

DRAINAGE CONFORMANCE LETTER

Clock Tower Family Dental Lot 4C, Metzler Ranch Filing No3 2nd Amendment

PREPARED FOR:

CLOCKTOWER FAMILY DENTAL

718 MALETA, LANE, SUITE 101

CASTLE ROCK, CO 80108

PREPARED BY:



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Initial: December, 2025

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Section 1: Summary

1.1 Executive Summary

Clock Tower Dental will be located on Lot 4-C within the Metzler Ranch Development. This parcel, zoned B2 (General Business District), currently includes an existing bank on its southern portion. The site is bounded by three streets: Founders Parkway to the south, East Allen Street to the northeast, and the private drive Maleta Lane to the northwest.

The site consists of undeveloped, naturally vegetated land with a natural slope of roughly 5% from north to south. An existing Porous Landscape Detention (PLD) pond, originally constructed with the bank, is located in the southwest corner of Lot 4-C and provides water quality detention for the entire parcel. The pond was designed conservatively to accommodate future development.

The proposed project includes construction of a single commercial building with associated parking and utilities. Stormwater improvements are designed to route site drainage first to the existing water quality pond and eventually to a regional detention pond.

1.2 Existing Studies

An existing master drainage report, titled Metzler Ranch Master Drainage Study *prepared by Inter-Mountain Engineering, Ltd., Dated February, 1996 and revised on January 20, 1997* included drainage analysis for Lot 4-C, identified as part of basin IG in the study. The impact of on and offsite flows for basin IG were accounted for, and the master study provides a regional detention pond. The average impervious ratio of the basin must be limited to 60% to comply with the limitations set forth in the master drainage study. A separate drainage study, titled Phase III Drainage Report for US Bank, Castle Rock *prepared by Zeiler-Pennock, Inc., Dated March 25, 2011 and revised on March 8, 2013*, details Lot 4-C drainage including the proposed bank development and a conservative estimate of flow from the future dental site.

Section 2: GENERAL LOCATION & SITE CONDITION

2.1 Site Location

Clock Tower Dental (Project/Site) includes a single parcel of land located in the Town of Castle Rock and in the community of Metzler Ranch. Allen St is northeast, Maleta Ln to the northwest, and Founders Pkwy to the south. An existing bank occupies the southern portion of the parcel. Lot 4-B of the subdivision is located to the west.

By rectangular survey coordinates the Site is located in the southern half of Section 26 Township 7 South, Range 67 West of the 6th Principal Meridian, Town of Castle Rock, Douglas County, State of Colorado.

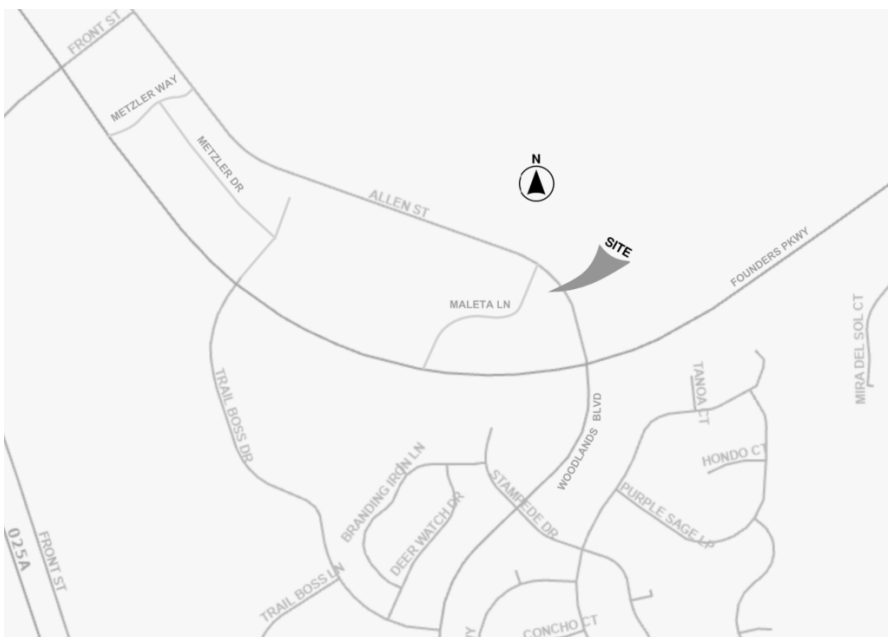


Figure 1: Vicinity Map

2.2 Description of Property

The total site area includes approximately 0.69 acres of undeveloped land.

The topography follows a moderate to shallow natural slope, averaging about 5% from north to south. Existing vegetation is light to moderate, consisting mostly of dry grasses.

2.2.1 Soil Types and Groundwater Investigation

Natural Resource Conservation Service (NRCS) depicts Site soils to be in hydrological soils group D, Table 1 and Figure 2. These soil types are noted by the NRCS as slow draining with a low infiltration rate when wetted. The soils exhibit a low erosion potential.

Map Unit Symbol	Soil Name	Hydrological Soils Group	Percent of AOI (%)
KtE	Kutch Sandy Loam	D	100

Table 1: Hydrological Soil Group Summary (Courtesy NRCS Websoil Survey Website)

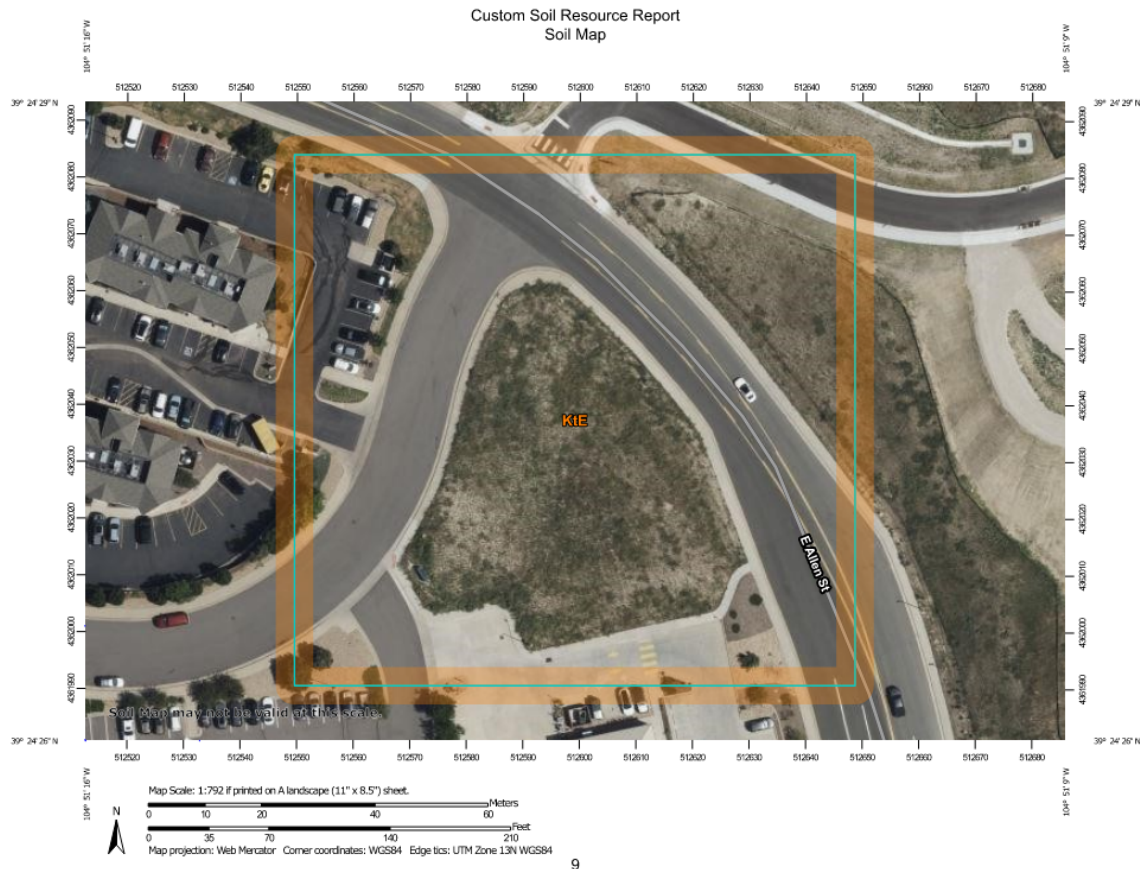


Figure 2: NRCS Soil Map (Courtesy NRCS Web Soil Survey Website)

2.2.2 Existing Irrigation and Environmental

There are no known wetlands on the site.

There are no irrigation facilities on the Site.

2.2.3 Existing Drainage

Existing drainage flows generally from north to south, with a high point near the center of the site dividing flow to the east and west. Runoff from the eastern portion drains to Allen Street

and then south along the curb and gutter to Founders Parkway. Runoff from the western portion drains to Maleta Lane and then south along curb and gutter to Founders Parkway. The southern portion drains south directly toward the existing bank and is conveyed to the Porous Landscape Detention (PLD) pond located southwest of the bank.

The existing detention pond, located within Lot 4-C and constructed with the bank, provides water quality treatment for the entire parcel. For the site to be in conformance with the aforementioned drainage study, the composite site impervious value must remain at or below 60%. Reference Appendix B for composite site impervious calculations.

Section 3: MAJOR DRAINAGE BASINS & SUB-BASINS

3.1 Major Basin

The Site is located within the Plum Creek Watershed.

The Site is shown on Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM), Map Number 08035C0186G, Figure 3. The FIRM indicates that there are no jurisdictional floodplains within the limits of the Project. The Site is shown to be in Zone X Flood Area on this FIRM map. Zone X Flood Areas are “Areas determined to be outside the 500-year plain”.

National Flood Hazard Layer FIRMette

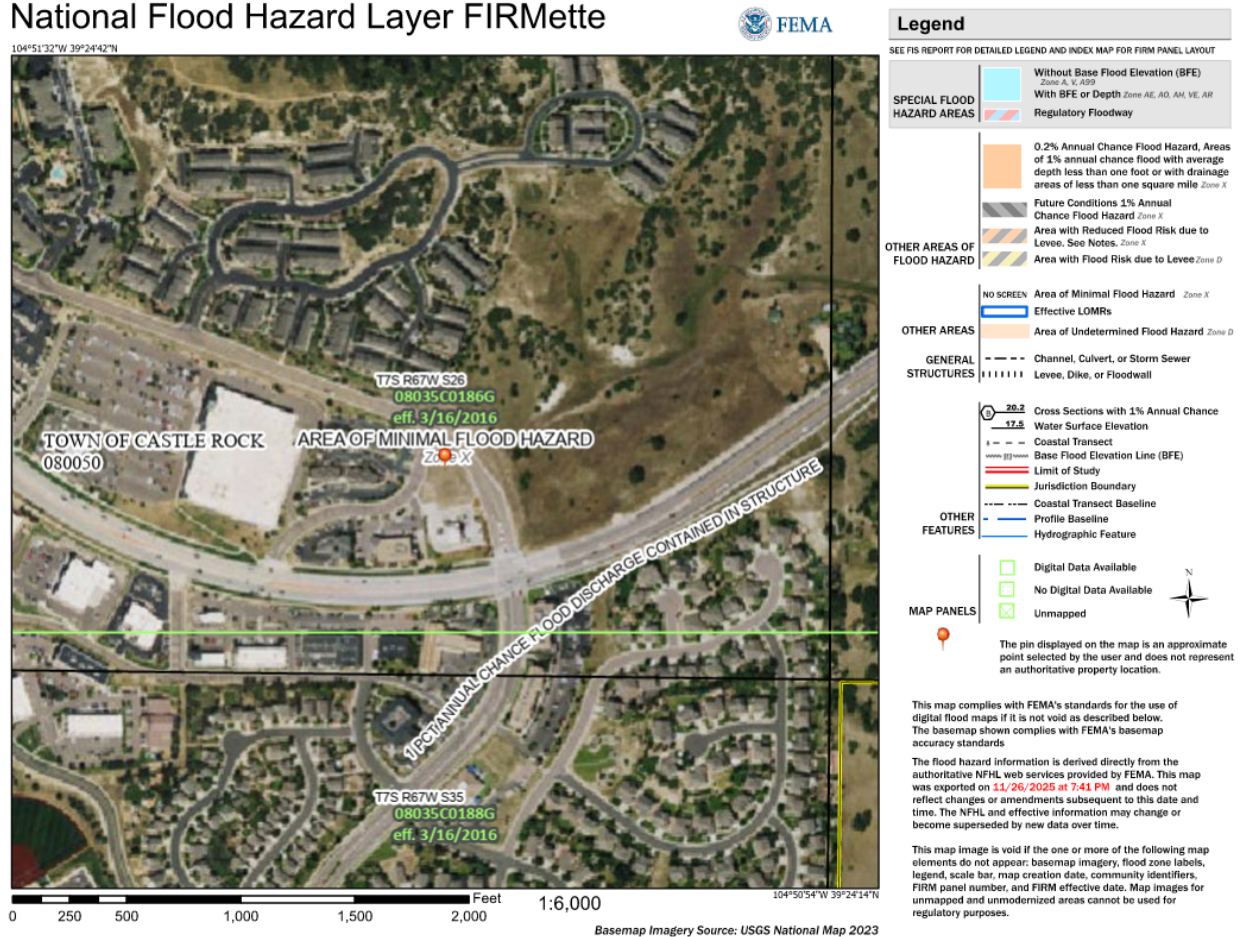


Figure 3: FIRM 08035C0186G Effective 3/16/2016 (Courtesy FEMA)

3.2 Existing Sub-Basin

3.2.1 Existing Studies

An existing drainage study, titled Metzler Ranch Master Drainage Study *prepared by Inter-Mountain Engineering, Ltd., Dated February 1996 and revised on January 20, 1997* provided master drainage design for the Metzler Ranch Subdivision, including the proposed site area. Reference the MDR drainage map in Appendix D.

The site, designated as Lot 4-C and located within Basin IG of the MDR, was assumed to be limited to 60% impervious area while relying on an off-site regional detention pond for stormwater control. The Phase III Drainage Report for US Bank, Castle Rock *prepared by Zeiler-Pennock, Inc., Dated March 25, 2011 and revised on March 8, 2013* studied the subject site. This study reports a composite site impervious value of 60-percent and includes both the bank site and subject site. Reference Appendix D for study excerpts.

3.2.2 Existing Drainage

The Site includes 0.69 acres of the 1.896 Acres that is part of Lot 4-C in the MDR. This makes up 36.4% of the basin area. The US Bank drainage study details the existing imperviousness of the site and conservatively estimates the runoff from the future dental site.

Table 2 shows the sub-basins that were delineated in the US Bank report and encompass the proposed dental site. While these areas do not exactly correspond to the proposed sub basins in this report, they provide a reliable basis for showing that the proposed impervious area is consistent with what was assumed in the original water quality pond design. Reference Appendix D for Lot 4-C existing Sub-Basins from the US Bank Drainage Study.

Sub Basin	Area (ac)	Existing Imperviousness (%)	Runoff Coefficients 5 / 100 Year	Direct Runoff 5/ 100 Year (cfs)
A	0.85	77.1%	0.60/0.72	1.88/4.14
DRN	0.17	74.4%	0.54/0.68	0.43/1.01
DRE	0.14	5.4%	0.18/0.52	0.12/0.63
LOT 4-C	1.896	58.8%	0.39/ 0.60	6.16 / 14.89

Table 2: Existing Sub-Basin Summary

Existing Sub-Basin A roughly corresponds to proposed sub-basin A-1 and C-1, existing sub-basin DRN with proposed sub-basin B-1, and existing sub-basin DRE with proposed sub-basin D-1. Due to overlapping basins between the bank and dental sites in the US Bank study, the impervious percentage for the dental site alone exceeds 60%. However, when Lot 4-C is considered in its entirety, the total site imperviousness is below 60%.

Overall site imperviousness was calculated to ensure compliance with MDR drainage concepts. "Site Composite" in Table 3 represents the drainage areas from the US Bank Study, with Drainage Area A split into A-1 (dental site) and A-2 (bank site) to reflect the updated impervious percentage for the dental site. Historic impervious values were used for A-2 to align with the previous study, while current MHFD values were used for A-1. The composite site imperviousness is 59.2% which is below the MDR maximum of 60%. See Appendix C for US Bank Castle Rock Branch Sheet C1.4 modified with areas A-1 and A-2.

Sub- Basin	Percent Impervious (%)
A-1	70.6
A-2	87.6
B	72.9
DRN	70.5
DRE	5.4
DRS	15.3
DRW	47.9
SITE COMPOSITE	59.2

Table 3: Percent Impervious & Runoff Coefficients

Section 4: DRAINAGE DESIGN CRITERIA

4.1 Regulations

Drainage design references Town of Castle Rock Storm Drainage Design and Technical Criteria Manual (Town Criteria) in conjunction with Mile High Flood District's (MHFD) standards and criteria. Drainage concepts outlined in the MDR and US Bank study were followed.

4.2 Hydrologic Criteria

One hour rainfall depths from the Town of Castle Rock Storm Drainage Design and Technical Criteria Manual. One Hour Point Rainfall Values for the Project area, Table 4, Appendix A. Rainfall depths were used to calculate and graph intensity duration frequency curves (IDF) for the 5-year and 100-year storm frequencies.

Storm Frequency (Year)	1-Hour Rainfall Depth (in)
5	1.43
100	2.60

Table 4: One Hour Rainfall Depths (Town of Castle Rock)

The rational method was used, as described in the Town Criteria manual, to calculate developed direct runoff for the 5-year and 100-year storm frequencies. Reference Appendix B for proposed rational method calculations using the MHFD spreadsheet.

Sub Basin	Area (ac)	Existing Imperviousness (%)	Runoff Coefficients 5 / 100 Year	Direct Runoff 5/ 100 Year (cfs)
A-1	0.42	80.1%	0.69/0.81	1.41/3.02
B-1	0.14	75.7%	0.65/0.79	0.44/0.98
C-1	0.04	5.0%	0.08/0.50	0.01/0.18
D-1	0.06	5.0%	0.08/0.50	0.02/0.27

Table 5: Proposed Sub-Basin Summary

4.3 Hydraulic Criteria

The on-site storm system conveyance elements were sized to convey direct runoff for the 100-year storm event with 93-percent full capacity when piped. There is no proposed curb overtopping within the private roadways.

Offsite flow is separated by curb and gutter and will not contribute to on-site runoff. It is conveyed along existing drainage paths.

4.4 Detention Criteria

The existing porous land detention pond in the southwest corner of Lot 4-C was designed to provide water quality treatment. Offsite regional detention is provided for the 100-yr storm per the MDR. The contributing drainage areas of the proposed site are Sub Basins A-1 and C-1, as shown in the Proposed Drainage Map in Appendix C. Sub Basin A-1 has an area of 0.42 Acres and an impervious percentage of 80.1%, and Sub Basin C-1 has an area of 0.04 Acres and an impervious percentage of 5.0%. When the contributing areas are combined, the resulting weighted impervious percentage is 74%, lower than the 76% used in the original PLD volume sizing calculations. With no increase to the Contributing Watershed Area used in the original calculations, the Existing PLD has been found to accommodate the proposed site. Reference Appendix D for the design of the existing water quality pond from the US Bank Study.

4.5 Waivers

No waivers are requested.

Section 5: DRAINAGE FACILITY DESIGN

Drainage concepts for the Site follow general design standards for commercial development. Existing drainage outfalls are utilized and the general direction of drainage along existing topography is followed. Site direct runoff will flow overland as sheet flow to localized low points. Onsite storm sewer will be used to collect and convey drainage to the existing detention pond.

Developed runoff rates were calculated at design points (DP), Proposed Drainage Map, Appendix C. Detailed calculations are provided in Appendix B.

5.1.1 Minor Drainage Basins

Based on the existing and proposed drainage patterns, four small basins were delineated to determine direct runoff rates. These values were used to size the onsite inlets and storm sewer. Reference Appendix B for Inlet and Storm Sewer Pipe Sizing Calculations.

Sub-Basin	Area (Acres)	Direct Runoff 5-year (cfs)	Direct Runoff 100-year (cfs)
A-1	0.42	1.41	3.02
B-1	0.14	0.44	0.98
C-1	0.04	0.01	0.18
D-1	0.06	0.02	0.27

Table 6: Direct Runoff Summary

For sub-basin A-1, runoff will flow overland to low points in the parking lot, where it will be collected by the proposed storm sewer system and conveyed to the existing PLD pond southwest of the site. Sub-basin B-1 will flow west down the proposed driveway to the curb and gutter on Maleta Lane, eventually making its way south to Founders Parkway. Similarly, sub-basin D-1 will flow east to E Allen St. and south via curb and gutter to Founders Parkway. Sub-basin C-1 will flow overland to the bank parking lot and be picked up at low points and conveyed to the existing PLD pond.

All times of concentrations were assumed to be 5 minutes due to small basin sizes and the urban location of the site.

Section 6: CONCLUSIONS

The proposed project drainage system has been designed in accordance with the Town of Castle Rock stormwater criteria, Mile High Food District standards, and the existing Metzler Ranch MDR. The purpose of this drainage report is to confirm that the proposed impervious area does not exceed the percentage that the existing Porous Land Detention (PLD) Pond was designed to accommodate.

To meet both MDR requirements and the PLD pond design, Lot 4-C must maintain an average imperviousness below 60%. Proposed improvements must therefore remain under 70% impervious. For consistency with previous studies, the bank areas were calculated using historic impervious values, while the dental areas used current MHFD values. Impervious percentages of the proposed site and Lot 4-C are 67.7% and 59.2%, respectively. Impervious breakdowns for the site and a full analysis of Lot 4-C are provided in Appendix B.

References

1. Town of Castle Rock Storm Drainage Design and Technical Criteria Manual; Colorado. February 2025.
2. Urban Storm Drainage Criteria Manual, Vol. 1 and Vol. 2, Urban Drainage and Flood Control District, 2018.
3. Urban Storm Drainage Criteria Manual, Vol. 3, Urban Drainage and Flood Control District, November 2010.
4. Federal Emergency Management Agency, Firmett Web Service.
5. Metzler Ranch Master Drainage Study, Prepared by Inter-Mountain Engineering, January 20, 1997, Revised February 1996.
6. Phase III Drainage Report for US Bank, Castle Rock, Prepared by Zeiler-Pennock, Inc., March 25, 2011, Revised March 8, 2013

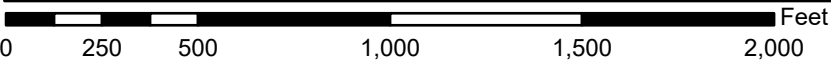
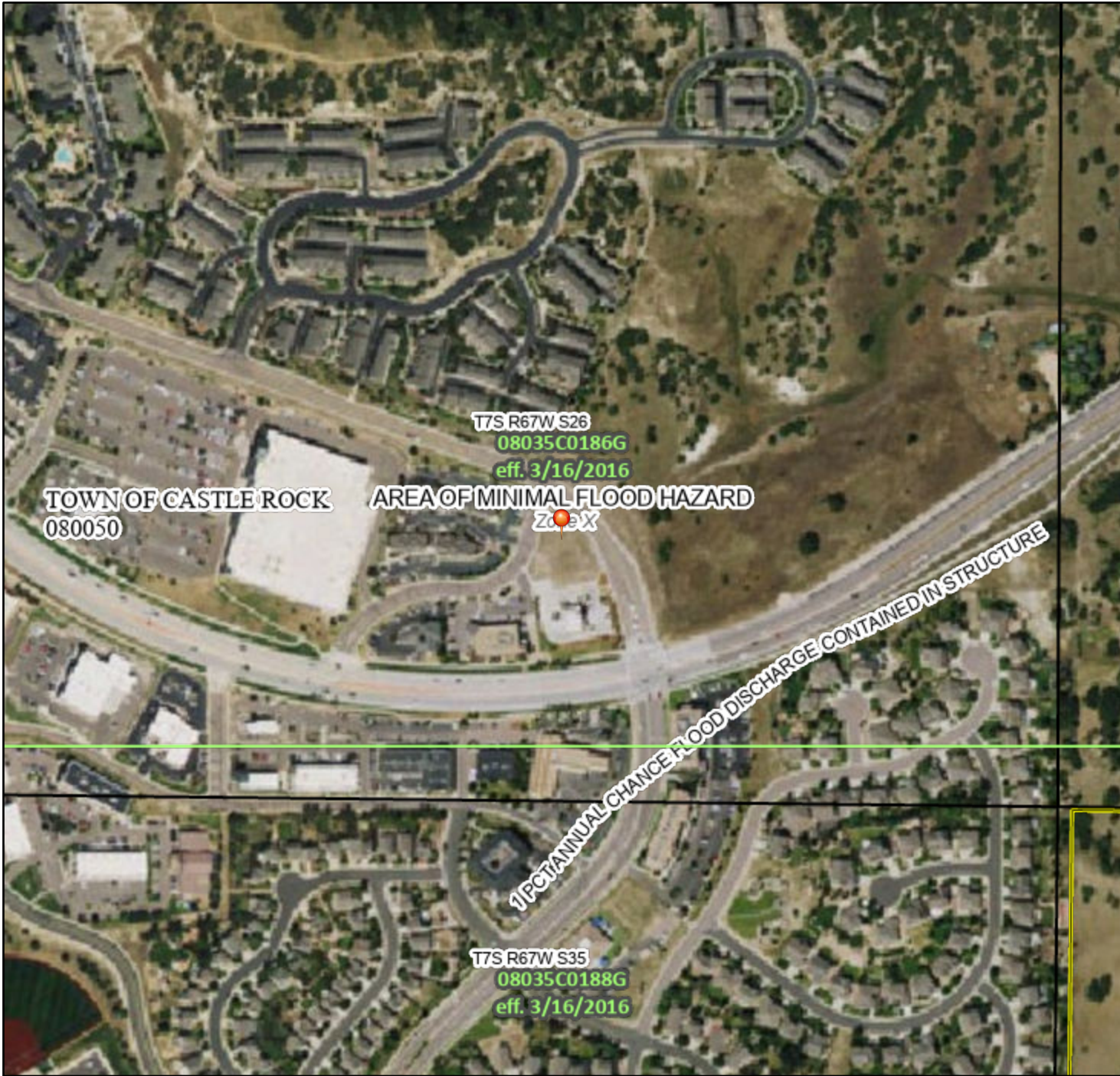
Appendix A: CRITERIA REFERENCES

1. FIRM Panel 08035C0186G Effective 3/16/2016

National Flood Hazard Layer FIRMette



104°51'32"W 39°24'42"N



1:6,000

104°50'54"W 39°24'14"N

Basemap Imagery Source: USGS National Map 2023

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
GENERAL STRUCTURES		Area of Undetermined Flood Hazard Zone D
		Channel, Culvert, or Storm Sewer
OTHER FEATURES		Levee, Dike, or Floodwall
		Cross Sections with 1% Annual Chance Water Surface Elevation
		Coastal Transect
		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



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 **11/26/2025 at 7:41 PM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

Appendix B: HYDROLOGY, HYDRAULICS

1. Impervious Calculations for Lot 4-C
2. MHFD Rational – Clock Tower Dental Rational Calculations



MILE HIGH FLOOD DISTRICT

PEAK RUNOFF PREDICTION BY THE RATIONAL METHOD

MHFD-Rational, Version 3.00 (August 2025)
Mile High Flood District
Denver, Colorado
www.mhfd.org

Purpose:

This workbook applies the Rational Method to estimate stormwater runoff and peak flows from small urban catchments (typically less than 90 acres)

Function:

1. To calculate the area-weighted runoff coefficient, C for a subcatchment
2. To calculate the time of concentration, and then compare with the regional time of concentration limit used for the Denver region. The smaller value is recommended as the rainfall duration for use with the Rational Method.
3. To calculate the design rainfall intensity and resulting peak flow rate.
4. To calculate the combined peak flow rate at design points for sizing inlets and storm drain systems. Considers the cumulative drainage area, area-weighted runoff coefficient, and total travel time through the storm drain system to each design point.

Content:

The workbook consists of the following sheets:

Rational Calcs Performs Rational Method calculations, $Q = CIA$

Runoff Coeffs Calculates area-weighted runoff coefficients for subareas, soil types, and imperviousness.

Runoff Routing Calculates combined peak flow rates at design points for inlet and storm drain sizing.

Weighted Slope Supporting tool to calculate length-weighted slope from multiple flow reaches.

Weighted Tc Supporting tool to calculate reach-weighted time of concentration from multiple flow reaches.

Design Info Provides background information from the USDCM

Acknowledgements: *Spreadsheet Development Team:*

Derek N. Rapp, P.E.

Peak Stormwater Engineering, LLC

Brik Zivkovich, P.E., Holly Piza, P.E., and Ken A. MacKenzie, P.E.

Mile High Flood District

Accessibility:

MHFD is committed to ensuring equitable access design resources for all users, regardless of ability. If you experience any issues, need assistance accessing information, or have comments on how we can enhance accessibility to our resources, please contact us by email at questions@mhfd.org or by phone at 303-455-6277.

Comments?

Direct all comments regarding this spreadsheet workbook to:

[MHFD email](mailto:questions@mhfd.org)

Revisions?

Check for revised versions of this or any other workbook at:

[Downloads](#)

Calculation of Peak Runoff using Rational Method

Designer: M. Dimmick
Company: Shrewsberry
Date: 12/11/2025
Project: Clock Tower Dental
Location: Douglas County

MHFD-Rational, Version 3.00 (August 2025)

Cells of this color are for required user-input
 Cells of this color are for optional override values

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_i^{0.33}}$$

Computed t_i

$$t_t = \frac{L_t}{60K\sqrt{S_t}} = \frac{L_t}{60V_t}$$

Regional t_c

Provide input for area, soil type, and imperviousness on the Runoff Coeffs worksheet.

Subcatchment Name	Area (ac)	NRCS Hydrologic Soil Group(s)	Imperviousness	Runoff Coefficient, C							Overland (Initial) Flow Time			
				WQE & 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)
A-1	0.48	C/D	70.6%	0.58	0.61	0.65	0.71	0.74	0.77	0.81	0.00			0.020
A-2	0.37	C/D	87.6%	0.73	0.75	0.78	0.81	0.83	0.84	0.86	0.00			0.020
B	0.31	C/D	72.9%	0.58	0.63	0.67	0.73	0.75	0.78	0.82	0.00			0.020
DRN	0.17	C/D	70.5%	0.56	0.61	0.65	0.71	0.74	0.77	0.81	0.00			0.020
DRE	0.14	C/D	5.4%	0.03	0.08	0.17	0.35	0.42	0.51	0.61				
DRS	0.30	C/D	15.3%	0.10	0.16	0.24	0.40	0.47	0.55	0.64	0.00			0.020
DRW	0.13	C/D	47.9%	0.37	0.43	0.48	0.59	0.63	0.68	0.74				
OVERALL SITE	1.90	C/D	59.2%	0.47	0.52	0.57	0.65	0.69	0.73	0.77	70.00			0.055
											70.00			0.080

Calculation of Peak Runoff using Rational Method

Designer: _____
Company: $t_c = t_i + t_t$
Date: _____

$t_{c \text{ minimum}} = 5$ (urban)
 $t_{c \text{ minimum}} = 10$ (non-urban)

[Select MHFD location for NOA](#)

1-hour rainfall depth, P1 (in) = _____

Project: _____
Location: $= (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}}$

Selected $t_c = \max\{t_{\text{minimum}}, \min(\text{Computed } t_c, \text{Regional } t_c)\}$

Rainfall Intensity Equation Coe _____

Subcatchment Name	Overland Flow Time t_i (min)	Channelized (Travel) Flow Time							Time of Concentration			
		Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Velocity V_t (ft/sec)	Channelized Flow Time t_t (min)	Computed t_c (min)	Regional t_c (min)	Selected t_c (min)	(Optional) Override t_c (min)
A-1	0.00	0.00			0.020	20	2.83	0.00	0.00	13.99	5.00	5.00
A-2	0.00	0.00			0.020	20	2.83	0.00	0.00	11.11	5.00	5.00
B	0.00	0.00			0.020	20	2.83	0.00	0.00	13.61	5.00	5.00
DRN	0.00	0.00			0.020	20	2.83	0.00	0.00	14.02	5.00	5.00
DRE												
DRS	0.00	0.00			0.020	20	2.83	0.00	0.00	23.40	10.00	5.00
DRW												
OVERALL SITE	5.01	40.00			0.040	10	2.00	0.33	5.35	16.13	5.35	
		0.00			0.010	10	1.00	0.00				

Calculation of Peak Runoff using Rational Method

Designer: [A Atlas 14 Rainfall Depths from the pulldown list OR enter your own depths obtained from the NOAA website \(click this link\)](#)

Company:	WQE	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
Date:	0.69	1.06	1.43	1.66	1.74	2.26	2.60	3.09

Project:

Location: ficients =

a	b	c
28.50	10.00	0.786

$$I(in/hr) = \frac{a * P_1}{(b + t_c)^c}$$

$$Q(cfs) = CIA$$

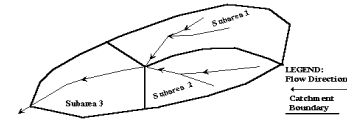
Subcatchment Name	Rainfall Intensity, I (in/hr)								Peak Flow, Q (cfs)							
	WQE	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	WQE	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
A-1	2.32	3.60	4.85	5.63	5.90	7.67	8.82	10.48	0.65	1.00	1.42	1.76	2.02	2.73	3.27	4.08
A-2	2.32	3.60	4.85	5.63	5.90	7.67	8.82	10.48	0.62	0.97	1.34	1.62	1.77	2.34	2.75	3.35
B	2.32	3.60	4.85	5.63	5.90	7.67	8.82	10.48	0.42	0.66	0.95	1.17	1.34	1.80	2.15	2.67
DRN	2.32	3.60	4.85	5.63	5.90	7.67	8.82	10.48	0.23	0.35	0.51	0.63	0.73	0.98	1.18	1.47
DRE																
DRS	2.32	3.60	4.85	5.63	5.90	7.67	8.82	10.48	0.07	0.11	0.23	0.41	0.72	1.08	1.45	2.00
DRW																
OVERALL SITE	2.28	3.53	4.76	5.53	5.80	7.53	8.66	10.29	2.05	3.17	4.68	5.96	7.16	9.80	11.95	15.15

Determination of Runoff Coefficients for Rational Method

MHFD-Rational, Version 3.00 (August 2025)

Designer: M. Dimmick
Company: Shrewsberry
Date: 12/11/2025
Project: Clock Tower Dental
Location: Douglas County

Cells of this color are for required user-input
Cells of this color are for optional override values



Provide subcatchment names on the Rational Calcs worksheet to open up the table below.

Subcatchment Name	# of Subareas	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness			(Optional) Override Imperviousness	Runoff Coefficient, C								(Optional) Override Runoff Coefficient, C								Comments
				Imperviousness Source	Imperviousness Category	Calculated Imperviousness		WQE & 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	WQE & 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr			
A-1	4	0.48	C/D			74.7%	70.6%	0.58	0.61	0.65	0.71	0.74	0.77	0.81	0.58	0.61	0.65	0.71	0.74	0.77	0.81			
		0.21	C/D	Surface Type	Roadways and Paved Streets	95%		0.79	0.81	0.83	0.85	0.86	0.87	0.89										
		0.10	C/D	Surface Type	Roofs	95%		0.79	0.81	0.83	0.85	0.86	0.87	0.89										
		0.13	C/D	Surface Type	Receiving Pervious Areas (GB & GS)	20%	5%	0.03	0.08	0.17	0.35	0.42	0.50	0.60										
		0.04	C/D	Surface Type	Concrete Driveways and Walks	95%		0.79	0.81	0.83	0.85	0.86	0.87	0.89										
A-2	3	0.37	C/D			88.9%	87.6%	0.73	0.75	0.78	0.81	0.83	0.84	0.86	0.73	0.75	0.78	0.81	0.83	0.84	0.86			
		0.30	C/D	Surface Type	Concrete Driveways and Walks	95%	96%	0.80	0.82	0.84	0.86	0.87	0.88	0.89										
		0.04	C/D	Surface Type	Roofs	95%	90%	0.74	0.77	0.79	0.82	0.84	0.85	0.87										
		0.03	C/D	Surface Type	Receiving Pervious Areas (GB & GS)	20%	0%	0.00	0.04	0.13	0.32	0.39	0.48	0.59										
B	1	0.31	C/D			20.0%	72.9%	0.58	0.63	0.67	0.73	0.75	0.78	0.82	0.58	0.63	0.67	0.73	0.75	0.78	0.82			
		0.312	C/D	Surface Type	Receiving Pervious Areas (GB & GS)	20%	72.9%	0.58	0.63	0.67	0.73	0.75	0.78	0.82										
DRN	1	0.17	C/D			20.0%	70.5%	0.56	0.61	0.65	0.71	0.74	0.77	0.81	0.56	0.61	0.65	0.71	0.74	0.77	0.81			
		0.173	C/D	Surface Type	Receiving Pervious Areas (GB & GS)	20%	70.5%	0.56	0.61	0.65	0.71	0.74	0.77	0.81										
DRE	1	0.14	C/D			20.0%	5.4%	0.03	0.08	0.17	0.35	0.42	0.51	0.61	0.03	0.08	0.17	0.35	0.42	0.51	0.61			
		0.138	C/D	Surface Type	Receiving Pervious Areas (GB & GS)	20%	5.4%	0.03	0.08	0.17	0.35	0.42	0.51	0.61										
DRS	1	0.30	C/D			20.0%	15.3%	0.10	0.16	0.24	0.40	0.47	0.55	0.64	0.10	0.16	0.24	0.40	0.47	0.55	0.64			
		0.30	C/D	Surface Type	Receiving Pervious Areas (GB & GS)	20%	15.3%	0.10	0.16	0.24	0.40	0.47	0.55	0.64										
DRW	1	0.13	C/D			20.0%	47.9%	0.37	0.43	0.48	0.59	0.63	0.68	0.74	0.37	0.43	0.48	0.59	0.63	0.68	0.74			
		0.126	C/D	Surface Type	Receiving Pervious Areas (GB & GS)	20%	47.9%	0.37	0.43	0.48	0.59	0.63	0.68	0.74										
OVERALL SITE	7	1.90	C/D			34.6%	59.2%	0.47	0.52	0.57	0.65	0.69	0.73	0.77	0.47	0.52	0.57	0.65	0.69	0.73	0.77			
		0.48	C/D	Surface Type	Receiving Pervious Areas (GB & GS)	20%	70.6%	0.56	0.61	0.65	0.71	0.74	0.77	0.81										
		0.37	C/D	Surface Type	Concrete Driveways and Walks	95%	87.6%	0.72	0.75	0.78	0.81	0.83	0.84	0.86										
		0.31	C/D	Surface Type	Receiving Pervious Areas (GB & GS)	20%	72.9%	0.58	0.63	0.67	0.73	0.75	0.78	0.82										
		0.17	C/D	Surface Type	Receiving Pervious Areas (GB & GS)	20%	70.5%	0.56	0.61	0.65	0.71	0.74	0.77	0.81										
		0.14	C/D	Surface Type	Receiving Pervious Areas (GB & GS)	20%	5.4%	0.03	0.08	0.17	0.35	0.42	0.51	0.61										
		0.30	C/D	Surface Type	Receiving Pervious Areas (GB & GS)	20%	15.3%	0.10	0.16	0.24	0.40	0.47	0.55	0.64										
		0.13	C/D	Surface Type	Receiving Pervious Areas (GB & GS)	20%	47.9%	0.37	0.43	0.48	0.59	0.63	0.68	0.74										



MILE HIGH FLOOD DISTRICT

PEAK RUNOFF PREDICTION BY THE RATIONAL METHOD

MHFD-Rational, Version 3.00 (August 2025)
Mile High Flood District
Denver, Colorado
www.mhfd.org

Purpose:

This workbook applies the Rational Method to estimate stormwater runoff and peak flows from small urban catchments (typically less than 90 acres)

Function:

1. To calculate the area-weighted runoff coefficient, C for a subcatchment
2. To calculate the time of concentration, and then compare with the regional time of concentration limit used for the Denver region. The smaller value is recommended as the rainfall duration for use with the Rational Method.
3. To calculate the design rainfall intensity and resulting peak flow rate.
4. To calculate the combined peak flow rate at design points for sizing inlets and storm drain systems. Considers the cumulative drainage area, area-weighted runoff coefficient, and total travel time through the storm drain system to each design point.

Content:

The workbook consists of the following sheets:

Rational Calcs Performs Rational Method calculations, $Q = CIA$

Runoff Coeffs Calculates area-weighted runoff coefficients for subareas, soil types, and imperviousness.

Runoff Routing Calculates combined peak flow rates at design points for inlet and storm drain sizing.

Weighted Slope Supporting tool to calculate length-weighted slope from multiple flow reaches.

Weighted Tc Supporting tool to calculate reach-weighted time of concentration from multiple flow reaches.

Design Info Provides background information from the USDCM

Acknowledgements: *Spreadsheet Development Team:*

Derek N. Rapp, P.E.

Peak Stormwater Engineering, LLC

Brik Zivkovich, P.E., Holly Piza, P.E., and Ken A. MacKenzie, P.E.

Mile High Flood District

Accessibility:

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Comments?

Direct all comments regarding this spreadsheet workbook to:

[MHFD email](mailto:questions@mhfd.org)

Revisions?

Check for revised versions of this or any other workbook at:

[Downloads](#)

Calculation of Peak Runoff using Rational Method

Designer: G. Guzman

Company: Shrewsberry

Date: 4/20/2026

Project: Clock Tower Dental

Location: Douglas County

MHFD-Rational, Version 3.00 (August 2025)

Cells of this color are for required user-input

Cells of this color are for optional override values

$$t_i = \frac{0.395(1.1 - C_s)\sqrt{L_i}}{S_i^{0.33}}$$

Computed t_i

$$t_t = \frac{L_t}{60K\sqrt{S_t}} = \frac{L_t}{60V_t}$$

Regional t_c

Provide input for area, soil type, and imperviousness on the Runoff Coeffs worksheet.

Subcatchment Name	Area (ac)	NRCS Hydrologic Soil Group(s)	Imperviousness	Runoff Coefficient, C							Overland (Initial) Flow Time			
				WQE & 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)
A-1	0.42	C/D	80.1%	0.66	0.69	0.72	0.77	0.79	0.81	0.84	0.00			0.020
B-1	0.14	C/D	75.7%	0.62	0.65	0.69	0.74	0.77	0.79	0.83	0.00			0.020
C-1	0.04	C/D	5.0%	0.03	0.08	0.17	0.35	0.42	0.50	0.60	0.00			0.020
D-1	0.06	C/D	5.0%	0.03	0.08	0.17	0.35	0.42	0.50	0.60	0.00			0.020
Proposed Site	0.66	C/D	67.7%	0.56	0.59	0.63	0.70	0.73	0.76	0.80	0.00			0.020
EX-1	0.18	C/D	5.0%	0.03	0.08	0.17	0.35	0.42	0.50	0.60	70.00			0.055
EX-2	0.25	C/D	5.0%	0.03	0.08	0.17	0.35	0.42	0.50	0.60	70.00			0.080
EX-3	0.23	C/D	5.0%	0.03	0.08	0.17	0.35	0.42	0.50	0.60	140.00			0.070
EX-SITE	0.66	C/D	5.0%	0.03	0.08	0.17	0.35	0.42	0.50	0.60	140.00			0.070

Calculation of Peak Runoff using Rational Method

Designer: _____
Company: _____
Date: _____

$t_{c \text{ minimum}} = 5 \text{ (urban)}$
 $t_{c \text{ minimum}} = 10 \text{ (non-urban)}$

[Select MHFD location for NOAA](#)

1-hour rainfall depth, P1 (in) = _____

Project: _____
Location: $= (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}}$

Selected $t_c = \max\{t_{\text{minimum}}, \min(\text{Computed } t_c, \text{Regional } t_c)\}$

Rainfall Intensity Equation Coe _____

Subcatchment Name	Overland Flow Time t_i (min)	Channelized (Travel) Flow Time							Time of Concentration			
		Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Velocity V_t (ft/sec)	Channelized Flow Time t_t (min)	Computed t_c (min)	Regional t_c (min)	Selected t_c (min)	(Optional) Override t_c (min)
A-1	0.00	0.00			0.020	20	2.83	0.00	0.00	12.39	5.00	5.00
B-1	0.00	0.00			0.020	20	2.83	0.00	0.00	13.13	5.00	5.00
C-1	0.00	0.00			0.020	20	2.83	0.00	0.00	25.15	10.00	5.00
D-1	0.00	0.00			0.020	20	2.83	0.00	0.00	25.15	10.00	5.00
Proposed Site	0.00	0.00			0.020	20	2.83	0.00	0.00	14.49	5.00	5.00
EX-1	8.82	40.00			0.040	10	2.00	0.33	9.15	25.49	10.00	
EX-2	7.79	0.00			0.010	10	1.00	0.00	7.79	25.15	10.00	
EX-3	11.51	0.00			0.010	10	1.00	0.00	11.51	25.15	11.51	
EX-SITE	11.51	0.00			0.010	10	1.00	0.00	11.51	25.15	11.51	

Calculation of Peak Runoff using Rational Method

Designer: \ Atlas 14 Rainfall Depths from the pulldown list OR enter your own depths obtained from the NOAA website (click this link)

Company:	WQE	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
Date:	0.69	1.06	1.43	1.66	1.74	2.26	2.60	3.09

Project:

Location:	a	b	c
Efficients =	28.50	10.00	0.786

$$I(in/hr) = \frac{a * P_1}{(b + t_c)^c}$$

$$Q(cfs) = CIA$$

Subcatchment Name	Rainfall Intensity, I (in/hr)								Peak Flow, Q (cfs)							
	WQE	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	WQE	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
A-1	2.32	3.60	4.85	5.63	5.90	7.67	8.82	10.48	0.65	1.00	1.41	1.71	1.91	2.55	3.02	3.72
B-1	2.32	3.60	4.85	5.63	5.90	7.67	8.82	10.48	0.20	0.31	0.44	0.54	0.61	0.82	0.98	1.21
C-1	2.32	3.60	4.85	5.63	5.90	7.67	8.82	10.48	0.00	0.00	0.01	0.04	0.08	0.13	0.18	0.25
D-1	2.32	3.60	4.85	5.63	5.90	7.67	8.82	10.48	0.00	0.01	0.02	0.06	0.12	0.19	0.27	0.38
Proposed Site	2.32	3.60	4.85	5.63	5.90	7.67	8.82	10.48	0.85	1.32	1.88	2.34	2.72	3.68	4.43	5.54
EX-1	1.85	2.87	3.87	4.49	4.71	6.11	7.03	8.36	0.01	0.01	0.05	0.14	0.29	0.46	0.64	0.91
EX-2	1.85	2.87	3.87	4.49	4.71	6.11	7.03	8.36	0.01	0.02	0.07	0.19	0.41	0.64	0.89	1.26
EX-3	1.75	2.71	3.65	4.24	4.45	5.77	6.64	7.89	0.01	0.02	0.06	0.16	0.35	0.55	0.77	1.10
EX-SITE	1.75	2.71	3.65	4.24	4.45	5.77	6.64	7.89	0.03	0.05	0.18	0.47	1.02	1.59	2.21	3.15



MILE HIGH FLOOD DISTRICT STREET AND INLET HYDRAULICS WORKBOOK

MHFD-Inlet, Version 6.00 (August 2025)

*Mile High Flood District
Denver, Colorado
www.mhfd.org*

Purpose: This workbook can be used to size a variety of inlets based on the design peak flow, allowable spread, and depth in a street or swale.

Function:

1. To calculate allowable half-street capacity based on allowable depth and spread.
2. To determine the inlet capacity for selected inlet types.
3. To manage inlet information and connect inlets in series to account for bypass flow.

Content: **The workbook consists of the following sheets:**

Inlet Management This worksheet is used to add new street and area inlets by creating new Inlet [#] worksheets with specified names. It can also be used to re-organize inlets with the rename, move, and delete buttons in order to connect inlets in series so that bypass flow from an upstream inlet is added to flow for the next downstream inlet. Peak flows generated from the MHFD-Rational workbook (or other methods) are entered on this worksheet.

Inlet [#] *Inlet [#]* sheets are created each time the user adds a new inlet on the *Inlet Management* sheet. The Inlet [#] sheets calculate allowable half-street capacity or grass channel capacity based on allowable depth and allowable spread for the minor and major storm events. This is also where the user selects an inlet type and calculates the capacity of that inlet.

Inlet Pictures Contains a library of photographs of the various types of inlets contained in MHFD-Inlet and referenced in the USDCM.

Acknowledgements: Spreadsheet Development Team:
Ken A. MacKenzie, P.E., Holly Piza, P.E., Chris Carandang
Mile High Flood District

Derek N. Rapp, P.E.
Peak Stormwater Engineering, LLC

Dr. James C.Y. Guo, Ph.D., P.E.
Professor, Department of Civil Engineering, University of Colorado at Denver

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Comments? Direct all comments regarding this spreadsheet workbook to:
Revisions? Check for revised versions of this or any other workbook at:

MHFD E-mail
Downloads

INLET MANAGEMENT

Project: Clock Tower Dental
Minor: 5-year
Major: 100-year

Worksheet Protected

INLET NAME	Inlet 1
Inlet Application (Street or Area)	STREET
Hydraulic Condition	In Sump
Inlet Type	CDOT/Denver 13 Valley Grate
Number of Inlet Units	1

USER-DEFINED INPUT

User-Defined Peak Flows

Minor Peak Flow, Q (cfs)	0.98
Major Peak Flow, Q (cfs)	2.17

Bypass (Carry-Over) Flow from Upstream

Inlets must be organized from upstream (left) to downstream (right)

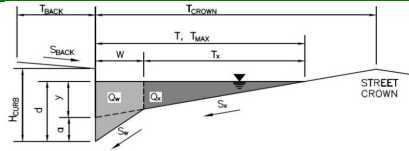
Receive Bypass Flow from:	No Bypass Flow Received
Bypass Flow Description (Optional):	
Minor Bypass Flow Received, Q_b (cfs)	0.00
Major Bypass Flow Received, Q_b (cfs)	0.00

CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	0.98
Major Total Design Peak Flow, Q (cfs)	2.17
Minor Inlet Interception Capacity, Q_a (cfs)	2.64
Major Inlet Interception Capacity, Q_a (cfs)	2.64
Minor Flow Bypassed Downstream, Q_b (cfs)	N/A
Major Flow Bypassed Downstream, Q_b (cfs)	N/A
Minor Flow Capture Percentage, C%	100%
Major Flow Capture Percentage, C%	100%

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

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

Project: **Clock Tower Dental**Inlet ID: **Inlet 1****Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

T_{BACK}	=	0.0	ft
S_{BACK}	=	0.000	ft/ft
n_{BACK}	=	0.020	

H_{CURB}	=	6.00	inches
T_{CROWN}	=	60.0	ft
W	=	2.00	ft
S_X	=	0.028	ft/ft
S_W	=	0.083	ft/ft
S_D	=	0.000	ft/ft
n_{STREET}	=	0.016	

Max. Allowable Spread for Minor & Major Storm

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

Check boxes are not applicable in SUMP conditions

	Minor Storm	Major Storm	
T_{MAX}	=	17.0	ft
d_{MAX}	=	6.0	inches

☐☐

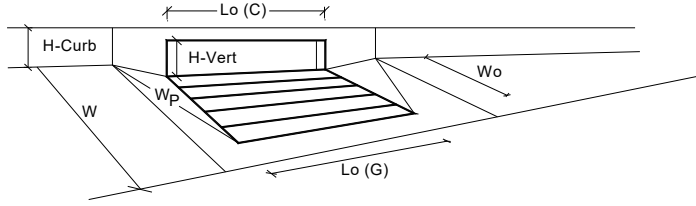
MINOR STORM Allowable Capacity is not applicable to Sump Condition

MAJOR STORM Allowable Capacity is not applicable to Sump Condition

	Minor Storm	Major Storm	
Q_{allow}	=	SUMP	cfs

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 6.00 (August 2025)



Design Information (Input) CDOT/Denver 13 Valley Grate

Type of Inlet
Local Depression (additional to continuous gutter depression 'a' from above)
Number of Unit Inlets (Grate or Curb Opening)
Water Depth at Flowline (outside of local depression)
Grate Information
Length of a Unit Grate
Width of a Unit Grate
Open Area Ratio for a Grate (typical values 0.15-0.90)
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)
Grate Weir Coefficient (typical value 2.15 - 3.60)
Grate Orifice Coefficient (typical value 0.60 - 0.80)

Curb Opening Information
Length of a Unit Curb Opening
Height of Vertical Curb Opening in Inches
Height of Curb Orifice Throat in Inches
Angle of Throat
Side Width for Depression Pan (typically the gutter width of 2 feet)
Clogging Factor for a Single Curb Opening (typical value 0.10)
Curb Opening Weir Coefficient (typical value 2.3-3.7)
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)

Low Head Performance Reduction (Calculated)

Depth for Grate Midwidth
Depth for Curb Opening Weir Equation
Grated Inlet Performance Reduction Factor for Long Inlets
Curb Opening Performance Reduction Factor for Long Inlets
Combination Inlet Performance Reduction Factor for Long Inlets

Total Inlet Interception Capacity (assumes clogged condition)

Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)

	MINOR	MAJOR	
Type =	CDOT/Denver 13 Valley Grate		
a_{local} =	2.00	2.00	inches
No =	1	1	
Ponding Depth =	6.0	6.0	inches
	MINOR	MAJOR	
L_o (G) =	3.00	3.00	feet
W_o =	1.73	1.73	feet
A_{ratio} =	0.43	0.43	
C_f (G) =	0.50	0.50	
C_w (G) =	3.30	3.30	
C_o (G) =	0.60	0.60	
	MINOR	MAJOR	
L_o (C) =	N/A	N/A	feet
H_{vert} =	N/A	N/A	inches
H_{throat} =	N/A	N/A	inches
Theta =	N/A	N/A	degrees
W_o =	N/A	N/A	feet
C_f (C) =	N/A	N/A	
C_w (C) =	N/A	N/A	
C_o (C) =	N/A	N/A	

	MINOR	MAJOR	
d_{Grate} =	0.52	0.52	ft
d_{Curb} =	N/A	N/A	ft
RF_{Grate} =	0.94	0.94	
RF_{Curb} =	N/A	N/A	
$RF_{Combination}$ =	N/A	N/A	

	MINOR	MAJOR	
Q_a =	2.6	2.6	cfs
$Q_{PEAK REQUIRED}$ =	1.0	2.2	cfs

INLET PICTURES



CDOT Type A Curb Opening



Denver No. 14 Curb Opening



Colorado Springs E-10-R



CDOT Denver 13 Valley Grate



CDOT Denver 13 Combination



Denver No. 18 Combination



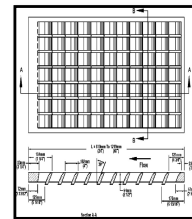
Wreck Ridge Combination Inlet



Denver No. 18 Valley Grate



Directional Cast Vane Grate



Directional 30-Degree Bar Grate (courtesy HEC-22)



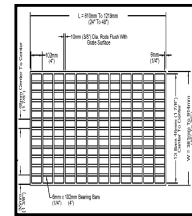
Directional 45-Degree Bar Grate



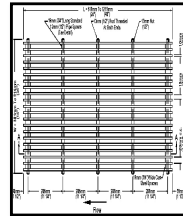
Reticuline Inverted Grate



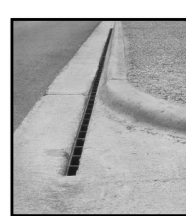
1-7/8" Bar Grate, Crossbars @ 8"



1-7/8" Bar Grate, Crossbars @ 4" (courtesy HEC-22)



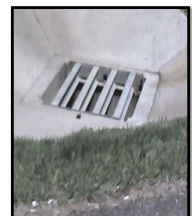
1-1/8" Bar Grate, Crossbars @ 8 in. (courtesy HEC-22)



Clothed Inlet Parallel to Flow



CDOT Type C Grate (Close Mesh)



CDOT Type C Grate



CDOT Type C Inlet



CDOT Type C Inlet in Depression



CDOT Type D Inlet in Corrieo (Flat & Depressed)



CDOT Type D Inlet in Corrieo (10° Incline & Depressed)



CDOT Type D Inlet in Corrieo (20° Incline & Depressed)



CDOT Type D Inlet in Corrieo (30° Incline & Depressed)



CDOT Type D Inlet Parallel (Flat & Depressed)



CDOT Type D Inlet Parallel (10° Incline & Depressed)

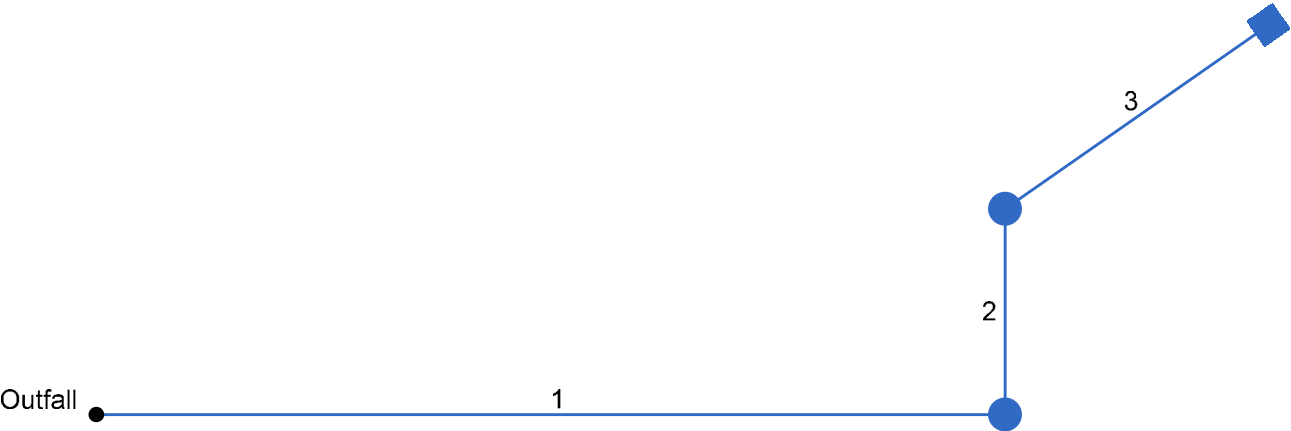


CDOT Type D Inlet Parallel (20° Incline & Depressed)



CDOT Type D Inlet Parallel (30° Incline & Depressed)

Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	(2)	4.10	18	Cir	117.000	6287.14	6288.14	0.855	6287.82	6288.92	0.46	6288.92	End	Curb-Horiz
2		3.02	18	Cir	26.600	6288.14	6288.41	1.015	6288.92	6289.07	n/a	6289.07 j	1	Manhole
3		3.02	18	Cir	41.400	6288.41	6288.82	0.990	6289.07	6289.48	n/a	6289.48	2	Grate
Project File: clock tower full system.stm									Number of lines: 3			Run Date: 4/21/2026		
NOTES: Return period = 100 Yrs. ; j - Line contains hyd. jump.														

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (l)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr	Total		Incr	Total	Inlet	Syst					Size	Slope	Dn	Up	Dn	Up	Dn	Up	
		(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	End 1	117.000	0.00	0.00	0.00	0.00	0.00	0.0	5.7	0.0	4.10	9.71	4.86	18	0.85	6287.14	6288.14	6287.82	6288.92	0.00	0.00	(2)
2		26.600	0.00	0.00	0.00	0.00	0.00	0.0	5.4	0.0	3.02	10.58	3.66	18	1.02	6288.14	6288.41	6288.92	6289.07	0.00	0.00	
3	2	41.400	0.00	0.00	0.00	0.00	0.00	5.0	5.0	0.0	3.02	10.45	4.03	18	0.99	6288.41	6288.82	6289.07	6289.48	0.00	0.00	(2)
Project File: clock tower full system.stm																Number of lines: 3				Run Date: 4/21/2026		
NOTES:Intensity = 69.51 / (Inlet time + 6.40) ^ 0.81; Return period =Yrs. 100 ; c = cir e = ellip b = box																						

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
(1)	(in) (2)	(cfs) (3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(ft) (12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(K) (23)	(ft) (24)
1	18	4.10	6287.14	6287.82	0.68	0.78	5.26	0.31	6288.13	0.000	117.00	6288.14	6288.92	0.77**	0.92	4.45	0.31	6289.22	0.000	0.000	n/a	1.50	0.46
2	18	3.02	6288.14	6288.92	0.77	0.75	3.28	0.25	6289.17	0.000	26.600	6288.41	6289.07 j	0.66**	0.75	4.03	0.25	6289.32	0.000	0.000	n/a	0.85	n/a
3	18	3.02	6288.41	6289.07	0.66*	0.75	4.03	0.25	6289.32	0.000	41.400	6288.82	6289.48	0.66**	0.75	4.03	0.25	6289.73	0.000	0.000	n/a	1.00	n/a
Project File: clock tower full system.stm														Number of lines: 3					Run Date: 4/21/2026				
Notes: * Normal depth assumed; ** Critical depth.; j-Line contains hyd. jump ; c = cir e = ellip b = box																							

Appendix C: DRAINAGE MAPS

1. Proposed Drainage Map
2. US Bank Castle Rock Branch Sheet C1.4 - MODIFIED

METZLER RANCH FILING NO. 3 2nd AMENDMENT, LOT 4-C
LOCATED IN THE SOUTH 1/2 OF SECTION 26, TOWNSHIP 7 SOUTH, RANGE 67, WEST OF THE 6TH P.M.,
CITY OF CASTLE ROCK, DOUGLAS COUNTY, COLORADO
1.89 ACRES

AMENDMENT NO.1



PROPERTY LINE

LOT LINE

PROPOSED CURB

PROPOSED FLOW LINE

PROPOSED PAN/LIP

EXISTING STORM SEWER

EXISTING / PROPOSED DRAINAGE BASIN

DRAINAGE BASIN CALL OUT

BASIN AREA (ACRES)

RUNOFF COEFFICIENT 100 YEAR

RUNOFF COEFFICIENT 5 YEAR

DRAINAGE BASIN BOUNDARY

PROPOSED STORM SEWER

DESIGN POINT

PROPOSED CONTOUR

EXISTING CONTOUR

EXISTING / PROPOSED GRADE
(FL=FLOWLINE, TC=TOP CURB, FG=FINISH GRADE)

SLOPE

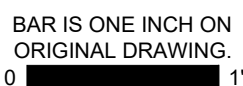
EXISTING / PROPOSED CONCRETE

PROPOSED ASPHALT

INLET PONDING LIMITS

Design Point	Contributing Basins	Contributing Area (ac)	Percent Impervious (%)	Runoff Coefficients 5 & 100 year	Runoff 5 yr (cfs)	Runoff 100 yr (cfs)
A-1	A-1	0.42	80.1	0.69/0.81	1.41	3.02
B-1	B-1	0.14	75.7	0.65/0.79	0.44	0.98
C-1	C-1	0.04	5	0.08/0.50	0.01	0.18
D-1	D-1	0.06	5	0.08/0.50	0.02	0.27

THIS PROPERTY LIES WITHIN ZONE X (AREAS DETERMINED TO BE OUTSIDE THE 1% ANNUAL CHANCE FLOODPLAIN) AS DELINEATED IN THE FEMA FLOOD INSURANCE RATE MAP (FIRM) NO. 08035C0186G EFFECTIVE MARCH 16, 2016.

[illegible]

 COPYRIGHTED BY SHREWSBERRY AND ASSOCIATE

CLOCK TOWER DENTAL
LOT 4-C, METZLER RANCH FILING NO. 3 2nd AMENDMENT

MALETA LANE
CASLTE ROCK, CO 80104

DATE:	12/17/2025	PROJECT NO.:	25-0049
DRAWN BY:	RDR	CHECKED BY:	CDN
DRAWING STATUS:			
REVIEW			
SHEET TITLE:			
PR DRAINAGE MAP			
SHEET NO.:			
1			
TOTAL SHEETS:			16



**Know what's below.
Call before you dig.**

1-800-922-1987

ELEVATIONS AND TOPOGRAPHIC FEATURES SHOWN HEREON ARE BASED ON A GROUND SURVEY. THE CONTOUR INTERVAL IS 1'. BENCHMARK CDOT CONTROL POINT 555 AS DESCRIBED IN RIGHT OF WAY PLANS DATED JANUARY 7, 2022 AT RECEPTION NO. 10005780, BEING A 1-5/16" YELLOW PLASTIC CAP ON 8" REBAR STAMPED "CONTROL POINT" LOCATED AT THE NORTHWEST CORNER OF THE INTERSECTION BETWEEN ALLEN STREET AND FOUNDERS PARKWAY.
ELEVATION: 6286.45', NAVD88 DATUM.

MODIFIED



Zeller - Pennock, Inc.
2727 Bryant Street
Suite 600
Denver, CO 80211

303.455.3322 T
303.455.3708 F
WWW.ZELLERPENNOCK.COM



US BANK
CASTLE ROCK BRANCH

825 MALETA LANE

ISSUE:
SUBMITTAL 2 3-8-13
SUBMITTAL 3 5-23-13
CONST. DOC. 6-11-13
SUBMITTAL 4 6-20-13

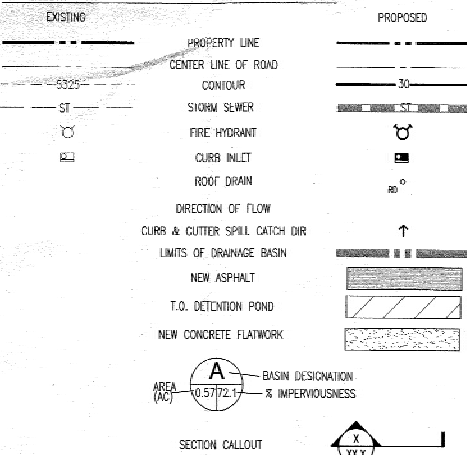
JOB NUMBER:
210-165
SHEET TITLE:
DRAINAGE PLAN

C1.4

WATER QUALITY AND DETENTION					
	VOLUME REQUIRED		VOLUME PROVIDED		RELEASE RATE (CFS)
	CUBIC FT	ACRE-FT	CUBIC FT	ACRE-FT	
FOREBAY	NA	NA	NA	NA	NA
MICROPOOL	NA	NA	NA	NA	NA
WATER QUALITY	1040	0.024	1040	0.024	88.32
10 YEAR	NA	NA	NA	NA	NA
10 YEAR+WQ	NA	NA	NA	NA	NA
100 YEAR	NA	NA	NA	NA	NA
100 YEAR+WQ	NA	NA	NA	NA	NA

SUMMARY RUNOFF TABLE					
BASIN	DESCRIPTION	DESIGN POINT	CONTRIBUTING AREA (ACRES)	RUNOFF 5 YR. (C.F.S.)	PEAK RUNOFF 100 YR. (C.F.S.)
A	NORTH BASIN	A	0.848	1.88	4.14
B	SOUTH BASIN	B	0.312	0.64	1.46
C	EMERGENCY OVERFLOW (A+B)	C	1.160	2.52	5.61
DRN	DIRECT RUNOFF NORTH	DRN	0.173	0.45	1.00
DRE	DIRECT RUNOFF EAST	DRE	0.138	0.12	0.63
DRS	DIRECT RUNOFF SOUTH	DRS	0.300	0.33	1.38
DRW	DIRECT RUNOFF WEST	DRW	0.126	0.24	0.66

LEGEND



PROFESSIONAL ENGINEER'S STATEMENT
I HEREBY AFFIRM THAT THESE FINAL CONSTRUCTION PLANS WERE PREPARED UNDER MY DIRECT SUPERVISION, IN ACCORDANCE WITH ALL APPLICABLE TOWN OF CASTLE ROCK AND STATE OF COLORADO STANDARDS AND STATUTES, RESPECTIVELY, AND THAT I AM FULLY RESPONSIBLE FOR ALL DESIGN AND REVISIONS RELATIVE TO SAID PLANS.

WILLIAM J. LOGAN, P.E.

DATE:

TOWN OF CASTLE ROCK APPROVALS
THESE PLANS ARE HEREBY APPROVED FOR ONE YEAR FROM DATE OF DEVELOPMENT SERVICES DIRECTOR APPROVAL

RECOMMEND APPROVAL BY:

ENGINEERING DIVISION

DATE

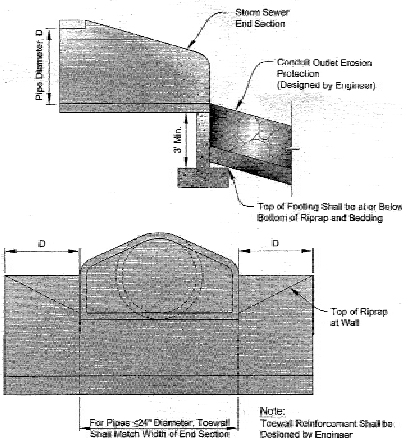
APPROVED BY:

DEVELOPMENT SERVICES DIRECTOR

DATE

Chapter 10. Conduit Outlet Structures

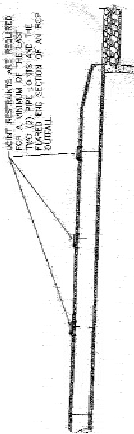
FIGURE 10-1
CONCEPTUAL TOEWALL DETAIL



Town of Castle Rock Storm Drainage Design and Technical Criteria Manual Page 10-6

Chapter 10. Conduit Outlet Structures

FIGURE 10-2
PIPE OUTFALL JOINT RESTRAINT REQUIREMENTS

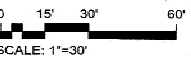


Town of Castle Rock Storm Drainage Design and Technical Criteria Manual Page 10-6



DRAINAGE PLAN

NOTES:
1. BENCHMARK DATUM DERIVED FROM NGS DATA SHEET FOR POINT IDENTIFICATION NUMBER 880201, DESIGNATION 4355, ELEVATION 6050.74 FEET NAVD83. STATION FALLS IN THE TOP OF A HEADWALL OF A CONCRETE CULVERT THAT IS CROSSED OVER BY THE U.P.R.R. STATION IS A BRASS DISC FLUSH WITH THE SURFACE OF THE CONCRETE.
2. AND 6200' TO ELEVATIONS TO BEING AT DRAIN.
3. ALL POINT ELEVATIONS ARE TO FLOWLINE, UNLESS NOTED OTHERWISE.



DRAWING: 210-165-DR-01-A.DWG
SCALE: 1"=30'
DATE: 6/20/13

Appendix D: EXISTING STUDIES

1. Copies of MDR Drainage Map
2. Copies of MDR Hydrology
3. Copies of Pertinent Portions of US Bank Drainage Report



#824D

Dup.
Copy

TOWN OF CASTLE ROCK

METZLER RANCH

MASTER DRAINAGE STUDY

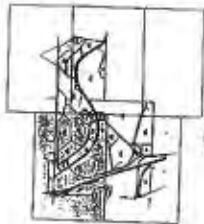
PREPARED FOR

WINTERGREEN HOMES

PROJECT NO. 950598E

FEBRUARY, 1996

REVISED January 20, 1997



KEY MAP

Scale 1" = 200 ft

SUMMARY REPORT TABLE

STATION	COMPUTED	CORRECTION	ADJUSTED	REMARKS	DATE	BY
1+00	14.1	0.0	14.1	START OF GRADE	1/18	JLB
1+20	14.1	0.0	14.1			
1+40	14.1	0.0	14.1			
1+60	14.1	0.0	14.1			
1+80	14.1	0.0	14.1			
2+00	14.1	0.0	14.1			
2+20	14.1	0.0	14.1			
2+40	14.1	0.0	14.1			
2+60	14.1	0.0	14.1			
2+80	14.1	0.0	14.1			
3+00	14.1	0.0	14.1			
3+20	14.1	0.0	14.1			
3+40	14.1	0.0	14.1			
3+60	14.1	0.0	14.1			
3+80	14.1	0.0	14.1			
4+00	14.1	0.0	14.1	END OF GRADE	1/18	JLB

NOTE: THE ABOVE TABLE IS SUBJECT TO THE 10% GRADE ADJUSTMENT

SITE



NOTES

1. THE DRAINAGE DITCH SHALL BE 10' WIDE AT THE TOP AND 6' WIDE AT THE BOTTOM. THE DITCH SHALL BE 1' DEEP AT THE TOP AND 6' DEEP AT THE BOTTOM. THE DITCH SHALL BE 1' WIDE AT THE TOP AND 6' WIDE AT THE BOTTOM. THE DITCH SHALL BE 1' DEEP AT THE TOP AND 6' DEEP AT THE BOTTOM.
2. THE DRAINAGE DITCH SHALL BE 10' WIDE AT THE TOP AND 6' WIDE AT THE BOTTOM. THE DITCH SHALL BE 1' DEEP AT THE TOP AND 6' DEEP AT THE BOTTOM. THE DITCH SHALL BE 1' WIDE AT THE TOP AND 6' WIDE AT THE BOTTOM. THE DITCH SHALL BE 1' DEEP AT THE TOP AND 6' DEEP AT THE BOTTOM.
3. THE DRAINAGE DITCH SHALL BE 10' WIDE AT THE TOP AND 6' WIDE AT THE BOTTOM. THE DITCH SHALL BE 1' DEEP AT THE TOP AND 6' DEEP AT THE BOTTOM. THE DITCH SHALL BE 1' WIDE AT THE TOP AND 6' WIDE AT THE BOTTOM. THE DITCH SHALL BE 1' DEEP AT THE TOP AND 6' DEEP AT THE BOTTOM.
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5. THE DRAINAGE DITCH SHALL BE 10' WIDE AT THE TOP AND 6' WIDE AT THE BOTTOM. THE DITCH SHALL BE 1' DEEP AT THE TOP AND 6' DEEP AT THE BOTTOM. THE DITCH SHALL BE 1' WIDE AT THE TOP AND 6' WIDE AT THE BOTTOM. THE DITCH SHALL BE 1' DEEP AT THE TOP AND 6' DEEP AT THE BOTTOM.
6. THE DRAINAGE DITCH SHALL BE 10' WIDE AT THE TOP AND 6' WIDE AT THE BOTTOM. THE DITCH SHALL BE 1' DEEP AT THE TOP AND 6' DEEP AT THE BOTTOM. THE DITCH SHALL BE 1' WIDE AT THE TOP AND 6' WIDE AT THE BOTTOM. THE DITCH SHALL BE 1' DEEP AT THE TOP AND 6' DEEP AT THE BOTTOM.
7. THE DRAINAGE DITCH SHALL BE 10' WIDE AT THE TOP AND 6' WIDE AT THE BOTTOM. THE DITCH SHALL BE 1' DEEP AT THE TOP AND 6' DEEP AT THE BOTTOM. THE DITCH SHALL BE 1' WIDE AT THE TOP AND 6' WIDE AT THE BOTTOM. THE DITCH SHALL BE 1' DEEP AT THE TOP AND 6' DEEP AT THE BOTTOM.
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9. THE DRAINAGE DITCH SHALL BE 10' WIDE AT THE TOP AND 6' WIDE AT THE BOTTOM. THE DITCH SHALL BE 1' DEEP AT THE TOP AND 6' DEEP AT THE BOTTOM. THE DITCH SHALL BE 1' WIDE AT THE TOP AND 6' WIDE AT THE BOTTOM. THE DITCH SHALL BE 1' DEEP AT THE TOP AND 6' DEEP AT THE BOTTOM.
10. THE DRAINAGE DITCH SHALL BE 10' WIDE AT THE TOP AND 6' WIDE AT THE BOTTOM. THE DITCH SHALL BE 1' DEEP AT THE TOP AND 6' DEEP AT THE BOTTOM. THE DITCH SHALL BE 1' WIDE AT THE TOP AND 6' WIDE AT THE BOTTOM. THE DITCH SHALL BE 1' DEEP AT THE TOP AND 6' DEEP AT THE BOTTOM.



APPROVED FOR THE YEAR 1961 THE DATE

DATE

DATE

J. L. B. (JLB)
 Professional Engineer
 License No. 10000
 State of Texas
 EXPIRATION DATE 12/31/61
 PROJECT NO. 10000
 PROJECT NAME
 PROJECT LOCATION
 PROJECT OWNER
 PROJECT DATE
 PROJECT SCALE
 PROJECT SHEET NO. 1 OF 1

BASIN 1

Basin 1, in the center, is the main basin on the site and will be developed with a combination of residential, commercial and open space. The acreage included within this basin is 1,047 acres, 539.4 on-site and 507.6 off-site. There are 7 on-site sub-basins and 11 off-site sub-basins. The elevation differential within this basin is from the high of 6600 feet to the low of 6100 feet. All storm runoff entering the site from off-site sub-basins, will be allowed to pass through the site undetained. See Figure 2 for a flowchart graphic for Basin 1.

Basin 1 contains six different types of soil as classified by the U.S. Department of Agriculture, Soil Conservation Service, "Soil Survey of Castle Rock, Colorado", issued in November, 1974. These soil types and their percentages of coverage are as follows:

SOIL TYPE SYMBOL	DESCRIPTION	% COVERAGE (acre)	SOIL TYPE
KtE	Kutch-Sandy Loam 5% to 10% slopes	72.2%	D
KwF	Kutch-Newland- Stapleton Complex 8% to 40% slopes	16.51%	50%D 50%B
BrB	Bresser Sandy Loam 1% to 3% slopes	3.74%	B
Bo	Blakeland Orsa Association	2.59%	A
Sv	Stony Steep Land	3.95%	D
Fu	Fondis-Kutch Association	1%	50%C 50%D

As shown in the table above, Basin 1 is predominantly soil type D. (i.e. Assign A=1, B=2, C=3, D=4 then

$$SE = (0.7221)(4) + (0.1651)(0.5) + (0.1651)(0.5)(2) + (0.0374)(2) + (0.0259)(1) + (0.0395)(4) + (0.01)(0.5)(3) + (0.01)(0.5)(4) = 3.68$$
 which is approximately 4 therefore use type D.

Design Precipitation information was obtained from the NOAA Atlas and that issued in the Douglas County Criteria mention previously. This data can be viewed in Appendix A at the end of this report.

Sub-basin and drainage routing topographical information were obtained from Topographical Maps generated from Aerial Photography of the area dated: 1/12/96. These topographical maps have been developed at 2-foot contour intervals. Sub-basin areas in the Metzler Ranch range in size from about 0.4 acre to 325 acres. The boundaries for these sub-basins are defined by significant stream junctions, road ways, major topographical breaks, detention facilities and in the case of the transition from off-site to on-site, some of the property boundaries have been used for off-site sub-basin definition only.

Soil Characteristics were identified for the study area using USDA Soil Survey identification maps (USDA SCS, 1974) Soil Series information are shown on the included Soils Map. Hydrologic parameters of the soil include infiltration rates and decay coefficients.

Landuse within the Metzler Ranch development includes parks, open space, residential and commercial development. The proposed landuses are shown on the included Drainage Plans (sheets 1 thru 5). The Land use parameter sets the percent impervious for a basin. Table 2-2 summarizes the percent impervious used for each sub-basin within the model.

Stormwater conveyance within and downstream of Metzler Ranch is controlled by a number of existing culverts within and downstream of the site. The downstream culverts are located under I-25. The location of these culverts are shown on sheets 1 thru 6 of 6, included at the back of this report.

The capacity of the culverts below I-25 were identified using the Federal Highway Administration nomographs, assuming inlet control (included at the beginning of Appendix D). The capacity was identified for the headwater to diameter ratio as it exists in the field.

TABLE 2-2

PERCENT IMPERVIOUS FOR SUB-BASINS

BASIN NAME	PERCENT IMPERVIOUS
1-A	60%
1-B	70 %
1-C	40 %
1-D	40 %
1-E	40 %
1-F	60%
1-G	60%
2-H	60%
2-L	60%
3-J	40 %
3-K	40 %
2	60%
4	60%

HISTORICAL LAND USE

The computer output for the historic land use storm water discharge is listed in Appendix B. Table 2-1 summarizes the discharge identified at these points. The maximum allowable discharge is as listed above, based on the acreage within the basin. With 0.3 cfs per acre for the 10 year event and 1.0 cfs per acre for the 100 year storm (for Basins 1, the northern portion of 2, 3 and 4 only, Basin 2 southern portion is a different soil type.

PHASE III DRAINAGE REPORT
FOR
U.S. BANK, CASTLE ROCK

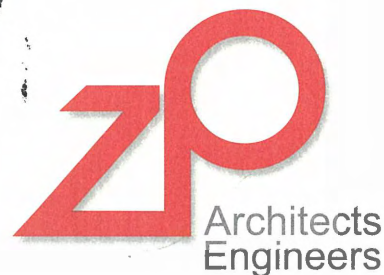
Founders Pkwy & E. Allen St.
Metzler Ranch Filing No. 3,
Amendment 2, Lot 4-c
Castle Rock , Colorado
March 25, 2011
Revised: March 8, 2013
ZP#: Z10-165

Prepared for: U.S. Bank
633 W. Fifth St., 25th Floor
Los Angeles, CA 90071
(213) 615-6407
(213) 615-6595 fax

Prepared by: Zeiler-Pennock, Inc.
2727 Bryant Street, Suite 600
Denver, CO 80211
(303) 455-3322

William J. Logan, P.E.
Project Manager

Marshall L. Newlin, E.I.
Project Engineer



II.A.3. Currently a 36-inch storm sewer line runs westerly along the south property line and collects surface runoff at the intersection of Founders Parkway and E. Allen St. The impact of off and onsite flows for basin 1G have been accounted for and per the master study provides a regional detention pond and limits the basins average impervious ratio to 60 percent. The proposed design, including an approximation of the future development to the north of the site, has an average imperviousness of 58.8 percent, which complies with the limitations set forth in the master drainage study.

II.B. Minor Drainage Basin

II.B.1. The current condition of the site is isolated from the offsite flows that define Basin 1G of the master study. Runoff within Malta Lane drains west and around the site. Runoff in East Allen drains southerly and is either collected in storm inlets at the intersection or collected in Founders Parkway where drainage flows westerly to storm inlets. Runoff from the west lot drains to the south and west and will not contribute to the site runoff. Runoff from the site primarily surface drains from north to the south into Founders Parkway. The site itself is divided into six drainage basins which identify internal and direct runoff drainage patterns.

II.B.2 The proposed land use is to develop the south end of the lot for a commercial bank building with room for a future building to the north while limiting the sites average impervious ratio to 60% per the master study. The proposed design includes the future development of the northern area of the lot. Off-site flow is separated by curb and gutters and will not contribute to the on-site runoff.

TABLE II-B. DRAINAGE BASINS AND SUB-BASINS								
Major Drainage Basin	1-G							
Minor Drainage Basin	Location	Existing Imperviousness (%)	Proposed Imperviousness (%)	Area, acres	Design Point	Runoff Q, cfs (5 yr)	Runoff Q, cfs (100 yr)	Conveyance Element Type at DP
A	Onsite	0.0	77.1	0.848	A	1.88	4.14	Inlet
B	Onsite	0.0	72.9	0.312	B	0.64	1.46	Curb Cut
C	Onsite	0.0	75.9	1.160	C	2.52	5.61	PLD
DRN	Onsite	74.4	70.5	0.173	DRN	0.43	1.01	Curb Flow Line
DRE	Onsite	5.4	5.4	0.138	DRE	0.12	0.63	Sheet Flow
DRS	Onsite	13.7	15.3	0.300	DRS	0.33	1.38	Curb Flow Line
DRW	Onsite	38.8	47.9	0.126	DRW	0.24	0.66	Curb Flow Line
TOTAL		11.6	58.8	1.896				

ZP Job#: Z10-165

% Imperviousness and Runoff Coefficients

Project Name: US Bank Castle Rock

Basin Surface Imperviousness:

Area	% Imper.
Roofs	90
Hard	96
Gravel (Packed)	40
Landscape	0

Predevelopment NRCS Sols Group:

C A, B, C or D

Basin	Description	Total Area (sq.ft.)	Roof Area (sq.ft.)	Hard Srfcs. Area (sq.ft.)	Gravel Area (sq.ft.)	Landscape Area (sq.ft.)	Average Imper. (%)	Runoff Coefficients			Total Area (acre)	Basin
								C _s	C ₁₀	C ₁₀₀		
A	North Basin	36937	6074	23956	0	6907	77.1	0.60	0.63	0.72	0.848	A
B	South Basin	13574	2168	8210	150	3046	72.9	0.56	0.60	0.69	0.312	B
	PLD Basin	50511	8242	32166	150	9953	75.9	0.58	0.62	0.71	1.160	
DRN	Direct Runoff North	7530	0	5531	0	1999	70.5	0.54	0.58	0.68	0.173	DRN
DRE	Direct Runoff East	6021	0	336	0	5685	5.4	0.18	0.28	0.52	0.138	DRE
DRS	Direct Runoff South	13079	0	1863	547	10669	15.3	0.24	0.33	0.54	0.300	DRS
DRW	Direct Runoff West	5468	0	2726	0	2742	47.9	0.39	0.45	0.60	0.126	DRW
	Lot 4-C Average	82609	8242	42622	697	31048	58.8	0.45	0.50	0.63	1.896	

STANDARD FORM SF-2

TIME TO CONCENTRATION

SUBDIVISION _ Metzler Ranch Filing No. 3

CALCULATED BY _____ MLN

DATE 3/8/2013

[illegible]

STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

STORM DRAINAGE SYSTEM DESIGN (RATIONAL METHOD PROCEDURE)

CHECKED BY: W. Logan

DESIGN STORM: 5 Year

[illegible]

DESIGN STORM: 100 Year

[illegible]

Design Procedure Form: Porous Landscape Detention (PLD)

Designer: W. Logan
 Company: Zeller-Pennock, Inc.
 Date: March 13, 2013
 Project: US Bank Castle Rock
 Location: Foundations Pkwy and E. Allen St.

1. Basin Storage Volume
 ($I_a = 100\%$ if all paved and roofed areas u/s of PLD)
 A) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)
 B) Contributing Watershed Area including the PLD (Area)
 C) Water Quality Capture Volume (WQCV)
 ($WQCV = 0.8 * (0.91 * I^2 - 1.19 * I^3 + 0.78 * I)$)
 D) Design Volume: $Vol_{PLD} = (WQCV / 12) * Area$

$$I_a = \frac{75.90}{0.78} \%$$

$$Area = 50,511 \text{ square feet}$$

$$WQCV = 0.24 \text{ watershed inches}$$

$$Vol = 1.025 \text{ cubic feet}$$

Combined Impervious of contributing area:

A-1 (0.42 Acres x 80.1% impervious)

C-1 (0.04 Acres x 5% impervious)

Gives I_a of 0.74 - A lower impervious

percentage than the 0.76 used in original calculations

No increase to previously calculated area = Lower WQCV and Volume

Required

2. PLD Surface Area (A_{PLD}) and Average Depth (d_{av})
 (from 1024.96 square feet to 2049.92 square feet)
 ($d_{av} = (Vol / A_{PLD})$, Min=0.5', Max=1.0')

$$A_{PLD} = 1,274 \text{ square feet}$$

$$d_{av} = 0.80 \text{ feet}$$

3. Draining of PLD (Check A, or B, or C, answer D)
 Based on answers to 3A through 3D, check the appropriate method

- A) Check box if subgrade is heavy or expansive clay ☒
 B) Check box if subgrade is silty or clayey sand ☐
 C) Check box if subgrade is well-draining soil ☐
 D) Check box if underdrains are not desirable or if underdrains are not feasible at this site. ☐
 E) Does tributary catchment contain land uses that may have petroleum products, greases, or other chemicals present, such as gas station, hardware store, restaurant, etc.? ☐ yes ☒ no

Intiltration to Subgrade with Permeable Membrane: 3(C) checked and 3(E) = no

☒ Underdrain with Impermeable Liner: 3(A) checked or 3(E) = yes

Underdrain with Woven Geotextile Fabric (See note 1): 3(B) checked and 3(E) = no

16-Mil. Impermeable Membrane with No Underdrain: 3(D) checked - Evapotranspiration only

Other: _____

4. Sand/Peat Mix and Gravel Subbase (See Figure PLD-1)

- A) Heavy or Expansive Clay (NRCS Group D Soils) Present; Perforated HDPE Underdrain Used.
 B) Silty or Clayey Sand (NRCS Group C Soils) Present; Perforated HDPE Underdrain Used.
 C) No Potential For Contamination And Well-Draining (NRCS Group A or B Soils) Are Present; Underdrains Eliminated.
 D) Underdrains Are Not Desirable Or Are Not Feasible At This Site.
 E) Other: _____

☒ 18" Minimum Depth Sand-Peat Mix with 8" Gravel Layer, 16-Mil. Impermeable Liner and a 3" to 4" Perforated HDPE Underdrain.

18" Minimum Depth Sand-Peat Mix with 8" Gravel Layer and a 3" to 4" Perforated HDPE Underdrain w/ Non-Woven Permeable Membrane.

16" Minimum Depth Sand-Peat Mix with Non-Woven Permeable Membrane and No Underdrain (Direct Infiltration).

16" Minimum Depth Sand-Peat Mix with An Additional 18" Minimum Layer Sand-Peat Mix or Sand-Class 'A' Compost Bottom Layer (Total Sand-Peat Depth of 36"). 16-Mil. Impermeable Liner Used.

Other: _____

Notes: 1) Woven geotextile fabric shall meet ASTM D4751 - AOS U.S. Std. Sieve #50 to #70, ASTM D4633 min. trapezoidal tear strength 100 x 60 lbs, min. CQE specified open area of 4%.

2) It is critical that vegetation planting be in accordance with USDCM V3 guidelines for PLD's

EXCESS URBAN RUNOFF CONTROL (FULL-SPECTRUM) DETENTION SIZING

Project: **US Bank Castle Rock**
 Basin ID: _____

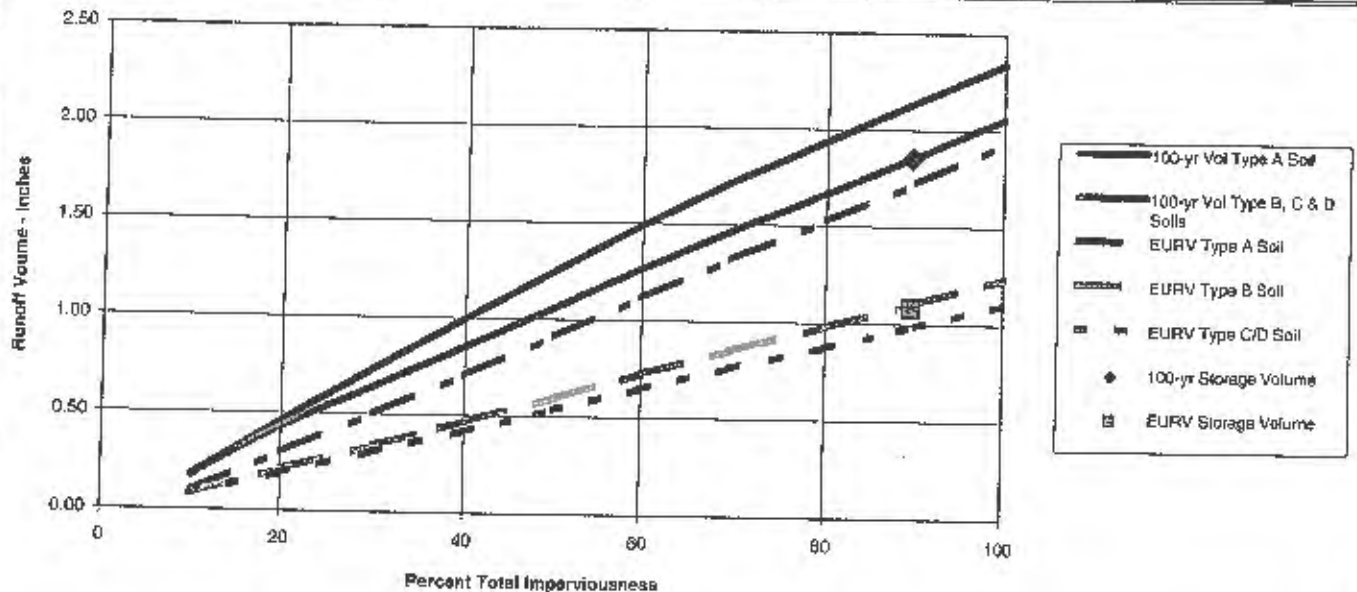
* User input data
 shown in blue.

Area of Watershed (acres)	1.08	
Subwatershed Imperviousness	89.4%	
Level of Minimizing Directly Connected Impervious Area (MDCIA)	0	0 ▼
Effective Imperviousness ¹	89.4%	
Hydrologic Soil Type	Percentage of Area	Area (acres)
Type A	0.0%	0.0
Type B	0.0%	0.0
Type C or D	100.0%	1.1

Recommended Horton's Equation Parameters for CUHP		
Infiltration (inches per hour)		Decay Coefficient- α
Initial- f_i	Final- f_o	
3	0.5	0.0018

Detention Volumes ^{2,5}		Maximum Allowable Release Rate, cfs ³
(watershed inches)	(acre-feet)	
1.08	0.0978	Design Outlet to Empty EURV In 72 Hours
1.85	0.17	1.08

Excess Urban Runoff Volume⁴
 100-year Detention Volume Including WQCV⁵



Notes:

- 1) Effective imperviousness is based on Figure ND-1 of the Urban Storm Drainage Criteria Manual (USDCM).
- 2) Results shown reflect runoff reduction from Level 1 or 2 MDCIA and are plotted at the watershed's total imperviousness value; the impact of MDCIA is reflected by the results being below the curves.
- 3) Maximum allowable release rates for 100-year event are based on Table SO-1. Outlet for the Excess Urban Runoff Volume (EURV) to be designed to empty out the EURV in 72 hours. Outlet design is similar to one for the WQCV outlet of an extended detention basin (i.e., perforated plate with a micro-pool) and extends to top of EURV water surface elevation.
- 4) EURV approximates the difference between developed and pre-developed runoff volume.
- 5) 100-yr detention volume includes EURV. No need to add more volume for WQCV or EURV.

SUMMARY RUNOFF TABLE					
BASIN	DESCRIPTION	DESIGN POINT	CONTRIBUTING AREA (ACRES)	RUNOFF 5 YR. (C.F.S.)	PEAK RUNOFF 100 YR. (C.F.S.)
A	NORTH BASIN		0.848	1.88	4.14
B	SOUTH BASIN		0.312	0.64	1.46
C	EMERGENCY OVERFLOW (A+B)		1.160	2.52	5.61
DRN	DIRECT RUNOFF NORTH		0.173	0.45	1.00
DRE	DIRECT RUNOFF EAST		0.138	0.12	0.63
DRS	DIRECT RUNOFF SOUTH		0.300	0.33	1.38
DRW	DIRECT RUNOFF WEST		0.126	0.24	0.66

EXISTING

PROPOSED

PROPERTY LINE

CENTER LINE OF ROAD

COURTLINE

STORM SEWER

FIRE HYDRANT

CURB INLET

ROOF DRAIN

DIRECTION OF FLOW

CURB & GUTTER SPILL CATCH DIR

LIMITS OF DRAINAGE BASIN

NEW ASPHALT

T.O. DETENTION POND

NEW CONCRETE FLATWORK

AREA (AC)

BASIN DESIGNATION

% IMPERVIOUSNESS

SECTION CALLOUT

I HEREBY AFFIRM THAT THESE FINAL CONSTRUCTION PLANS WERE PREPARED UNDER MY DIRECT SUPERVISION, IN ACCORDANCE WITH ALL APPLICABLE TOWN OF CASTLE ROCK AND STATE OF COLORADO STANDARDS AND STATUTES, RESPECTIVELY; AND THAT I AM FULLY RESPONSIBLE FOR ALL DESIGN AND REVISIONS RELATIVE TO SAID PLANS.

DATE: _____

THESE PLANS ARE HEREBY APPROVED FOR ONE YEAR FROM
DATE OF DEVELOPMENT SERVICES DIRECTOR APPROVAL.

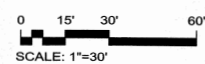
DATE _____

DATE _____



NOTES:

1. BENCHMARK DATUM DERIVED FROM NGS DATA SHEET FOR POINT IDENTIFICATION NUMBER K02021, DESIGNATION A355. ELEVATION 6050.74 FEET NAVD88. STATION FALLS IN THE TOP OF A HEADWALL OF A CONCRETE CULVERT THAT IS CROSSED OVER BY THE U.P.R.R. STATION IS A BRASS DISC FLUSH WITH THE SURFACE OF THE CONCRETE.
2. ADD 6200' TO ELEVATIONS TO ARRIVE AT DATUM.
3. ALL POINT ELEVATIONS ARE TO FLOWLINE, U.N.O.



The image contains two technical drawings. The top drawing is a side elevation of a storm sewer end section. It shows a pipe with diameter 'D' entering a structure. A label 'Storm Sewer End Section' points to the top of the structure. Another label 'Conduit Outlet Erosion Protection (Designed by Engineer)' points to a sloped section of the structure. A dimension '3' Min.' is shown for a vertical section. The bottom drawing is a cross-section of a pipe with diameter 'D' inside a concrete wall. The wall has a thickness 'D' on each side. A label 'Top of Riprap at Wall' points to the top of the wall structure. Below the drawings, there is a note: 'Note: Toward Reinforcement Shall be Designed by Engineer'.

Storm Sewer End Section

Conduit Outlet Erosion Protection (Designed by Engineer)

3' Min.

Top of Footing Shall be at or Below Bottom of Riprap and Bedding

Top of Riprap at Wall

Note:
Toward Reinforcement Shall be Designed by Engineer

A technical diagram showing a cross-section of a bridge structure. It includes a horizontal beam representing the stiffener, with a vertical line indicating the flange end of an RSP outfall. A dimension line with arrows indicates the required minimum length of the first stiffener from this point. The diagram is labeled with 'JOINT RESTRAINTS ARE REQUIRED FOR A MINIMUM OF THE FIRST STIFFENER FROM THE FLANGE END SECTION OF AN RSP OUTFALL'.

Town of Castle Rock Storm Drainage Design and Technical Criteria Manual Page 10-6