



MONUMENT STEEL STRUCTURES

FINAL DRAINAGE STUDY

AUGUST 2019

For:
Steel Structures America Inc.
3635 E. Covington Ave.
Post Falls, ID 83854

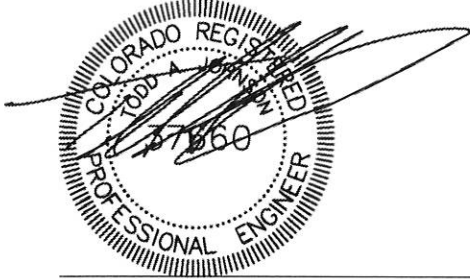
By:
Terra Forma Solutions
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Todd Johnson, P.E.
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PCD File No. PPR1919

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ENGINEER'S CERTIFICATION:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the applicable master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.



Todd Johnson, P.E. #37660

08/17/2019
Date

Owner/Developer's Statement:

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

Justin Sternberg
Steel Structures America Inc.
3635 E. Covington Ave.
Post Falls, ID 83854

8-19-19
Date

El Paso County:

Filed in accordance with the requirements of the Drainage Criteria Manual, Volumes 1 and 2, El Paso County Engineering Criteria Manual and Land Development Code as amended.

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

Date

Conditions:

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SCOPE

The purpose of this report is to present the drainage plan for the proposed Monument Steel Structures development. The following includes final analysis and design information for the proposed drainage systems in general conformance with the standards and specifications established by El Paso County, Colorado Springs and the Urban Drainage and Flood Control District (UDFCD).

I. GENERAL LOCATION AND DESCRIPTION

A. Site Location

- The Monument Steel Structures development is located at 18910 Base Camp Road in Section 11, Township 11 South, Range 67 West of the 6th Principal Meridian in El Paso County, State of Colorado.
- Approximate geodetic coordinates for the site are: 39°6'21"N, 104°51'48"W
- The site is bordered to the north by the Greater Europe Missions, to the east by Base Camp Road, to the west by Monument Hill Road and to the south by Deer Creek Road.
- See Site Location Map below for overall site location: (See Vicinity Map in the Appendices)



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B. Description of Property

- The site is approximately 4.0 acres in size. The site is currently vacant and is covered by native grasses and weeds. Topography generally slopes from northeast to southwest towards a roadside ditch along Monument Hill Road with grades generally varying from 1% to 10%.
- The site is not located within a floodplain as shown on the FEMA FIRM Map No. 08041C0276G dated December 7, 2018.
- The site lies within Zone X which is described as follows: Areas of 0.2% annual chance flood; areas of 1% annual chance of a flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood. See Appendix D for a FEMA Firm panel exhibit.
- The proposed Monument Steel Structures development is proposing a sales office with display structures and Mini Warehouse and RV Boat Storage.
- Soil types on site as identified by the Natural Resources Conservation Service (NRCS) are as follows:

Hydrologic Soil Group				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
92	Tomah – Crowfoot Loamy sands, 3 to 8 percent slopes	B	4.7	80.6%
93	Tomah – Crowfoot complex, 8 to 15 percent slopes	B	1.1	19.4%

- See Appendix D for soils map.
- There are no known irrigation canals or ditches within the project boundaries.

II. DRAINAGE BASINS AND SUB-BASINS

A. Major Drainage Basins

- The site is tributary to the Crystal Creek basin within Monument Creek watershed. There are no major drainageways crossing or adjacent to the site. Runoff from the proposed site will release from the on-site extended detention basin at the southwest corner of the site and will enter the recently constructed 30" FES (constructed with the Monument Hill Widening Project), matching existing drainage patterns.
- Off-site flow patterns will not be influenced by the development of this site.

B. Historic Drainage Basins

- **Basin E-1:** Consists of the West half of Base Camp Road from the Greater Europe Missions southern access to the Deer Creek Road intersection, native grasses and weeds between the Base Camp Road and the eastern property boundary and native grasses and weeds from the Greater Europe Missions parking lot to the northern property boundary.

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- Historically, runoff from this basin flows onto the site and sheet flows across the subject property to the southwest corner of the site where it releases through the recently constructed 30" FES (constructed with the Monument Hill Widening Project).
- **Basin E-2:** Encompasses the property boundary and consists of vacant land covered by native grasses and weeds.
 - Historically, runoff from this basin sheet flows to the southwest corner of the site where it releases through the recently constructed 30" FES (constructed with the Monument Hill Widening Project).

C. Minor Drainage Basins

- **Basin OS-1:** Consists of vacant land in between the north boundary of the site and the southern parking lot of the Greater Europe Missions property.
 - Runoff generated in this basin will sheet flow overland from north to south entering the site along the northern property boundary and combine flows with Basin A-4 (See Below)
- **Basin OS-2:** Consists of vacant land in between the north boundary of the site and the southern parking lot of the Greater Europe Missions property.
 - Runoff generated in this basin will sheet flow overland from north to south entering the site along the northern property boundary and combine flows with Basin A-3.
- **Basin OS-3:** Consists of vacant land between the north boundary of the site and the southern parking lot of the Greater Europe Missions property. This basin also consists of the western half of Base Camp Road from the middle of the eastern property boundary north to the southern access of Greater Europe Missions property.
 - Runoff generated in this basin will sheet flow overland from north to south and east to west entering the site along the northern and eastern property boundary and combine flows with Basin A-2
- **Basin OS-4:** Consists of the western half of Base Camp Road and landscaping from the middle of the eastern property boundary south to the intersection of Base Camp Road and Deer Creek Road.
 - Runoff generated in this basin will sheet flow overland from east to west entering the site along the eastern property boundary and combine flows with Basin A-1.
- **Basin OS-5:** Consists of vacant land in between the north boundary of the site and the southern parking lot of the Greater Europe Missions property.
 - Runoff generated in this basin will sheet flow overland from the north to the south entering the site along the northern boundary and be directed west to the Monument Hill Road roadside via a drainage swale.
- **Basin OS-6:** Consists of rooftops and landscaping at the western portion of the site.
 - Runoff generated within this boundary will be released from the rooftops via downspouts and be directed west to the Monument Hill Road roadside ditch. Low Impact Development is being achieved within this basin as impervious and

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pervious areas are being disconnected along with implementing infiltration as the flows run along the earth lined roadside ditch. **The 100-year allowable release for the EDB has been reduced by the derived 100-yr runoff of this basin.**

- This basin is ~4.0% of the site (0.16ac) and therefore falls within the ECM exclusions from the MS4 Permit per Appendix I Section I.7.1.C.1a stating:
100% of the applicable development site is captured, except the County may exclude up to 20 percent, not to exceed 1 acre, of the applicable development site area when the County has determined that it is not practicable to capture runoff from portions of the site that will not drain towards control measures. In addition, the County must also determine that the implementation of a separate control measure for that portion of the site is not practicable (e.g., driveway access that drains directly to street).
 - This area is implementing Low Impact Development (LID) techniques to Minimize Directly Connected Impervious Area (MDCIA) by routing runoff from impervious surfaces over grassy areas to slow runoff and promote infiltration. MDCIA is recommended as a key technique for reducing runoff peaks and volumes for frequently-occurring storms following urbanization. MDCIA is a key component of LID.
 - The UD-BMP Runoff Reduction spreadsheet was used to quantify the WQCV Reduction within this area (See results in Appendix F). This spreadsheet was developed by UDFCD to provide a simple tool that can be used to demonstrate compliance with the Runoff Reduction Standard in the MS4 General Permit.
 - Using the spreadsheet, a WQCV of 272 cubic feet was derived with the roadside ditch providing a 100% reduction. Such that there is anticipated to 0% untreated WQCV leaving the site
- **Basin OS-7:** Consists of the existing 20-foot Monument Hill Road roadside ditch drainage and utility easement and landscaping behind the proposed buildings along the western boundary of the site.
 - Runoff generated in this basin will combine with the flows entering the basin from the Monument Hill Road roadside ditch to the north and the flows from Basin OS-5 and OS-6 described above. The combined flows will travel south along the earth lined roadside ditch to the recently constructed 30" FES transporting the flows under Deer Creek Road and off site.
 - This basin is ~10% of the site (0.40ac) and combines with Basin OS-6.
 - The sum of these basins is ~14% of the site (0.56ac) and therefore falls within the ECM exclusions from the MS4 Permit per Appendix I Section I.7.1.c.1a stating:
100% of the applicable development site is captured, except the County may exclude up to 20 percent, not to exceed 1 acre, of the applicable development site area when the County has determined that it is not practicable to capture runoff from portions of the site that will not drain towards control measures. In addition, the County must also determine that the implementation of a separate control measure for that portion of

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the site is not practicable (e.g., driveway access that drains directly to street).

- **Basin A-1:** Consist of rooftops, pavement and landscaping at the southeastern corner of the site.
 - Runoff generated in this basin will combine with the flows entering the site from the east (Basin OS-4) and the flows entering the site from the south (Basin OS-5). The flows will travel along the southern curb and gutter from the northeast to the southwest being captured by the proposed on-grade 10' Type R inlet (IN-1) at Design Point 1 where it will combine with flows from Basin A-2. This inlet has been sized to capture the 5-year flows and most of the 100-yr flows
 - Captured flows will be transported to the proposed EDB via concrete pipe.
 - Bypassing flows will travel west to Design Point 3 and be captured by a proposed Double Type 13 Combo inlet (IN-2) before entering the proposed EDB via concrete pipe.
- **Basin A-2:** Consists of rooftops, pavement and landscaping stretching from the northern boundary to the southern boundary encompassing the eastern-middle portion of the site.
 - Runoff generated in this basin will combine with the flows entering the site from the north (Basin OS-3). The flows will be directed towards and transported south via a 4-foot drainage pan being captured by the proposed on-grade 10' Type R inlet (IN-1) at Design Point 1 where it will combine with flows from Basin A-1 (See basin description above).
- **Basin A-3:** Consists of rooftops, pavement, and landscaping stretching from the northern boundary to the southern boundary encompassing the middle portion of the site.
 - Runoff generated in this basin will combine with the flows entering the site from the north (Basin OS-2). The flows will be directed towards and transported south via a modified 2-foot curb and gutter running along the east side of the 48-foot storage building.
 - The said curb is proposed to be modified by having a 1-foot vertical height instead of the typical 0.5-foot vertical height for added capacity and building protection.
 - The flows will flow from the 2-curb and gutter to a 4-foot drainage pan at the south end of the 48-foot storage building directing flows south to Design Point 3. Here the flows will be combined with any bypass flows bypassing the on-grade IN-1 and be captured by a proposed Triple - Type 13 Combo inlet (IN-2) in sump and be transported to the EDB via concrete pipe.
- **Basin A-4:** Consists of rooftops, pavement, sidewalk and landscaping stretching from the northern boundary to the southern boundary encompassing the western-middle portion of the site.
 - Runoff generated in this basin will combine with the flows entering the site from the north (Basin OS-1). The flows will be directed towards and transported south via a 4-foot drainage pan towards Design Point 4 being captured by a proposed

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Double - Type 13 Combo inlet (IN-3) in sump and be transported to the EDB via concrete pipe.

- **Basin A-5:** Consists of the onsite EDB.
 - Runoff generated in this basin will combine with all flows tributary to the EDB and will be captured and released by a controlled outlet structure.

III. DRAINAGE DESIGN CRITERIA

A. Regulations

- The site has been designed in accordance with the El Paso County *Drainage Design Criteria Manual*, adopted portions of the City of Colorado Springs *Drainage Criteria Manual Volume 1, dated May 2014*, and the *Urban Storm Drainage Criteria Manual, Volumes 1, 2, and 3 (UDFCD)*, Urban Drainage and Flood Control District, latest revisions. The portions of the City of *Colorado Springs Drainage Criteria Manual* adopted by the County are Chapter 6 (Hydrology) and Chapter 13 Section 3.2.1 (Full Spectrum Detention).

B. Drainage Studies, Outfall Systems Plans, Site Constraints

- The site is included within the limits of the Dirty Woman Creek and Crystal Creek Drainage Basin Planning Study prepared by Kiowa Engineering in September of 1993. There are no drainage way facilities proposed in the study that are located within the limits of the site.

C. Hydrology

- Peak storm runoff was determined using the Rational Formula: $Q=CIA$
- Design storm recurrence intervals are the 5-year storm for the minor event and the 100-year storm for the major event.
- Rainfall intensities were determined per Table 6-2, in accordance with the City of Colorado Springs Drainage Criteria Manual Volume 1, dated May 2014.
- Runoff coefficients have been determined per Table 6-6, in accordance with the City of Colorado Springs Drainage Criteria Manual Volume 1, dated May 2014.
- Time of Concentration has been calculated per Section 3-2, in accordance with the City of Colorado Springs Drainage Criteria Manual Volume 1, dated May 2014.
- See Appendix A for all hydrologic calculations.

D. Hydraulics

- The calculation methods for private improvements are based upon the Manning's Equation and the City of Colorado Springs Drainage Criteria Manual Volumes 1 and 2, dated May 2014.
- On-Site storm drainage improvements are designed for the 5-year and 100-year events.
- See Appendix B for all hydraulic calculations.

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IV. STORMWATER MANAGEMENT FACILITY DESIGN

A. Existing Stormwater Drainage

- The existing stormwater runoff for the proposed site flows overland from the northeast corner of the site towards the southwest corner with a fairly uniform grade of 3.5%.
- Historically the runoff from the vacant land between the north boundary of the site and the southern parking lot of the Greater Europe Missions property flows onto the site along the northern boundary of the site.
- Historically the runoff from the western half of Base Camp Road flows onto the site along the eastern boundary of the site.
- The eastern half of the proposed site flows into the Monument Hill roadside ditch north of Deer Creek Road and flows to the southwest corner of the site where it will be captured by the recently constructed 30" RCP flared end section (constructed with the Monument Hill Widening Project). As the proposed site will be release at or below historic levels the recently constructed 30" RCP crossing under Deer Creek Road is suitable outfall for the proposed development.
- The western half of the proposed site flows into the reconstructed roadside ditch east of Monument Hill Road (reconstructed with the Monument Hill widening project) and flows to the southwest corner of the site where it will be captured by the recently constructed 30" RCP flared end section (constructed with the Monument Hill Widening Project).

B. Proposed Stormwater Conveyance Facilities

- The proposed drainage patterns will follow historic flow patterns as closely as possible.
- The general concept for the site drainage will be for storm runoff to surface flow from the building roofs and pavement generally flowing from the north side of the site to the south side of the site via 4-foot v-channel drainage pans and curb and gutter. Runoff will be captured by a series of inlets south of the on-site drive isles and piped to the proposed Extended Detention Basin designed in accordance with City of Colorado Springs criteria.
- The proposed Extended Detention Basin will drain through a modified CDOT Type C outlet structure. The outlet structures released flow will be piped to the roadside ditch east of Monument Hill Road and be captured by the 30" RCP flared end section (which was constructed with the Monument Hill widening project.)
- The on-site storm sewers and EDB will be private and will be maintained by the property owner.
- Conveyance of off-site runoff is generated from Basin OS-6. Low Impact Development is being achieved within this basin as impervious and pervious areas are being disconnected along with implementing infiltration as the flows run along the earth lined roadside ditch. **The 100-year allowable release for the EDB has been reduced by the derived 100-yr runoff of this basin.**

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C. Proposed Stormwater Storage Facilities

- An Extended Detention Basin is proposed at the southwest corner of the site to treat storm runoff and attenuate peak flows in accordance with the City of Colorado Springs criteria and UDFCD.
- The Extended Detention Basin and outlet structure have been sized and designed with the UDFCD UD-Detention v3.07 spreadsheet to control the Water Quality Capture Volume (WQCV) and 100-year detention volume.
- The pond will include a trickle channel for low flow conditions, an outlet structure including a 2.5-ft deep micropool, and an emergency spillway with riprap erosion protection.
- See Appendix C for Detention and Water Quality Calculations

D. Water Quality Enhancement Best Management Practices

- El Paso County requires the Four Step Process be followed for the selection and siting of structural BMPs for new development to provide water quality for stormwater runoff being discharged into State Waters. The Four Steps are; employ runoff reduction practices, stabilize drainageways, provide water quality capture volume (WQCV) and consider need for industrial and commercial BMP's.
 - The design of the site has followed this process as much as possible. Pavement has been minimized to meet only the parking spaces as required by the county and landscaped areas are included to assist in reducing runoff. There are no major drainageways on site. The drainageways adjacent to the site are being improved with riprap protection where concentrated flows may cause erosion. The WQCV is being provided in the permanent BMP which is an Extended Detention Basin designed in accordance with county regulations
- Discharge will be controlled by a standard outlet structure with a flow control plate designed to release the WQCV over 40 hours and release 97% of the 5-year storm in less than 72 hours.
- The 100-year discharge will be limited to be at or below 2.95 cfs (0.85 cfs/acre for Type B soils minus the 100-yr peak runoff from Basin OS-7 which will bypass the EDB) and will be controlled by a circular orifice plate located at the discharge side of the outlet structure prior to the flow entering an 18" RCP flowing to the proposed drainage swale adjacent to Monument Hill Road. This swale flows to the south and will be captured by the 30" FES to be constructed as part of the Monument Hill Road widening Improvements. In the event the outlet structure should become clogged with debris, and emergency overflow weir and swale will be constructed along the west side of the EDB. The emergency overflow swale will be a notched 15' wide by 1' deep cavity in the proposed EDB upper wall. Overflow will go to the proposed drainage swale along Monument Hill Road flowing to the south to the existing 30" FES and will be routed off site.

E. Floodplain Modification

- A floodplain modification is not anticipated for the construction of the Monument Steel Structures development.

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F. Additional Permitting Requirements

- No additional permitting is anticipated for the construction of the Monument Steel Structures development.

V. CONCLUSIONS

A. Compliance with Standards

- The drainage design for the Monument Steel Structures site detailed within this report is in general compliance with the El Paso County, Colorado Springs and UDFCD criteria.
- Per Note 9 of the Greater Europe Mission Subdivision Filing Number 1 Plat:
 - DRAINAGE FEES FOR LOT 2 SHALL BE PAID PRIOR TO THE ISSUANCE OF A BUILDING PERMIT AND THOSE FEES ARE TO BE CALCULATED ON THE BASIS OF THE FEE STRUCTURE IN EFFECT AT THE TIME OF BUILDING PERMIT APPLICATION.
- Per the 2019 Drainage Basin Fees – Drainage Basin FOMO5300
 - Drainage Basin Fee = \$18,350 / Impervious Acre
 - Bridge Fee = \$1,004 / Impervious Acre

2019 DRAINAGE BASIN FEES - LOT 2			
Fee	\$ / Imp Acre	Imp Acres	Fee
Drainage Basin Fee	\$18,350	2.98	\$54,629.39
Bridge Fee	\$1,004	2.98	\$2,988.99

B. Variances / Deviations / Exclusion

- An Exclusion from *Appendix I Section I.7.1B – Providing Water Quality for Entire Development* for proposed basins OS-6 and OS-7 is requested per *Appendix I Section I.7.1.C.1a*.
- Approximately 0.56 acres (14.0%) of 4.0-acre site will not reach a proposed on-site water quality facility. Of the area inside the development boundary that will not reach a facility, 0.14 acres is proposed roofs and 0.42 acres is the existing Monument Hill Road roadside ditch and landscape areas behind the proposed buildings.
 - The 0.14 acres of roofs drains to the Monument Hill Road roadside ditch as the site naturally drains towards the ditch.
 - This area is implementing Low Impact Development (LID) techniques to Minimize Directly Connected Impervious Area (MDCIA) by routing runoff from impervious surfaces over grassy areas to slow runoff and promote infiltration. MDCIA is recommended as a key technique for reducing runoff peaks and volumes for frequently-occurring storms following urbanization. MDCIA is a key component of LID.
 - The UD-BMP Runoff Reduction spreadsheet was used to quantify the WQCV Reduction within this area (See results in Appendix F). This

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spreadsheet was developed by UDFCD to provide a simple tool that can be used to demonstrate compliance with the Runoff Reduction Standard in the MS4 General Permit.

- Using the spreadsheet, a WQCV of 272 cubic feet was derived with the roadside ditch providing a 100% reduction. Such that there is anticipated to 0% untreated WQCV leaving the site.
- The 0.42 acres of landscaping is primarily composed of an existing 20-foot drainage and utility easement running the entire length of the western boundary of the site transporting the runoff from Monument Hill Road from the north boundary of the site to the south boundary of the site. It is not practical to change the existing topography or modify the elevation to force additional area to the WQ facilities.

C. Drainage Concept

- The proposed drainage patterns will follow historic flow patterns as closely as possible. The majority of the site will sheet flow to the southwest into the proposed Extended Detention Basin.
- With the development of the proposed site; there should be no adverse impact to downstream facilities, adjacent properties, channel depths, velocities, or erosion rates, due to release flows being below historic rates.

VI. LIST OF REFERENCES

- El Paso County's *Engineering Criteria Manual*, Revised 07/29/2015 Revision 5.
- City of Colorado Springs *Drainage Criteria Manual Volumes 1 and 2*, dated May 2014.
- *Urban Storm Drainage Criteria Manual, Volumes 1, 2, and 3*, Urban Drainage and Flood Control District, latest editions.
- Federal Emergency Management Agency Flood Insurance Rate Map Panel Number 08041C0276G, effective December 7, 2018.
- *Dirty Woman Creek and Crystal Creek Drainage Basin Planning Study* prepared by Kiowa Engineering Dated September, 1993.

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APPENDICES

VICINITY MAP

APPENDIX A – Hydrologic Computations

APPENDIX B – Hydraulic Computations

APPENDIX C – Detention/Water Quality Enhancement BMPs

APPENDIX D – Referenced Information

APPENDIX F – UD-BMP Runoff Reduction

APPENDIX A - HYDROLOGIC COMPUTATIONS



Project: Monument Steel Structures
Location: Monument, CO
Designer: TAJ
Date: 4/7/2019
Latest Revision: 8/17/2019

¹From Table 6-6 in Colorado Springs DCM, Volume 1

²From Table 6-6 in Colorado Springs DCM, Volume 1

IMPERVIOUSNESS AND RUNOFF COEFFICIENT CALCULATIONS

				Roofs	Lawn	Pavement	Sidewalk	Pond HWL	Misc							
				Impervious % ¹	90%	0%	100%	100%	100%	0%						
Basin Designation	NRCS Hydrologic Soil Group	Total Area (ac)	Total Area (sf)	Roofs (sf)	Lawn (sf)	Pavement (sf)	Sidewalk (sf)	Pond HWL (sf)	Misc (sf)	Percent Impervious	Impervious Area (ac)	Runoff Coefficients, C ²				
												C ₂	C ₅	C ₁₀	C ₁₀₀	
E-1	B	1.35	58,906		52,085	6,821				11.58%	0.16	0.12	0.17	0.24	0.42	
E-2	B	4.00	174,280		174,280					0.00%	0.00	0.02	0.08	0.15	0.35	
OS-1	B	0.45	19,479		19,479			0	0	0.00%	0.00	0.02	0.08	0.15	0.35	
OS-2	B	0.22	9,459		9,459			0	0	0.00%	0.00	0.02	0.08	0.15	0.35	
OS-3	B	0.42	18,281		13,642	4,639		0	0	25.38%	0.11	0.24	0.29	0.35	0.50	
OS-4	B	0.15	6,407		4,225	2,182		0	0	34.06%	0.05	0.32	0.36	0.41	0.56	
OS-5	B	0.12	5,280		5,280			0	0	0.00%	0.00	0.02	0.08	0.15	0.35	
OS-6	B	0.16	7,031	6,636	395			0	0	84.94%	0.14	0.67	0.69	0.72	0.78	
OS-7	B	0.40	17,418		17,418			0	0	0.00%	0.00	0.02	0.08	0.15	0.35	
A-1	B	0.43	18,530	3,272	4,867	10,392		0	0	71.97%	0.31	0.63	0.65	0.69	0.77	
A-2	B	0.90	39,189	9,409	6,191	23,589		0	0	81.80%	0.74	0.71	0.73	0.76	0.83	
A-3	B	0.95	41,543	17,660	819	23,064		0	0	93.78%	0.89	0.80	0.81	0.83	0.88	
A-4	B	0.93	40,705	13,218	825	25,847	815	0	0	94.73%	0.89	0.81	0.83	0.85	0.90	
A-5	B	0.23	9,864		9,064	800		0	0	8.11%	0.02	0.09	0.15	0.21	0.40	
								0	0							
Area Treated by EDB	B	4.67	203,457	Basins (OS-1, OS-2 OS-3, OS-4, A-1, A-2, A-3, A-4, A-5)				0	0	64.16%	3.00					
Area Not Treated by EDB	B	0.68	29,729	Basins (OS-5, OS-6, OS-7)				0	0	20.09%	0.14					
								0	0							
Overall		5.35	233,186					0	0	58.54%	3.13					

Project: Monument Steel Structures
Location: Monument, CO
Designer: TAJ
Date: 4/7/2019
Latest Revision: 8/17/2019

NRCS Conveyance Factors, K ²	
Type of Land Surface	K
Heavy Meadow	2.5
Tillage/Field	5
Short Pasture/Lawns	7
Nearly Bare Ground	10
Grassed Waterway	15
Paved Areas	20

¹Max 100 ft in Urban areas and 300 ft in rural areas

²From Table 6-7 - Colorado Springs DCM

TIME OF CONCENTRATION CALCULATIONS

Basin Designation	Imperviousness (%)	C _s	Initial/Overland Flow Time, T _i			Channelized Flow/Travel Time, T _t					Time of Concentration, T _c (Check)			
			Length (ft) ¹	Slope (%)	T _i (min)	Land Surface	Length (ft)	Slope (%)	Velocity (ft/sec)	T _t (min)	Computed T _c (min)	First Design Point T _c (min)	Minimum T _c (min)	Selected T _c (min)
E-1	11.58%	0.17	25	3.00	5.81	Paved Areas	140	3.40	3.69	0.63	6.44	10.92	10.00	10.00
E-2	0.00%	0.08	100	3.40	12.30	Short Pasture/Lawns	445	4.65	1.51	4.91	17.21	13.03	10.00	13.03
OS-1	0.00%	0.08	25	5.00	5.41	Short Pasture/Lawns	175	5.00	1.57	1.86	7.28	11.11	5.00	7.28
OS-2	0.00%	0.08	25	5.00	5.41	Short Pasture/Lawns	110	5.00	1.57	1.17	6.59	10.75	5.00	6.59
OS-3	25.38%	0.29	25	2.00	5.83	Short Pasture/Lawns	130	5.00	1.57	1.38	7.22	10.86	5.00	7.22
OS-4	34.06%	0.36	15	2.00	4.12	Short Pasture/Lawns	20	16.00	2.80	0.12	4.24	10.19	5.00	5.00
OS-5	0.00%	0.08	25	5.00	5.41	Short Pasture/Lawns	163	5.00	1.57	1.74	7.15	11.04	5.00	7.15
OS-6	84.94%	0.69	10	2.00	1.85	Grassed Waterway	25	2.00	2.12	0.20	2.04	10.19	5.00	5.00
OS-7	0.00%	0.08	25	25.00	3.18	Grassed Waterway	392	2.80	2.51	2.60	5.79	12.32	5.00	5.79
A-1	71.97%	0.65	45	3.05	3.73	Paved Areas	292	1.37	2.34	2.08	5.81	11.87	5.00	5.81
A-2	81.80%	0.73	45	4.80	2.67	Paved Areas	412	2.18	2.96	2.32	5.00	12.54	5.00	5.00
A-3	93.78%	0.81	45	2.50	2.58	Paved Areas	433	1.73	2.63	2.74	5.32	12.66	5.00	5.32
A-4	94.73%	0.83	65	1.65	3.35	Paved Areas	365	2.19	2.96	2.05	5.41	12.39	5.00	5.41
A-5	8.11%	0.15	25	10.00	4.03	Paved Areas	140	0.50	1.41	1.65	5.68	10.92	5.00	5.68

3.2.1 Overland (Initial) Flow Time

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

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

Where:

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

3.2.2 Travel Time

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

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

Where:

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

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

Where:

t_c = time of concentration (min)
 t_o = overland (initial) flow time (min)
 t_t = travel time in the ditch, channel, gutter, storm sewer, etc. (min)

3.2.3 First Design Point Time of Concentration in Urban Catchments

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

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

Where:

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

Equation 6-10 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional "calibration" of the Rational Method. Normally, Equation 6-10 will result in a lesser

3.2.4 Minimum Time of Concentration

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



Project: Monument Steel Structures

Location: Monument, CO

Designer: TAJ

Date: 4/7/2019

Latest Revision: 8/17/2019

Design Storm: 5-Yr

1-hr Design Point Rainfall (in): 1.50

5-YEAR PEAK RUNOFF CALCULATIONS

Basin Designation	Design Point	Basin Outfall	Area (ac)	C _s	C X A	T _c (min)	Intensity (in/hr)	Peak Flow, Q (cfs)
E-1	1	Basin E-1	1.35	0.17	0.24	10.00	4.06	0.96
E-2	2	Ex 30" RCP	4.00	0.08	0.32	13.03	3.63	1.16
OS-1	4	Basin A-4	0.45	0.08	0.04	7.28	4.55	0.16
OS-2	3	Basin A-3	0.22	0.08	0.02	6.59	4.70	0.08
OS-3	2	Basin A-2	0.42	0.29	0.12	7.22	4.57	0.55
OS-4	1	Basin A-1	0.15	0.36	0.05	5.00	5.09	0.27
OS-5		Basin OS-7	0.12	0.08	0.01	7.15	4.58	0.04
OS-6		Basin OS-7	0.16	0.69	0.11	5.00	5.09	0.57
OS-7		Ex 30" RCP	0.40	0.08	0.03	5.79	4.89	0.16
A-1	1	IN-1 (10' Type R)	0.43	0.65	0.28	5.81	4.88	1.36
A-2	2	IN-1 (10' Type R)	0.90	0.73	0.66	5.00	5.09	3.34
A-3	3	IN-2 (Triple Type 13)	0.95	0.81	0.77	5.32	5.00	3.87
A-4	4	IN-3 (Double Type 13)	0.93	0.83	0.77	5.41	4.98	3.86
A-5	5	EDB Outlet Structure	0.23	0.15	0.03	5.68	4.91	0.16

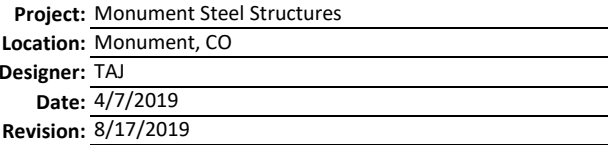


Project: Monument Steel Structures
Location: Monument, CO
Designer: TAJ
Date: 4/7/2019
Latest Revision: 8/17/2019

Design Storm: 100-Yr
 1-hr Design Point Rainfall (in): 2.52

100-YEAR PEAK RUNOFF CALCULATIONS

Basin Designation	Design Point	Basin Outfall	Area (ac)	C ₁₀₀	C X A	T _c (min)	Intensity (in/hr)	Peak Flow, Q (cfs)
E-1	1	Basin E-1	1.35	0.42	0.57	10.00	6.82	3.88
E-2	2	Ex 30" RCP	4.00	0.35	1.40	13.03	6.10	8.55
OS-1	4	Basin A-4	0.45	0.35	0.16	7.28	7.65	1.20
OS-2	3	Basin A-3	0.22	0.35	0.08	6.59	7.90	0.60
OS-3	2	Basin A-2	0.42	0.50	0.21	7.22	7.67	1.62
OS-4	1	Basin A-1	0.15	0.56	0.08	5.00	8.55	0.70
OS-5		Basin OS-7	0.12	0.35	0.04	7.15	7.69	0.33
OS-6		Basin OS-7	0.16	0.78	0.13	5.00	8.55	1.08
OS-7		Ex 30" RCP	0.40	0.35	0.14	5.79	8.21	1.15
A-1	1	IN-1 (10' Type R)	0.43	0.77	0.33	5.81	8.20	2.70
A-2	2	IN-1 (10' Type R)	0.90	0.83	0.74	5.00	8.55	6.36
A-3	3	IN-2 (Triple Type 13)	0.95	0.88	0.84	5.32	8.41	7.09
A-4	4	IN-3 (Double Type 13)	0.93	0.90	0.84	5.41	8.37	7.03
A-5	5	EDB Outlet Structure	0.23	0.40	0.09	5.68	8.26	0.75



MINOR STORM ROUTING CALCULATIONS

[illegible]



TERRA FORMA
SOLUTIONS

Project: Monument Steel Structures

Location: Monument, CO

Designer: TAJ

Date: 4/7/2019

at Revision: 8/17/2019

Design Storm: 100-Yr

1-hr Design Point Rainfall (in): 2.52

MAJOR STORM ROUTING CALCULATIONS

[illegible]

APPENDIX B - HYDRAULIC COMPUTATIONS

2ft Catch Curb and 24' Drive Isle Capacity

Version 4.05 Released March 2017

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

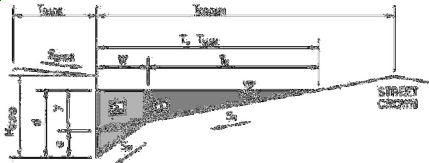
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Monument Steel Structures

Inlet ID:

IN-1



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

$T_{BACK} = 10.0$ ft
 $S_{BACK} = 0.100$ ft/ft
 $n_{BACK} = 0.015$

Height of Curb at Gutter Flow Line
Distance from Curb Face to Street Crown
Gutter Width
Street Transverse Slope
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)
Street Longitudinal Slope - Enter 0 for sump condition
Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$H_{CURB} = 6.00$ inches
 $T_{CROWN} = 24.0$ ft
 $W = 2.00$ ft
 $S_X = 0.020$ ft/ft
 $S_W = 0.083$ ft/ft
 $S_O = 0.008$ ft/ft
 $n_{STREET} = 0.012$

Max. Allowable Spread for Minor & Major Storm
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm
Allow Flow Depth at Street Crown (leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX} =$	24.0	24.0	ft
$d_{MAX} =$	6.0	12.0	inches
	<input type="checkbox"/>	<input type="checkbox"/>	check = yes

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

	Minor Storm	Major Storm	
$Q_{allow} =$	16.4	31.1	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'

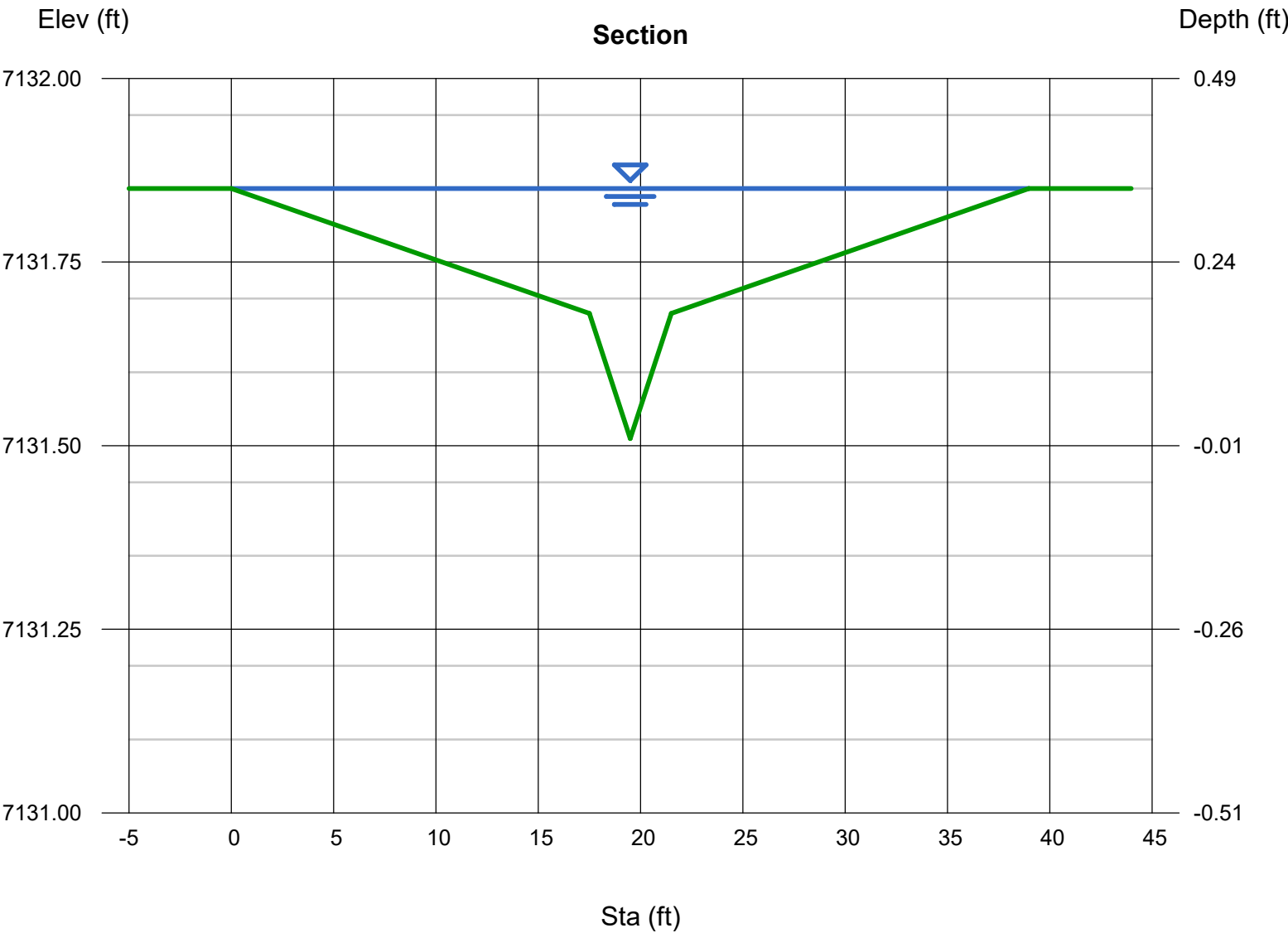
Channel Report

40 Foot Drainage Pan Capacity

User-defined		Highlighted	
Invert Elev (ft)	= 7131.51	Depth (ft)	= 0.34
Slope (%)	= 1.80	Q (cfs)	= 14.54
N-Value	= Composite	Area (sqft)	= 3.99
		Velocity (ft/s)	= 3.64
		Wetted Perim (ft)	= 39.00
		Crit Depth, Yc (ft)	= 0.34
		Top Width (ft)	= 38.98
		EGL (ft)	= 0.55

(Sta, El, n)-(Sta, El, n)...

(0.00, 7131.85)-(17.50, 7131.68, 0.012)-(19.50, 7131.51, 0.012)-(21.50, 7131.68, 0.012)-(38.98, 7131.85, 0.012)



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

Monday, Apr 8 2019

60 Foot Drainage Pan Capacity

User-defined

Invert Elev (ft) = 7127.89
Slope (%) = 2.00
N-Value = Composite

Calculations

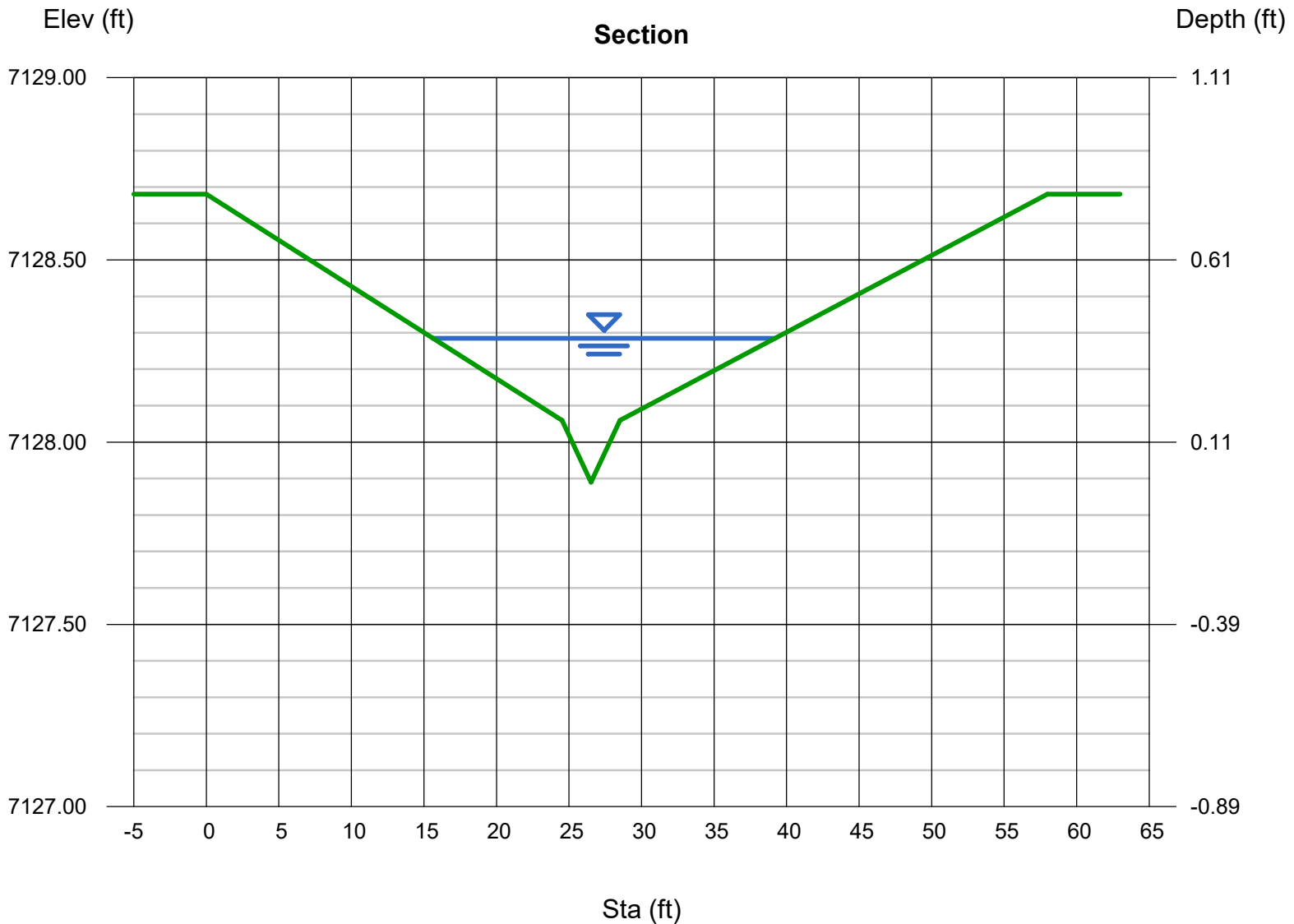
Compute by: Q vs Depth
No. Increments = 10

Highlighted

Depth (ft) = 0.40
Q (cfs) = 16.75
Area (sqft) = 3.45
Velocity (ft/s) = 4.86
Wetted Perim (ft) = 23.61
Crit Depth, Yc (ft) = 0.51
Top Width (ft) = 23.59
EGL (ft) = 0.76

(Sta, El, n)-(Sta, El, n)...

(0.00, 7128.68)-(24.52, 7128.06, 0.012)-(26.52, 7127.89, 0.012)-(28.52, 7128.06, 0.012)-(57.98, 7128.68, 0.012)



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

Monday, Apr 8 2019

12 IN Vertical Curb Alley Capacity

User-defined

Invert Elev (ft) = 7131.32
Slope (%) = 2.00
N-Value = Composite

Calculations

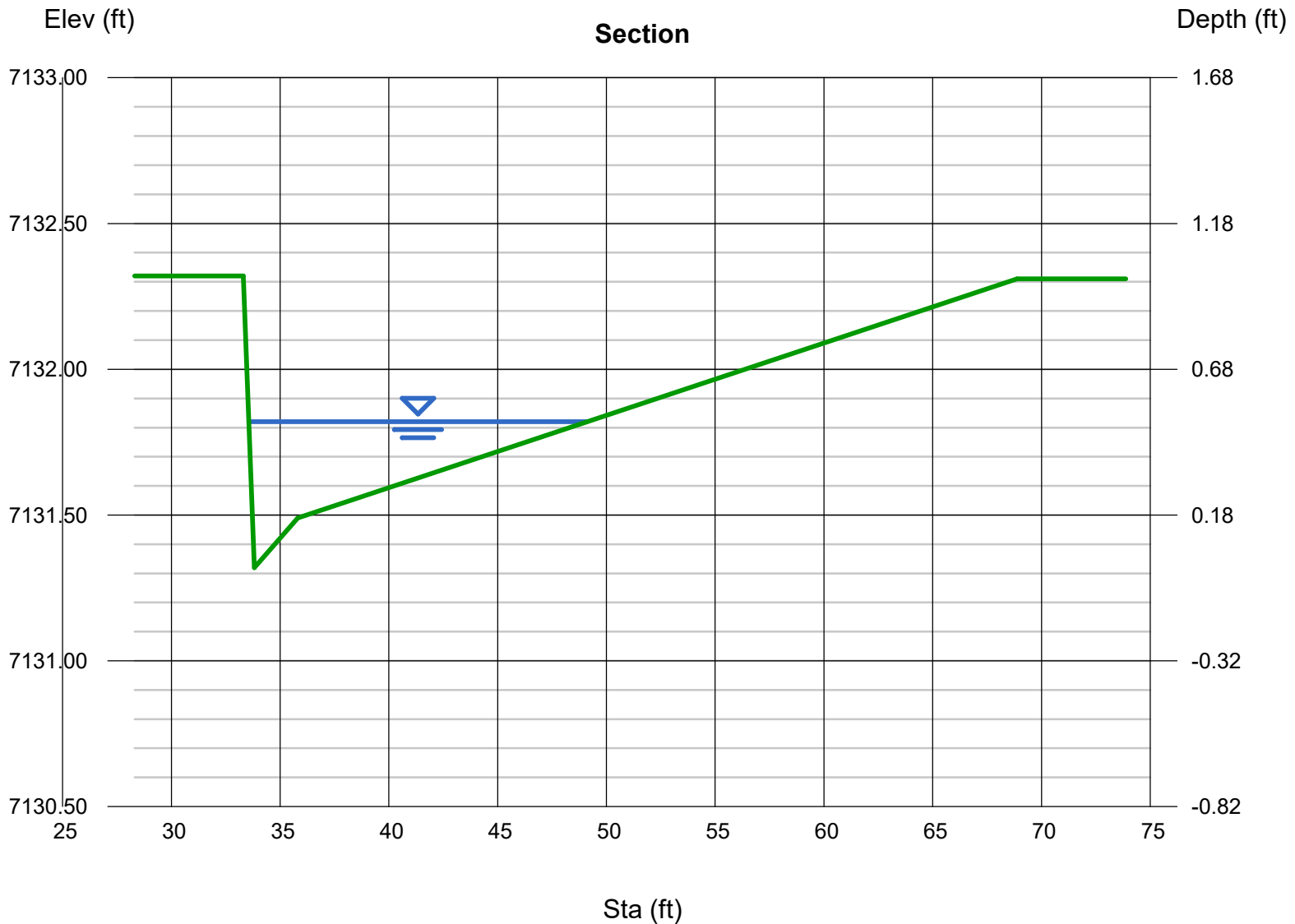
Compute by: Q vs Depth
No. Increments = 10

Highlighted

Depth (ft) = 0.50
Q (cfs) = 18.14
Area (sqft) = 3.08
Velocity (ft/s) = 5.89
Wetted Perim (ft) = 15.87
Crit Depth, Yc (ft) = 0.66
Top Width (ft) = 15.54
EGL (ft) = 1.04

(Sta, El, n)-(Sta, El, n)...

(33.31, 7132.32)-(33.81, 7131.32, 0.012)-(35.81, 7131.49, 0.012)-(68.88, 7132.31, 0.012)



Version 4.05 Released March 2017

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

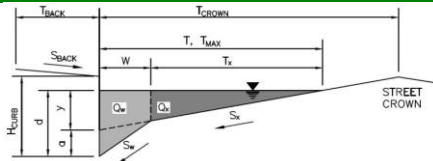
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Monument Steel Structures

Inlet ID:

IN-1

**Gutter Geometry (Enter data in the blue cells)**

Maximum Allowable Width for Spread Behind Curb

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

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

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

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

Street Longitudinal Slope - Enter 0 for sump condition

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

$T_{BACK} = 10.0$ ft
 $S_{BACK} = 0.100$ ft/ft
 $n_{BACK} = 0.015$

$H_{CURB} = 6.00$ inches
 $T_{CROWN} = 24.0$ ft
 $W = 2.00$ ft
 $S_X = 0.020$ ft/ft
 $S_W = 0.083$ ft/ft
 $S_O = 0.008$ ft/ft
 $n_{STREET} = 0.012$

Max. Allowable Spread for Minor & Major Storm

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

Allow Flow Depth at Street Crown (leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX} =$	24.0	24.0	ft
$d_{MAX} =$	6.0	12.0	inches
	<input type="checkbox"/>	<input type="checkbox"/>	check = yes

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

$Q_{allow} =$

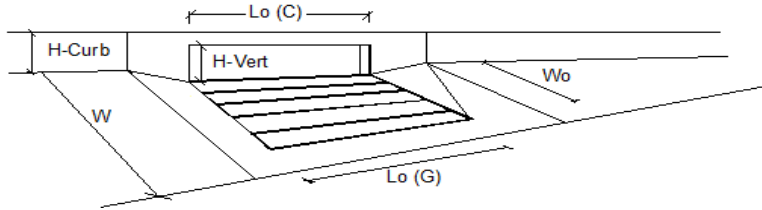
Minor Storm	Major Storm	
16.4	31.1	cfs

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

Version 4.05 Released March 2017



Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		N_o =	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_r-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_r-C =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity*		MINOR		MAJOR	
Total Inlet Interception Capacity		Q =	4.2	6.5	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		Q_b =	0.3	2.9	cfs
Capture Percentage = Q_i/Q_o =		C% =	93	69	%

Version 4.05 Released March 2017

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

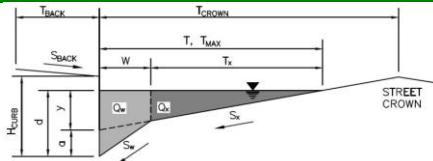
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Monument Steel Structures

Inlet ID:

IN-2

**Gutter Geometry (Enter data in the blue cells)**

Maximum Allowable Width for Spread Behind Curb

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

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

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

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

Street Longitudinal Slope - Enter 0 for sump condition

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

Max. Allowable Spread for Minor & Major Storm

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

Check boxes are not applicable in SUMP conditions

MINOR STORM Allowable Capacity is based on Depth Criterion**MAJOR STORM** Allowable Capacity is based on Depth Criterion $T_{BACK} = 5.0$ ft $S_{BACK} = 0.020$ ft/ft $n_{BACK} = 0.015$ $H_{CURB} = 6.00$ inches $T_{CROWN} = 24.0$ ft $W = 2.00$ ft $S_x = 0.020$ ft/ft $S_w = 0.083$ ft/ft $S_o = 0.000$ ft/ft $n_{STREET} = 0.012$

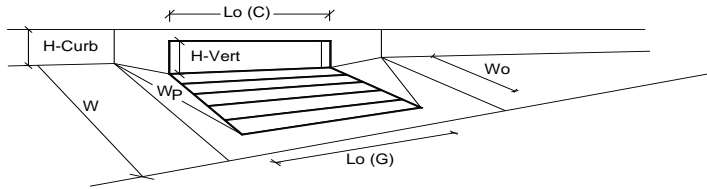
	Minor Storm	Major Storm	
$T_{MAX} =$	24.0	24.0	ft
$d_{MAX} =$	6.0	8.0	inches

☐☐

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

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)

Type of Inlet CDOT/Denver 13 Combination
 Local Depression (additional to continuous gutter depression 'a' from above)
 Number of Unit Inlets (Grate or Curb Opening)
 Water Depth at Flowline (outside of local depression)

Grate Information

Length of a Unit Grate
 Width of a Unit Grate
 Area Opening Ratio for a Grate (typical values 0.15-0.90)
 Clogging Factor for a Single Grate (typical value 0.50 - 0.70)
 Grate Weir Coefficient (typical value 2.15 - 3.60)
 Grate Orifice Coefficient (typical value 0.60 - 0.80)

Curb Opening Information

Length of a Unit Curb Opening
 Height of Vertical Curb Opening in Inches
 Height of Curb Orifice Throat in Inches
 Angle of Throat (see USDCM Figure ST-5)
 Side Width for Depression Pan (typically the gutter width of 2 feet)
 Clogging Factor for a Single Curb Opening (typical value 0.10)
 Curb Opening Weir Coefficient (typical value 2.3-3.7)
 Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)

Low Head Performance Reduction (Calculated)

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

Total Inlet Interception Capacity (assumes clogged condition)

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

	MINOR	MAJOR	
Type =	CDOT/Denver 13 Combination		
a _{local} =	2.00	2.00	inches
No =	3	3	
Ponding Depth =	6.0	7.3	inches
	MINOR	MAJOR	<input type="checkbox"/> Override Depths
L _g (G) =	3.00	3.00	feet
W _o =	1.73	1.73	feet
A _{ratio} =	0.43	0.43	
C _f (G) =	0.50	0.50	
C _w (G) =	3.30	3.30	
C _o (G) =	0.60	0.60	
	MINOR	MAJOR	
L _c (C) =	3.00	3.00	feet
H _{vert} =	6.50	6.50	inches
H _{throat} =	5.25	5.25	inches
Theta =	0.00	0.00	degrees
W _p =	2.00	2.00	feet
C _f (C) =	0.10	0.10	
C _w (C) =	3.70	3.70	
C _o (C) =	0.66	0.66	
	MINOR	MAJOR	
d _{Grate} =	0.523	0.629	ft
d _{Curb} =	0.33	0.44	ft
RF _{Combination} =	0.57	0.69	
RF _{Curb} =	0.97	1.00	
RF _{Grate} =	0.57	0.69	
	MINOR	MAJOR	
Q _a =	6.4	11.0	cfs
Q _{PEAK REQUIRED} =	3.7	9.4	cfs

Version 4.05 Released March 2017

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

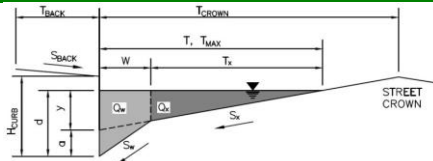
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Monument Steel Structures

Inlet ID:

IN-3

**Gutter Geometry (Enter data in the blue cells)**

Maximum Allowable Width for Spread Behind Curb

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

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

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

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

Street Longitudinal Slope - Enter 0 for sump condition

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

 $T_{BACK} = 5.0$ ft $S_{BACK} = 0.020$ ft/ft $n_{BACK} = 0.015$ $H_{CURB} = 6.00$ inches $T_{CROWN} = 24.0$ ft $W = 2.00$ ft $S_x = 0.020$ ft/ft $S_W = 0.083$ ft/ft $S_O = 0.000$ ft/ft $n_{STREET} = 0.012$

Max. Allowable Spread for Minor & Major Storm

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

Check boxes are not applicable in SUMP conditions

	Minor Storm	Major Storm	
$T_{MAX} =$	24.0	24.0	ft
$d_{MAX} =$	6.0	8.0	inches



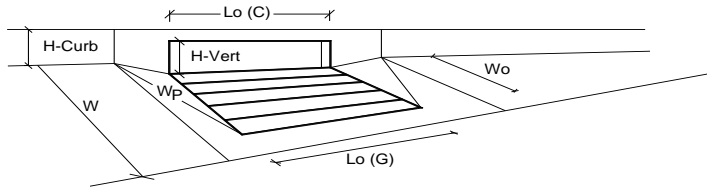
MINOR STORM Allowable Capacity is based on Depth Criterion

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

Version 4.05 Released March 2017



Design Information (Input)

Type of Inlet CDOT/Denver 13 Combination
 Local Depression (additional to continuous gutter depression 'a' from above)
 Number of Unit Inlets (Grate or Curb Opening)
 Water Depth at Flowline (outside of local depression)

Grate Information

Length of a Unit Grate
 Width of a Unit Grate
 Area Opening Ratio for a Grate (typical values 0.15-0.90)
 Clogging Factor for a Single Grate (typical value 0.50 - 0.70)
 Grate Weir Coefficient (typical value 2.15 - 3.60)
 Grate Orifice Coefficient (typical value 0.60 - 0.80)

Curb Opening Information

Length of a Unit Curb Opening
 Height of Vertical Curb Opening in Inches
 Height of Curb Orifice Throat in Inches
 Angle of Throat (see USDCM Figure ST-5)
 Side Width for Depression Pan (typically the gutter width of 2 feet)
 Clogging Factor for a Single Curb Opening (typical value 0.10)
 Curb Opening Weir Coefficient (typical value 2.3-3.7)
 Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)

Low Head Performance Reduction (Calculated)

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

Total Inlet Interception Capacity (assumes clogged condition)

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

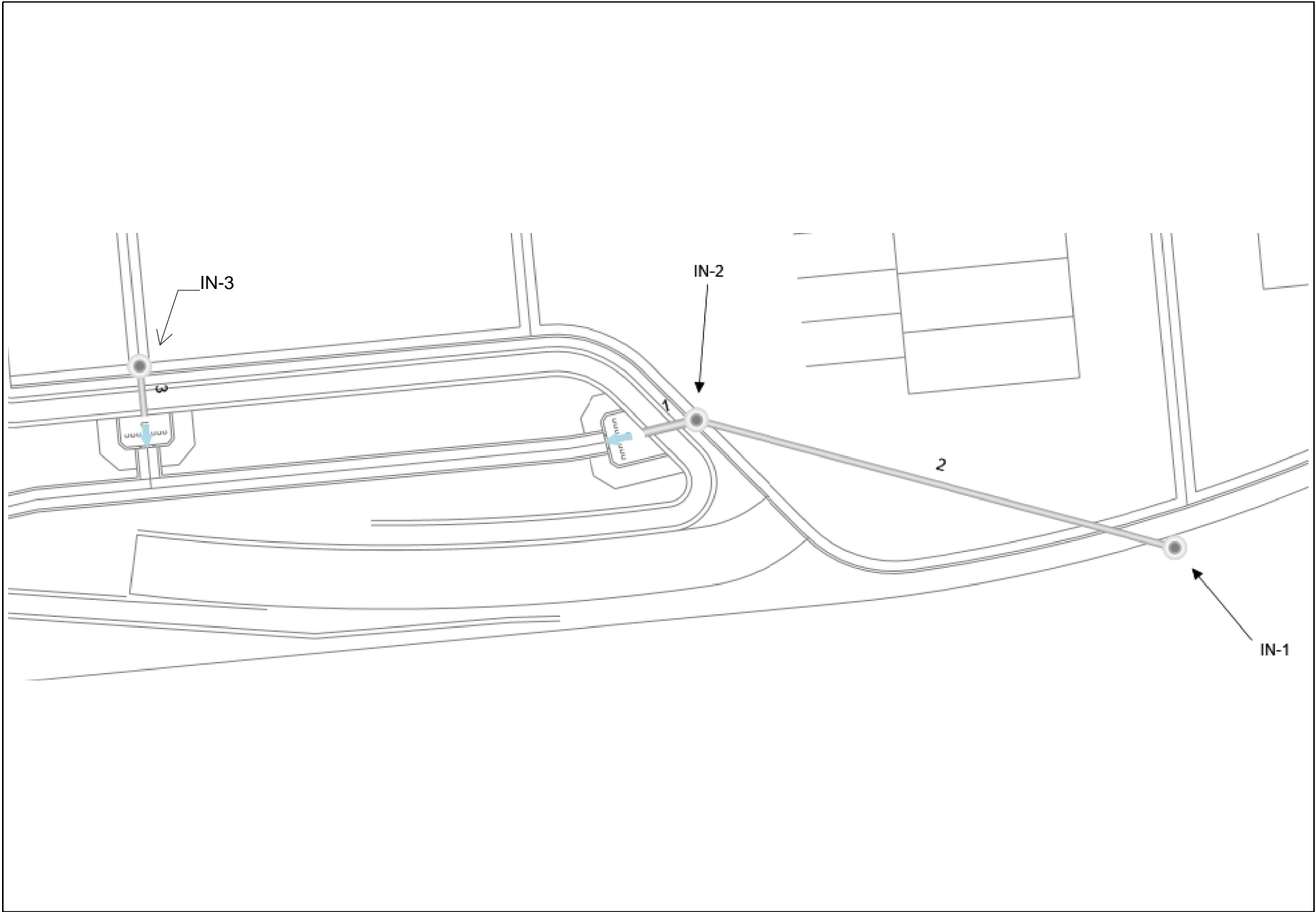
	MINOR	MAJOR	
Type =	CDOT/Denver 13 Combination		
a_{local} =	2.00	2.00	inches
No =	2	2	
Ponding Depth =	6.0	7.3	inches
	MINOR	MAJOR	<input type="checkbox"/> Override Depths
L_g (G) =	3.00	3.00	feet
W_o =	1.73	1.73	feet
A_{ratio} =	0.43	0.43	
C_f (G) =	0.50	0.50	
C_w (G) =	3.30	3.30	
C_o (G) =	0.60	0.60	
	MINOR	MAJOR	
L_c (C) =	3.00	3.00	feet
H_{vert} =	6.50	6.50	inches
H_{throat} =	5.25	5.25	inches
Theta =	0.00	0.00	degrees
W_p =	2.00	2.00	feet
C_f (C) =	0.10	0.10	
C_w (C) =	3.70	3.70	
C_o (C) =	0.66	0.66	
	MINOR	MAJOR	
d_{Grate} =	0.523	0.629	ft
d_{Curb} =	0.33	0.44	ft
$RF_{Combination}$ =	0.71	0.86	
RF_{Curb} =	1.00	1.00	
RF_{Grate} =	0.71	0.86	
	MINOR	MAJOR	
Q_a =	5.3	9.0	cfs
$Q_{PEAK REQUIRED}$ =	3.4	7.0	cfs

Plan View

Stormwater Studio 2019 v 3.0.0.7

Project Name: 10StormDesign

04-10-2019



Energy Grade Line Calculations

Stormwater Studio 2019 v 3.0.0.14

Project Name: 10StormDesign

08-17-2019

Line No	Line Size (in)	Q (cfs)	Downstream							Length (ft)	Upstream							Pipe		Junction		
			Invert Elev (ft)	Depth (ft)	Area (sqft)	HGL Elev (ft)	Vel (ft/s)	Vel Head (ft)	EGL Elev (ft)		Invert Elev (ft)	Depth (ft)	Area (sqft)	HGL Elev (ft)	Vel (ft/s)	Vel Head (ft)	EGL Elev (ft)	n Value	Enrgy Loss (ft)	HGLa Elev (ft)	EGLa Elev (ft)	Enrgy Loss (ft)
1	24	7.90	7119.22	0.77†	1.12	7119.99	7.07	0.78	7120.61	10.71	7119.76	1.00²	1.56	7120.75	5.06	0.40	7121.15	0.013	0.536	7120.75	7121.15	0.00
2	18	4.20	7121.26	0.51†	0.53	7121.77	7.85	0.96	7122.35	100.98	7124.54	0.78²	0.93	7125.32	4.51	0.32	7125.64	0.013	3.282	7125.32	7125.64	0.00
3	18	3.40	7119.05	0.52†	0.55	7119.57	6.18	0.59	7120.02	9.97	7119.55	0.70²	0.81	7120.25	4.18	0.27	7120.52	0.013	0.499	7120.25	7120.52	0.00

Notes: Return Period = 5-yrs. ² Critical depth. † Supercritical.

Project File: Monument SSA - 5 yr.sws

Energy Grade Line Calculations

Stormwater Studio 2019 v 3.0.0.14

Project Name: 10StormDesign

08-17-2019

Line No	Line Size (in)	Q (cfs)	Downstream							Length (ft)	Upstream							Pipe		Junction		
			Invert Elev (ft)	Depth (ft)	Area (sqft)	HGL Elev (ft)	Vel (ft/s)	Vel Head (ft)	EGL Elev (ft)		Invert Elev (ft)	Depth (ft)	Area (sqft)	HGL Elev (ft)	Vel (ft/s)	Vel Head (ft)	EGL Elev (ft)	n Value	Enrgy Loss (ft)	HGLa Elev (ft)	EGLa Elev (ft)	Enrgy Loss (ft)
1	24	15.90	7119.22	1.12‡	1.82	7120.34	8.75	1.19	7121.33	10.71	7119.76	1.41‡	2.37	7121.17	6.70	0.70	7121.87	0.013	0.535	7121.17	7121.87	0.00
2	18	6.50	7121.26	0.64‡	0.72	7121.90	9.02	1.26	7122.67	100.98	7124.54	0.97‡	1.21	7125.51	5.36	0.45	7125.96	0.013	3.282	7125.51	7125.96	0.00
3	18	7.00	7119.05	1.45	1.75	7120.50	4.00	0.25	7120.75	9.97	7119.55	1.01‡	1.27	7120.56	5.53	0.48	7121.03	0.013	0.284	7120.56	7121.03	0.00

Notes: Return Period = 100-yrs. [‡] Critical depth. [‡] Supercritical.

Project File: Monument SSA - 100 yr.sws

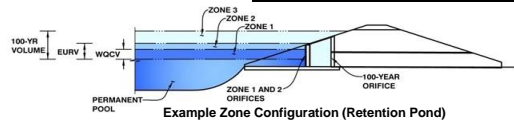
**APPENDIX C - DETENTION/WATER QUALITY
ENHANCEMENT BMPs**

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: 18910 Base Camp Road

Basin ID: Lot 2 - SSA



Required Volume Calculation

Selected BMP Type =	EDB	
Watershed Area =	4.67	acres
Watershed Length =	630	ft
Watershed Slope =	0.034	ft/ft
Watershed Imperviousness =	64.16%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Sedalia	
Water Quality Capture Volume (WQCV) =	0.098	acre-feet
Excess Urban Runoff Volume (EURV) =	0.327	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.270	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	0.361	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	0.466	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	0.600	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	0.702	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	0.830	acre-feet
500-yr Runoff Volume (P1 = 3.1 in.) =	1.087	acre-feet
Approximate 2-yr Detention Volume =	0.253	acre-feet
Approximate 5-yr Detention Volume =	0.340	acre-feet
Approximate 10-yr Detention Volume =	0.434	acre-feet
Approximate 25-yr Detention Volume =	0.468	acre-feet
Approximate 50-yr Detention Volume =	0.487	acre-feet
Approximate 100-yr Detention Volume =	0.527	acre-feet

Optional User Override
1-hr Precipitation

1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
3.10	inches

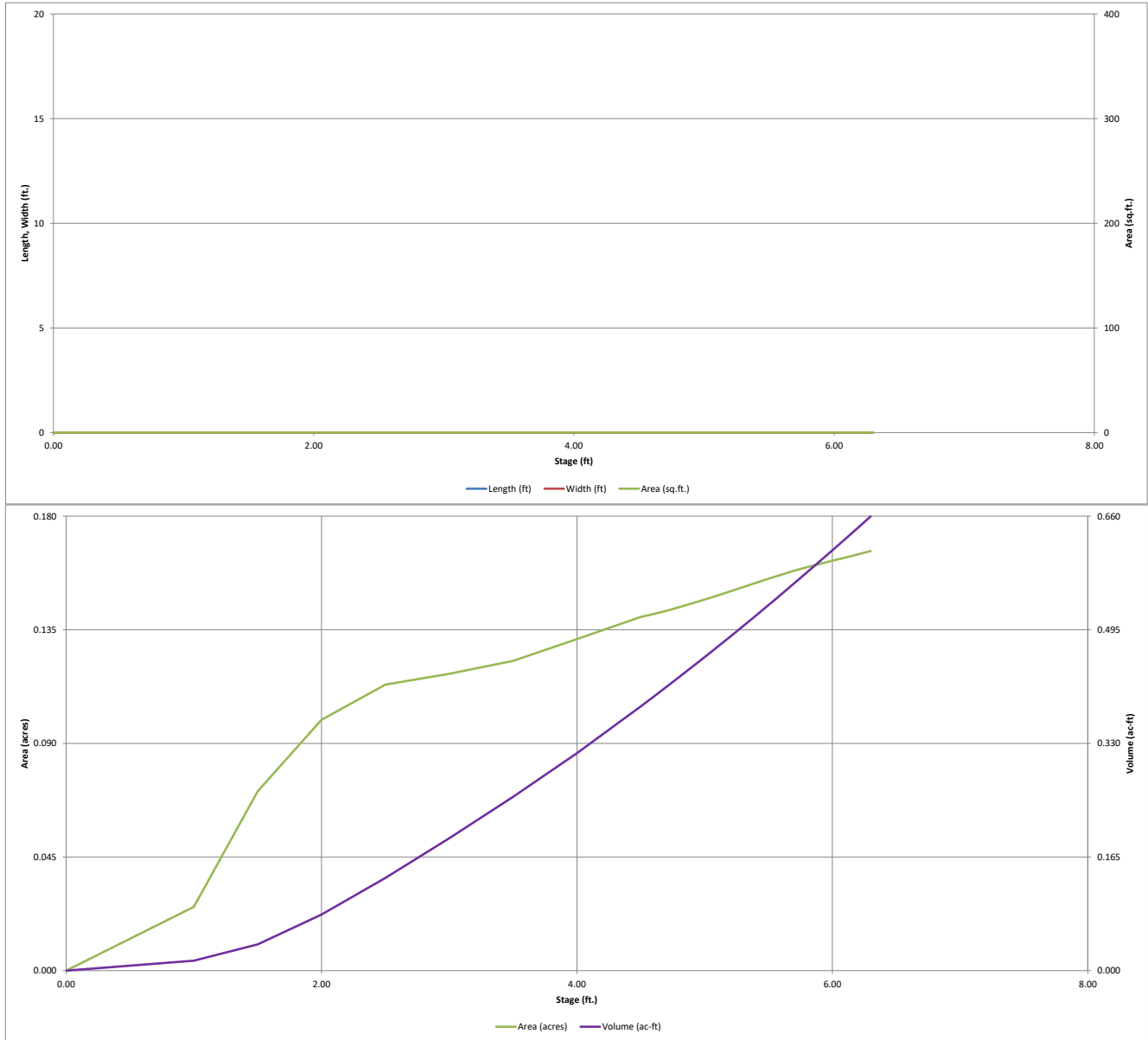
Stage-Storage Calculation

Zone 1 Volume (V_{QCV1}) =	0.098	acre-feet
Zone 2 Volume ($V_{EURV} - \text{Zone 1}$) =	0.229	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.200	acre-feet
Total Detention Basin Volume =	0.527	acre-feet
Initial Surge Volume (ISV) =	user	ft ³
Initial Surge Depth (ISD) =	user	ft
Total Available Detention Depth ($H_{(dss)}$) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides ($S_{(dss)}$) =	user	H:V
Basin Length-to-Width Ratio ($R_{(LW)}$) =	user	
Initial Surge Area ($A_{(SV)}$) =	user	ft ²
Surge Volume Length ($L_{(SV)}$) =	user	ft
Surcharge Volume Width ($W_{(SV)}$) =	user	ft
Depth of Basin Floor ($H_{(flood)}$) =	user	ft
Length of Basin Floor ($L_{(flood)}$) =	user	ft
Width of Basin Floor ($W_{(flood)}$) =	user	ft
Area of Basin Floor ($A_{(flood)}$) =	user	ft ²
Volume of Basin Floor ($V_{(flood)}$) =	user	ft ³
Depth of Main Basin ($H_{(Main)}$) =	user	ft
Length of Main Basin ($L_{(Main)}$) =	user	ft
Width of Main Basin ($W_{(Main)}$) =	user	ft
Area of Main Basin ($A_{(Main)}$) =	user	ft ²
Volume of Main Basin ($V_{(Main)}$) =	user	ft ³
Calculated Total Basin Volume ($V_{(total)}$) =	user	acre-feet

[illegible]

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

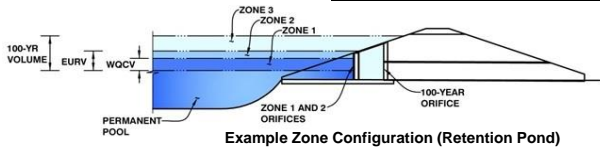


Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: **Monument Steel Structures - PCD File No. PPR1919**

Basin ID: **18910 Base Camp Road - El Paso County**



	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.33	0.098	Orifice Plate
Zone 2 (EURV)	4.26	0.229	Orifice Plate
Zone 3 (100-year)	5.65	0.200	Weir&Pipe (Circular)
		0.527	Total

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

Underdrain Orifice Invert Depth = ft (distance below the filtration media surface)
Underdrain Orifice Diameter = inches

Calculated Parameters for Underdrain

Underdrain Orifice Area = ft²
Underdrain Orifice Centroid = feet

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

Invert of Lowest Orifice = ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate = ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing = inches
Orifice Plate: Orifice Area per Row = inches

Calculated Parameters for Plate

WQ Orifice Area per Row = ft²
Elliptical Half-Width = feet
Elliptical Slot Centroid = feet
Elliptical Slot Area = ft²

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	2.17	2.42					
Orifice Area (sq. inches)	0.69	0.89	0.52					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected
Invert of Vertical Orifice =	N/A	N/A
Depth at top of Zone using Vertical Orifice =	N/A	N/A
Vertical Orifice Diameter =	N/A	N/A

ft (relative to basin bottom at Stage = 0 ft)
ft (relative to basin bottom at Stage = 0 ft)
inches

Calculated Parameters for Vertical Orifice

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

ft²
feet

User Input: Overflow Weir (Dropbox) and Gate (Flat or Sloped)

	Zone 3 Weir	Not Selected
Overflow Weir Front Edge Height, Ho =	4.55	N/A
Overflow Weir Front Edge Length =	2.50	N/A
Overflow Weir Slope =	4.00	N/A
Horiz. Length of Weir Sides =	2.92	N/A
Overflow Gate Open Area % =	70%	N/A
Debris Clogging % =	50%	N/A

ft (relative to basin bottom at Stage = 0 ft)
feet
H:V (enter zero for flat grate)
feet
%, grate open area/total area
%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected
Height of Grate Upper Edge, H ₁ =	5.28	N/A
Over Flow Weir Slope Length =	3.01	N/A
Grate Open Area / 100-yr Orifice Area =	11.91	N/A
Overflow Gate Open Area w/o Debris =	5.26	N/A
Overflow Gate Open Area w/ Debris =	2.63	N/A

feet
feet
should be ≥ 4
ft²
ft²

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

	Zone 3 Circular	Not Selected
Depth to Invert of Outlet Pipe =	0.33	N/A
Circular Orifice Diameter =	9.00	N/A

ft (distance below basin bottom at Stage = 0 ft)
inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Circular	Not Selected
Outlet Orifice Area =	0.44	N/A
Outlet Orifice Centroid =	0.38	N/A
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A

ft²
feet
radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway

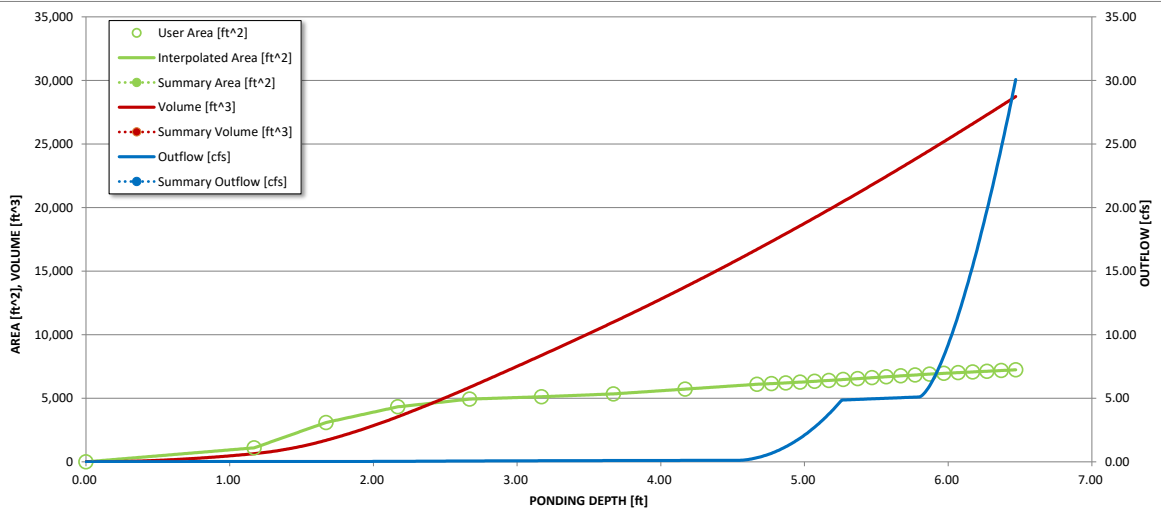
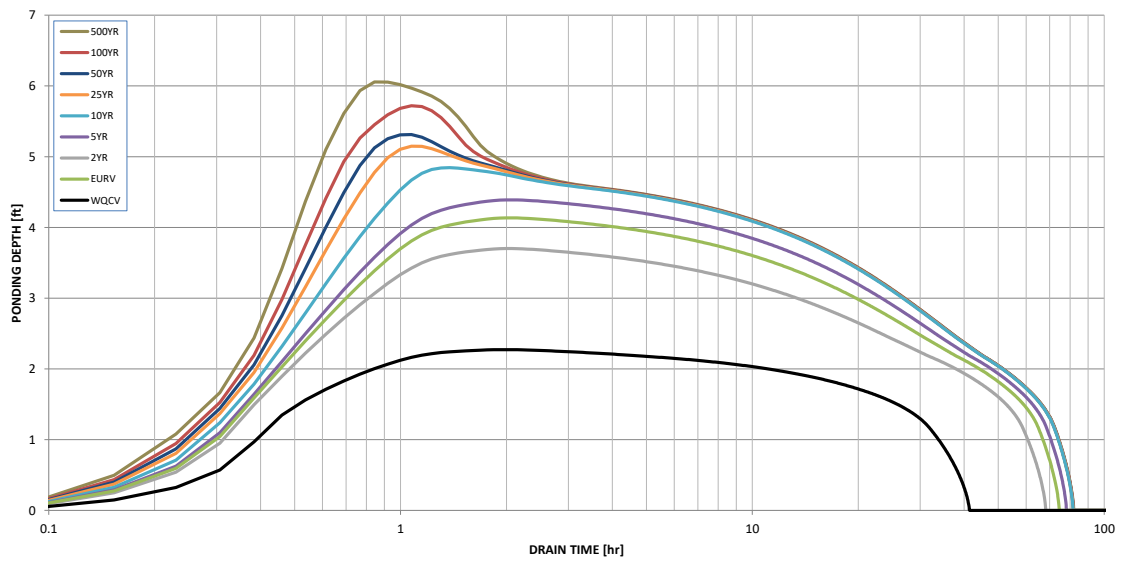
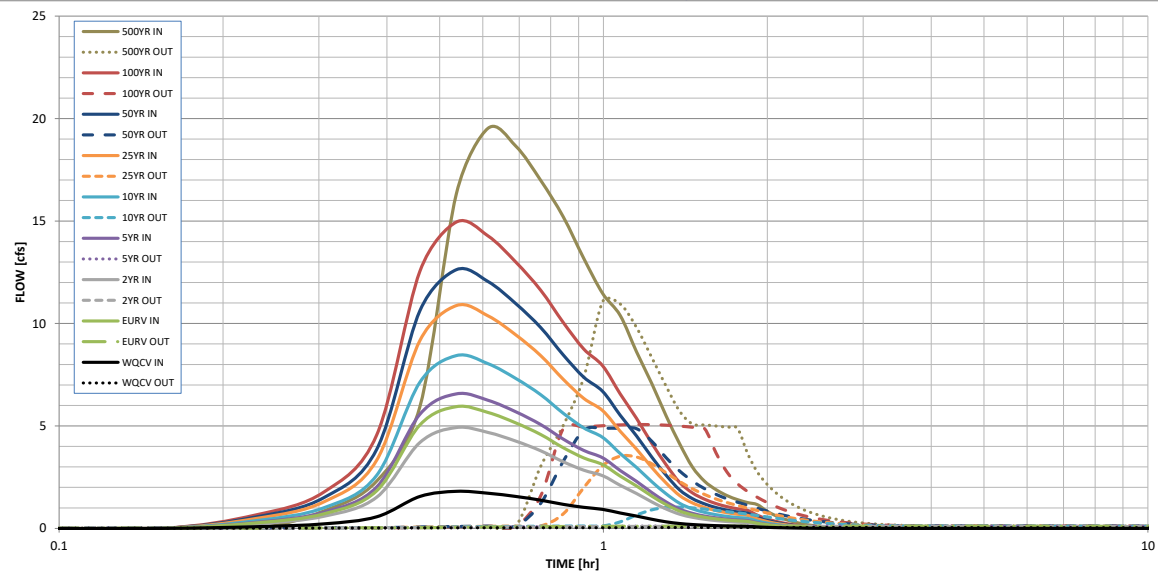
Spillway Design Flow Depth = feet
Stage at Top of Freeboard = feet
Basin Area at Top of Freeboard = acres

Routed Hydrograph Results

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.10
One-Hour Rainfall Depth (in) =	0.098	0.327	0.270	0.361	0.466	0.602	0.700	0.830	1.087
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.098	0.326	0.270	0.361	0.465	0.602	0.700	0.831	1.088
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.23	0.73	1.01	1.36	1.98
Predevelopment Peak Q (cfs) =	0.0	0.0	0.1	0.1	1.1	3.4	4.7	6.4	9.3
Peak Inflow Q (cfs) =	1.8	5.9	4.9	6.6	8.4	10.9	12.6	15.0	19.5
Peak Outflow Q (cfs) =	0.0	0.1	0.1	0.1	1.0	3.5	4.9	5.1	11.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.1	1.0	1.0	1.0	0.8	1.2
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.2	0.6	0.9	0.9	1.0
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	68	62	71	72	71	69	68	65
Time to Drain 99% of Inflow Volume (hours) =	40	72	66	75	78	77	76	76	74
Maximum Ponding Depth (ft) =	2.27	4.13	3.70	4.39	4.84	5.15	5.31	5.72	6.06
Area at Maximum Ponding Depth (acres) =	0.10	0.13	0.12	0.13	0.14	0.15	0.15	0.16	0.16
Maximum Volume Stored (acre-ft) =	0.091	0.311	0.256	0.344	0.408	0.451	0.476	0.537	0.591

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)



Forebay Design

	Tributary Area (ac)	Imp. Tributary Area (ac)	% Imp.	WQCV (in)	WQCV (ac-ft)	Forebay Vol (cf)	
North Forebay	1.38	0.89	64.1%	0.26	0.029	25.66	2% of WQCV
East Forebay	3.06	2.09	68.3%	0.27	0.070	60.95	2% of WQCV

$$WQCV = a(0.91I^3 - 1.19I^2 + 0.78I)$$

Equation 3-1

Where:

WQCV = Water Quality Capture Volume (watershed inches)

a = Coefficient corresponding to WQCV drain time (Table 3-2)

I = Imperviousness (%/100) (see Figures 3-3 through 3-5 [single family land use] and /or the *Runoff* chapter of Volume 1[other typical land uses])

Table 3-2. Drain Time Coefficients for WQCV Calculations

Drain Time (hrs)	Coefficient, a
12 hours	0.8
24 hours	0.9
40 hours	1.0

Once the WQCV in watershed inches is found from Figure 3-2 or using Equation 3-1 and/or 3-2, the required BMP storage volume in acre-feet can be calculated as follows:

$$V = \left(\frac{WQCV}{12}\right)A$$

Equation 3-3

Table EDB-4. EDB component criteria

	On-Site EDBs for Watersheds up to 1 Impervious Acre ¹	EDBs with Watersheds between 1 and 2 Impervious Acres ¹	EDBs with Watersheds up to 5 Impervious Acres	EDBs with Watersheds over 5 Impervious Acres	EDBs with Watersheds over 20 Impervious Acres
Forebay Release and Configuration	EDBs should not be used for watersheds with less than 1 impervious acre.	Release 2% of the undetained 100-year peak discharge by way of a wall/notch configuration	Release 2% of the undetained 100-year peak discharge by way of a wall/notch configuration	Release 2% of the undetained 100-year peak discharge by way of a wall/notch configuration	Release 2% of the undetained 100-year peak discharge by way of a wall/notch or berm/pipe ² configuration
Minimum Forebay Volume		1% of the WQCV	2% of the WQCV	3% of the WQCV	3% of the WQCV
Maximum Forebay Depth		12 inches	18 inches	18 inches	30 inches
Trickle Channel Capacity		≥ the maximum possible forebay outlet capacity	≥ the maximum possible forebay outlet capacity	≥ the maximum possible forebay outlet capacity	≥ the maximum possible forebay outlet capacity
Micropool		Area ≥ 10 ft ²	Area ≥ 10 ft ²	Area ≥ 10 ft ²	Area ≥ 10 ft ²
Initial Surge Volume		Depth ≥ 4 inches	Depth ≥ 4 inches	Depth ≥ 4 in. Volume ≥ 0.3% WQCV	Depth ≥ 4 in. Volume ≥ 0.3% WQCV

¹ EDBs are not recommended for sites with less than 2 impervious acres. Consider a sand filter or rain garden.

² Round up to the first standard pipe size (minimum 8 inches).

APPENDIX D - REFERENCED INFORMATION

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The community map repository should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations (BFEs)** and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only to landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the **North American Vertical Datum of 1988 (NAVD88)**. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at <http://www.ngs.noaa.gov/> or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, NNGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242 or visit its website at <http://www.ngs.noaa.gov/>.

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, City of Fountain, Bureau of Land Management, National Oceanic and Atmospheric Administration, United States Geological Survey, and Anderson Consulting Engineers, Inc. These data are current as of 2006.

This map reflects more detailed and up-to-date **stream channel configurations** and **floodplain delineations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map. The profile baselines depicted on this map represent the hydraulic modeling baselines that match the flood profiles and Floodway Data Tables if applicable, in the FIS report. As a result, the profile baselines may deviate significantly from the new base map channel representation and may appear outside of the floodplain.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

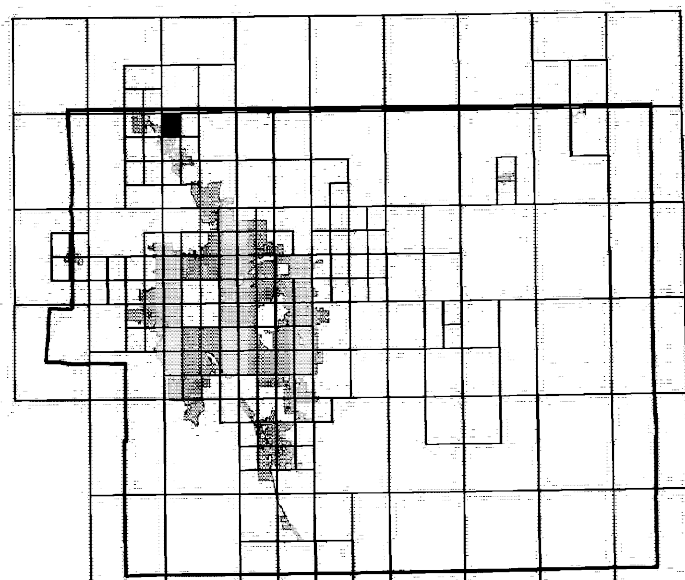
Contact **FEMA Map Service Center (MSC)** via the FEMA Map Information eXchange (FMIX) 1-877-338-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The MSC may also be reached by Fax at 1-800-358-9620 and its website at <http://www.msc.fema.gov/>.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call 1-877-FEMA MAP (1-877-336-2627) or visit the FEMA website at <http://www.fema.gov/business/nfp>.

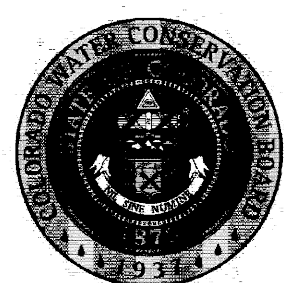
El Paso County Vertical Datum Offset Table

Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

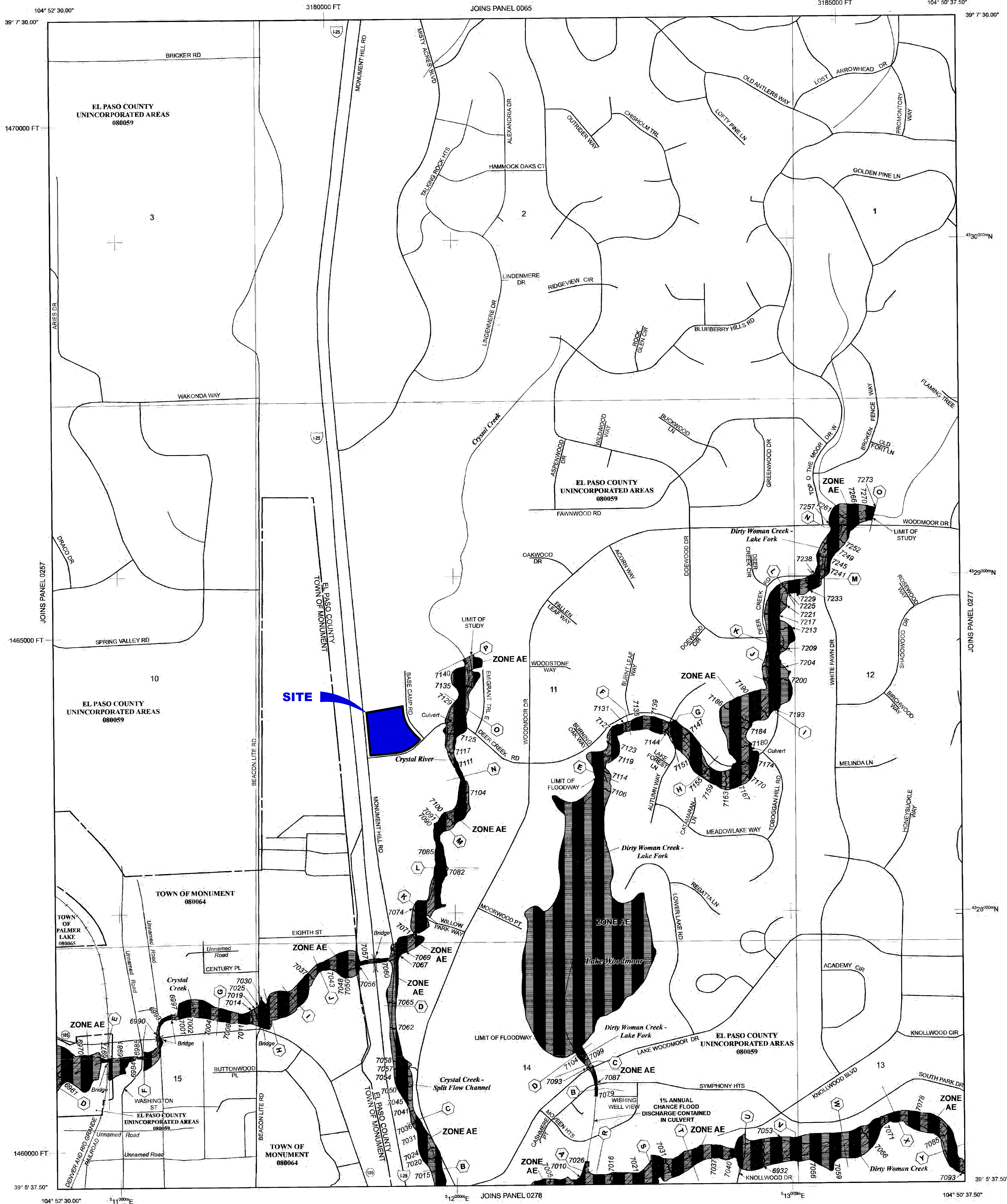
Panel Location Map



This Digital Flood Insurance Rate Map (DFIRM) was produced through a Cooperating Technical Partner (CTP) agreement between the State of Colorado Water Conservation Board (CWB) and the Federal Emergency Management Agency (FEMA).



Additional Flood Hazard information and resources are available from local communities and the Colorado Water Conservation Board.



NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 11 SOUTH, RANGE 67 WEST.

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAS) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

- ZONE A** No Base Flood Elevations determined.
- ZONE AE** Base Flood Elevations determined.
- ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
- ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- ZONE AR** Special Flood Hazard Area Formerly protected from the 1% annual chance flood by a flood control system that was subsequently decommissioned. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
- ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- Floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- Base Flood Elevation line and value; elevation in feet* (E1.987)
- Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

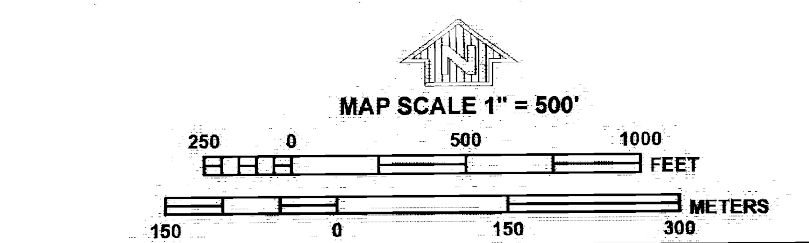
- Cross section line
- Transect line
- Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- 1000-meter Universal Transverse Mercator grid ticks, zone 13
- 5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPS ZONE 0502), Lambert Conformal Conic Projection
- Bench mark (see explanation in Notes to Users section of this FIRM panel)
- River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index
EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
MARCH 17, 1997

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
DECEMBER 7, 2018 - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

For community map revision history prior to countywide mapping, refer to the Community Map History Table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.



PANEL 0276G

FIRM

FLOOD INSURANCE RATE MAP
EL PASO COUNTY,
COLORADO
AND INCORPORATED AREAS

PANEL 276 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:	COMMUNITY	NUMBER	PANEL	SUFFIX
	EL PASO COUNTY	080054	0276	G
	MONUMENT, TOWN OF	080061	0276	G
	PALMER LAKE, TOWN OF	080065	0276	G

Notice to User: The Map Number shown below should be used when placing map orders. The Community Number shown above should be used on insurance applications for the subject community.

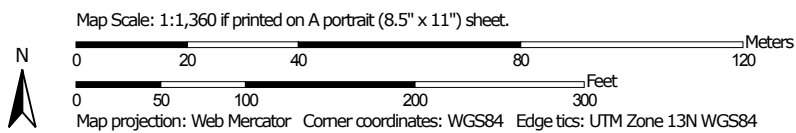
MAP NUMBER
08041C0276G

MAP REVISED
DECEMBER 7, 2018
Federal Emergency Management Agency

Hydrologic Soil Group—El Paso County Area, Colorado
(Lot 2)



Soil Map may not be valid at this scale.



Natural Resources
Conservation Service

Web Soil Survey
National Cooperative Soil Survey

1/30/2019
Page 1 of 4

MAP LEGEND

Area of Interest (AOI)









 Area of Interest (AOI)

Soils

Soil Rating Polygons





 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Lines

 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Points

 A
 A/D
 B
 B/D

 C
 C/D
 D
 Not rated or not available


Water Features

 Streams and Canals

Transportation

 Rails
 Interstate Highways
 US Routes
 Major Roads
 Local Roads

Background

 Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 16, Sep 10, 2018

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

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

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
92	Tomah-Crowfoot loamy sands, 3 to 8 percent slopes	B	4.7	80.6%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	B	1.1	19.4%
Totals for Area of Interest			5.9	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

El Paso County Drainage Basin Fees

Resolution No. 18-470

Basin Number	Receiving Waters	Year Studied	Drainage Basin Name	2019 Drainage Fee (per Impervious Acre)	2019 Bridge Fee (per Impervious Acre)
<u>Drainage Basins with DBPS's:</u>					
CHMS0200	Chico Creek	2013	Haegler Ranch	\$10,324	\$1,524
CHWS1200	Chico Creek	2001	Bennett Ranch	\$11,558	\$4,433
CHWS1400	Chico Creek	2013	Falcon	\$29,822	\$4,069
FOFO2000	Fountain Creek	2001	West Fork Jimmy Camp Creek	\$12,584	\$3,717
FOFO2600	Fountain Creek	1991*	Big Johnson / Crews Gulch	\$18,350	\$2,370
FOFO2800	Fountain Creek	1988*	Widefield	\$18,350	\$0
FOFO2900	Fountain Creek	1988*	Security	\$18,350	\$0
FOFO3000	Fountain Creek	1991*	Windmill Gulch	\$18,350	\$275
FOFO3100 / FOFO3200	Fountain Creek	1988*	Carson Street / Little Johnson	\$11,192	\$0
FOFO3400	Fountain Creek	1984*	Peterson Field	\$13,235	\$1,004
FOFO3600	Fountain Creek	1991*	Fisher's Canyon	\$18,350	\$0
FOFO4000	Fountain Creek	1996	Sand Creek	\$18,940	\$5,559
FOFO4200	Fountain Creek	1977	Spring Creek	\$9,517	\$0
FOFO4600	Fountain Creek	1984*	Southwest Area	\$18,350	\$0
FOFO4800	Fountain Creek	1991	Bear Creek	\$18,350	\$1,004
FOFO5400	Fountain Creek	1977	21st Street	\$5,521	\$0
FOFO5600	Fountain Creek	1964	19th Street	\$3,611	\$0
FOFO5800	Fountain Creek	1964	Camp Creek	\$2,033	\$0
FOMO0400	Monument Creek	1986*	Mesa	\$9,598	\$0
FOMO1000	Monument Creek	1981	Douglas Creek	\$11,540	\$255
FOMO1200	Monument Creek	1977	Templeton Gap	\$11,847	\$275
FOMO1400	Monument Creek	1976	Pope's Bluff	\$3,676	\$627
FOMO1600	Monument Creek	1976	South Rockrimmon	\$4,314	\$0
FOMO1800	Monument Creek	1973	North Rockrimmon	\$5,521	\$0
FOMO2000	Monument Creek	1971	Pulpit Rock	\$6,085	\$0
FOMO2200	Monument Creek	1994	Cottonwood Creek / S. Pine	\$18,350	\$1,004
FOMO2400	Monument Creek	1966	Dry Creek	\$14,486	\$524
FOMO3600	Monument Creek	1989*	Black Squirrel Creek	\$8,331	\$524
FOMO3700	Monument Creek	1987*	Middle Tributary	\$15,312	\$0
FOMO3800	Monument Creek	1987*	Monument Branch	\$18,350	\$0
FOMO4000	Monument Creek	1996	Smith Creek	\$7,481	\$1,004
FOMO4200	Monument Creek	1989*	Black Forest	\$18,350	\$500
FOMO5200	Monument Creek	1993*	Dirty Woman Creek	\$18,350	\$1,004
FOMO5300	Fountain Creek	1993*	Crystal Creek	\$18,350	\$1,004

Miscellaneous Drainage Basins: ¹

CHBS0800	Chico Creek	Book Ranch	\$17,217	\$2,492
CHEC0400	Chico Creek	Upper East Chico	\$9,380	\$272
CHWS0200	Chico Creek	Telephone Exchange	\$10,306	\$241
CHWS0400	Chico Creek	Livestock Company	\$16,976	\$202
CHWS0600	Chico Creek	West Squirrel	\$8,849	\$3,672
CHWS0800	Chico Creek	Solberg Ranch	\$18,350	\$0
FOFO1200	Fountain Creek	Crooked Canyon	\$5,540	\$0
FOFO1400	Fountain Creek	Calhan Reservoir	\$4,625	\$270
FOFO1600	Fountain Creek	Sand Canyon	\$3,342	\$0
FOFO2000	Fountain Creek	Jimmy Camp Creek ³	\$18,350	\$658
FOFO2200	Fountain Creek	Fort Carson	\$14,486	\$524
FOFO2700	Fountain Creek	West Little Johnson	\$1,209	\$0
FOFO3800	Fountain Creek	Stratton	\$8,801	\$394
FOFO5000	Fountain Creek	Midland	\$14,486	\$524
FOFO6000	Fountain Creek	Palmer Trail	\$14,486	\$524
FOFO6800	Fountain Creek	Black Canyon	\$14,486	\$524
FOMO4600	Monument Creek	Beaver Creek	\$10,970	\$0
FOMO3000	Monument Creek	Kettle Creek	\$9,909	\$0
FOMO3400	Monument Creek	Elkhorn	\$1,665	\$0
FOMO5000	Monument Creek	Monument Rock	\$7,953	\$0
FOMO5400	Monument Creek	Palmer Lake	\$12,717	\$0
FOMO5600	Monument Creek	Raspberry Mountain	\$4,278	\$0
PLPL0200	Monument Creek	Bald Mountain	\$9,116	\$0

Interim Drainage Basins: ²

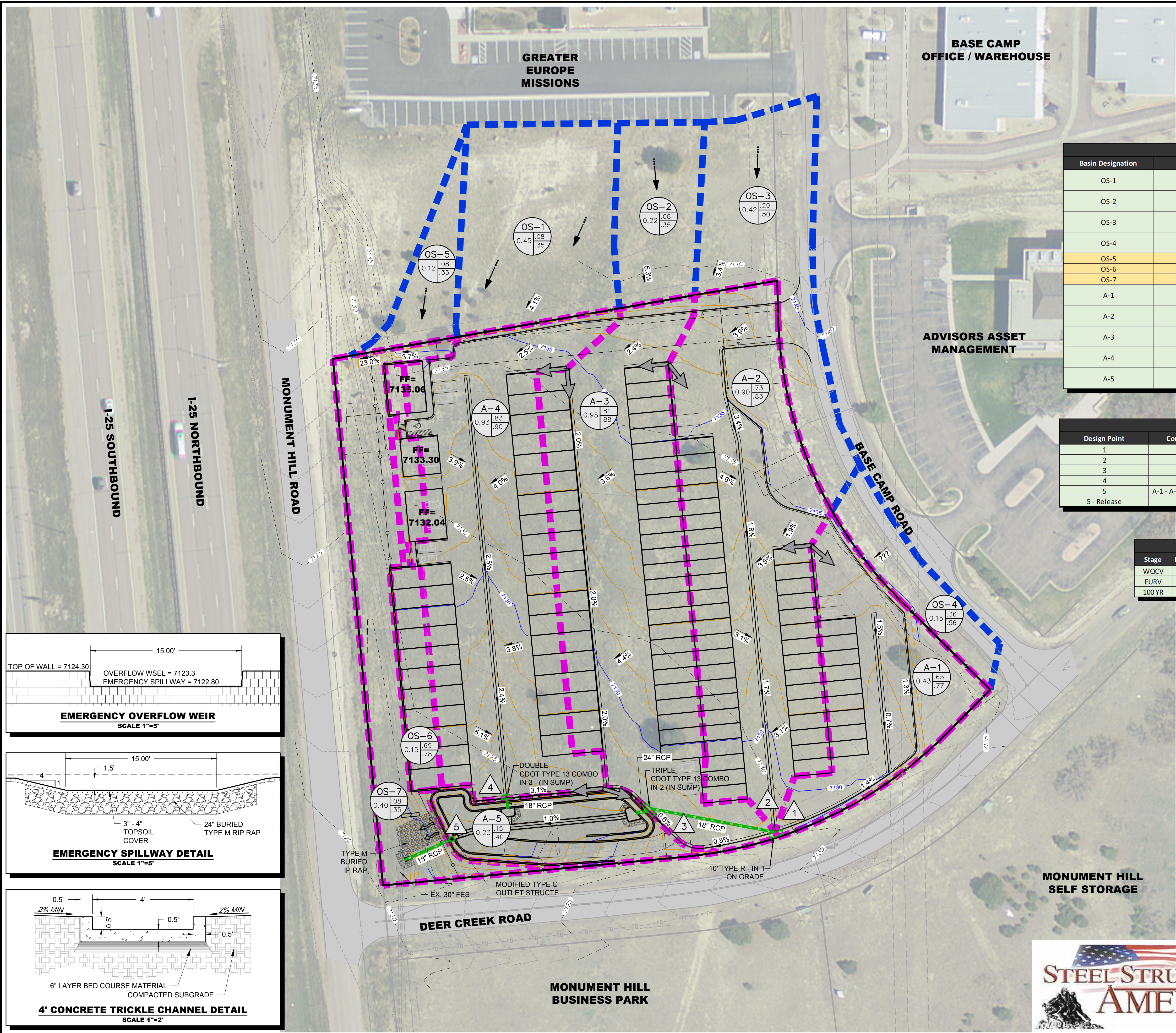
FOFO1800	Fountain Creek	Little Fountain Creek	\$2,346	\$0
FOMO4400	Monument Creek	Jackson Creek	\$7,263	\$0
FOMO4800	Monument Creek	Teachout Creek	\$5,044	\$758

1. The miscellaneous drainage fee previous to September 1999 resolution was the average of all drainage fees for basins with Basin Planning Studies performed.

2. Interim Drainage Fees are based upon draft Drainage Basin Planning Studies or the Drainage Basin Identification and Fee Estimation Report. (Best available)

3. This is an interim fee and will be adjusted when a DBPS is completed. In addition to the Drainage Fee a surety in the amount of \$7,285 per impervious acre shall be provided. If the DBPS results in a fee greater than the current fee. Fees paid in excess of the future revised fee will be reimbursed. See Resolution 06-326 (9/14/06) and Resolution 18-470.

APPENDIX E - DRAINAGE MAPS



NOTES:
1. BENCHMARK:
NGS CONTROL POINT T 395 BEING A STANDARD NGS STEEL ROD IN A LOGO MONUMENT BOX LOCATED 20 MILES NORTH OF COLORADO SPRINGS ON THE EAST SIDE OF I-25, 1,200 FEET NORTH OF THE WEIGH STATION BUILDING, AND 20.5 FEET EAST OF THE EASTERLY EDGE OF OIL OF THE NORTHBOUND LANES OF I-25.

NAVD88 ELEVATION: 7111.32'

PROPOSED BASIN SUMMARY TABLE					
Basin Designation	Area (ac)	Q ₂ (cfs)	Q ₅ (cfs)	Q ₁₀₀ (cfs)	TREATED OR UNTREATED
OS-1	0.45	0.03	0.16	1.20	Treated with Proposed WQ and Detention Facilities
OS-2	0.22	0.02	0.08	0.60	Treated with Proposed WQ and Detention Facilities
OS-3	0.42	0.37	0.55	1.62	Treated with Proposed WQ and Detention Facilities
OS-4	0.15	0.19	0.27	0.70	Treated with Proposed WQ and Detention Facilities
OS-5	0.12	0.01	0.04	0.33	Bypasses the site.
OS-6	0.16	0.44	0.57	1.08	Bypasses the site.
OS-7	0.40	0.03	0.16	1.15	Bypasses the site.
A-1	0.43	1.04	1.36	2.70	Treated with Proposed WQ and Detention Facilities
A-2	0.90	2.58	3.34	6.36	Treated with Proposed WQ and Detention Facilities
A-3	0.95	3.01	3.87	7.09	Treated with Proposed WQ and Detention Facilities
A-4	0.93	3.01	3.86	7.03	Treated with Proposed WQ and Detention Facilities
A-5	0.23	0.08	0.16	0.75	Treated with Proposed WQ and Detention Facilities

DESIGN POINT SUMMARY TABLE			
Design Point	Contributing Basins	Q ₂ (cfs)	Q ₁₀₀ (cfs)
1	A-1, OS-4	1.62	3.37
2	A-2, OS-3	3.17	6.56
3	A-3, OS-2	3.34	6.52
4	A-4, OS-1	3.37	6.96
5	A-1 - A-4, OS-1 Through OS-4	11.07	22.53
5 - Release		0.12	5.07

Pond Summary Table			
Stage	Required Vol (Ac-Ft)	Designed Vol (Ac-Ft)	As-Built Vol (Ac-Ft)
WQCV	0.091	0.101	
EURV	0.311	0.342	
100 YR	0.537	0.578	

LEGEND:

ROW/PROPERTY LINE

EX. STORM

PROP. STORM

HISTORICAL DRAINAGE BASIN

DRAINAGE BASIN

DRAINAGE FLOW PATTERN

OVERFLOW ROUTE

DESIGN POINT

DRAINAGE BASIN DESIGNATION

BASIN DESIGNATION

BASIN AREA

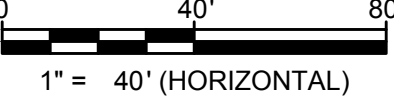
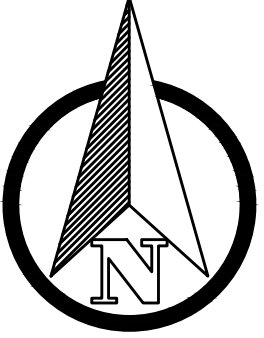
EMERGENCY OVERFLOW WEIR
SCALE 1"=5'

EMERGENCY SPILLWAY DETAIL
SCALE 1"=5'

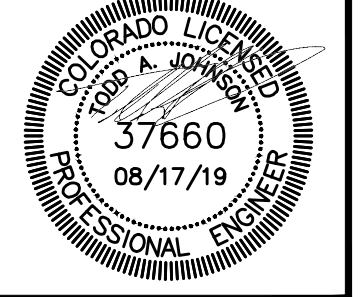
4" CONCRETE TRICKLE CHANNEL DETAIL
SCALE 1"=2'

MONUMENT HILL SELF STORAGE

MONUMENT HILL BUSINESS PARK



DRAINAGE EXHIBIT
MONUMENT STEEL STRUCTURES
PROPOSED DRAINAGE MAP
18910 BASE CAMP ROAD
MONUMENT, COLORADO



PROJ NO: SSA
ENG :
CHKD:
DATE: 08/17/2019

SHEET NUMBER
PDR
2 OF 2

REV. NO.	DESCRIPTION	DATE

TERRA FORMA
SOLUTIONS

APPENDIX F - RUNOFF REDUCTION CALCULATION

Sheet 1 of 1

Designer:	Todd Johnson
Company:	Terra Forma Solutions
Date:	June 24, 2019
Project:	Monument Steel Structures - PCD File No. PPR1919
Location:	18910 Base Camp Road - El Paso County

SITE INFORMATION (User Input in Blue Cells)

WQCV Rainfall Depth	0.60	inches
Depth of Average Runoff Producing Storm, d_6	0.43	inches (for Watersheds Outside of the Denver Region, Figure 3-1 in USDCM Vol. 3)

[illegible]

CALCULATED RUNOFF RESULTS

[illegible]

CALCULATED WQCV RESULTS

[illegible]

CALCULATED DESIGN POINT RESULTS (sums results from all columns with the same Downstream Design Point ID)

[illegible]

CALCULATED SITE RESULTS (sums results from all columns in worksheet)

Total Area (ft ²)	23,958
Total Impervious Area (ft ²)	6,534
WQCV (ft ³)	272
WQCV Reduction (ft ³)	272
WQCV Reduction (%)	100%
Untreated WQCV (ft ³)	0