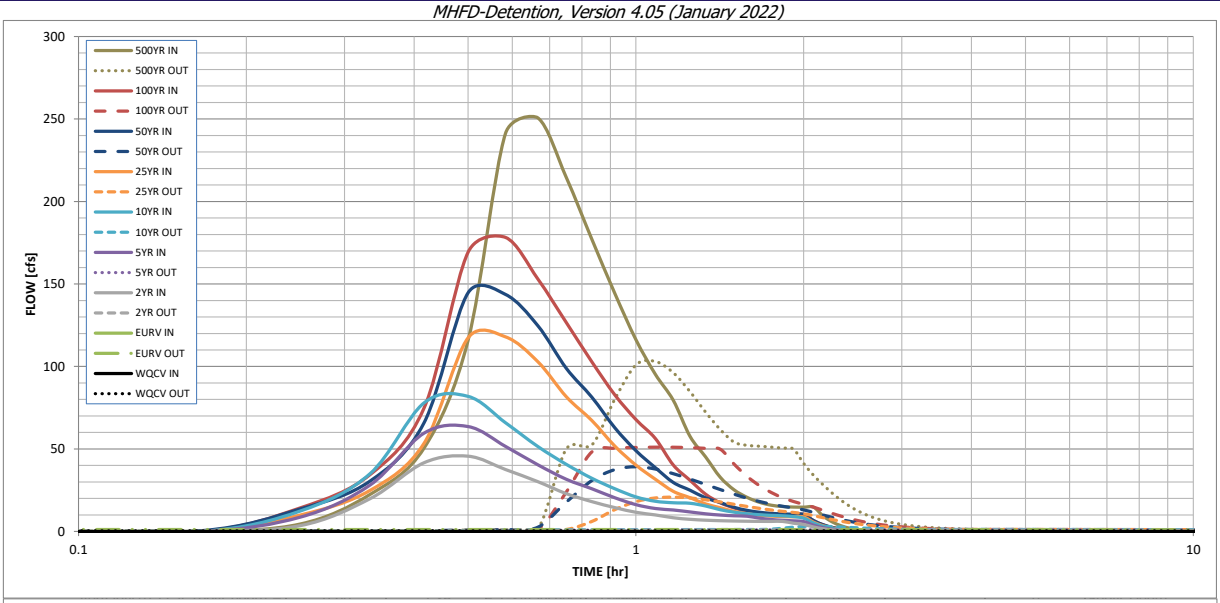
Routed Hydrograph Results

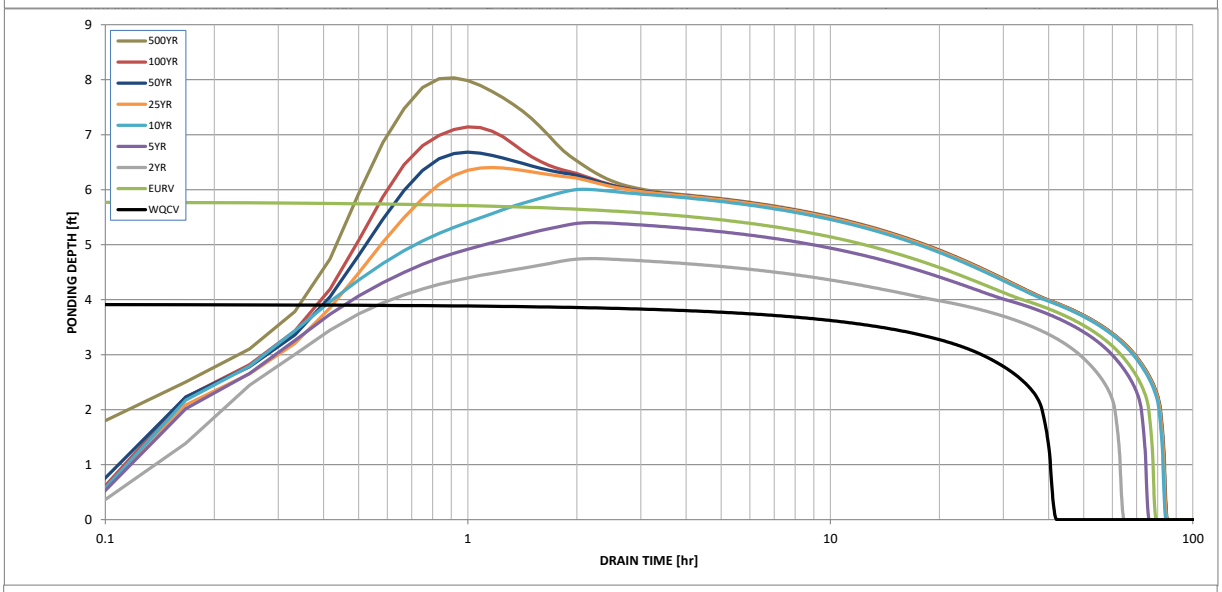
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

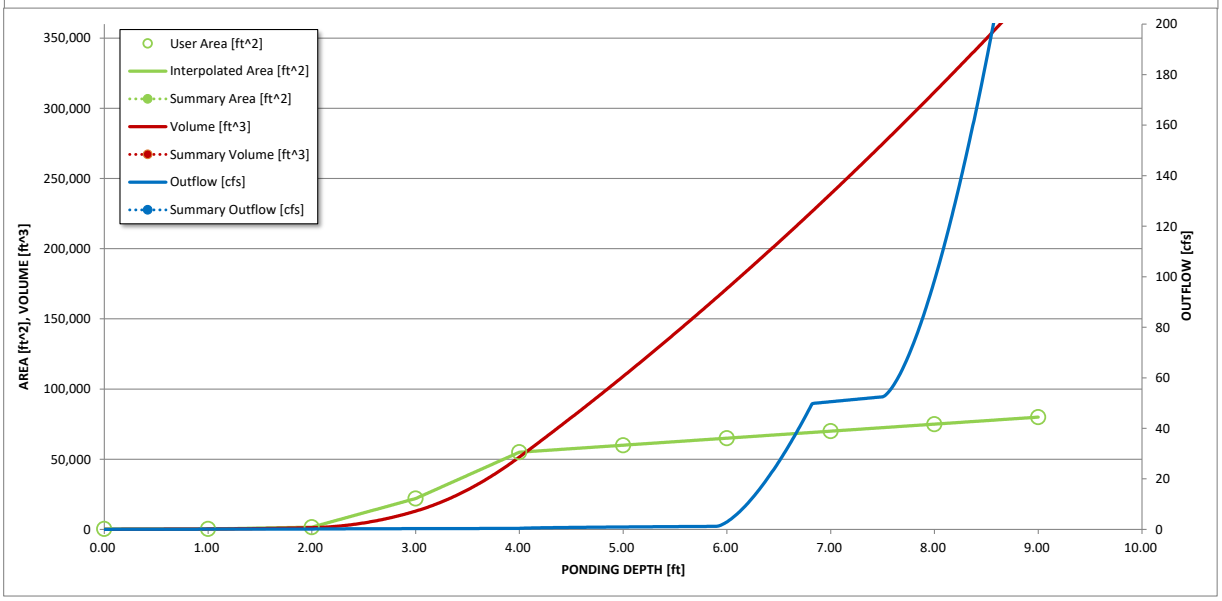
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.90	1.19	1.45	1.85	2.17	2.52	3.42
CUHP Runoff Volume (acre-ft) =	1.077	3.613	2.281	3.222	4.180	5.904	7.192	8.723	12.461
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	2.281	3.222	4.180	5.904	7.192	8.723	12.461
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.6	4.4	14.4	40.6	56.3	75.4	118.9
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.09	0.30	0.85	1.18	1.58	2.50
Peak Inflow Q (cfs) =	N/A	N/A	45.6	63.6	81.9	118.0	144.7	178.2	250.7
Peak Outflow Q (cfs) =	0.4	1.2	0.9	1.1	3.2	20.8	39.2	51.1	103.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.2	0.5	0.7	0.7	0.9
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.1	0.5	1.0	1.4	1.5
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	71	59	68	76	74	72	71	67
Time to Drain 99% of Inflow Volume (hours) =	**40**	75	62	72	80	79	79	78	77
Maximum Ponding Depth (ft) =	3.92	5.79	4.75	5.40	6.01	6.40	6.68	7.14	8.03
Area at Maximum Ponding Depth (acres) =	1.20	1.47	1.35	1.42	1.49	1.54	1.57	1.62	1.73
Maximum Volume Stored (acre-ft) =	1.085	3.627	2.149	3.064	3.938	4.544	4.979	5.714	7.204

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

	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	0.51	0.10	4.53
	0:15:00	0.00	0.00	3.56	8.70	12.41	9.96	13.66	14.31	22.42
	0:20:00	0.00	0.00	19.86	28.10	34.99	24.87	30.52	34.42	50.48
	0:25:00	0.00	0.00	41.66	59.57	77.92	53.36	65.80	74.72	115.90
	0:30:00	0.00	0.00	45.63	63.59	81.87	117.38	144.68	169.28	241.15
	0:35:00	0.00	0.00	37.56	51.58	65.93	117.97	143.67	178.23	250.69
	0:40:00	0.00	0.00	30.20	40.43	51.53	102.93	124.77	153.10	214.58
	0:45:00	0.00	0.00	22.92	31.65	40.69	81.68	98.90	126.65	177.23
	0:50:00	0.00	0.00	18.11	25.91	32.26	67.30	81.45	102.88	144.26
	0:55:00	0.00	0.00	14.46	20.44	25.90	51.74	62.84	82.77	116.26
	1:00:00	0.00	0.00	11.64	16.26	20.96	40.22	48.99	67.85	95.32
	1:05:00	0.00	0.00	10.05	13.93	18.32	31.68	38.69	56.39	79.55
	1:10:00	0.00	0.00	8.33	13.03	17.41	24.33	29.73	40.31	57.75
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	1:30:00	0.00	0.00	6.34	9.52	11.71	12.16	14.65	14.28	20.67
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	1:45:00	0.00	0.00	6.11	7.25	9.75	9.31	10.99	10.53	15.13
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	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	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
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	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	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
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	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
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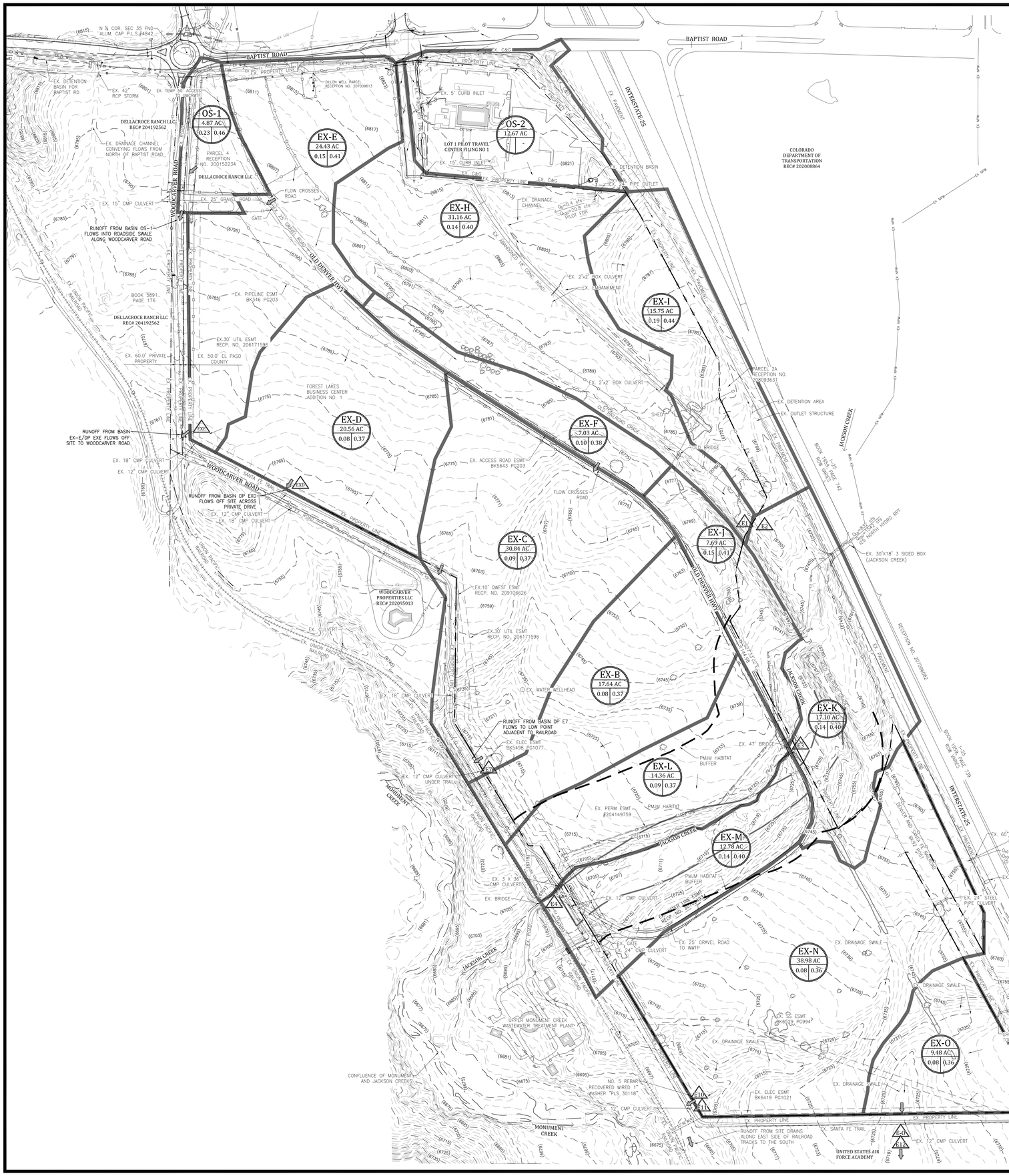
APPENDIX D

Existing Condition and Proposed Condition Drainage Plans



LEGEND

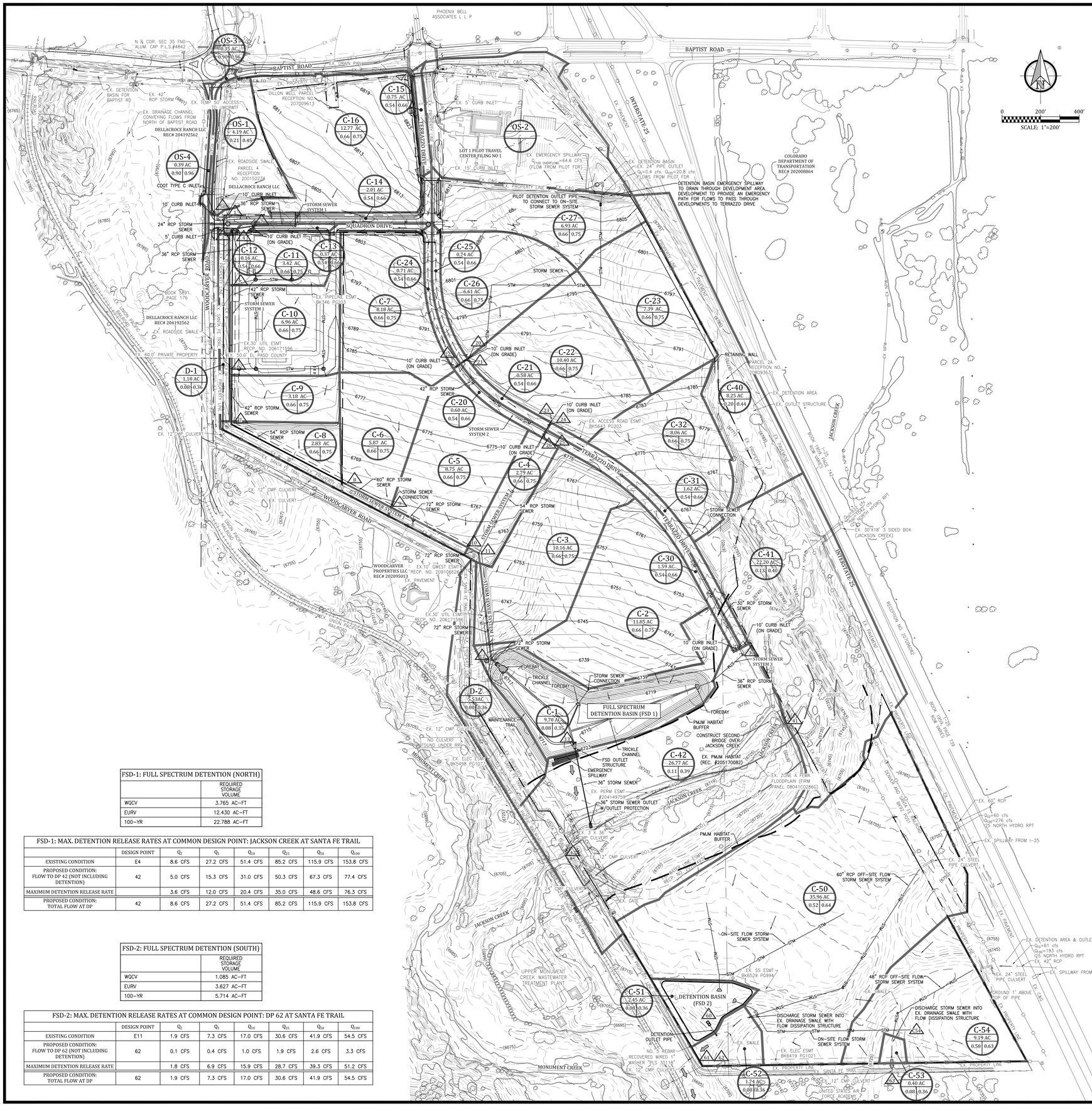
- A — 1.84 AC — 0.76 | 0.83 — EXISTING BASIN DESIGNATION; DRAINAGE BASIN ACRES; C5 RUNOFF COEF; C100 RUNOFF COEFFICIENT
- EXISTING BUILDING
- DIRECTIONAL FLOW ARROW
- DRAINAGE BASIN BOUNDARY
- 1 — DESIGN POINT
- STORMWATER PATH
- R.O.W. / PROPERTY LINE
- EXISTING EASEMENT
- EX STM — EXISTING STORM SEWER
- (6020) — EXISTING CONTOURS
- (2.3%) — EXISTING FLOW DIRECTION AND SLOPE
- C100 — EXISTING 100 YEAR FLOODPLAIN

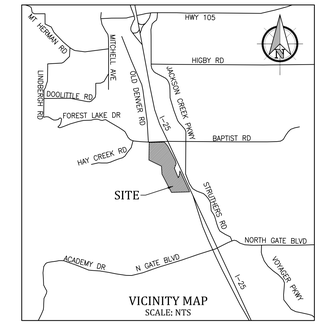
SUB-BASIN AND DESIGN POINT DISCHARGES

BASIN & DESIGN POINT	CONTRIBUTING BASINS	5-YR FLOW	100-YR FLOW
	EX-B	2.8 cfs	20.6 cfs
	EX-C	6.7 cfs	44.6 cfs
	EX-D	4.4 cfs	32.1 cfs
	EX-E	6.8 cfs	32.2 cfs
	EX-F	1.6 cfs	9.6 cfs
	EX-H	10.4 cfs	51.5 cfs
	EX-I	8.2 cfs	31.2 cfs
	EX-J	3.2 cfs	14.6 cfs
	EX-K	7.6 cfs	38.1 cfs
	EX-L	3.6 cfs	24.3 cfs
	EX-M	5.2 cfs	25.8 cfs
DP E11	EX-N	7.3 cfs	54.5 cfs
	EX-O	2.2 cfs	16.4 cfs
	OS-1	3.5 cfs	11.7 cfs
	OS-2Hist	3.5 cfs	26.3 cfs
	OS-2	0.4 cfs	20.8 cfs
DP E1	OS-2,EX-H	10.8 cfs	72.3 cfs
DP E2	DPE1+EX-I	17.7 cfs	98.9 cfs
DP E3	DPE2, EX-J,K	23.0 cfs	131.1 cfs
DP E4	DPE3, EX-L,M	25.8 cfs	158.8 cfs
DP E4Hist		27.2 cfs	153.8 cfs
DP E7	EX-B,C,F	8.5 cfs	65.6 cfs
DP E10	EX-H, I-25, North	67.3 cfs	330.5 cfs
DP E12	EX-O+I-25 South	63.2 cfs	209.4 cfs

Kiowa Engineering Corporation
1604 South 21st Street
Colorado Springs, Colorado 80904
(719) 630-7342

EXHIBIT A
FALCON COMMERCE CENTER
MASTER DEVELOPMENT DRAINAGE PLAN UPDATE
DRAINAGE PLAN - EXISTING CONDITION
DATE: MAY 17, 2022





LEGEND

- A / 1.84 AC / 0.76 0.83 — PROPOSED BASIN DESIGNATION; DRAINAGE BASIN ACRES; C5 RUNOFF COEF; C100 RUNOFF COEFFICIENT
- DIRECTIONAL FLOW ARROW
- DRAINAGE BASIN BOUNDARY
- 1 — DESIGN POINT
- STORMWATER FLOW PATH
- PROPOSED BUILDING
- EXISTING BUILDING
- R.O.W. / PROPERTY LINE
- EXISTING EASEMENT
- EXISTING STORM SEWER
- EXISTING CONTOURS
- (6020) — PROPOSED CONTOURS
- 6020 / (2.3%) — EXISTING FLOW DIRECTION AND SLOPE
- 2.3% — PROPOSED FLOW DIRECTION AND SLOPE
- 100 — EXISTING 100 YEAR FLOODPLAIN
- PROPOSED STORM SEWER PIPE AND MANHOLE
- PROPOSED DRAINAGE INLET
- PROPOSED DETENTION OUTLET STRUCTURE

FSD-1: FULL SPECTRUM DETENTION (NORTH)

	REQUIRED STORAGE VOLUME
WQCV	3.765 AC-FT
EURV	12.430 AC-FT
100-YR	22.788 AC-FT

FSD-1: MAX. DETENTION RELEASE RATES AT COMMON DESIGN POINT: JACKSON CREEK AT SANTA FE TRAIL

	DESIGN POINT	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
EXISTING CONDITION	E4	8.6 CFS	27.2 CFS	51.4 CFS	85.2 CFS	115.9 CFS	153.8 CFS
PROPOSED CONDITION: FLOW TO DP 42 (NOT INCLUDING DETENTION)	42	5.0 CFS	15.3 CFS	31.0 CFS	50.3 CFS	67.3 CFS	77.4 CFS
MAXIMUM DETENTION RELEASE RATE		3.6 CFS	12.0 CFS	20.4 CFS	35.0 CFS	48.6 CFS	76.3 CFS
PROPOSED CONDITION: TOTAL FLOW AT DP	42	8.6 CFS	27.2 CFS	51.4 CFS	85.2 CFS	115.9 CFS	153.8 CFS

FSD-2: FULL SPECTRUM DETENTION (SOUTH)

	REQUIRED STORAGE VOLUME
WQCV	1.085 AC-FT
EURV	3.627 AC-FT
100-YR	5.714 AC-FT

FSD-2: MAX. DETENTION RELEASE RATES AT COMMON DESIGN POINT: DP 62 AT SANTA FE TRAIL

	DESIGN POINT	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
EXISTING CONDITION	E11	1.9 CFS	7.3 CFS	17.0 CFS	30.6 CFS	41.9 CFS	54.5 CFS
PROPOSED CONDITION: FLOW TO DP 62 (NOT INCLUDING DETENTION)	62	0.1 CFS	0.4 CFS	1.0 CFS	1.9 CFS	2.6 CFS	3.3 CFS
MAXIMUM DETENTION RELEASE RATE		1.8 CFS	6.9 CFS	15.9 CFS	28.7 CFS	39.3 CFS	51.2 CFS
PROPOSED CONDITION: TOTAL FLOW AT DP	62	1.9 CFS	7.3 CFS	17.0 CFS	30.6 CFS	41.9 CFS	54.5 CFS

SUB-BASIN AND DESIGN POINT DISCHARGES

BASIN & DESIGN POINT	CONTRIBUTING BASINS	5-YR FLOW	100-YR FLOW
C-1	EX-L	4.1 cfs	30.5 cfs
C-2	EX-B	33.7 cfs	64.7 cfs
C-3	EX-C	33.1 cfs	63.6 cfs
C-4		3.4 cfs	9.5 cfs
C-5	EX-D	25.3 cfs	48.6 cfs
C-7	OS-1	27.3 cfs	52.4 cfs
C-8	EX-E	6.8 cfs	14.5 cfs
C-9	EX-F	10.3 cfs	19.9 cfs
C-10	EX-H	20.5 cfs	39.3 cfs
C-11	EX-H	11.6 cfs	22.3 cfs
C-12	EX-F	0.4 cfs	0.9 cfs
C-13		0.9 cfs	1.8 cfs
C-14		4.8 cfs	9.7 cfs
C-15		1.8 cfs	3.8 cfs
C-16		35.3 cfs	67.8 cfs
C-20		1.4 cfs	2.8 cfs
C-21		1.4 cfs	2.8 cfs
C-22		29.6 cfs	56.8 cfs
C-23		19.3 cfs	37.0 cfs
C-24		1.8 cfs	3.7 cfs
C-25		1.9 cfs	3.9 cfs
C-26		20.0 cfs	38.5 cfs
C-27		21.7 cfs	41.6 cfs
C-30		3.3 cfs	6.8 cfs
C-31		3.4 cfs	6.9 cfs
C-32		23.3 cfs	44.7 cfs
C-40		4.1 cfs	15.0 cfs
C-41		6.9 cfs	36.0 cfs
C-42		6.9 cfs	39.9 cfs
C-50		68.2 cfs	141.3 cfs
C-51		0.9 cfs	7.1 cfs
C-52		0.4 cfs	3.3 cfs
C-53		0.1 cfs	0.9 cfs
C-54		18.4 cfs	38.5 cfs
D-1		0.4 cfs	2.7 cfs
D-2		1.7 cfs	13.0 cfs
OS-1		1.5 cfs	8.3 cfs
OS-2		0.4 cfs	20.8 cfs
OS-3		1.6 cfs	2.8 cfs
OS-4		1.7 cfs	3.0 cfs
DP1	C-15+C-16	35.2 cfs	67.8 cfs
DP2	DP1+C-13	35.2 cfs	67.9 cfs
DP3	C-12+C-14	5.1 cfs	10.5 cfs
DP4	DP2+DP3	39.6 cfs	77.0 cfs
DP5	DP4+C-11	47.9 cfs	92.8 cfs
DP6	DP5+C-10	64.4 cfs	124.5 cfs
DP7	DP6+C-9	71.1 cfs	137.2 cfs
DP8	DP7+C-7+C-8	94.2 cfs	182.6 cfs
DP9	DP8+C-6	106.9 cfs	207.0 cfs
DP10	DP9+C-5	125.1 cfs	262.8 cfs
DP11	DP10+DP26+C-4	205.7 cfs	419.8 cfs
DP12	DP11+C-3	227.3 cfs	461.3 cfs
DP13	DP12+DP30+C1+C2	276.5 cfs	571.5 cfs
DP20	C-27+C-26+OS2	40.5 cfs	97.8 cfs
DP21	DP20+C-25	42.3 cfs	101.5 cfs
DP22	DP21+C-24	44.0 cfs	104.9 cfs
DP23	C-22+C-23	45.0 cfs	86.5 cfs
DP24	DP23+C-21	46.2 cfs	88.9 cfs
DP25	DP22+DP24	83.8 cfs	181.5 cfs
DP26	DP25+C-20	85.0 cfs	183.9 cfs
DP30	C-30+C-31+C-32	27.1 cfs	52.9 cfs
DP41	C-40+C-41	10.2 cfs	45.8 cfs
DP42	DP41+C-42	15.3 cfs	77.4 cfs
DP50	E-18+OS-1	2.5 cfs	10.0 cfs
DP60	C-50, C-51, C-54	83.4 cfs	176.8 cfs
DP61	FSD 2+C-52+I-25, North	61.5 cfs	330.4 cfs
DP62	FSD2+C-52	1.5 cfs	54.4 cfs

Kiowa Engineering Corporation
1604 South 21st Street
Colorado Springs, Colorado 80904
(719) 630-7342

EXHIBIT B
FALCON COMMERCE CENTER
MASTER DEVELOPMENT DRAINAGE PLAN
DRAINAGE PLAN - PROPOSED CONDITION
DATE: MAY 17, 2022