

PRELIMINARY/ FINAL DRAINAGE REPORT FOR RIVERBEND CROSSING FILINGS NO. 1 AND 2

SEPTEMBER 2018

Prepared for:

Avatar Fountain, LP.
6800 Jericho Tpke., Suite 120W #204
Syosset, NY 11791

Prepared By:



PCD FILE NOS:
SP 187
SF 2517
SF 2518

PRELIMINARY/FINAL DRAINAGE REPORT FOR REIVERBEND CROSSING FILING
NO. 1 AND 2

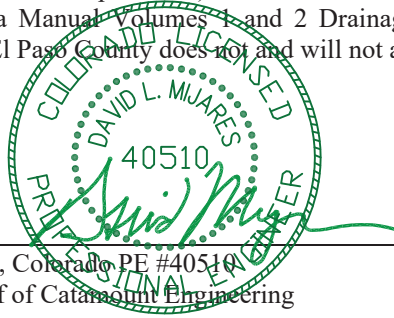
Engineer's Statement:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the 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.

Certification Statement:

This report and plan for the preliminary and final drainage design for the RIVERBEND CROSSING was prepared by me (or under my direct supervision) in accordance with the provisions of City of Colorado Springs/El Paso County Drainage Criteria Manual Volumes 1 and 2 Drainage Design and Technical Criteria for the owners thereof. I understand that El Paso County does not and will not assume liability for drainage facilities designed by others.

David L. Mijares, Colorado PE #40510
For and on behalf of Catamount Engineering



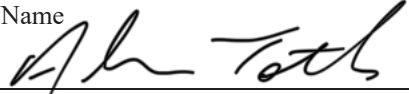
Date 06/08/2026

Developer's Statement:

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

AVATAR FOUNTAIN, LP. hereby certifies that the drainage facilities for RIVERBEND CROSSING shall be constructed according to the design presented in this report. I understand that El Paso County does not and will not assume liability for the drainage facilities designed and or certified by my engineer and that the El Paso County reviews drainage plans pursuant to Colorado Revised Statutes, Title 30, Article 28; but cannot, on behalf of RIVERBEND CROSSING guarantee that final drainage design review will absolve AVATAR FOUNTAIN, LP. and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the final plat does not imply approval of my engineer's drainage design.

AVATAR FOUNTAIN, LP.
Business Name

By: 

Title: Manager

Address: 6800 Jericho Turnpike, Suite 120W #204
Syosset, NY 11791

El Paso County:

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

Joshua J. Palmer, PE
County Engineer/ECM Administrator

Date

Conditions:

**PRELIMINARY/FINAL DRAINAGE REPORT FOR REIVERBEND CROSSING
FILING NO. 1 AND 2**

TABLE OF CONTENTS

PURPOSE	1
GENERAL LOCATION AND DESCRIPTION	1
EXISTING DRAINAGE BASINS	2
DEVELOPED DRAINAGE BASINS	4
Offsite Basins	4
‘A’ Basins	4
‘B’ Basins	5
‘C’ Basins	6
Storm Sewer	6
CHANNEL BANK STABILIZATION	8
EXTENDED DETENTION BASIN	9
4-STEP PROCESS	10
COST ESTIMATE	11
DRAINAGE FEE CALCULATION	12
DRAINAGE METHODOLOGY	13
SUMMARY	13
REFERENCES	14

APPENDICES

VICINITY MAP
WEB SOIL SURVEY
HYDROLOGIC AND HYDRAULIC CALCULATIONS
Rational Calculations
Street Capacity Calculation
Inlet Calculations
Hydraulic Grade Line Calculations
Extended Detention Basin Calculations
Fountain Creek Floodway Data
Bank Stabilization Analysis

DRAINAGE MAPS

EXISTING CONDITIONS MAP (DBPS)
FIRM PANEL OVERLAY
EXISTING CONDITIONS MAP (PDR)
PROPOSED DRAINAGE CONDITIONS

PRELIMINARY/FINAL DRAINAGE REPORT FOR REIVERBEND CROSSING FILING
NO. 1 AND 2

PURPOSE

The purpose of this drainage report is to identify existing drainage patterns and establish outfall scenarios from the proposed development. The site is contained within the West Little Johnson Drainage Basin and outfalls directly to Fountain Creek. The parcel was previously studied in the Little Johnson/Security Creek Drainage Basin Planning Study prepared by Simons, Li and Associates, dated December 1987, and the Preliminary Drainage Report for Riverbend Crossing., prepared by Nolte and Associates, dated February 14, 2007. The Little Johnson Drainage Basin Planning Study identifies the parcel as direct flow into Fountain Creek and does not propose improvements to the adjacent reach. The overall Riverbend development consists of two overall projects, The Riverbend Crossing residential subdivision filings 1 and 2 to be developed in El Paso County; and the Riverbend Crossing Commons Development to be developed within City of Fountain. This report develops broad analysis of both El Paso County and Fountain development parcels and provides Final Drainage Report detail for the residential parcels.

GENERAL LOCATION AND DESCRIPTION

The Riverbend Crossing Developments are located within the NE ¼ of Section 14, Township 15 South and Range 66 West of the 6th principal meridian. The proposed commercial parcel contains approximately 10.69 acres to be developed within the City of Fountain incorporation limits. The existing commercial development is proposed to have the majority of buildings and infrastructure demolished and reconstruction of the site will incorporate access to the proposed commercial development.

The proposed residential developments contain approximately 52.0 acres of undeveloped land with approximately 10 acres located within the existing Fountain Creek 100-year floodplain. Improvements are proposed in the portions of the property identified as outside of the existing floodplain. Residential development is proposed to be completed in 2 filings. Filing No. 1 will contain 136 residential lots situated on approximately 36.5 acres within the easterly and southerly portions of the residential parcel. Filing No. 2 will contain 86 residential lots on approximately 15.5 acres. The 10 acres within the floodplain not proposed for development are contained within the boundary of Filing No. 1.

The overall development is bounded to the north and west by undeveloped land zoned A-5, to the east by U.S. Highway 85/87 and Southmoor Drive, and to the south by Fountain Creek. The easterly portions of the development contained within the City of Fountain incorporation limits are predominantly zoned commercial and the southerly and westerly portions of the development are zoned PUD. An RS-5000 zone is being sought with entitlement applications within the El Paso County portions.

Existing soils on the site consist of Limon clay (Hydrologic Group 'C'), Schamber-Razor complex (Hydrologic Group 'A'), and Nunn clay loam (Hydrologic Group 'C'). Soils have been identified as determined by the Natural Resources Conservation Service Web Soil Survey. Hydrologic Group 'C' soils have been used in hydrologic calculations.

The 10.69 acres contained within the commercial site contains existing structures, paved parking, and paved drive aisles with little existing vegetation. The 52.0 acre residential portion remains substantially ungraded and vegetated with native grasses and volunteer trees and shrubs within roadside ditches and established drainage swales.

The property contains an abandoned irrigation pond within the northern portion of the site that was historically supplied by two wells located within the commercial development. There is no active irrigation within the parcel currently. The parcel contains an abandoned sewer outfall crossing the site that previously served the commercial development. The abandoned sewer conveyed sewage to a lagoon system located within the Fountain Creek Floodplain. The lagoon was filled when central sewer became available to the commercial development from Security Sanitation District. No development is proposed in the location of the filled lagoon.

The existing commercial site sits 10-15 feet higher than the undeveloped residential portion of the parcels and runoff sheetflows predominantly at 1%-1.5% to the south and into Southmoor Drive. Flows are contained within the Southmoor Drive roadside ditch and conveyed southwest to Fountain Creek. The undeveloped portion of the Riverbend Crossing Developments falls flows predominantly to the south at an average slope of 1.5%

The majority of the site is located within Shaded Zone X (500-year) floodplain and the southern portion of the site is contained within a F.E.M.A. designated Zone AE (100-year) floodplain per FIRM panels 08041C0763G and 08041C0951 F, effective December 07, 2018. The F.E.M.A. Flood Insurance Rate Map has been provided. The portion of the site within the Zone AE floodplain will not be utilized for residential development.

A portion of the FIRM Panels were further modified by LOMR 17-08-0467P effective 1/15/2019. The LOMR modified floodplain affected by Security Creek and shows 100-YR flood being contained east of the centerline of Highway 85/87. LOMR revisions did not remove shaded zone X contained within the subject property.

EXISTING DRAINAGE

The parcels are located within the West Little Johnson Drainage Basin and are directly tributary to Fountain Creek within the reach. The Little Johnson/Security Creek Drainage Basin Planning Study identifies three separate sub-basins (75,76, and 77) within the parcel. The majority of the parcels are identified as within Shaded Zone X 500-year floodplain and the southerly portion of the property not proposed for development lies with Zone AE 100-yr floodplain and floodway. The effective firm panel is included in the appendix of the report. The West Little Johnson drainage basin contains approximately five square miles located in the semi-arid region of the high plains. Precipitation within the basin ranges from 14 to 16 inches per year with thunderstorms typical in the summer months.

The existing drainage patterns for the parcel were summarized in the "Preliminary Drainage Study Riverbend Crossing", prepared by Nolte and Associates, inc. dated 2/14/2007. No development

within the parcel has been pursued since the Nolte analysis was completed and the existing drainage analysis has been accepted in this report. The northerly adjacent parcel has been developed for use as St. Dominic Catholic Church. Flows from the Church are collected on-site and conveyed to an existing full spectrum extended detention basin within the southwest corner of the church parcel. Outfall from the extended detention basin is piped to outfall to an existing swale within a drainage easement on agricultural property west of the Riverbend properties and does not enter the subject property. No other changes to surrounding properties are evident.

The report indicates the 3 sub-basins identified in the Drainage Basin Planning Study as sub-basins 75, 76, and 77. The basins are direct flow basins directly tributary to Fountain Creek and traverse the site from north to south where they enter Fountain Creek.

Basin 77 represents the existing commercial center development northwest of proposed Riverbend Crossing Filings No. 1 and 2 and the southeasterly portion of the residential filings. Redevelopment of the commercial development within the City of Fountain is being concurrently pursued by the developer of both properties. Existing flows entering the residential portion at the southern limits of the commercial development were modeled as $Q_5=25.99$ cfs, $Q_{100}=45.15$ cfs in the Preliminary Drainage Report and are conveyed in a drainage swale to outfall within Fountain Creek. Total outfall to Fountain Creek from Basin 77 was $Q_5=15.28$ cfs, $Q_{100}=31.70$ cfs.

Basin 76 represents the central portion of the undeveloped parcel and the northwesterly portion of the existing commercial development and is directly tributary to Fountain Creek. The property north of Basin 76 is contained within the St. Dominic's Church Subdivision. Storm runoff from the St. Dominic's Church Subdivision is collected on-site and conveyed through a private detention pond prior to historic release west of the parcel. The Preliminary Drainage Report shows $Q_5=6.89$ cfs, $Q_{100}=12.07$ cfs entering the residential parcel from the northwest corner of the commercial development and exhibits $Q_5=11.87$ cfs, $Q_{100}=28.05$ cfs leaving the site and entering Fountain Creek.

Basin 75 contains the westerly portion of the proposed residential development. The preliminary drainage report indicates that $Q_5=20.28$ cfs, $Q_{100}=45.99$ cfs enter the west side of the parcel from the adjacent agricultural property. Topography does not indicate a channelized flow but rather overland flow from the west. The anticipated long term use for the adjacent parcel is to remain agricultural. The foundation that owns the parcel is extending an irrigation ditch along the west boundary of the subject property to divert flows from the adjacent parcel south to Fountain Creek. An additional 15' setback is proposed in the residential development plan to allow for grading of a fill slope to convey flows south the Fountain Creek.

DEVELOPED DRAINAGE BASINS

The intent of the proposed development is to follow closely to historic drainage patterns while satisfying current El Paso County development and water quality criteria. The area of the site proposed for impervious development will be contained within the parking/private roadway section and private on-site storm sewer system conveying flows to a full spectrum detention basin and water quality facility within the southeast portion of the site prior to outfall to Fountain Creek.

Development of the site includes 225 residential lots, roadway and utility infrastructure to be constructed in 2 filings. Due to limited grade within the site necessitating flat roadway sections minimal drainage will be conveyed within the street roadway sections and drainage will primarily be conveyed is public storm drain systems conveying flows to outfall within a private extended detention basin. The private extended detention basin will be developed to accept developed runoff from the proposed redeveloped commercial center along the parcel's northeasterly boundary.

Flows generated within the proposed commercial center redevelopment will be conveyed within the commercial curb lines and private storm drain to be constructed along the southerly property boundary and outfall directly to the proposed shared extended detention basin.

Offsite Basins

Offsite flow (Historic sub-basin 75) generates runoff of $Q_5=20.28$ cfs, $Q_{100}=45.99$ cfs from the adjacent westerly agricultural parcel currently enter the property at an existing low point along the westerly boundary. Flows will be conveyed in a 10' wide constructed grass swale at 0.5% with 3:1 side slopes from the existing low point south approximately 300' to outfall within the adjacent reach of Fountain Creek. See calculations in the Appendix.

Historic Basins 76 and 77 have been remodeled in this report as either 'B' designated basins within the interior or 'C' basins representing the commercial development. 'B' designated basins will be conveyed within interior street, inlet, and storm sewer conveyance systems to the proposed full spectrum pond proposed with the development. 'C' designated basins will be conveyed in a separate storm sewer system developed in conjunction with commercial redevelopment to outfall to the shared on-site extended detention system. The detailed drainage plan for the commercial development is currently under review with the city of Fountain and a composite basin representing the commercial development is utilized in calculation for sizing the shared pond. Runoff from the commercial development will not directly enter the Riverbend Crossing residential development with the exception of storm sewer outfall directly to the pond.

'A Basins'

Basin A1 (1.30 Acres, $Q_2=0.2$ cfs, $Q_5=0.6$ cfs, $Q_{10}=1.1$ cfs, $Q_{25}=1.8$ cfs, $Q_{50}=2.3$ cfs, and $Q_{100}=2.9$ cfs) consists of the proposed diversion swale along the southern portion of the western boundary. Development will consist of a grass lined swale intended to divert offsite flows south to Fountain Creek. The swale will be located within a tract to be owned and maintained by the Riverbend Crossing Metropolitan District.

The intent of the diversion channel is to safely direct offsite high flows from the adjacent parcel to south to the main stem of Fountain Creek. The proposed diversion channel is not intended to convey flows from the Rivervbend Crossing development and consists of a grass lined swale at 0.4% longitudinal slope and will provide some water quality treatment for the area of the swale prior to direct outfall to Fountain Creek in accordance with ECM section I.7.1.B. Basin A1 does not require water quality control measures since it is an open space area with land disturbance to undeveloped land that will remain undeveloped per ECM Appendix I Section I.7.1.B.7

‘B Basins’

‘B’ designated basins consist of the majority of the residential development. Runoff from ‘B’ basins will primarily sheetflow to residential street sections, be collected in Type ‘R’ inlets and conveyed in public storm drainage systems to the extended detention basin.

Basin B17 (0.87 acres) contains the rear portions of lots adjacent to Fountain Creek. Runoff generated within Basin B17 will be collected in private area drains placed along rear lot lines. Flows will be conveyed in a private 8” HDPE storm sewer to confluence with the 48” HDPE at storm design point 12.

Basin B18 (4.86 acres) consists of rear portions of lots adjacent to the proposed extended detention basin and the extended detention basin. Runoff generated within Basin B18 will sheet flow overland directly to the proposed extended detention basin.

BASIN	AREA	Q ₂	Q ₅	Q ₁₀	Q ₂₅	Q ₅₀	Q ₁₀₀	Type R Inlet
B1	1.84	2.2	3.1	4.1	5.3	6.3	7.4	10’
B2	1.33	2.0	2.7	3.4	4.3	5.1	6.0	10’
B3	2.29	2.9	4.0	5.2	6.6	7.9	9.3	10’
B4	1.26	1.8	2.5	3.2	4.0	4.8	5.6	5’
B5	3.57	4.8	6.6	8.4	10.5	12.5	14.6	10’
B6	1.67	2.1	2.9	3.7	4.6	5.5	6.4	10’
B7	3.79	4.0	5.7	7.7	9.9	11.9	14.2	10’
B8	0.33	0.5	0.7	0.9	1.1	1.3	1.6	5’
B9	3.19	4.3	5.9	7.6	9.5	11.3	13.2	10’
B10	2.15	3.0	4.0	5.2	6.5	7.6	9.0	10’
B11	4.41	6.0	8.2	10.6	13.2	15.7	18.4	15’
B12	3.74	5.1	7.0	9.0	11.3	13.3	15.6	15’
B13	1.96	2.6	3.5	4.6	5.7	6.7	7.9	DP-A1
B14	1.35	1.8	2.5	3.2	4.0	4.7	5.5	5’
B15	1.15	1.2	1.6	2.1	2.6	3.1	3.7	5’
B16	2.04	2.3	3.1	4.0	4.9	5.8	6.9	DP-A1
B17	0.87	1.2	1.7	2.2	2.7	3.2	3.7	AREA
B18	4.86	1.9	3.6	5.8	8.5	10.7	13.3	POND

The development contains roadways with minimum grades of 1.0%. Roadway conveyance at minimum grade of 1.0% is $Q_5=8.5$ cfs and $Q_{100}=37$ cfs exceeding individual basin runoff. Inlets were developed in sump locations throughout the development and flow-by is not anticipated. Inlet calculations for Basins B1 through B16 are provided in the appendix. Lots will be developed with side lot line swales directed to the streets. Lot templates for 'A' lot grading, 'B' lot grading, and a limited number of Walkout units will be provided in the final grading plan.

Basin B13 and Basin B16 are combined in the southerly knuckle at design Point A1. Combined flows at Design Point A1 of $Q_5=6.0$ cfs and $Q_{100}=13.4$ cfs are collected in a 15' sump inlet within the knuckle. Inlet calculation is provided in the appendix.

'C Basins'

Basin C/ DP-P4 (11.25 Acres, $Q_5=38.5$ cfs, $Q_{100}=70.2$ cfs) represents the combined flow generated within the commercial development. Runoff generated within the commercial development sheet flows within the proposed curb line and is collected within private inlets on-site and will be conveyed in a private storm sewer to the residential development represented by Pipe Design Point P4. Runoff will be conveyed in a proposed private 42" storm sewer to confluence with the proposed public storm sewer system within the residential development. From the confluence commercial runoff will be conveyed in public (El Paso County) storm sewer to outfall within the sub-regional extended detention basin.

Overall contribution of the redeveloped commercial development is comparable with the historical analysis contributions from basin 77 ($Q_5=25.99$ cfs, $Q_{100}=45.15$ cfs) and commercial portion of Basin 76 ($Q_5=6.89$ cfs, $Q_{100}=12.07$ cfs) for a total commercial runoff of ($Q_5=32.88$ cfs, $Q_{100}=57.22$ cfs). Developed runoff from the commercial development at Design Point P4 is $Q_5=38.5$ cfs, $Q_{100}=70.2$ cfs. Final design of the commercial storm system requires installation of 2 additional CDOT type D inlets within landscape area at downstream (southerly) limits of development. The inlets will serve as a repetitive catchment in the case of upstream inlet failure and provide emergency flow path for commercial development.

The "Master Development Drainage Report for Riverbend Crossing and Final Drainage Report for Riverbend Crossing Commons" has completed review with City of Fountain. Approval is contingent upon providing final El Paso County/City of Fountain pond maintenance agreement and offsite extended detention basin Operation and Maintenance plan submitted as submitted to El Paso County.

Storm Sewer

Flows collected within 'B' designated basin inlets will be conveyed in a public storm sewer system located predominantly within the street ROW which outfalls to the private extended detention basin. Hydraulic grade line calculations developed with UDCFD UDSEWER are provided in the appendix of this report.

Pipe Design Point P4 (commercial outfall) ($Q_5=38.5$ cfs and $Q_{100}=70.2$) represents combined flows from the commercial development and will be conveyed in a public 42" RCP at a minimum grade of 0.5%.

Pipe Design Point 1 ($Q_5=40.6$ cfs and $Q_{100}=76.8$) represents combined flows from basins B1 and B2 and Design Point P4 (commercial) and will be conveyed in a public 42" RCP.

Pipe Design Point 2 ($Q_5=6.4$ cfs and $Q_{100}=14.6$) represents combined flows from basins B3 and B4 and will be conveyed in a public 24" RCP at a minimum grade of 1.8%.

Pipe Design Point 3 ($Q_5=14.9$ cfs and $Q_{100}=33.6$) represents combined flows from basins B5 and B6 and Pipe Design Point 2. Combined flows will be conveyed in a public 24" RCP at a minimum grade of 0.65%.

Pipe Design Point 5 ($Q_5=6.3$ cfs and $Q_{100}=15.5$) represents combined flows from basins B7 and B8 and will be conveyed in a public 24" RCP at a minimum grade of 0.5%.

Pipe Design Point 6 ($Q_5=15.8$ cfs and $Q_{100}=36.5$) represents combined flows from basins B9 and B10 and Pipe Design Point 5. Combined flows will be conveyed in a public 30" RCP at a minimum grade of 0.66%.

Pipe Design Point 7 ($Q_5=33.7$ cfs and $Q_{100}=76.2$) represents combined flows from Pipe Design Points 6 and 11. Combined flows will be conveyed in a public 48" RCP at a minimum grade of 0.7%.

Pipe Design Point 8 ($Q_5=15.2$ cfs and $Q_{100}=33.9$) represents combined flows from basins B11 and B12 and will be conveyed in a public 30" RCP at a minimum grade of 0.70%.

Pipe Design Point 9 ($Q_5=17.5$ cfs and $Q_{100}=39.1$) represents combined flows from Basin B9 and Pipe Design Point 8. Combined flows will be conveyed in a public 42" RCP at a minimum grade of 0.50%.

Pipe Design Point 10 ($Q_5=20.4$ cfs and $Q_{100}=45.4$) represents combined flows from Pipe Design Point 9 and overland Design Point A1. Combined flows will be conveyed in a private 42" RCP pipe at a minimum grade of 0.065%. Emergency overflow will utilize a depressed driveway access for the adjacent lift station flag lot access and convey overflow directly to Fountain Creek.

Pipe Design Point 11 ($Q_5=20.9$ cfs and $Q_{100}=46.6$) represents combined flows from Pipe Design Point 10 and Basin B15. Combined flows will be conveyed in a private 42" RCP pipe at a minimum grade of 0.065%.

Pipe Design Point 4 ($Q_5=46.0$ cfs and $Q_{100}=104.0$) represents combined flows from Pipe Design Points 1, 3, and 7. Combined flows will be conveyed in a private 60" RCP at a minimum grade of 0.5%.

Pipe Design Point 12 ($Q_5=47.3$ cfs and $Q_{100}=106.8$) represents combined flows from Pipe Design Points 4 and Basin B17. Combined flows will be conveyed in a private 60" RCP at a minimum grade of 0.5%.

CHANNEL BANK STABILIZATION

Fountain Creek in this location is considered a large conveyance natural channel. The existing channel bed is composed of sand and gravel with scattered boulders and cobbles. The channel bottom width varies from 300' to 1,250'. This channel reach relatively straight except for the south end where it makes an abrupt bend just downstream of the project limits. The channel conveys flow from north to south with bed slopes in the range of 0.9% to 1.4%. Moderate to dense vegetation (brush and grasses) are present along the channel edges. The project study reach is approximately 1,615' long. Refer to the Drainage Map in the appendix which depicts the proposed conditions.

The study in effect for this reach is the FEMA Flood Insurance Study (FIS) 08041CV dated December 7, 2018. A flow value for the 100yr design storm was determined using the FIS Summary of Discharges table values of mean velocity and section area at section "CH" which was the location adjacent to the project which yielded the highest flow value of ~26,300cfs. Additional hydraulic analysis was performed for this project using USACE HECRAS software, version 5.07. A supercritical flow regime was used to compute the theoretical water surface elevation profile and determine flow velocities, Froude numbers, and flow depths. A roughness coefficient value of 0.035 was used for design purposes per criteria recommendation. Although the channel has a higher roughness coefficient based on actual bed material and vegetation conditions, using the lower value is a more conservative design approach.

Resultant velocities ranged from ~9ft/s to ~15ft/s. Flow depths ranged from 4ft to 7ft. Froude numbers were determined to be around 1.0. Using this data and the UDFCD Volume 1, Chapter 8 design methodology for channel design, bank lining was deemed necessary. Erosion protection in the form of 12" soil riprap (24' thick) will be provided along the proposed 2.5:1 side slopes. Assuming the channel is entirely composed of non-cohesive soils, the riprap toe protection will be constructed with a five foot bury depth. The height of the soil riprap on the slope will be based on the FIS flow depths and not the model results, which is a conservative approach since the model revealed lower depths. A freeboard value of 1.5' will be used per criteria recommendations. Refer to appendix for additional hydraulic analysis and design information.

GROUNDWATER MITIGATION

Review of the project geotechnical report, "GEOTECHNICAL REPORT Avatar River Bend Crossing Commercial and Residential Development Fountain, Colorado", prepared by RMG Engineers indicates the presence of shallow groundwater in portions of the development. As a condition of not installing underdrain with the development sanitary sewer basements are not allowed within Riverbend Filings No. 1 and No. 2. If during lot development groundwater is encountered in foundation excavations it will be the responsibility of the developer to propose mitigation.

Borings R-8, R-9, and R-10 are located in the proximity of proposed extended detention basin 'A'. EBD 'A' is located east and elevated above the existing swale located in the central portion of the site. Boring R-8 is located in the center of the existing swale located north and west of the proposed EDB location and indicated a groundwater elevation approximately 7' below the bottom of pond elevation (19.5' below existing grade). Boring R-9 is located north of proposed

EDB 'A' and no groundwater was located in borings (>20' depth). Boring R-10 was located within the existing bank of Fountain Creek and indicated groundwater at a shallow depth as(6.0') as it is under direct influence of the Fountain Creek waterway.

Based on existing geotechnical borings it is not anticipated that groundwater mitigation will be necessary in the proposed pond location and elevation. If during pond development groundwater is encountered in pond excavation a geomembrane liner of the pond facility should be pursued.

EXTENDED DETENTION BASIN

The parcel proposes to develop 54.90 acres within the West Little Johnson Drainage Basin directly tributary to Fountain Creek requiring development of water quality treatment and full-spectrum detention per the criteria of the El Paso County Drainage Criteria Manual Volume 2. The proposed extended detention basin will be developed to provide water quality and full spectrum detention for both the Riverbend Crossing residential development Filings No. 1 and 2 and the Riverbend Crossing Commons Commercial development within the City of Fountain. Filing No. 1 and Filing No. 2 will be constructed concurrently. The proposed Extended Detention Basin located in the southerly portion of the development has 54.90 tributary acres of development with an average imperviousness of 65.40%. Full spectrum pond development requires 1.170 acre-ft of water quality capture volume ponding to an elevation of 5685.56, an EURV volume of 2.54-acre ft, and a total volume of 6.17 acre-ft ponding to an elevation of 5690.65 providing full spectrum detention including the 100-YR event.

Runoff generated within the site will be conveyed to the pond through storm sewer systems or as direct sheetflow. The storm sewer systems will outfall directly to 6" concrete forebays with baffle providing adequate protection at discharge point. The concrete forebays require a total volume of 1,525 cubic feet of volume (2% of the design WQCV). Forebay 'A' conveying flows from the majority of the residential development will be constructed of a concrete slab with sides conforming to the pond slopes and 30" wall with a 7.9" rectangular notch which outfalls to the proposed trickle channel at the downstream end. Forebay 'B' conveying flows from the commercial development and Basins B1 and B2 will be constructed of a concrete slab with sides conforming to the pond slopes and 18' wall with a 6.6" rectangular notch which outfalls to the proposed trickle channel at the downstream end.

The pond will be constructed with 4:1 minimum side slopes to be vegetated per the final landscape plan. A 6' wide by 6" deep concrete trickle channel with a 0.5% longitudinal slope will convey low flows across the pond bottom to the micropool/outlet structure. The trickle channel will outfall to a 20' long by 8' wide by 2.5' deep concrete micropool. The micropool will provide a surface area of 120 square feet and an initial surcharge volume of 80 cubic feet utilizing an 6" initial surcharge depth.

A portion of the pond is situated below the Base Flood Elevation of the 100-YR recurrence event within the adjacent portion of Fountain Creek, 5689.00. Excess volume exceeding the 100-YR event volume above the base flood elevation was incorporated into the pond to overcome backwater effects should the subdivision experience a 100-YR event concurrent with passage of maximum flood event within the adjacent reach of Fountain Creek.

The outlet structure will consist of a concrete box with orifice plate and screen providing water quality outlet and weir with trash rack for larger storm outfall. The pond will outfall through a private 36" RCP pipe system directly to Fountain Creek.

The emergency spillway will consist of a 60' weir along the southerly end of the pond at an elevation of 5691.0. The overflow area will consist of 24" depth of type M soil riprap.

Outfall from the extended detention basin of $Q_2=1.3$ cfs, $Q_5=1.6$ cfs, $Q_{10}=12.1$ cfs, $Q_{25}=36.4$ cfs, $Q_{50}=55.6$ cfs, and $Q_{100}=67.7$ will be conveyed in a private restricted 36" RCP. Combined flows at Design P-out is less than historic runoff from basins 75, 76, and 77. Outfall from the onsite extended detention basin will be conveyed directly to Fountain Creek through the private 36" RCP and full spectrum release will have no impacts on the Fountain Creek Drainage.

4-STEP PROCESS

STEP 1: EMPLOY RUNOFF REDUCTION PRACTICES

The development addresses Low Impact Development strategies primarily through the utilization of landscape swales within sides and rear of proposed residential lots and directing runoff from buildings and walkways through swales with minimal longitudinal grade prior to outfall to street collection and storm conveyance systems.

STEP 2: STABILIZE DRAINAGEWAYS

The ultimate recipient of runoff from the site is Fountain Creek. Flows from the site are tributary to the full spectrum extended detention basin constructed on site with development of the Riverbend Crossing community and commercial center attenuating flows to predevelopment levels. Existing slopes adjacent to Fountain Creek will be anchored with rip rap toe protection and excessive slopes will be lain back to a slope of 2.5 Horizontal to 1' Vertical. 100=YEAR slope protection will be installed within reconstructed slopes.

STEP 3: PROVIDE WATER QUALITY CAPTURE VOLUME

On-site flow is directed to the on-site private proposed full spectrum extended detention basin constructed with development of the project which outfalls directly to historic outfall within Fountain Creek. The extended detention basin provides Water Quality Capture Volume required for this site and concurrent commercial development and attenuates release of flows to approximate historic runoff.

STEP 4: CONSIDER NEED FOR INDUSTRIAL AND COMMERCIAL BMP'S

A Grading, Erosion Control, and Stormwater Quality Plan and narrative will be approved by El Paso County prior to any soil disturbance. The erosion control plan will include specific source control BMP's as well as defined overall site management practices for the construction period. The grading narrative will address materials storage and spill containment during construction operations. No industrial processes are proposed in development of the Riverbend Community.

COST ESTIMATE

Public Improvements Non-reimbursable

18" RCP	213 LF	@\$	88/LF	\$ 18,744
24" RCP	1,588 LF	@\$	105/LF	\$ 166,740
30" RCP	196 LF	@\$	132/LF	\$ 25,872
36" RCP	860 LF	@\$	162/LF	\$ 139,320
42" RCP	576 LF	@\$	216/LF	\$ 124,416
48" RCP	244 LF	@\$	263/LF	\$ 64,172
60" RCP	240 LF	@\$	402/LF	\$ 96,480
36" RCP FES	1 EA	@\$	972/LF	\$ 972
Cutoff Wall	2 EA	@\$	12,000/LF	\$ 24,000
5' Type R Inlet	5 EA	@\$	7,753/EA	\$ 38,765
10' Type R Inlet	8 EA	@\$	10,669/EA	\$ 85,352
15' Type R Inlet	3 EA	@\$	13,875/EA	\$ 41,625
Type I Manhole	17 EA	@\$	16,265/EA	\$ 40,000
RipRap Lining	4,334 CY	@\$	156/CY	\$ 276,505
Type VI Impact Basin	1 EA	@\$	45,000/CY	\$ 45,000
36" Impact Basin	1 EA	@\$	22,000/CY	\$ 22,000

SUBTOTAL	\$1,209,963
<i>10% CONTINGENCY</i>	<i>\$ 120,996</i>
<u>TOTAL</u>	<u>\$1,330,959</u>

Private Improvements Non-reimbursable

12" HDPE	463 LF	@\$	42/LF	\$ 19,446
36" RCP	209 LF	@\$	162/LF	\$ 33,858
42" RCP	508 LF	@\$	216/LF	\$ 109,728
60" RCP	240 LF	@\$	402/LF	\$ 96,480
6" Area Drain	9 EA	@\$	105/EA	\$ 945
WATER QUALITY POND				
Earthwork cut to fill	9954 CY	@\$	3/CY	\$ 29,862
Concrete Trickle Channel	81 CY	@\$	797/CY	\$ 64,557
Type 'M' riprap spillway	910 TONS	@\$	112/TON	\$ 101,920
Outfall Structure	1 EA	@\$	27,000/EA	\$ 27,000
Access Roadway	175 CY	@\$	71/CY	\$ 12,425

SUBTOTAL	\$ 496,221
<i>10% CONTINGENCY</i>	<i>\$ 49,622</i>
<u>TOTAL</u>	<u>\$ 545,843</u>

DRAINAGE FEE CALCULATION

Riverbend Crossing Filing No. 1 contains 36.5 acres to be platted within the West Little Johnson Drainage Basin. Riverbend Crossing Filing No. 2 contains 15.5 acres to be platted within the West Little Johnson Drainage Basin. The 2018 fee for the West Little Johnson Drainage Basin (A miscellaneous Drainage Basin) is \$1,133/ per impervious acre.

Filing No.1-36.547 total acres.

Use	Acres	Imperviousness
1/8 acre or less	23.45	65%
Open Space	13.09	7%
Composite Imperviousness:	44.2%	

$$36.547 \text{ acres} \times 44.2\% \times \$1,133.00 = \$18,311$$

Filing No.2-15.452 total acres.

Use	Acres	Imperviousness
1/8 acre or less	14.48	65%
Open Space	0.97	7%
Composite Imperviousness:	61.4%	

$$15.452 \text{ acres} \times 61.4\% \times \$1,133.00 = \$10,742$$

There are no bridge fees in the West Little Johnson Drainage Basin.

DRAINAGE METHODOLOGY

This drainage report was prepared in accordance to the criteria established in the City of Colorado Springs/El Paso County Drainage Criteria Manual Volumes 1 and 2, as revised May 2014.

The rational method for drainage basin study areas of less than 100 acres was utilized in the analysis. For the Rational Method, flows were calculated for the 2, 5, 10, 25, 50, and 100-year recurrence intervals. The average runoff coefficients, 'C' values, are taken from Table 6-6 and the Intensity-Duration-Frequency curves are taken from Figure 6-5 of the City Drainage Criteria Manual. Time of concentration for overland flow and storm drain or gutter flow are calculated per Section 3.2 of the City Drainage Criteria Manual. Calculations for the Rational Method are shown in the Appendix of this report.

Urban Drainage and Flood Control District methodology was utilized for determination of street capacity, inlet sizing, and extended detention basin design. UD-Inlet Version 4.05 was utilized in street capacity and inlet sizing calculations. UD-Culvert Version 3.05 was utilized in developing preliminary pipe sizing. Hydraulic Grade Line Calculations were developed using UD-Sewer version 1.4 and are provided in the appendix. UD-Detention version 3.07 was utilized in development of extended detention basin and outfall. Calculations are included in the appendix of this report.

SUMMARY

Development of Riverbend Crossing Filings No. 1 and No. 2 will require that flows be treated for water quality and be detained to historic levels prior to release from the site. Site runoff and storm drain and appurtenances will not adversely affect the downstream and surrounding developments. This report is in general conformance with all previously approved reports which included this site. Facilities will be owned or maintained by the Riverbend Crossing Metropolitan District.

REFERENCES:

City of Colorado Springs Engineering Division Drainage Criteria Manual Volumes 1 and 2, revised May 2014

“Little Johnson/Security Creek Drainage Basin Planning Study” prepared by Simons, Li and Associates, Inc. dated December 1987.

“Preliminary Drainage Study Riverbend Crossing” prepared by Nolte and Associates, Inc.” accepted February 2017.

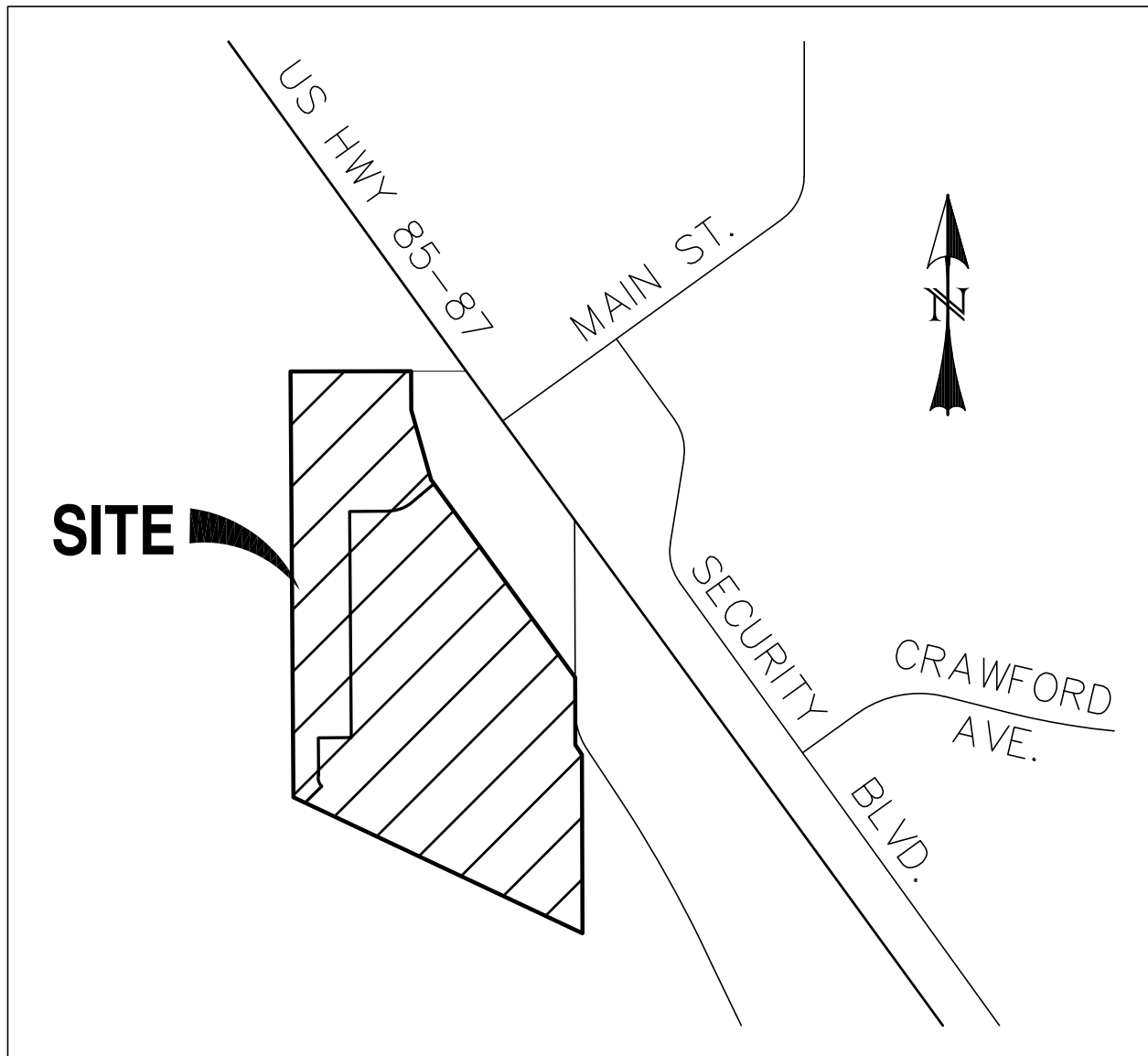
“Preliminary/Final Drainage Report for St. Dominic’s Church Subdivision”, accepted October 2007.

Natural Resources Conservation Service Web Soil Survey

“Master Development Drainage Report for Riverbend Crossing and Final Drainage Report for Riverbend Crossing Commons”, by Catamount Engineering, dated December 15, 2019.

GEOTECHNICAL REPORT Avatar River Bend Crossing Commercial and Residential Development Fountain, Colorado”, prepared by RMG Engineers, dated April 02, 2018

APPENDIX



VICINITY MAP

SCALE: N.T.S.



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

RIVERBEND CROSSING

VICINITY MAP

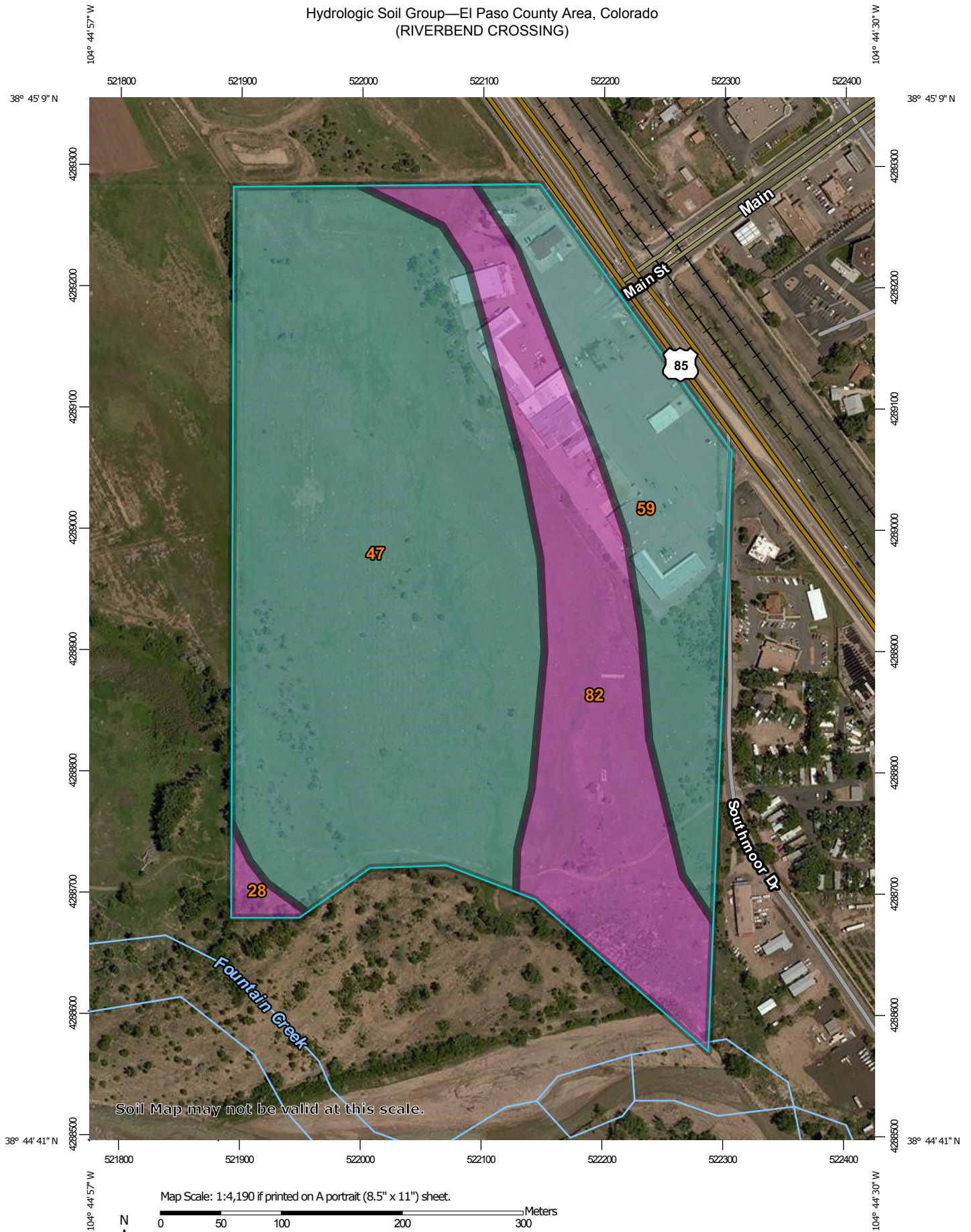
SCALE: NTS

JOB NO.: 17-114

DATE: 09/05/18

SHEET: 1 OF 1

Hydrologic Soil Group—El Paso County Area, Colorado (RIVERBEND CROSSING)



Hydrologic Soil Group—El Paso County Area, Colorado
(RIVERBEND CROSSING)

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

Soil Rating Polygons

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

Soil Rating Lines

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

Soil Rating Points

 A
 A/D
 B
 B/D

 C
 C/D
 D
 Not rated or not available

Water Features

 Streams and Canals

Transportation

 Rails
 Interstate Highways
 US Routes
 Major Roads
 Local Roads

Background

 Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
 Survey Area Data: Version 15, Oct 10, 2017

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

Date(s) aerial images were photographed: Apr 15, 2011—Jun 17, 2014

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
28	Ellicott loamy coarse sand, 0 to 5 percent slopes	A	0.5	0.9%
47	Limon clay, 0 to 3 percent slopes	C	32.6	57.0%
59	Nunn clay loam, 0 to 3 percent slopes	C	10.2	17.8%
82	Schamber-Razor complex, 8 to 50 percent slopes	A	13.9	24.3%
Totals for Area of Interest			57.2	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

HYDROLOGIC AND HYDRAULIC CALCULATIONS

PROPOSED DRAINAGE DESIGN - RATIONAL ANALYSIS

											CONVEYANCE TC							TT	INTENSITY							TOTAL FLOWS						
BASIN	AREA TOTAL (Acres)	C ₂	C ₅	C ₁₀	C ₂₅	C ₅₀	C ₁₀₀	Length (ft)	Height (ft)	TI (min)	Length (ft)	Height (ft)	C _v	Slope (%)	Velocity (fps)	TC (min)	TOTAL (min)	I ₂ (in/hr)	I ₅ (in/hr)	I ₁₀ (in/hr)	I ₂₅ (in/hr)	I ₅₀ (in/hr)	I ₁₀₀ (in/hr)	Q ₂ (c.f.s.)	Q ₅ (c.f.s.)	Q ₁₀ (c.f.s.)	Q ₂₅ (c.f.s.)	Q ₅₀ (c.f.s.)	Q ₁₀₀ (c.f.s.)			
A1 <i>Landscape</i>	1.30 <i>1.30</i>	0.09 <i>0.09</i>	0.19 <i>0.19</i>	0.29 <i>0.29</i>	0.40 <i>0.40</i>	0.46 <i>0.46</i>	0.52 <i>0.52</i>	70	1.8	10.1	1373	10	15	0.7%	1.3	17.9	27.9	2.1	2.6	3.0	3.5	3.9	4.3	0.2	0.6	1.1	1.8	2.3	2.9			
B1 <i>Residential 1/8 acre Landscape</i>	1.84 <i>1.59 0.25</i>	0.40 <i>0.45 0.09</i>	0.45 <i>0.49 0.19</i>	0.51 <i>0.54 0.29</i>	0.56 <i>0.59 0.40</i>	0.60 <i>0.62 0.46</i>	0.63 <i>0.65 0.52</i>	100	2	9.3	382	3.8	20	1.0%	2.0	3.2	12.5	3.0	3.8	4.4	5.1	5.7	6.4	2.2	3.1	4.1	5.3	6.3	7.4			
B2 <i>Residential 1/8 acre</i>	1.33 <i>1.33</i>	0.45 <i>0.45</i>	0.49 <i>0.49</i>	0.54 <i>0.54</i>	0.59 <i>0.59</i>	0.62 <i>0.62</i>	0.65 <i>0.65</i>	83	1.6	8.1	252	2.5	20	1.0%	2.0	2.1	10.2	3.3	4.1	4.8	5.5	6.2	6.9	2.0	2.7	3.4	4.3	5.1	6.0			
B3 <i>Residential 1/8 acre Landscape</i>	2.29 <i>2.04 0.25</i>	0.41 <i>0.45 0.09</i>	0.46 <i>0.49 0.19</i>	0.51 <i>0.54 0.29</i>	0.57 <i>0.59 0.40</i>	0.60 <i>0.62 0.46</i>	0.64 <i>0.65 0.52</i>	100	2	9.2	344	3	20	0.9%	1.9	3.1	12.3	3.0	3.8	4.5	5.1	5.7	6.4	2.9	4.0	5.2	6.6	7.9	9.3			
B4 <i>Residential 1/8 acre</i>	1.26 <i>1.26</i>	0.45 <i>0.45</i>	0.49 <i>0.49</i>	0.54 <i>0.54</i>	0.59 <i>0.59</i>	0.62 <i>0.62</i>	0.65 <i>0.65</i>	84	1.6	8.2	312	4	20	1.3%	2.3	2.3	10.5	3.2	4.1	4.7	5.4	6.1	6.8	1.8	2.5	3.2	4.0	4.8	5.6			
B5 <i>Residential 1/8 acre</i>	3.57 <i>3.57</i>	0.45 <i>0.45</i>	0.49 <i>0.49</i>	0.54 <i>0.54</i>	0.59 <i>0.59</i>	0.62 <i>0.62</i>	0.65 <i>0.65</i>	100	2	8.8	320	11	7	3.4%	1.3	4.1	12.9	3.0	3.8	4.4	5.0	5.6	6.3	4.8	6.6	8.4	10.5	12.5	14.6			
B6 <i>Residential 1/8 acre</i>	1.67 <i>1.67</i>	0.45 <i>0.45</i>	0.49 <i>0.49</i>	0.54 <i>0.54</i>	0.59 <i>0.59</i>	0.62 <i>0.62</i>	0.65 <i>0.65</i>	100	2	8.8	100 710	2 12	7 20	2.0% 1.7%	1.0 2.6	1.7 4.6	15.0	2.8	3.5	4.1	4.7	5.3	5.9	2.1	2.9	3.7	4.6	5.5	6.4			
B7 <i>Residential 1/8 acre Landscape</i>	3.79 <i>2.91 0.88</i>	0.37 <i>0.45 0.09</i>	0.42 <i>0.49 0.19</i>	0.48 <i>0.54 0.29</i>	0.55 <i>0.59 0.40</i>	0.58 <i>0.62 0.46</i>	0.62 <i>0.65 0.52</i>	100	12	5.4	100 780	3 6	7 20	3.0% 0.8%	1.2 1.8	1.4 7.4	14.2	2.9	3.6	4.2	4.8	5.4	6.1	4.0	5.7	7.7	9.9	11.9	14.2			

Calculated by: DLM
Date: 10/25/2020

PROPOSED DRAINAGE DESIGN - RATIONAL ANALYSIS

											CONVEYANCE TC							TT	INTENSITY							TOTAL FLOWS					
BASIN	AREA TOTAL (Acres)	C ₂	C ₅	C ₁₀	C ₂₅	C ₅₀	C ₁₀₀	Length (ft)	Height (ft)	TI (min)	Length (ft)	Height (ft)	C _v	Slope (%)	Velocity (fps)	TC (min)	TOTAL (min)	I ₂ (in/hr)	I ₅ (in/hr)	I ₁₀ (in/hr)	I ₂₅ (in/hr)	I ₅₀ (in/hr)	I ₁₀₀ (in/hr)	Q ₂ (c.f.s.)	Q ₅ (c.f.s.)	Q ₁₀ (c.f.s.)	Q ₂₅ (c.f.s.)	Q ₅₀ (c.f.s.)	Q ₁₀₀ (c.f.s.)		
B8 <i>Residential 1/8 acre</i>	0.33 0.33	0.45 0.45	0.49 0.49	0.54 0.54	0.59 0.59	0.62 0.62	0.65 0.65	75	1.5	7.6	124	1.5	20	1.2%	2.2	0.9	8.5	3.5	4.4	5.1	5.8	6.6	7.3	0.5	0.7	0.9	1.1	1.3	1.6		
B9 <i>Residential 1/8 acre</i>	3.19 3.19	0.45 0.45	0.49 0.49	0.54 0.54	0.59 0.59	0.62 0.62	0.65 0.65	100	4	7.0	810	12	20	1.5%	2.4	5.5	12.5	3.0	3.8	4.4	5.1	5.7	6.4	4.3	5.9	7.6	9.5	11.3	13.2		
B10 <i>Residential 1/8 acre</i>	2.15 2.15	0.45 0.45	0.49 0.49	0.54 0.54	0.59 0.59	0.62 0.62	0.65 0.65	73	1.5	7.4	720	11	20	1.5%	2.5	4.9	12.3	3.1	3.8	4.5	5.1	5.7	6.4	3.0	4.0	5.2	6.5	7.6	9.0		
B11 <i>Residential 1/8 acre</i>	4.41 4.41	0.45 0.45	0.49 0.49	0.54 0.54	0.59 0.59	0.62 0.62	0.65 0.65	100	2	8.8	515	7.5	20	1.5%	2.4	3.6	12.3	3.0	3.8	4.5	5.1	5.7	6.4	6.0	8.2	10.6	13.2	15.7	18.4		
B12 <i>Residential 1/8 acre</i>	3.74 3.74	0.45 0.45	0.49 0.49	0.54 0.54	0.59 0.59	0.62 0.62	0.65 0.65	100	6	6.1	40 803	0.8 12	7 20	2.0% 1.5%	1.0 2.4	0.7 5.5	12.2	3.1	3.8	4.5	5.1	5.7	6.4	5.1	7.0	9.0	11.3	13.3	15.6		
B13 <i>Residential 1/8 acre</i>	1.96 1.96	0.45 0.45	0.49 0.49	0.54 0.54	0.59 0.59	0.62 0.62	0.65 0.65	100	2	8.8	657	9	20	1.4%	2.3	4.7	13.4	2.9	3.7	4.3	4.9	5.5	6.2	2.6	3.5	4.6	5.7	6.7	7.9		
B14 <i>Residential 1/8 acre</i>	1.35 1.35	0.45 0.45	0.49 0.49	0.54 0.54	0.59 0.59	0.62 0.62	0.65 0.65	100	2	8.8	554	7.5	20	1.4%	2.3	4.0	12.7	3.0	3.8	4.4	5.0	5.7	6.3	1.8	2.5	3.2	4.0	4.7	5.5		
B15 <i>Residential 1/8 acre</i>	1.15 1.15	0.45 0.45	0.49 0.49	0.54 0.54	0.59 0.59	0.62 0.62	0.65 0.65	50	2	4.9	1026	20	7	1.9%	1.0	17.5	22.4	2.3	2.9	3.4	3.9	4.4	4.9	1.2	1.6	2.1	2.6	3.1	3.7		
B16 <i>Residential 1/8 acre</i>	2.04 2.04	0.45 0.45	0.49 0.49	0.54 0.54	0.59 0.59	0.62 0.62	0.65 0.65	50	2	4.9	934	20	7	2.1%	1.0	15.2	20.1	2.5	3.1	3.6	4.1	4.6	5.2	2.3	3.1	4.0	4.9	5.8	6.9		

Calculated by: DLM
Date: 10/25/2020

PROPOSED DRAINAGE DESIGN - RATIONAL ANALYSIS

											CONVEYANCE TC						TT	INTENSITY							TOTAL FLOWS					
BASIN	AREA TOTAL (Acres)	C ₂	C ₅	C ₁₀	C ₂₅	C ₅₀	C ₁₀₀	Length	Height	TI	Length	Height	C _V	Slope	Velocity	TC	TOTAL	I ₂	I ₅	I ₁₀	I ₂₅	I ₅₀	I ₁₀₀	Q ₂	Q ₅	Q ₁₀	Q ₂₅	Q ₅₀	Q ₁₀₀	
								(ft)	(ft)	(min)	(ft)	(ft)		(%)	(fps)	(min)	(min)	(in/hr)	(in/hr)	(in/hr)	(in/hr)	(in/hr)	(in/hr)	(c.f.s.)	(c.f.s.)	(c.f.s.)	(c.f.s.)	(c.f.s.)	(c.f.s.)	
B17 <i>Residential 1/8 acre</i>	0.87 0.87	0.45 0.45	0.49 0.49	0.54 0.54	0.59 0.59	0.62 0.62	0.65 0.65	75	1.5	7.6	428	4	20	0.9%	1.9	3.7	11.3	3.2	3.9	4.6	5.3	5.9	6.6	1.2	1.7	2.2	2.7	3.2	3.7	
B18 <i>Landscape Residential 1/8 acre</i>	4.86 3.88 0.98	0.16 0.09 0.45	0.25 0.19 0.49	0.34 0.29 0.54	0.44 0.40 0.59	0.49 0.46 0.62	0.55 0.52 0.65	100	6	8.5	527	5	7	0.9%	0.7	12.9	21.4	2.4	3.0	3.5	4.0	4.5	5.0	1.9	3.6	5.8	8.5	10.7	13.3	
C <i>Commercial P4</i>	11.25 11.25	0.80 0.80	0.82 0.82	0.84 0.84	0.87 0.87	0.88 0.88	0.89 0.89										9.7	3.3	4.2	4.9	5.6	6.3	7.0	30.0	38.5	46.0	54.5	62.0	70.2	

Calculated by: DLM
Date: 10/25/2020

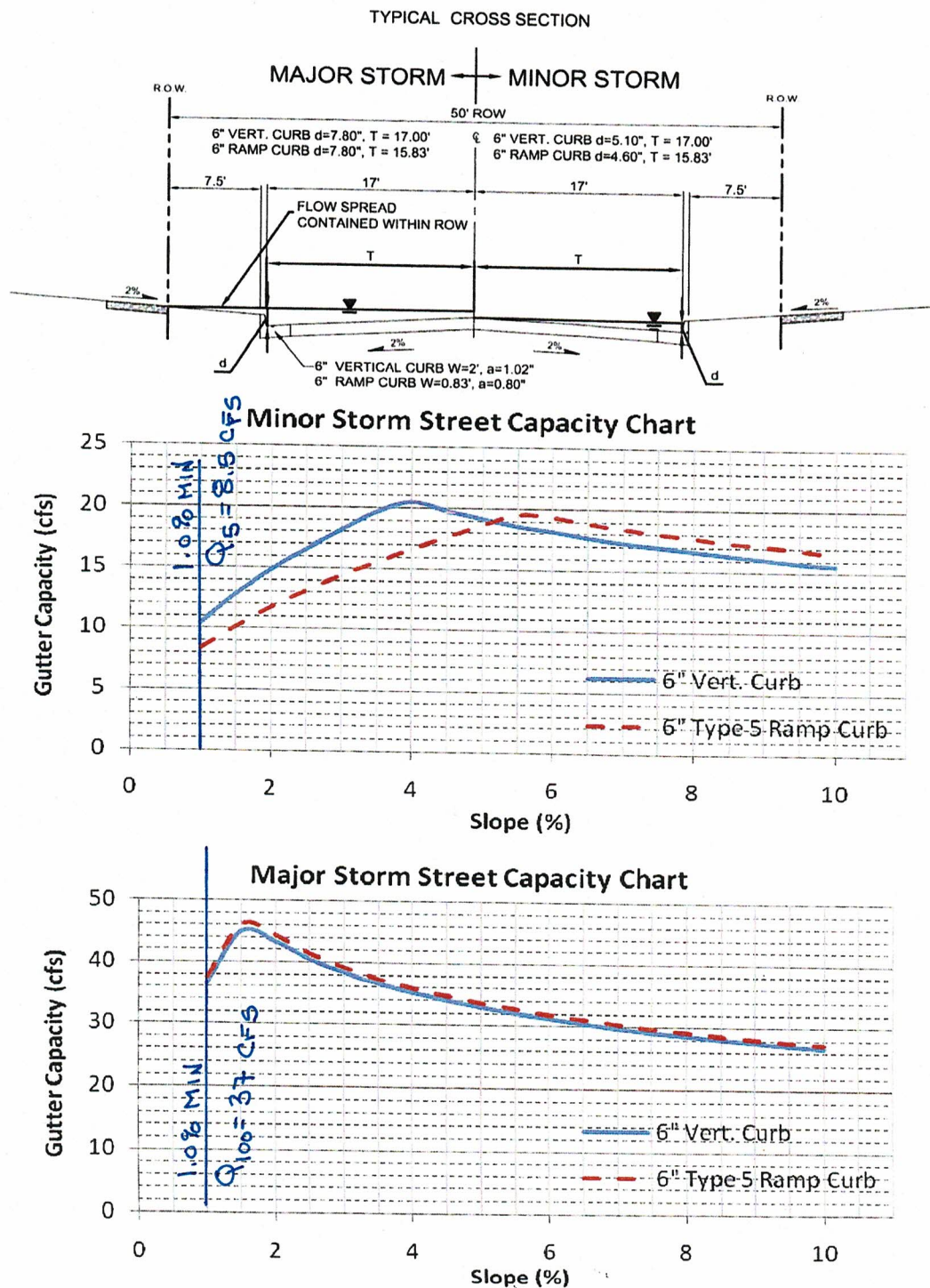
PROPOSED DRAINAGE DESIGN - RATIONAL ANALYSIS

DESIGN POINT	AREA TOTAL (Acres)	WEIGHTED						TT (min)	INTENSITY						TOTAL FLOWS					
		C ₂	C ₅	C ₁₀	C ₂₅	C ₅₀	C ₁₀₀		I ₂	I ₅	I ₁₀	I ₂₅	I ₅₀	I ₁₀₀	Q ₂	Q ₅	Q ₁₀	Q ₂₅	Q ₅₀	Q ₁₀₀
									(in/hr)	(in/hr)	(in/hr)	(in/hr)	(in/hr)	(in/hr)	(c.f.s.)	(c.f.s.)	(c.f.s.)	(c.f.s.)	(c.f.s.)	(c.f.s.)
P4 COMMERCIAL	11.26	0.8	0.82	0.84	0.87	0.88	0.89	9.7	3.3	4.2	4.9	5.6	6.3	7	30.0	38.5	46.1	54.5	62.1	70.2
1 P4	14.43	0.72	0.74	0.77	0.81	0.82	0.84	12.5	3.0	3.8	4.4	5.1	5.7	6.4	31.3	40.6	49.2	58.8	67.4	76.8
BASIN B1	11.26	0.80	0.82	0.84	0.87	0.88	0.89	9.7												
BASIN B2	1.84	0.40	0.45	0.51	0.56	0.60	0.63	12.5												
	1.33	0.45	0.49	0.54	0.59	0.62	0.65	10.2												
2 BASIN B3	3.55	0.42	0.47	0.52	0.58	0.61	0.64	12.3	3.0	3.8	4.5	5.1	5.7	6.4	4.6	6.4	8.3	10.4	12.4	14.6
BASIN B4	2.29	0.41	0.46	0.51	0.57	0.60	0.64	12.3												
	1.26	0.45	0.49	0.54	0.59	0.62	0.65	10.5												
3 BASIN B5	8.79	0.44	0.48	0.53	0.58	0.62	0.65	15.0	2.8	3.5	4.1	4.7	5.3	5.9	10.9	14.9	19.2	24.1	28.6	33.6
BASIN B6	3.57	0.45	0.49	0.54	0.59	0.62	0.65	12.9												
DP-2	1.67	0.45	0.49	0.54	0.59	0.62	0.65	15.0												
	3.55	0.42	0.47	0.52	0.58	0.61	0.64	12.3												
4 DP-7	32.90	0.44	0.48	0.53	0.58	0.61	0.65	22.4	2.3	2.9	3.4	3.9	4.4	4.9	33.6	46.0	59.5	74.7	88.5	104.0
DP-3	24.11	0.44	0.48	0.53	0.58	0.61	0.65	22.4												
	8.79	0.44	0.48	0.53	0.58	0.62	0.65	15.0												
5 BASIN B7	4.12	0.37	0.43	0.49	0.55	0.59	0.62	14.2	2.9	3.6	4.2	4.8	5.4	6.1	4.4	6.3	8.4	10.9	13.0	15.5
BASIN B8	3.79	0.37	0.42	0.48	0.55	0.58	0.62	14.2												
	0.33	0.45	0.49	0.54	0.59	0.62	0.65	8.5												
6 BASIN B9	9.46	0.42	0.46	0.52	0.57	0.61	0.64	14.2	2.9	3.6	4.2	4.8	5.4	6.1	11.3	15.8	20.6	26.0	31.0	36.5
BASIN B10	3.19	0.45	0.49	0.54	0.59	0.62	0.65	12.5												
DP 5	2.15	0.45	0.49	0.54	0.59	0.62	0.65	12.3												
	4.12	0.37	0.43	0.49	0.55	0.59	0.62	14.2												
7 DP-11	24.11	0.44	0.48	0.53	0.58	0.61	0.65	22.4	2.3	2.9	3.4	3.9	4.4	4.9	24.6	33.7	43.6	54.7	64.8	76.2
DP-6	14.65	0.45	0.49	0.54	0.59	0.62	0.65	22.4												
	9.46	0.42	0.46	0.52	0.57	0.61	0.64	14.2												
8 BASIN B11	8.15	0.45	0.49	0.54	0.59	0.62	0.65	12.3	3.0	3.8	4.5	5.1	5.7	6.4	11.2	15.2	19.6	24.5	28.9	33.9
BASIN B12	4.41	0.45	0.49	0.54	0.59	0.62	0.65	12.3												
	3.74	0.45	0.49	0.54	0.59	0.62	0.65	12.2												
9 B14	9.50	0.45	0.49	0.54	0.59	0.62	0.65	12.7	3.0	3.8	4.4	5.0	5.7	6.3	12.9	17.5	22.5	28.2	33.3	39.1
DP-8	1.35	0.45	0.49	0.54	0.59	0.62	0.65	12.7												
	8.15	0.45	0.49	0.54	0.59	0.62	0.65	12.3												
A1 BASIN B13	4.00	0.45	0.49	0.54	0.59	0.62	0.65	20.1	2.5	3.1	3.6	4.1	4.6	5.2	4.4	6.0	7.8	9.7	11.5	13.4
BASIN B16	1.96	0.45	0.49	0.54	0.59	0.62	0.65	13.4												
	2.04	0.45	0.49	0.54	0.59	0.62	0.65	20.1												
10 DP A1	13.50	0.45	0.49	0.54	0.59	0.62	0.65	20.1	2.5	3.1	3.6	4.1	4.6	5.2	15.0	20.4	26.2	32.7	38.7	45.4
DP-9	4.00	0.45	0.49	0.54	0.59	0.62	0.65	20.1												
	9.50	0.45	0.49	0.54	0.59	0.62	0.65	12.7												
11 BASIN B15	14.65	0.45	0.49	0.54	0.59	0.62	0.65	22.4	2.3	2.9	3.4	3.9	4.4	4.9	15.4	20.9	26.9	33.6	39.8	46.6
DP-10	1.15	0.45	0.49	0.54	0.59	0.62	0.65	22.4												
	13.50	0.45	0.49	0.54	0.59	0.62	0.65	20.1												
12 BASIN B17	33.77	0.44	0.48	0.53	0.58	0.61	0.65	22.4	2.3	2.9	3.4	3.9	4.4	4.9	34.5	47.3	61.1	76.7	90.9	106.8
DP-4	0.87	0.45	0.49	0.54	0.59	0.62	0.65	11.3												
	32.90	0.44	0.48	0.53	0.58	0.61	0.65	22.4												
P-IN BASIN B18	53.06	0.41	0.46	0.51	0.57	0.60	0.64	22.4	2.3	2.9	3.4	3.9	4.4	4.9	51.1	71.1	92.9	117.7	140.1	165.4
DP-1	4.86	0.16	0.25	0.34	0.44	0.49	0.55	21.4												
DP-12	14.43	0.72	0.74	0.77	0.81	0.82	0.84	12.5												
	33.77	0.44	0.48	0.53	0.58	0.61	0.65	22.4												
P-OUT POND OUTLET	54.90								POND ROUTED SEE UD DENTENTION						1.3	1.6	12.1	36.4	55.6	67.7

Calculated by: DLM

Date: 10/25/2020

Figure 7-7. Street Capacity Charts Residential (Detached Sidewalk)



These charts shall only be used for the standard street sections as shown. The capacity shown is based on $\frac{1}{2}$ the street section as calculated by the UD-Inlet spreadsheets. Minor storm capacities are based on no crown overtopping, curb height or maximum allowable spread widths. Major storm capacities are based on flow being contained within the public right-of-way, including conveyance capacity behind the curb. The UDFCD Safety Reduction Factor was applied. An 'n_{STREET}' of 0.016 and 'n_{BACK}' of 0.020 was used. Calculations were done using UD-Inlet 3.00.xls, March, 2011.

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

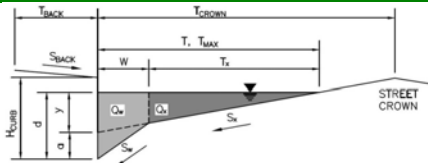
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Riverbend Crossing

Inlet ID:

B1

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

Maximum Allowable Width for Spread Behind Curb

 $T_{BACK} = 7.5$ ft

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

 $S_{BACK} = 0.012$ ft/ft

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

 $n_{BACK} = 0.020$

Height of Curb at Gutter Flow Line

 $H_{CURB} = 6.00$ inches

Distance from Curb Face to Street Crown

 $T_{CROWN} = 16.2$ 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)

 $n_{STREET} = 0.016$

Max. Allowable Spread for Minor & Major Storm

	Minor Storm	Major Storm	
$T_{MAX} =$	16.2	16.2	ft
$d_{MAX} =$	5.1	7.8	inches

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

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

☐ ☐ check = yes
MINOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm	
$Q_{allow} =$	14.6	22.9	cfs

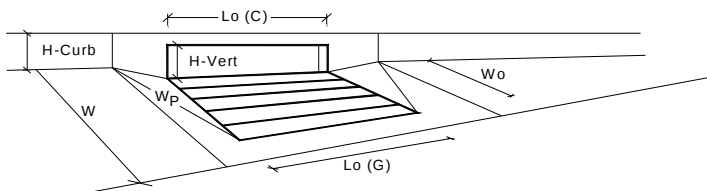
MAJOR STORM Allowable Capacity is based on Spread Criterion

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 IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)

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

Grate Information

Length of a Unit Grate
Width of a Unit Grate
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 Type R Curb Opening		
a_{local} =	3.00	3.00	inches
No =	1	1	
Ponding Depth =	5.1	7.8	inches
	MINOR	MAJOR	☒ Override Depths
L_o (G) =	N/A	N/A	feet
W_o =	N/A	N/A	feet
A_{ratio} =	N/A	N/A	
C_r (G) =	N/A	N/A	
C_w (G) =	N/A	N/A	
C_o (G) =	N/A	N/A	
	MINOR	MAJOR	
L_o (C) =	10.00	10.00	feet
H_{vert} =	6.00	6.00	inches
H_{throat} =	6.00	6.00	inches
Theta =	63.40	63.40	degrees
W_p =	2.00	2.00	feet
C_r (C) =	0.10	0.10	
C_w (C) =	3.60	3.60	
C_o (C) =	0.67	0.67	
	MINOR	MAJOR	
d_{Grate} =	N/A	N/A	ft
d_{Curb} =	0.26	0.48	ft
$RF_{Combination}$ =	0.48	0.74	
RF_{Curb} =	0.88	1.00	
RF_{Grate} =	N/A	N/A	
	MINOR	MAJOR	
Q_a =	5.3	15.5	cfs
$Q_{PEAK REQUIRED}$ =	3.1	7.4	cfs

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

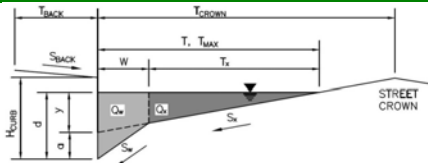
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Riverbend Crossing

Inlet ID:

B2



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb

$T_{BACK} = 7.5$ ft

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

$S_{BACK} = 0.012$ ft/ft

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

$n_{BACK} = 0.020$

Height of Curb at Gutter Flow Line

$H_{CURB} = 6.00$ inches

Distance from Curb Face to Street Crown

$T_{CROWN} = 16.2$ 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)

$n_{STREET} = 0.016$

Max. Allowable Spread for Minor & Major Storm

	Minor Storm	Major Storm	
$T_{MAX} =$	16.2	16.2	ft
$d_{MAX} =$	5.1	7.8	inches

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

$d_{MAX} = 5.1$ inches

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

☐ ☐ check = yes

MINOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm	
$Q_{allow} =$	14.6	22.9	cfs

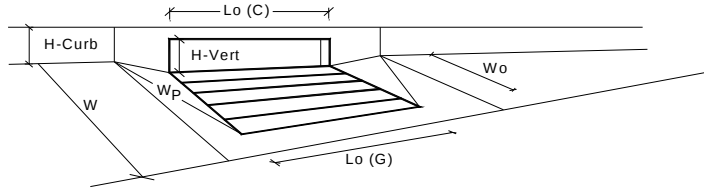
MAJOR STORM Allowable Capacity is based on Spread Criterion

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 IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	CDOT Type R Curb Opening			
Local Depression (additional to continuous gutter depression 'a' from above)		a _{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	5.1	7.8	inches
Grate Information		MINOR		MAJOR	
Length of a Unit Grate		L _g (G) =	N/A	N/A	feet
Width of a Unit Grate		W _o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A _{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C _r (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		C _w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C _o (G) =	N/A	N/A	
Curb Opening Information		MINOR		MAJOR	
Length of a Unit Curb Opening		L _o (C) =	10.00	10.00	feet
Height of Vertical Curb Opening in Inches		H _{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		H _{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	63.40	63.40	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 _r (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		C _w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C _o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR		MAJOR	
Depth for Grate Midwidth		d _{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation		d _{Curb} =	0.26	0.48	ft
Combination Inlet Performance Reduction Factor for Long Inlets		RF _{Combination} =	0.48	0.74	
Curb Opening Performance Reduction Factor for Long Inlets		RF _{Curb} =	0.88	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets		RF _{Grate} =	N/A	N/A	
Total Inlet Interception Capacity (assumes clogged condition)		MINOR		MAJOR	
		Q _a =	5.3	15.5	cfs
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)		Q _{PEAK REQUIRED} =	2.7	6.0	cfs

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

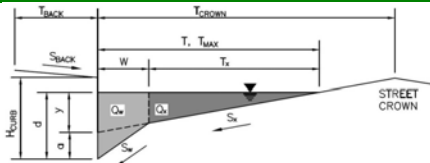
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Riverbend Crossing

Inlet ID:

B3

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

Maximum Allowable Width for Spread Behind Curb

 $T_{BACK} = 7.5$ ft

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

 $S_{BACK} = 0.012$ ft/ft

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

 $n_{BACK} = 0.020$

Height of Curb at Gutter Flow Line

 $H_{CURB} = 6.00$ inches

Distance from Curb Face to Street Crown

 $T_{CROWN} = 16.2$ 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)

 $n_{STREET} = 0.016$

Max. Allowable Spread for Minor & Major Storm

	Minor Storm	Major Storm	
$T_{MAX} =$	16.2	16.2	ft

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

	Minor Storm	Major Storm	
$d_{MAX} =$	5.1	7.8	inches

Check boxes are not applicable in SUMP conditions

☐☐

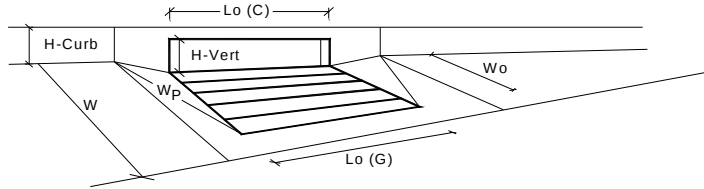
MINOR STORM Allowable Capacity is based on Depth Criterion

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

MAJOR STORM Allowable Capacity is based on Depth Criterion

INLET IN A SUMP OR SAG LOCATION

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' from above)		a _{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	5.1	7.8	inches
Grate Information		MINOR		MAJOR	
Length of a Unit Grate		L _o (G) =	N/A	N/A	feet
Width of a Unit Grate		W _o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A _{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C _r (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		C _w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C _o (G) =	N/A	N/A	
Curb Opening Information		MINOR		MAJOR	
Length of a Unit Curb Opening		L _o (C) =	10.00	10.00	feet
Height of Vertical Curb Opening in Inches		H _{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		H _{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	63.40	63.40	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 _r (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		C _w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C _o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR		MAJOR	
Depth for Grate Midwidth		d _{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation		d _{Curb} =	0.26	0.48	ft
Combination Inlet Performance Reduction Factor for Long Inlets		RF _{Combination} =	0.48	0.74	
Curb Opening Performance Reduction Factor for Long Inlets		RF _{Curb} =	0.88	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets		RF _{Grate} =	N/A	N/A	
Total Inlet Interception Capacity (assumes clogged condition)		MINOR		MAJOR	
		Q _a =	5.3	15.5	cfs
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)		Q _{PEAK REQUIRED} =	4.0	9.3	cfs

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

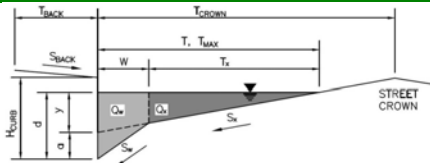
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Riverbend Crossing

Inlet ID:

B4

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

Maximum Allowable Width for Spread Behind Curb

 $T_{BACK} = 7.5$ ft

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

 $S_{BACK} = 0.012$ ft/ft

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

 $n_{BACK} = 0.020$

Height of Curb at Gutter Flow Line

 $H_{CURB} = 6.00$ inches

Distance from Curb Face to Street Crown

 $T_{CROWN} = 16.2$ 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)

 $n_{STREET} = 0.016$

Max. Allowable Spread for Minor & Major Storm

	Minor Storm	Major Storm	
$T_{MAX} =$	16.2	16.2	ft
$d_{MAX} =$	5.1	7.8	inches

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

Check boxes are not applicable in SUMP conditions

☐☐

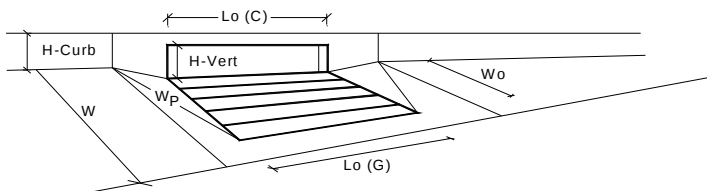
MINOR STORM Allowable Capacity is based on Depth Criterion

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

MAJOR STORM Allowable Capacity is based on Depth Criterion

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)

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

Grate Information

Length of a Unit Grate
Width of a Unit Grate
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 Type R Curb Opening		
a_{local} =	3.00	3.00	inches
No =	1	1	
Ponding Depth =	5.1	7.8	inches
	MINOR	MAJOR	☒ Override Depths
L_o (G) =	N/A	N/A	feet
W_o =	N/A	N/A	feet
A_{ratio} =	N/A	N/A	
C_r (G) =	N/A	N/A	
C_w (G) =	N/A	N/A	
C_o (G) =	N/A	N/A	
	MINOR	MAJOR	
L_o (C) =	5.00	5.00	feet
H_{vert} =	6.00	6.00	inches
H_{throat} =	6.00	6.00	inches
Theta =	63.40	63.40	degrees
W_p =	2.00	2.00	feet
C_r (C) =	0.10	0.10	
C_w (C) =	3.60	3.60	
C_o (C) =	0.67	0.67	
	MINOR	MAJOR	
d_{Grate} =	N/A	N/A	ft
d_{Curb} =	0.26	0.48	ft
$RF_{Combination}$ =	0.65	1.00	
RF_{Curb} =	1.00	1.00	
RF_{Grate} =	N/A	N/A	
	MINOR	MAJOR	
Q_a =	3.7	9.0	cfs
$Q_{PEAK REQUIRED}$ =	2.5	5.6	cfs

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

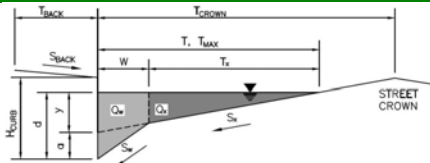
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Riverbend Crossing

Inlet ID:

B5

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

Maximum Allowable Width for Spread Behind Curb

 $T_{BACK} = 7.5$ ft

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

 $S_{BACK} = 0.012$ ft/ft

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

 $n_{BACK} = 0.020$

Height of Curb at Gutter Flow Line

 $H_{CURB} = 6.00$ inches

Distance from Curb Face to Street Crown

 $T_{CROWN} = 16.2$ 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)

 $n_{STREET} = 0.016$

Max. Allowable Spread for Minor & Major Storm

	Minor Storm	Major Storm	
$T_{MAX} =$	16.2	16.2	ft
$d_{MAX} =$	5.1	7.8	inches

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

Check boxes are not applicable in SUMP conditions

☐☐

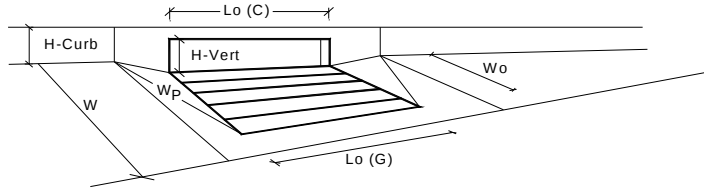
MINOR STORM Allowable Capacity is based on Depth Criterion

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

MAJOR STORM Allowable Capacity is based on Depth Criterion

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	CDOT Type R Curb Opening			
Local Depression (additional to continuous gutter depression 'a' from above)		a_{local}	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth	5.5	7.8	inches
Grate Information		MINOR		MAJOR	
Length of a Unit Grate		$L_o (G)$	N/A	N/A	feet
Width of a Unit Grate		W_o	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A_{ratio}	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		$C_r (G)$	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		$C_w (G)$	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		$C_o (G)$	N/A	N/A	
Curb Opening Information		MINOR		MAJOR	
Length of a Unit Curb Opening		$L_o (C)$	10.00	10.00	feet
Height of Vertical Curb Opening in Inches		H_{vert}	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		H_{throat}	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta	63.40	63.40	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)		$C_r (C)$	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		$C_w (C)$	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		$C_o (C)$	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR		MAJOR	
Depth for Grate Midwidth		d_{Grate}	N/A	N/A	ft
Depth for Curb Opening Weir Equation		d_{Curb}	0.29	0.48	ft
Combination Inlet Performance Reduction Factor for Long Inlets		$RF_{Combination}$	0.52	0.74	
Curb Opening Performance Reduction Factor for Long Inlets		RF_{Curb}	0.90	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets		RF_{Grate}	N/A	N/A	
Total Inlet Interception Capacity (assumes clogged condition)		MINOR		MAJOR	
		Q_a	6.6	15.5	cfs
WARNING: Inlet Capacity less than Q Peak for Minor Storm		$Q_{PEAK REQUIRED}$	6.6	14.6	cfs

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

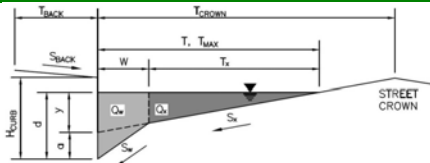
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Riverbend Crossing

Inlet ID:

B6

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

Maximum Allowable Width for Spread Behind Curb

 $T_{BACK} = 7.5$ ft

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

 $S_{BACK} = 0.012$ ft/ft

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

 $n_{BACK} = 0.020$

Height of Curb at Gutter Flow Line

 $H_{CURB} = 6.00$ inches

Distance from Curb Face to Street Crown

 $T_{CROWN} = 16.2$ 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)

 $n_{STREET} = 0.016$

Max. Allowable Spread for Minor & Major Storm

	Minor Storm	Major Storm	
$T_{MAX} =$	16.2	16.2	ft

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

	Minor Storm	Major Storm	
$d_{MAX} =$	5.1	7.8	inches

Check boxes are not applicable in SUMP conditions



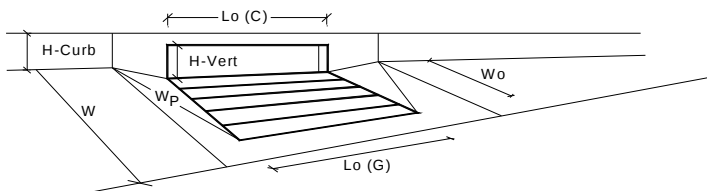
MINOR STORM Allowable Capacity is based on Depth Criterion

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

MAJOR STORM Allowable Capacity is based on Depth Criterion

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)

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

Grate Information

Length of a Unit Grate
Width of a Unit Grate
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 Type R Curb Opening		
a_{local} =	3.00	3.00	inches
No =	1	1	
Ponding Depth =	5.5	7.8	inches
	MINOR	MAJOR	☒ Override Depths
$L_o (G)$ =	N/A	N/A	feet
W_o =	N/A	N/A	feet
A_{ratio} =	N/A	N/A	
$C_r (G)$ =	N/A	N/A	
$C_w (G)$ =	N/A	N/A	
$C_o (G)$ =	N/A	N/A	
	MINOR	MAJOR	
$L_o (C)$ =	10.00	10.00	feet
H_{vert} =	6.00	6.00	inches
H_{throat} =	6.00	6.00	inches
Theta =	63.40	63.40	degrees
W_p =	2.00	2.00	feet
$C_r (C)$ =	0.10	0.10	
$C_w (C)$ =	3.60	3.60	
$C_o (C)$ =	0.67	0.67	
	MINOR	MAJOR	
d_{Grate} =	N/A	N/A	ft
d_{Curb} =	0.29	0.48	ft
$RF_{Combination}$ =	0.52	0.74	
RF_{Curb} =	0.90	1.00	
RF_{Grate} =	N/A	N/A	
	MINOR	MAJOR	
Q_a =	6.6	15.5	cfs
$Q_{PEAK REQUIRED}$ =	2.9	6.4	cfs

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

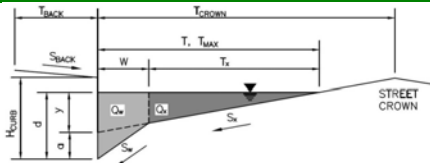
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Riverbend Crossing

Inlet ID:

B7

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

Maximum Allowable Width for Spread Behind Curb

 $T_{BACK} = 7.5$ ft

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

 $S_{BACK} = 0.012$ ft/ft

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

 $n_{BACK} = 0.020$

Height of Curb at Gutter Flow Line

 $H_{CURB} = 6.00$ inches

Distance from Curb Face to Street Crown

 $T_{CROWN} = 16.2$ 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)

 $n_{STREET} = 0.016$

Max. Allowable Spread for Minor & Major Storm

	Minor Storm	Major Storm	
$T_{MAX} =$	16.2	16.2	ft
$d_{MAX} =$	5.5	7.8	inches

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

Check boxes are not applicable in SUMP conditions



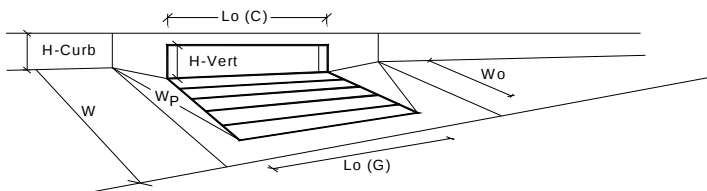
MINOR STORM Allowable Capacity is based on Depth Criterion

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

MAJOR STORM Allowable Capacity is based on Depth Criterion

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)

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

Grate Information

Length of a Unit Grate
Width of a Unit Grate
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 Type R Curb Opening		
a_{local} =	3.00	3.00	inches
No =	1	1	
Ponding Depth =	5.5	7.8	inches
	MINOR	MAJOR	☒ Override Depths
$L_o (G)$ =	N/A	N/A	feet
W_o =	N/A	N/A	feet
A_{ratio} =	N/A	N/A	
$C_r (G)$ =	N/A	N/A	
$C_w (G)$ =	N/A	N/A	
$C_o (G)$ =	N/A	N/A	
	MINOR	MAJOR	
$L_o (C)$ =	10.00	10.00	feet
H_{vert} =	6.00	6.00	inches
H_{throat} =	6.00	6.00	inches
Theta =	63.40	63.40	degrees
W_p =	2.00	2.00	feet
$C_r (C)$ =	0.10	0.10	
$C_w (C)$ =	3.60	3.60	
$C_o (C)$ =	0.67	0.67	
	MINOR	MAJOR	
d_{Grate} =	N/A	N/A	ft
d_{Curb} =	0.29	0.48	ft
$RF_{Combination}$ =	0.52	0.74	
RF_{Curb} =	0.90	1.00	
RF_{Grate} =	N/A	N/A	
	MINOR	MAJOR	
Q_a =	6.6	15.5	cfs
$Q_{PEAK REQUIRED}$ =	5.7	14.2	cfs

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

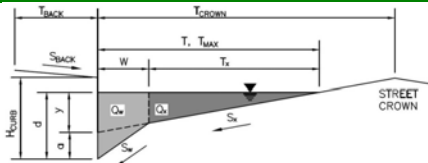
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Riverbend Crossing

Inlet ID:

B8

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

Maximum Allowable Width for Spread Behind Curb

 $T_{BACK} = 7.5$ ft

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

 $S_{BACK} = 0.012$ ft/ft

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

 $n_{BACK} = 0.020$

Height of Curb at Gutter Flow Line

 $H_{CURB} = 6.00$ inches

Distance from Curb Face to Street Crown

 $T_{CROWN} = 16.2$ 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)

 $n_{STREET} = 0.016$

Max. Allowable Spread for Minor & Major Storm

	Minor Storm	Major Storm	
$T_{MAX} =$	16.2	16.2	ft
$d_{MAX} =$	5.1	7.8	inches

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

Check boxes are not applicable in SUMP conditions

☐☐

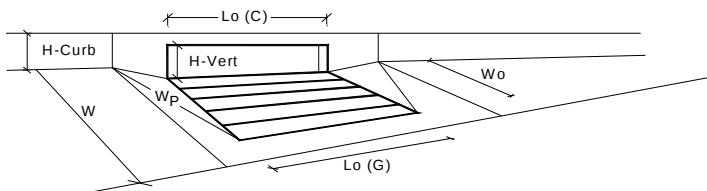
MINOR STORM Allowable Capacity is based on Depth Criterion

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

MAJOR STORM Allowable Capacity is based on Depth Criterion

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)

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

Grate Information

Length of a Unit Grate
Width of a Unit Grate
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 Type R Curb Opening		
a_{local} =	3.00	3.00	inches
No =	1	1	
Ponding Depth =	5.1	7.8	inches
	MINOR	MAJOR	☒ Override Depths
L_o (G) =	N/A	N/A	feet
W_o =	N/A	N/A	feet
A_{ratio} =	N/A	N/A	
C_r (G) =	N/A	N/A	
C_w (G) =	N/A	N/A	
C_o (G) =	N/A	N/A	
	MINOR	MAJOR	
L_o (C) =	5.00	5.00	feet
H_{vert} =	6.00	6.00	inches
H_{throat} =	6.00	6.00	inches
Theta =	63.40	63.40	degrees
W_p =	2.00	2.00	feet
C_r (C) =	0.10	0.10	
C_w (C) =	3.60	3.60	
C_o (C) =	0.67	0.67	
	MINOR	MAJOR	
d_{Grate} =	N/A	N/A	ft
d_{Curb} =	0.26	0.48	ft
$RF_{Combination}$ =	0.65	1.00	
RF_{Curb} =	1.00	1.00	
RF_{Grate} =	N/A	N/A	
	MINOR	MAJOR	
Q_a =	3.7	9.0	cfs
$Q_{PEAK REQUIRED}$ =	0.7	1.6	cfs

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

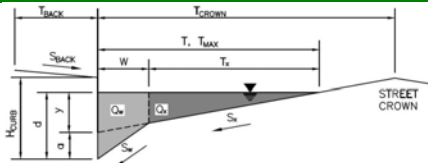
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Riverbend Crossing

Inlet ID:

B9

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

Maximum Allowable Width for Spread Behind Curb

 $T_{BACK} = 7.5$ ft

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

 $S_{BACK} = 0.012$ ft/ft

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

 $n_{BACK} = 0.020$

Height of Curb at Gutter Flow Line

 $H_{CURB} = 6.00$ inches

Distance from Curb Face to Street Crown

 $T_{CROWN} = 16.2$ 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)

 $n_{STREET} = 0.016$

Max. Allowable Spread for Minor & Major Storm

	Minor Storm	Major Storm	
$T_{MAX} =$	16.2	16.2	ft

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

	Minor Storm	Major Storm	
$d_{MAX} =$	5.5	7.8	inches

Check boxes are not applicable in SUMP conditions



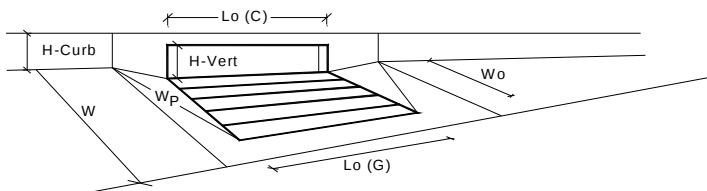
MINOR STORM Allowable Capacity is based on Depth Criterion

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

Version 4.05 Released March 2017



Design Information (Input)

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

Grate Information

Length of a Unit Grate
Width of a Unit Grate
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 Type R Curb Opening		
a_{local} =	3.00	3.00	inches
No =	1	1	
Ponding Depth =	5.5	7.8	inches
	MINOR	MAJOR	☒ Override Depths
L_o (G) =	N/A	N/A	feet
W_o =	N/A	N/A	feet
A_{ratio} =	N/A	N/A	
C_r (G) =	N/A	N/A	
C_w (G) =	N/A	N/A	
C_o (G) =	N/A	N/A	
	MINOR	MAJOR	
L_o (C) =	10.00	10.00	feet
H_{vert} =	6.00	6.00	inches
H_{throat} =	6.00	6.00	inches
Theta =	63.40	63.40	degrees
W_p =	2.00	2.00	feet
C_r (C) =	0.10	0.10	
C_w (C) =	3.60	3.60	
C_o (C) =	0.67	0.67	
	MINOR	MAJOR	
d_{Grate} =	N/A	N/A	ft
d_{Curb} =	0.29	0.48	ft
$RF_{Combination}$ =	0.52	0.74	
RF_{Curb} =	0.90	1.00	
RF_{Grate} =	N/A	N/A	
	MINOR	MAJOR	
Q_a =	6.6	15.5	cfs
$Q_{PEAK REQUIRED}$ =	5.9	13.2	cfs

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

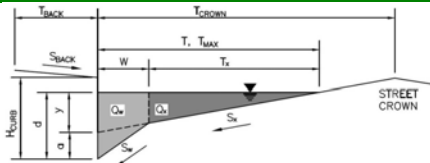
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Riverbend Crossing

Inlet ID:

B10

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

Maximum Allowable Width for Spread Behind Curb

 $T_{BACK} = 7.5$ ft

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

 $S_{BACK} = 0.012$ ft/ft

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

 $n_{BACK} = 0.020$

Height of Curb at Gutter Flow Line

 $H_{CURB} = 6.00$ inches

Distance from Curb Face to Street Crown

 $T_{CROWN} = 16.2$ 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)

 $n_{STREET} = 0.016$

Max. Allowable Spread for Minor & Major Storm

	Minor Storm	Major Storm	
$T_{MAX} =$	16.2	16.2	ft

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

	Minor Storm	Major Storm	
$d_{MAX} =$	5.5	7.8	inches

Check boxes are not applicable in SUMP conditions



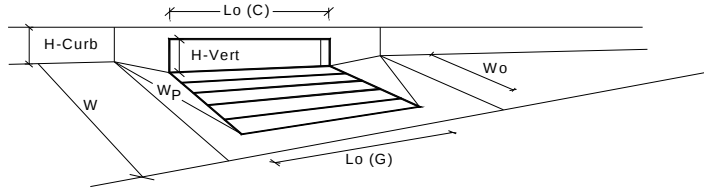
MINOR STORM Allowable Capacity is based on Depth Criterion

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

Version 4.05 Released March 2017



Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	CDOT Type R Curb Opening			
Local Depression (additional to continuous gutter depression 'a' from above)		$a_{local} =$	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	5.5	7.8	inches
Grate Information		MINOR		MAJOR	
Length of a Unit Grate		$L_o (G) =$	N/A	N/A	feet
Width of a Unit Grate		$W_o =$	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		$A_{ratio} =$	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		$C_r (G) =$	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		$C_w (G) =$	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		$C_o (G) =$	N/A	N/A	
Curb Opening Information		MINOR		MAJOR	
Length of a Unit Curb Opening		$L_o (C) =$	10.00	10.00	feet
Height of Vertical Curb Opening in Inches		$H_{vert} =$	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		$H_{throat} =$	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	63.40	63.40	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)		$C_r (C) =$	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		$C_w (C) =$	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		$C_o (C) =$	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR		MAJOR	
Depth for Grate Midwidth		$d_{Grate} =$	N/A	N/A	ft
Depth for Curb Opening Weir Equation		$d_{Curb} =$	0.29	0.48	ft
Combination Inlet Performance Reduction Factor for Long Inlets		$RF_{Combination} =$	0.52	0.74	
Curb Opening Performance Reduction Factor for Long Inlets		$RF_{Curb} =$	0.90	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets		$RF_{Grate} =$	N/A	N/A	
Total Inlet Interception Capacity (assumes clogged condition)		MINOR		MAJOR	
		$Q_a =$	6.6	15.5	cfs
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)		$Q_{PEAK REQUIRED} =$	4.0	9.0	cfs

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

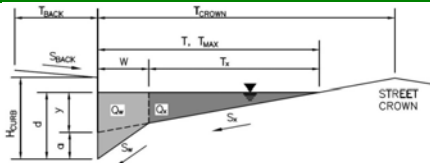
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Riverbend Crossing

Inlet ID:

B11

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

Maximum Allowable Width for Spread Behind Curb

 $T_{BACK} = 7.5$ ft

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

 $S_{BACK} = 0.012$ ft/ft

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

 $n_{BACK} = 0.020$

Height of Curb at Gutter Flow Line

 $H_{CURB} = 6.00$ inches

Distance from Curb Face to Street Crown

 $T_{CROWN} = 16.2$ 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)

 $n_{STREET} = 0.016$

Max. Allowable Spread for Minor & Major Storm

	Minor Storm	Major Storm	
$T_{MAX} =$	16.2	16.2	ft
$d_{MAX} =$	5.5	7.8	inches

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

Check boxes are not applicable in SUMP conditions

☐☐

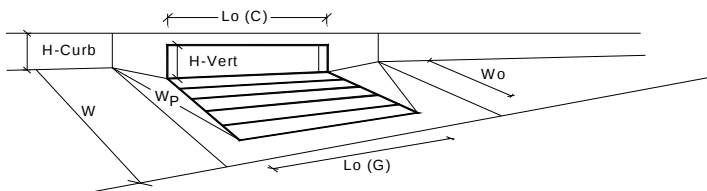
MINOR STORM Allowable Capacity is based on Depth Criterion

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

MAJOR STORM Allowable Capacity is based on Depth Criterion

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)

Type of Inlet = **CDOT Type R Curb Opening**
 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)

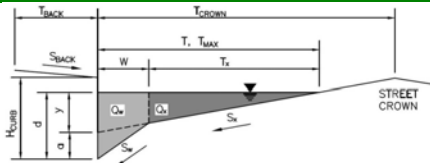
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)

	MINOR	MAJOR	
Type =	CDOT Type R Curb Opening		
a_{local} =	3.00	3.00	inches
No =	1	1	
Ponding Depth =	5.7	7.8	inches
	MINOR	MAJOR	☒ Override Depths
L_o (G) =	N/A	N/A	feet
W_o =	N/A	N/A	feet
A_{ratio} =	N/A	N/A	
C_r (G) =	N/A	N/A	
C_w (G) =	N/A	N/A	
C_o (G) =	N/A	N/A	
	MINOR	MAJOR	
L_o (C) =	15.00	15.00	feet
H_{vert} =	6.00	6.00	inches
H_{throat} =	6.00	6.00	inches
Theta =	63.40	63.40	degrees
W_p =	2.00	2.00	feet
C_r (C) =	0.10	0.10	
C_w (C) =	3.60	3.60	
C_o (C) =	0.67	0.67	
	MINOR	MAJOR	
d_{Grate} =	N/A	N/A	ft
d_{Curb} =	0.31	0.48	ft
$RF_{Combination}$ =	0.54	0.74	
RF_{Curb} =	0.77	0.88	
RF_{Grate} =	N/A	N/A	
	MINOR	MAJOR	
Q_a =	8.5	19.1	cfs
$Q_{PEAK REQUIRED}$ =	8.2	18.4	cfs

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

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

Project: **Riverbend Crossing**
 Inlet ID: **B12**



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)

$T_{BACK} = 7.5$ ft
 $S_{BACK} = 0.012$ ft/ft
 $n_{BACK} = 0.020$

$H_{CURB} = 6.00$ inches
 $T_{CROWN} = 16.2$ ft
 $W = 2.00$ ft
 $S_x = 0.020$ ft/ft
 $S_w = 0.083$ ft/ft
 $S_o = 0.000$ ft/ft
 $n_{STREET} = 0.016$

Max. Allowable Spread for Minor & Major Storm
 Max. Allowable Depth at Gutter Flowline for Minor & Major Storm
 Check boxes are not applicable in SUMP conditions

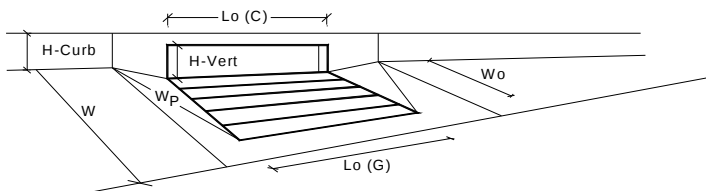
	Minor Storm	Major Storm	
$T_{MAX} =$	16.2	16.2	ft
$d_{MAX} =$	5.5	7.8	inches
	☐	☐	

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
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 Type R Curb Opening		
a_{local} =	3.00	3.00	inches
No =	1	1	
Ponding Depth =	5.5	7.8	inches
	MINOR	MAJOR	☒ Override Depths
$L_o (G)$ =	N/A	N/A	feet
W_o =	N/A	N/A	feet
A_{ratio} =	N/A	N/A	
$C_r (G)$ =	N/A	N/A	
$C_w (G)$ =	N/A	N/A	
$C_o (G)$ =	N/A	N/A	
	MINOR	MAJOR	
$L_o (C)$ =	15.00	15.00	feet
H_{vert} =	6.00	6.00	inches
H_{throat} =	6.00	6.00	inches
Theta =	63.40	63.40	degrees
W_p =	2.00	2.00	feet
$C_r (C)$ =	0.10	0.10	
$C_w (C)$ =	3.60	3.60	
$C_o (C)$ =	0.67	0.67	
	MINOR	MAJOR	
d_{Grate} =	N/A	N/A	ft
d_{Curb} =	0.29	0.48	ft
$RF_{Combination}$ =	0.52	0.74	
RF_{Curb} =	0.75	0.88	
RF_{Grate} =	N/A	N/A	
	MINOR	MAJOR	
Q_a =	7.6	19.1	cfs
$Q_{PEAK REQUIRED}$ =	7.0	15.6	cfs

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

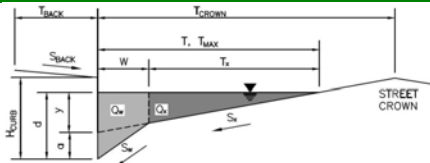
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Riverbend Crossing

Inlet ID:

A1

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

Maximum Allowable Width for Spread Behind Curb

 $T_{BACK} = 5.5$ ft

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

 $S_{BACK} = 0.012$ ft/ft

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

 $n_{BACK} = 0.020$

Height of Curb at Gutter Flow Line

 $H_{CURB} = 6.00$ inches

Distance from Curb Face to Street Crown

 $T_{CROWN} = 16.2$ 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)

 $n_{STREET} = 0.016$

Max. Allowable Spread for Minor & Major Storm

	Minor Storm	Major Storm	
$T_{MAX} =$	16.2	16.2	ft
$d_{MAX} =$	5.5	8.1	inches

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

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

☐ ☐ check = yes

MINOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm	
$Q_{allow} =$	14.6	22.9	cfs

MAJOR STORM Allowable Capacity is based on Spread Criterion

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'

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

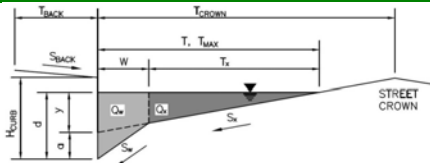
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Riverbend Crossing

Inlet ID:

B14

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

Maximum Allowable Width for Spread Behind Curb

 $T_{BACK} = 7.5$ ft

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

 $S_{BACK} = 0.012$ ft/ft

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

 $n_{BACK} = 0.020$

Height of Curb at Gutter Flow Line

 $H_{CURB} = 6.00$ inches

Distance from Curb Face to Street Crown

 $T_{CROWN} = 16.2$ 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)

 $n_{STREET} = 0.016$

Max. Allowable Spread for Minor & Major Storm

	Minor Storm	Major Storm	
$T_{MAX} =$	16.2	16.2	ft

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

	Minor Storm	Major Storm	
$d_{MAX} =$	5.1	7.8	inches

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

☐ ☐ check = yes
MINOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm	
$Q_{allow} =$	14.6	22.9	cfs

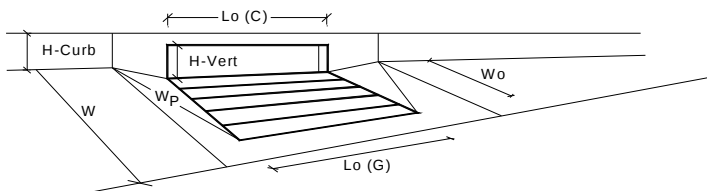
MAJOR STORM Allowable Capacity is based on Spread Criterion

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 IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)

Type of Inlet: **CDOT Type R Curb Opening**
 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)

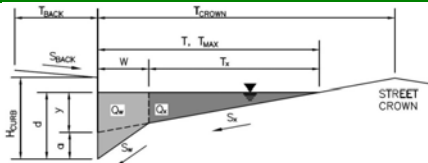
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)

	MINOR	MAJOR	
Type =	CDOT Type R Curb Opening		
a_{local} =	3.00	3.00	inches
No =	1	1	
Ponding Depth =	5.1	7.8	inches
	MINOR	MAJOR	☒ Override Depths
$L_o (G)$ =	N/A	N/A	feet
W_o =	N/A	N/A	feet
A_{ratio} =	N/A	N/A	
$C_r (G)$ =	N/A	N/A	
$C_w (G)$ =	N/A	N/A	
$C_o (G)$ =	N/A	N/A	
	MINOR	MAJOR	
$L_o (C)$ =	5.00	5.00	feet
H_{vert} =	6.00	6.00	inches
H_{throat} =	6.00	6.00	inches
Theta =	63.40	63.40	degrees
W_p =	2.00	2.00	feet
$C_r (C)$ =	0.10	0.10	
$C_w (C)$ =	3.60	3.60	
$C_o (C)$ =	0.67	0.67	
	MINOR	MAJOR	
d_{Grate} =	N/A	N/A	ft
d_{Curb} =	0.26	0.48	ft
$RF_{Combination}$ =	0.65	1.00	
RF_{Curb} =	1.00	1.00	
RF_{Grate} =	N/A	N/A	
	MINOR	MAJOR	
Q_a =	3.7	9.0	cfs
$Q_{PEAK REQUIRED}$ =	2.5	5.5	cfs

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

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

Project: _____
 Inlet ID: _____
 Riverbend Crossing
 B15

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

Maximum Allowable Width for Spread Behind Curb

 $T_{BACK} = 7.5$ ft

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

 $S_{BACK} = 0.012$ ft/ft

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

 $n_{BACK} = 0.020$

Height of Curb at Gutter Flow Line

 $H_{CURB} = 6.00$ inches

Distance from Curb Face to Street Crown

 $T_{CROWN} = 16.2$ 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)

 $n_{STREET} = 0.016$

Max. Allowable Spread for Minor & Major Storm

	Minor Storm	Major Storm	
$T_{MAX} =$	16.2	16.2	ft

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

	Minor Storm	Major Storm	
$d_{MAX} =$	5.1	7.8	inches

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

☐ ☐ check = yes

MINOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm	
$Q_{allow} =$	14.6	22.9	cfs

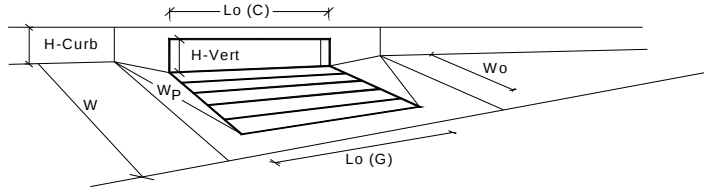
MAJOR STORM Allowable Capacity is based on Spread Criterion

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

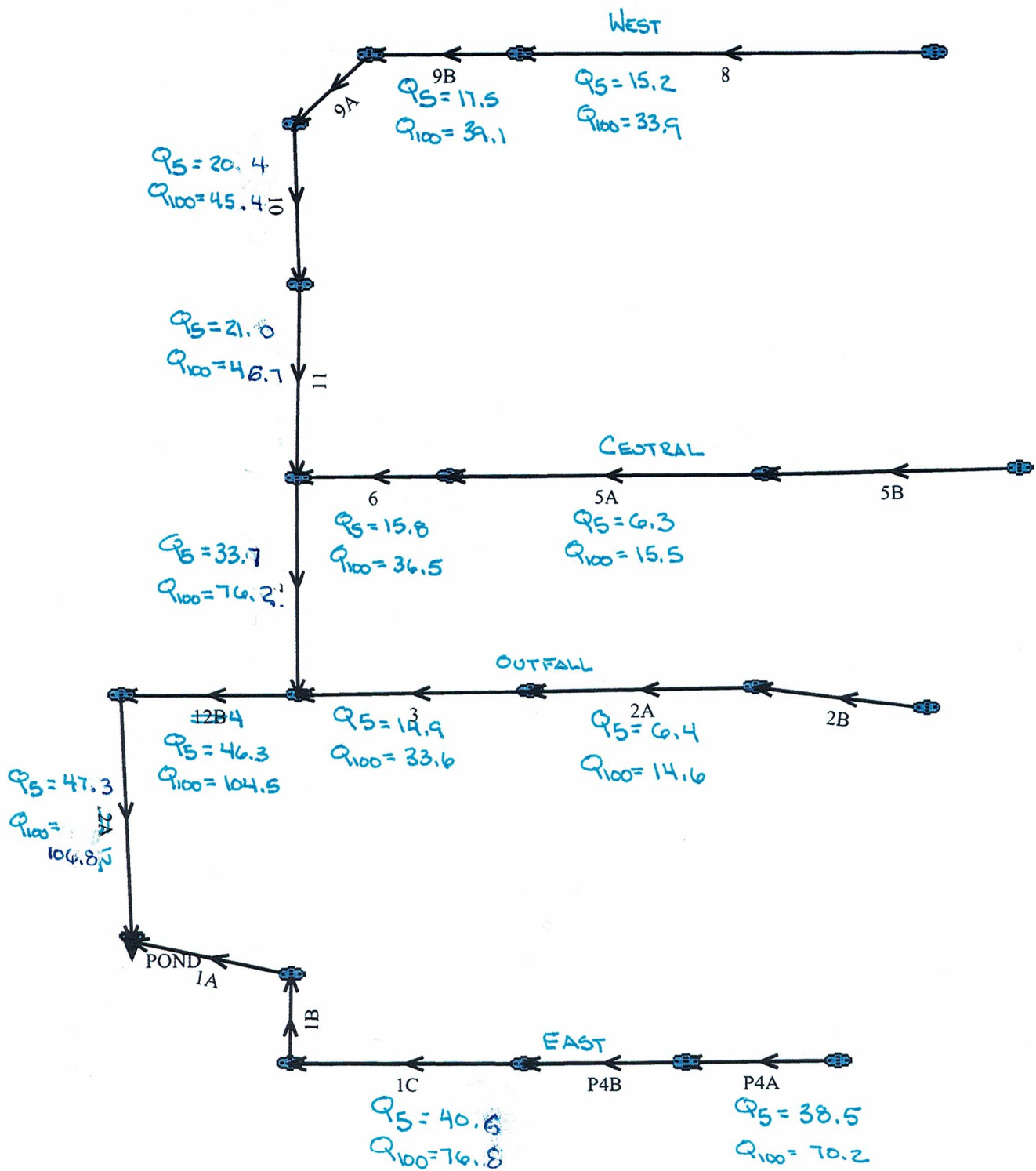
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	CDOT Type R Curb Opening			
Local Depression (additional to continuous gutter depression 'a' from above)		a_{local}	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth	5.1	5.4	inches
Grate Information		MINOR		MAJOR	
Length of a Unit Grate		$L_o (G)$	N/A	N/A	feet
Width of a Unit Grate		W_o	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A_{ratio}	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		$C_r (G)$	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		$C_w (G)$	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		$C_o (G)$	N/A	N/A	
Curb Opening Information		MINOR		MAJOR	
Length of a Unit Curb Opening		$L_o (C)$	5.00	5.00	feet
Height of Vertical Curb Opening in Inches		H_{vert}	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		H_{throat}	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta	63.40	63.40	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)		$C_r (C)$	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		$C_w (C)$	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		$C_o (C)$	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR		MAJOR	
Depth for Grate Midwidth		d_{Grate}	N/A	N/A	ft
Depth for Curb Opening Weir Equation		d_{Curb}	0.26	0.28	ft
Combination Inlet Performance Reduction Factor for Long Inlets		$RF_{Combination}$	0.65	0.69	
Curb Opening Performance Reduction Factor for Long Inlets		RF_{Curb}	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets		RF_{Grate}	N/A	N/A	
Total Inlet Interception Capacity (assumes clogged condition)		MINOR		MAJOR	
		Q_a	3.7	4.2	cfs
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)		$Q_{PEAK REQUIRED}$	1.6	3.7	cfs



Program:
UDSEWER Math
Model Interface
2.2.1.2
Run Date:
10/28/2020 4:50:21
AM

UDSewer Results Summary

Project Title: RIVERBEND CROSSING
Project Description: STORM SYSTEM

System Input Summary

Rainfall Parameters

Rainfall Return Period: 100
Rainfall Calculation Method: Formula

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

Rational Method Constraints

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

Sizer Constraints

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

Backwater Calculations:

Tailwater Elevation (ft): 5690.50

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
POND	5692.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1AA	5701.65	76.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

1A	5711.18	76.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1B	5714.41	76.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1C	5714.19	76.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P4B	5714.13	70.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P4A	5718.52	70.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	5692.81	106.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	5701.35	104.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	5702.66	33.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2A	5709.43	14.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2B	5712.26	14.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2C	5713.89	14.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	5698.85	76.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	5702.66	36.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5A	5706.30	15.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5B	5708.70	15.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	5697.28	46.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	5698.53	45.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9A	5698.65	39.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9B	5699.75	39.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8A	5704.21	33.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8B	5704.21	33.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
POND	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
1AA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	
1A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	
1B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	
1C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	
P4B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	70.20	
P4A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	70.20	
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	106.80	
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	104.00	
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.60	
2A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.60	
2B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.60	
2C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.60	
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.20	
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	36.50	

5A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.50	
5B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.50	
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	46.70	
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.40	
9A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	39.10	
9B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	39.10	
8A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.90	
8B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.90	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
1AA	168.67	5686.50	3.00	5691.56	0.013	0.00	0.00	CIRCULAR	42.00 in	42.00 in
1A	55.24	5694.78	3.08	5696.48	0.013	0.05	0.00	CIRCULAR	42.00 in	42.00 in
1B	106.85	5702.47	1.01	5703.55	0.013	1.00	0.00	CIRCULAR	42.00 in	42.00 in
1C	94.58	5703.80	1.00	5704.75	0.013	0.77	0.00	CIRCULAR	42.00 in	42.00 in
P4B	160.58	5705.00	0.50	5705.80	0.013	0.05	0.00	CIRCULAR	42.00 in	42.00 in
P4A	141.16	5706.05	1.80	5708.59	0.013	1.00	0.00	CIRCULAR	42.00 in	42.00 in
12	132.82	5685.50	0.50	5686.16	0.013	0.00	0.00	CIRCULAR	60.00 in	60.00 in
4	107.02	5686.41	0.50	5686.95	0.013	0.57	0.00	CIRCULAR	60.00 in	60.00 in
3	96.06	5691.50	5.50	5696.78	0.013	0.05	0.00	CIRCULAR	30.00 in	30.00 in
2A	496.00	5697.04	1.39	5703.93	0.013	0.05	0.00	CIRCULAR	24.00 in	24.00 in
2B	151.04	5704.18	1.71	5706.76	0.013	0.05	0.00	CIRCULAR	24.00 in	24.00 in
2C	80.02	5707.01	2.76	5709.22	0.013	0.37	0.00	CIRCULAR	24.00 in	24.00 in
7	243.84	5688.45	0.50	5689.67	0.013	1.00	0.00	CIRCULAR	48.00 in	48.00 in
6	99.58	5691.17	2.70	5693.86	0.013	1.00	0.00	CIRCULAR	30.00 in	30.00 in
5A	458.00	5694.34	1.36	5700.57	0.013	0.05	0.00	CIRCULAR	24.00 in	24.00 in
5B	403.87	5700.82	0.65	5703.45	0.013	0.05	0.00	CIRCULAR	24.00 in	24.00 in
11	152.10	5690.17	0.50	5690.93	0.013	0.05	0.00	CIRCULAR	42.00 in	42.00 in
10	79.98	5691.18	0.50	5691.58	0.013	0.05	0.00	CIRCULAR	42.00 in	42.00 in
9A	17.37	5691.83	0.52	5691.92	0.013	0.30	0.00	CIRCULAR	42.00 in	42.00 in
9B	92.28	5691.92	0.50	5692.38	0.013	0.10	0.00	CIRCULAR	42.00 in	42.00 in
8A	408.50	5692.88	0.55	5695.13	0.013	0.05	0.00	CIRCULAR	36.00 in	36.00 in
8B	451.83	5695.38	0.55	5697.87	0.013	0.05	0.00	CIRCULAR	36.00 in	36.00 in

Sewer Flow Summary:

Full Flow Capacity		Critical Flow		Normal Flow							
Element	Flow	Velocity	Depth	Velocity	Depth	Velocity	Froude	Flow	Flow	Surcharged	Comment

Name	(cfs)	(fps)	(in)	(fps)	(in)	(fps)	Number	Condition	(cfs)	Length (ft)	
1AA	174.73	18.16	32.89	9.50	19.49	17.58	2.77	Supercritical Jump	76.80	20.66	
1A	176.98	18.40	32.89	9.50	19.34	17.74	2.81	Supercritical	76.80	0.00	
1B	101.38	10.54	32.89	9.50	27.33	11.59	1.45	Supercritical	76.80	0.00	
1C	100.88	10.49	32.89	9.50	27.42	11.54	1.44	Supercritical Jump	76.80	38.26	
P4B	71.33	7.41	31.50	9.07	33.84	8.45	0.86	Subcritical	70.20	0.00	
P4A	135.35	14.07	31.50	9.07	21.46	14.20	2.10	Supercritical	70.20	0.00	
12	184.66	9.40	35.35	8.87	32.74	9.75	1.16	Pressurized	106.80	132.82	
4	184.66	9.40	34.86	8.79	32.22	9.68	1.16	Pressurized	104.00	107.02	
3	96.45	19.65	23.66	8.09	12.22	17.89	3.60	Supercritical	33.60	0.00	
2A	26.74	8.51	16.52	6.33	12.65	8.70	1.67	Supercritical Jump	14.60	42.44	
2B	29.66	9.44	16.52	6.33	11.89	9.40	1.88	Supercritical	14.60	0.00	
2C	37.68	12.00	16.52	6.33	10.37	11.23	2.44	Supercritical	14.60	0.00	
7	101.84	8.10	31.71	8.65	30.96	8.89	1.05	Supercritical Jump	76.20	124.30	
6	67.58	13.77	24.57	8.48	15.70	14.03	2.42	Supercritical Jump	36.50	2.70	
5A	26.45	8.42	17.03	6.50	13.20	8.75	1.63	Supercritical Jump	15.50	36.33	
5B	18.29	5.82	17.03	6.50	16.96	6.53	1.01	Supercritical	15.50	0.00	
11	71.33	7.41	25.59	7.61	24.78	7.91	1.06	Supercritical	46.70	0.00	
10	71.33	7.41	25.22	7.53	24.34	7.86	1.07	Supercritical	45.40	0.00	
9A	72.75	7.56	23.32	7.13	21.92	7.70	1.13	Supercritical	39.10	0.00	
9B	71.33	7.41	23.32	7.13	22.18	7.58	1.10	Supercritical	39.10	0.00	
8A	49.60	7.02	22.69	7.22	21.85	7.55	1.08	Supercritical	33.90	0.00	
8B	49.60	7.02	22.69	7.22	21.85	7.55	1.08	Supercritical	33.90	0.00	

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

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft ²)	Comment
1AA	76.80	CIRCULAR	42.00 in	42.00 in	33.00 in	33.00 in	42.00 in	42.00 in	9.62	
1A	76.80	CIRCULAR	42.00 in	42.00 in	33.00 in	33.00 in	42.00 in	42.00 in	9.62	
1B	76.80	CIRCULAR	42.00 in	42.00 in	42.00 in	42.00 in	42.00 in	42.00 in	9.62	
1C	76.80	CIRCULAR	42.00 in	42.00 in	42.00 in	42.00 in	42.00 in	42.00 in	9.62	

P4B	70.20	CIRCULAR	42.00 in	42.00 in	42.00 in	42.00 in	42.00 in	42.00 in	9.62	
P4A	70.20	CIRCULAR	42.00 in	42.00 in	33.00 in	33.00 in	42.00 in	42.00 in	9.62	
12	106.80	CIRCULAR	60.00 in	60.00 in	54.00 in	54.00 in	60.00 in	60.00 in	19.63	
4	104.00	CIRCULAR	60.00 in	60.00 in	54.00 in	54.00 in	60.00 in	60.00 in	19.63	
3	33.60	CIRCULAR	30.00 in	30.00 in	21.00 in	21.00 in	30.00 in	30.00 in	4.91	
2A	14.60	CIRCULAR	24.00 in	24.00 in	21.00 in	21.00 in	24.00 in	24.00 in	3.14	
2B	14.60	CIRCULAR	24.00 in	24.00 in	21.00 in	21.00 in	24.00 in	24.00 in	3.14	
2C	14.60	CIRCULAR	24.00 in	24.00 in	18.00 in	18.00 in	24.00 in	24.00 in	3.14	
7	76.20	CIRCULAR	48.00 in	48.00 in	48.00 in	48.00 in	48.00 in	48.00 in	12.57	
6	36.50	CIRCULAR	30.00 in	30.00 in	24.00 in	24.00 in	30.00 in	30.00 in	4.91	
5A	15.50	CIRCULAR	24.00 in	24.00 in	21.00 in	21.00 in	24.00 in	24.00 in	3.14	
5B	15.50	CIRCULAR	24.00 in	24.00 in	24.00 in	24.00 in	24.00 in	24.00 in	3.14	
11	46.70	CIRCULAR	42.00 in	42.00 in	36.00 in	36.00 in	42.00 in	42.00 in	9.62	
10	45.40	CIRCULAR	42.00 in	42.00 in	36.00 in	36.00 in	42.00 in	42.00 in	9.62	
9A	39.10	CIRCULAR	42.00 in	42.00 in	36.00 in	36.00 in	42.00 in	42.00 in	9.62	
9B	39.10	CIRCULAR	42.00 in	42.00 in	36.00 in	36.00 in	42.00 in	42.00 in	9.62	
8A	33.90	CIRCULAR	36.00 in	36.00 in	33.00 in	33.00 in	36.00 in	36.00 in	7.07	
8B	33.90	CIRCULAR	36.00 in	36.00 in	33.00 in	33.00 in	36.00 in	36.00 in	7.07	

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

Grade Line Summary:

Tailwater Elevation (ft): 5690.50

Element Name	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)
1AA	5686.50	5691.56	0.00	0.00	5690.50	5694.30	5691.49	4.21	5695.70
1A	5694.78	5696.48	0.05	0.00	5696.68	5699.22	5699.89	0.73	5700.62
1B	5702.47	5703.55	0.99	0.00	5704.75	5706.29	5706.83	0.86	5707.69
1C	5703.80	5704.75	0.76	0.00	5707.47	5707.49	5708.45	0.44	5708.89
P4B	5705.00	5705.80	0.04	0.00	5707.85	5708.62	5708.93	0.80	5709.73
P4A	5706.05	5708.59	0.83	0.00	5709.45	5711.22	5710.97	1.53	5712.49
12	5685.50	5686.16	0.00	0.00	5691.49	5691.71	5691.95	0.22	5692.17
4	5686.41	5686.95	0.25	0.00	5691.98	5692.15	5692.42	0.17	5692.59
3	5691.50	5696.78	0.04	0.00	5692.52	5698.75	5697.48	2.29	5699.77
2A	5697.04	5703.93	0.02	0.00	5699.45	5705.31	5699.79	6.14	5705.93
2B	5704.18	5706.76	0.02	0.00	5705.32	5708.14	5706.54	2.22	5708.76

2C	5707.01	5709.22	0.12	0.00	5708.26	5710.60	5709.83	1.38	5711.22
7	5688.45	5689.67	0.57	0.00	5692.72	5692.86	5693.30	0.35	5693.64
6	5691.17	5693.86	0.86	0.00	5693.72	5695.91	5694.53	2.49	5697.02
5A	5694.34	5700.57	0.02	0.00	5696.67	5701.99	5697.04	5.60	5702.65
5B	5700.82	5703.45	0.02	0.00	5702.24	5704.87	5702.90	2.63	5705.53
11	5690.17	5690.93	0.02	0.00	5693.24	5693.24	5693.66	0.32	5693.99
10	5691.18	5691.58	0.02	0.00	5693.26	5693.68	5694.17	0.39	5694.56
9A	5691.83	5691.92	0.08	0.00	5693.76	5693.86	5694.64	0.01	5694.65
9B	5691.92	5692.38	0.03	0.00	5694.04	5694.32	5694.68	0.43	5695.11
8A	5692.88	5695.13	0.02	0.00	5694.70	5697.02	5695.59	2.24	5697.83
8B	5695.38	5697.87	0.02	0.00	5697.21	5699.76	5698.09	2.48	5700.57

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

Excavation Estimate:

The trench side slope is 1.0 ft/ft

The minimum trench width is 2.00 ft

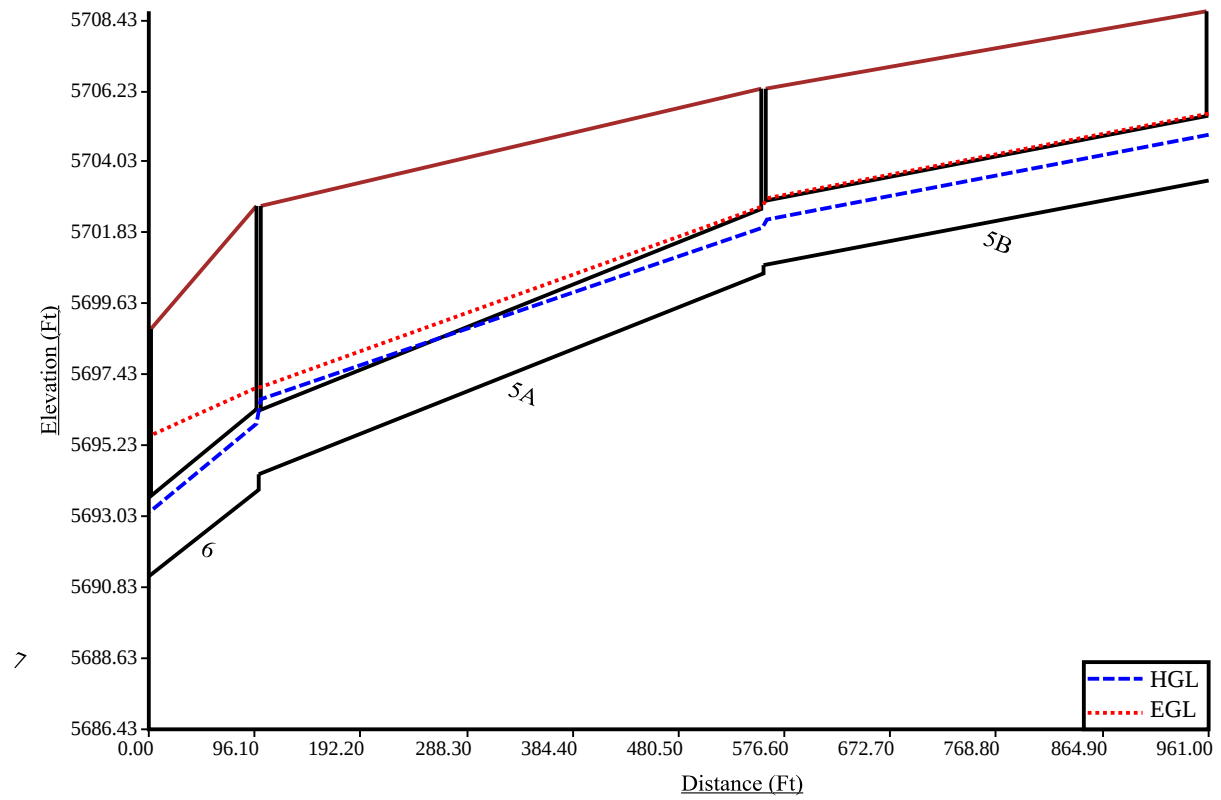
					Downstream			Upstream				
Element Name	Length (ft)	Wall (in)	Bedding (in)	Bottom Width (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Volume (cu. yd)	Comment
1AA	168.67	4.50	6.00	7.25	10.12	7.19	2.44	17.68	10.97	6.22	502.40	
1A	55.24	4.50	6.00	7.25	11.24	7.75	3.00	26.90	15.58	10.83	275.77	
1B	106.85	4.50	6.00	7.25	14.92	9.58	4.83	19.22	11.74	6.99	405.80	
1C	94.58	4.50	6.00	7.25	18.71	11.48	6.73	16.38	10.32	5.57	370.79	
P4B	160.58	4.50	6.00	7.25	15.89	10.07	5.32	14.16	9.21	4.46	506.45	
P4A	141.16	4.50	6.00	7.25	13.66	8.96	4.21	17.36	10.81	6.06	468.17	
12	132.82	6.00	8.00	9.00	10.63	8.48	1.81	9.30	7.82	1.15	362.46	Sewer Too Shallow
4	107.02	6.00	8.00	9.00	0.00	7.56	0.90	24.80	15.57	8.90	520.26	Sewer Too Shallow
3	96.06	3.50	6.00	6.08	18.21	10.64	7.06	10.26	6.67	3.09	260.51	
2A	496.00	3.00	4.00	5.50	10.25	6.21	3.37	10.00	6.08	3.25	719.21	
2B	151.04	3.00	4.00	5.50	9.51	5.84	3.00	10.00	6.08	3.25	208.74	
2C	80.02	3.00	4.00	5.50	9.50	5.83	3.00	8.34	5.25	2.42	99.25	
7	243.84	5.00	6.00	7.83	22.80	13.82	8.48	15.36	10.10	4.76	1162.60	
6	99.58	3.50	6.00	6.08	13.86	8.47	4.89	16.10	9.59	6.01	276.74	
5A	458.00	3.00	4.00	5.50	15.64	8.90	6.07	10.46	6.31	3.48	979.85	
5B	403.87	3.00	4.00	5.50	9.95	6.06	3.23	9.50	5.83	3.00	556.12	
11	152.10	4.50	6.00	7.25	14.86	9.56	4.81	10.20	7.23	2.48	389.59	
10	79.98	4.50	6.00	7.25	9.70	6.97	2.22	11.40	7.83	3.08	167.52	

9A	17.37	4.50	6.00	7.25	10.90	7.58	2.83	10.96	7.61	2.86	37.58	
9B	92.28	4.50	6.00	7.25	10.96	7.61	2.86	12.24	8.25	3.50	212.92	
8A	408.50	4.00	6.00	6.67	11.73	7.70	3.53	16.16	9.91	5.75	1107.28	
8B	451.83	4.00	6.00	6.67	15.65	9.66	5.49	10.68	7.17	3.01	1141.41	

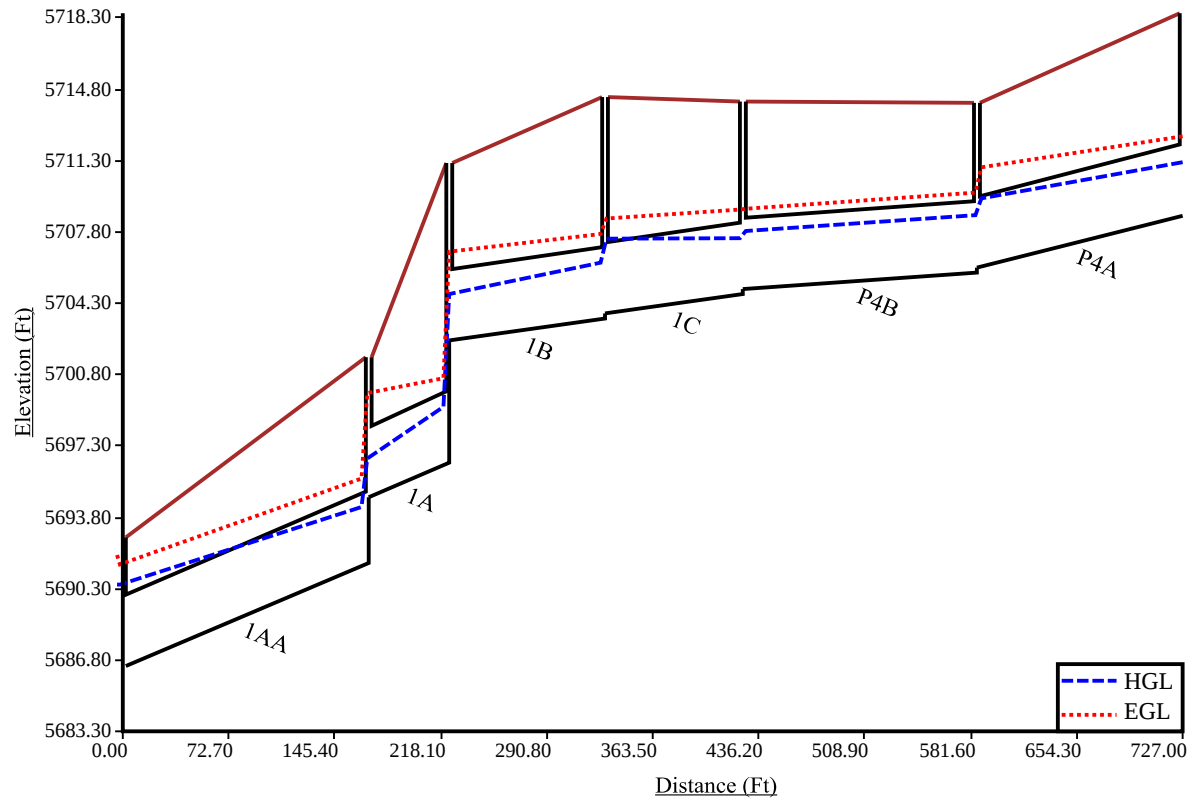
Total earth volume for sewer trenches = 10731 cubic yards.

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

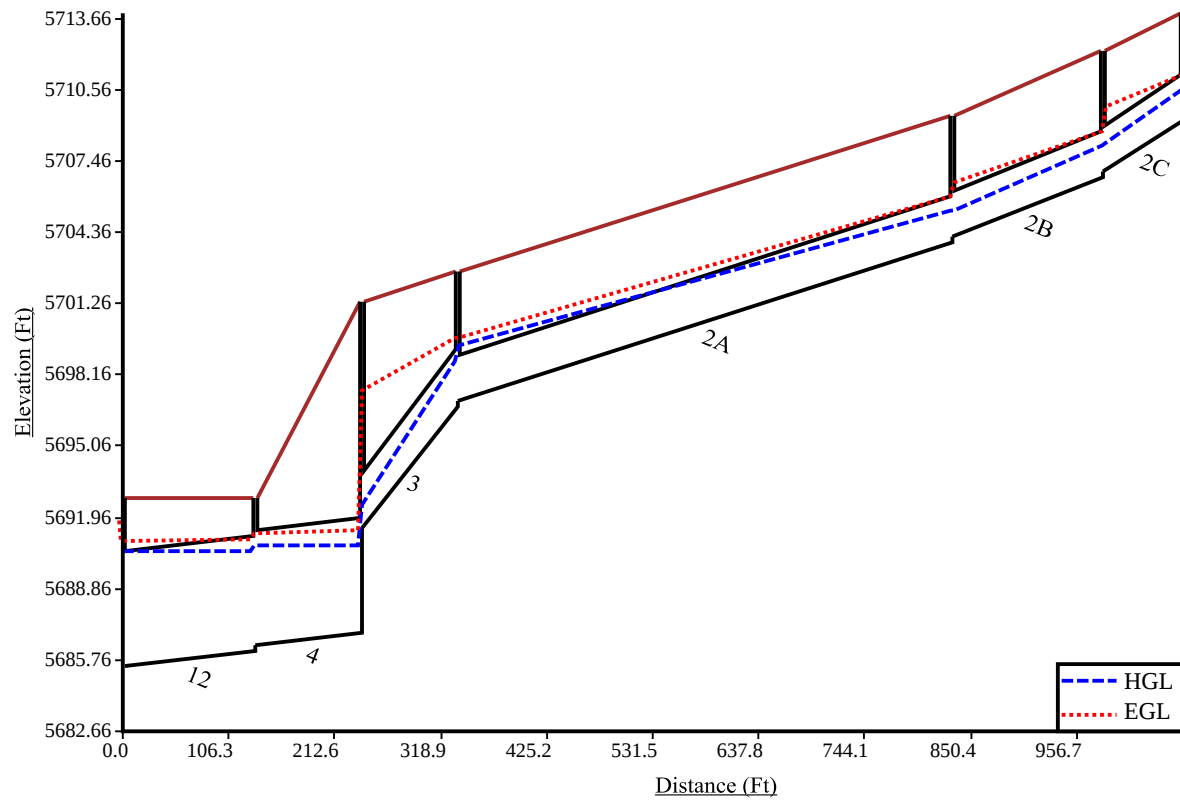
CENTRAL



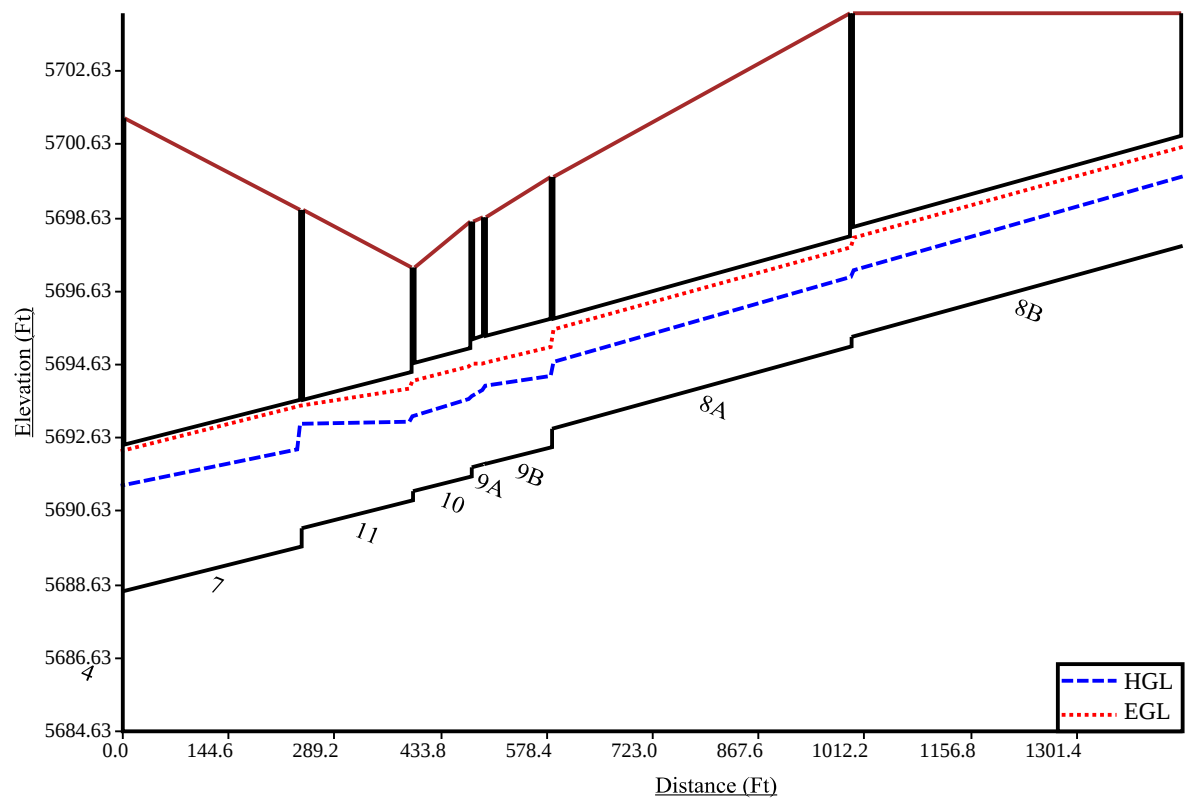
EAST



OUTFALL



WEST





321 W. HENRIETTA SUITE 'A'
PO BOX 221
WOODLAND PARK, CO 80863
(719) 426-2124

JOB RIVERBED

SHEET NO. _____ OF _____

CALCULATED BY DLM DATE _____

CHECKED BY _____ DATE _____

SCALE _____

DP-12 TYPE VI STILLING BASIN

$$A - \text{AREA OF FLOW} = 10.97 \text{ FT}^2$$

$$D = (A)^{0.5} = 3.31 \text{ FT}$$

$$V = 9.75 \text{ FT/S}$$

$$W = 2.94 \cdot D \left[\frac{V}{(g \cdot D)^{0.5}} \right]^{0.556} = 9.42 \text{ FT} \checkmark$$

USE $W = 10.0 \text{ FT}$

FIGURE 42

"HYDRAULIC DESIGN OF
STILLING BASINS AND
ENERGY DISSIPATORS"

$$H = \frac{3}{4} W = 7.5 \text{ FT}$$

$$L = \frac{4}{3} W = 13.33 \text{ FT}$$

$$a = \frac{1}{2} W = 5.0 \text{ FT}$$

$$b = \frac{3}{8} W = 3.75 \text{ FT}$$

$$c = \frac{1}{2} W = 5.0 \text{ FT}$$

$$d = \frac{1}{6} W = 1.67 \text{ FT}$$

$$e = \frac{1}{12} W = 0.833 \text{ FT}$$

$$f = \frac{1}{8} W = 1.25 \text{ FT}$$

$$t = \frac{1}{12} W = 0.833 \text{ FT} \rightarrow \text{USE } 1.0' \text{ MIN}$$

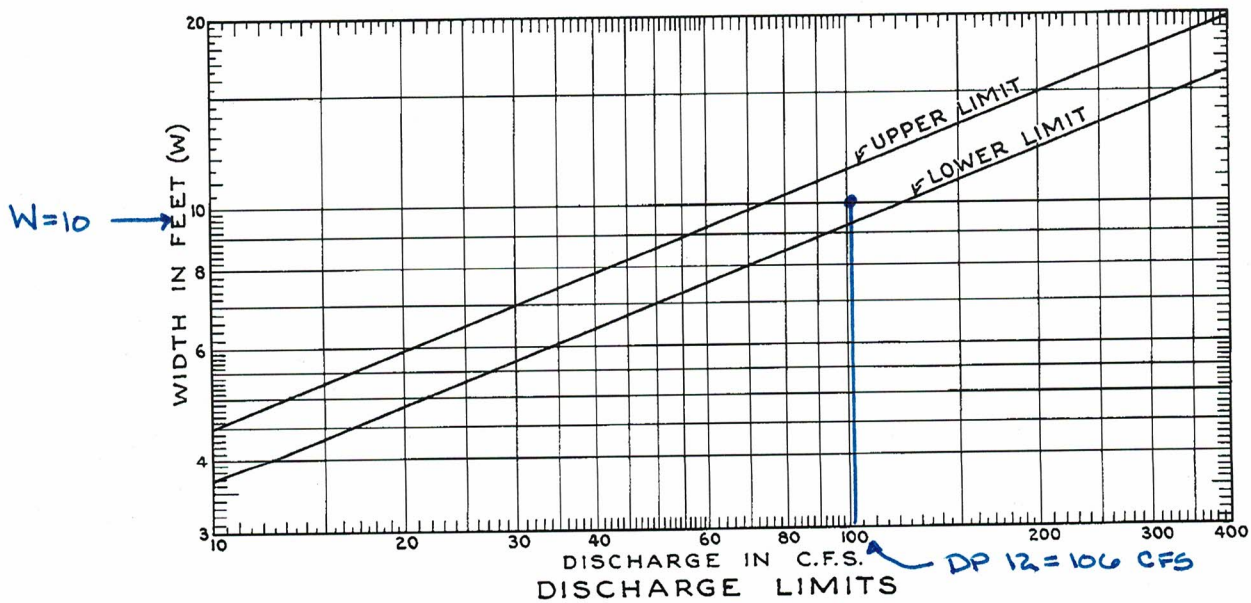
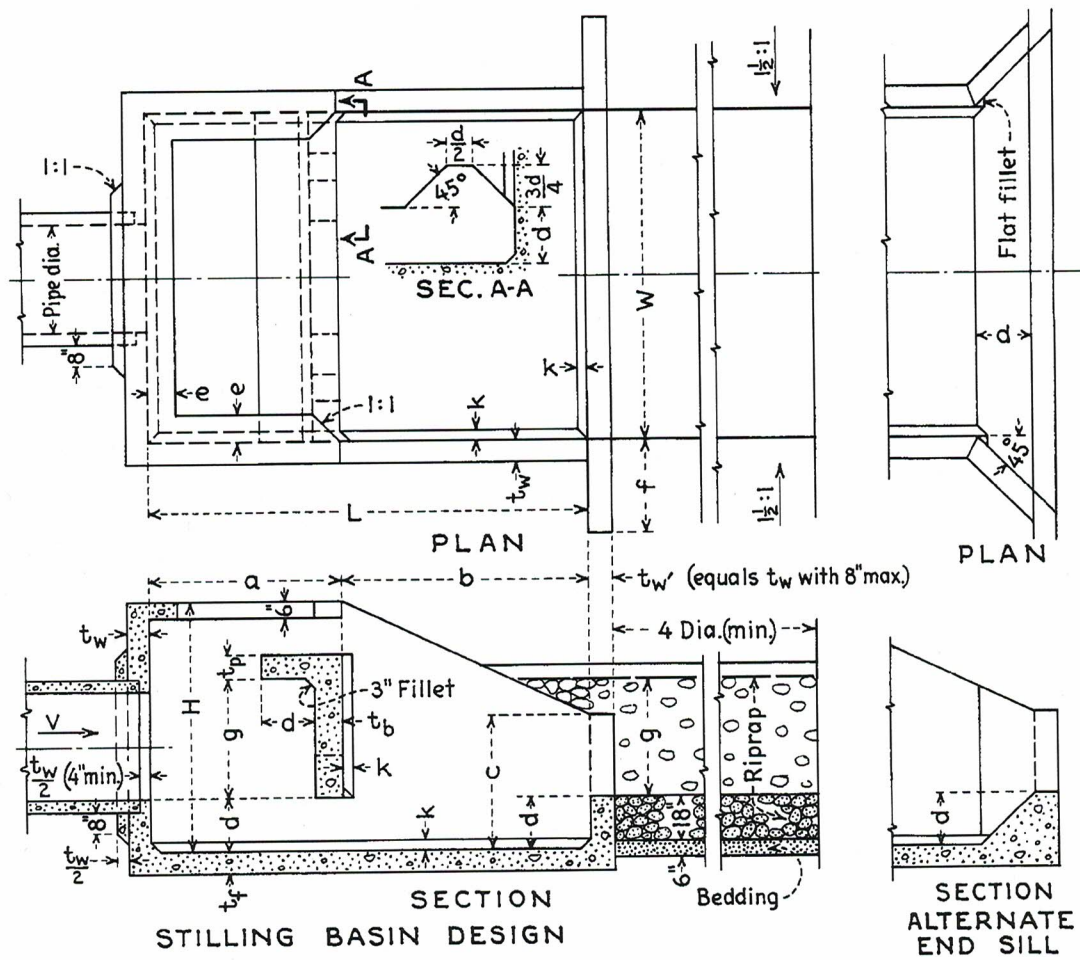


FIGURE 42.—Impact-type energy dissipator (Basin VI).

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.06, November 2016)

Sheet 1 of 4

Designer: David Mijares
Company: Catamount
Date: August 17, 2020
Project: Riverbend Crossing
Location: Extended Detention Basin 1

1. Basin Storage Volume

- A) Effective Imperviousness of Tributary Area, I_a
- B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)
- C) Contributing Watershed Area
- D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm
- E) Design Concept
(Select EURV when also designing for flood control)
- F) Design Volume (WQCV) Based on 40-hour Drain Time
($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * \text{Area})$)
- G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume
($V_{WQCV \text{ OTHER}} = (d_6 * (V_{DESIGN} / 0.43))$)
- H) User Input of Water Quality Capture Volume (WQCV) Design Volume
(Only if a different WQCV Design Volume is desired)
- I) Predominant Watershed NRCS Soil Group
- J) Excess Urban Runoff Volume (EURV) Design Volume
 For HSG A: $EURV_A = 1.68 * i^{1.28}$
 For HSG B: $EURV_B = 1.36 * i^{1.08}$
 For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$

$I_a = 65.4$ %

$i = 0.654$

Area = 54.900 ac

$d_6 =$ in

Choose One

- ☐ Water Quality Capture Volume (WQCV)
☒ Excess Urban Runoff Volume (EURV)

$V_{DESIGN} = 1.170$ ac-ft

$V_{DESIGN \text{ OTHER}} =$ ac-ft

$V_{DESIGN \text{ USER}} =$ ac-ft

Choose One

- ☐ A
☐ B
☒ C / D

EURV = 3.471 ac-ft

2. Basin Shape: Length to Width Ratio

(A basin length to width ratio of at least 2:1 will improve TSS reduction.)

L : W = 4.0 : 1

3. Basin Side Slopes

- A) Basin Maximum Side Slopes
(Horizontal distance per unit vertical, 4:1 or flatter preferred)

Z = 4.00 ft / ft

4. Inlet

- A) Describe means of providing energy dissipation at concentrated inflow locations:

Concrete Forebay with Pipe outfalls and Energy Baffle per Urban Drainage Criteria

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.06, November 2016)

Sheet 1 of 4

Designer: David Mijares
Company: Catamount
Date: October 25, 2020
Project: Riverbend Crossing
Location: Extended Detention Basin 1 FOREBAY A

1. Basin Storage Volume

- A) Effective Imperviousness of Tributary Area, I_a
- B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)
- C) Contributing Watershed Area
- D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm
- E) Design Concept
(Select EURV when also designing for flood control)
- F) Design Volume (WQCV) Based on 40-hour Drain Time
($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i)) / 12 * \text{Area}$)
- G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume
($V_{WQCV \text{ OTHER}} = (d_6 * (V_{DESIGN} / 0.43))$)
- H) User Input of Water Quality Capture Volume (WQCV) Design Volume
(Only if a different WQCV Design Volume is desired)
- I) Predominant Watershed NRCS Soil Group
- J) Excess Urban Runoff Volume (EURV) Design Volume
 For HSG A: $EURV_A = 1.68 * i^{1.28}$
 For HSG B: $EURV_B = 1.36 * i^{1.08}$
 For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$

$I_a = 65.4$ %

$i = 0.654$

Area = 35.140 ac

$d_6 =$ in

Choose One

- ☐ Water Quality Capture Volume (WQCV)
☒ Excess Urban Runoff Volume (EURV)

$V_{DESIGN} = 0.749$ ac-ft

$V_{DESIGN \text{ OTHER}} =$ ac-ft

$V_{DESIGN \text{ USER}} =$ ac-ft

Choose One

- ☐ A
☐ B
☒ C / D

EURV = 2.221 ac-ft

2. Basin Shape: Length to Width Ratio

(A basin length to width ratio of at least 2:1 will improve TSS reduction.)

L : W = 4.0 : 1

3. Basin Side Slopes

- A) Basin Maximum Side Slopes
(Horizontal distance per unit vertical, 4:1 or flatter preferred)

Z = 4.00 ft / ft

4. Inlet

- A) Describe means of providing energy dissipation at concentrated inflow locations:

Concrete Forebay with Pipe outfalls and Energy Baffle per Urban Drainage Criteria

Design Procedure Form: Extended Detention Basin (EDB)

Sheet 2 of 4

Designer: David Mijares
Company: Catamount
Date: October 25, 2020
Project: Riverbend Crossing
Location: Extended Detention Basin 1 FOREBAY A

5. Forebay

A) Minimum Forebay Volume
($V_{FMIN} = 3\%$ of the WQCV)

$V_{FMIN} = 0.022$ ac-ft

B) Actual Forebay Volume

$V_F = 0.023$ ac-ft

C) Forebay Depth
($D_F = 30$ inch maximum)

$D_F = 30.0$ in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge

$Q_{100} = 106.80$ cfs

ii) Forebay Discharge Design Flow
($Q_F = 0.02 * Q_{100}$)

$Q_F = 2.14$ cfs

E) Forebay Discharge Design

Choose One

☐ Berm With Pipe
☒ Wall with Rect. Notch
☐ Wall with V-Notch Weir

F) Discharge Pipe Size (minimum 8-inches)

Calculated $D_p =$ in

G) Rectangular Notch Width

Calculated $W_N = 7.9$ in

6. Trickle Channel

A) Type of Trickle Channel

Choose One

☒ Concrete
☐ Soft Bottom

F) Slope of Trickle Channel

$S =$ ft / ft

7. Micropool and Outlet Structure

A) Depth of Micropool (2.5-feet minimum)

$D_M = 2.5$ ft

B) Surface Area of Micropool (10 ft² minimum)

$A_M = 153$ sq ft

C) Outlet Type

Choose One

☒ Orifice Plate
☐ Other (Describe):

D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing
(Use UD-Detention)

$D_{orifice} = 1.69$ inches

E) Total Outlet Area

$A_{ot} = 6.77$ square inches

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.06, November 2016)

Sheet 1 of 4

Designer: David Mijares
Company: Catamount
Date: October 25, 2020
Project: Riverbend Crossing
Location: Extended Detention Basin 1 FOREBAY B

1. Basin Storage Volume

- A) Effective Imperviousness of Tributary Area, I_a
- B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)
- C) Contributing Watershed Area
- D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm
- E) Design Concept
(Select EURV when also designing for flood control)
- F) Design Volume (WQCV) Based on 40-hour Drain Time
($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i)) / 12 * \text{Area}$)
- G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume
($V_{WQCV \text{ OTHER}} = (d_6 * (V_{DESIGN} / 0.43))$)
- H) User Input of Water Quality Capture Volume (WQCV) Design Volume
(Only if a different WQCV Design Volume is desired)
- I) Predominant Watershed NRCS Soil Group
- J) Excess Urban Runoff Volume (EURV) Design Volume
 For HSG A: $EURV_A = 1.68 * i^{1.28}$
 For HSG B: $EURV_B = 1.36 * i^{1.08}$
 For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$

$I_a = 65.4$ %

$i = 0.654$

Area = 15.410 ac

$d_6 =$ in

Choose One

- ☐ Water Quality Capture Volume (WQCV)
☒ Excess Urban Runoff Volume (EURV)

$V_{DESIGN} = 0.328$ ac-ft

$V_{DESIGN \text{ OTHER}} =$ ac-ft

$V_{DESIGN \text{ USER}} =$ ac-ft

Choose One

- ☐ A
☐ B
☒ C / D

EURV = 0.974 ac-ft

2. Basin Shape: Length to Width Ratio

(A basin length to width ratio of at least 2:1 will improve TSS reduction.)

L : W = 4.0 : 1

3. Basin Side Slopes

- A) Basin Maximum Side Slopes
(Horizontal distance per unit vertical, 4:1 or flatter preferred)

Z = 4.00 ft / ft

4. Inlet

- A) Describe means of providing energy dissipation at concentrated inflow locations:

Concrete Forebay with Pipe outfalls and Energy Baffle per Urban Drainage Criteria

Design Procedure Form: Extended Detention Basin (EDB)

Sheet 2 of 4

Designer: David Mijares
Company: Catamount
Date: October 25, 2020
Project: Riverbend Crossing
Location: Extended Detention Basin 1 FOREBAY B

5. Forebay

A) Minimum Forebay Volume
($V_{FMIN} = 3\%$ of the WQCV)

$V_{FMIN} = 0.010$ ac-ft

B) Actual Forebay Volume

$V_F = 0.010$ ac-ft

C) Forebay Depth
($D_F = 18$ inch maximum)

$D_F = 18.0$ in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge

$Q_{100} = 76.80$ cfs

ii) Forebay Discharge Design Flow
($Q_F = 0.02 * Q_{100}$)

$Q_F = 1.54$ cfs

E) Forebay Discharge Design

Choose One

☐ Berm With Pipe
☒ Wall with Rect. Notch
☐ Wall with V-Notch Weir

(flow too small for berm w/ pipe)

F) Discharge Pipe Size (minimum 8-inches)

Calculated $D_p =$ in

G) Rectangular Notch Width

Calculated $W_N = 6.6$ in

6. Trickle Channel

A) Type of Trickle Channel

Choose One

☒ Concrete
☐ Soft Bottom

F) Slope of Trickle Channel

$S =$ ft / ft

7. Micropool and Outlet Structure

A) Depth of Micropool (2.5-feet minimum)

$D_M = 2.5$ ft

B) Surface Area of Micropool (10 ft² minimum)

$A_M = 153$ sq ft

C) Outlet Type

Choose One

☒ Orifice Plate
☐ Other (Describe):

D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing
(Use UD-Detention)

$D_{orifice} = 1.69$ inches

E) Total Outlet Area

$A_{ot} = 6.77$ square inches

Design Procedure Form: Extended Detention Basin (EDB)

Sheet 3 of 4

Designer: David Mijares
 Company: Catamount
 Date: August 17, 2020
 Project: Riverbend Crossing
 Location: Extended Detention Basin 1

8. Initial Surge Volume

- A) Depth of Initial Surge Volume
(Minimum recommended depth is 4 inches)
- B) Minimum Initial Surge Volume
(Minimum volume of 0.3% of the WQCV)
- C) Initial Surge Provided Above Micropool

$D_{IS} =$ 12 in

$V_{IS} =$ 152.9 cu ft

$V_s =$ 153.0 cu ft

9. Trash Rack

- A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5 * (e^{-0.095D})$
- B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open area to the total screen area for the material specified.)

Other (Y/N): N

C) Ratio of Total Open Area to Total Area (only for type 'Other')

D) Total Water Quality Screen Area (based on screen type)

E) Depth of Design Volume (EURV or WQCV)
(Based on design concept chosen under 1E)

F) Height of Water Quality Screen (H_{TR})

G) Width of Water Quality Screen Opening ($W_{opening}$)
(Minimum of 12 inches is recommended)

$A_t =$ 222 square inches

Aluminum Amico-Klemp SR Series with Cross Rods 2" O.C.

User Ratio =

$A_{total} =$ 313 sq. in.

$H =$ _____ feet

$H_{TR} =$ _____ inches

$W_{opening} =$ _____ inches

Design Procedure Form: Extended Detention Basin (EDB)

Sheet 4 of 4

Designer: David Mijares
Company: Catamount
Date: August 17, 2020
Project: Riverbend Crossing
Location: Extended Detention Basin 1

10. Overflow Embankment

A) Describe embankment protection for 100-year and greater overtopping:

2.0' depth Type H soil riprap to channel toe

B) Slope of Overflow Embankment
(Horizontal distance per unit vertical, 4:1 or flatter preferred)

2.5:1 existing bank

11. Vegetation

Choose One

☐ Irrigated

☒ Not Irrigated

12. Access

A) Describe Sediment Removal Procedures

12' width access road. See IM Plan for sediment removal procedures.

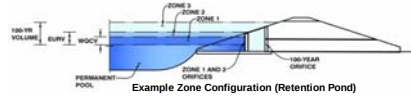
Notes:

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: RIVERBEND CROSSING

Basin ID: EXTENDED DETENTION BASIN



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type	EDB	
Watershed Area	54.90	acres
Watershed Length	1.921	ft
Watershed Slope	0.027	ft/ft
Watershed Imperviousness	65.40%	percent
Percentage Hydrologic Soil Group A	24.3%	percent
Percentage Hydrologic Soil Group B	0.0%	percent
Percentage Hydrologic Soil Groups C/D	75.7%	percent
Desired WQCV Drain Time	40.0	hours
Location for 1-hr Rainfall Depths = Denver - Capitol Building		
Water Quality Capture Volume (WQCV) =	1.375	acre-feet
Excess Urban Runoff Volume =	3.712	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	1.250	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	1.504	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	1.530	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	1.692	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	1.898	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	1.969	acre-feet
500-yr Runoff Volume (P1 = 3.34 in.) =	12.843	acre-feet
Approximate 2-yr Detention Volume =	3.058	acre-feet
Approximate 5-yr Detention Volume =	4.247	acre-feet
Approximate 10-yr Detention Volume =	4.914	acre-feet
Approximate 25-yr Detention Volume =	5.393	acre-feet
Approximate 50-yr Detention Volume =	5.647	acre-feet
Approximate 100-yr Detention Volume =	6.169	acre-feet

Water Quality Capture Volume (WQCV) =	1.170	acre-feet	Optional User Override 1-hr Precipitation
Excess Urban Runoff Volume (EURV) =	3.712	acre-feet	
2-yr Runoff Volume (P1 = 1.19 in.) =	3.254	acre-feet	1.19 inches
5-yr Runoff Volume (P1 = 1.5 in.) =	4.504	acre-feet	1.50 inches
10-yr Runoff Volume (P1 = 1.75 in.) =	5.530	acre-feet	1.75 inches
25-yr Runoff Volume (P1 = 2 in.) =	6.972	acre-feet	2.00 inches
50-yr Runoff Volume (P1 = 2.25 in.) =	8.198	acre-feet	2.25 inches
100-yr Runoff Volume (P1 = 2.52 in.) =	9.691	acre-feet	2.52 inches
500-yr Runoff Volume (P1 = 3.44 in.) =	12.843	acre-feet	inches

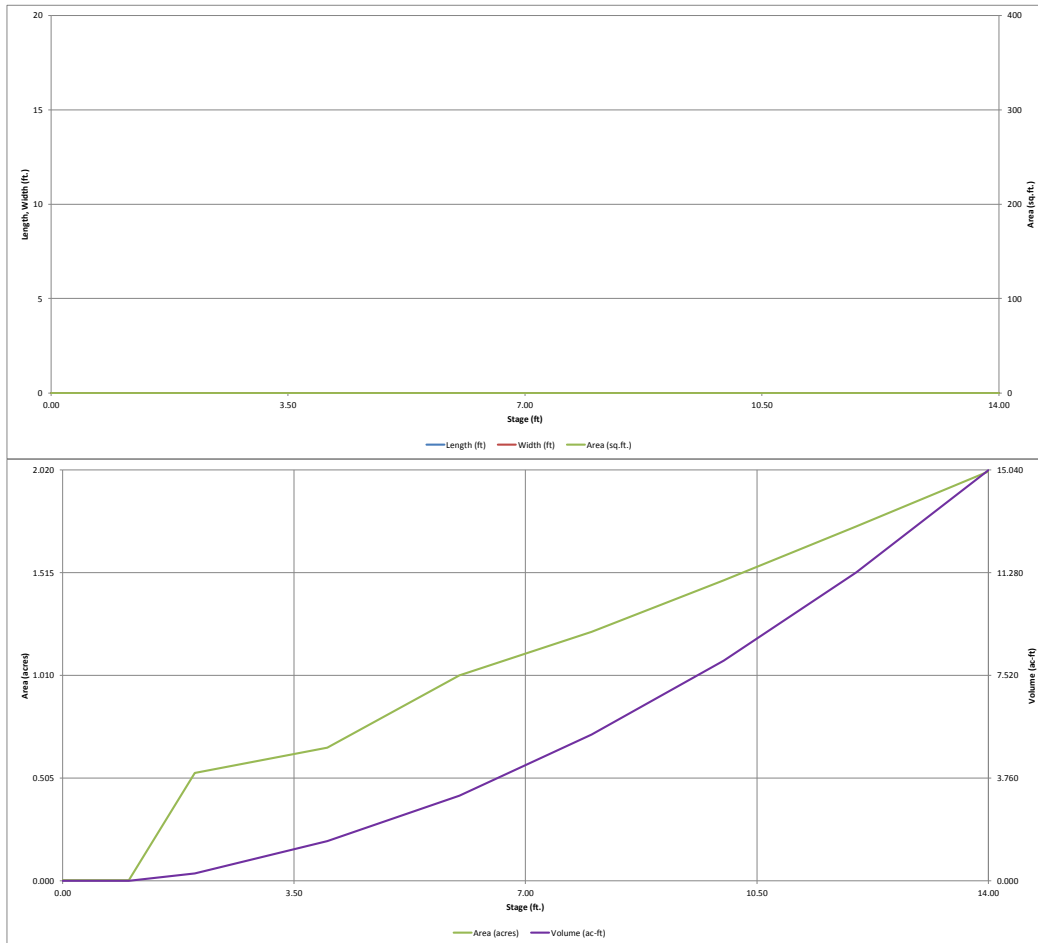
Stage-Storage Calculation

Zone 1 Volume (W_{QVC})	1.170	acre-feet
Zone 2 Volume (E_{URV} - Zone 1)	2.542	acre-feet
Zone 3 Volume (100 Year - Zones 1 & 2)	2.458	acre-feet
Total Detention Basin Volume	6.169	acre-feet
Initial Surge Volume (ISV)	user	ft ³
Initial Surge Depth (ISD)	user	ft
Total Available Storage Depth (H_{ASD})	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_{MBin})	user	ft/ft
Basin Length-to-Width Ratio (R_{MBin})	user	
Initial Surge Area (A_{ISV})	user	ft ²
Surcharge Volume Length (L_{SV})	user	ft
Surcharge Volume Width (W_{SV})	user	ft
Depth of Basin Floor ($H_{f,100yr}$)	user	ft
Length of Basin Floor ($L_{f,100yr}$)	user	ft
Width of Basin Floor ($W_{f,100yr}$)	user	ft
Area of Basin Floor ($A_{f,100yr}$)	user	ft ²
Volume of Basin Floor ($V_{f,100yr}$)	user	ft ³
Depth of Main Basin (H_{MBin})	user	ft
Length of Main Basin (L_{MBin})	user	ft
Width of Main Basin (W_{MBin})	user	ft
Area of Main Basin (A_{MBin})	user	ft ²
Volume of Main Basin (V_{MBin})	user	ft ³
Calculated Total Basin Volume (V_{MBin})	user	acre-feet

[illegible]

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

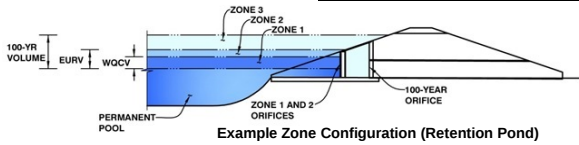
UD-Detention, Version 3.07 (February 2017)



Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: RIVERBEND CROSSING
Basin ID: EXTENDED DETENTION BASIN



	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.56	1.170	Orifice Plate
Zone 2 (EURV)	6.57	2.542	Orifice Plate
Zone 3 (100-year)	8.65	2.458	Weir&Pipe (Restrict)
		6.169	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	2.19	4.38					
Orifice Area (sq. inches)	5.51	5.51	12.00					

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

User Input: Vertical Orifice (Circular or Rectangular)

Invert of Vertical Orifice = ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice = ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter = inches

Calculated Parameters for Vertical Orifice

Vertical Orifice Area = ft²
Vertical Orifice Centroid = feet

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

Overflow Weir Front Edge Height, H_o = ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length = feet
Overflow Weir Slope = H:V (enter zero for flat grate)
Horiz. Length of Weir Sides = feet
Overflow Grate Open Area % = %, grate open area/total area
Debris Clogging % = %

Calculated Parameters for Overflow Weir

Height of Grate Upper Edge, H_t = feet
Over Flow Weir Slope Length = feet
Grate Open Area / 100-yr Orifice Area = should be ≥ 4
Overflow Grate Open Area w/o Debris = ft²
Overflow Grate Open Area w/ Debris = ft²

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

Depth to Invert of Outlet Pipe = ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter = inches
Restrictor Plate Height Above Pipe Invert = inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

Outlet Orifice Area = ft²
Outlet Orifice Centroid = feet
Half-Central Angle of Restrictor Plate on Pipe = 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

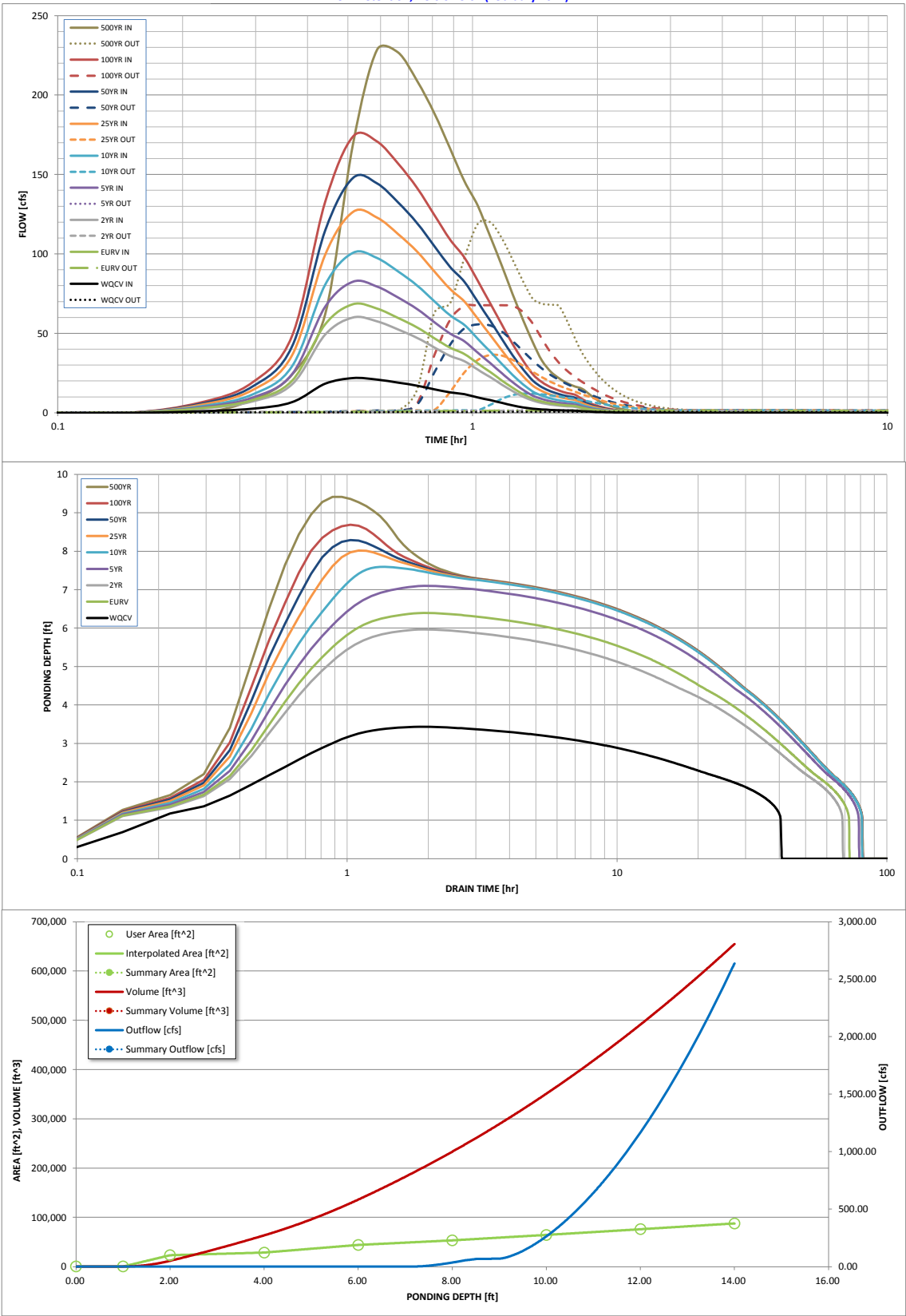
Spillway Design Flow Depth = feet
Stage at Top of Freeboard = feet
Basin Area at Top of Freeboard = acres

Routed Hydrograph Results

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =									
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.14
Calculated Runoff Volume (acre-ft) =	1.170	3.712	3.254	4.504	5.530	6.972	8.198	9.691	12.843
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	1.169	3.707	3.250	4.499	5.516	6.964	8.180	9.671	12.826
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.11	0.30	0.70	0.97	1.32	2.01
Predevelopment Peak Q (cfs) =	0.0	0.0	0.7	6.1	16.7	38.3	53.1	72.3	110.4
Peak Inflow Q (cfs) =	21.8	68.2	60.0	82.5	100.7	126.4	147.8	173.9	228.4
Peak Outflow Q (cfs) =	0.5	1.4	1.3	1.6	12.1	36.4	55.6	67.7	120.0
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.3	0.7	1.0	1.0	0.9	1.1
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.5	1.5	2.4	2.9	3.1
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	67	63	72	72	70	69	67	63
Time to Drain 99% of Inflow Volume (hours) =	40	71	67	76	78	77	77	76	75
Maximum Ponding Depth (ft) =	3.43	6.39	5.96	7.10	7.59	8.01	8.29	8.69	9.42
Area at Maximum Ponding Depth (acres) =	0.62	1.05	1.00	1.13	1.18	1.22	1.26	1.31	1.40
Maximum Volume Stored (acre-ft) =	1.093	3.522	3.080	4.284	4.861	5.365	5.701	6.214	7.204

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)



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

Detention Basin Outlet Structure Design

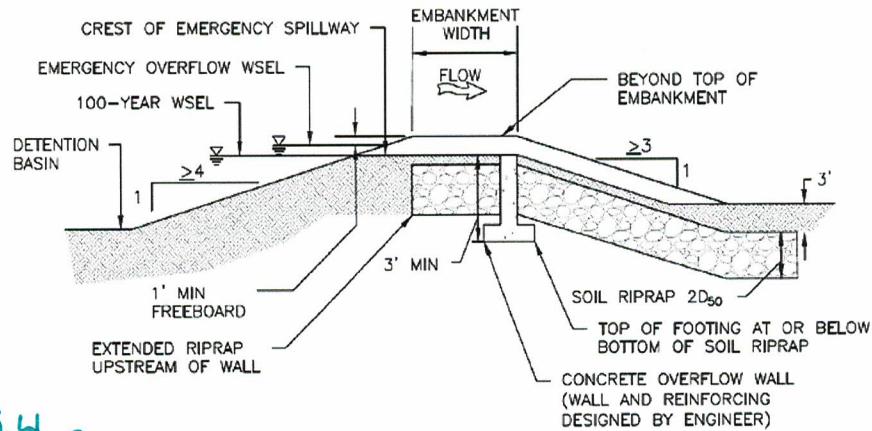
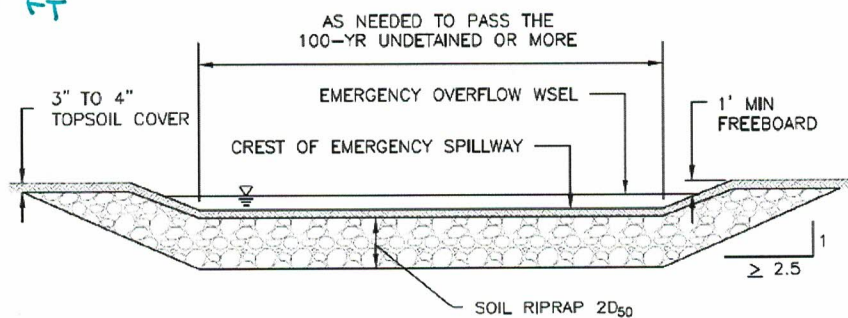
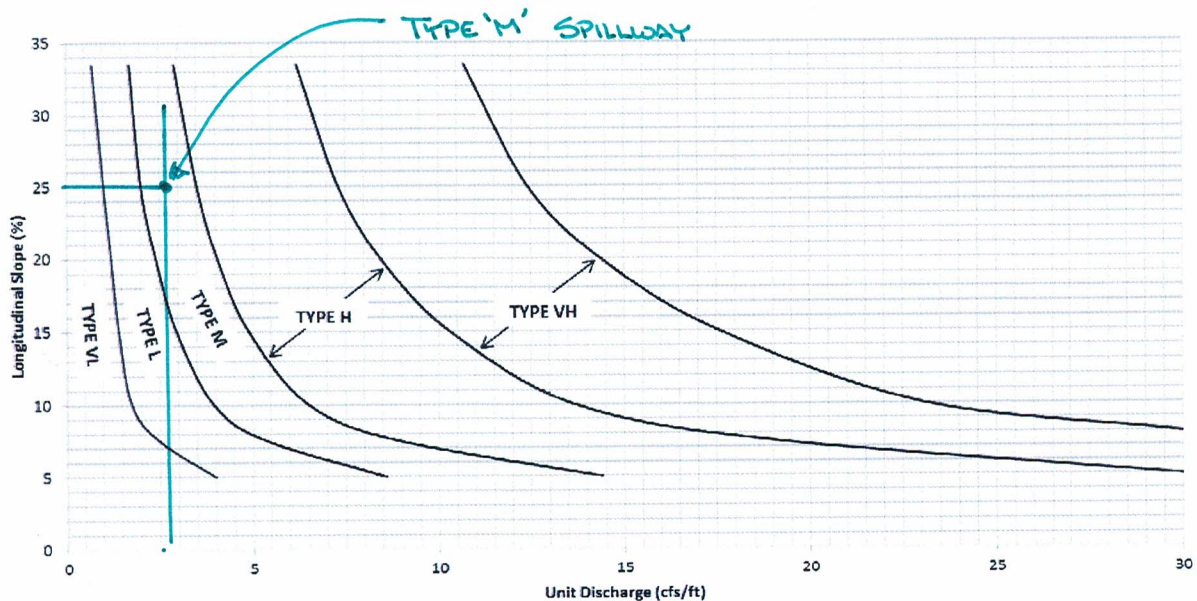
UD-Detention, Version 3.07 (February 2017)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

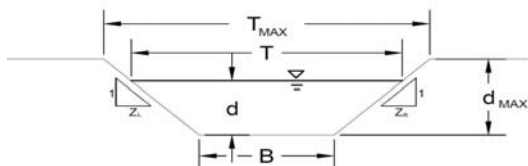
[illegible]

**EMERGENCY SPILLWAY PROFILE****EMERGENCY SPILLWAY SECTION AND SPILLWAY CHANNEL****Figure 12-21. Embankment protection details and rock sizing chart (adapted from Arapahoe County)**

AREA INLET IN A TRAPEZOIDAL GRASS-LINED CHANNEL

Riverbend Crossing

Basin A1



Grass Type	Limiting Manning's n
A	0.06
B	0.04
C	0.033
D	0.03
E	0.024

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

NRCS Vegetal Retardance (A, B, C, D, or E)

Manning's n (Leave cell D16 blank to manually enter an n value)

Channel Invert Slope

Bottom Width

Left Side Slope

Right Side Slope

Check one of the following soil types:

Soil Type:	Max. Velocity (V _{max})	Max Froude No. (F _{max})
Sandy	5.0 fps	0.50
Non-Sandy	7.0 fps	0.80

A, B, C, D or E

n =	0.035
S ₀ =	0.0040 ft/ft
B =	10.00 ft
Z1 =	4.00 ft/ft
Z2 =	4.00 ft/ft

Choose One:

- ☒ Sandy
☐ Non-Sandy

Max. Allowable Top Width of Channel for Minor & Major Storm

Max. Allowable Water Depth in Channel for Minor & Major Storm

	Minor Storm	Major Storm	
T _{MAX} =	22.00	22.00	feet
d _{MAX} =	0.80	1.25	feet

Maximum Channel Capacity Based On Allowable Top Width

Max. Allowable Top Width

Water Depth

Flow Area

Wetted Perimeter

Hydraulic Radius

Manning's n based on NRCS Vegetal Retardance

Flow Velocity

Velocity-Depth Product

Hydraulic Depth

Froude Number

Max. Flow Based On Allowable Top Width

	Minor Storm	Major Storm	
T _{MAX} =	22.00	22.00	ft
d =	1.50	1.50	ft
A =	24.00	24.00	sq ft
P =	22.37	22.37	ft
R =	1.07	1.07	ft
n =	0.035	0.035	
V =	2.82	2.82	fps
VR =	3.03	3.03	ft ² /s
D =	1.09	1.09	ft
Fr =	0.48	0.48	
Q _T =	67.72	67.72	cfs

Maximum Channel Capacity Based On Allowable Water Depth

Max. Allowable Water Depth

Top Width

Flow Area

Wetted Perimeter

Hydraulic Radius

Manning's n based on NRCS Vegetal Retardance

Flow Velocity

Velocity-Depth Product

Hydraulic Depth

Froude Number

Max. Flow Based On Allowable Water Depth

	Minor Storm	Major Storm	
d _{MAX} =	0.80	1.25	feet
T =	16.40	20.00	feet
A =	10.56	18.75	square feet
P =	16.60	20.31	feet
R =	0.64	0.92	feet
n =	0.035	0.035	
V =	1.99	2.55	fps
VR =	1.27	2.36	ft ² /s
D =	0.64	0.94	feet
Fr =	0.44	0.46	
Q _d =	21.03	47.87	cfs

Allowable Channel Capacity Based On Channel Geometry

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm	
Q _{allow} =	21.03	47.87	cfs
d _{allow} =	0.80	1.25	ft

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow

Water Depth

Top Width

Flow Area

Wetted Perimeter

Hydraulic Radius

Manning's n based on NRCS Vegetal Retardance

Flow Velocity

Velocity-Depth Product

Hydraulic Depth

Froude Number

	Minor Storm	Major Storm	
Q _p =	20.28	46.00	cfs
d =	0.78	1.22	feet
T =	16.27	19.79	feet
A =	10.30	18.23	square feet
P =	16.47	20.09	feet
R =	0.63	0.91	feet
n =	0.035	0.035	
V =	1.97	2.52	fps
VR =	1.23	2.29	ft ² /s
D =	0.63	0.92	feet
Fr =	0.44	0.46	

Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

AREA INLET IN A TRAPEZOIDAL GRASS-LINED CHANNEL

Riverbend Crossing

Basin A1

Inlet Design Information (Input)

Type of Inlet

Inlet Type =

Angle of Inclined Grate (must be ≤ 30 degrees)

Width of Grate

Length of Grate

Open Area Ratio

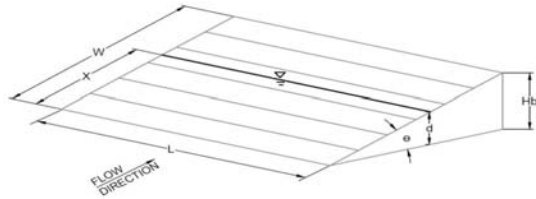
Height of Inclined Grate

Clogging Factor

Grate Discharge Coefficient

Orifice Coefficient

Weir Coefficient



$\theta =$ degrees

$W =$ feet

$L =$ feet

$A_{RATIO} =$

$H_B =$ feet

$C_1 =$

$C_d =$

$C_o =$

$C_w =$

Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)

$d =$

MINOR	MAJOR

Grate Capacity as a Weir

Submerged Side Weir Length

Inclined Side Weir Flow

Base Weir Flow

Interception without Clogging

Interception with Clogging

$X =$ feet

$Q_{ws} =$ cfs

$Q_{wb} =$ cfs

$Q_{wi} =$ cfs

$Q_{wi} =$ cfs

Grate Capacity as an Orifice

Interception without Clogging

Interception with Clogging

$Q_{oi} =$ cfs

$Q_{oi} =$ cfs

Total Inlet Interception Capacity (assumes clogged condition)

$Q_a =$ cfs

Bypassed Flow, $Q_b =$ cfs

Capture Percentage = $Q_a/Q_o = C\%$ %

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD88)			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Fountain Creek (cont.)								
BU	104,500	560	2,948	8.9	5608.6	5608.6	5608.6	0.0
BV	105,500	640	4,060	6.5	5614.2	5614.2	5614.3	0.1
BW	106,524	432	3,160	8.2	5620.0	5620.0	5620.7	0.7
BX	107,580	163	1,609	16.2	5623.9	5623.9	5624.2	0.3
BY	108,824	354	3,684	7.1	5634.6	5634.6	5634.6	0.0
BZ	109,747	430	2,945	8.8	5638.0	5638.0	5638.0	0.0
CA	110,486	241	2,776	9.4	5642.6	5642.6	5642.6	0.0
CB	111,228	384	4,253	6.1	5646.3	5646.3	5646.3	0.0
CC	113,189	340	3,304	7.9	5657.5	5657.5	5657.6	0.1
CD	115,609	169	1,696	15.3	5669.2	5669.2	5669.3	0.1
CE	117,000	461	5,232	5.0	5676.8	5676.8	5677.4	0.6
CF	118,746	350	2,798	9.3	5682.9	5682.9	5682.9	0.0
CG	119,965	700	8,842	2.9	5691.7	5691.7	5692.7	1.0
CH	121,500	837	5,247	5.0	5694.5	5694.5	5694.7	0.2
CI	123,000	1,908	10,866	2.4	5707.2	5707.2	5707.2	0.0
CJ	124,455	960	5,500	4.7	5711.3	5711.3	5711.7	0.4
CK	125,500	627	4,527	5.7	5716.6	5716.6	5716.6	0.0
CL	127,000	935	6,844	3.7	5723.5	5723.5	5723.7	0.2
CM	128,000	735	3,894	6.6	5727.3	5727.3	5727.4	0.1
CN	129,150	807	4,142	6.2	5733.4	5733.4	5733.7	0.3
CO	129,880	966	4,104	6.2	5736.5	5736.5	5736.6	0.1
CP	130,854	405	2,110	12.1	5741.3	5741.3	5741.3	0.0
CQ	131,623	1,299	5,023	5.1	5747.1	5747.1	5747.1	0.0
CR	132,429	703	4,341	5.9	5751.0	5751.0	5751.1	0.1

¹Feet Above El Paso – Pueblo County Line.

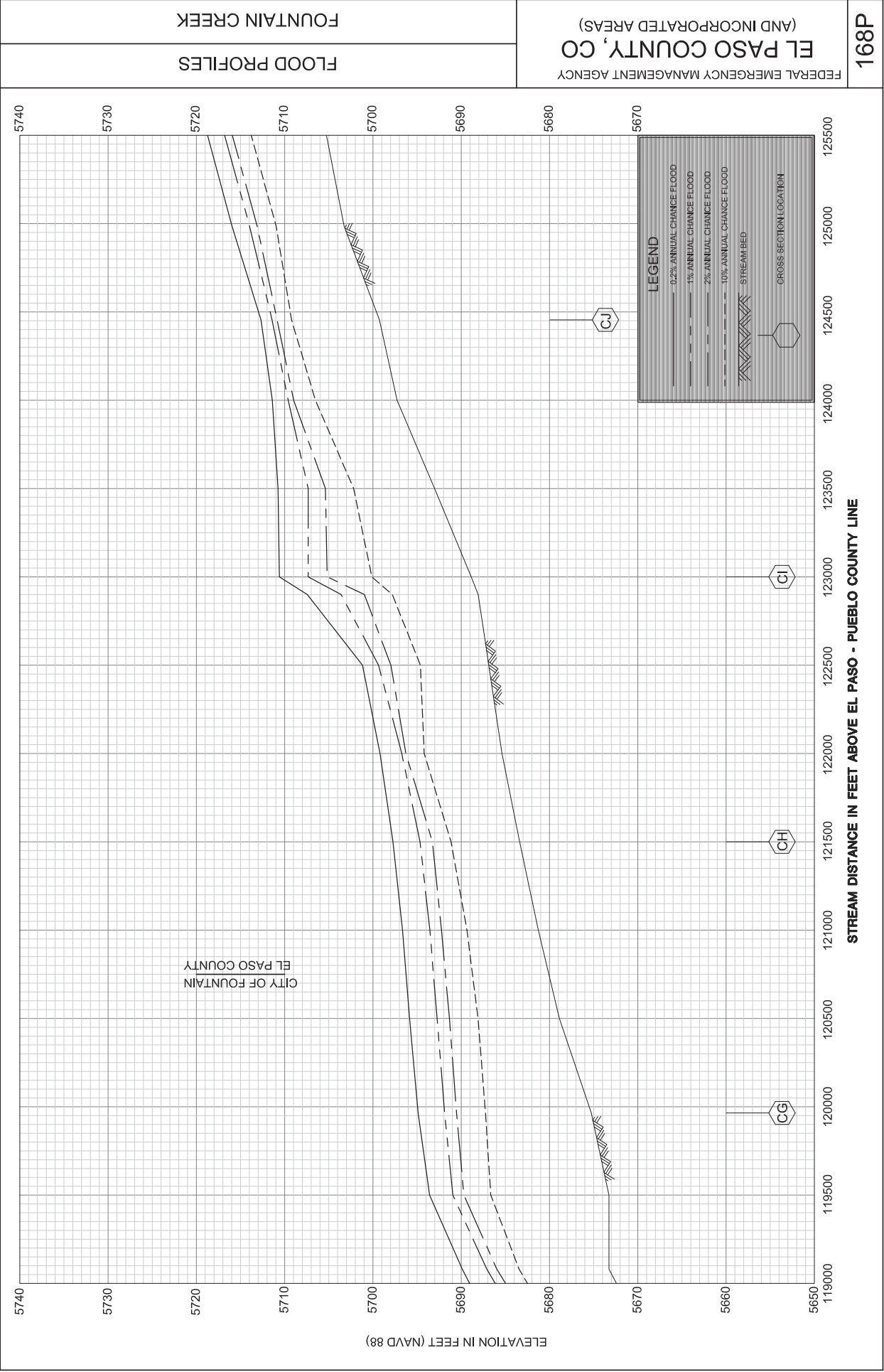
TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

**EL PASO COUNTY, CO
AND INCORPORATED AREAS**

FLOODWAY DATA

FOUNTAIN CREEK



BANK LINING DESIGN CALCULATIONS

11/23/2019

HECRAS INPUT

1. EXISTING CONDITIONS CHANNEL WITH 2.5:1 SIDE SLOPES ALONG PROJECT
2. SUPERCRITICAL FLOW REGIME ASSUMED BASED ON N=0.035 (PER TABLE 8-5)
3. 100YR STORM FLOW FROM FIS MAX AT SECTION "CH" ROUNDED TO 26,300CFS
4. NORMAL DEPTH BOUNDARY CONDITION ASSUMED AT DOWNSTREAM REACH

HECRAS OUTPUT

HEC-RAS Plan: 100YrSuper River: Fountain Creek Reach: Main Stem Profile: PF 1												
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main Stem	1615	PF 1	26300.00	5686.80	5690.50	5690.50	5691.72	0.013669	8.86	2969.15	1248.13	1.01
Main Stem	1225	PF 1	26300.00	5682.40	5686.73	5686.73	5688.55	0.011757	10.85	2436.01	681.43	1.01
Main Stem	800	PF 1	26300.00	5678.60	5682.29	5682.29	5683.72	0.012542	9.60	2744.29	959.93	1.00
Main Stem	375	PF 1	26300.00	5673.90	5678.55	5678.55	5680.70	0.010990	11.82	2243.21	527.70	1.00
Main Stem	0	PF 1	26300.00	5671.00	5677.49	5677.49	5680.71	0.009575	14.46	1843.01	291.72	1.00

RIPRAP DESIGN

UDFCD Volume 1, Chapter 8

$$d_{50} \geq \left[\frac{VS^{0.17}}{4.5(G_s - 1)^{0.66}} \right]^2$$

Equation 8-11

Where:

V = mean channel velocity (ft/sec)

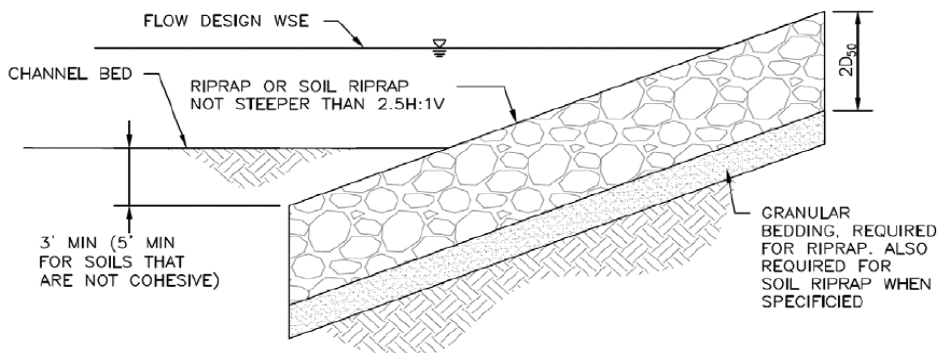
S = longitudinal channel slope (ft/ft)

d₅₀ = mean rock size (ft)

G_s = specific gravity of stone (minimum = 2.50, typically 2.5 to 2.7), Note: In this equation (G_s - 1) considers the buoyancy of the water, in that the specific gravity of water is subtracted from the specific gravity of the rock.

Begin Sta	End Sta	INPUT			OUTPUT		
		V	S	G _s	d50(ft)	d50(in)	
1615	1225	9.86	0.0113	2.5	0.61	7.3	Use Type L=9in
1225	800	10.22	0.0089	2.5	0.61	7.3	Use Type L=9in
800	375	10.71	0.0111	2.5	0.72	8.6	Use Type L=9in
375	0	13.14	0.0077	2.5	0.95	11.5	Use Type M=12in

USE TYPE M SOIL RIPRAP ENTIRE REACH



THICKNESS - 2*D50 = 24"

SIDE SLOPE - 2.5:1

BURY DEPTH - 5' (ASSUME NOT COHESIVE)

HEC-RAS Plan: 100YrSuper River: Fountain Creek Reach: Main Stem Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Stem	1615	PF 1	26300.00	5686.80	5690.50	5690.50	5691.72	0.013669	8.86	2969.15	1248.13	1.01
Main Stem	1225	PF 1	26300.00	5682.40	5686.73	5686.73	5688.55	0.011757	10.85	2436.01	681.43	1.01
Main Stem	800	PF 1	26300.00	5678.60	5682.29	5682.29	5683.72	0.012542	9.60	2744.29	959.93	1.00
Main Stem	375	PF 1	26300.00	5673.90	5678.55	5678.55	5680.70	0.010990	11.82	2243.21	527.70	1.00
Main Stem	0	PF 1	26300.00	5671.00	5677.49	5677.49	5680.71	0.009575	14.46	1843.01	291.72	1.00

Plan: 100YrSuper Fountain Creek Main Stem RS: 1615 Profile: PF 1

E.G. Elev (ft)	5691.72	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.22	Wt. n-Val.	0.035	0.035	0.035
W.S. Elev (ft)	5690.50	Reach Len. (ft)	573.00	390.00	552.00
Crit W.S. (ft)	5690.50	Flow Area (sq ft)	1.11	2965.37	2.68
E.G. Slope (ft/ft)	0.013669	Area (sq ft)	1.11	2965.37	2.68
Q Total (cfs)	26300.00	Flow (cfs)	2.18	26286.21	11.61
Top Width (ft)	1248.13	Top Width (ft)	4.40	1241.41	2.32
Vel Total (ft/s)	8.86	Avg. Vel. (ft/s)	1.97	8.86	4.34
Max Chl Dpth (ft)	3.70	Hydr. Depth (ft)	0.25	2.39	1.15
Conv. Total (cfs)	224952.0	Conv. (cfs)	18.6	224834.0	99.3
Length Wtd. (ft)		Wetted Per. (ft)	4.43	1242.50	3.27
Min Ch El (ft)	5686.80	Shear (lb/sq ft)	0.21	2.04	0.70
Alpha	1.00	Stream Power (lb/ft s)	0.42	18.05	3.03
Frctn Loss (ft)		Cum Volume (acre-ft)	0.98	90.23	0.36
C & E Loss (ft)		Cum SA (acres)	0.46	26.88	0.18

Plan: 100YrSuper Fountain Creek Main Stem RS: 1225 Profile: PF 1

E.G. Elev (ft)	5688.55	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.82	Wt. n-Val.	0.035	0.035	0.035
W.S. Elev (ft)	5686.73	Reach Len. (ft)	487.00	425.00	422.00
Crit W.S. (ft)	5686.73	Flow Area (sq ft)	25.50	2400.46	10.04
E.G. Slope (ft/ft)	0.011757	Area (sq ft)	25.50	2400.46	10.04
Q Total (cfs)	26300.00	Flow (cfs)	188.24	26054.58	57.18
Top Width (ft)	681.43	Top Width (ft)	11.79	663.00	6.64
Vel Total (ft/s)	10.80	Avg. Vel. (ft/s)	7.38	10.85	5.70
Max Chl Dpth (ft)	4.32	Hydr. Depth (ft)	2.16	3.62	1.51
Conv. Total (cfs)	242557.4	Conv. (cfs)	1736.0	240294.0	527.3
Length Wtd. (ft)		Wetted Per. (ft)	12.56	663.00	7.30
Min Ch El (ft)	5682.40	Shear (lb/sq ft)	1.49	2.66	1.01
Alpha	1.01	Stream Power (lb/ft s)	11.00	28.84	5.75

Plan: 100YrSuper Fountain Creek Main Stem RS: 1225 Profile: PF 1 (Continued)

Frctn Loss (ft)		Cum Volume (acre-ft)	0.81	66.21	0.28
C & E Loss (ft)		Cum SA (acres)	0.35	18.36	0.13

Plan: 100YrSuper Fountain Creek Main Stem RS: 800 Profile: PF 1

E.G. Elev (ft)	5683.72	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.43	Wt. n-Val.	0.035	0.035	0.035
W.S. Elev (ft)	5682.29	Reach Len. (ft)	460.00	425.00	531.00
Crit W.S. (ft)	5682.29	Flow Area (sq ft)	16.82	2726.70	0.77
E.G. Slope (ft/ft)	0.012542	Area (sq ft)	16.82	2726.70	0.77
Q Total (cfs)	26300.00	Flow (cfs)	114.32	26183.78	1.90
Top Width (ft)	959.93	Top Width (ft)	9.12	950.00	0.81
Vel Total (ft/s)	9.58	Avg. Vel. (ft/s)	6.80	9.60	2.47
Max Chl Dpth (ft)	3.69	Hydr. Depth (ft)	1.84	2.87	0.94
Conv. Total (cfs)	234835.9	Conv. (cfs)	1020.8	233798.2	16.9
Length Wtd. (ft)		Wetted Per. (ft)	9.83	950.00	2.06
Min Ch El (ft)	5678.60	Shear (lb/sq ft)	1.34	2.25	0.29
Alpha	1.00	Stream Power (lb/ft s)	9.10	21.58	0.72
Frctn Loss (ft)		Cum Volume (acre-ft)	0.57	41.20	0.23
C & E Loss (ft)		Cum SA (acres)	0.24	10.49	0.09

Plan: 100YrSuper Fountain Creek Main Stem RS: 375 Profile: PF 1

E.G. Elev (ft)	5680.70	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.15	Wt. n-Val.	0.035	0.035	0.035
W.S. Elev (ft)	5678.55	Reach Len. (ft)	438.00	375.00	362.00
Crit W.S. (ft)	5678.55	Flow Area (sq ft)	32.19	2197.72	13.30
E.G. Slope (ft/ft)	0.010990	Area (sq ft)	32.19	2197.72	13.30
Q Total (cfs)	26300.00	Flow (cfs)	242.60	25969.95	87.45
Top Width (ft)	527.70	Top Width (ft)	13.85	508.00	5.85
Vel Total (ft/s)	11.72	Avg. Vel. (ft/s)	7.54	11.82	6.57
Max Chl Dpth (ft)	4.65	Hydr. Depth (ft)	2.32	4.33	2.27

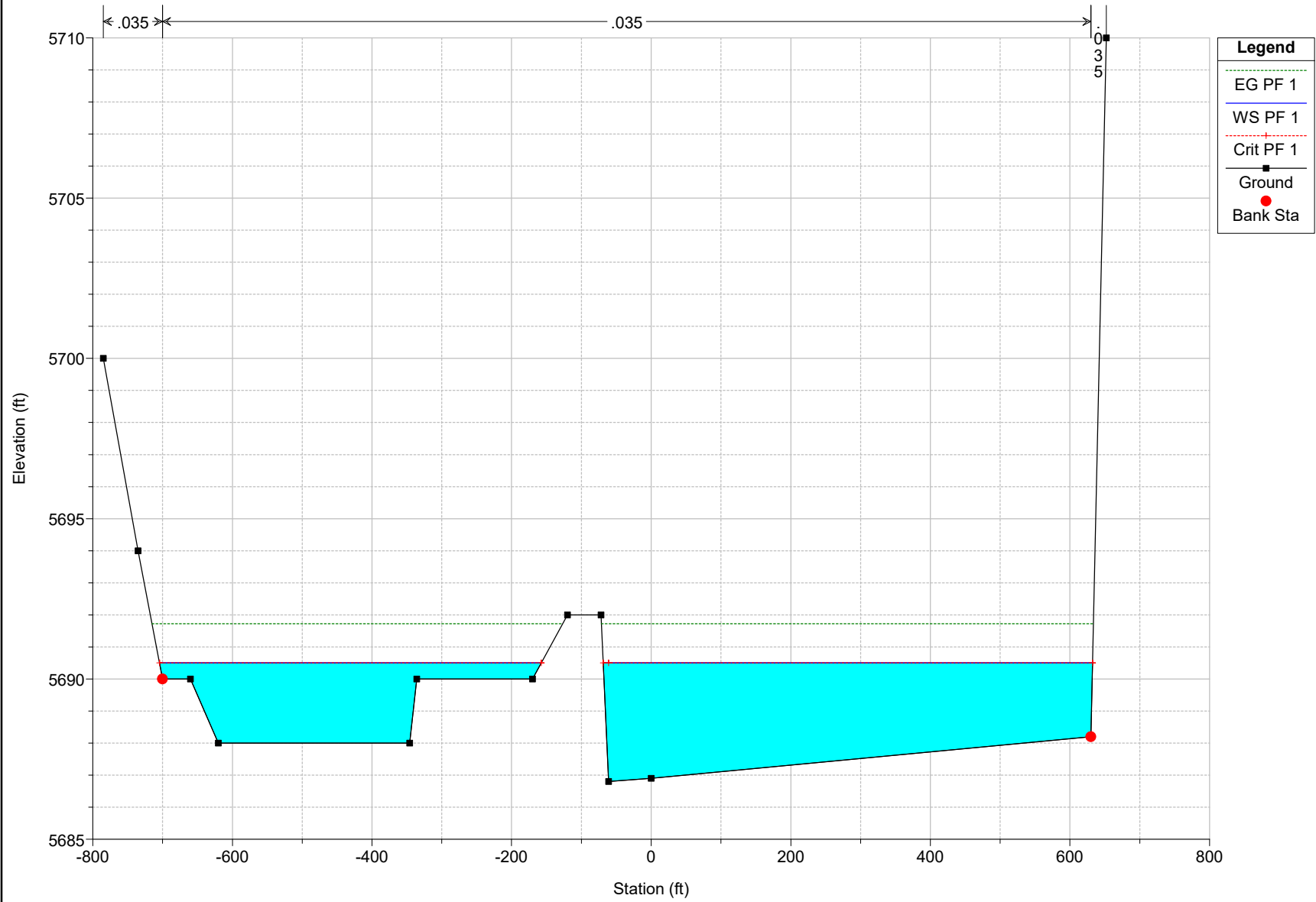
Plan: 100YrSuper Fountain Creek Main Stem RS: 375 Profile: PF 1 (Continued)

Conv. Total (cfs)	250873.9	Conv. (cfs)	2314.1	247725.6	834.2
Length Wtd. (ft)	375.52	Wetted Per. (ft)	14.61	508.00	7.41
Min Ch El (ft)	5673.90	Shear (lb/sq ft)	1.51	2.97	1.23
Alpha	1.01	Stream Power (lb/ft s)	11.39	35.08	8.10
Frctn Loss (ft)	3.85	Cum Volume (acre-ft)	0.31	17.17	0.14
C & E Loss (ft)	0.11	Cum SA (acres)	0.12	3.37	0.05

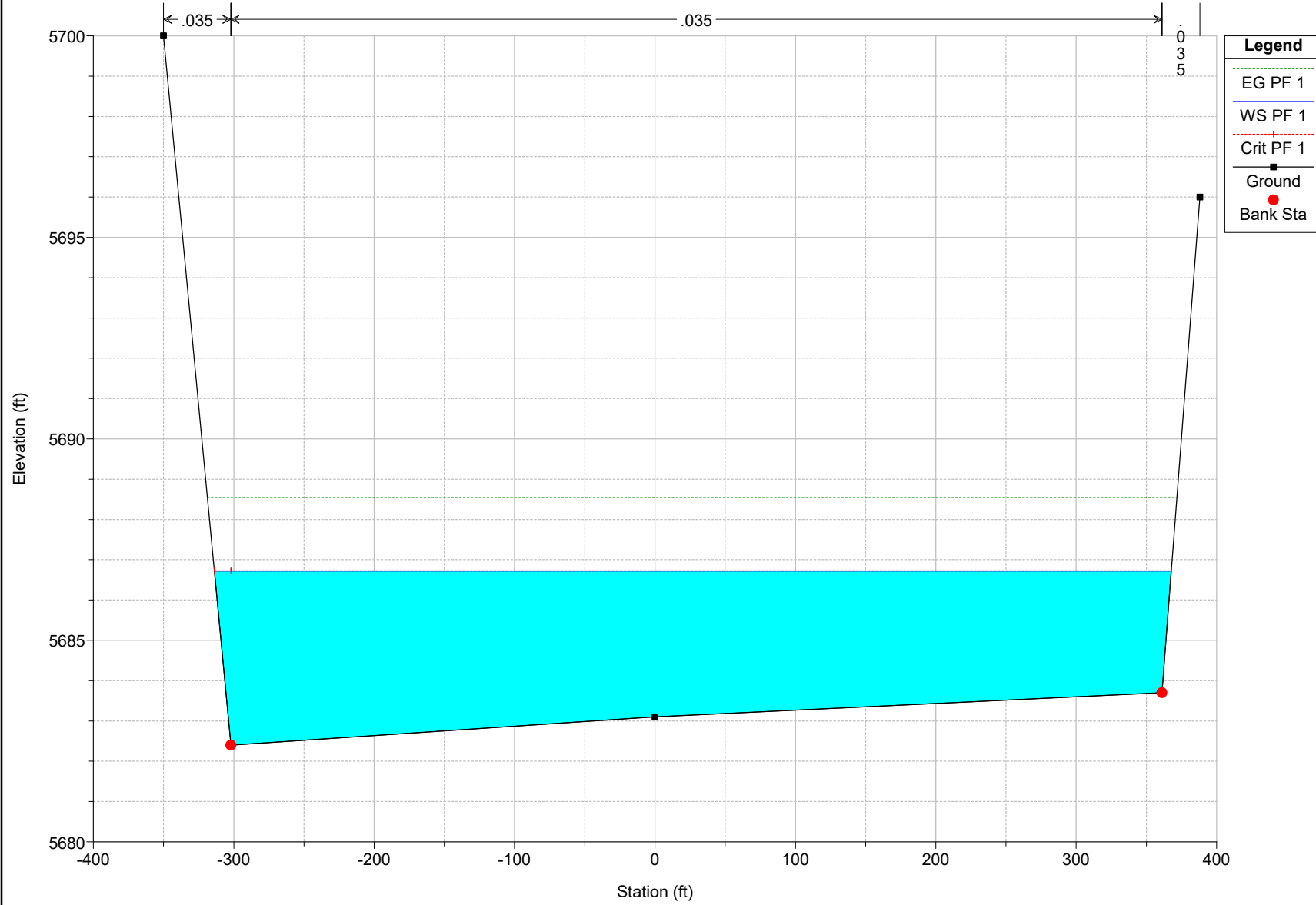
Plan: 100YrSuper Fountain Creek Main Stem RS: 0 Profile: PF 1

E.G. Elev (ft)	5680.71	Element	Left OB	Channel	Right OB
Vel Head (ft)	3.21	Wt. n-Val.	0.035	0.035	0.035
W.S. Elev (ft)	5677.49	Reach Len. (ft)			
Crit W.S. (ft)	5677.49	Flow Area (sq ft)	29.95	1791.98	21.08
E.G. Slope (ft/ft)	0.009575	Area (sq ft)	29.95	1791.98	21.08
Q Total (cfs)	26300.00	Flow (cfs)	238.58	25909.05	152.37
Top Width (ft)	291.72	Top Width (ft)	9.23	276.00	6.49
Vel Total (ft/s)	14.27	Avg. Vel. (ft/s)	7.97	14.46	7.23
Max Chl Dpth (ft)	6.49	Hydr. Depth (ft)	3.25	6.49	3.25
Conv. Total (cfs)	268769.7	Conv. (cfs)	2438.1	264774.4	1557.2
Length Wtd. (ft)		Wetted Per. (ft)	11.28	276.00	9.18
Min Ch El (ft)	5671.00	Shear (lb/sq ft)	1.59	3.88	1.37
Alpha	1.02	Stream Power (lb/ft s)	12.64	56.12	9.92
Frctn Loss (ft)		Cum Volume (acre-ft)			
C & E Loss (ft)		Cum SA (acres)			

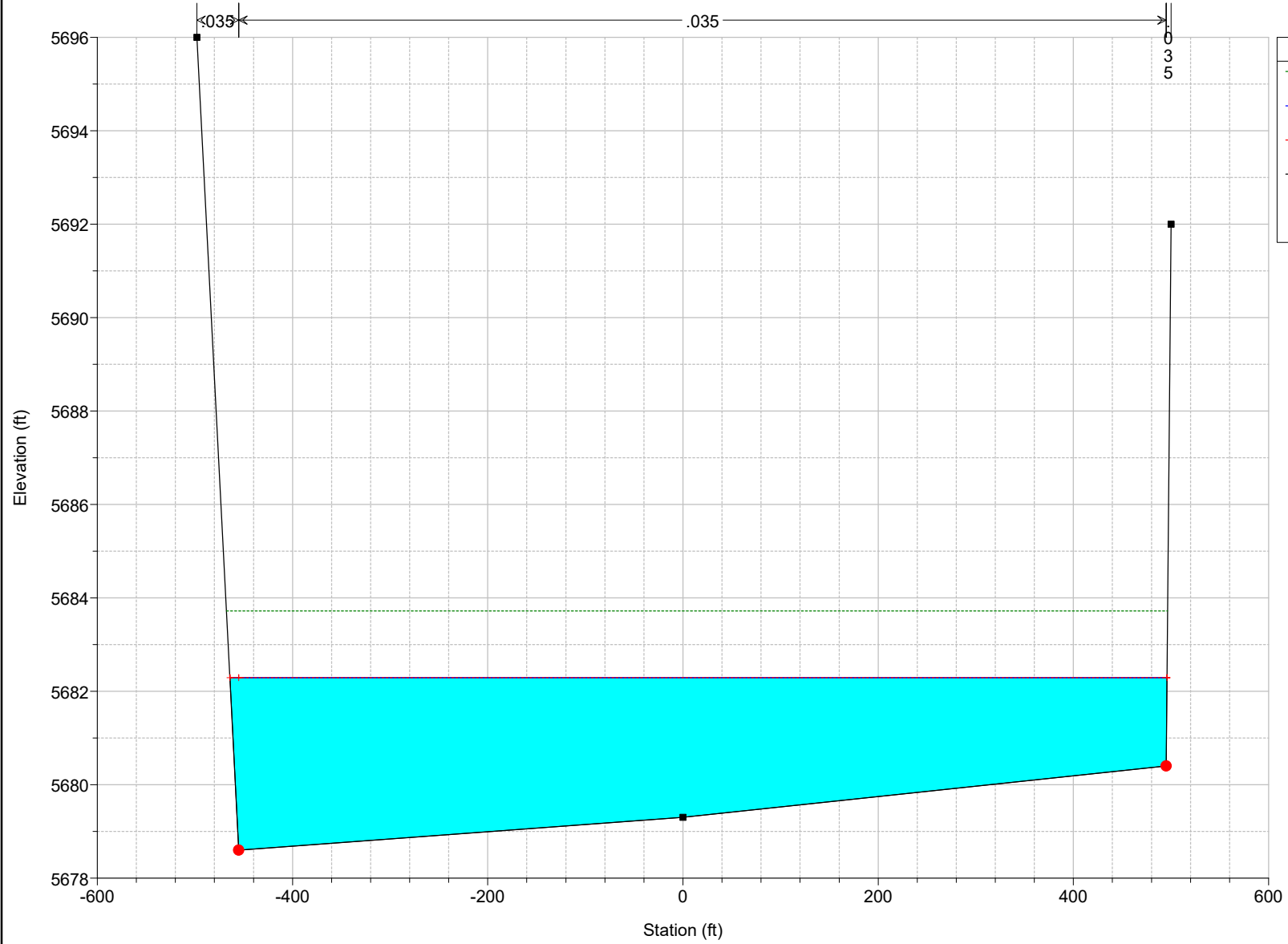
Riverbend Plan: 100yr Sup 11/23/2019
Sta 16+15



Riverbend Plan: 100yr Sup 11/23/2019
Sta 12+25



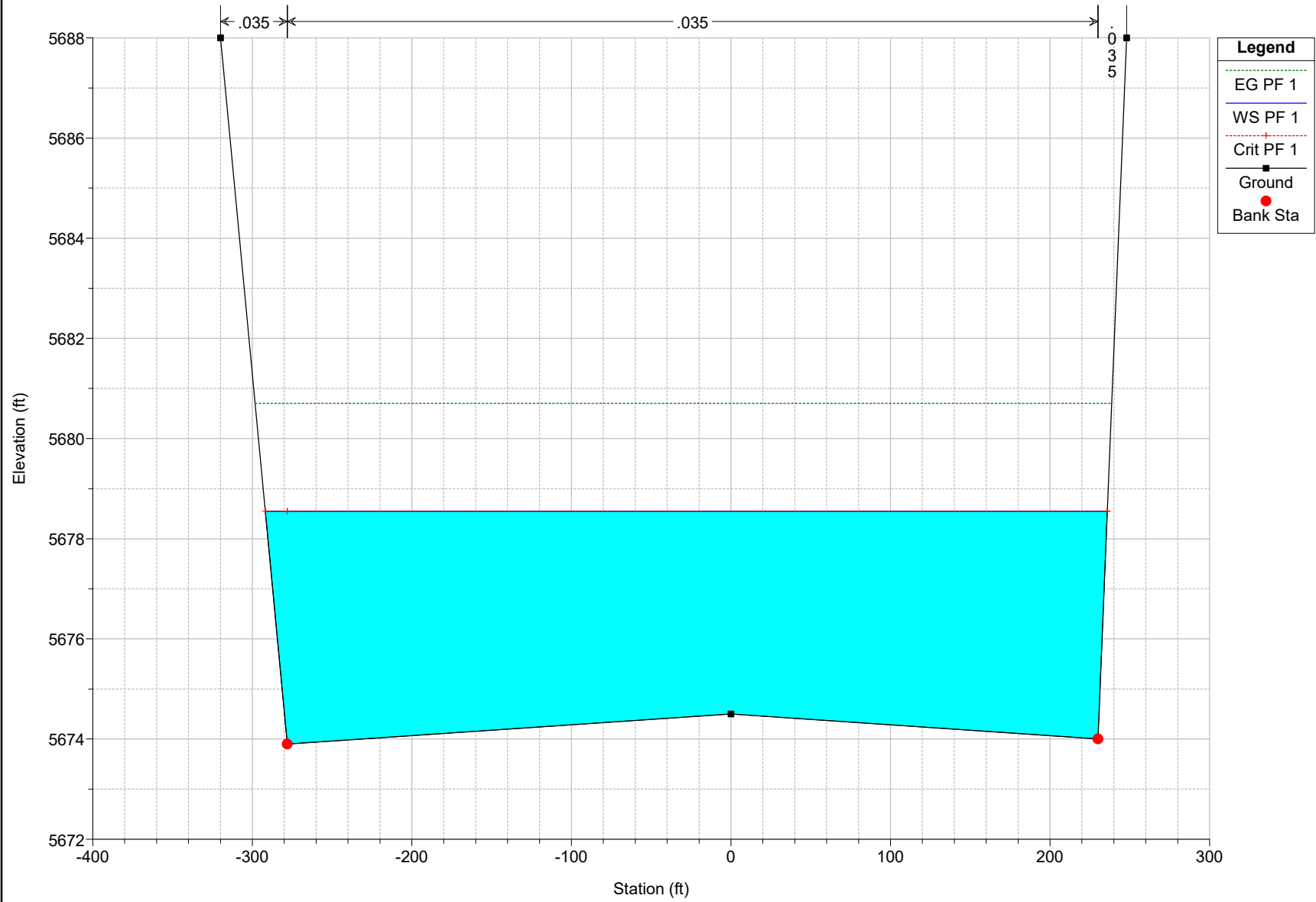
Riverbend Plan: 100yr Sup 11/23/2019
Sta 8+00



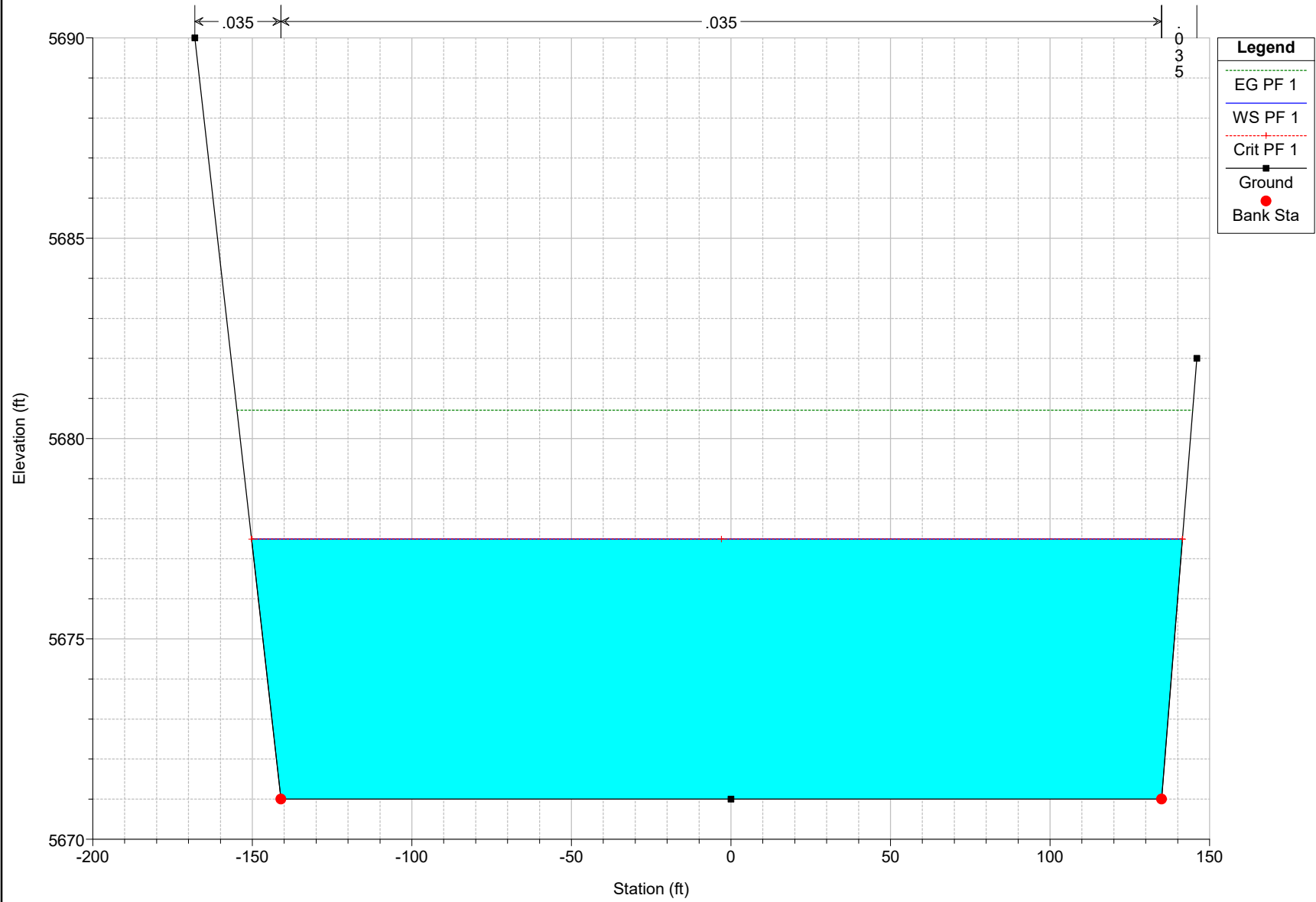
Legend

- EG PF 1
- WS PF 1
- Crit PF 1
- Ground
- Bank Sta

Riverbend Plan: 100yr Sup 11/23/2019
Sta 3+75

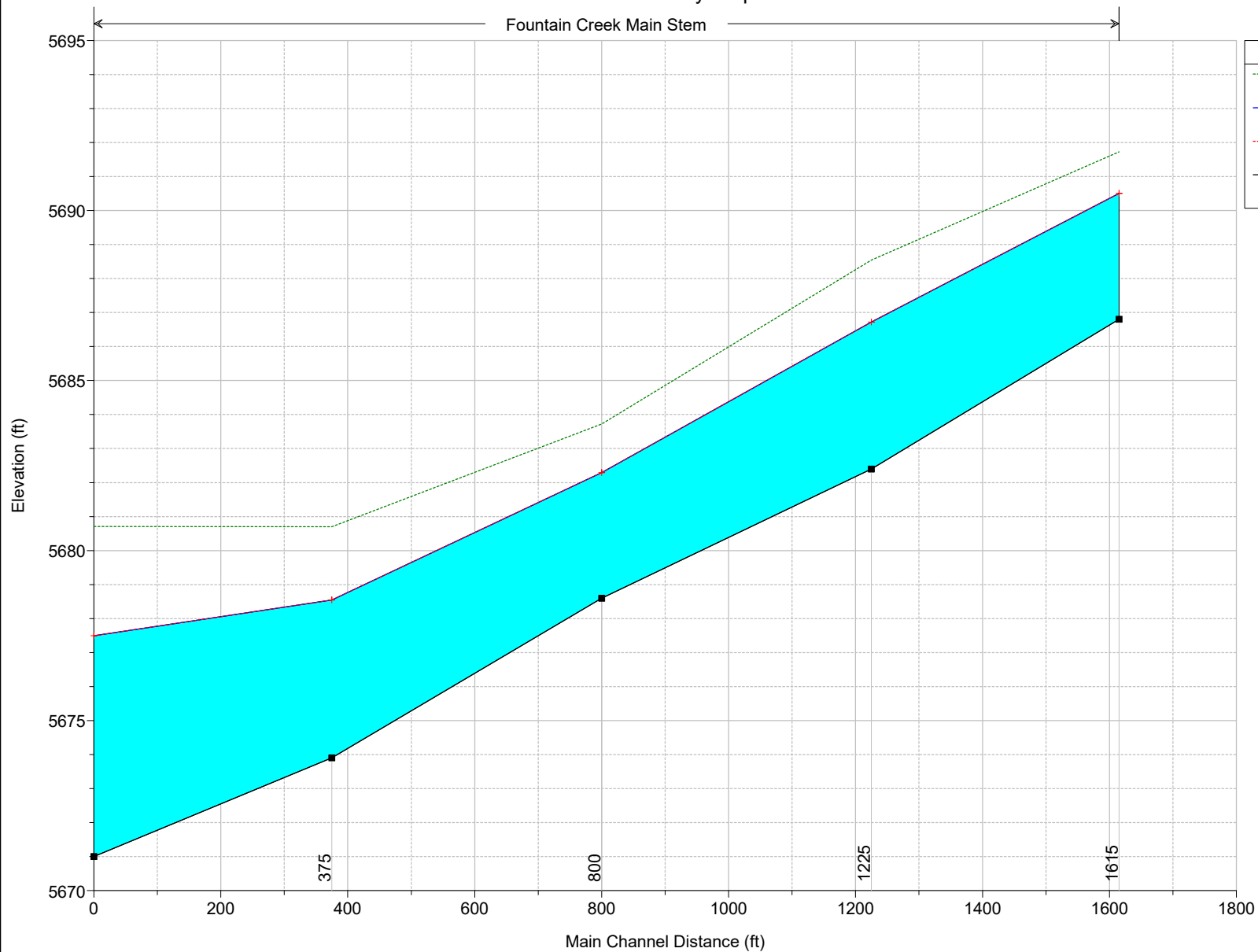


Riverbend Plan: 100yr Sup 11/23/2019
Sta 0+00



Riverbend Plan: 100yr Sup 11/23/2019

Fountain Creek Main Stem



Legend

EG PF 1

WS PF 1

Crit PF 1

Ground

Architecture
Structural
Geotechnical



ROCKY MOUNTAIN GROUP

Materials Testing
Forensic
Civil/Planning

GEOTECHNICAL REPORT

Avatar River Bend Crossing Commercial and Residential Development Fountain, Colorado

PREPARED FOR:

Avatar Fountain, LP
P.O. Box 927215
San Diego, CA 92192

JOB NO. 161921

April 2, 2018

Respectfully Submitted,

RMG – Rocky Mountain Group

A handwritten signature in blue ink that reads "Kelli Zigler".

Kelli Zigler
Project Geologist

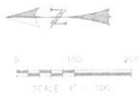
Reviewed by,

RMG – Rocky Mountain Group

Geoff Webster, P.E.
Sr. Geotechnical Project Manager



FIGURES



REFERENCE
NOT TO SCALE

R: RESIDENTIAL
C: COMMERCIAL

 DENOTES APPROXIMATE
LOCATION OF TEST BORINGS



ROCKY MOUNTAIN GROUP

Southern Office
Colorado Springs, CO
80918
(719) 548-0600
Central Office:
Englewood, CO 80112
(303) 688-9475
Northern Office:
Greeley / Evans, CO 80620
(970) 330-1071

TEST BORING LOCATION PLAN

RESIDENTIAL / RETAIL
RIVER BEND CROSSING
FOUNTAIN, CO
AVATAR FOUNTAIN, LP

JOB No. 161921

FIG No. 2

DATE 3-21-2018

SOILS DESCRIPTION

	ASPHALT
	CLAYSTONE
	SHALE
	SILTY CLAY
	SILTY SAND
	SILTY TO CLAYEY SAND

UNLESS NOTED OTHERWISE, ALL LABORATORY
TESTS PRESENTED HEREIN WERE PERFORMED BY:
RMG - ROCKY MOUNTAIN GROUP
2910 AUSTIN BLUFFS PARKWAY
COLORADO SPRINGS, COLORADO

SYMBOLS AND NOTES

	XX	STANDARD PENETRATION TEST - MADE BY DRIVING A SPLIT-BARREL SAMPLER INTO THE SOIL BY DROPPING A 140 LB. HAMMER 30", IN GENERAL ACCORDANCE WITH ASTM D-1586. NUMBER INDICATES NUMBER OF HAMMER BLOWS PER FOOT (UNLESS OTHERWISE INDICATED).
	XX	UNDISTURBED CALIFORNIA SAMPLE - MADE BY DRIVING A RING-LINED SAMPLER INTO THE SOIL BY DROPPING A 140 LB. HAMMER 30", IN GENERAL ACCORDANCE WITH ASTM D-3550. NUMBER INDICATES NUMBER OF HAMMER BLOWS PER FOOT (UNLESS OTHERWISE INDICATED).
		FREE WATER TABLE
		DEPTH AT WHICH BORING CAVED
	BULK	DISTURBED BULK SAMPLE
	AUG	AUGER "CUTTINGS"
4.5		WATER CONTENT (%)

Architectural
Structural
Forensics



Colorado Springs (Corporate Office)
2910 Austin Bluffs Parkway
Colorado Springs, CO 80918
(719) 548-0600

SOUTHERN COLORADO, DENVER METRO, NORTHERN COLORADO

Geotechnical
Materials Testing
Civil, Planning

EXPLANATION OF TEST BORING LOGS

JOB No. 161921

FIGURE No. 3

DATE 4/2/18

TEST BORING: C05 DATE DRILLED: 3/12/18 ELEVATION (FT): NO GROUNDWATER ON 3/12/18	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %	TEST BORING: R01 DATE DRILLED: 3/2/18 ELEVATION (FT): GROUNDWATER @ 19.0 ' 3/2/18	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
2" ASPHALT SAND, SILTY, with gravel, brown, loose to medium dense, moist	5			8	3.4	SAND, SILTY TO CLAYEY, with gravel and cobbles, brown to reddish brown, medium dense to dense, moist to wet	5			17	4.3
	10			24	3.4		10			32	4.1
	15			21	2.9		15				3.4
	20			25	4.3		20			17	13.6

ROCKY MOUNTAIN GROUP

Architectural
Structural
Forensics



Geotechnical
Materials Testing
Civil, Planning

Colorado Springs: (Corporate Office)
2910 Austin Bluffs Parkway
Colorado Springs, CO 80918
(719) 548-0600

SOUTHERN COLORADO, DENVER METRO, NORTHERN COLORADO

TEST BORING LOGS

JOB No. 161921

FIGURE No. 6

DATE 4/2/18

TEST BORING: R02 DATE DRILLED: 3/2/18 ELEVATION (FT): GROUNDWATER @ 13.0 ' 3/5/18					TEST BORING: R03 DATE DRILLED: 3/2/18 ELEVATION (FT): GROUNDWATER @ 13.0 ' 3/5/18				
DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SAND, SILTY TO CLAYEY, with gravel, brown, loose, moist					SAND, SILTY TO CLAYEY, brown, loose, moist				
5			9	11.5	5			7	7.7
SAND, SILTY, with gravel and cobbles, tan and reddish brown to gray, medium dense, moist to wet									
10			17	1.6	10			19	2.4
BORING CAVED AT 14' DUE TO LOOSE SANDS, BULK SAMPLES TAKEN									
15				3.5	15			15	14.4
20				12.8	20			19	8.2

ROCKY MOUNTAIN GROUP

Architectural
Structural
Forensics



Geotechnical
Materials Testing
Civil, Planning

Colorado Springs - (Corporate Office)
2810 Austin Bluffs Parkway
Colorado Springs, CO 80918
(719) 548-0600

SOUTHERN COLORADO, DENVER METRO, NORTHERN COLORADO

TEST BORING LOGS

JOB No. 161921

FIGURE No. 7

DATE 4/2/18

TEST BORING: R04 DATE DRILLED: 3/2/18 ELEVATION (FT): NO GROUNDWATER ON 3/2/18					TEST BORING: R05 DATE DRILLED: 3/2/18 ELEVATION (FT): GROUNDWATER @ 12.0' 3/5/18				
DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
5			8	3.0	5			10	9.4
					10			17	2.5
15			26	3.5	15			9	31.4
20				3.0	20				29.3

ROCKY MOUNTAIN GROUP

Architectural
Structural
Forensics



Colorado Springs: (Corporate Office)
2910 Austin Bluffs Parkway
Colorado Springs, CO 80918
(719) 548-0600

SOUTHERN COLORADO, DENVER METRO, NORTHERN COLORADO

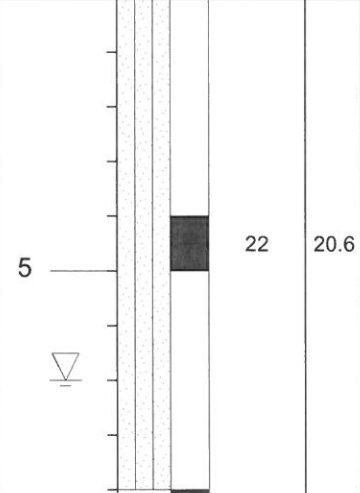
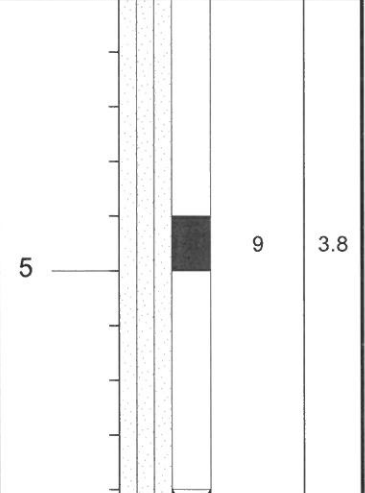
Geotechnical
Materials Testing
Civil, Planning

TEST BORING LOGS

JOB No. 161921

FIGURE No. 8

DATE 4/2/18

TEST BORING: R06 DATE DRILLED: 3/2/18 ELEVATION (FT): GROUNDWATER @ 7.0' 3/5/18	DEPTH (FT) SYMBOL SAMPLES BLOWS PER FT. WATER CONTENT %	TEST BORING: R07 DATE DRILLED: 3/2/18 ELEVATION (FT): NO GROUNDWATER ON 3/2/18	DEPTH (FT) SYMBOL SAMPLES BLOWS PER FT. WATER CONTENT %
SAND, SILTY, with gravel and cobbles, brown, medium dense, moist		SAND, SILTY, with gravel and cobbles, brown to reddish brown, loose, moist	
CLAYSTONE, SILTY, gray to dark gray with rust staining, firm, moist to wet		BORING CAVED AT 9' DUE TO LOOSE SANDS, BULK SAMPLES TAKEN	
SHALE, SILTY, gray to dark gray, very hard, moist to wet			

ROCKY MOUNTAIN GROUP

Architectural
Structural
Forensics



Geotechnical
Materials Testing
Civil, Planning

Colorado Springs - Corporate Office

2910 Austin Bluffs Parkway
Colorado Springs, CO 80918
(719) 548-0600

SOUTHERN COLORADO, DENVER METRO, NORTHERN COLORADO

TEST BORING LOGS

JOB No. 161921

FIGURE No. 9

DATE 4/2/18

TEST BORING: R08 DATE DRILLED: 3/2/18 ELEVATION (FT): GROUNDWATER @ 19.5' 3/1/18					TEST BORING: R09 DATE DRILLED: 3/2/18 ELEVATION (FT): NO GROUNDWATER ON 3/2/18				
DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SAND, SILTY, with gravel and cobbles, medium dense, moist					SAND, SILTY, with gravel and cobbles, brown to reddish brown, loose to medium dense, moist				
5			17	13.4	5		6		1.7
CLAYSTONE, SILTY, brown to gray, hard, moist									
10			50/11"	23.0	10		14		3.3
SHALE, SILTY, gray to dark gray, very hard, moist to wet									
15			50/6"	13.6	15		18		3.9
20				13.1	20		17		2.8

ROCKY MOUNTAIN GROUP

Architectural
Structural
Forensics



Colorado Springs (Corporate Office)
2910 Austin Bluffs Parkway
Colorado Springs, CO 80918
(719) 548-0600

SOUTHERN COLORADO, DENVER METRO, NORTHERN COLORADO

Geotechnical
Materials Testing
Civil, Planning

TEST BORING LOGS

JOB No. 161921

FIGURE No. 10

DATE 4/2/18

TEST BORING: R10 DATE DRILLED: 3/2/18 ELEVATION (FT): GROUNDWATER @ 6.0 ' 3/5/18					TEST BORING: R11 DATE DRILLED: 3/2/18 ELEVATION (FT): GROUNDWATER @ 17.0 ' 3/5/18				
DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SAND, SILTY TO CLAYEY, with gravel and cobbles, medium dense, moist to wet			10	4.0	SAND, SILTY TO CLAYEY, brown, loose, moist			7	11.1
5					5				
SHALE, SILTY, gray to dark gray, hard moist to wet			20	17.7	SAND, SILTY, with gravel and cobbles, medium dense, moist			16	8.3
10					10				
15			50/7"	14.5	CLAYSTONE, SANDY, gray with rust staining, medium hard, moist			30	28.3
					15				
20				35.5	SHALE, SILTY, gray to dark gray, very hard, moist to wet			50/6"	19.1
					20				

ROCKY MOUNTAIN GROUP

Architectural
Structural
Forensics



Geotechnical
Materials Testing
Civil, Planning

Colorado Springs, (Corporate Office)
2910 Austin Bluffs Parkway
Colorado Springs, CO 80916
(719) 548-0600

SOUTHERN COLORADO, DENVER METRO, NORTHERN COLORADO

TEST BORING LOGS

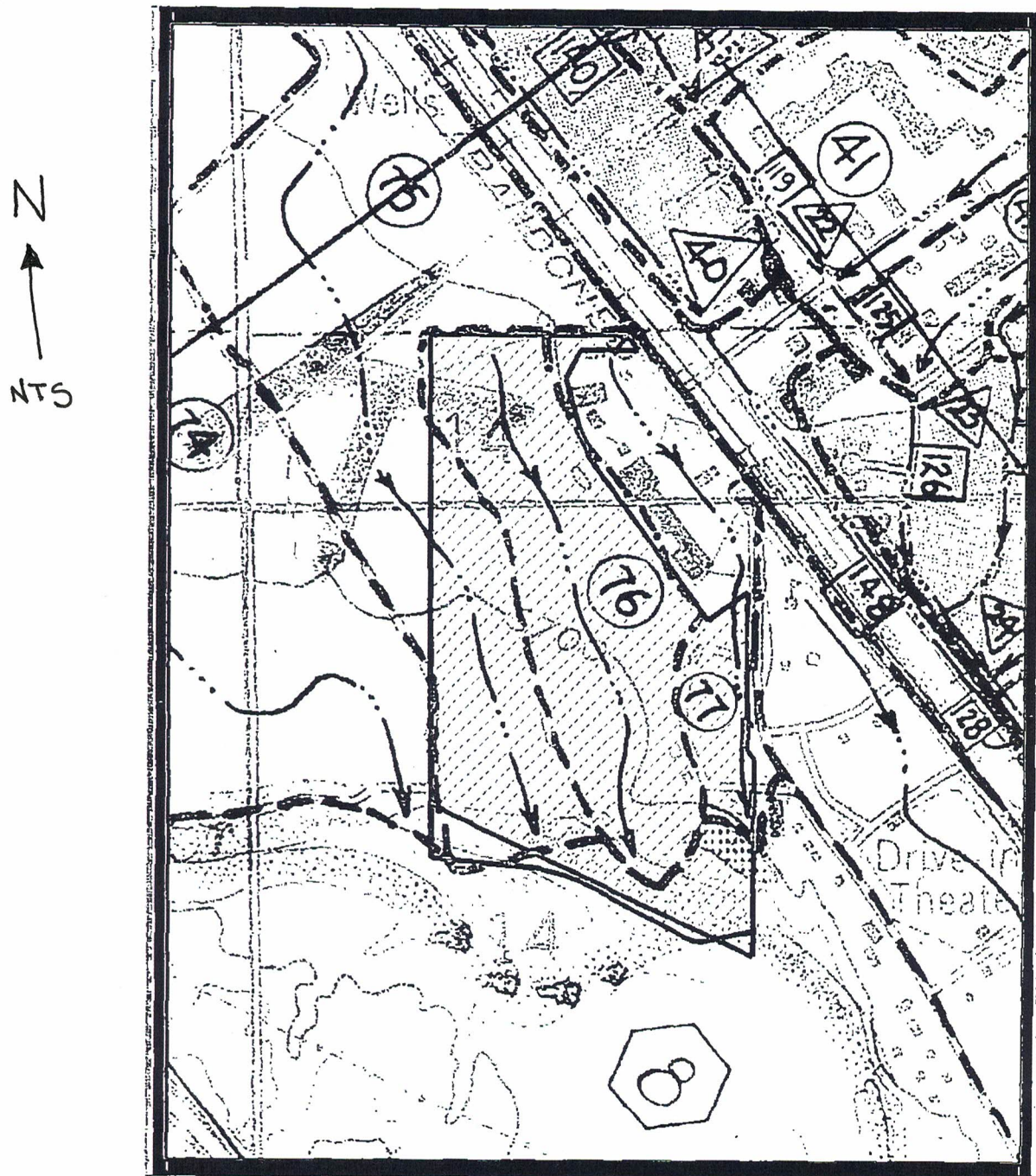
JOB No. 161921

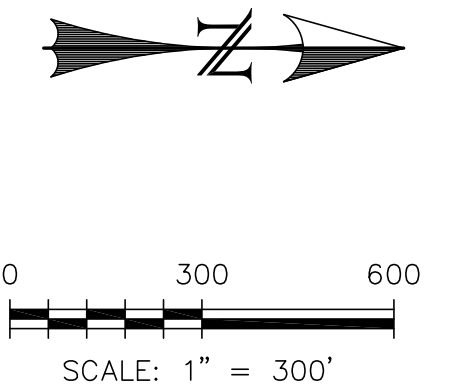
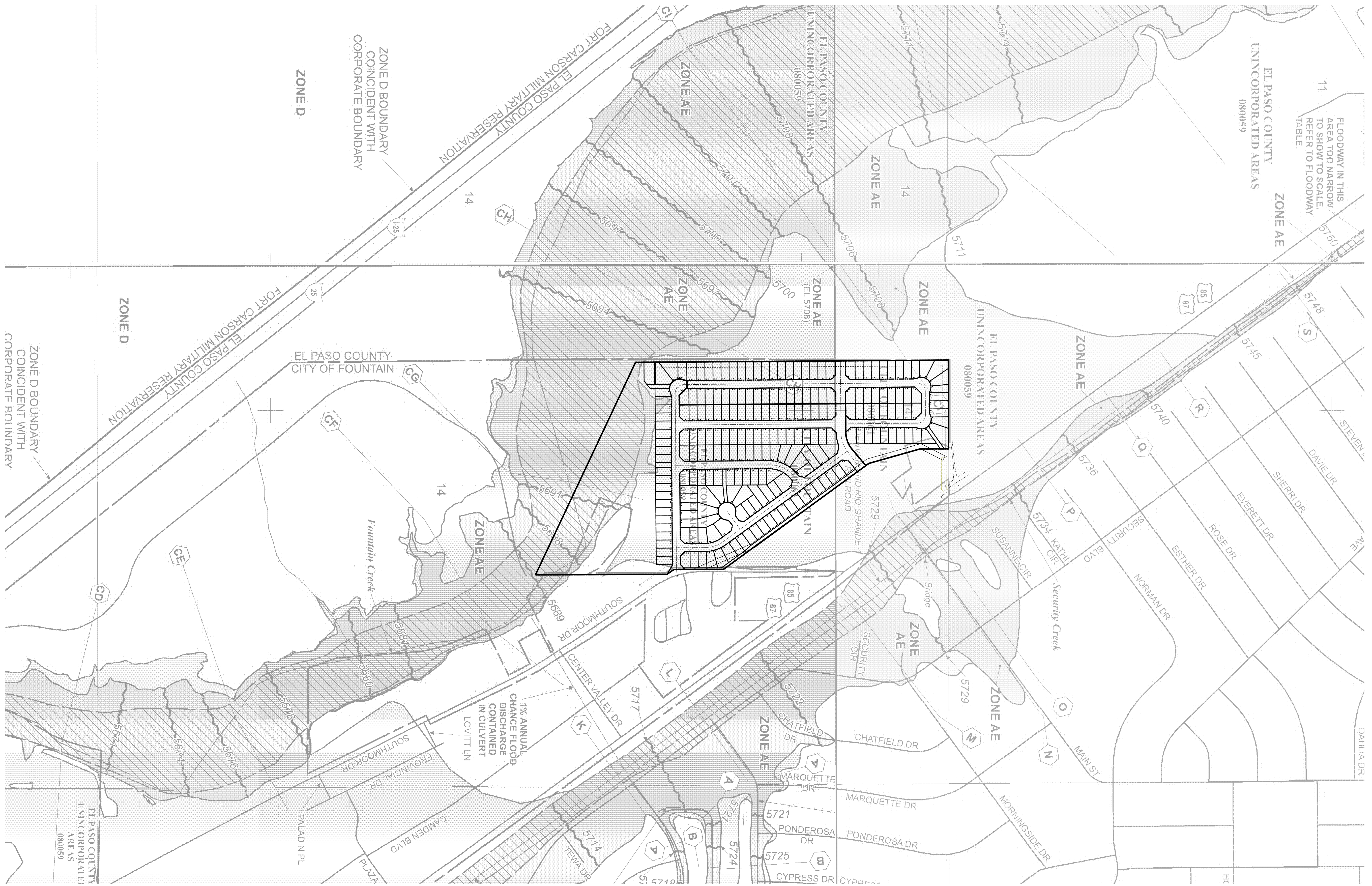
FIGURE No. 11

DATE 4/2/18

DRAINAGE MAP

FIGURE A4 – Drainage Patterns as Depicted in the DBPS

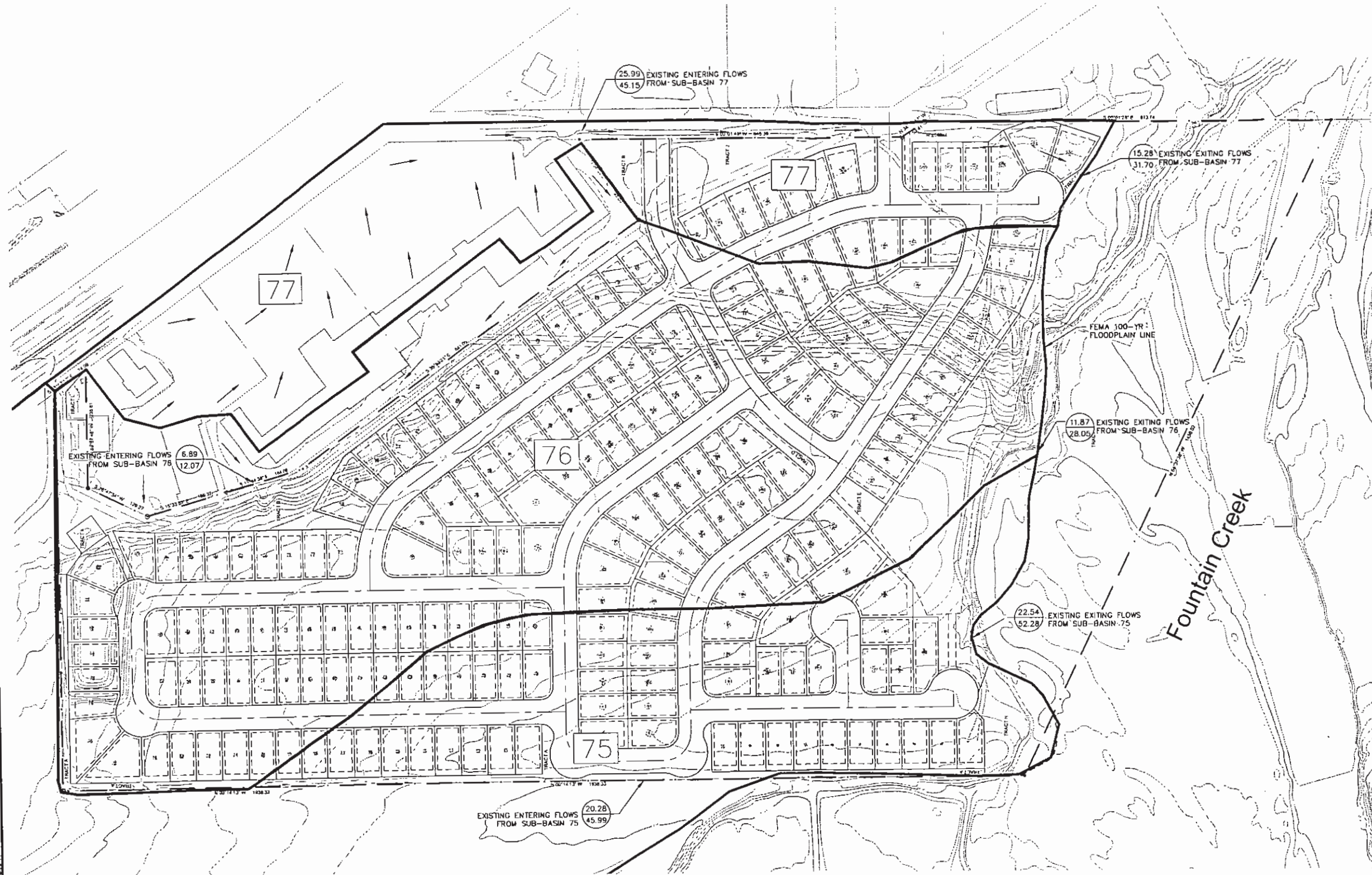




PREPARED FOR: COMPANY NAME ADDRESS CITY, STATE ZIP PHONE	 PO BOX 692 DUNDE, CO 80814 (719) 426-2124	COMPOSITE FIRM MAP RIVERBEND DEVELOPMENTS		DRAWN BY: DLM
		FIRM PANELS- 744G,763G,932G,AND 951G		SCALE: 1"=300' DATE: 09/11/19
				JOB NUMBER SHEET 17-114 1 OF 1

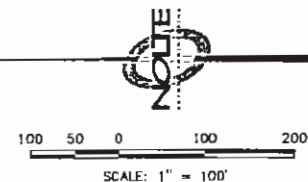
RIVERBEND CROSSING

EXISTING DRAINAGE CONDITONS MAP



EXISTING DRAINAGE BASINS 75, 76 AND 77 WERE TAKEN FROM THE APPROVED LITTLE JOHNSON DRAINAGE BASIN
PLANNING STUDY, DATED: APRIL, 1988

WATERSHED	TOTAL AREA (acres)	COMPOSITE RAINFALL COEFF. (C)				COMPOSITE RAINFALL COEFF. (C)				OVERLAND COMPONENT				CHANNEL COMPONENT				TOTAL	HUNTER COEFFICIENT, C				INTENSITY (in/hr)				FLOW (cfs)			
		C1	C2	C3	C4	C1	C2	C3	C4	Length (ft)	Height (ft)	Slope	T (min)	Length (ft)	Height (ft)	Slope	T (min)		C1	C2	C3	C4	15 min	30 min	60 min	120 min	Q 5-yr	Q 10-yr	Q 25-yr	Q 50-yr
75 (IN)	59.11	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	1000	24	0.004	37.05	100	2	0.004	7.1	11.34	0.25	0.25	0.25	0.25	1.5	2.0	2.5	3.0	25.30	25.30	25.30	25.30
75 (OUT)	70.0	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	1000	24	0.004	37.05	100	2	0.004	7.1	11.34	0.25	0.25	0.25	0.25	1.5	2.0	2.5	3.0	25.30	25.30	25.30	25.30
76 (IN)	70.0	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	1000	24	0.004	37.05	100	2	0.004	7.1	11.34	0.25	0.25	0.25	0.25	1.5	2.0	2.5	3.0	25.30	25.30	25.30	25.30
76 (OUT)	70.0	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	1000	24	0.004	37.05	100	2	0.004	7.1	11.34	0.25	0.25	0.25	0.25	1.5	2.0	2.5	3.0	25.30	25.30	25.30	25.30
77 (IN)	70.0	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	1000	24	0.004	37.05	100	2	0.004	7.1	11.34	0.25	0.25	0.25	0.25	1.5	2.0	2.5	3.0	25.30	25.30	25.30	25.30
77 (OUT)	70.0	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	1000	24	0.004	37.05	100	2	0.004	7.1	11.34	0.25	0.25	0.25	0.25	1.5	2.0	2.5	3.0	25.30	25.30	25.30	25.30



LEGEND	
	BOUNDARY
	EXISTING MAJOR CONTOURS
	EXISTING MINOR CONTOURS
	5-YR. FLOW (cfs) 100-YR. FLOW (cfs)
	FLOW DIRECTION ARROW
	SUB-BASIN BOUNDARY
	SUB-BASIN IDENTIFICATION

RIVERBEND CROSSING EXISTING DRAINAGE CONDITIONS

PREPARED FOR: DR HORTON - MELODY SERIES

DATE SUBMITTED: FEB 17, 2006

NOTE

BEYOND ENGINEERING

COLORADO SPRINGS, CO 80918
WWW.BEYONDE.COM

5325 N. ACADEMY BLVD., SUITE 304
719.588.8500 TEL 719.588.8500 FAX

PRELIMINARY
NOT FOR CONSTRUCTION

SHEET NUMBER

DP01

1 of 2 SHEETS

SCALE

VERTICAL: N/A

HORIZONTAL: 1" = 100'

JOB NUMBER

CSB011207

