DRAINAGE LETTER
Cascade Subdivision Filing No. 1,

IN THE CITY OF COLORADO SPRINGS, COUNTY OF EL PASO, STATE OF COLORADO
820 Rancho Santa Fe Point

January 18, 2022

Revised
November 16, 2023

Prepared for
Praveen Maheshwari
6438 Farthing Drive
Colorado Springs, CO 80906
(405) 406-2207

Prepared by:
Oliver E. Watts, Consulting Engineer, Inc.
Colorado Springs, Colorado

OLIVER E. WATTS, PE-LS
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Celebrating over 44 years in business

November 16, 2023

City Engineering
Development Review Division
30 South Nevada Ave
Suite 402
Colorado Springs, CO 80903

ATTN: *Sara Rivera*

SUBJECT: Drainage Letter, Cascade Subdivision, Filing No. 1

Ms Rivera,

Transmitted herewith for your review and approval is the drainage letter for Cascade Subdivision, Filing No. 1. It has been revised per the reviews by SWENT

The proposed development will follow existing drainage patterns. Please contact our office if we may provide any further information.

Oliver E. Watts, Consulting Engineer, Inc.

BY: ________________________________
Oliver E. Watts, President

Encl:
- Drainage Letter 5 pages
- Vicinity Map
- FIRM Panel
- Computations, 2 sheets
- UD Sewer Computations, 5 and 100- year
- Soils Map and Interpretation Sheets from Cascade Subdivision Filing No. 1, 3 pages
- Back up data 6 pages
- Existing Conditions Drainage Map Cascade Subdivision Filing No. 1, 11”x17”
- Drainage Map Cascade Subdivision Filing No. 1
- Drainage Plan, Dwg 21-5647-05

1. ENGINEER'S STATEMENT:

This report and plan for the drainage design of Cascade Subdivision Filing No 1 was prepared by me (or under my direct supervision) and is correct to the best of my knowledge and belief. Said drainage report and plan has been prepared in accordance with the City of Colorado Springs Drainage Criteria Manual and is in conformity with the master plan of the drainage basin. I understand that the City of Colorado Springs does not and will not assume liability for drainage facilities designed by others. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

Oliver E. Watts, Consulting Engineer, Inc.

OLIVER E. WATTS REGISTERED 9853 P. E. & L. S. STATE OF COLORADO

1/16/24

Oliver E. Watts Colo. PE-LS No. 9853 date

2. DEVELOPER'S STATEMENT:

Praveen Maheshwari hereby certifies that the drainage facilities for Cascade Subdivision Filing No 1 shall be constructed according to the design presented in this report. I understand that the City of Colorado Springs does not and will not assume liability for the drainage facilities designed and / or certified by my engineer and that are submitted to the City of Colorado Springs pursuant to section 7.7.906 of the City Code; and cannot, on behalf of Cascade Subdivision Filing No 1, guarantee that final drainage design review will absolve Praveen Maheshwari and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the final plat does not imply approval of my engineer's drainage design

By: 01/16/2024

Praveen Maheshwari, owner date
6438 Farthing Drive
Colorado Springs, CO 80906
(405) 406-2207

3. CITY OF COLORADO SPRINGS STATEMENT:

Filed in accordance with Section 7.7.906 of the Code of the City of Colorado Springs, 2001, as amended.

02/20/2024

for City Engineer Dana Davison date

Conditions:

4. LOCATION AND DESCRIPTION:

Cascade Subdivision No 1 is a two-lot, subdivision; one single family, one multifamily (townhome). The site was subdivided by Barron Land Surveying 8-20-18. The drainage report for Cascade Subdivision No 1 was prepared by Catamount Engineering, David Mijares, PE 40510; City approved 7-2-18. The site is located in the in the South Half of Section 9, Township 14 South, Range 66 West of the 6th P.M., in the City of Colorado Springs, County of El Paso, State of Colorado. We proposed to construct a multi- family townhome on lot 1. There will be no change to the single family home / garage and concrete driveway on lot 2. The 0.57 acre site is zoned R-4. It is located at 2610 East Dale (lot 2) and 820, 841 and 860 Rancho Santa Fe (lot 1). It is on the north side of Dale, west of Yuma. The Assessor's Parcel Numbers are 6409402140 and 6409402139. It is part of the Shooks Run Drainage Basin.

We propose to slightly modify the site by constructing a slightly smaller 4-plex on the north end of Lot 1, and another 4-plex along the east site, and changing the parking (on lot 1). Lot 1 Unit 1 was removed and 4 parking spaces were added to existing parking for a new total of 8 parking spaces. See the enclosed drainage plan for details. A total of 20466 square feet will be disturbed by this amendment.

The lot falls roughly five feet' from the north to the south toward Dale at an average grade of just over 1%. Roughly 75% of the site is covered with vegetation to include pine trees, scrub oak, buck brush and native grasses. The majority of the vegetation is on (undeveloped) Lot 1. Lot 2 is landscaped outside the dwelling and driveway

Surrounding properties are as follows;
Portions of Lots 3 and 4, Block C, East Hills Subdivision lie to the northwest, west and southeast of the site. Lot 1, Amended Silvercrest Subdivision lies to the northeast. All are single family lots. Lots 1, 2, 14, 15 and 16 Little Village Subdivision lies to the east. It is a multi-family development. To the south is East Dale Street.

All utility mains are in place to service the site.

5. DRAINAGE CRITERIA AND SOILS CONDITIONS:

The method used for all computations is that specified in the City of Colorado Springs Drainage Criteria Manual, using the rational method for areas of the size of the subdivision and the SCS method for the review of the major basin involved. All computations are enclosed for reference and review.

The local USDA/SCS office has mapped the soils in the subdivision. A soils map and interpretation sheet are enclosed for reference in the copy of the City approved drainage report for Cascade Subdivision No 1. All soils in this area are Blakeland loamy sand, of hydrologic group "A" within the major basin.

6. DESCRIPTION OF RUNOFF:

Per the City approved drainage report for Cascade Subdivision Filing No. 1:

EXISTING DRAINAGE BASINS

The parcel exists in an older neighborhood originally platted as Lot 4 Block C, East Hills prior to establishment of current drainage criteria. The parcel was studied in the Shooks Run Drainage

Basin Planning Study and identified as a portion of Basin 0-1. The portion of Basin 0-1 tributary flows in a southeasterly direction towards the subject property and the adjacent westerly parcel. The upstream tributary area consists of residential single family and duplexdevelopment. The portion of Basin 0-1 affecting the parcel is tributary to the inlets and storm system within East Dale Street

Existing Basin OS-1 contains 3.67 acres of residential development generating an approximate runoff of Q2=4.4 cfs, Q5=6.l cfs, Q10=7.7 cfs, Q25=9.7 cfs, Q50=l 1.6 cfs, and Q100=13.4 cfs. Runoff enters the north side of the subject property and does not appear to have a viable outfall.

Existing Basin OS-2 consisting of the adjacent (westerly) 0.13 acres of undeveloped residential lot is tributary to the westerly limits of the subject parcel. Basin OS-2 generates anticipated runoff of Q2=0.0 cfs, Q5=0.0 cfs, Q10=0.I cfs, Q25=0.2 cfs, Q50=0.2 cfs, and Q100=0.3 cfs. Runoff from Basin OS-2 is conveyed south along the lot line to East Dale Street Right of Way.

Existing Basin OS-3 consists of that portion of the adjacent townhome development tributary tothe easterly limits of the subject parcel and not collected on-site in the existing inlet and storm drainage system. Basin OS-3 containing 0.09 acres generates anticipated runoff of Q2=0.l cfs, Q5=0.2 cfs, Q10=0.2 cfs, Q25=0.3 cfs, Q50=0.3 cfs, and Q100=0.4 cfs. Runoff is conveyed to the rear of the subject parcel and does not appear to have a viable outfall.

Existing Basin A (0.09 Acres, Q2=0.2 cfs, Q5=0.2 cfs, Q10=0.3 cfs, Q25=0.3 cfs, Q50=0.4 cfs, and Q100=0.5 cfs) consists of the southerly portion of the subject parcel containing an existing residential lot and driveway improvements. Existing Basin A is tributary to East Dale Street Right of Way.

Existing Basin B (0.47 Acres, Q2 0.0 cfs, Q5 0.2 cfs, Q10=0.4 cfs, Q25=0.6 cfs, Q50-=0.8 cfs, and Q100= 1.1 cfs) is the northern portion of the subject parcel that is currently undeveloped with the exception of portions of abandoned foundations. Runoff generated within existing basin B is directed to the northern portion of the lot and does not appear to have a viable outfall

DEVELOPED DRAINAGE BASINS

The intent of the proposed development is to follow closely to historic drainage patterns and resolve the current sump condition in the northerly portion of the lot while satisfying current City of Colorado Springs development criteria. Tributary off-site flows and on-site flows, excepting basin A, will be collected in a private drainage system and conveyed to the existing public 30" RCP storm drain within Dale Street. The total lot area is 0.57 acres. The development is not part of a larger common plan of development and total disturbed area proposed with site development is less than I acre. Water quality treatment and full spectrum detention are not required per criteria.

Development of the site is currently proposed to consist of eight townhome units on proposed lot 2 with the existing single-family residence to remain on proposed lot I.

Basin A (0.09 Acres, Q2=0.2 cfs, Q5=0.2 cfs, Q10=0.3 cfs, Q25=0.3 cfs, Q50o=0.4 cfs, and Q100 =0.5 cfs) consists of the southerly portion of the subject parcel containing an existing residential lot and driveway improvements. Basin A is tributary to East Dale Street Right of Way. The existing structure and landscaping will remain on lot I while the drive aisle will be reconstructedto allow for access to Lot 2. Flows generated within Basin A will be combined with flows historic flows from Basin OS-2 within the northerly curb line of Dale Street at Design Point 3 (Q2=0,1 cfs, Qs=0.2 cfs, Q10=0.3 cfs, Q25=0.4 cfs, Q50=0.5 cfs, and Q,100=0.7 cfs)

Basin B1 (0.36 Acres, Q5=1.5 cfs, and Q1oo=2.8 cfs) consists of the central portion of the proposed development and will be conveyedwithin curb sections and private 8" storm sewer and area drain system to a proposed private grated at Design Point I (0.47 Acres, Q5=-1.7 cfs, and Q1oo=3.3 cfs). Analysis of area drains and small diameter storm systems is not included in this report.

Basin B2 (0.12 Acres, Q5=0.1 cfs, and Q100=0.2 cfs) consist of the northerly portion of the site to be conveyed directly to the proposed gratedinlet at design point 2.

Design Point 2, 4.24 acres, Q5=7.1 cfs, and Q100=15.2 cfs) is the confluence of Basin OS-I, OS-3, and B2. Flows are conveyed in a proposed private 18" HDPE storm sewer.

Combined flows from D e s i g n Point 2 of Q5=7.1 cfs, and Q100=15.2 cfs are conveyed in a proposed

private 1 8 " HDPE storm sewer to the existing public 30" RCP storm sewer within Dale Street to be connected with a proposed public Type II manhole, with minimum 5'-4" x 5'4" cast base and precast risers set on the existing storm sewer.
The design is preliminary in nature and will be followed by a final design after potholing of utilities and the existing 30" RCP storm sewer in Dale Street. If the depth at that point is not sufficient for the assumed hydraulic grade line, the storm sewers will be increased in size accordingly.
The development addresses Low Impact Development strategies primarily through the utilizationof landscaped areas where possible directing runoff from rooflines and patios through swales with minimal longitudinal grade prior to outfall to either the street system or storm sewer system.

PROPOSED REVISED DEVELOPMENT
As shown on the enclosed area drainage map, runoff from the site will outfall in the Southwest corner of the lot where it drains into Dale Street. The total runoff at this point will be 7.1 cfs / 15.2 cfs (5-year / 100- year runoffs) in the storm sewer and approximately 0.2 cfs / 0.9 cfs via surface runoff. This runoff will be carried westerly down Dale Street in the City Storm Sewer, being the outfall point of this development. The runoffs in the previous final drainage report were 6.4 cfs/14.1 cfs for the total and 0.2 cfs / 0.5 cfs for the surface runoff. The existing storm sewer in Dale Street has ample capacity for the minor increase in runoff. Conditions described in the original report have been confirmed for this report.

Enclosed are the UD Sewer computations sheets describing the storm sewer and hydraulic grade lines.

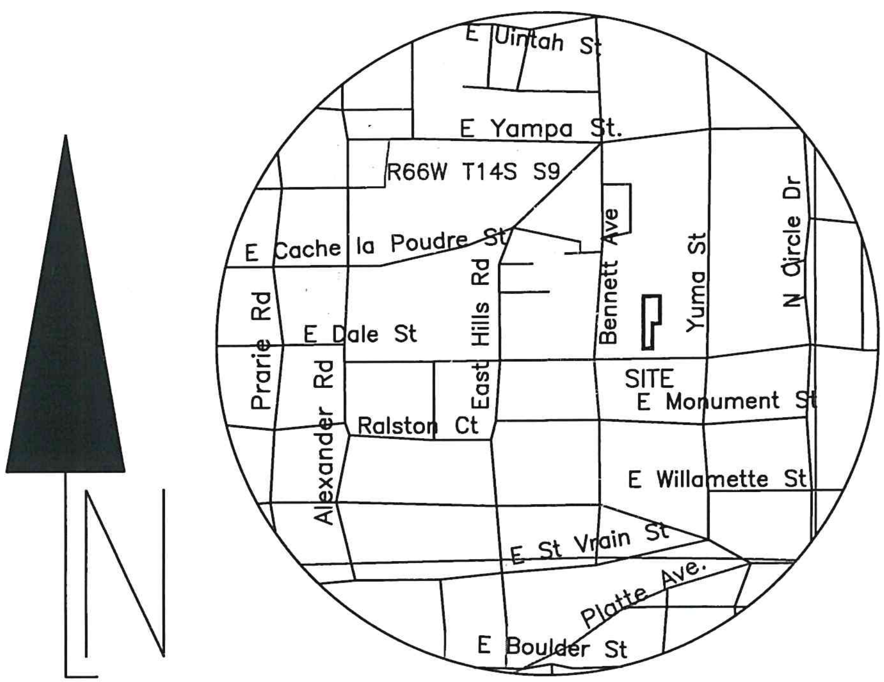
<u>4 STEP PROCESS</u>
The 4 step process is not required due to the fact the site is less than 1 acre.

7. FLOOD PLAIN STATEMENT:
This subdivision is not within the limits of a flood plain or flood hazard area, according to FEMA map panels numbers 08041C0734 G, and 08041C0732 G, both dated December 7, 2018. A copy of the FIRM panel is included in the attached, City approved drainage report for Cascade Subdivision No 1

8. FEES:
This Site is subdivided so no drainage fees are due

9. SUMMARY:
Runoff for The Cascade Subdivision Filing No. 1 will not adversely affect the surrounding and downstream developments. No storm drainage modifications or design changes are necessary as a result of this proposed development. This letter is in general conformance will all previously approved drainage reports / studies which include this site.

The drainage letter has been prepared in accordance with the current City of Colorado Springs Drainage Criteria Manuel. Supporting information, calculations and the City approved drainage report for Cascade Subdivision No 1 are included in this letter.



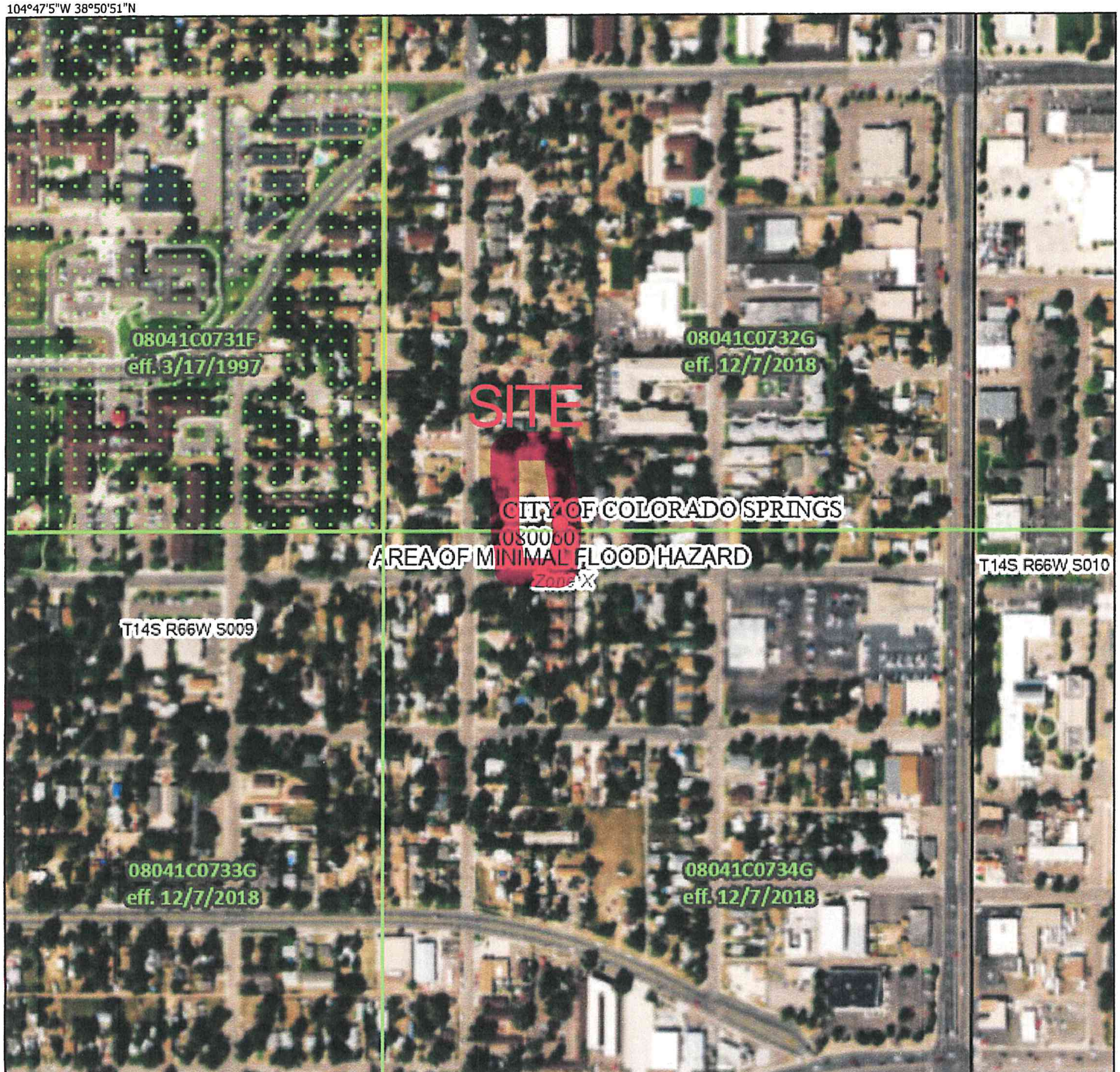
VICINITY MAP

NOT TO SCALE

National Flood Hazard Layer FIRMette

FEMA

104°47'5"W 38°50'51"N



104°46'28"W 38°50'23"N

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

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
- B 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 represen 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 7/1/2022 at 3:19 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.

MAJOR BASIN	SUB BASIN	AREA		BASIN		Tc MIN	I in./hr.		SOIL GRP	DEV. TYPE	C		FLOW 5-ry	FLOW 100-yr	RETURN PERIOD -years-	
		PLANIM READ	ACRES	LENGTH -FT.-	HEIGHT -FT.-								qp -CFS-	qp -CFS-		
Shooks Run	B2	COGO	0.025						A	BLDG	0.73	0.81			5	100
			0.073							L/S	0.08	0.35				
		TOTAL	0.098	91	1	14	3.5	5.9			0.245	0.467	0.08	0.27	5	100
	OS-1		3.67	50	2	5.3	5.1	8.7			0.45	0.59				
				+667	26	13.4										
	TOTAL	DP1	3.77				3.6	6.0			0.444	0.586	6.1	13.4	5	100
	OS-3		0.09	25	1+	6.6	4.9	8.1			0.45	0.59	0.2	0.4	5	100
	B-1		0.088			+0.6				BLDG	0.73	0.81				
			0.272	+100	2	4..3				PAV'T	0.90	0.96				
			0.021	+80	1	+18				L/S	0.08	0.35				
		TOTAL	0.381			6.1	4.9	8.3		MIX	0.800	0.892	1.5	2.8	5	100
	TOTAL	@CB	0.471	+155	V=7.41	+0.3					0.733	0.834	1.7	3.3	5	100
		DP2	4.24			13.7	3.5	5.9			0.476	0.609	7.1	15.2	5	100
	OS-2		0.136	50	1	10.3	4.0	6.6	A		0.09	0.36	0.0	0.2	5	100
	A	COGO	0.032	85	1	9.2	4.2	7.0	A	CONC	0.90	0.96				
			0.021							BLDG	0.73	0.81				
		V=0.54	0.039	+49	0.3	+1.5				L/S	0.08	0.35				
		TOTAL	0.092	+75	2	10.7	3.9	8.6		MIX	0.514	0.667	0.2	0.5	5	100
	OS-2+A		0.228		+1.1	11.4	3.8	8.4		MIX	0.261	0.484	0.2	0.9	5	100

HYDROLOGICAL COMPUTATION – BASIC DATA
PROJ: 2610 E. DALE STREET BY: O.E. WATTS
RATIONAL METHOD DATE: 2-8-22 11-16-23

OLIVER E. WATTS, CONSULTING ENGINEER, INC.
614 ELKTON DRIVE COLORADO SPRINGS, CO 80907

Curve #5

B2

$$C_5 = \frac{0.025}{0.098} \times 0.73 + \frac{0.073}{0.098} \times 0.08 = 0.245$$

$$C_{100} = \frac{0.025}{0.098} \times 0.81 + \frac{0.073}{0.098} \times 0.35 = 0.467$$

+ OS-1 (3.67 + 0.098 = 3.768)

$$C_5 \quad \frac{0.098}{3.77} \times 0.245 + \frac{3.67}{3.77} \times 0.45 = 0.444$$

$$C_{100} \quad \frac{3.67}{3.77} \times 0.59 + \frac{0.98}{3.77} \times 0.467 = 0.586$$

B1

$$C_5 \quad \frac{0.088}{0.381} \times 0.73 + \frac{0.272}{0.381} \times 0.9 + \frac{0.021}{0.381} \times 0.08 = 0.800$$

$$C_{100} \quad \frac{0.088}{0.381} \times 0.81 + \frac{0.272}{0.381} \times 0.96 + \frac{0.021}{0.381} \times 0.35 = 0.892$$

A

$$C_5 \quad \frac{0.032}{0.092} \times 0.73 + \frac{0.021}{0.092} \times 0.73 + \frac{0.039}{0.092} \times 0.35 = 0.514$$

$$C_{100} \quad \frac{0.032}{0.092} \times 0.96 + \frac{0.021}{0.092} \times 0.81 + \frac{0.039}{0.092} \times 0.35 = 0.667$$

Dp1 = B2 + OS-1 (3.67 + 0.098 = 3.77)

$$C_5 \quad \frac{0.098}{3.77} * 0.245 + \frac{3.67}{3.77} \times 0.467 = 0.444$$

$$C_{100} \quad \frac{0.098}{3.77} \times 0.467 + \frac{3.67}{3.77} \times 0.59 = 0.586$$

Dp2 = OS-3 + B1

$$C_5 \quad \frac{0.098}{0.471} \times 0.45 + \frac{0.381}{0.471} \times 0.8 = 0.733$$

$$C_{100} \quad \frac{0.09}{0.471} \times 0.59 + \frac{0.381}{0.471} \times 0.892 = 0.834$$

1-647 Cascade Sub #1 Drainage Comps OEW 12/27/22 18/2

B2 $T_T = \frac{0.395(1.1-0.245)\sqrt{91}}{(1/91)^{0.33}} = 14$

OS1 $T_T = \frac{0.395(1.1-0.45)\sqrt{50}}{(2/50)^{0.33}} = 5.3$

$V_s = C_u S_w^{0.5} = 7\left(\frac{26}{667}\right)^{1/2} = 1.4\ (1.38)$

$T_T = \frac{667}{1.38 \times 60} = 8.1\ (8.05)$

$8.1 + 5.3 = \boxed{13.4}$

OS2 $T_T = \frac{0.395(1.1-0.09)\sqrt{50}}{(1/50)^{0.33}} = 10.3\ (10.25)$

$V_T = 7\left(\frac{2}{75}\right)^{1/2} = 1.1$ $\frac{75}{1.1 \times 60} = 1.1\ (1.09)$ $\sum_{T_c} = \boxed{11.4}$

OS3 $T_T = \frac{0.395(1.1-0.45)\sqrt{25}}{(1/25)^{0.33}} = 3.7$ $\frac{145}{0.8 \times 60} = 2.9$ $2.9 + 3.7 = \boxed{6.6}$

$V_s = 7\left(\frac{2}{145}\right)^{1/2} = 0.8$

B_1 $T_T = \frac{0.395(1.1-0.8)\sqrt{100}}{(2/100)^{0.33}} = 4.3$

$V_s = 7\left(\frac{1}{80}\right)^{0.5} = 0.8$ $\frac{80}{0.8 \times 60} = 1.8$ $1.8 + 4.3 = \boxed{6.1}$

A ★ $T_T = \frac{0.395(1.1-0.514)\sqrt{85}}{(1/85)^{0.33}} = 9.2$

$Q_p = CIA$

B	5yr	$Q_p = 0.098 \times 0.245 \times 3.5 = 0.08$
	100yr	$Q_p = 0.098 \times 5.9 \times 0.261 = 0.15$
OS1	5yr	$3.67 \times 0.45 \times 3.7 = 6.1$
	100yr	$3.67 \times 0.59 \times 6.2 = 13.4$
B1	5yr	$0.381 \times 4.9 \times 0.8 = 1.5$
	100yr	$0.381 \times 8.3 \times 0.892 = 2.8$
OS3	5yr	$0.09 \times 5.2 \times 0.45 = 0.1$
	100yr	$0.09 \times 8.8 \times 0.59 = 0.4$
OS2	5yr	$0.136 \times 4.0 \times 0.09 = 0.0$
	100yr	$0.136 \times 5.6 \times 0.36 = 0.3$
★	5yr	$0.092 \times 5.2 \times 0.514 = 0.2$

STREET AND STORM SEWER CALCULATIONS

STREET	LOCATION	DISTANCE -ft.- HGL	ELEVATION & SLOPE WS OG INV	TOTAL RUNOFF -cfs- 5-yr./100-yr	STREET FLOW / CAPACITY -cfs- 5-yr./100-yr	PIPE FLOW -cfs-	TYPE PIPE, CATCH BASIN & SLOPE %
PRIVATE	DP1 3+19.96			6.0/13.4		13.4 6.0	GRATED INLET, GUTTER D=0.70’, CAP =16.2@1’
							SEE ENCLOSED INLET CAPACITY CHART
	DP2 1+43.22/ 0+00.00 “A”			1.7/3.3		3.3 1.7	GRATED INLET GUTTER D=0.29’, CAP =11.2 @ 0.50’

STREET AND STORM SEWER CALCULATIONS PROJECT: 2610 E. DALE BY: O.E. WATTS DATE: 2-8-22 11-16-23	OLIVER E. WATTS, CONSULTING ENGINEER, INC. 614 ELKTON DRIVE COLORADO SPRINGS, CO 80907	Page: 2 Of Pages: 2

STREET AND STORM SEWER CALCULATIONS

STREET	LOCATION	DISTANCE -ft.- HGL	ELEVATION & SLOPE WS OG INV	TOTAL RUNOFF -cfs- 5-yr./100-yr	STREET FLOW / CAPACITY -cfs- 5-yr./100-yr	PIPE FLOW -cfs-	TYPE PIPE, CATCH BASIN & SLOPE %
PRIVATE	DP1 3+19.96	40.20	30.92 39.00 37.43 37.76	6.0/13.4	6.0/13.4 5 yr d=0.33	13.4 6.0	GRATED INLET, D=MIN. 18" PV C hi=0.92' WS=39.92 hi[0.40' WS=39.40
		6.90	1.04%	6.0/13.4	-0-	13.4	18" HDPE S=0.96% MIN. (HGL) V=7.41 FPS
	3+13.06 45° BEND	39.17 38.71	35.98 37.43			13.4 6.0	45° BEND K=0.40 hl=0.36 5 yr hi v=5.53 hi=0.19'
		169.84	1.04%		5-yr d=0.33	13.4 6.0	18" PVC S=0.96% MIN (HGL)
	DP2 1+43.22/ 0+00.00 "A"		38.34 36.07 36.03	1.7/3.3	5-yr d=0.15	3.3 1.7	GRATED INLET, D=0.27' 12" HDPE hi=1.05' hi=0.15 ws=38.49
		143.22	1.04%	7.1/15.2	5-yr d=036	15.2 7.1	18" HDPE S=1.24% MIN (HGL) V=8.60 FPS
	DP3 0+00.00		39.89 34.18 30"=31.64				
		8.85			1.		INLET hi=0.016V2 12" HDPE S=0.69% MIN (HGL) K=0.27 hl=0.02'
	0+08.85 "A"		38.58 36.84	1.7/3.8	1.7/3.8	3.00	GRATED INLET H=0.24' TOP=38.34
PUBLIC		2.52%			CAPACITY	65.1	3O"RCP

Program: UDSEWER Math Model Interface 2.1.1.4 **Run Date:** 11/16/2023 9:17:29 AM	# UDSewer Results Summary **Project Title:** 2610 E Dale **Project Description:** 5 yr HGL

System Input Summary

Rainfall Parameters

Rainfall Return Period: 5
Rainfall Calculation Method: Formula

One Hour Depth (in):
Rainfall Constant "A": 28.5
Rainfall Constant "B": 10
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20
Maximum Rural Overland Len. (ft): 500
Maximum Urban Overland Len. (ft): 300
Used UDFCD Tc. Maximum: Yes

Sizer Constraints

Minimum Sewer Size (in): 18.00
Maximum Depth to Rise Ratio: 0.90
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 6133.64

Tailwater Elevation assumes the existing 30" pipe to be at 80% full.

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
OUTFALL 1	6139.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Manhole	6140.50	7.80	1.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45 Deg Bend	6140.00	6.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grated Inlet	6139.00	6.10	6.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
OUTFALL 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Manhole	0.00	0.00	0.00	0.00	1.70	0.00	0.00	0.00	7.80	
45 Deg Bend	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.10	
Grated Inlet	0.00	0.00	0.00	0.00	6.10	0.00	0.00	0.00	6.10	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
Manhole	143.32	6132.64	1.7	6135.07	0.011	0.00	0.25	CIRCULAR	18.00 in	18.00 in
45 Deg Bend	169.74	6135.17	1.0	6136.93	0.011	0.05	0.00	CIRCULAR	18.00 in	18.00 in

Grated Inlet	6.89	6136.93	1.0	6137.00	0.011	0.29	0.00	CIRCULAR	18.00 in	18.00 in

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	**Flow (cfs)**	**Velocity (fps)**	**Depth (in)**	**Velocity (fps)**	**Depth (in)**	**Velocity (fps)**	**Froude Number**	**Flow Condition**	**Flow (cfs)**	**Surcharged Length (ft)**	**Comment**
Manhole	16.21	9.17	12.98	5.72	8.80	9.08	2.12	Supercritical	7.80	0.00	
45 Deg Bend	12.68	7.17	11.45	5.14	8.80	7.10	1.65	Supercritical	6.10	0.00	
Grated Inlet	12.53	7.09	11.45	5.14	8.86	7.04	1.63	Supercritical	6.10	0.00	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	**Peak Flow (cfs)**	**Cross Section**	**Rise**	**Span**	**Rise**	**Span**	**Rise**	**Span**	**Area (ft^2)**	**Comment**
Manhole	7.80	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
45 Deg Bend	6.10	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
Grated Inlet	6.10	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics where calculated using the 'Used' parameters.

Grade Line Summary:

Tailwater Elevation (ft): 6133.64

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	**Downstream (ft)**	**Upstream (ft)**	**Bend Loss (ft)**	**Lateral Loss (ft)**	**Downstream (ft)**	**Upstream (ft)**	**Downstream (ft)**	**Friction Loss (ft)**	**Upstream (ft)**
Manhole	6132.64	6135.07	0.00	0.00	6133.64	6136.15	6134.66	2.00	6136.66
45 Deg Bend	6135.17	6136.93	0.01	0.00	6136.16	6137.88	6136.69	1.61	6138.29
Grated Inlet	6136.93	6137.00	0.05	0.00	6137.94	6138.18	6138.44	0.00	6138.44

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K * V_fi ^ 2/(2*g)
- Lateral loss = V_fo ^ 2/(2*g)- Junction Loss K * V_fi ^ 2/(2*g).
- Friction loss is always Upstream EGL - Downstream EGL.

Excavation Estimate:

The trench side slope is 1.0 ft/ft
The minimum trench width is 2.00 ft

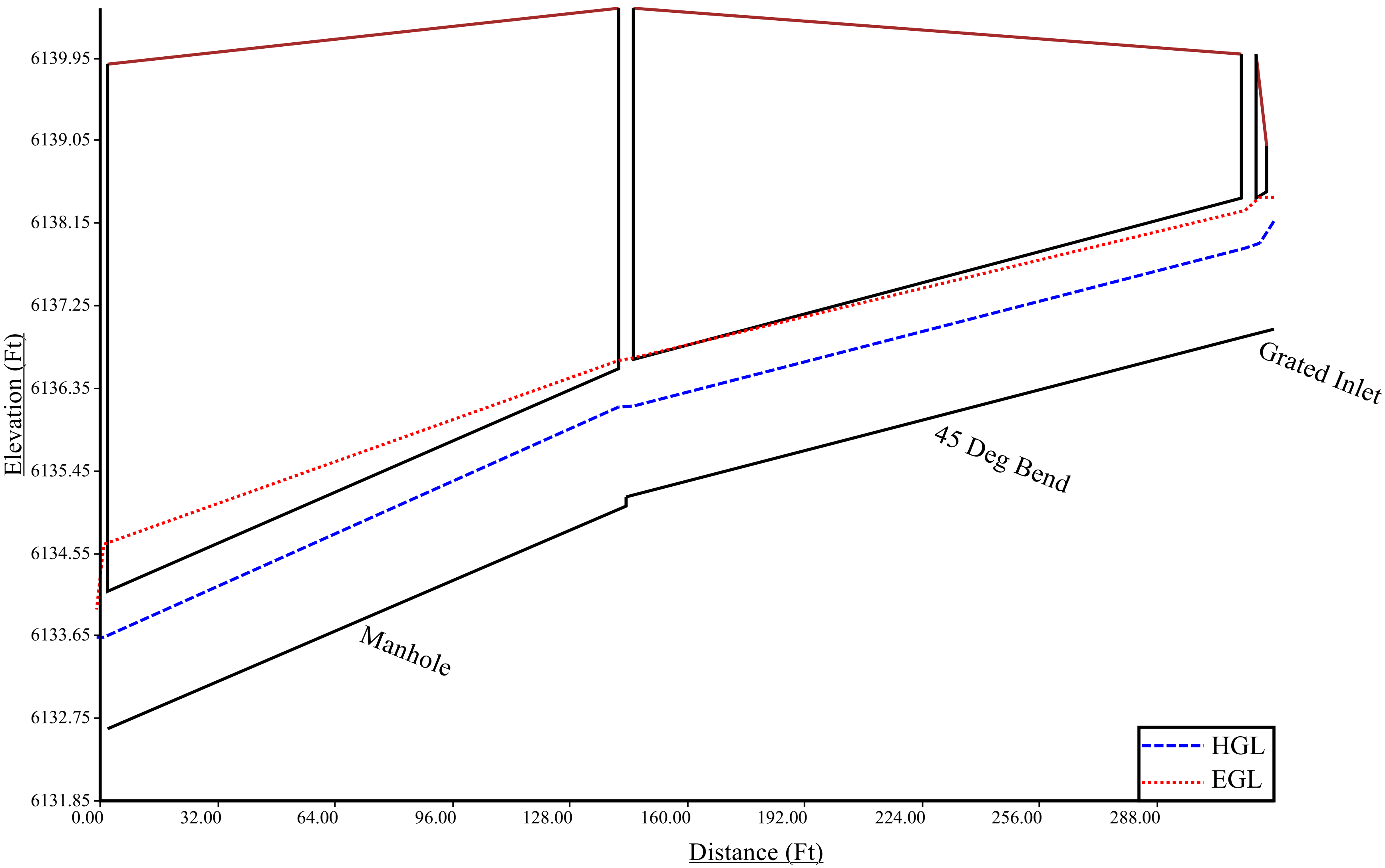
					Downstream			Upstream				
Element Name	**Length (ft)**	**Wall (in)**	**Bedding (in)**	**Bottom Width (ft)**	**Top Width (ft)**	**Trench Depth (ft)**	**Cover (ft)**	**Top Width (ft)**	**Trench Depth (ft)**	**Cover (ft)**	**Volume (cu. yd)**	**Comment**
Manhole	143.32	2.50	4.00	4.92	14.00	7.79	5.54	10.36	5.97	3.72	253.99	
45 Deg Bend	169.74	2.50	4.00	4.92	10.16	5.87	3.62	5.64	3.61	1.36	168.59	Sewer Too Shallow
Grated Inlet	6.89	2.50	4.00	4.92	5.64	3.61	1.36	4.92	2.54	0.29	3.69	Sewer Too Shallow

Total earth volume for sewer trenches = 426 cubic yards.

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
  - Four inches for pipes less than 33 inches.

- Six inches for pipes less than 60 inches.
- Eight inches for all larger sizes.

5 Year Profile



Program: UDSEWER Math Model Interface 2.1.1.4 **Run Date:** 11/16/2023 9:12:33 AM	# UDSewer Results Summary **Project Title:** 2610 E Dale **Project Description:** 100 yr HGL

System Input Summary

Rainfall Parameters

Rainfall Return Period: 100
Rainfall Calculation Method: Formula

One Hour Depth (in):
Rainfall Constant "A": 28.5
Rainfall Constant "B": 10
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20
Maximum Rural Overland Len. (ft): 500
Maximum Urban Overland Len. (ft): 300
Used UDFCD Tc. Maximum: Yes

Sizer Constraints

Minimum Sewer Size (in): 18.00
Maximum Depth to Rise Ratio: 0.90
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 6134.14

Tailwater Elevation assumes the existing 30" pipe to be at 100% full.

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
OUTFALL 1	6139.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Manhole	6140.50	16.70	3.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45 Deg Bend	6140.00	13.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grated Inlet	6139.00	13.40	13.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
OUTFALL 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Manhole	0.00	0.00	0.00	0.00	3.30	0.00	0.00	0.00	16.70	
45 Deg Bend	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.40	
Grated Inlet	0.00	0.00	0.00	0.00	13.40	0.00	0.00	0.00	13.40	Surface Water Present (Upstream)

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
Manhole	143.32	6132.64	1.7	6135.07	0.011	0.00	0.25	CIRCULAR	18.00 in	18.00 in
45 Deg Bend	169.74	6135.17	1.0	6136.93	0.011	0.05	0.00	CIRCULAR	18.00 in	18.00 in

Grated Inlet	6.89	6136.93	1.0	6137.00	0.011	0.29	0.00	CIRCULAR	18.00 in	18.00 in

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	**Flow (cfs)**	**Velocity (fps)**	**Depth (in)**	**Velocity (fps)**	**Depth (in)**	**Velocity (fps)**	**Froude Number**	**Flow Condition**	**Flow (cfs)**	**Surcharged Length (ft)**	**Comment**
Manhole	16.21	9.17	18.00	9.45	18.00	9.45	0.00	Pressurized	16.70	143.32	
45 Deg Bend	12.68	7.17	18.00	7.58	18.00	7.58	0.00	Pressurized	13.40	169.74	
Grated Inlet	12.45	7.04	18.00	7.58	18.00	7.58	0.00	Pressurized	13.40	6.89	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	**Peak Flow (cfs)**	**Cross Section**	**Rise**	**Span**	**Rise**	**Span**	**Rise**	**Span**	**Area (ft^2)**	**Comment**
Manhole	16.70	CIRCULAR	18.00 in	18.00 in	21.00 in	21.00 in	18.00 in	18.00 in	1.77	Existing height is smaller than the suggested height. Existing width is smaller than the suggested width. Exceeds max. Depth/Rise
45 Deg Bend	13.40	CIRCULAR	18.00 in	18.00 in	21.00 in	21.00 in	18.00 in	18.00 in	1.77	Existing height is smaller than the suggested height. Existing width is smaller than the suggested width. Exceeds max. Depth/Rise
Grated Inlet	13.40	CIRCULAR	18.00 in	18.00 in	21.00 in	21.00 in	18.00 in	18.00 in	1.77	Existing height is smaller than the suggested height.

										Existing width is smaller than the suggested width. Exceeds max. Depth/Rise

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics where calculated using the 'Used' parameters.

Grade Line Summary:

Tailwater Elevation (ft): 6134.14

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	**Downstream (ft)**	**Upstream (ft)**	**Bend Loss (ft)**	**Lateral Loss (ft)**	**Downstream (ft)**	**Upstream (ft)**	**Downstream (ft)**	**Friction Loss (ft)**	**Upstream (ft)**
Manhole	6132.64	6135.07	0.00	0.00	6134.14	6136.72	6135.53	2.58	6138.11
45 Deg Bend	6135.17	6136.93	0.04	0.00	6137.26	6139.23	6138.15	1.97	6140.12
Grated Inlet	6136.93	6137.00	0.26	0.00	6139.48	6139.56	6140.38	0.08	6140.46

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K * V_fi ^ 2/(2*g)
- Lateral loss = V_fo ^ 2/(2*g)- Junction Loss K * V_fi ^ 2/(2*g).
- Friction loss is always Upstream EGL - Downstream EGL.

Excavation Estimate:

The trench side slope is 1.0 ft/ft
The minimum trench width is 2.00 ft

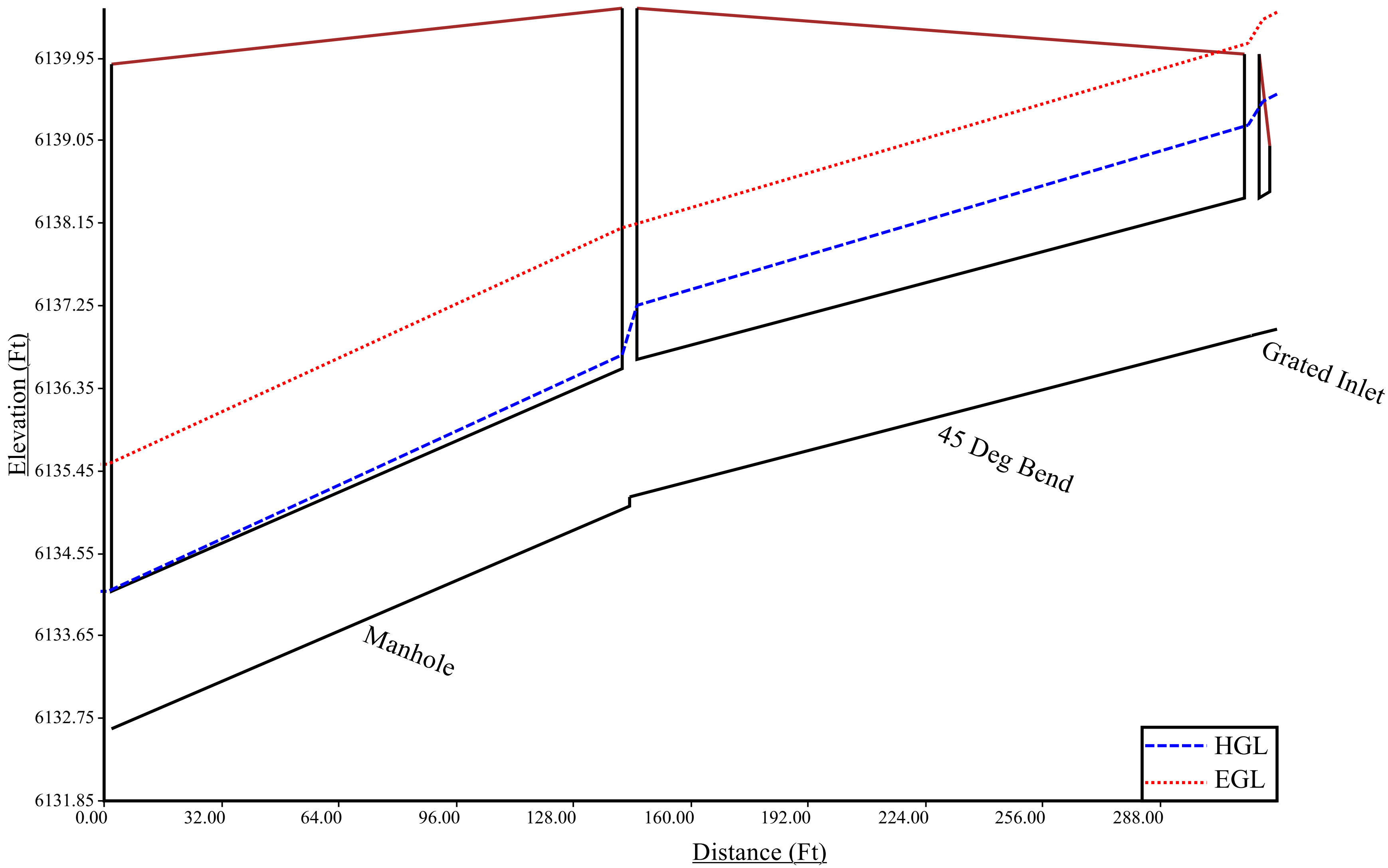
					Downstream			Upstream				
Element Name	**Length (ft)**	**Wall (in)**	**Bedding (in)**	**Bottom Width (ft)**	**Top Width (ft)**	**Trench Depth (ft)**	**Cover (ft)**	**Top Width (ft)**	**Trench Depth (ft)**	**Cover (ft)**	**Volume (cu. yd)**	**Comment**

Manhole	143.32	2.50	4.00	4.92	14.00	7.79	5.54	10.36	5.97	3.72	253.99	
45 Deg Bend	169.74	2.50	4.00	4.92	10.16	5.87	3.62	5.64	3.61	1.36	168.59	Sewer Too Shallow
Grated Inlet	6.89	2.50	4.00	4.92	5.64	3.61	1.36	4.92	2.54	0.29	3.69	Sewer Too Shallow

Total earth volume for sewer trenches = 426 cubic yards.

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
  - Four inches for pipes less than 33 inches.
  - Six inches for pipes less than 60 inches.
  - Eight inches for all larger sizes.

100 Year Profile



Hydrologic Soil Group—El Paso County Area, Colorado
(Cascade Subdivision)

Map Scale: 1:571 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0, 5, 10, 20, 30

Feet: 0, 25, 50, 100, 150

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 15, Oct 10, 2017

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

Date(s) aerial images were photographed: Jun 3, 2014—Jun 17, 2014

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
8	Blakeland loamy sand, 1 to 9 percent slopes	A	0.6	100.0%
Totals for Area of Interest			**0.6**	**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

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.

$$t_c = t_i + t_t \quad \text{(Eq. 6-7)}$$

Where:

t_c = time of concentration (min)

t_i = overland (initial) flow time (min)

t_t = travel time in the ditch, channel, gutter, storm sewer, etc. (min)

3.2.1 Overland (Initial) Flow Time

The overland flow time, t_i, may be calculated using Equation 6-8.

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

Where:

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

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

3.2.2 Travel Time

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

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

Where:

V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

Table 6-7. Conveyance Coefficient, C_v

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

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

The travel time is calculated by dividing the flow distance (in feet) by the velocity calculated using Equation 6-9 and converting units to minutes.

The time of concentration (t_c) is then the sum of the overland flow time (t_i) and the travel time (t_t) per Equation 6-7.

3.2.3 First Design Point Time of Concentration in Urban Catchments

Using this procedure, the time of concentration at the first design point (typically the first inlet in the system) in an urbanized catchment should not exceed the time of concentration calculated using Equation 6-10. The first design point is defined as the point where runoff first enters the storm sewer system.

$$t_c = \frac{L}{180} + 10 \qquad \text{(Eq. 6-10)}$$

Where:

t_c = maximum time of concentration at the first design point in an urban watershed (min)

L = waterway length (ft)

Equation 6-10 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional "calibration" of the Rational Method. Normally, Equation 6-10 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed. For subsequent design points, the time of concentration is calculated by accumulating the travel times in downstream drainageway reaches.

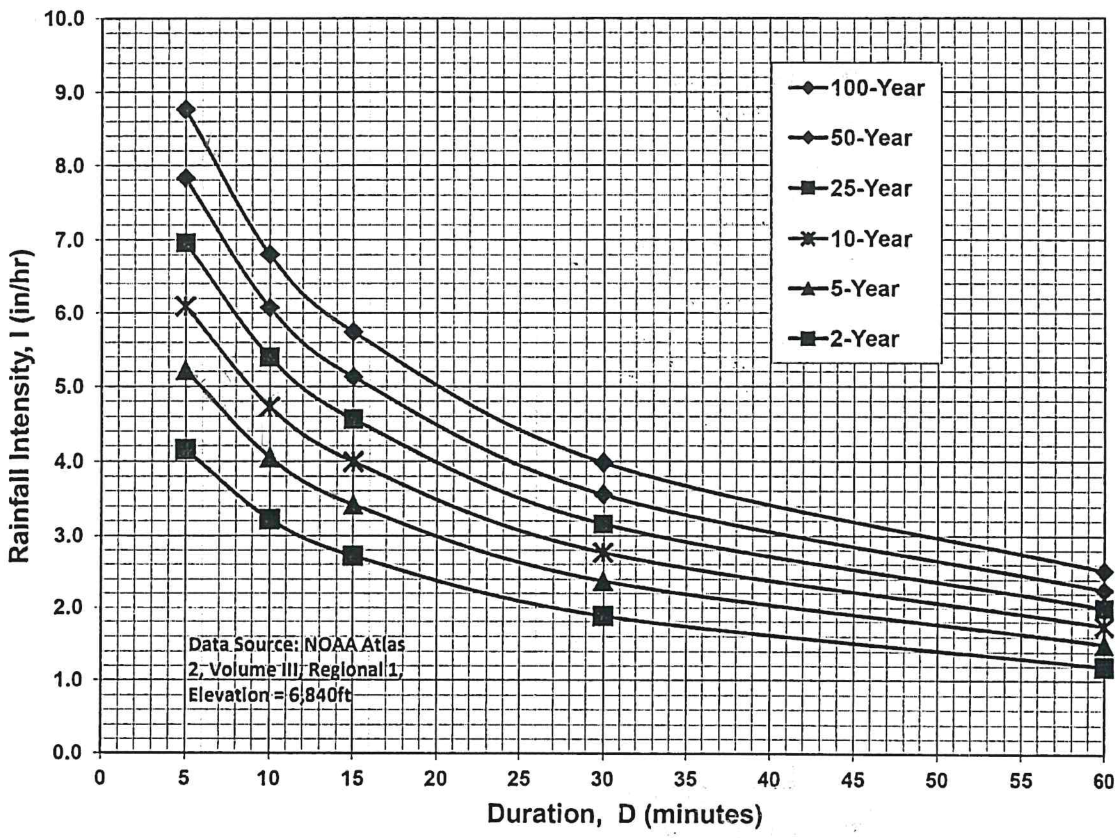
3.2.4 Minimum Time of Concentration

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

3.2.5 Post-Development Time of Concentration

As Equation 6-8 indicates, the time of concentration is a function of the 5-year runoff coefficient for a drainage basin. Typically, higher levels of imperviousness (higher 5-year runoff coefficients) correspond to shorter times of concentration, and lower levels of imperviousness correspond to longer times of

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

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

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

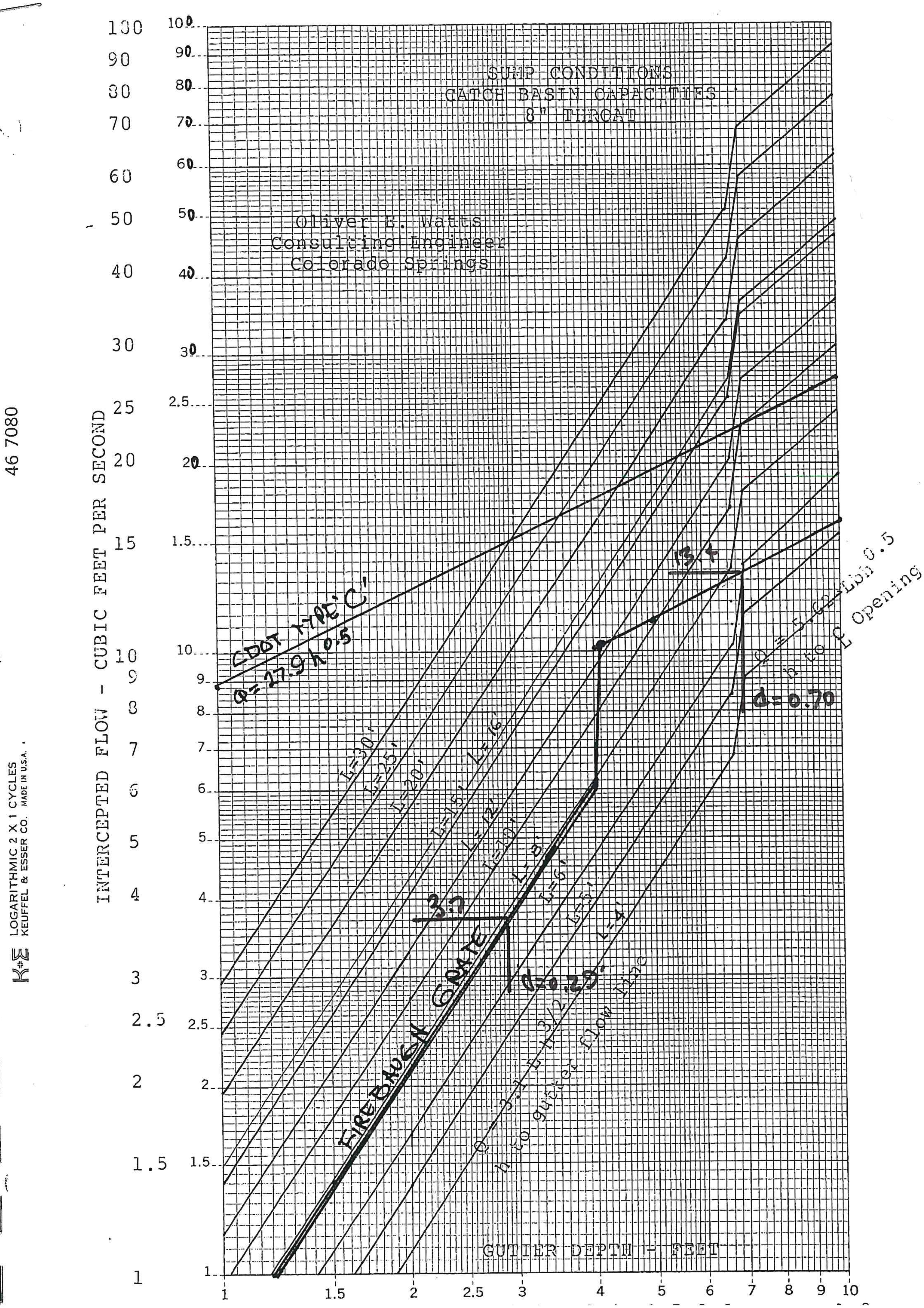
$I_{25} = -2.00 \ln(D) + 10.111$

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

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

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

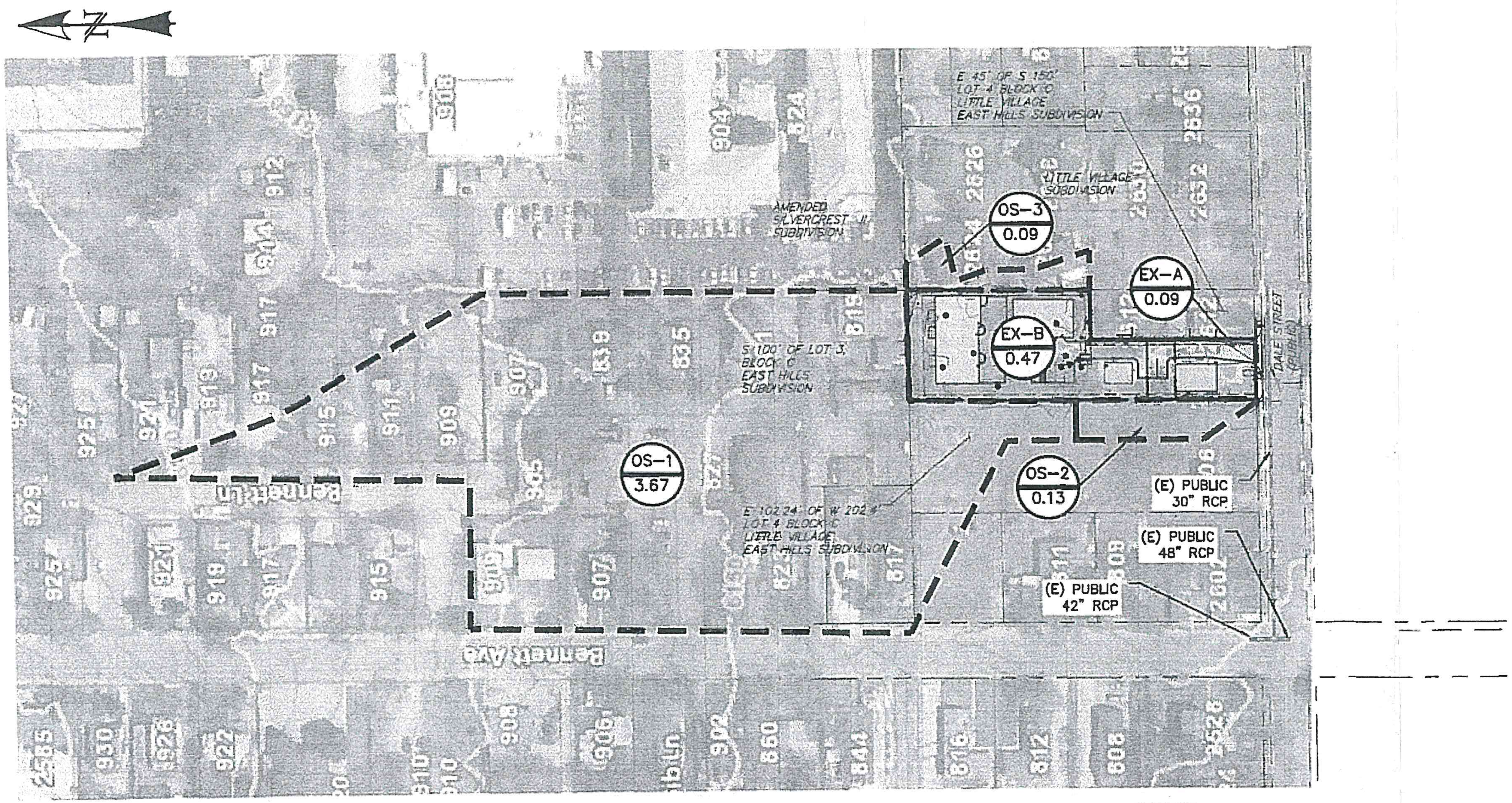
Note: Values calculated by equations may not precisely duplicate values read from figure.


SUMP CONDITIONS
CATCH BASIN CAPACITIES
8" THROAT
Oliver E. Watts
Consulting Engineer
Colorado Springs
INTERCEPTED FLOW - CUBIC FEET PER SECOND
GUTTER DEPTH - FEET
CDOT TYPE 'C'
Q = 27.9 h 0.5
FIREBAUGH GRATE
3.7
d=0.29'
13.4
d=0.70
Q = 5.62 Lbh 0.5
h to ℄ Opening
Q = 3.1 L h 3/2
h to gutter flow line
L=30'
L=25'
L=20'
L=16'
L=15'
L=12'
L=10'
L=8'
L=6'
L=5'
L=4'
46 7080
LOGARITHMIC 2 X 1 CYCLES
KEUFFEL & ESSER CO. MADE IN U.S.A.

$Q = \frac{0.463}{n} D^{8/3} S^{1/2}$ $Q = KS^{1/2}$

DIAMETER -IN.-	AREA -FT2-	D 8/3 -FT-	K N=0.010	K N=0.013	K N=0.024	K N=0.026
2	0.02182	0.008413	0.3895	---	---	---
4	0.08727	0.053420	2.4733	---	---	---
6	0.19630	0.157500	7.2922	5.609	---	---
8	0.34910	0.339200	15.7050	12.081	---	---
10	0.54540	0.615000	28.4745	21.903	---	---
12	0.78540	1.000000	46.3000	35.615	---	---
15	1.22720	1.813100	83.9465	64.574	---	---
18	1.76710	2.948300	136.5100	105.000	56.88	52.50
21	2.40530	4.447400	205.9100	158.400	85.80	79.20
24	3.14160	6.349600	293.9900	226.140	122.49	113.07
27	3.97610	8.692700	402.4700	309.590	167.70	154.79
30	4.90870	11.512600	533.0300	410.030	222.10	205.02
33	5.93960	14.844100	---	528.680	---	---
36	7.06860	18.720800	866.7700	666.700	361.20	333.30
39	8.29580	23.175100	---	825.400	---	---
42	9.62110	28.238900	---	1005.000	544.80	502.50
48	12.56640	40.317500	---	1436.000	777.80	718.00
54	15.90430	55.195000	---	1966.000	1065.00	983.00
60	19.63500	73.100400	---	2604.000	1410.00	1302.00
66	23.75830	94.254200	---	3357.000	1818.00	1678.00
72	28.27430	118.869400	---	4234.000	2293.00	2117.00
78	33.18310	147.152900	---	5241.000	2839.00	2620.00
84	38.48450	179.306000	---	6386.000	3459.00	3193.00
90	44.17860	215.524500	---	7676.000	4158.00	3838.00
96	50.26550	256.000000	---	9118.000	4939.00	4559.00
108	63.61730	350.466600	---	12480.000	6761.00	6140.00
120	78.53980	464.158900	---	16530.000	8954.00	8265.00

Oliver E. Watts
Consulting Engine
Colorado Springs



EXISTING DRAINAGE BASINS

BASIN	AREA (ACRES)	Q2 (CFS)	Q5 (CFS)	Q10 (CFS)	Q25 (CFS)	Q50 (CFS)	Q100 (CFS)
OS1	3.67	4.4	6.1	7.7	9.7	11.6	13.4
OS2	0.13	0.0	0.0	0.1	0.2	0.2	0.3
OS3	0.09	0.1	0.2	0.2	0.3	0.3	0.4
EXA	0.09	0.2	0.2	0.3	0.3	0.4	0.5
EXB	0.47	0.0	0.2	0.4	0.6	0.8	1.1

LEGEND

EXISTING	(E)
PROPOSED	(P)
FUTURE	(F)
BOUNDARY	
ROW	
LOT LINE	
EASEMENT	
(E) CONTOUR, INDEX	5960
(E) CONTOUR	
(E) STORM SEWER, MH	

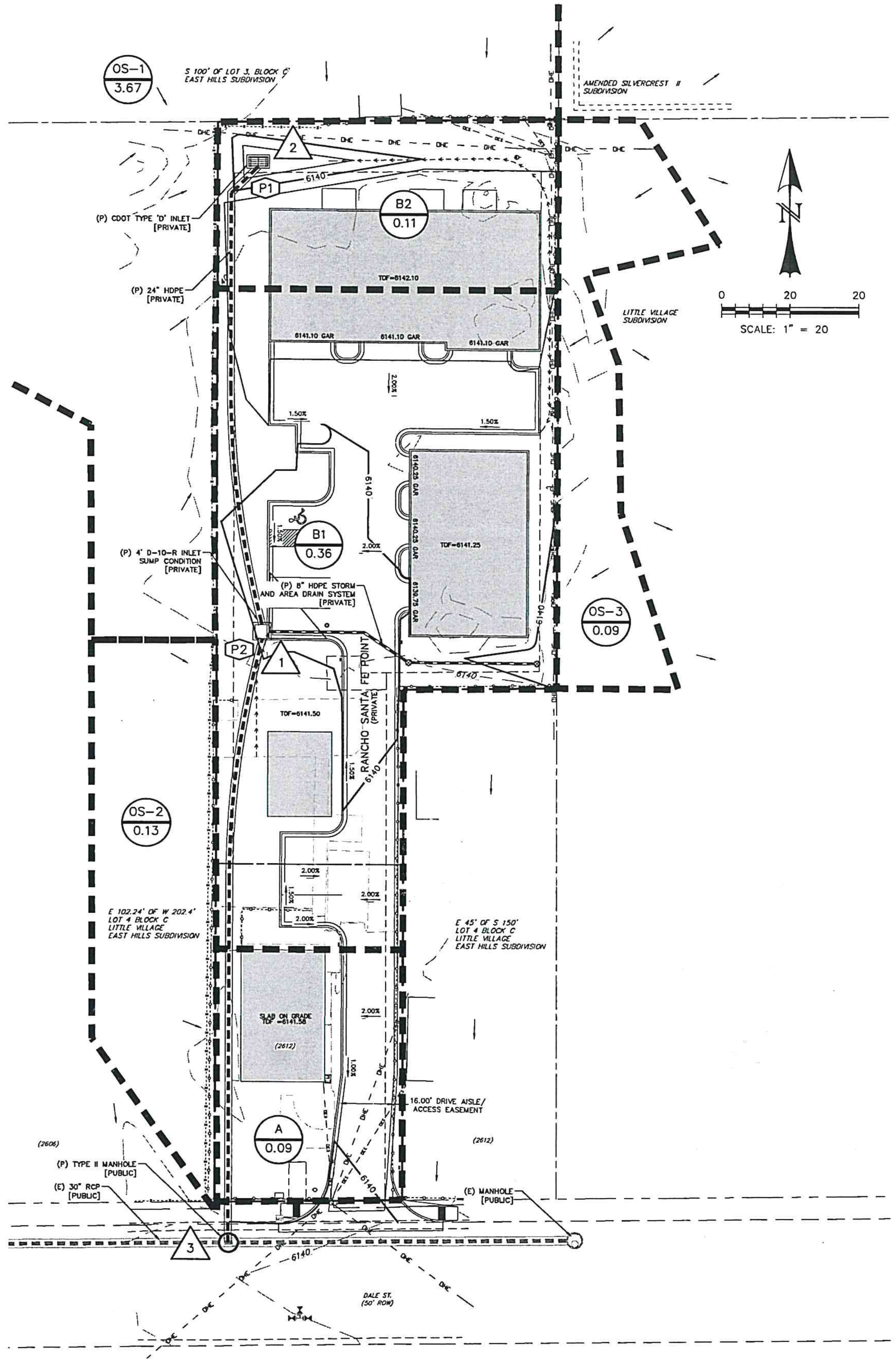
CASCADE SUBDIVISION FILING NO. 1

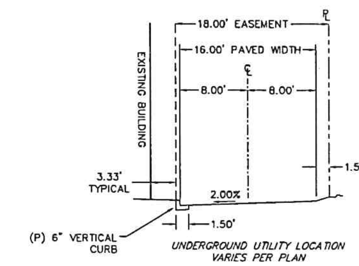
EXISTING CONDITIONS

PREPARED FOR:
CASCADE ENTERPRISES
1880 OFFICE CLUB POINTE
COLORADO SPRINGS, CO 80920

CATAMOUNT ENGINEERING
PO BOX 692
DIVIDE, CO 80814
(719) 426-2124

SCALE: 1"=100'	DRAWN BY: DLM
	DATE: 06/15/18
JOB NUMBER 17-139	SHEET 1 OF 1





SHARED DRIVE
N.T.S.

PROPOSED DRAINAGE BASINS							
BASIN	AREA (ACRES)	Q2 (CFS)	Q5 (CFS)	Q10 (CFS)	Q25 (CFS)	Q50 (CFS)	Q100 (CFS)
OS1	3.67	4.4	6.1	7.7	9.7	11.6	13.4
OS2	0.13	0.0	0.0	0.1	0.2	0.2	0.3
OS3	0.09	0.1	0.2	0.2	0.3	0.3	0.4
A	0.09	0.2	0.2	0.3	0.3	0.4	0.5
B1	0.36	0.6	0.8	1.1	1.3	1.6	1.8
B2	0.11	0.2	0.2	0.3	0.4	0.4	0.5

PROPOSED DESIGN POINTS						
DESIGN POINT	Q2 (CFS)	Q5 (CFS)	Q10 (CFS)	Q25 (CFS)	Q50 (CFS)	Q100 (CFS)
1	0.6	0.8	1.1	1.3	1.6	1.8
2	4.7	6.4	8.2	10.3	12.2	14.1
3	0.1	0.2	0.3	0.4	0.5	0.7

PROPOSED PIPE DESIGN POINTS						
DESIGN POINT	Q2 (CFS)	Q5 (CFS)	Q10 (CFS)	Q25 (CFS)	Q50 (CFS)	Q100 (CFS)
P1	4.7	6.4	8.2	10.3	12.2	14.1
P2	5.1	7.0	8.9	11.2	13.3	15.4

LEGEND

EXISTING	(E)
PROPOSED	(P)
FUTURE	(F)
CURB AND GUTTER	C&G
EASEMENT	ESMT
BOUNDARY	
RIGHT-OF-WAY	
LOT LINE	
EASEMENT	
SETBACK	
(E) CONTOUR, INDEX	6860
(E) CONTOUR	
(E) STORM SEWER, INLET, MH	
(P) CONTOUR, INDEX	6860
(P) CONTOUR	
(P) STORM SEWER, INLET, MH	
(P) DRAINAGE BASIN / ACREAGE	XX.X / X.XX
(P) SURFACE DESIGN POINT	X
(P) PIPE DESIGN POINT	PX

REV.	DESCRIPTION	DATE

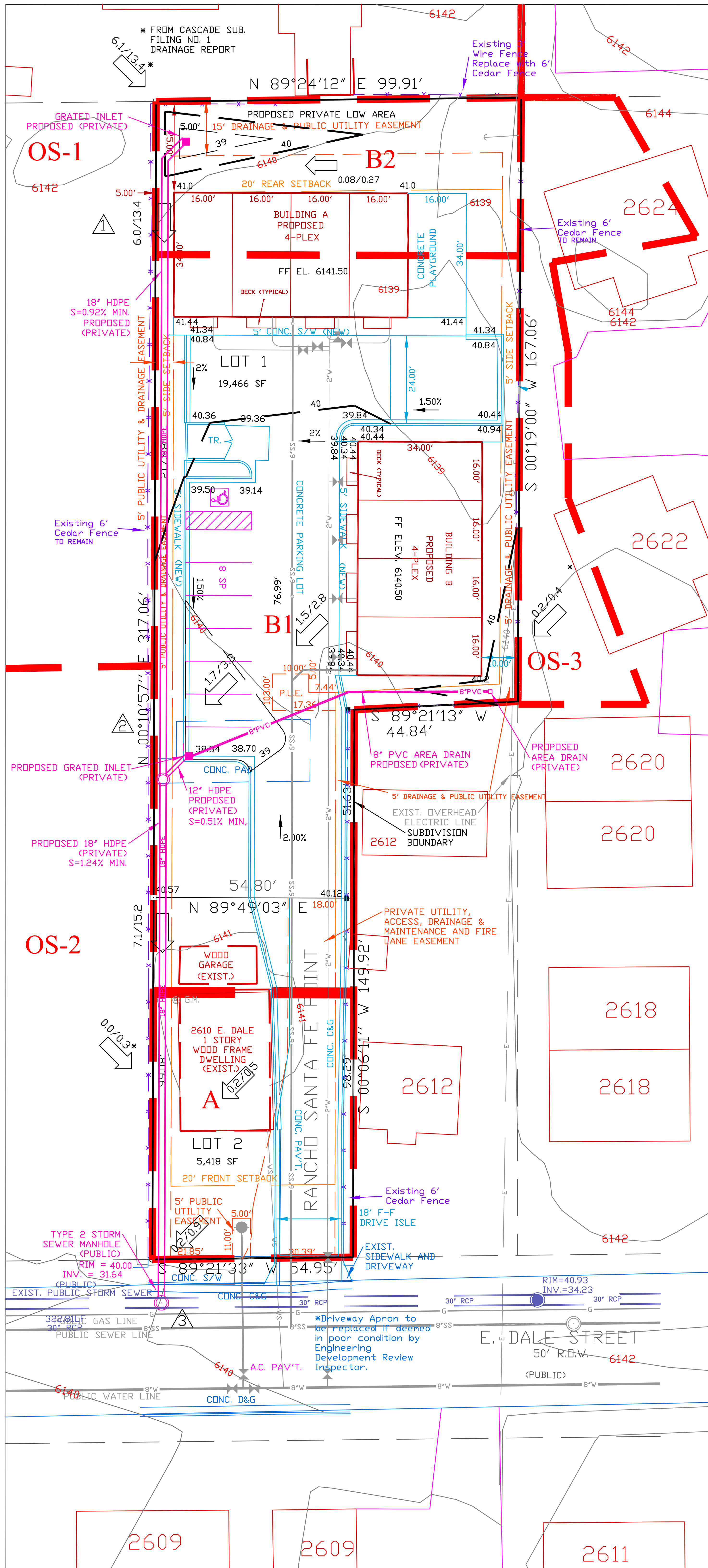
Know what's **below.** Call 72 hours before you dig. For more details visit: www.call811.com

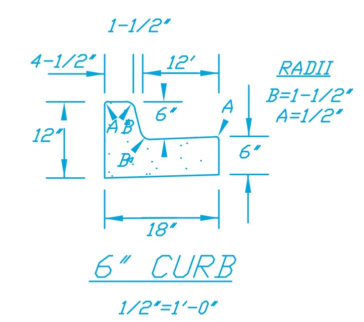
PREPARED FOR:
BARRY FARAH
1880 OFFICE CLUB POINTE
COLORADO SPRINGS, CO 80920

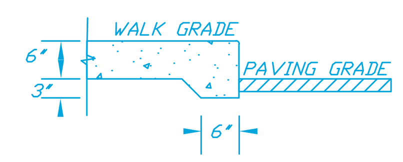
CATAMOUNT ENGINEERING
PO BOX 892 DIVIDE, CO 80814 (719)426-2124

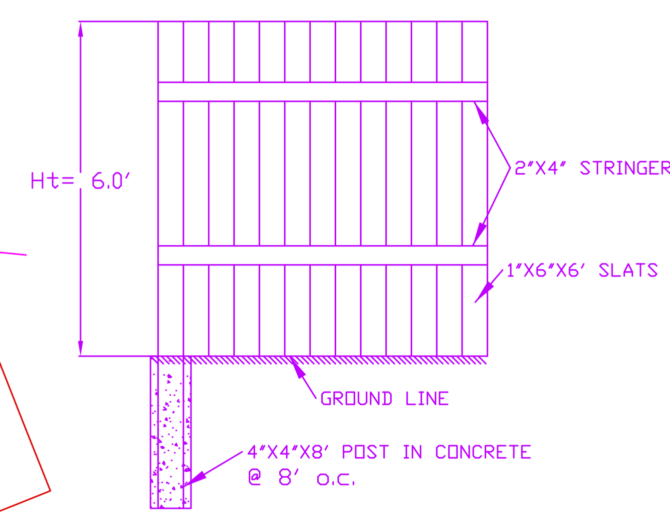
CASCADE SUBDIVISION
FILING NO. 1
PROPOSED
DRAINAGE PLAN

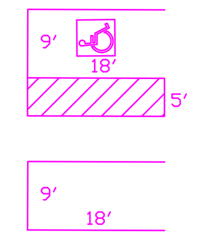
DESIGNED BY: DM	DRAWN BY: JLH
SCALE: 1" = 20'	DATE: 02/22/18
JOB NUMBER	SHEET
17-139	GR1 3 OF 9

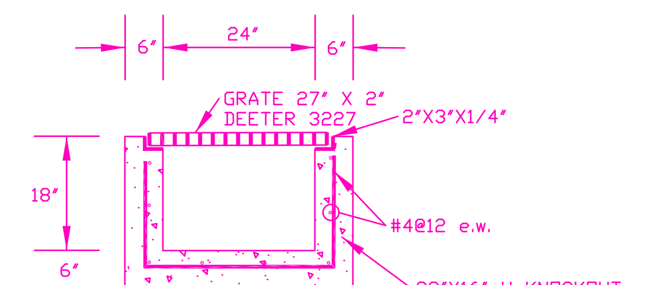








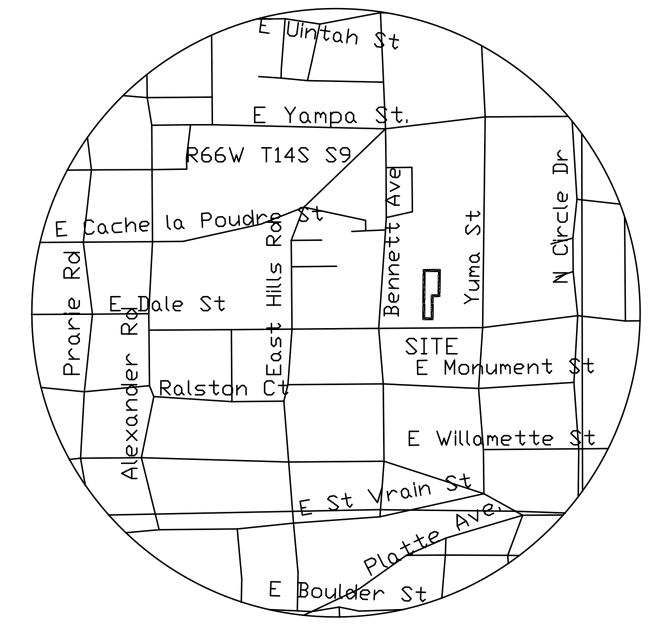


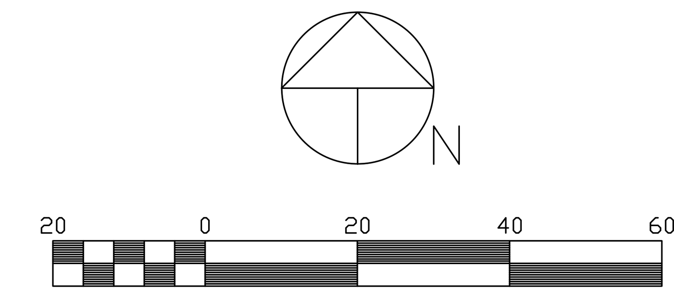


CONTOUR LEGEND:

ORIGINAL CONTOURS:

FINISH CONTOURS:





Contour Interval: 1'

LEGEND:

- FOUND 1-1/4" ORANGE #38141 CAP ON #5 REBAR
- FOUND #4 REBAR
- FOUND 1" AL. CAP, WC., @38141 ON #5 REBAR
- ILLEG. WASHER ON CONCRETE NAIL
- SEWER MANHOLE
- POWER POLE

DRAINAGE BASIN SUMMARY

BASIN	AREA -AC.-	RUNOFF IN CFS 5-YEAR	100-YEAR
OS-1*	3.67	6.0	13.4
OS-2*	0.13	0.0	0.3
OS-3*	0.09	0.2	0.4
A	0.09	0.2	0.9
B1	0.38	1.5	2.8
B2	0.10	0.1	0.3

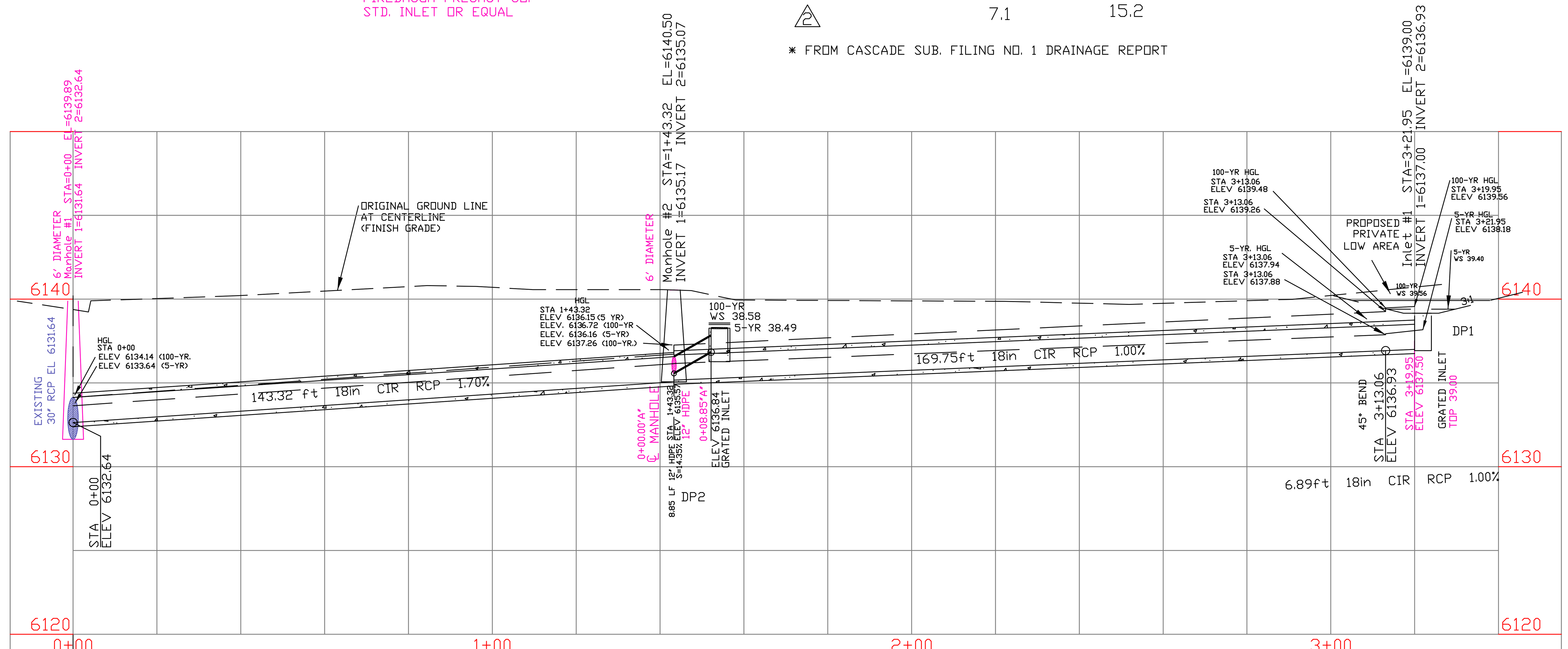
DESIGN POINTS

	5-YEAR	100-YEAR
1	6.0	13.4
2	7.1	15.2

* FROM CASCADE SUB. FILING NO. 1 DRAINAGE REPORT

LEGEND:

- 10.5/20.4 RUNOFF IN CFS 5-YEAR/100-YEAR
- A LIMIT OF DRAINAGE BASIN AND DESIGNATION
- EXISTING STORM SEWER AS LABELED
- PROPOSED STORM SEWER AS LABELED
- B LIMIT OF SOILS TYPE AND GROUP



STORM SEWER PROFILE

SCALE: H: 1"=20'
V: 1"=5'

** At station 3+13.06 (the 45 degree bend), the HGL is 6139.48, the FG is 6140.55, resulting in an elevation difference of 1.07'.

** At station 3+19.95 (the top of the grated inlet), the HGL is 6139.56, the FG elevation is 6140.71, which is an elevation difference of 1.15'

Prepared by the office of:
Oliver E. Watts, Consulting Engineer, Inc.
614 Elkton Drive
Colorado Springs, CO 80907
(719) 593-0173
Olliewatts@aol.com
Celebrating 42 years in Business

City File No.: DEPN-22-0083

DRAWN BY: O.E. WATTS	APPROVED BY:	REVISIONS 3-31-23 REVISED PER CITY REVIEW COMMENTS	OEW
DATE: 2-8-22	PROJ. NO.	11-27-23 REVISED PER CITY REVIEW COMMENTS	OEW
DWG. NO.: 21-5647-05	DWG.	12-27-22 REVISED PER CITY REVIEW COMMENTS	OEW
SURVEYED BY: ESW, OEW V 6-22-21, 8-17-22		1-20-23 REVISED PER CITY REVIEW COMMENTS	OEW

OLIVER E. WATTS
CONSULTING ENGINEER
COLORADO SPRINGS

PROJECT
2610 EAST DALE
CASCADE SUBDIVISION FILING NO. 1
COLORADO SPRINGS

SHT. NAME
DRAINAGE PLAN

SHT. NO. 1 OF 1