HYDROLOGY AND HYDRAULICS REPORT FOR THE US 6 WEST EDWARDS INTERSECTION IMPROVEMENT PROJECT

Township 4 South, Range 83 West, of the 6th P.M., Eagle County, CO

Prepared for:

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11/08/2023

FHU Reference No. 118339-01

November 2023

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1. INTRODUCTION

1.1 Project Location

This project consists of roadway and intersection improvements on US 6 at Hillcrest Drive in Eagle County, Colorado. The project is in the SE ¼ of the SE ¼ of Section 36 of Township 4 South, Range 83 West of the 6th P.M., Eagle County, Colorado. **Figure 1** shows the project vicinity. This project is adjacent to the Eagle River and runoff from the project will outfall to the Eagle River.

The project limits are approximately 0.5 miles along US 6 at Hillcrest Drive. The main project scope involves roadway widening along US 6 and a new roundabout at the intersection of US 6 and Hillcrest Drive. New storm sewer and a water quality vault are also proposed to accommodate these roadway improvements.

Figure 1-1. Project Location

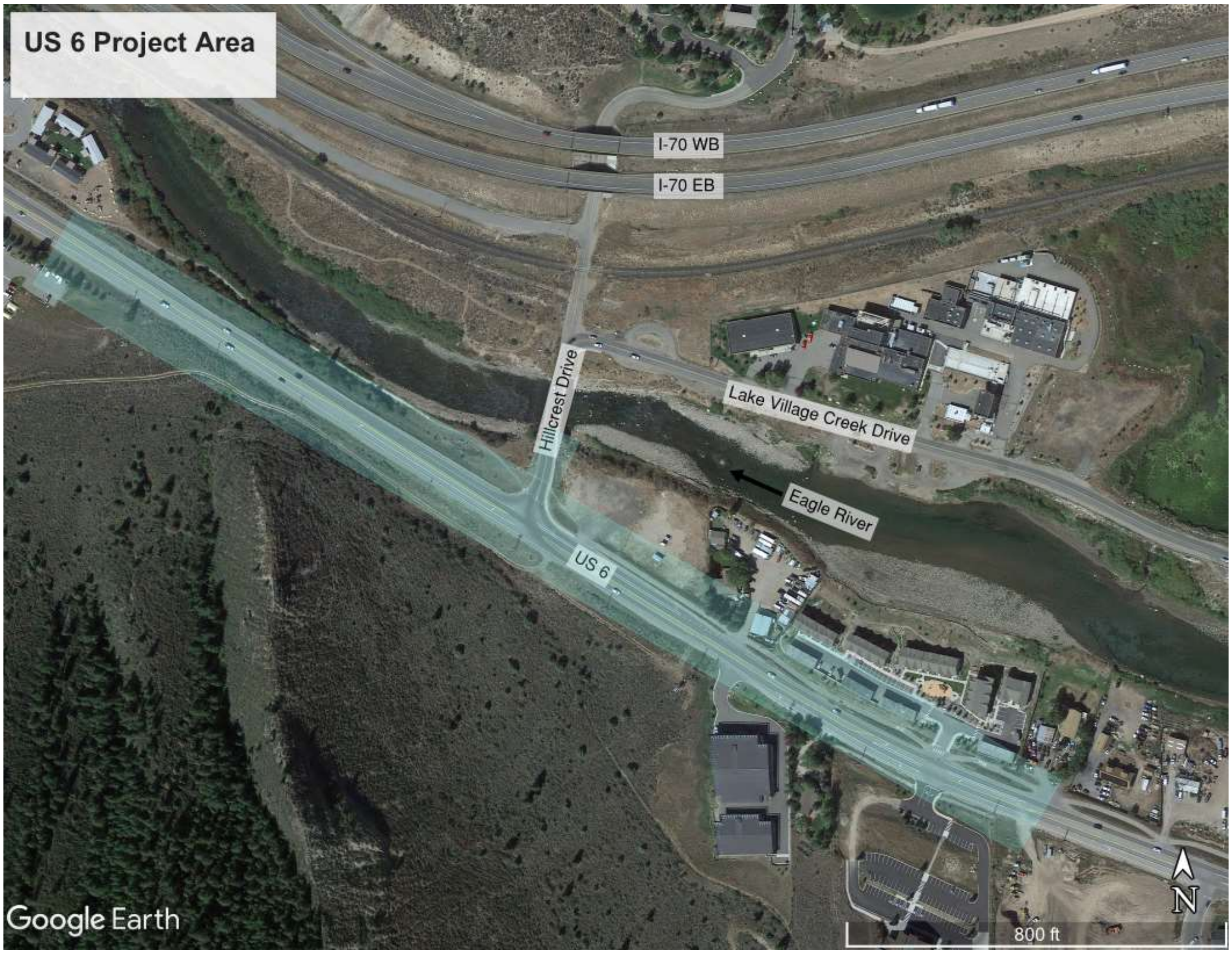

Figure 1-2. Project Area

1.2 Description of Property

The project area consists of the intersection of US 6 and Hillcrest Drive and portions of US 6 and Hillcrest Drive adjacent to the intersection. The surrounding area consists of the Mountain Life Calvary Chapel and the St. Clare of Assisi Parish on the west of side of the project, undeveloped land in the middle of the project area and commercial development at the east end of the project area. North of US 6, the Eagle River flows from east to west and is the main outfall for the project area. The project ties into existing conditions just south of the Hillcrest Drive Bridge over the Eagle River and approximately ¼ mile east and west along US 6 from Hillcrest Drive.

There are no known irrigation facilities in the project area. See Table 1-1 for soils information in the project area and on the offsite basins.

Table 1-1. Project Area Soils

Soil Type	Hydrologic Soil Group	Notes
Atencio-Azeltine, 3 to 6 percent slopes	B	Offsite Basin
Gypsum land- Gypsiorthids complex, 12 to 65 percent slopes	Assume C/D	Offsite Basin
Mussel loam, 1 to 6 percent slopes	B	Project Area
Tanna-Pinelli complext, 12 to 25 percent slopes	D	Offsite Basin
Torriorthents- Camborthids-Rock outcrop complex, 6 to 65 percent	C	Offsite Basin
Uracca, moist-Mergel complex, 12 to 25 percent slopes	B	Offsite Basin
Vandamore channery sandy loam, 25 to 65 percent slopes	B	Project Area/Offsite Basin
Yamo loam, 6 to 12 percent slopes	B	Project Area

2. HYDROLOGY

2.1 Major Basins

The project is in the Eagle River major drainage basin and stormwater runoff will outfall to the Eagle River. Eagle River has a Federal Emergency Management Agency (FEMA) designated floodplain as identified on Flood Insurance Rate Map (FIRM) 08037C0419D, effective 12/4/2007. The regulatory designated floodplain is identified as Zone AE with a floodway delineated. Outfalls from the proposed storm sewer systems will require work in the FEAM designated floodplain, however, it is not anticipated that the proposed work will cause a rise in the base flood elevations because no net fill is proposed.

According to the Eagle County Flood Insurance Study (FIS), effective December 4, 2007, Eagle River has a drainage basin of approximately 402 square miles upstream of the project area with a 100-year flow of 5,430 cfs.

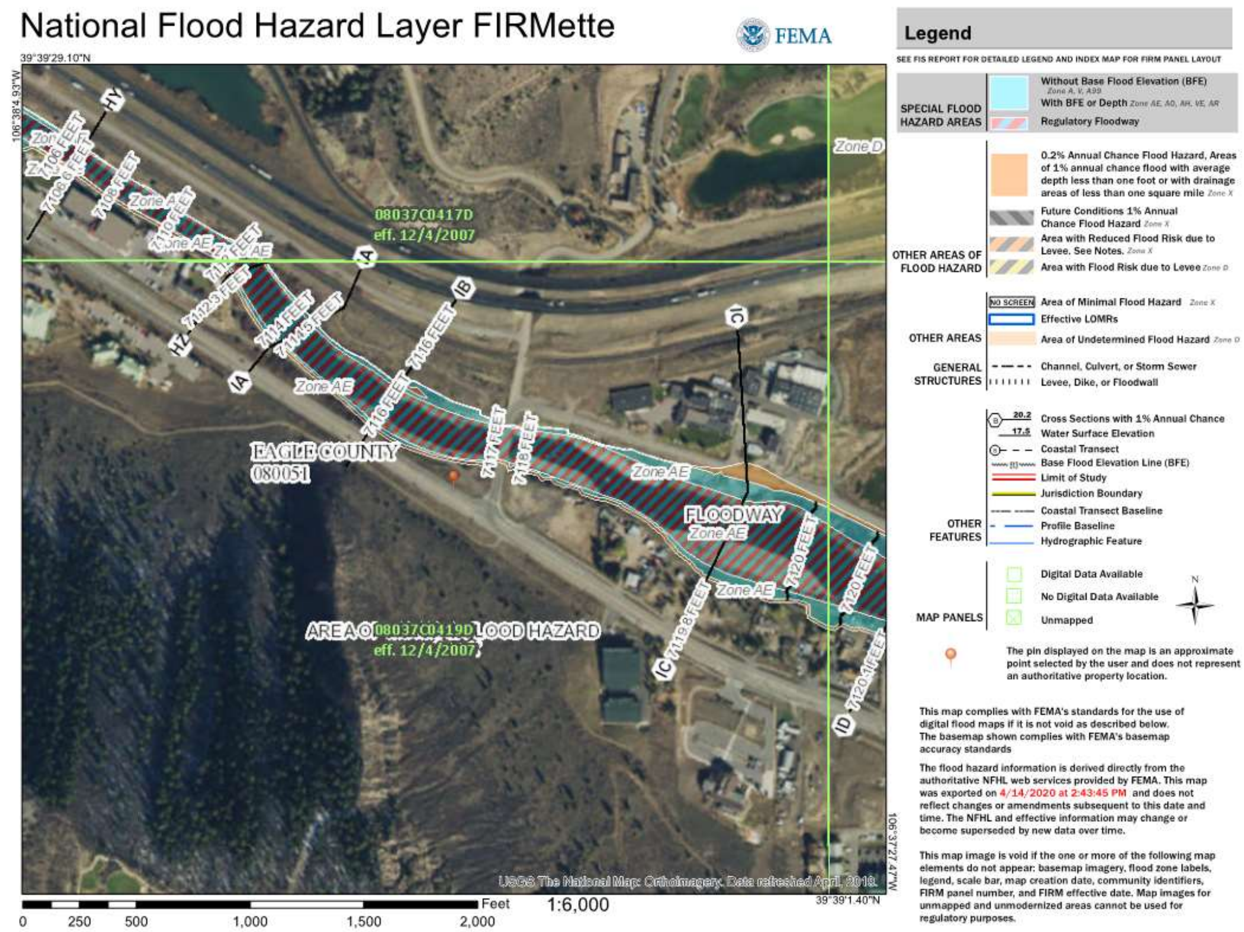

Figure 2-1. FEMA FIRM

2.2 Minor Basins

2.2.1 Offsite Basins/Existing Basins

There are approximately 7 major offsite basins contributing flow to the project area and several smaller offsite basins contributing flow to existing storm sewer systems. All these basins are south of the project area and flow to the north. Most of the basins consist of undeveloped land with relatively steep slopes ranging from 12 to 60 percent. Refer to Appendix A for the existing basin maps which show both the existing basins in the project area and the offsite basins south of the project area.

Table 2-1. Offsite/Existing Basins Summary

BASIN SUMMARY TABLE					
Basin	Basin	10yr	100yr	Q10	Q100
ID	Area (Ac)	Coefficient		cfs	
N1	1.08	0.40	0.63	0.80	2.14
N2	1.15	0.36	0.60	0.66	1.90
N3	0.14	0.87	0.90	0.31	0.54
N4	0.86	0.87	0.90	1.85	3.28
N5	0.40	0.75	0.83	0.76	1.44
S1	0.99	0.44	0.65	0.84	2.11
S2	5.83	0.15	0.48	1.55	8.72
S3	17.34	0.11	0.46	3.04	21.67
S4	0.01	0.23	0.53	0.00	0.02
S5	0.20	0.39	0.62	0.16	0.43
S6	0.09	0.25	0.54	0.05	0.17
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S10	0.16	0.07	0.44	0.02	0.24
S11	3.35	0.23	0.53	1.47	5.70
S12	0.39	0.50	0.68	0.39	0.93
S13	0.14	0.41	0.63	0.11	0.28

2.2.2 Proposed Roadway Basins

There are 10 roadway basins based on the roadway design and the proposed storm sewer layout. There are two low points on either side of the roundabout where the roadway transitions through a normal crown to the roundabout sloping to the north. The eastern and western legs of the project limits on US 6 drain toward the roundabout and then to the north.

Basins PA3, PA4, PA12, PA13 include the south side of the US 6 roadway from the western and eastern project limits to the roundabout. These basins are all directed to the low points on the edge of the roundabout.

Basins PA2 and PA10 include the north side of the US 6 roadway from the western and eastern project limits to the roundabout. These basins are collected by on-grade inlets that are placed before the cross walks on either side of the roundabout.

Basins PA6 and PA9 include the west and east sides of the roundabout and drain from the south to the north.

Basins PA7 and PA8 include the Hillcrest roadway north of the roundabout. These basins drain to the north and are collected by inlets that will replace existing inlets just south of the existing bridge.

Basin PA4 is the offsite basin south of the project area that drains to the cross-culvert under US 6 just west of the roundabout.

Table 2-2. Proposed Basins Summary

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ID	Area (Ac)	Coefficient		cfs	
PA2	0.07	0.87	0.90	0.15	0.27
PA3	0.08	0.87	0.90	0.18	0.31
PA4	16.88	0.13	0.47	3.83	23.49
PA5	0.02	0.87	0.90	0.04	0.08
PA6	0.23	0.87	0.90	0.50	0.89
PA7	0.07	0.87	0.90	0.15	0.27
PA8	0.08	0.87	0.90	0.18	0.31
PA9	0.20	0.87	0.90	0.44	0.78
PA10	0.11	0.87	0.90	0.24	0.43
PA11	0.26	0.87	0.90	0.57	1.01
PA12	0.09	0.87	0.90	0.20	0.35
PA13	0.03	0.87	0.90	0.07	0.12

3. DESIGN DISCUSSION

3.1 Regulations and Constraints

This study complies with CDOT Storm Drainage Criteria which includes utilizing parts of the Mile High Flood District (MHFD) Urban Storm Drainage Criteria Manual when appropriate. The Eagle County Land Use Regulations have also been referenced for this design.

3.2 Hydrologic Criteria

The Rational Method was used to calculate the peak runoff for the minor and major rainfall events for the offsite and roadway basins. The minor event is the 10-year storm with a 1-hour rainfall intensity of 0.745 in/hr. The major event is the 100-year storm with a 1-hour rainfall intensity of 1.28 in/hr. These values were obtained from NOAA Atlas 14, Volume 8, Version 2 for the project area.

3.3 Hydraulic Criteria

Spread Width

US 6 is classified as a major collector with a design speed of 50 miles per hour which decreases at the roundabout approaches. The proposed improvements include curb and gutter and a varying typical section. According to the CDOT criteria, the stormwater spread from the 10-year event should only extend to the shoulder width assuming the shoulder width is 4 feet or wider. In cases where the shoulder width is less than 4 feet, or there is no shoulder, 4 feet from the flowline will be considered for the maximum spread. However, CDOT criteria also makes allowances for roadways with curb and gutter and no shoulder or parking lane and relatively flat longitudinal slopes of 0.3% to 1%. In these cases, flow may spread into the travel lane, however flow spread width must never exceed the lane width adjacent to the gutter for the design conditions, which is the 10-year event in this case. Most of the project longitudinal slope is less than 1% and spread into the adjacent travel lane may be considered during final design as the storm sewer layout is finalized.

For the major, 100-year event, the allowable depth and inundation must not exceed the following conditions:

- Residential dwellings, public, commercial, and industrial buildings must not be flooded at the foundations unless the buildings are floodproofed.
- The depth of water at the street crown on continuous-grade sections must not exceed 6 inches to allow the passage of emergency vehicles.
- The depth of water at the panline on continuous-grade sections must not exceed 18 inches.

Storm Sewer System

Inlets have been placed at roadway sumps and at logical locations like upstream of median breaks and crosswalks. Inlets will also be placed approximately 10 feet upstream of superelevation transitions. The MHFD UD-Inlet spreadsheet and CDOT nomographs were referenced for inlet capacity calculations. Table 13.2 in the CDOT Drainage Manual was referenced for the clogging factor for inlets.

Twenty-four-inch minimum pipe diameter is assumed for the storm drains. SewerGEMs was used to analyze the storm sewer system in regards to velocity and pipe capacity.

Allowable Headwater

Cross-culverts in the project area will adhere to the CDOT criteria regarding allowable headwater elevations. Specifically, Section 9.2.2 of the CDOT Drainage Criteria manual was referenced for allowable headwater limitations and Table 9.3 was used to determine the maximum headwater depth to structure depth ratio of 2.0 for structures less than 36 inches and 1.7 for structures between 36 inches and 60 inches.

Water Quality

The project is adjacent to Eagle River and improvements are proposed within 100 feet of the river. According to Eagle County's Land Use Regulations, Section 4-650, stormwater is not allowed to discharge directly to a natural water body without first either being treated or by sheet flow across at least 100 feet of stable vegetation. A water quality vault is proposed to treat the 2-year flow from the majority of the roadway basins in the project area of 1.6 cfs. The water quality vault will be required to bypass the 100-year peak flow of 4.8 cfs.

3.4 Variances from Criteria

No variances from criteria are proposed at this time or expected during final design.

4. RECOMMENDED DESIGN

4.1 General Concept

Proposed drainage patterns will remain as close to historic patterns as possible with Eagle River as the ultimate outfall. Off-site flow will be captured either in existing storm sewer systems adjacent to the project area or captured in a cross culvert and directed to Eagle River. The majority of the project area will be treated in a water quality vault before discharging to the Eagle River. Hydraulic calculations are included in Appendix B of this report. The hydraulic design will be within the allowable limits as stated in the CDOT Drainage Manual.

The existing Hillcrest Drive Bridge over Eagle River will not be impacted by this project and work is not anticipated in the Eagle River at the Bridge. There will be outfalls with rundowns directed to the Eagle River which will require work in the floodplain and on the banks of the river.

4.2 Specific Details

Runoff from the proposed improvements will be captured in Type 16 inlets placed on the west and east legs of the roundabout and at the north project limits on Hillcrest Drive. These inlets are all tied into the same proposed storm sewer system (Line C) that will collect and convey the roadway runoff to the northwest corner of the new roundabout. The storm sewer will flow through a water quality vault before discharging to the Eagle River.

There is one cross culvert (Line A) in the project area directing offsite flows from the south side of the project to the north to discharge to the Eagle River. This in existing drainage pattern with the existing cross-culvert being upsized to meet the capacity criteria of passing the 100-year flow.

There is another cross culvert (Line B) on the south side of the roundabout directing flows from east to west. These flows are made up of roadway runoff and offsite flow from the south that combine in an existing roadside ditch on the south side of US 6. The proposed roundabout pushes the existing ditch further south and decreases the ditch size due to the proximity of a steep hill on the south side of the project. The existing ditch size was further decreased because an existing 2-track road has been regraded south of the roundabout to maintain access through the property south of US 6. A 30"x19" elliptical pipe allows low flows in the drainage ditch to flow under the 2-track road. The 100-year flows will pass from the east to the west using the elliptical pipe and overtop the 2-track road to flow to Line A and then discharge to the Eagle River.

The headwater elevations for both Lines A and B were checked to ensure they were below the curb and gutter elevation of US 6 and the roundabout so there will be no overtopping of US 6 in the major event.

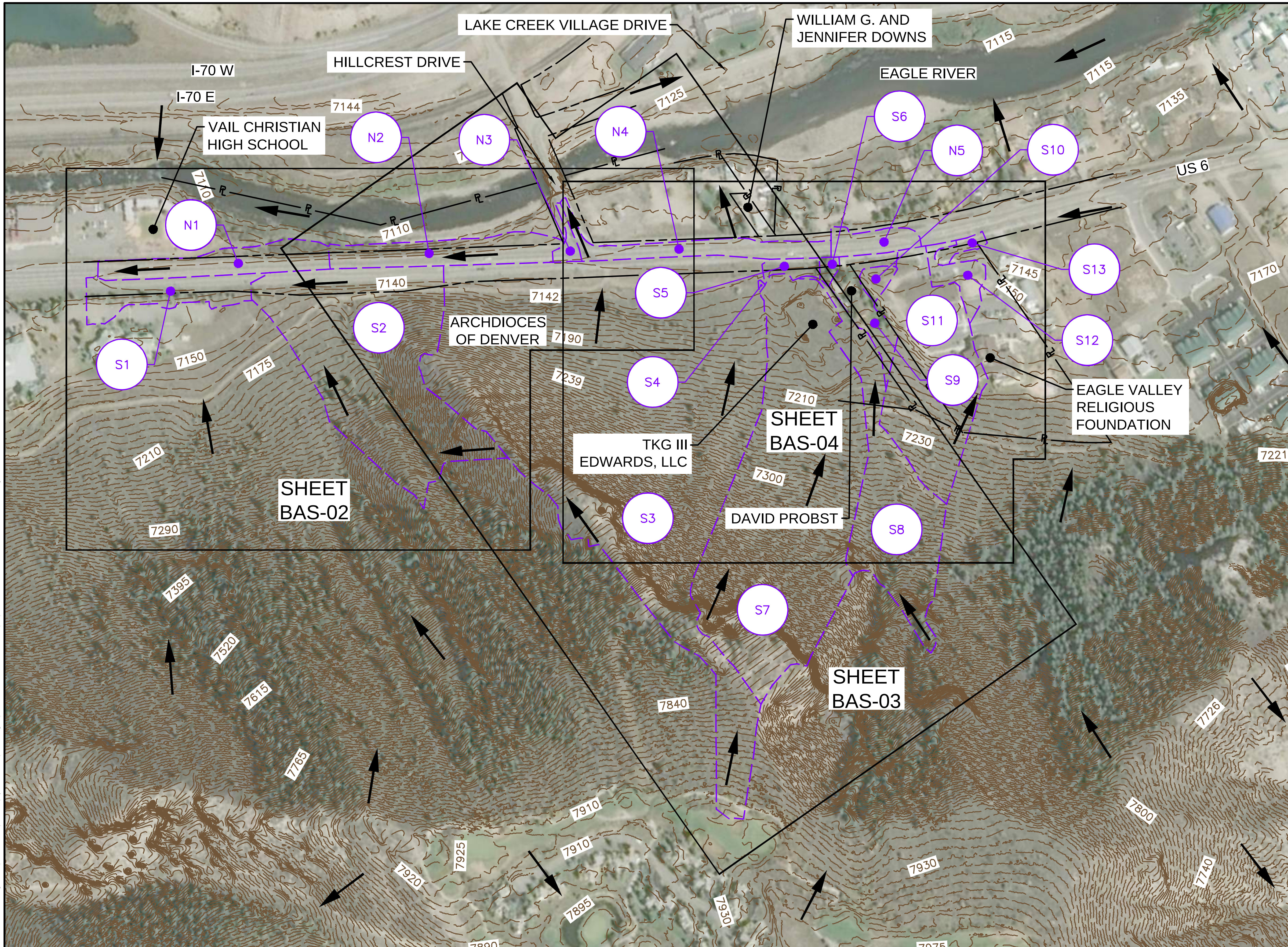
5. STORMWATER MANAGEMENT PLAN

The estimated disturbance area is approximately 2.4 acres. Stormwater management plans following the CDOT standards have been provided in the final plan set. The final SWMP plans in the construction plan set are to be followed by the contractor. These sheets will address various grading, erosion, and sedimentation issues and project area requirements.

6. REFERENCES

1. Colorado Department of Transportation Drainage Design Manual. 2019.
2. Eagle County Land Use Regulations. Updated July 2019.
3. Mile High Flood District Urban Storm Criteria Manuals.
4. FEMA Flood Insurance Study for Eagle County. Effective December 4, 2007.
5. FEMA FIRM 08037C0419D, Effective December, 4, 2007.
6. NOAA Atlas 14, Volume 8, Version 2. Referenced April 2021.
7. Natural Resources Conservation Service Web Soil Survey. Referenced April 2021.

APPENDIX A. HYDROLOGIC ANALYSIS



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LEGEND

EXISTING RIGHT-OF-WAY
EXISTING PROPERTY LINE
BASIN BOUNDARY
FLOW DIRECTION
X — BASIN DESIGNATION – SEE NEXT SHEET

N

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US 6 WEST EDWARDS IMPROVEMENTS
PRE-PROJECT
OVERALL BASIN MAP

DESIGNER: KMG
DETAILER: SV
SHEET SUBSET: DRAINAGE
STRUCTURE NUMBERS
BAS-01 OF 7

PROJECT NO./CODE
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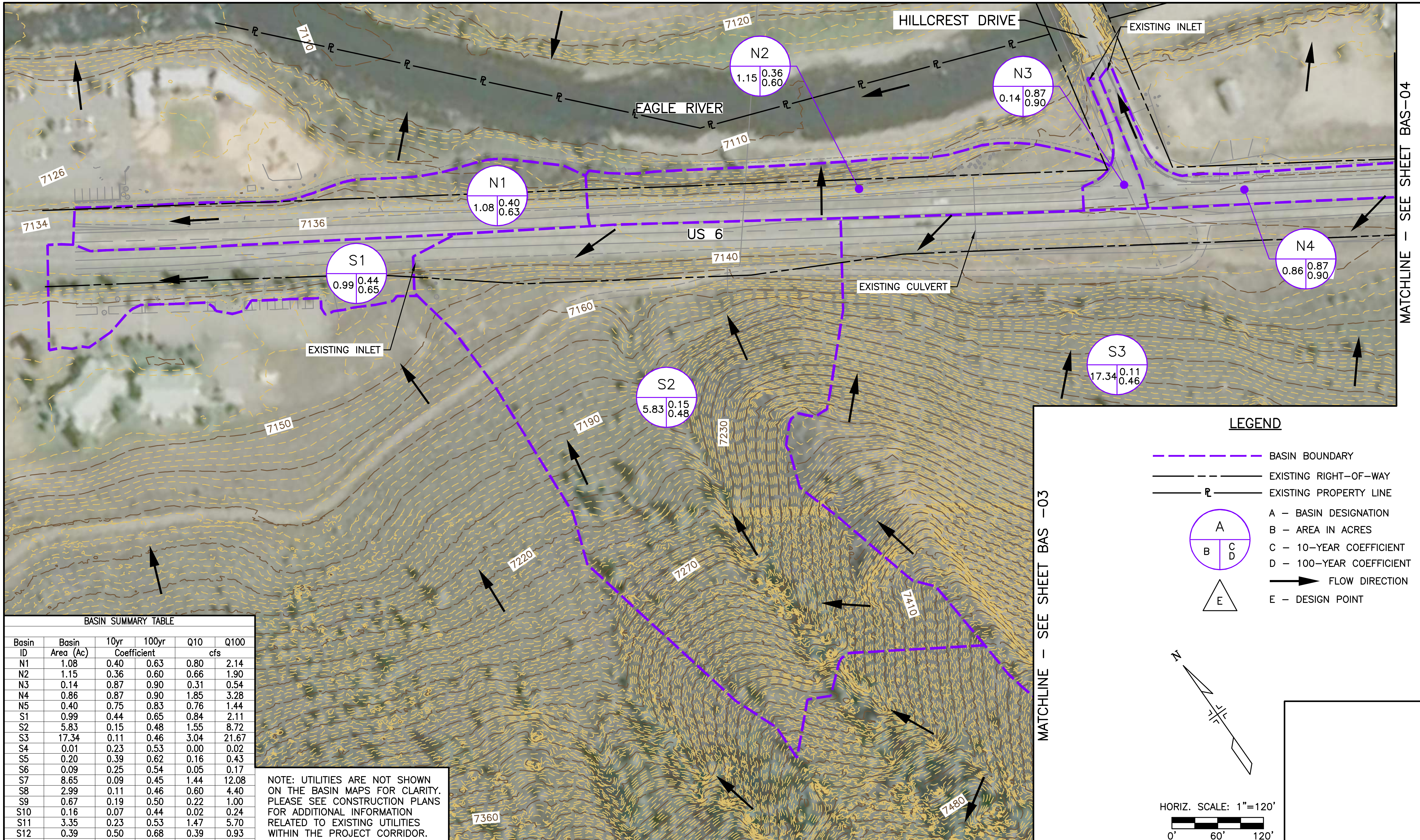

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US 6 WEST EDWARDS IMPROVEMENTS
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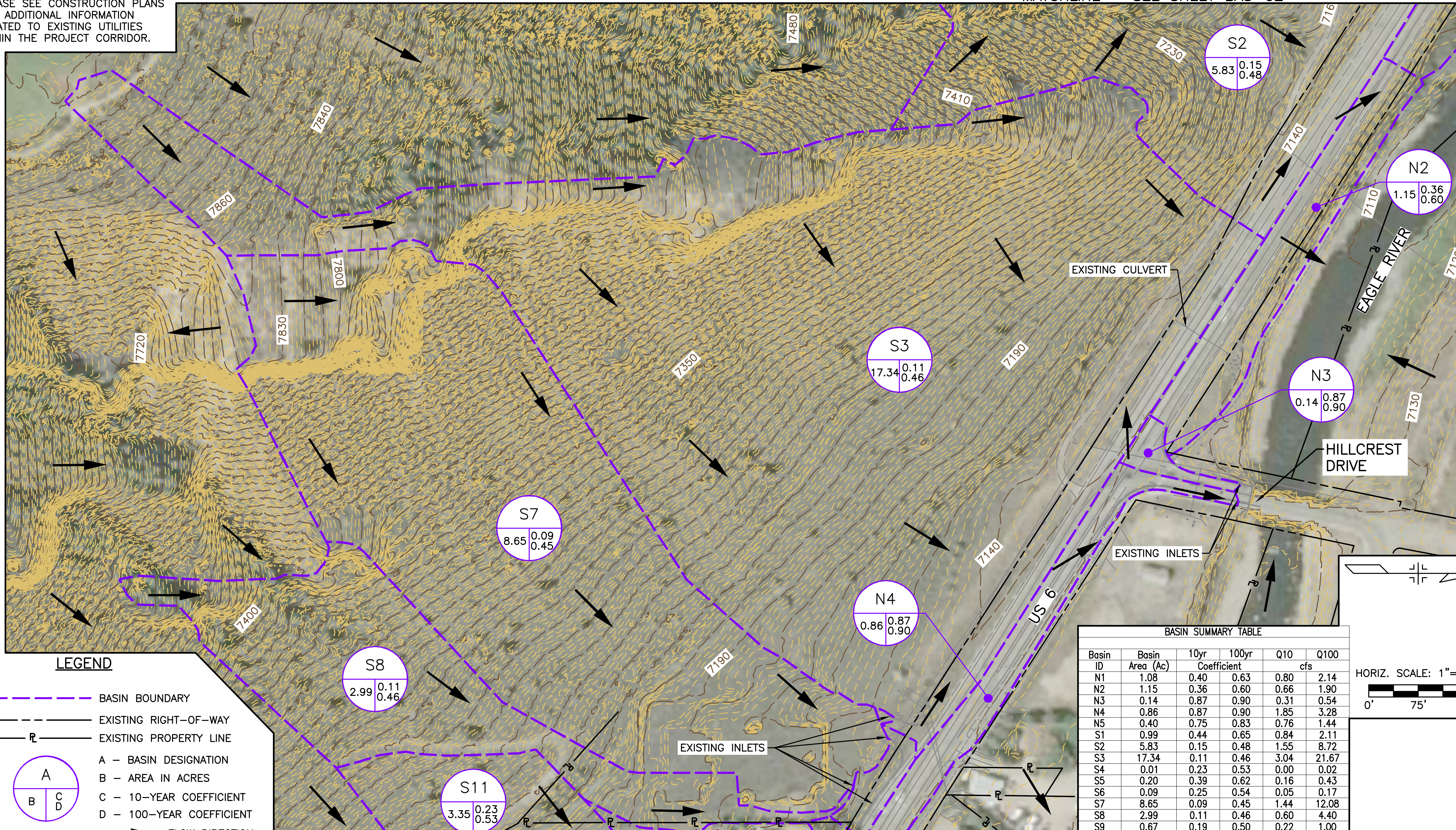
MATCHLINE – SEE SHEET BAS–02



MATCHLINE – SEE SHEET BAS–04

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LEGEND

- BASIN BOUNDARY
- EXISTING RIGHT–OF–WAY
- EXISTING PROPERTY LINE
- A – BASIN DESIGNATION
- B – AREA IN ACRES
- C – 10–YEAR COEFFICIENT
- D – 100–YEAR COEFFICIENT
- FLOW DIRECTION
- E – DESIGN POINT

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DETAILER: SV

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STRUCTURE NUMBERS

BAS–03 OF 7

PROJECT NO./CODE

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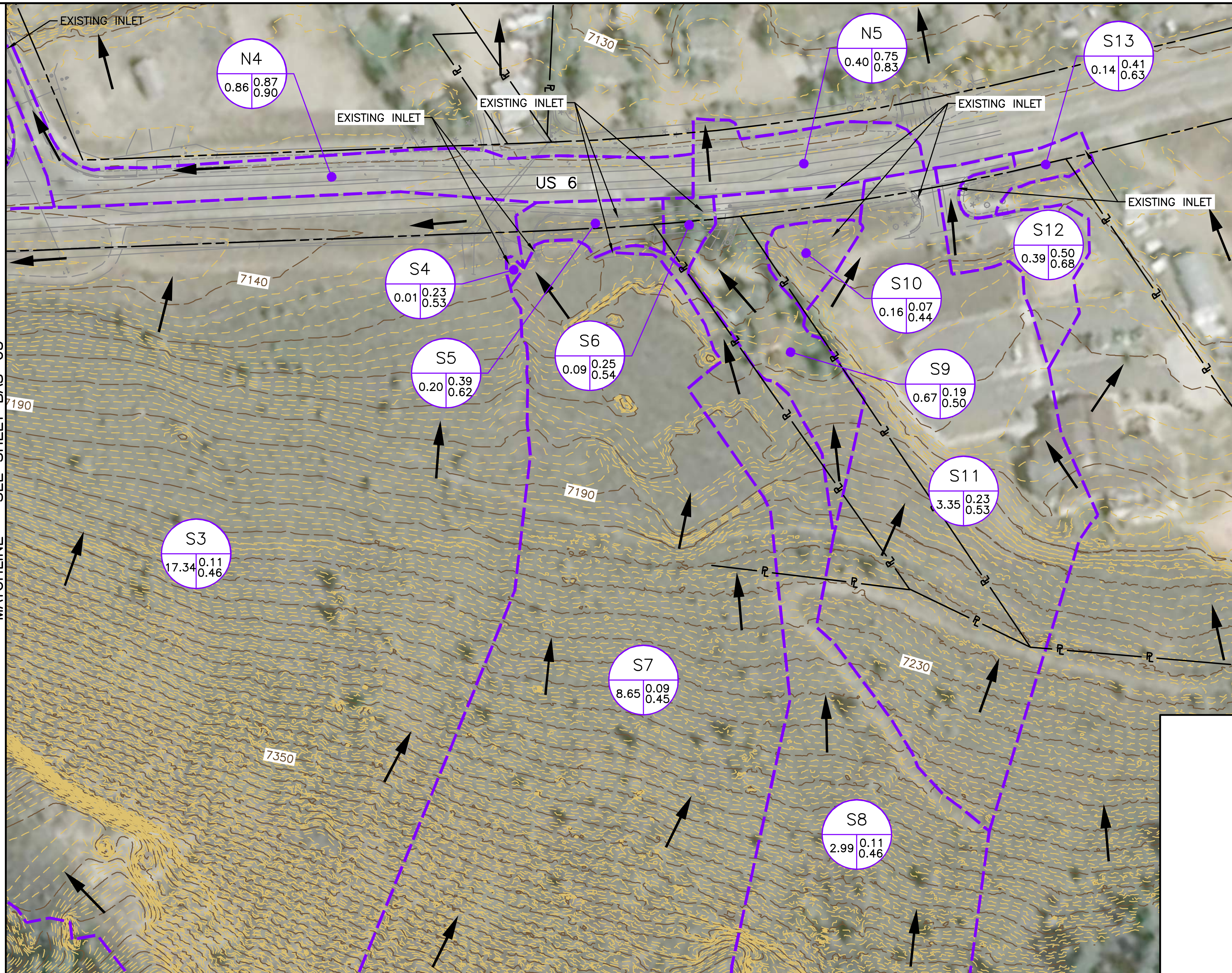
3

MATCHLINE – SEE SHEET BAS-03



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COEFFICIENTS OF DEVELOPMENT

Project: US 6 West, Hillcrest to Arrowgrass

Project #: 118339-01

Date: 07-May-21

File: Hydro_Existing.xlsx

			IMPERVIOUSNESS							SOIL TYPE			RUNOFF COEFF.			
BASIN	DES.	AREA	Open	Residential	Residential	Roofs	Commercial	Paved	Comp.							
	PT.	ACRES	% Imp.	% Imp.	% Imp.	% Imp.	% Imp.	% Imp.	% Imp.	A	B	C/D	2	5	10	100
			2	25	35	90	95	100		Percent of	Percent of	Percent of	YEAR	YEAR	YEAR	YEAR
			Acres	Acres	Acres	Acres	Acres	Acres		Total Area	Total Area	Total Area				
N1		1.08	0.63	0.00	0.00	0.00	0.00	0.45	42.83	0.0	100.0	0.0	0.31	0.34	0.40	0.63
N2		1.15	0.74	0.00	0.00	0.00	0.00	0.41	36.94	0.0	100.0	0.0	0.26	0.29	0.36	0.60
N3		0.14	0.00	0.00	0.00	0.00	0.00	0.14	100.00	0.0	100.0	0.0	0.84	0.86	0.87	0.90
N4		0.86	0.00	0.00	0.00	0.00	0.00	0.86	100.00	0.0	100.0	0.0	0.84	0.86	0.87	0.90
N5		0.40	0.06	0.00	0.00	0.00	0.00	0.34	85.30	0.0	100.0	0.0	0.70	0.72	0.75	0.83
S1		0.99	0.53	0.00	0.00	0.00	0.00	0.46	47.54	0.0	100.0	0.0	0.35	0.38	0.44	0.65
S2		5.83	5.50	0.00	0.00	0.00	0.00	0.33	7.55	0.0	58.0	42.0	0.04	0.07	0.15	0.48
S3		17.34	16.88	0.00	0.00	0.00	0.00	0.46	4.60	0.0	77.0	23.0	0.02	0.04	0.11	0.46
S4		0.01	0.01	0.00	0.00	0.00	0.00	0.002	21.60	0.0	100.0	0.0	0.14	0.16	0.23	0.53
S5		0.20	0.12	0.00	0.00	0.00	0.00	0.08	41.20	0.0	100.0	0.0	0.30	0.33	0.39	0.62
S6		0.09	0.07	0.00	0.00	0.00	0.00	0.02	23.78	0.0	100.0	0.0	0.16	0.18	0.25	0.54
S7		8.65	8.65	0.00	0.00	0.00	0.00	0.002	2.02	0.0	74.0	26.0	0.01	0.02	0.09	0.45
S8		2.99	2.99	0.00	0.00	0.00	0.00	0.003	2.10	0.0	53.0	47.0	0.01	0.03	0.11	0.46
S9		0.67	0.57	0.00	0.00	0.04	0.00	0.06	16.03	0.0	100.0	0.0	0.10	0.12	0.19	0.50
S10		0.16	0.16	0.00	0.00	0.00	0.00	0.00	2.00	0.0	100.0	0.0	0.01	0.01	0.07	0.44
S11		3.35	2.68	0.00	0.00	0.09	0.00	0.58	21.33	0.0	93.0	7.0	0.14	0.16	0.23	0.53
S12		0.39	0.18	0.00	0.00	0.00	0.00	0.21	54.77	0.0	100.0	0.0	0.42	0.45	0.50	0.68
S13		0.14	0.08	0.00	0.00	0.00	0.00	0.06	44.00	0.0	100.0	0.0	0.32	0.35	0.41	0.63

TIME OF CONCENTRATION

Project: US 6 West, Hillcrest to Arrowgrass
Project #: 118339-01
Date: 07-May-21
File: Hydro_Existing.xlsx

Equation:
$t_i=0.395(1.1-C_5)L^{0.5}/S^{0.33}$
$V=C_V S_W^{0.5}$
$t_t=L_W/(60V)$

SURFACE TYPES
A=Forest with ground litter & meadow
B=Fallow or minimum tillage cultivation
C= Short grass pasture & lawns
D=Nearly bare ground
E=Grassed waterway
F=Paved area (sheet flow) & shallow gutter flow

Surface Type	Factor (C_V)
A	0.25
B	0.50
C	0.70
D	1.00
E	1.50
F	2.00

SUB-BASIN DATA			INITIAL/OVERLAND TIME (t_i)				TRAVEL TIME (t_t)					T_C	T_C Check (Urban)				BASIN DEFINITION	FINAL
BASIN	**DESIGN** PT.	**C5**	**AREA** (AC)	**LENGTH, L** (FT)	**SLOPE, S** (%)	**t_i** (MIN)	**LENGTH, L_W** (FT)	**SLOPE, S_W** (%)	**SURF.** TYPE	**VEL.** (F/S)	**t_t** (MIN)	**t_i+t_t** (MIN)	**$L_T=L+L_W$** (FT)	**S_0** (FT/FT)	**i** (AC/AC)	**(18-15i)+L_t/(60(24i+12)SQRT(S_0))** (MIN)	**URBAN OR NON-URBAN**	**T_C** (MIN)
N1		0.34	1.08	21.7	3.10	4.4	647	0.5	F	1.3	8.0	12.4	668.9	0.005	0.428	18.4	URBAN	12.4
N2		0.29	1.15	30.9	4.75	4.9	637	0.2	F	0.9	11.9	16.7	667.8	0.004	0.369	20.8	URBAN	16.7
N3		0.86	0.14	31.5	5.87	1.4	154	3.8	F	3.9	0.7	5.0	185.8	0.041	1.000	3.4	URBAN	5.0
N4		0.86	0.86	36.4	4.95	1.5	610	1.4	E	1.8	5.7	7.3	646.7	0.016	1.000	5.4	URBAN	5.4
N5		0.72	0.40	57.3	10.60	2.4	168	0.6	E	1.2	2.4	5.0	225.4	0.032	0.853	5.9	URBAN	5.0
S1		0.38	0.99	25.6	1.43	5.8	460	0.8	E	1.4	5.6	11.4	485.1	0.009	0.475	14.6	URBAN	11.4
S2		0.07	5.83	500.1	52.3	11.3	585	12.2	E	5.2	1.9	13.1	1085.3	0.307	0.075	19.2	NON-URBAN	13.1
S3		0.04	17.34	500.0	30.84	13.8	1836	34.9	E	8.9	3.5	17.3	2335.7	0.340	0.046	22.4	NON-URBAN	17.3
S4		0.16	0.01	9	13.1	2.2	14	12.6	F	7.1	0.0	5.0	23.2	0.128	0.216	14.8	NON-URBAN	10.0
S5		0.33	0.20	86	3.5	8.6	71	0.4	E	1.0	1.2	9.8	156.9	0.021	0.412	12.6	URBAN	9.8
S6		0.18	0.09	72	20.0	5.2	37	0.6	F	1.6	0.4	5.6	108.8	0.134	0.238	14.7	NON-URBAN	10.0
S7		0.02	8.65	500	60.4	11.2	742	21.4	E	6.9	1.8	13.0	1241.7	0.371	0.020	20.4	NON-URBAN	13.0
S8		0.03	2.99	418	55.6	10.5	832	15.0	F	7.8	1.8	12.3	1249.6	0.286	0.021	20.8	NON-URBAN	12.3
S9		0.12	0.67	372	15.6	13.8	93	5.1	E	3.4	0.5	14.3	464.8	0.135	0.160	16.9	NON-URBAN	14.3
S10		0.01	0.16	27	35.5	3.1	67	13.4	E	5.5	0.2	5.0	93.9	0.197	0.020	18.0	NON-URBAN	10.0
S11		0.16	3.35	344	30.0	10.2	502	5.4	F	4.7	1.8	12.0	845.9	0.154	0.213	16.9	NON-URBAN	12.0
S12		0.45	0.39	219	6.2	9.6	94	5.9	F	4.9	0.3	9.9	312.9	0.061	0.548	10.6	URBAN	9.9
S13		0.35	0.14	147	2.2	12.7	70	1.5	F	2.4	0.5	13.2	217.2	0.019	0.440	12.6	URBAN	12.6

STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)
10-YEAR

Project: US 6 West, Hillcrest to Arrowgrass
Project #: 118339-01
Date: 44323.00
File: Hydro_Existing.xlsx

Q=C*I*A

1-Hour Intensities (P1)
10-Year
0.745
$I=(28.5\ P_1)/(10+T_C)^{0.786}$

BASIN	DES. PT.	DIRECT RUNOFF AREA ACRES	Open % Imp.	COEF.	tc (MIN)	C*A (AC)	I (IN/HR)	Q (CFS)	TOTAL RUNOFF tc (MIN)	C*A (AC)	I (IN/HR)	Q (CFS)	STREET SLOPE (%)	Q	PIPE DESIGN (CFS)	SLOPE (%)	PIPE SIZE	TRAVEL TIME LENGTH (FT.)	VEL. (FPS)	tt (MIN)	REMARKS
N1		1.08	42.83	0.40	12.4	0.44	1.84	0.8													
N2		1.15	36.94	0.36	16.7	0.41	1.60	0.7													
N3		0.14	100.00	0.87	5.0	0.12	2.53	0.3													
N4		0.86	100.00	0.87	5.4	0.75	2.48	1.8													
N5		0.40	85.30	0.75	5.0	0.30	2.53	0.8													
S1		0.99	47.54	0.44	11.4	0.44	1.91	0.8													
S2		5.83	7.55	0.15	13.1	0.86	1.80	1.5													
S3		17.34	4.60	0.11	17.3	1.92	1.58	3.0													
S4		0.01	21.60	0.23	10.0	0.00	2.02	0.0													
S5		0.20	41.20	0.39	9.8	0.08	2.04	0.2													
S6		0.09	23.78	0.25	10.0	0.02	2.02	0.0													
S7		8.65	2.02	0.09	13.0	0.80	1.80	1.4													
S8		2.99	2.10	0.11	12.3	0.32	1.85	0.6													
S9		0.67	16.03	0.19	14.3	0.13	1.73	0.2													
S10		0.16	2.00	0.07	10.0	0.01	2.02	0.0													
S11		3.35	21.33	0.23	12.0	0.78	1.87	1.5													
S12		0.39	54.77	0.50	9.9	0.20	2.02	0.4													
S13		0.14	44.00	0.41	12.6	0.06	1.83	0.1													

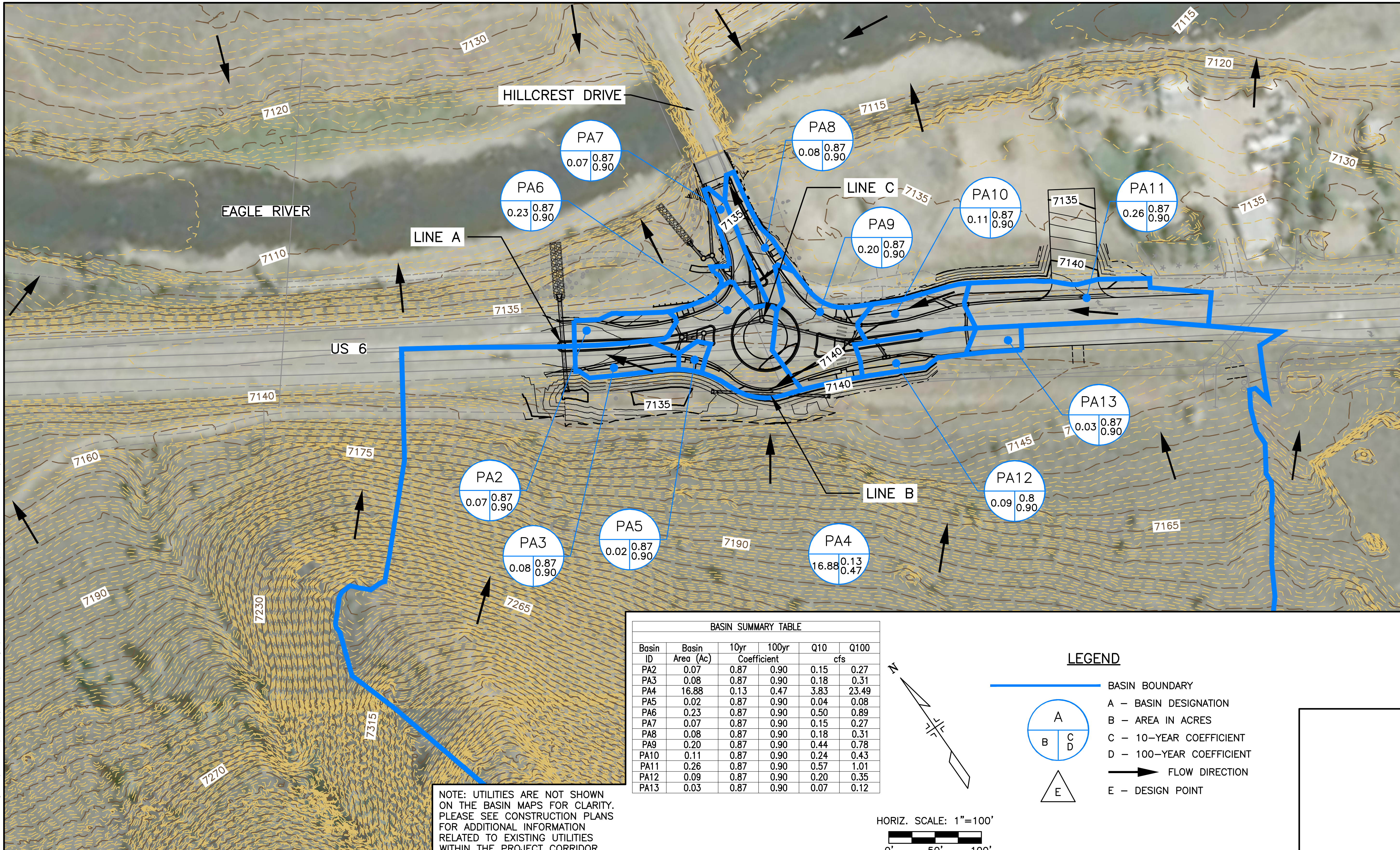
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)
100-YEAR

Project: US 6 West, Hillcrest to Arrowgrass
Project #: 118339-01
Date: 44323.00
File: Hydro_Existing.xlsx

Q=C*I*A

1-Hour Intensities (P1)
100-Year
1.28
$I=(28.5\ P_1)/(10+T_C)^{0.786}$

BASIN	DES. PT.	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
		AREA ACRES	Open % Imp.	COEF.	tc (MIN)	C*A (AC)	I (IN/HR)	Q (CFS)	tc (MIN)	C*A (AC)	I (IN/HR)	Q (CFS)	SLOPE (%)	Q	DESIGN (CFS)	SLOPE (%)	PIPE SIZE	LENGTH (FT.)	VEL. (FPS)	tt (MIN)	
N1		1.08	42.83	0.63	12.4	0.68	3.16	2.1													
N2		1.15	36.94	0.60	16.7	0.69	2.76	1.9													
N3		0.14	100.00	0.90	5.0	0.13	4.34	0.5													
N4		0.86	100.00	0.90	5.4	0.77	4.26	3.3													
N5		0.40	85.30	0.83	5.0	0.33	4.34	1.4													
S1		0.99	47.54	0.65	11.4	0.64	3.28	2.1													
S2		5.83	7.55	0.48	13.1	2.82	3.09	8.7													
S3		17.34	4.60	0.46	17.3	7.98	2.71	21.7													
S4		0.01	21.60	0.53	10.0	0.01	3.46	0.0													
S5		0.20	41.20	0.62	9.8	0.12	3.50	0.4													
S6		0.09	23.78	0.54	10.0	0.05	3.46	0.2													
S7		8.65	2.02	0.45	13.0	3.90	3.10	12.1													
S8		2.99	2.10	0.46	12.3	1.38	3.18	4.4													
S9		0.67	16.03	0.50	14.3	0.34	2.97	1.0													
S10		0.16	2.00	0.44	10.0	0.07	3.46	0.2													
S11		3.35	21.33	0.53	12.0	1.77	3.21	5.7													
S12		0.39	54.77	0.68	9.9	0.27	3.48	0.9													
S13		0.14	44.00	0.63	12.6	0.09	3.15	0.3													



BASIN SUMMARY TABLE

Basin ID	Basin Area (Ac)	10yr Coefficient	100yr Coefficient	Q10 cfs	Q100 cfs
PA2	0.07	0.87	0.90	0.15	0.27
PA3	0.08	0.87	0.90	0.18	0.31
PA4	16.88	0.13	0.47	3.83	23.49
PA5	0.02	0.87	0.90	0.04	0.08
PA6	0.23	0.87	0.90	0.50	0.89
PA7	0.07	0.87	0.90	0.15	0.27
PA8	0.08	0.87	0.90	0.18	0.31
PA9	0.20	0.87	0.90	0.44	0.78
PA10	0.11	0.87	0.90	0.24	0.43
PA11	0.26	0.87	0.90	0.57	1.01
PA12	0.09	0.87	0.90	0.20	0.35
PA13	0.03	0.87	0.90	0.07	0.12

NOTE: UTILITIES ARE NOT SHOWN ON THE BASIN MAPS FOR CLARITY. PLEASE SEE CONSTRUCTION PLANS FOR ADDITIONAL INFORMATION RELATED TO EXISTING UTILITIES WITHIN THE PROJECT CORRIDOR.

N

HORIZ. SCALE: 1"=100'
0' 50' 100'

LEGEND

BASIN BOUNDARY
A – BASIN DESIGNATION
B – AREA IN ACRES
C – 10-YEAR COEFFICIENT
D – 100-YEAR COEFFICIENT
FLOW DIRECTION
E – DESIGN POINT

PRINT DATE: 12/17/2021 1:53 PM
FILE NAME: 1_18339_DRBA_04.DWG
HORIZ. SCALE: 1" = 100' VERT. SCALE: N/A

FELSBURG HOLT & ULLEVIG
6400 S Fiddler's Green Circle, Suite 1500,
Greenwood Village, CO 80111
Phone: 303.721.1440
www.FHUENG.com

Sheet Status

EAGLE COUNTY
ENGINEERING
P.O. BOX
500 BROADWAY
EAGLE, CO 81631

AS CONSTRUCTED
NO. REVISIONS:
REVISED:
VOID:

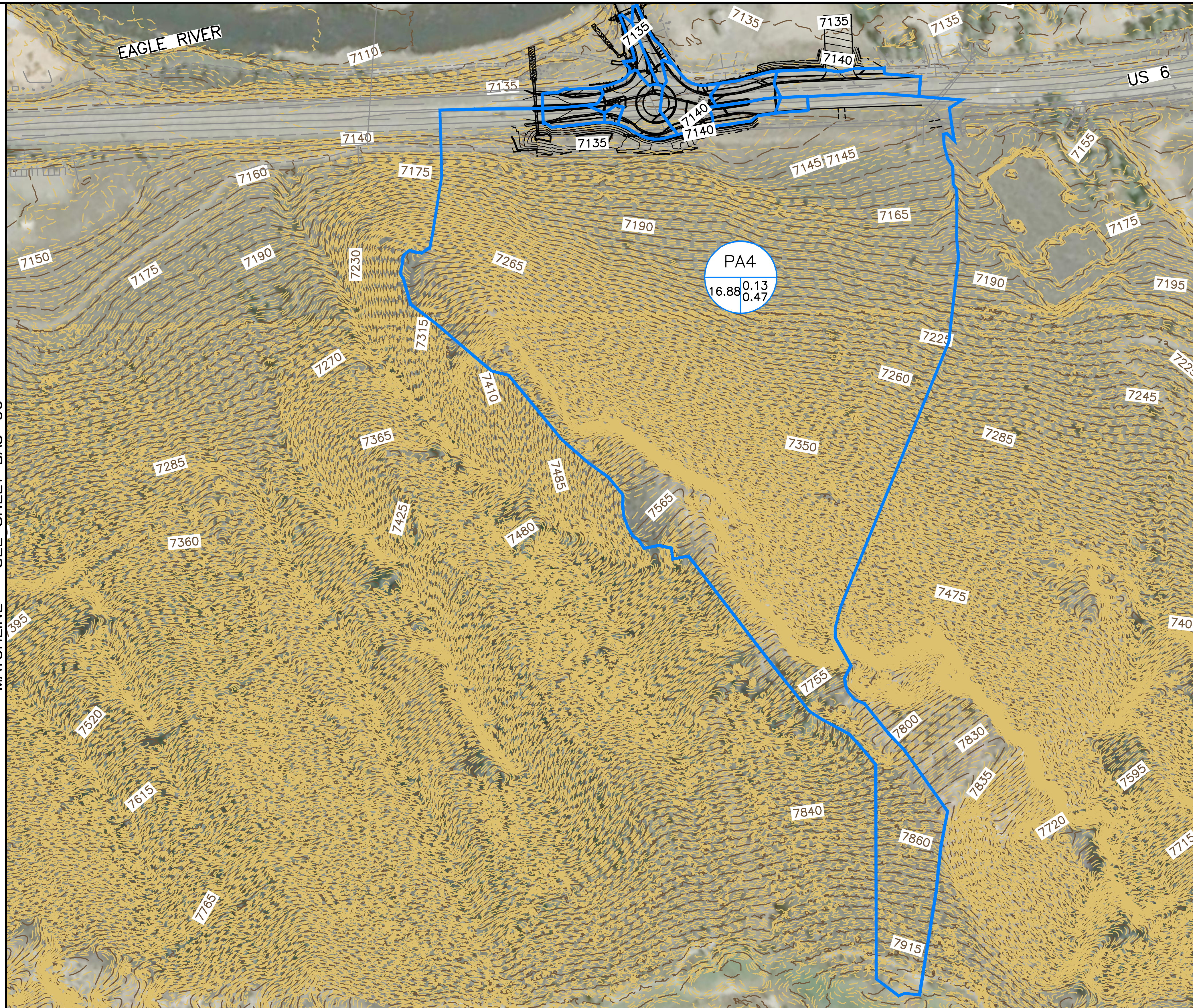
US 6 WEST EDWARDS IMPROVEMENTS
POST-PROJECT
BASIN MAP

DESIGNER: KMG
DETAILER: SV
SHEET SUBSET: DRAINAGE
STRUCTURE NUMBERS
BAS-06 OF 7

PROJECT NO./CODE
##########
6

i:\118339-01 US6W Hillcrest to Arrowgrass\04_CIVIL\CADD\Hydraulics\Drawings\1_18339_DRBA_04, 12/17/2021 1:53:12 PM, Ryan.Walker

MATCHLINE – SEE SHEET BAS-06



BASIN SUMMARY TABLE					
Basin ID	Basin Area (Ac)	10yr Coefficient	100yr	Q10 cfs	Q100
PA2	0.07	0.87	0.90	0.15	0.27
PA3	0.08	0.87	0.90	0.18	0.31
PA4	16.88	0.13	0.47	3.83	23.49
PA5	0.02	0.87	0.90	0.04	0.08
PA6	0.23	0.87	0.90	0.50	0.89
PA7	0.07	0.87	0.90	0.15	0.27
PA8	0.08	0.87	0.90	0.18	0.31
PA9	0.20	0.87	0.90	0.44	0.78
PA10	0.11	0.87	0.90	0.24	0.43
PA11	0.26	0.87	0.90	0.57	1.01
PA12	0.09	0.87	0.90	0.20	0.35
PA13	0.03	0.87	0.90	0.07	0.12

NOTE: UTILITIES ARE NOT SHOWN ON THE BASIN MAPS FOR CLARITY. PLEASE SEE CONSTRUCTION PLANS FOR ADDITIONAL INFORMATION RELATED TO EXISTING UTILITIES WITHIN THE PROJECT CORRIDOR.

LEGEND

- BASIN BOUNDARY
- A – BASIN DESIGNATION
- B – AREA IN ACRES
- C – 10-YEAR COEFFICIENT
- D – 100-YEAR COEFFICIENT
- FLOW DIRECTION
- E – DESIGN POINT

N

HORIZ. SCALE: 1"=200'

0' 100' 200'

PRINT DATE: 12/17/2021 1:53 PM
FILE NAME: 1_18339_DRBA_04.DWG
HORIZ. SCALE: 1" = 200' VERT. SCALE: N/A

FELSBURG HOLT & ULLEVIG
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Sheet Status

EAGLE COUNTY

ENGINEERING
P.O. BOX
500 BROADWAY
EAGLE, CO 81631

AS CONSTRUCTED
NO. REVISIONS:
REVISED:
VOID:

US 6 WEST EDWARDS IMPROVEMENTS
POST-PROJECT BASIN MAP

DESIGNER:	KMG	STRUCTURE NUMBERS	
DETAILER:	SV		
SHEET SUBSET:	DRAINAGE		BAS-07 OF 7

PROJECT NO./CODE
#########

COEFFICIENTS OF DEVELOPMENT

Project: US 6 West, Hillcrest to Arrowgrass

Project #: 118339-01

Date: 17-Dec-21

File: Hydro_Proposed.xlsx

			IMPERVIOUSNESS							SOIL TYPE			RUNOFF COEFF.			
BASIN	DES.	AREA	Open	Residential	Residential	Residential	Commercial	Paved	Comp.							
	PT.	ACRES	% Imp.	% Imp.	% Imp.	% Imp.	% Imp.	% Imp.	% Imp.	A	B	C/D	2	5	10	100
			2	25	35	45	95	100		Percent of	Percent of	Percent of	YEAR	YEAR	YEAR	YEAR
			Acres	Acres	Acres	Acres	Acres	Acres		Total Area	Total Area	Total Area				
PA2	C130	0.07	0.00	0.00	0.00	0.00	0.00	0.07	100.00	0.0	100.0	0.0	0.84	0.86	0.87	0.90
PA3	C120	0.08	0.00	0.00	0.00	0.00	0.00	0.08	100.00	0.0	100.0	0.0	0.84	0.86	0.87	0.90
PA4	A01	16.88	15.88	0.00	0.00	0.00	0.80	0.20	7.57	0.0	80.0	20.0	0.04	0.06	0.13	0.47
PA5	C110	0.02	0.000	0.00	0.00	0.00	0.00	0.02	100.00	0.0	100.0	0.0	0.84	0.86	0.87	0.90
PA6	C50	0.23	0.000	0.00	0.00	0.00	0.00	0.23	100.00	0.0	100.0	0.0	0.84	0.86	0.87	0.90
PA7	C30	0.07	0.00	0.00	0.00	0.00	0.00	0.07	100.00	0.0	100.0	0.0	0.84	0.86	0.87	0.90
PA8	C40	0.08	0.00	0.00	0.00	0.00	0.00	0.08	100.00	0.0	100.0	0.0	0.84	0.86	0.87	0.90
PA9	C70	0.20	0.00	0.00	0.00	0.00	0.00	0.20	100.00	0.0	100.0	0.0	0.84	0.86	0.87	0.90
PA10	C170	0.11	0.00	0.00	0.00	0.00	0.00	0.11	100.00	0.0	100.0	0.0	0.84	0.86	0.87	0.90
PA11	C200	0.26	0.00	0.00	0.00	0.00	0.00	0.26	100.00	0.0	100.0	0.0	0.84	0.86	0.87	0.90
PA12	C180	0.09	0.00	0.00	0.00	0.00	0.00	0.09	100.00	0.0	100.0	0.0	0.84	0.86	0.87	0.90
PA13	C190	0.03	0.00	0.00	0.00	0.00	0.00	0.03	100.00	0.0	100.0	0.0	0.84	0.86	0.87	0.90

TIME OF CONCENTRATION

Project: US 6 West, Hillcrest to Arrowgrass
Project #: 118339-01
Date: 17-Dec-21
File: Hydro_Proposed.xlsx

Equation:
$t_i=0.395(1.1-C_5)L^{0.5}/S^{0.33}$
$V=C_V S_W^{0.5}$
$t_t=L_W/(60V)$

SURFACE TYPES
A=Forest with ground litter & meadow
B=Fallow or minimum tillage cultivation
C= Short grass pasture & lawns
D=Nearly bare ground
E=Grassed waterway
F=Paved area (sheet flow) & shallow gutter flow

Surface Type	Factor (C_V)
A	0.25
B	0.50
C	0.70
D	1.00
E	1.50
F	2.00

SUB-BASIN DATA			INITIAL/OVERLAND TIME (t_i)				TRAVEL TIME (t_t)					T_C	T_C Check (Urban)				BASIN DEFINITION	FINAL
BASIN	**DESIGN** PT.	**C5**	**AREA** (AC)	**LENGTH, L** (FT)	**SLOPE, S** (%)	**t_i** (MIN)	**LENGTH, L_W** (FT)	**SLOPE, S_W** (%)	**SURF.** TYPE	**VEL.** (F/S)	**t_t** (MIN)	**t_i+t_t** (MIN)	**$L_T=L+L_W$** (FT)	**S_0** (FT/FT)	**i** (AC/AC)	**$(18-15i)+L_t/(60(24i+12)SQRT(S_0))$** (MIN)	**URBAN OR NON-URBAN**	**T_C** (MIN)
PA2	C130	0.86	0.07	22.5	2.56	1.5	106	0.7	F	1.7	1.1	5.0	128.4	0.010	1.000	3.6	URBAN	5.0
PA3	C120	0.86	0.08	25.4	1.21	2.1	103	0.1	F	0.7	2.4	5.0	128.4	0.003	1.000	4.0	URBAN	5.0
PA4	A01	0.06	16.88	300.0	28.67	10.7	2036	34.9	E	8.9	3.8	14.6	2336.4	0.341	0.076	21.7	NON-URBAN	14.6
PA5	C110	0.86	0.02	13.9	5.19	0.9	27	1.5	F	2.4	0.2	5.0	40.5	0.028	1.000	3.1	URBAN	5.0
PA6	C50	0.86	0.23	81.9	2.20	3.0	110	1.7	F	2.6	0.7	5.0	192.3	0.019	1.000	3.6	URBAN	5.0
PA7	C30	0.86	0.07	38.5	3.60	1.8	95	4.0	F	4.0	0.4	5.0	133.1	0.039	1.000	3.3	URBAN	5.0
PA8	C40	0.86	0.08	50.8	3.14	2.1	85	4.4	F	4.2	0.3	5.0	135.6	0.039	1.000	3.3	URBAN	5.0
PA9	C70	0.86	0.20	29.3	2.04	1.9	94	2.3	F	3.0	0.5	5.0	123.7	0.022	1.000	3.4	URBAN	5.0
PA10	C170	0.86	0.11	25.6	2.46	1.6	99	0.8	F	1.8	0.9	5.0	124.5	0.012	1.000	3.5	URBAN	5.0
PA11	C200	0.86	0.26	30.1	1.88	1.9	219	0.5	F	1.5	2.5	5.0	249.5	0.007	1.000	4.4	URBAN	5.0
PA12	C180	0.86	0.09	26.5	2.84	1.6	67	0.0001	F	0.0	55.8	57.4	93.5	0.008	1.000	3.5	URBAN	5.0
PA13	C190	0.86	0.03	24.2	2.19	1.6	52	0.6	F	1.6	0.5	5.0	76.1	0.011	1.000	3.3	URBAN	5.0

STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)
10-YEAR

Project: US 6 West, Hillcrest to Arrowgrass
Project #: 118339-01
Date: 44547.00
File: Hydro_Proposed.xlsx

Q=C*I*A

1-Hour Intensities (P1)
10-Year
0.745
$I=(28.5\ P_1)/(10+T_C)^{0.786}$

BASIN	DES. PT.	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
		AREA ACRES	Open % Imp.	COEF.	tc (MIN)	C*A (AC)	I (IN/HR)	Q (CFS)	tc (MIN)	C*A (AC)	I (IN/HR)	Q (CFS)	SLOPE (%)	Q	DESIGN (CFS)	SLOPE (%)	PIPE SIZE	LENGTH (FT.)	VEL. (FPS)	tt (MIN)	
PA2	C130	0.07	100.00	0.87	5.0	0.06	2.53	0.2													
PA3	C120	0.08	100.00	0.87	5.0	0.07	2.53	0.2													
PA4	A01	16.88	7.57	0.13	14.6	2.23	1.71	3.8													
PA5	C110	0.02	100.00	0.87	5.0	0.02	2.53	0.0													
PA6	C50	0.23	100.00	0.87	5.0	0.20	2.53	0.5													
PA7	C30	0.07	100.00	0.87	5.0	0.06	2.53	0.2													
PA8	C40	0.08	100.00	0.87	5.0	0.07	2.53	0.2													
PA9	C70	0.20	100.00	0.87	5.0	0.17	2.53	0.4													
PA10	C170	0.11	100.00	0.87	5.0	0.10	2.53	0.2													
PA11	C200	0.26	100.00	0.87	5.0	0.23	2.53	0.6													
PA12	C180	0.09	100.00	0.87	5.0	0.08	2.53	0.2													
PA13	C190	0.03	100.00	0.87	5.0	0.03	2.53	0.1													

STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)
100-YEAR

Project: US 6 West, Hillcrest to Arrowgrass
Project #: 118339-01
Date: 44547.00
File: Hydro_Proposed.xlsx

Q=C*I*A

1-Hour Intensities (P1)
100-Year
1.28
$I=(28.5\ P_1)/(10+T_C)^{0.786}$

BASIN	DES. PT.	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
		AREA ACRES	Open % Imp.	COEF.	tc (MIN)	C*A (AC)	I (IN/HR)	Q (CFS)	tc (MIN)	C*A (AC)	I (IN/HR)	Q (CFS)	SLOPE (%)	Q	DESIGN (CFS)	SLOPE (%)	PIPE SIZE	LENGTH (FT.)	VEL. (FPS)	tt (MIN)	
PA2	C130	0.07	100.00	0.90	5.0	0.06	4.34	0.3													
PA3	C120	0.08	100.00	0.90	5.0	0.07	4.34	0.3													
PA4	A01	16.88	7.57	0.47	14.6	7.97	2.95	23.5													
PA5	C110	0.02	100.00	0.90	5.0	0.02	4.34	0.1													
PA6	C50	0.23	100.00	0.90	5.0	0.21	4.34	0.9													
PA7	C30	0.07	100.00	0.90	5.0	0.06	4.34	0.3													
PA8	C40	0.08	100.00	0.90	5.0	0.07	4.34	0.3													
PA9	C70	0.20	100.00	0.90	5.0	0.18	4.34	0.8													
PA10	C170	0.11	100.00	0.90	5.0	0.10	4.34	0.4													
PA11	C200	0.26	100.00	0.90	5.0	0.23	4.34	1.0													
PA12	C180	0.09	100.00	0.90	5.0	0.08	4.34	0.4													
PA13	C190	0.03	100.00	0.90	5.0	0.03	4.34	0.1													

APPENDIX B. HYDRAULIC CALCULATIONS

MHFD-Inlet, Version 5.01 (April 2021)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	Type 16 on grade single 0.5%	C130	C50
Site Type (Urban or Rural)			
Inlet Application (Street or Area)	STREET	STREET	STREET
Hydraulic Condition	On Grade	On Grade	On Grade
Inlet Type	Denver No. 16 Combination	Denver No. 16 Combination	Denver No. 16 Combination

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	0.5	0.2	0.5
Major Q_{Known} (cfs)	2.0	0.3	0.9

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	No Bypass Flow Received	No Bypass Flow Received	C130
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0

Watershed Characteristics

Subcatchment Area (acres)			
Percent Impervious			
NRCS Soil Type			

Watershed Profile

Overland Slope (ft/ft)			
Overland Length (ft)			
Channel Slope (ft/ft)			
Channel Length (ft)			

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	**0.5**	**0.2**	**0.5**
Major Total Design Peak Flow, Q (cfs)	**2.0**	**0.3**	**0.9**
Minor Flow Bypassed Downstream, Q_b (cfs)	0.0	0.0	0.1
Major Flow Bypassed Downstream, Q_b (cfs)	0.7	0.0	0.1

MHFD-Inlet, Version 5.01 (April 2021)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	C30	C120	C110
Site Type (Urban or Rural)			
Inlet Application (Street or Area)	STREET	STREET	STREET
Hydraulic Condition	On Grade	In Sump	In Sump
Inlet Type	Denver No. 16 Combination	Denver No. 16 Combination	Denver No. 16 Combination

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	0.2	0.2	0.0
Major Q_{Known} (cfs)	0.3	0.3	0.1

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	C50	No Bypass Flow Received	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)	0.1	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.1	0.0	0.0

Watershed Characteristics

Subcatchment Area (acres)			
Percent Impervious			
NRCS Soil Type			

Watershed Profile

Overland Slope (ft/ft)			
Overland Length (ft)			
Channel Slope (ft/ft)			
Channel Length (ft)			

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	**0.2**	**0.2**	**0.0**
Major Total Design Peak Flow, Q (cfs)	**0.4**	**0.3**	**0.1**
Minor Flow Bypassed Downstream, Q_b (cfs)	0.0	N/A	N/A
Major Flow Bypassed Downstream, Q_b (cfs)	0.0	N/A	N/A

MHFD-Inlet, Version 5.01 (April 2021)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	C200	C170	C70
Site Type (Urban or Rural)			
Inlet Application (Street or Area)	STREET	STREET	STREET
Hydraulic Condition	On Grade	On Grade	On Grade
Inlet Type	Denver No. 16 Combination	Denver No. 16 Combination	Denver No. 16 Combination

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	0.6	0.2	0.4
Major Q_{Known} (cfs)	1.0	0.4	0.8

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	No Bypass Flow Received	C200	C170
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0	0.1	0.0

Watershed Characteristics

Subcatchment Area (acres)			
Percent Impervious			
NRCS Soil Type			

Watershed Profile

Overland Slope (ft/ft)			
Overland Length (ft)			
Channel Slope (ft/ft)			
Channel Length (ft)			

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	**0.6**	**0.2**	**0.4**
Major Total Design Peak Flow, Q (cfs)	**1.0**	**0.6**	**0.8**
Minor Flow Bypassed Downstream, Q_b (cfs)	0.0	0.0	0.1
Major Flow Bypassed Downstream, Q_b (cfs)	0.1	0.0	0.2

MHFD-Inlet, Version 5.01 (April 2021)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	C40	C190	C180
Site Type (Urban or Rural)			
Inlet Application (Street or Area)	STREET	STREET	STREET
Hydraulic Condition	On Grade	On Grade	In Sump
Inlet Type	Denver No. 16 Combination	Denver No. 16 Combination	Denver No. 16 Combination

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	0.2	0.1	0.2
Major Q_{Known} (cfs)	0.3	0.1	0.4

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	C70	No Bypass Flow Received	C190
Minor Bypass Flow Received, Q_b (cfs)	0.1	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.2	0.0	0.0

Watershed Characteristics

Subcatchment Area (acres)			
Percent Impervious			
NRCS Soil Type			

Watershed Profile

Overland Slope (ft/ft)			
Overland Length (ft)			
Channel Slope (ft/ft)			
Channel Length (ft)			

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

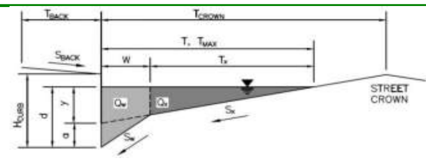
CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	**0.2**	**0.1**	**0.2**
Major Total Design Peak Flow, Q (cfs)	**0.5**	**0.1**	**0.4**
Minor Flow Bypassed Downstream, Q_b (cfs)	0.1	0.0	N/A
Major Flow Bypassed Downstream, Q_b (cfs)	0.2	0.0	N/A

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

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

Project: US 6 Edwards West Improvements
Inlet ID: C130



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	11.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.012	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

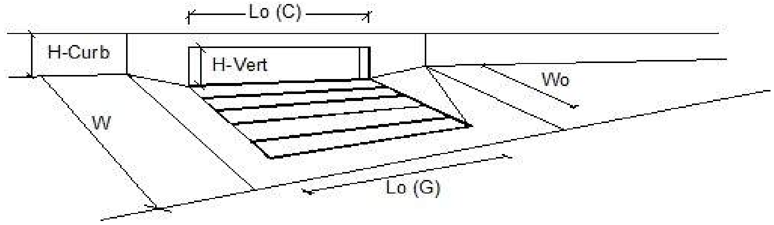
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	4.0	10.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion MAJOR STORM Allowable Capacity is based on Spread Criterion	Q_{allow} =	**0.9**	**4.2**	**cfs**

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

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



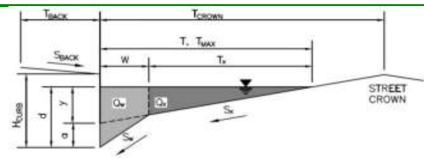
Design Information (Input)	Denver No. 16 Combination		MINOR	MAJOR	
Type of Inlet		Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity'			MINOR	MAJOR	
Total Inlet Interception Capacity		**Q =**	**0.1**	**0.3**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)		**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o =		**C% =**	**94**	**95**	**%**

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

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

Project: US 6 Edwards West Improvements

Inlet ID: C50



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	11.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.019	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

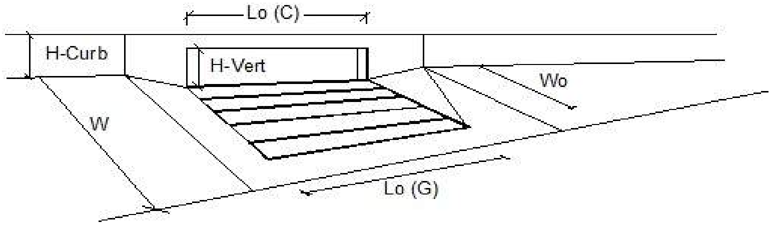
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	4.0	10.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**1.1**	**5.3**	**cfs**

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

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



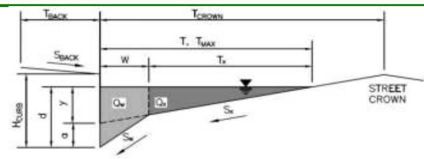
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.5**	**0.8**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.1**	**0.1**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**90**	**84**	**%**

Denver No. 16 Combination

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

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

Project: US 6 Edwards West Improvements
Inlet ID: C30



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	11.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.019	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

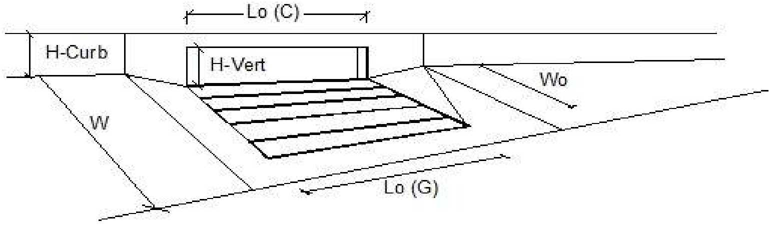
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	4.0	10.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**1.1**	**5.3**	**cfs**

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

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)	Denver No. 16 Combination		MINOR	MAJOR	
Type of Inlet		Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f-C =	0.10	0.10	

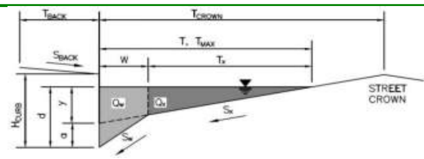
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.2**	**0.4**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**88**	**90**	**%**

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

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

Project: US 6 Edwards West Improvements

Inlet ID: C120



Gutter Geometry:

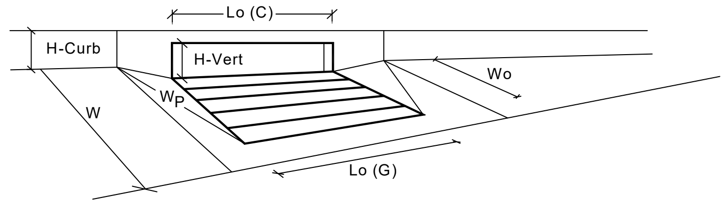
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =			ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =			
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	11.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.020		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	4.0	10.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

MINOR STORM Allowable Capacity is based on Depth Criterion
MAJOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm	
Q_{allow} =	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet (Denver No. 16 Combination)	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	2	2	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	2.5	3.9	inches
Grate Information		MINOR	MAJOR	Override Depths
Length of a Unit Grate	L_o (G) =	3.00	3.00	feet
Width of a Unit Grate	W_o =	1.73	1.73	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.60	3.60	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.50	6.50	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	0.00	0.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.229	0.349	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.04	0.16	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.29	0.46	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.80	0.96	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.29	0.46	

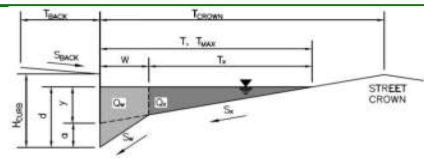
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**0.5**	**1.9**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	0.2	0.3	cfs

MHFD-Inlet, Version 5.01 (April 2021)

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

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

Project: **US 6 Edwards West Improvements**
Inlet ID: **C110**

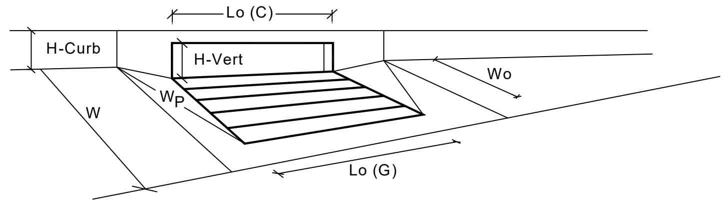


Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =			ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =			
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	11.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.020		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	4.0	10.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)

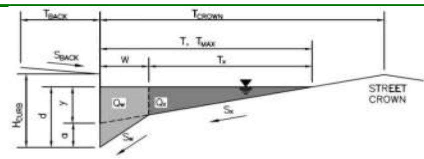


		MINOR	MAJOR	
Design Information (Input) — Denver No. 16 Combination				
Type of Inlet	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	2.5	3.9	inches
Grate Information		MINOR	MAJOR	Override Depths
Length of a Unit Grate	L_o (G) =	3.00	3.00	feet
Width of a Unit Grate	W_o =	1.73	1.73	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.60	3.60	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.50	6.50	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	0.00	0.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.229	0.349	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.04	0.16	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.39	0.61	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.39	0.61	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**0.4**	**1.3**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	0.0	0.1	cfs

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

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

Project: US 6 Edwards West Improvements
Inlet ID: C200



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	11.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.007	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

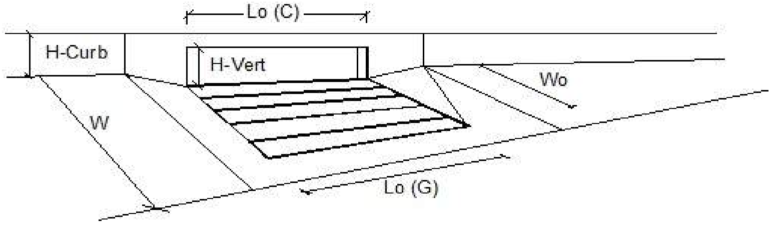
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	4.0	10.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**0.7**	**3.3**	**cfs**

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

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



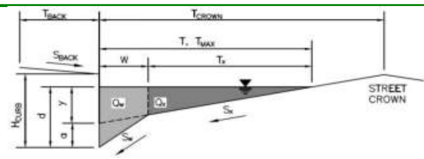
Design Information (Input)		MINOR	MAJOR	
Type of Inlet (Denver No. 16 Combination)	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.6**	**0.9**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.1**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**99**	**86**	**%**

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

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

Project: US 6 Edwards West Improvements
Inlet ID: C170



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =			ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =			
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	11.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.020		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.007		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	4.0	10.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

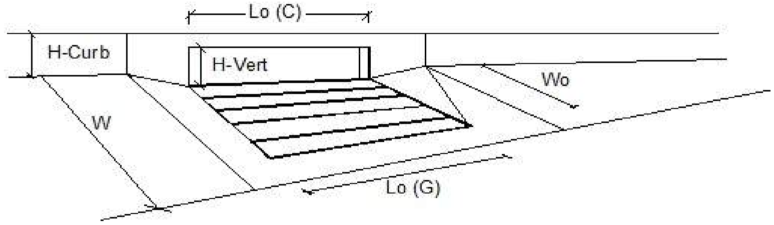
MINOR STORM Allowable Capacity is based on Spread Criterion
MAJOR STORM Allowable Capacity is based on Spread Criterion

		Minor Storm	Major Storm	
	Q_{allow} =	**0.7**	**3.3**	**cfs**

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

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)	Denver No. 16 Combination		MINOR	MAJOR	
Type of Inlet		Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.3**	**0.6**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**100**	**99**	**%**

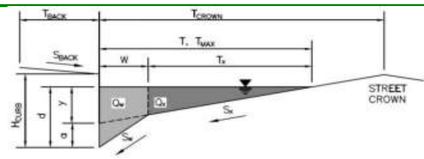
MHFD-Inlet, Version 5.01 (April 2021)

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

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

Project: **US 6 Edwards West Improvements**

Inlet ID: **C70**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	11.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.021	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

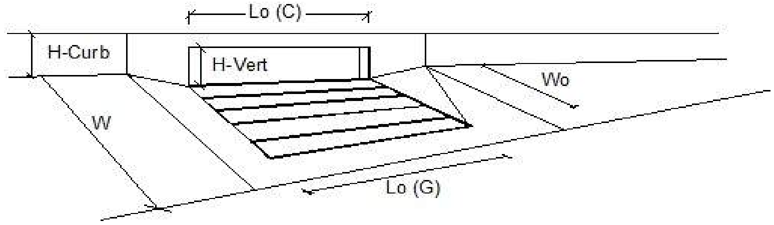
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	4.0	10.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**1.2**	**5.6**	**cfs**

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

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)

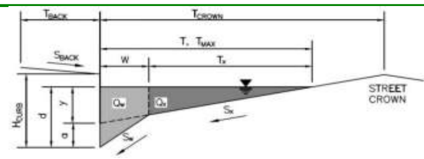


Design Information (Input)	Denver No. 16 Combination	MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.4**	**0.6**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.1**	**0.2**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**87**	**79**	**%**

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

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

Project: US 6 Edwards West Improvements
Inlet ID: C40



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	11.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.057	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

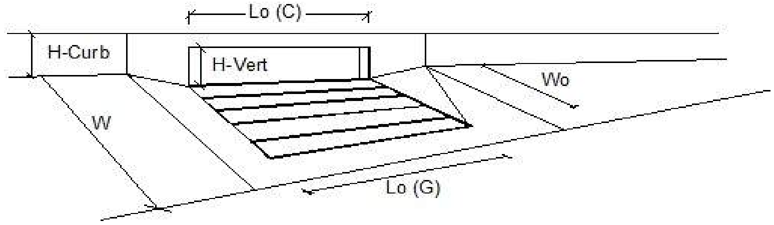
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	4.0	10.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**1.9**	**9.2**	**cfs**

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

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)

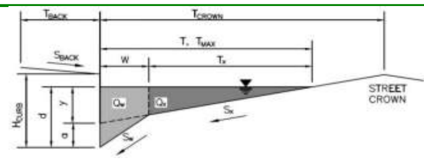


Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.2**	**0.3**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.1**	**0.2**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**75**	**66**	**%**

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

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

Project: **US 6 Edwards West Improvements**
Inlet ID: **C190**



Gutter Geometry:

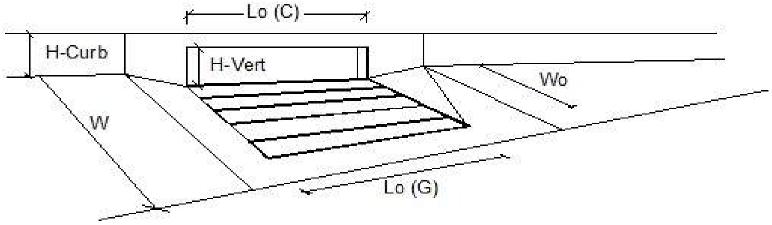
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =			ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =			
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	11.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.020		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.007		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	4.0	10.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**0.7**	**3.2**	**cfs**

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

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



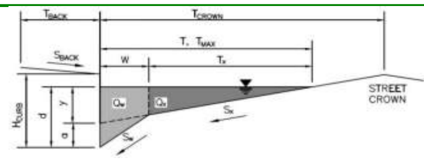
Design Information (Input)	Denver No. 16 Combination		MINOR	MAJOR	
Type of Inlet		Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.1**	**0.1**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**100**	**99**	**%**

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

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

Project: US 6 Edwards West Improvements
Inlet ID: C180

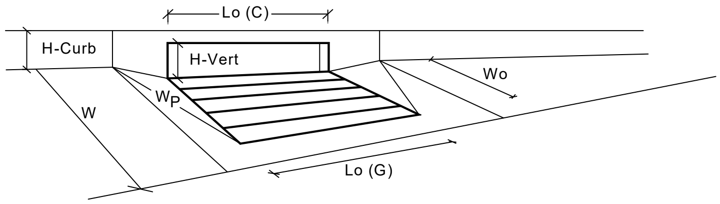


Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =			ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =			
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	11.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.020		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	4.0	10.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)	Denver No. 16 Combination		MINOR	MAJOR	
Type of Inlet		Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)		a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	2	2	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	2.5	3.9	inches
Grate Information			MINOR	MAJOR	Override Depths
Length of a Unit Grate		L_o (G) =	3.00	3.00	feet
Width of a Unit Grate		W_o =	1.73	1.73	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A_{ratio} =	0.31	0.31	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)		C_w (G) =	3.60	3.60	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C_o (G) =	0.60	0.60	
Curb Opening Information			MINOR	MAJOR	
Length of a Unit Curb Opening		L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches		H_{vert} =	6.50	6.50	inches
Height of Curb Orifice Throat in Inches		H_{throat} =	5.25	5.25	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	0.00	0.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		C_w (C) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C_o (C) =	0.66	0.66	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.229	0.349	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.04	0.16	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.29	0.46	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.80	0.96	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.29	0.46	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	$\mathbf{Q_a}$ =	**0.5**	**1.9**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	0.2	0.4	cfs

FlexTable: Catch Basin Table

Label	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Hydraulic Grade Line (In) (ft)	Headloss (ft)	Headloss Method	Headloss Coefficient (Standard)
C120	7,138.64	7,132.50	7,132.79	0.10	Standard	1.500
C130	7,138.10	7,132.20	7,132.47	0.09	Standard	1.500
C110	7,138.43	7,132.00	7,132.14	0.03	Standard	1.500
C50	7,137.12	7,130.43	7,131.60	0.42	Standard	1.500
C70	7,137.43	7,131.10	7,131.73	0.02	Standard	1.500
C40	7,132.24	7,129.51	7,129.86	0.12	Standard	1.500
C30	7,132.40	7,126.50	7,126.93	0.15	Standard	1.500
C190	7,140.87	7,136.00	7,136.18	0.06	Standard	1.500
C200	7,140.64	7,134.25	7,134.78	0.18	Standard	1.500
C180	7,140.07	7,135.00	7,135.31	0.10	Standard	1.500
C170	7,139.69	7,133.30	7,133.64	0.11	Standard	1.500
C305	7,139.93	7,132.36	7,132.82	0.01	Standard	1.500

FlexTable: Manhole Table

Label	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss Method	Headloss Coefficient (Standard)
C100	7,138.98	7,131.96	7,132.29	7,132.22	Standard	0.800
C90	7,138.83	7,131.78	7,132.13	7,132.06	Standard	0.700
C80	7,139.73	7,131.28	7,132.05	7,131.88	Standard	0.800
C60	7,138.35	7,130.77	7,131.71	7,131.59	Standard	0.800
C20	7,133.56	7,125.53	7,125.59	7,125.35	Standard	0.800
C10	7,133.01	7,124.50	7,125.40	7,125.10	Standard	1.000
C160	7,141.14	7,132.97	7,133.44	7,133.34	Standard	0.800
C150	7,140.82	7,132.42	7,132.97	7,132.90	Standard	0.700
C140	7,140.57	7,132.30	7,132.90	7,132.78	Standard	0.700
C136	7,140.10	7,132.16	7,132.81	7,132.68	Standard	0.700

FlexTable: Conduit Table

Label	Invert (Start) (ft)	Invert (Stop) (ft)	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Flow (cfs)	Velocity (ft/s)	Capacity (Full Flow) (cfs)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)
C115	7,132.50	7,132.00	18.0	0.028	24.0	0.31	3.63	37.70	7,132.69	7,132.29
C125	7,132.20	7,132.00	17.0	0.012	24.0	0.27	2.58	24.54	7,132.38	7,132.29
C95	7,131.96	7,131.86	20.0	0.005	24.0	0.58	2.41	16.00	7,132.22	7,132.13
C105	7,132.00	7,131.86	8.0	0.018	24.0	0.08	2.04	29.92	7,132.11	7,132.13
C85	7,131.78	7,131.48	60.0	0.005	24.0	0.66	2.51	16.00	7,132.06	7,132.05
C75	7,131.28	7,130.97	37.0	0.008	24.0	2.92	4.66	20.71	7,131.88	7,131.71
C55	7,130.77	7,130.63	25.0	0.006	24.0	3.70	4.31	16.93	7,131.59	7,131.60
C65	7,131.10	7,130.97	24.0	0.005	24.0	0.78	2.71	16.65	7,131.71	7,131.71
C45	7,130.43	7,125.73	34.0	0.138	24.0	4.59	14.32	84.11	7,131.18	7,126.06
C15	7,124.55	7,124.50	6.0	0.008	24.0	5.17	5.47	20.65	7,125.35	7,125.40
C05	7,124.30	7,124.12	35.0	0.005	24.0	5.17	4.59	16.22	7,125.10	7,124.90
C35	7,129.51	7,126.50	25.0	0.120	12.0	0.31	6.67	12.36	7,129.74	7,126.93
C25	7,126.50	7,124.80	78.0	0.022	18.0	0.58	4.20	15.51	7,126.78	7,125.59
C185	7,136.00	7,134.07	49.0	0.039	24.0	0.12	3.07	44.89	7,136.12	7,134.15
C195	7,134.25	7,134.10	23.0	0.007	24.0	1.01	3.12	18.27	7,134.60	7,134.42
C155	7,132.97	7,132.50	94.0	0.005	24.0	1.13	2.94	16.00	7,133.34	7,132.97
C175	7,135.00	7,134.81	17.0	0.011	24.0	0.35	2.74	23.91	7,135.20	7,134.98
C165	7,133.30	7,133.19	19.0	0.006	24.0	0.43	2.32	17.21	7,133.52	7,133.41
C145	7,132.42	7,132.30	26.0	0.005	24.0	1.48	3.09	15.37	7,132.90	7,132.90
C137	7,132.30	7,132.16	26.0	0.005	24.0	1.91	3.52	16.60	7,132.78	7,132.81
C135	7,132.16	7,131.82	66.0	0.005	24.0	2.26	3.64	16.24	7,132.68	7,132.32
C300	7,132.36	7,132.26	17.0	0.006	24.0	0.35	2.19	17.35	7,132.81	7,132.81

Culvert Calculator Report
Cross Culvert A

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	7,138.00	ft	Headwater Depth/Height	0.86	
Computed Headwater Eleva	7,137.48	ft	Discharge	25.00	cfs
Inlet Control HW Elev.	7,137.23	ft	Tailwater Elevation	7,130.00	ft
Outlet Control HW Elev.	7,137.48	ft	Control Type	Entrance Control	

Grades

Upstream Invert	7,134.90	ft	Downstream Invert	7,132.08	ft
Length	82.00	ft	Constructed Slope	0.034390	ft/ft

Hydraulic Profile

Profile	S2		Depth, Downstream	0.96	ft
Slope Type	Steep		Normal Depth	0.91	ft
Flow Regime	Supercritical		Critical Depth	1.61	ft
Velocity Downstream	12.76	ft/s	Critical Slope	0.004410	ft/ft

Section

Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev.	7,137.48	ft	Upstream Velocity Head	0.65	ft
Ke	0.50		Entrance Loss	0.32	ft

Inlet Control Properties

Inlet Control HW Elev.	7,137.23	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	7.1	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Designer/Analyzer Report
Culvert B

Analysis Component			
Storm Event	Check	Discharge	23.50 cfs

Peak Discharge Method: User-Specified			
Design Discharge	16.00 cfs	Check Discharge	23.50 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	7,137.50 ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-19x30 inch Horiz Ellipse	12.63 cfs	7,139.24 ft	3.93 ft/s
Weir	Broad Crested	10.87 cfs	7,139.24 ft	N/A
Total	----------------	23.50 cfs	7,139.24 ft	N/A

Culvert Designer/Analyzer Report
Culvert B

Component:Culvert-1

Culvert Summary					
Computed Headwater Eleva	7,139.24	ft	Discharge	12.63	cfs
Inlet Control HW Elev.	7,139.14	ft	Tailwater Elevation	7,137.50	ft
Outlet Control HW Elev.	7,139.24	ft	Control Type	Entrance Control	
Headwater Depth/Height	1.09				

Grades					
Upstream Invert	7,137.50	ft	Downstream Invert	7,136.00	ft
Length	129.00	ft	Constructed Slope	0.011628	ft/ft

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	1.50	ft
Slope Type	Steep		Normal Depth	0.80	ft
Flow Regime	N/A		Critical Depth	1.03	ft
Velocity Downstream	3.93	ft/s	Critical Slope	0.004438	ft/ft

Section					
Section Shape	Horizontal Ellipse		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.52	ft
Section Size	19x30 inch		Rise	1.60	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	7,139.24	ft	Upstream Velocity Head	0.47	ft
Ke	0.50		Entrance Loss	0.24	ft

Inlet Control Properties					
Inlet Control HW Elev.	7,139.14	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge with headwall (horizontal ellipse)		Area Full	3.3	ft²
K	0.01000		HDS 5 Chart	29	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Designer/Analyzer Report
Culvert B

Component:Weir

Hydraulic Component(s): Broad Crested					
Discharge	10.87	cfs	Allowable HW Elevation	7,139.24	ft
Weir Coefficient	3.00	US	Length	30.00	ft
Crest Elevation	7,139.00	ft	Headwater Elevation	7,139.24	ft

FELSBURG HOLT & ULLEVIG	**Job Title:** US 6, Hillcrest to Arrowgrass	**By:** KMG	**Date:** 07/18/22	**Job No.:** 118339-01		
	Subject: Riprap Apron Sizing For Single Circular Conduit		**Checked:**	**Sheet** 1 of 1		

1. Given Information | **Structure Name and Location:** Endsection A01

Q	25.00	c.f.s	(design flow)
D	3.00	ft.	(pipe diameter)
n	0.013		(Manning's n)
S_o	0.03450	ft./ft.	(pipe slope)
Assume flow is	Supercritical	Supercritical/Subcritical	

Tailwater Depth (Y_t) = unknown, assume = 0.4*D   1.2 ft.

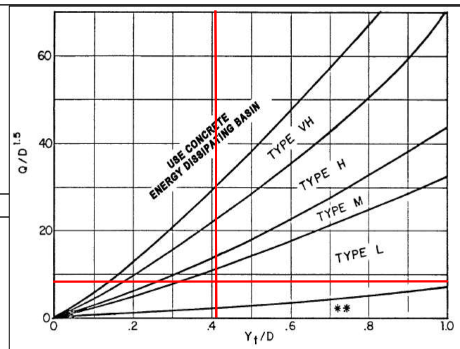
D / 3 = 3.00 ft / 3 = 1.000 ft.

Allowable Velocity = 5 fps

(Max.=7.0 fps if Clay, and 5.0 fps if Sandy)

2. Manning Formula - Input CulvertMaster Results

V	13.18	f.p.s.	(velocity)
y_n	0.94	ft.	(normal depth of supercritical flow)
y_n/D	0.31		
D_a	1.97	ft	$D_a=(D+y_n)/2$, for supercritical flow



Use D_a instead of D whenever flow is supercritical in the barrel.
** Use Type L for a distance of 3D downstream.

Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for $Q/D_a^{2.5} \le 6.0$)

3. Required Rock Size

$Q/D^{1.5}$ = Q / $D_?^{1.5}$ | D if subcritical or D_a if supercritical

$Q/D^{1.5}$ = 25.00 / (1.97)$^{1.5}$

$Q/D^{1.5}$ = **9.04**

y_t/D = 1.2 / 3.00

y_t/D = **0.40**

Per Fig 9-38, use Type **L** riprap d_{50} = **9** in.

d_{50} = = 0.38 ft check from putting eq. 9-18 into eq. 9-16 for supercritical

Minimum Thickness of d_{50}

$T_{MIN} = 2 * d_{50}$ = 2 * 9 = 18 in. = **1.5 ft.**

Riprap Designation	d_{50} (inches)
L	9
M	12
H	18
VH	24

4. Extent of Protection

Froude Parameter

$\frac{Q}{D^{2.5}} = \frac{25.00}{3.00^{2.5}}$ = **1.6** > 6.0 by ~ **0**

so increase L_{pmax} by 1/4D for every 1

Use Figure 9-35 to the right to find 1/(2TanΘ)

$\frac{1}{2Tan\Theta}$ = **6.2** = Expansion Factor

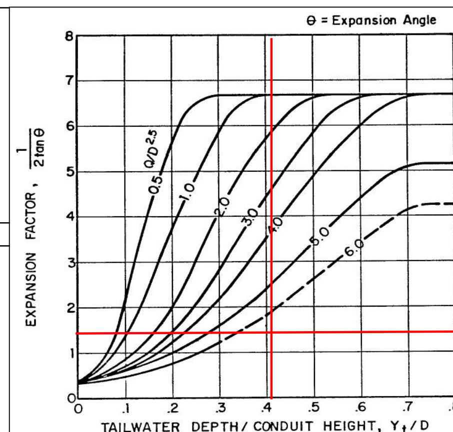


Figure 9-35. Expansion factor for circular conduits

5. Lp, Length of Protection

where V is max. allow velocity

L_p = *1/2 Tan Θ *(Q/V / y_t - D)*

L_p = 6.2 *(5.00 / 1.2 - 3.00)

L_p = 7.23 ft

L_p CHECK

$L_{p\ Min}$ = 3*D = 9 ft

$L_{p\ Max}$=10*D+1/4D(0) = 30 ft

USE = **9 ft**

7. T, Width of Protection

T = 2 (L_p * TanΘ) + Diameter of conduit = 2 * (9 * 1/(2*Expansion Factor)) + 3.00 = 4.5 ft. USE **5 ft.**

8. Summary

Riprap Min. d_{50} (in.)	T_{MIN}, Min. Thickness (ft.)	L_p, Min. Length (ft.)	T, Min. Width (ft.)	Riprap Quantity (C.Y.)	Filter Material (Class A) Quantity (C.Y.)
9	1.5	9	5	2.50	1.67

FELSBURG HOLT & ULLEVIG

Job Title: US 6, Hillcrest to Arrowgrass **By:** KMG **Date:** 02/16/22 **Job No.:** 118339-01

Subject: Riprap Apron Sizing For Single Circular Conduit **Checked:** **Sheet** 1 of 1

1. Given Information | **Structure Name and Location:** Endsection C01

Q	4.82	c.f.s	(design flow)
D	2.00	ft.	(pipe diameter)
n	0.013		(Manning's n)
S_o	0.00700	ft./ft.	(pipe slope)
Assume flow is	Supercritical	Supercritical/Subcritical	

Tailwater Depth (Y_t) = unknown, assume = 0.4*D 0.8 ft.

D / 3 = 2.00 ft / 3 = 0.667 ft.

Allowable Velocity = 5 fps

(Max.=7.0 fps if Clay, and 5.0 fps if Sandy)

2. Manning Formula - Input CulvertMaster Results

V	5.03	f.p.s.	(velocity)
y_n	0.69	ft.	(normal depth of supercritical flow)
y_n/D	0.35		
D_a	1.35	ft	$D_a=(D+y_n)/2$, for supercritical flow

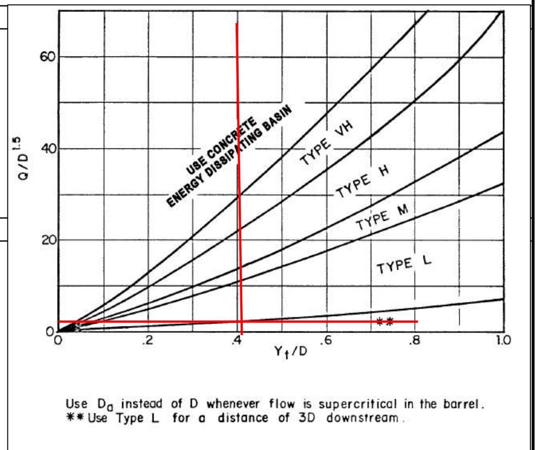


Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for $Q/D_{2.5} \le 6.0$)

3. Required Rock Size

$Q/D^{1.5}$ = Q / $D_?^{1.5}$ | D if subcritical or D_a if supercritical

$Q/D^{1.5}$ = 4.82 / (1.35 $)^{1.5}$

$Q/D^{1.5}$ = **3.09**

y_t/D = 0.8 / 2.00

y_t/D = **0.40**

Per Fig 9-38, use Type **L** riprap d_{50} = **9** **in.**

d_{50} = 0.13 ft check from putting eq. 9-18 into eq. 9-16 for supercritical

Minimum Thickness of d_{50}

$T_{MIN} = 2 * d_{50}$ = 2 * 9 = 18 in. = **1.5** **ft.**

Riprap Designation	d_{50} (inches)
L	9
M	12
H	18
VH	24

4. Extent of Protection

Froude Parameter

$\frac{Q}{D^{2.5}} = \frac{4.82}{2.00^{2.5}}$ = **0.9** > 6.0 by ~ **0**

so increase L_{pmax} by 1/4D for every 1

Use Figure 9-35 to the right to find 1/(2TanΘ)

$\frac{1}{2\tan\Theta}$ = **6.7** = Expansion Factor

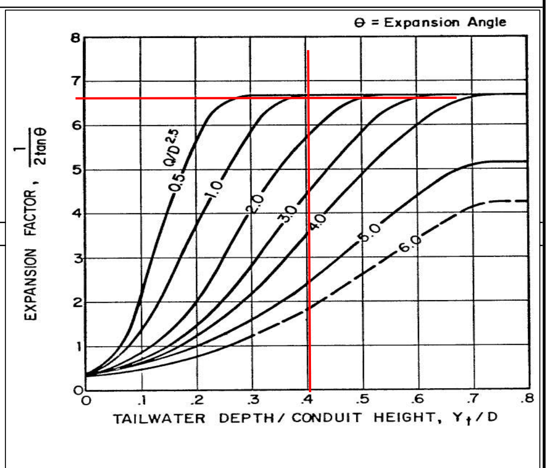


Figure 9-35. Expansion factor for circular conduits

5. Lp, Length of Protection

where V is max. allow velocity

*L_p = 1/2 Tan Θ *(Q/V / y_t - D)*

L_p = 6.7 *(0.96 / 0.8 - 2.00)

L_p = -5.33 ft

L_p CHECK

$L_{p\ Min}$ = 3*D = 6 ft

$L_{p\ Max}$=10*D+1/4D(0) = 20 ft

USE = **6** **ft**

7. T, Width of Protection

T = 2 (L_p * TanΘ) + Diameter of conduit = 2 * (6 * 1/(2*Expansion Factor)) + 2.00 = 2.9 ft. USE **3 ft.**

8. Summary

Riprap Min. d_{50} (in.)	T_{MIN}, Min. Thickness (ft.)	L_p, Min. Length (ft.)	T, Min. Width (ft.)	Riprap Quantity (C.Y.)	Filter Material (Class A) Quantity (C.Y.)
9	1.5	6	3	1.0	0.7

APPENDIX C. SUPPORTING INFORMATION

NOAA Atlas 14, Volume 8, Version 2
Location name: Edwards, Colorado, USA*
Latitude: 39.654°, Longitude: -106.6291°
Elevation: 7137.85 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffrey Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.106** (0.084-0.135)	**0.163** (0.129-0.208)	**0.253** (0.200-0.325)	**0.325** (0.254-0.419)	**0.419** (0.311-0.558)	**0.487** (0.355-0.663)	**0.551** (0.388-0.777)	**0.614** (0.413-0.897)	**0.690** (0.446-1.05)	**0.744** (0.471-1.16)
10-min	**0.155** (0.122-0.197)	**0.239** (0.189-0.305)	**0.371** (0.292-0.476)	**0.476** (0.372-0.614)	**0.613** (0.456-0.817)	**0.713** (0.519-0.971)	**0.807** (0.568-1.14)	**0.898** (0.604-1.31)	**1.01** (0.653-1.54)	**1.09** (0.690-1.70)
15-min	**0.189** (0.149-0.241)	**0.291** (0.230-0.372)	**0.453** (0.356-0.580)	**0.580** (0.454-0.749)	**0.747** (0.556-0.997)	**0.869** (0.633-1.18)	**0.985** (0.692-1.39)	**1.10** (0.737-1.60)	**1.23** (0.796-1.87)	**1.33** (0.841-2.08)
30-min	**0.274** (0.217-0.350)	**0.373** (0.295-0.476)	**0.535** (0.422-0.687)	**0.672** (0.526-0.867)	**0.864** (0.651-1.17)	**1.01** (0.745-1.40)	**1.17** (0.826-1.66)	**1.32** (0.896-1.95)	**1.53** (0.996-2.35)	**1.69** (1.07-2.65)
60-min	**0.362** (0.287-0.462)	**0.453** (0.358-0.578)	**0.609** (0.479-0.780)	**0.745** (0.583-0.962)	**0.945** (0.717-1.29)	**1.11** (0.817-1.54)	**1.28** (0.909-1.83)	**1.46** (0.992-2.17)	**1.71** (1.12-2.63)	**1.91** (1.21-2.98)
2-hr	**0.450** (0.359-0.569)	**0.533** (0.424-0.675)	**0.682** (0.541-0.867)	**0.818** (0.646-1.05)	**1.03** (0.789-1.39)	**1.20** (0.898-1.66)	**1.39** (1.00-1.98)	**1.59** (1.10-2.35)	**1.89** (1.25-2.88)	**2.12** (1.36-3.27)
3-hr	**0.518** (0.415-0.652)	**0.592** (0.473-0.745)	**0.729** (0.581-0.921)	**0.858** (0.680-1.09)	**1.06** (0.820-1.43)	**1.23** (0.926-1.69)	**1.42** (1.03-2.01)	**1.62** (1.13-2.38)	**1.92** (1.28-2.91)	**2.17** (1.39-3.32)
6-hr	**0.652** (0.527-0.814)	**0.731** (0.590-0.913)	**0.876** (0.704-1.10)	**1.01** (0.807-1.27)	**1.22** (0.950-1.62)	**1.39** (1.06-1.89)	**1.59** (1.16-2.22)	**1.80** (1.26-2.60)	**2.10** (1.41-3.14)	**2.34** (1.52-3.54)
12-hr	**0.808** (0.658-0.999)	**0.930** (0.756-1.15)	**1.14** (0.924-1.42)	**1.33** (1.07-1.66)	**1.60** (1.25-2.09)	**1.82** (1.39-2.42)	**2.05** (1.51-2.82)	**2.30** (1.62-3.26)	**2.64** (1.79-3.88)	**2.91** (1.91-4.35)
24-hr	**1.00** (0.821-1.23)	**1.16** (0.950-1.42)	**1.43** (1.17-1.76)	**1.67** (1.35-2.06)	**2.01** (1.58-2.60)	**2.28** (1.76-3.01)	**2.57** (1.91-3.49)	**2.87** (2.04-4.03)	**3.29** (2.25-4.77)	**3.62** (2.40-5.33)
2-day	**1.23** (1.02-1.50)	**1.40** (1.16-1.70)	**1.69** (1.39-2.06)	**1.95** (1.60-2.39)	**2.34** (1.86-3.00)	**2.66** (2.06-3.47)	**2.99** (2.25-4.02)	**3.35** (2.41-4.65)	**3.86** (2.67-5.53)	**4.26** (2.86-6.19)
3-day	**1.38** (1.14-1.66)	**1.57** (1.30-1.90)	**1.90** (1.57-2.31)	**2.19** (1.81-2.67)	**2.62** (2.10-3.34)	**2.97** (2.32-3.85)	**3.34** (2.52-4.46)	**3.74** (2.70-5.14)	**4.28** (2.98-6.09)	**4.72** (3.19-6.80)
4-day	**1.50** (1.25-1.80)	**1.71** (1.42-2.06)	**2.07** (1.72-2.50)	**2.38** (1.97-2.90)	**2.84** (2.28-3.60)	**3.22** (2.52-4.14)	**3.60** (2.73-4.78)	**4.02** (2.91-5.49)	**4.59** (3.20-6.48)	**5.04** (3.42-7.22)
7-day	**1.81** (1.52-2.17)	**2.04** (1.71-2.44)	**2.43** (2.03-2.91)	**2.76** (2.30-3.33)	**3.25** (2.63-4.09)	**3.65** (2.88-4.66)	**4.07** (3.10-5.34)	**4.51** (3.30-6.10)	**5.12** (3.60-7.14)	**5.60** (3.83-7.93)
10-day	**2.09** (1.76-2.48)	**2.32** (1.96-2.76)	**2.73** (2.29-3.26)	**3.09** (2.58-3.70)	**3.60** (2.93-4.50)	**4.02** (3.19-5.10)	**4.46** (3.42-5.82)	**4.93** (3.63-6.62)	**5.57** (3.94-7.73)	**6.08** (4.19-8.56)
20-day	**2.83** (2.40-3.33)	**3.13** (2.66-3.69)	**3.65** (3.09-4.31)	**4.10** (3.45-4.86)	**4.74** (3.88-5.84)	**5.25** (4.20-6.57)	**5.79** (4.47-7.44)	**6.35** (4.71-8.41)	**7.12** (5.09-9.72)	**7.72** (5.37-10.7)
30-day	**3.44** (2.94-4.03)	**3.82** (3.27-4.48)	**4.46** (3.79-5.24)	**4.99** (4.23-5.90)	**5.75** (4.72-7.02)	**6.34** (5.09-7.87)	**6.95** (5.40-8.85)	**7.58** (5.65-9.94)	**8.42** (6.05-11.4)	**9.07** (6.36-12.5)
45-day	**4.25** (3.65-4.94)	**4.73** (4.06-5.51)	**5.52** (4.72-6.45)	**6.17** (5.25-7.24)	**7.06** (5.81-8.54)	**7.74** (6.24-9.51)	**8.42** (6.57-10.6)	**9.10** (6.83-11.8)	**10.0** (7.23-13.4)	**10.7** (7.53-14.6)
60-day	**4.95** (4.27-5.74)	**5.53** (4.76-6.41)	**6.45** (5.54-7.51)	**7.20** (6.14-8.41)	**8.19** (6.76-9.83)	**8.94** (7.22-10.9)	**9.66** (7.56-12.1)	**10.4** (7.80-13.4)	**11.3** (8.18-15.0)	**12.0** (8.47-16.2)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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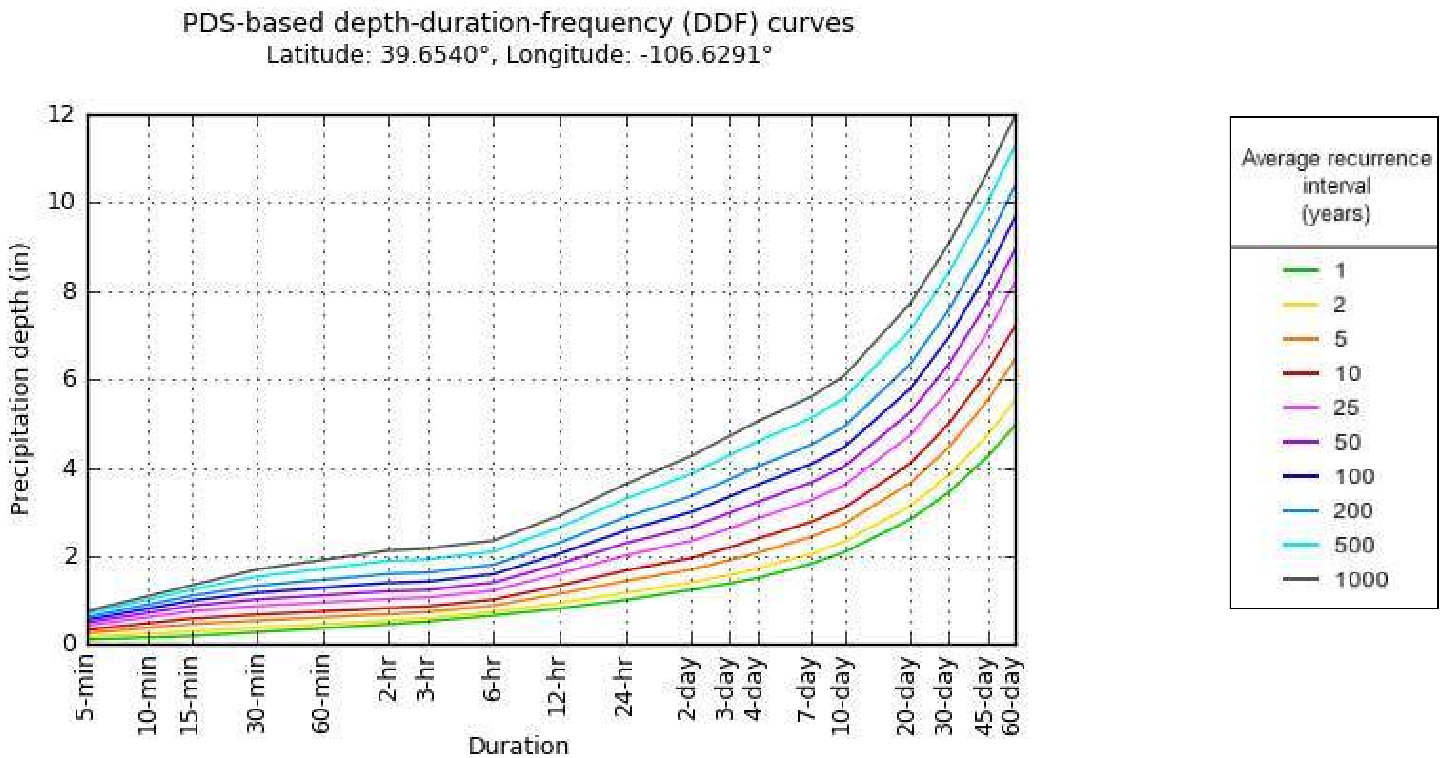
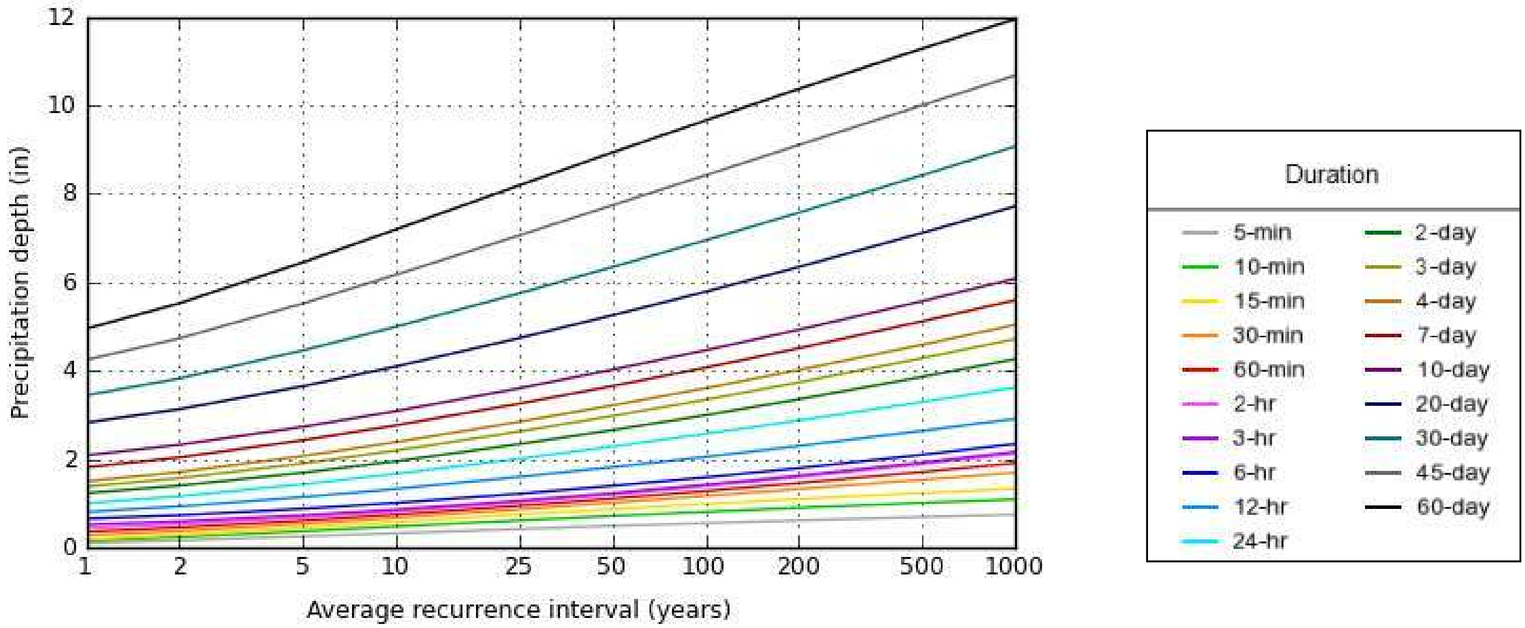
PF graphical





NOAA Atlas 14, Volume 8, Version 2

Created (GMT): Mon Apr 26 16:16:27 2021

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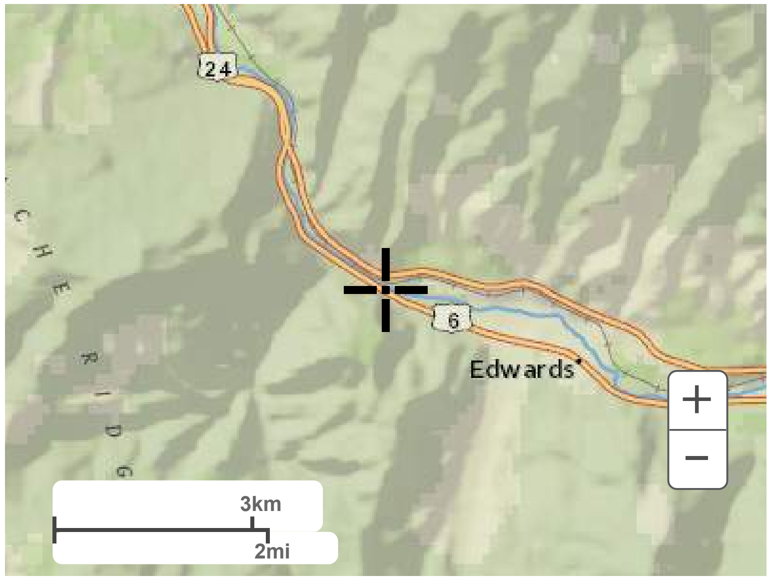
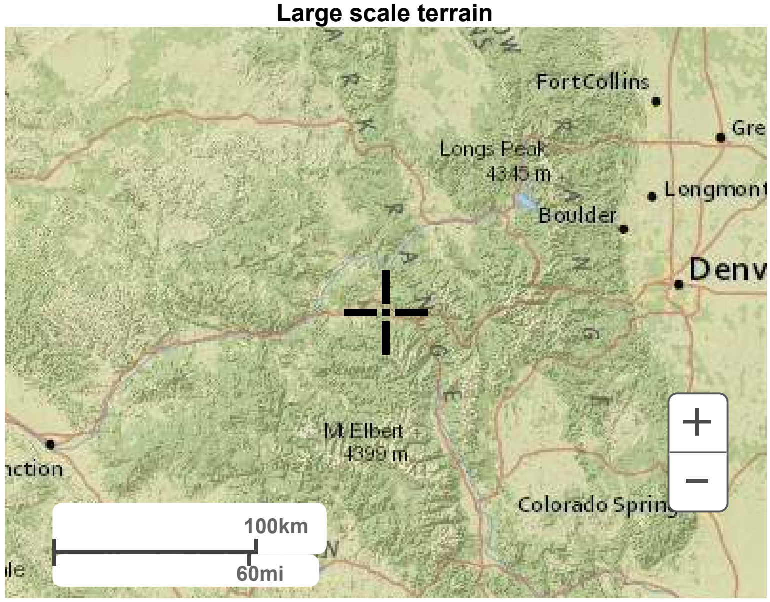
Maps & aerials

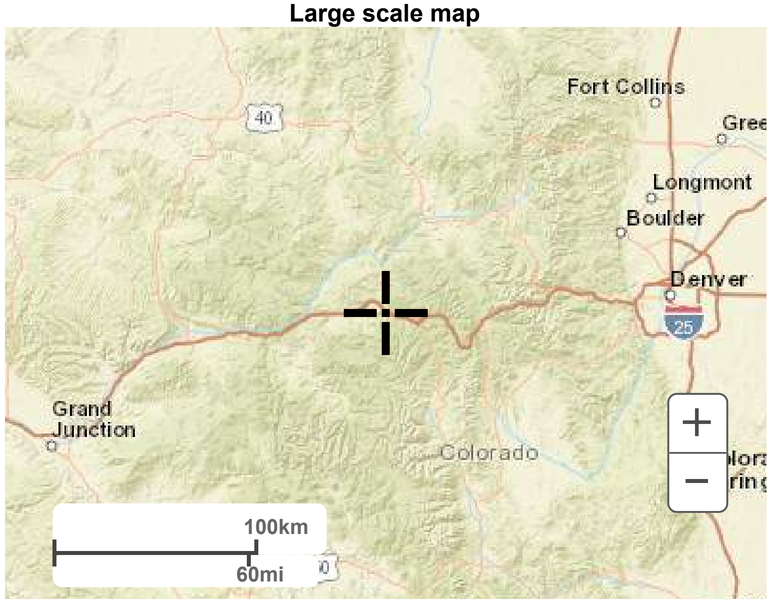
Small scale terrain



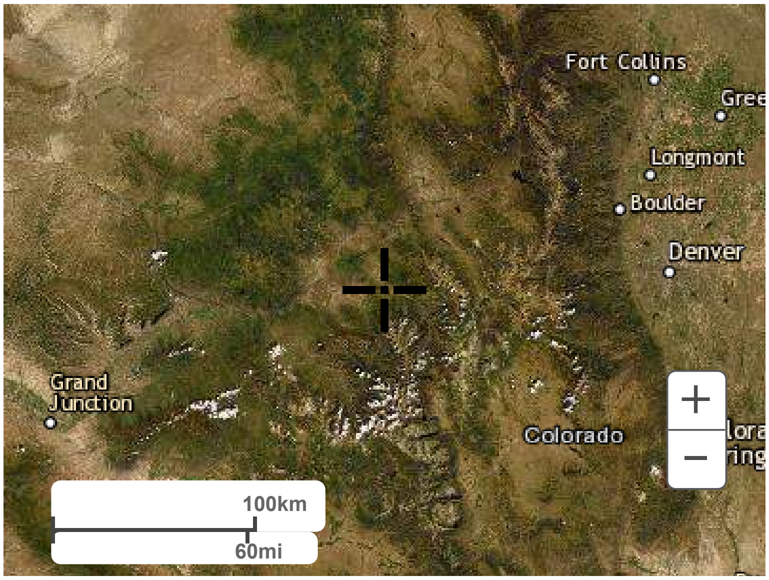
Large scale terrain



Large scale map



Large scale aerial


Fort Collins
Longmont
Boulder
Denver
Grand
Junction
Colorado
100km
60mi

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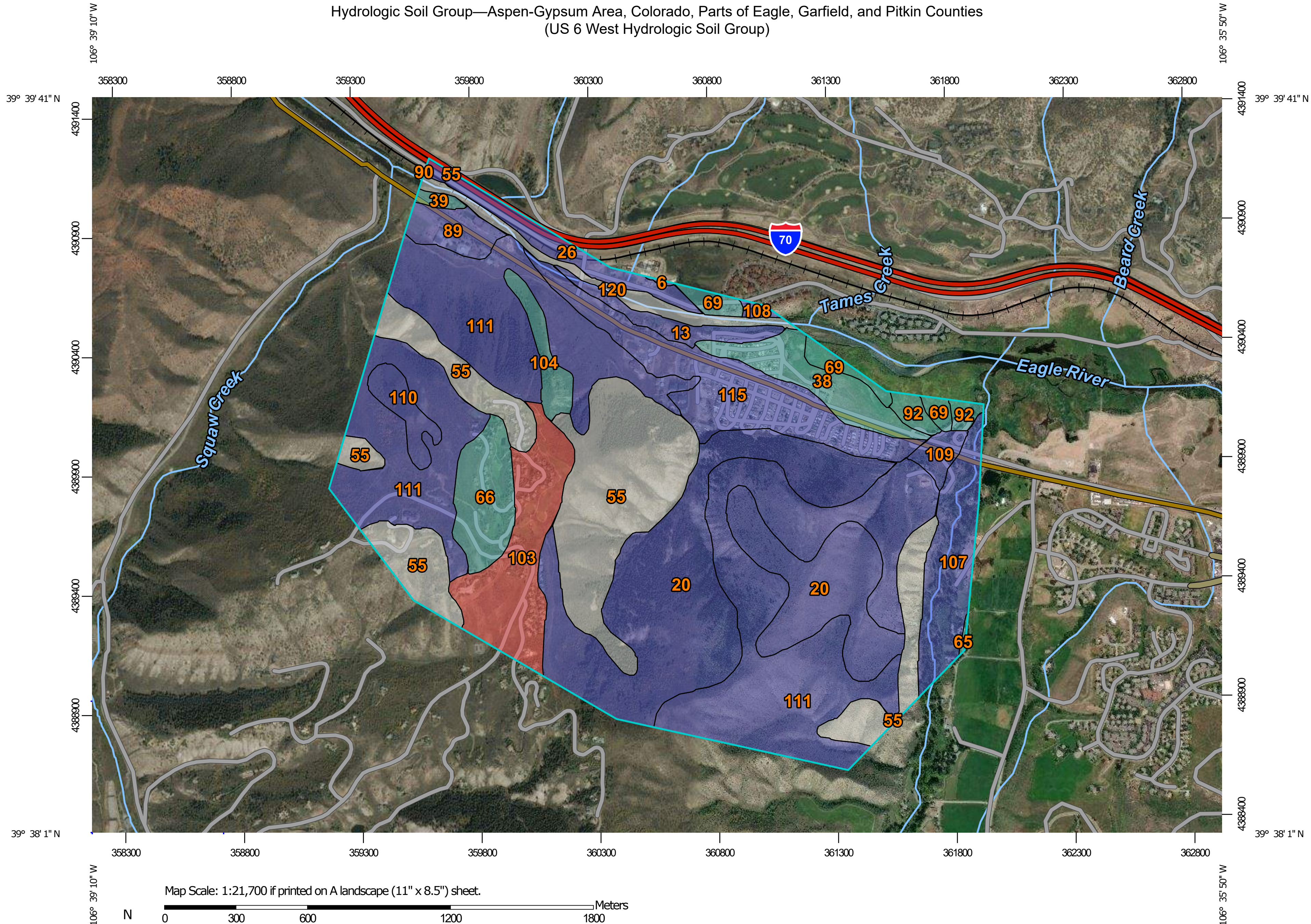
Hydrologic Soil Group—Aspen-Gypsum Area, Colorado, Parts of Eagle, Garfield, and Pitkin Counties
(US 6 West Hydrologic Soil Group)



Map Scale: 1:21,700 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 300, 600, 1200, 1800

Feet: 0, 1000, 2000, 4000, 6000

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.

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: Aspen-Gypsum Area, Colorado, Parts of Eagle, Garfield, and Pitkin Counties
Survey Area Data: Version 11, Jun 5, 2020

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

Date(s) aerial images were photographed: Oct 21, 2011—Oct 13, 2017

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
6	Almy loam, 1 to 12 percent slopes	B	0.4	0.0%
13	Atencio-Azeltine complex, 3 to 6 percent slopes	B	14.2	1.3%
20	Coulterg loam, 12 to 50 percent slopes	B	215.5	19.7%
26	Dahlquist-Southace complex, 6 to 12 percent slopes	B	20.2	1.8%
38	Evanston loam, 1 to 6 percent slopes	C	30.9	2.8%
39	Evanston loam, 6 to 25 percent slopes	C	2.7	0.3%
55	Gypsum land-Gypsiorthids complex, 12 to 65 percent slopes	Assume C/D	177.8	16.3%
65	Jerry-Millerlake loams, 1 to 6 percent slopes	C	0.7	0.1%
66	Jerry-Millerlake loams, 6 to 25 percent slopes	C	31.9	2.9%
69	Kilgore silt loam	C	13.9	1.3%
89	Mussel loam, 1 to 6 percent slopes	B	15.5	1.4%
90	Mussel loam, 6 to 12 percent slopes	B	1.6	0.1%
92	Redrob loam, 1 to 6 percent slopes	C	8.6	0.8%
103	Tanna-Pinelli complex, 12 to 25 percent slopes	D	59.5	5.4%
104	Torriorthents-Camborthids-Rock outcrop complex, 6 to 65 percent	C	13.0	1.2%
107	Uracca, moist-Mergel complex, 1 to 6 percent slopes, extremely s	B	43.0	3.9%
108	Uracca, moist-Mergel complex, 6 to 12 percent slopes, extremely	B	1.9	0.2%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
109	Uracca, moist-Mergel complex, 12 to 25 percent slopes, extremely	B	7.6	0.7%
110	Uracca, moist-Mergel complex, 25 to 65 percent slopes, extremely	B	12.9	1.2%
111	Vandamore channery sandy loam, 25 to 65 percent slopes	B	331.5	30.4%
115	Yamo loam, 6 to 12 percent slopes	B	70.7	6.5%
120	Water		17.8	1.6%
Totals for Area of Interest			**1,092.0**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher