

FINAL DRAINAGE PLAN

CREEKSIDE AT LORSON RANCH FILING NO. 1

APRIL 15, 2019

SF-19-00X

013

Prepared for:

Lorson, LLC
212 N. Wahsatch Ave, Suite 301
Colorado Springs, Colorado 80903
(719) 635-3200

Engineering Review

06/18/2019 11:01:30 AM

dsdrice

JeffRice@elpasoco.com

(719) 520-7877

**EPC Planning & Community
Development Department**

Prepared by:

Core Engineering Group, LLC
15004 1ST Avenue South
Burnsville, MN 55306
(719) 570-1100

Project No. 100.045



CORE

ENGINEERING GROUP

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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 El Paso County for drainage reports and said report is in conformity with the 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.

Richard L. Schindler, P.E. #33997
For and on Behalf of Core Engineering Group, LLC

Date

OWNER'S STATEMENT

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

Lorson, LLC

Date

By
Jeff Mark

Title
Manager

Address
212 N. Wahsatch Avenue, Suite 301, Colorado Springs, CO 80903

FLOODPLAIN STATEMENT

To the best of my knowledge and belief, this development is located within a designated floodplain as shown on Flood Insurance Rate Map Panel No. 08041C0957 G, dated December 7, 2018 and modified by modified per LOMR Case No. 14-08-0534P. (See Appendix A, FEMA FIRM Exhibit)

Richard L. Schindler, #33997

Date

EL PASO COUNTY

Filed in accordance with the requirements of the El Paso County Land Development Code, Drainage Criteria Manual, Volume 1 and 2, and Engineering Criteria Manual, As Amended.

Jennifer Irvine
County Engineer/ECM Administrator

Date

Conditions: _____

1.0 LOCATION and DESCRIPTION

Creekside at Lorson Ranch Filing No. 1 is located north of the East Tributary of Jimmy Camp Creek (Etrib). The site is located on approximately 83.088 acres of vacant land. Future plans are to develop this site into single-family residential developments. Also included in this report and plan is the proposed layout for Creekside at Lorson Ranch Filing No. 1 which is located west and north of the East Tributary of Jimmy Camp Creek. The land is currently owned by Lorson LLC or its nominees for Lorson Ranch.

The site is located in the North 1/2 of Section 23, Township 15 South and Range 65 West of the 6th Principal Meridian. The property is bounded on the north by Lorson Boulevard, on the east by the Etrib, the west by Jimmy Camp Creek, and the south by unplatted land in Lorson Ranch. For reference, a vicinity map is included in Appendix A of this report.

Conformance with applicable Drainage Basin Planning Studies

There is an existing (unapproved) DBPS for Jimmy Camp Creek prepared by Wilson & Company in 1987, and is referenced in this report. The only major drainage improvements for this study area according to the 1987 Wilson study was the reconstruction of the East Tributary of Jimmy Camp Creek (East Tributary). In 2014 a portion of the East Tributary was reconstructed from Fontaine Boulevard south 2,800 feet in accordance with the 1987 study which is located within this project. This section of the East Tributary included a trapezoidal channel section with 6:1 side slopes and a sand bottom. On March 9, 2015 a new DBPS for Jimmy Camp Creek and the East Tributary was completed by Kiowa Engineering. The Kiowa Engineering DBPS for Jimmy Camp Creek has not been adopted by El Paso County but is allowed for concept design. The concept design for the remaining portions of the Etrib include an armoring concept and full spectrum detention pond requirements. The Kiowa DBPS did not calculate drainage fees so current El Paso County drainage/bridge fees apply to this development. Per the Kiowa DBPS concept the preferred channel improvements include selective channel armoring on outer bends and a low flow channel for the East Tributary. Channel improvements in the East Tributary are potentially reimbursable against drainage fees for future development but need to be processed through the county process for reimbursement.

Conformance with Lorson Ranch MDDP1 by Pentacor Engineering

Lorson Ranch MDDP1 (October 26, 2006) includes this preliminary plan area and the East Tributary. This PDR conforms to the MDDP1 for Lorson Ranch and is referenced in this report. The major infrastructure to be constructed in this PDR site includes the Etrib armoring from the south property line of Lorson Ranch east and north to the previously reconstructed Etrib completed in 2014 and construction of several on-site detention ponds. Kiowa Engineering is currently designing this section of the East Tributary and is included in the appendix of this report. Detention/WQ Pond C1-R (existing) and several proposed detention ponds are shown within this preliminary plan area and will be designed/constructed as part of Creekside at Lorson Ranch Filing No. 1.

Reconstruction of the East Tributary of Jimmy Camp Creek

The Kiowa DBPS shows the East Tributary to be protected using selective armoring (soil rip rap) at the outside stream bends (500' minimum radius) and a stabilized low flow channel. The East Tributary has been divided into three different sections, south, middle, and north. The first section (south) is from the south property line east and north to design point ET-3 (see drainage map) and is roughly 2,900 feet in length. The south section is within this preliminary plan area and will be armored in accordance with the Kiowa DBPS and is currently being designed by Kiowa Engineering. The Etrib construction plans will be submitted for approval before or in conjunction with this preliminary plan submittal. The 100-year flow rate for design is 5,500cfs for the south section. The middle section is from Design Point ET-3 north 2,800 feet to the future extension of Fontaine Boulevard. The channel for this section was reconstructed and stabilized in 2014 in accordance with the 1987 Wilson DBPS. LOMR Case No. 14-08-0534P was approved by FEMA for this middle section. The northern section is from Fontaine Boulevard and extends north to the north property line. The north section is under construction in 2018 in conformance with the Kiowa DBPS as part of Lorson Ranch East Filing No. 1 improvements. The

Address what's being done. Is there a separate channel design report?

channel consists of a stabilized low flow channel and soil rip rap armored outer bends. A CLOMR for the creek construction is approved by FEMA under Case No. 17-08-1043R. The 100-year flow rate for design is from FEMA FIS data and is from 4,400cfs to 4,750cfs for this section. The low flow channel is sized using 10% of the 100-yr FEMA flow rates and is from 440cfs to 475cfs.

Creekside at Lorson Ranch Filing No. 1 is located within the ***“Jimmy Camp Creek Drainage Basin”***, which is a fee basin in El Paso County.

2.0 DRAINAGE CRITERIA

The supporting drainage design and calculations were performed in accordance with the City of Colorado Springs and El Paso County “Drainage Criteria Manual (DCM)”, dated November, 1991, the El Paso County “Engineering Criteria Manual”, Chapter 6 and Section 3.2.1 Chapter 13 of the City of Colorado Springs Drainage Criteria Manual dated May 2014, and the UDFCD “Urban Storm Drainage Criteria Manual” Volumes 1, 2 and 3 for inlet sizing and full spectrum ponds. No deviations from these published criteria are requested for this site. The proposed improvements to the Lorson Ranch Development will be in substantial compliance with the “Jimmy Camp Creek Drainage Basin Planning Study”, prepared by Kiowa Engineering Corp., Colorado Springs, CO.

The Rational Method as outlined in Section 6.3.0 of the May 2014 “Drainage Criteria Manual” and in Section 3.2.8.F of the El Paso County “Engineering Criteria Manual” was used for basins less than 130 acres to determine the rainfall and runoff conditions for the proposed development of the site. The runoff rates for the 5-year initial storm and 100-year major design storm were calculated.

Current updates to the Drainage Criteria manual for El Paso County states the if detention is necessary, Full Spectrum Detention will be included in the design, based on this criteria, Full Spectrum Detention will be required for this development

3.0 EXISTING HYDROLOGICAL CONDITIONS

The site is currently undeveloped with native vegetation (grass with no shrubs) and slopes in a southerly direction to the East Tributary of Jimmy Camp Creek.

The Soil Conservation Service (SCS) classifies the soils within the Lorson Ranch East property as Blendon Sandy Loam (40%); Ellicott Loamy Coarse Sand (1%) Manzanst clay loam (59%) [3]. The sandy loams are considered hydrologic soil group A/B soils with moderate to moderately rapid permeability. The clay loams are considered hydrologic soil group C soils with slow permeability. For the purposes of this report the Ellicott Loamy Coarse Sand will not be used since it is only 1% of the site and is in an area that will not be disturbed. All of these soils are susceptible to erosion by wind and water, have low bearing strength, moderate shrink-swell potential, and high frost heave potential (see table 3.1 below). The clay loams are difficult to vegetate. These soils can be mitigated easily by limiting their use as topsoil.

Table 3.1: SCS Soils Survey.

| Soil | Hydro. Group | Shrink/Swell Potential | Permeability | Surface Runoff Potential | Erosion Hazard |
|------------------------------------|--------------|------------------------|------------------|--------------------------|----------------|
| 10-Blendon Sandy Loam (40%) | B | Low | Moderately Rapid | Slow | Moderate |
| 28-Ellicott Loamy Coarse Sand (1%) | A | Low | Rapid | Slow | High |
| 52Manzanst Clay Loam (59%) | C | Moderate to High | Slow | Medium | Moderate |

Excerpts from the SCS "Soil Survey of El Paso County Area, Colorado" are provided in **Appendix A** for further reference.

For the purpose of preparing hydrologic calculations for this report, the soil of each basin are assumed to be wholly comprised of the majority soil hydrologic group.

Portions of the site are located within the delineated 100-year floodplain of the East Tributary of Jimmy Camp Creek per the Federal Emergency Management Agency (FEMA) Flood Rate Insurance Map (FIRM) number 08041C0957 F, effective March 17, 1997 [2]. Floodplain along Jimmy Camp Creek was modified per LOMR Case No. 06-08-B643P, effective August 29, 2007 (see appendix). Floodplain along the East Tributary was modified per LOMR Case No. 14-08-0534P, effective January 29, 2015 (see appendix). Floodplain designations include Zone AE and Zone X within the property boundary. A portion of this map is provided in **Appendix A** for reference. A CLOMR for the creek construction by Kiowa Engineering will not be necessary since BFE's are not changing.

Basin EX-B

This 35.5 acre basin includes the east portions of the site. Under existing conditions, this area flows overland south to the East Tributary contributes 17.6cfs and 94.0cfs for 5-year and 100-year events respectively.

Basin EX-C1

This 10.32 acre basin includes the middle portions of the site. Under existing conditions, this area flows overland south to the East Tributary contributes 5.3cfs and 29.7cfs for 5-year and 100-year events respectively.

Basin EX-D

This 29.29 acre basin includes the west portions of the site. Under existing conditions, this area flows overland south to the East Tributary contributes 8.6cfs and 57.5cfs for 5-year and 100-year events respectively. A very small portion of the runoff at the south property line of Lorson Ranch flows south onto the golf course property but was not calculated because the proposed Pond CR2 located next to the south property line will capture all the flow from the developed areas of the site.

4.0 DEVELOPED HYDROLOGICAL CONDITIONS

Hydrology for the **Creekside at Lorson Ranch Filing No. 1** drainage report was based on the City of Colorado Springs/El Paso County Drainage Criteria. Sub-basins that lie within this project were determined and the 5-year and 100-year peak discharges for the developed conditions have been presented in this report. Based on these flows, storm inlets will be added when the street capacity is exceeded.

This site can be broken into two soil types. The west portions are Soil Type B and the east portions are Soil Type C. See Appendix A for SCS Soils Map.

The time of concentration for each basin and sub-basin was developed using an overland, ditch, street and pipe flow components. The maximum overland flow length for developed conditions was limited to 100 feet. Travel time velocities ranged from 2 to 6 feet per second. The travel time calculations are included in the back of this report. Runoff coefficients for the various land uses were obtained from the City of Colorado Springs/El Paso County Drainage Criteria Manual.

Drainage concepts for each of the basins are briefly discussed as follow:

Basin C1.1

This basin consists of runoff from residential development. Runoff will be directed west in Kalama Drive to Design Point 1 in curb/gutter where it will be collected by a Type R inlet on Alsea Drive. The developed flow from this basin is 3.8cfs and 8.4cfs for the 5/100-year storm event. See the appendix for detailed calculations.

Basin C1.2

This basin consists of runoff from residential development. Runoff will be directed west in Castor Drive to Design Point 1 in curb/gutter where it will be collected by a Type R inlet on Alsea Drive. The developed flow from this basin is 5.4cfs and 12.1cfs for the 5/100-year storm event. See the appendix for detailed calculations.

Basin C1.3-C1.4

These basins consist of runoff from residential development. Runoff will be directed west in Kalama Drive to Design Point 2 in curb/gutter where it will be collected by a Type R inlet on Alsea Drive. The developed flow from these basins is 2.2cfs/ 4.9cfs for the 5/100-year storm event for Basin C1.3 and 4.5cfs/ 10.0cfs for the 5/100-year storm event for Basin C1.3. See the appendix for detailed calculations.

Basin C1.5

This basin consists of runoff from residential development. Runoff will be directed to Design Point 3 in curb/gutter where it will be collected by a Type R inlet on Alsea Drive. The developed flow from this basin is 0.4cfs and 1.0cfs for the 5/100-year storm event. See the appendix for detailed calculations.

Basin C1.6

This basin consists of runoff from residential development. Runoff will be directed west in Castor Drive to Design Point 6 in curb/gutter where it will be collected by a Type R inlet on Castor Drive. The developed flow from this basin is 1.5cfs and 3.3cfs for the 5/100-year storm event. See the appendix for detailed calculations.

Basin C1.7

This basin consists of runoff from residential development. Runoff will be directed east in Castor Drive to Design Point 6 in curb/gutter where it will be collected by a Type R inlet on Castor Drive. The developed flow from this basin is 3.1cfs and 6.8cfs for the 5/100-year storm event. See the appendix for detailed calculations.

Basin C1.8

This basin consists of runoff from residential development. Runoff will be directed east in Castor Drive to Design Point 6 in curb/gutter where it will be collected by a Type R inlet on Castor Drive. The developed flow from this basin is 1.6cfs and 3.5cfs for the 5/100-year storm event. See the appendix for detailed calculations.

Basin C1.9

This basin consists of runoff from residential development. Runoff will be directed west in Castor Drive to Design Point 10 in curb/gutter where it will be collected by a Type R inlet on Castor Drive. The developed flow from this basin is 4.9cfs and 10.8cfs for the 5/100-year storm event. See the appendix for detailed calculations.

Basin C1.10-C1.11

These basins consist of runoff from residential development. Runoff will be directed north in Maidford Drive to Design Point 2 in curb/gutter on Castor Drive. The developed flow from these basins is 0.4cfs/ 0.8cfs for the 5/100-year storm event for Basin C1.10 and 0.4cfs/ 0.9cfs for the 5/100-year storm event for Basin C1.11. See the appendix for detailed calculations.

Basin C1.12

This basin consists of runoff from residential development. Runoff will be directed west in Castor Drive to Design Point 10 in curb/gutter where it will be collected by a Type R inlet on Castor Drive. The developed flow from this basin is 2.5cfs and 5.5cfs for the 5/100-year storm event. See the appendix for detailed calculations.

Basin C1.13

This basin consists of runoff from residential development. Runoff will be directed east in Castor Drive to Design Point 10 in curb/gutter where it will be collected by a Type R inlet on Castor Drive. The developed flow from this basin is 1.4cfs and 3.0cfs for the 5/100-year storm event. See the appendix for detailed calculations.

Basin C1.14

This basin consists of runoff from residential development. Runoff will be directed east in Castor Drive to Design Point 10 in curb/gutter where it will be collected by a Type R inlet on Castor Drive. The developed flow from this basin is 2.3cfs and 5.1cfs for the 5/100-year storm event. See the appendix for detailed calculations.

Basin C1.15

This basin consists of runoff from residential development. Runoff will be directed south in Maidford Drive Design Point 11 in curb/gutter where it will be collected by a Type R inlet. The developed flow from this basin is 2.7cfs and 6.1cfs for the 5/100-year storm event. See the appendix for detailed calculations.

Basin C1.16

This basin consists of runoff from residential development. Runoff will be directed south in Maidford Drive Design Point 11 in curb/gutter where it will be collected by a Type R inlet. The developed flow from this basin is 1.1cfs and 2.5cfs for the 5/100-year storm event. See the appendix for detailed calculations.

Basin C1.17

This basin consists of runoff from residential development. Runoff will be directed south overland to Design Point 12 where it will be collected by a CDOT Type D inlet. The developed flow from this basin is 2.9cfs and 6.3cfs for the 5/100-year storm event. See the appendix for detailed calculations.

Basin C1.18

This basin consists of runoff from residential development and open space areas draining directly to Pond C1-R. Runoff will be directed overland to Pond C1-R. The developed flow from this basin is 5.7cfs and 19.5cfs for the 5/100-year storm event. See the appendix for detailed calculations.

Basin C2

This basin consists of runoff from open space areas draining directly to the East Tributary. The developed flow from this basin is 7.4cfs and 16.4cfs for the 5/100-year storm event.

Basin C4

This basin consists of runoff from backyards of residential development and open space areas draining directly to the East Tributary. The developed flow from this basin is 4.1cfs and 9.2cfs for the 5/100-year storm event. The backyard runoff will cross a grass buffer BMP prior to entering the East Tributary. See the appendix for detailed calculations. A deviation has been submitted with this preliminary plan.

Basin C5.1

This basin consists of runoff from residential development. Runoff will be directed south in Yazoo Drive Design Point 15 in curb/gutter where it will be collected by a Type R inlet. The developed flow from this basin is 2.2cfs and 3.7cfs for the 5/100-year storm event. See the appendix for detailed calculations.

Basin C5.2

This basin consists of runoff from backyards of residential development and open space areas draining to Pond CR3. The developed flow from this basin is 1.3cfs and 2.3cfs for the 5/100-year storm event. The runoff will be detained/treated in Pond CR3 prior to entering the East Tributary. See the appendix for detailed calculations.

Overall Basin C5

This overall basin consists of runoff from backyards of residential development and open space areas draining directly to Pond CR3. The developed flow from this overall basin is 3.5cfs and 6.0cfs for the 5/100-year storm event. The runoff will be detained/treated in Pond CR3 prior to entering the East Tributary. See the appendix for detailed calculations.

Basin C6

This basin consists of runoff from backyards of residential development and open space areas draining directly to Pond CR3. The developed flow from this basin is 1.5cfs and 3.3cfs for the 5/100-year storm event. The runoff will be detained/treated in Pond CR3 prior to entering the East Tributary. See the appendix for detailed calculations.

Basin D1.1

This basin consists of runoff from backyards of residential development and open space areas draining south to an 18" end section at Design Point 16. The developed flow from this basin is 2.1cfs and 4.6cfs for the 5/100-year storm event. See the appendix for detailed calculations.

Basin D1.2

This basin consists of runoff from Lorson Boulevard west of Tensas Drive. The runoff flows east to Tensas Drive then flows south in Tensas Drive. The developed flow from this basin is 2.2cfs and 3.9cfs for the 5/100-year storm event. See the appendix for detailed calculations.

Basin D1.3

This basin consists of runoff from residential development. Runoff will be directed west in Castor Drive to Design Point 17 at Tensas Drive. The developed flow from this basin is 0.8cfs and 1.7cfs for the 5/100-year storm event. See the appendix for detailed calculations.

Basin D1.4

This basin consists of runoff from residential development. Runoff will be directed south in Castor Drive to Design Point 18. The developed flow from this basin is 2.1cfs and 4.7cfs for the 5/100-year storm event. See the appendix for detailed calculations.

Basin D1.5

This basin consists of runoff from residential development. Runoff will be directed south in Castor Drive to Design Point 23 in curb/gutter where it will be collected by a Type R inlet. The developed flow from this basin is 1.9cfs and 4.1cfs for the 5/100-year storm event. See the appendix for detailed calculations.

Basin D1.6

This basin consists of runoff from residential development. Runoff will be directed south in Castor Drive to Design Point 20 in curb/gutter. The developed flow from this basin is 2.2cfs and 4.8cfs for the 5/100-year storm event. See the appendix for detailed calculations.

Basin D1.7

This basin consists of runoff from residential development. Runoff will be directed southwest in Winnicut Drive to Design Point 20 in curb/gutter. The developed flow from this basin is 2.2cfs and 4.9cfs for the 5/100-year storm event. See the appendix for detailed calculations.

Basin D1.8

This basin consists of runoff from residential development. Runoff will be directed southwest in Winnicut Drive to Design Point 21 in curb/gutter. The developed flow from this basin is 1.7cfs and 3.7cfs for the 5/100-year storm event. See the appendix for detailed calculations.

Basin D1.9

This basin consists of runoff from residential development. Runoff will be directed south in Castor Drive to Design Point 23 in curb/gutter where it will be collected by a Type R inlet. The developed flow from this basin is 0.5cfs and 1.1cfs for the 5/100-year storm event. See the appendix for detailed calculations.

Overall Basin D1

This overall basin consists of runoff from backyards of residential development and open space areas draining directly to Pond CR2 and is the total flow in the storm sewer at Design Point 23. The developed flow from this overall basin is 12.4cfs and 26.7cfs for the 5/100-year storm event. The runoff will be detained/treated in Pond CR2 prior to entering the East Tributary. See the appendix for detailed calculations.

Basin D2

This basin consists of runoff from backyards of residential development and open space areas draining directly to Jimmy Camp Creek. The developed flow from this basin is 2.4cfs and 5.2cfs for the 5/100-year storm event. The runoff will cross a grass buffer BMP prior to entering Jimmy Camp Creek. See the appendix for detailed calculations. A deviation must be provided at the final plat stage for the offsite runoff to be treated with a grass buffer.

Basin D3

This basin consists of runoff from open space areas draining directly to Jimmy Camp Creek. The developed flow from this basin is 0.5cfs and 2.2cfs for the 5/100-year storm event. See the appendix for detailed calculations.

Basin D4

This basin consists of runoff from backyards of residential development and open space areas draining directly to the East Tributary. The developed flow from this basin is 2.8cfs and 6.1cfs for the 5/100-year storm event. The runoff will cross a grass buffer BMP prior to entering the East Tributary. See the appendix for detailed calculations. A deviation must be provided at the final plat stage for the offsite runoff to be treated with a grass buffer.

Basin D5

This basin consists of runoff from backyards of residential development and open space areas draining directly to Pond CR2 which is a WQ pond. The developed flow from this basin is 1.4cfs and 4.5cfs for the 5/100-year storm event. See the appendix for detailed calculations.

Basin D6

This basin consists of runoff from open space areas draining south offsite onto the golf course as in existing conditions. No grading will be done in this basin and it will have the same drainage characteristics as in pre-developed conditions. The developed flow from this basin is 0.1cfs and 0.6cfs for the 5/100-year storm event. This flow is the same as pre-developed conditions. See the appendix for detailed calculations.

See the Developed Conditions Hydrology Calculations in the back of this report and the Developed Conditions Drainage Map (Map Pocket) for the 5-year and 100-year storm event amounts.

5.0 HYDRAULIC SUMMARY

The sizing of the hydraulic structures and detentions ponds were prepared by using the *StormSewers* and *Hydrographs* computer software programs developed by Intellisolve, which conforms to the methods outlined in the "City of Colorado Springs/El Paso County Drainage Criteria Manual". Street capacities and Inlets were sized by Denver Urban Drainage's xcel spreadsheet UD-Inlet.

It is the intent of this drainage report to use the proposed curb/gutter and storm sewer in the streets to convey runoff to detention and water quality ponds then to the East Tributary of Jimmy Camp Creek. Inlet size and location are preliminary only as shown on the storm sewer layout in the appendix. See Appendix C for detailed hydraulic calculations and the storm sewer model.

Table 1: Street Capacities (100-year capacity is only ½ of street)

| Street Slope | Residential Local | | Residential Collector | | Principal Arterial | |
|--------------|-------------------|----------|-----------------------|----------|--------------------|----------|
| | 5-year | 100-year | 5-year | 100-year | 5-year | 100-year |
| 0.5% | 6.3 | 26.4 | 9.7 | 29.3 | 9.5 | 28.5 |
| 0.6% | 6.9 | 28.9 | 10.6 | 32.1 | 10.4 | 31.2 |
| 0.7% | 7.5 | 31.2 | 11.5 | 34.6 | 11.2 | 33.7 |
| 0.8% | 8.0 | 33.4 | 12.3 | 37.0 | 12.0 | 36.0 |
| 0.9% | 8.5 | 35.4 | 13.0 | 39.3 | 12.7 | 38.2 |
| 1.0% | 9.0 | 37.3 | 13.7 | 41.4 | 13.4 | 40.2 |
| 1.4% | 10.5 | 44.1 | 16.2 | 49.0 | 15.9 | 47.6 |
| 1.8% | 12.0 | 45.4 | 18.4 | 50.4 | 18.0 | 50.4 |
| 2.2% | 13.3 | 42.8 | 19.4 | 47.5 | 19.5 | 47.5 |
| 2.6% | 14.4 | 40.7 | 18.5 | 45.1 | 18.5 | 45.1 |
| 3.0% | 15.5 | 39.0 | 17.7 | 43.2 | 17.8 | 43.2 |
| 3.5% | 16.7 | 37.2 | 16.9 | 41.3 | 17.0 | 41.3 |
| 4.0% | 17.9 | 35.7 | 16.2 | 39.7 | 16.3 | 29.7 |
| 4.5% | 19.0 | 34.5 | 15.7 | 38.3 | 15.7 | 38.3 |
| 5.0% | 19.9 | 33.4 | 15.2 | 37.1 | 15.2 | 37.1 |
| | | | | | | |

Note: all flows are in cfs (cubic feet per second)

Drainage calculations for Lorson Boulevard can be found in Project CDR 18-006 and are not included in this report.

Design Point 1

Design Point 1 is located at a low point in Alsea Drive (east side)

(5-year storm)

Tributary Basins: C1.1-C1.2

Upstream flowby: 0cfs

Inlet/MH Number: Inlet DP-1

Total Street Flow: 9.1cfs

Flow Intercepted: 9.1cfs

Inlet Size: 15' type R, sump

Flow Bypassed: 0

Street Capacity: Street slope = 1.5%, capacity = 10.9cfs, capacity okay

(100-year storm)

Tributary Basins: C1.1-C1.2

Upstream flowby: 0cfs

Inlet/MH Number: Inlet DP-1

Total Street Flow: 20.2cfs

Flow Intercepted: 20.2cfs

Inlet Size: 15' type R, sump

Flow Bypassed: 0

Street Capacity: Street slope = 1.5%, capacity = 44.4cfs (half street) is okay

Design Point 2

Design Point 2 is located on Alsea Drive and is located north of Design Point 3. This design point was added to verify the street capacity of Alsea Drive on the north side of Inlet DP-3. The total street flow is 5.7cfs and 12.6cfs in the 5/100-year storm events from Basins C1.3 & C1.4. The street capacity of Alsea Drive at 1.7% slope is 11.3cfs (5-yr) and 44.8cfs (100-yr). The street capacity is not exceeded north of Inlet DP-3.

Design Point 3

Design Point 3 is located at a low point in Alsea Drive (west side)

(5-year storm)

Tributary Basins: C1.3-C1.5

Upstream flowby: 0cfs

Inlet/MH Number: Inlet DP-3

Total Street Flow: 6.0cfs

Flow Intercepted: 6.0cfs

Inlet Size: 15' type R, sump

Flow Bypassed: 0

Street Capacity: Street slope = 1.5%, capacity = 10.9cfs, capacity okay

(100-year storm)

Tributary Basins: C1.3-C1.5

Upstream flowby: 0cfs

Inlet/MH Number: Inlet DP-3

Total Street Flow: 13.3cfs

Flow Intercepted: 13.3cfs

Inlet Size: 15' type R, sump

Flow Bypassed: 0

Street Capacity: Street slope = 1.5%, capacity = 44.4cfs (half street) is okay

Design Point 4

Design Point 4 is the total pipe flow in storm sewer from Alsea Drive to Pond C1-R and is located west of Design Point 3. The total pipe flow is 15.0cfs and 33.4cfs in the 5/100-year storm events. Since there is a low point in Alsea Drive an emergency overflow swale must be constructed from Alsea Drive to Pond C1-R for 33.4cfs. The overflow swale has an 8' bottom, 4:1 side slopes, 1.3% slope, and flows at a 0.69' flow depth.

Design Point 5

Design Point 5 is located on the north side of Castor Drive and is located west of Design Point 6. This design point was added to verify the street capacity of Castor Drive on the north side of the street. The total street flow is 4.1cfs and 9.1cfs in the 5/100-year storm events from Basins C1.7 & C1.8. The street capacity of Castor Drive at 0.65% slope is 7.2cfs (5-yr) and 30.0cfs (100-yr). The street capacity is not exceeded west of Inlet DP-6.

Design Point 6

Design Point 6 is located at a low point in Castor Drive adjacent to Pond C1-R (north side of street)

(5-year storm)

Tributary Basins: C1.6-C1.8

Upstream flowby: 0cfs

Inlet/MH Number: Inlet DP-6

Total Street Flow: 5.3cfs

Flow Intercepted: 5.3cfs

Inlet Size: 10' type R, sump

Flow Bypassed: 0

Street Capacity: Street slope = 0.65%, capacity = 7.2cfs, capacity okay

(100-year storm)

Tributary Basins: C1.6-C1.8

Upstream flowby: 0cfs

Inlet/MH Number: Inlet DP-6

Total Street Flow: 11.8cfs

Flow Intercepted: 11.8cfs

Inlet Size: 10' type R, sump

Flow Bypassed: 0

Street Capacity: Street slope = 0.65%, capacity = 30.0cfs (half street) is okay

Design Point 7

Design Point 7 is located on the south side of Castor Drive and is located west of Maidford Drive. This design point was added to verify the street capacity of Castor Drive on the south side of the street. The total street flow is 5.4cfs and 12.1cfs in the 5/100-year storm events from Basins C1.9 - C1.11. The street capacity of Castor Drive at 0.7% slope is 7.5cfs (5-yr) and 31.2cfs (100-yr). The street capacity is not exceeded at this design point.

Design Point 8

Design Point 8 is located on the south side of Castor Drive and is located east of Design Point 10. This design point was added to verify the street capacity of Castor Drive on the south side of the street on the east side of Inlet DP-10. The total street flow is 5.7cfs and 12.8cfs in the 5/100-year storm events from Basins C1.9 - C1.12. The street capacity of Castor Drive at 0.7% slope is 7.5cfs (5-yr) and 31.2cfs (100-yr). The street capacity is not exceeded at this design point.

Design Point 9

Design Point 9 is located on the south side of Castor Drive and is located west of Design Point 10. This design point was added to verify the street capacity of Castor Drive on the south side of the street on the west side of Inlet DP-10. The total street flow is 3.2cfs and 7.0cfs in the 5/100-year storm events from Basins C1.13 - C1.14. The street capacity of Castor Drive at 0.65% slope is 7.2cfs (5-yr) and 30.0cfs (100-yr). The street capacity is not exceeded at this design point.

Design Point 10

Design Point 10 is located at a low point in Castor Drive adjacent to Pond C1-R (south side of street)

(5-year storm)

Tributary Basins: C1.9-C1.14

Upstream flowby: 0cfs

Inlet/MH Number: Inlet DP-10

Total Street Flow: 9.7cfs

Flow Intercepted: 9.7cfs

Flow Bypassed: 0

Inlet Size: 15' type R, sump

Street Capacity: Street slope = 0.65%, capacity = 7.2cfs, capacity okay since half flow from east

(100-year storm)

Tributary Basins: C1.9-C1.14

Upstream flowby: 0cfs

Inlet/MH Number: Inlet DP-10

Total Street Flow: 21.5cfs

Flow Intercepted: 21.5cfs

Flow Bypassed: 0

Inlet Size: 15' type R, sump

Street Capacity: Street slope = 0.65%, capacity = 30.0cfs (half street) is okay

Design Point 11

Design Point 11 is located at a low point in Maidford Drive.

(5-year storm)

Tributary Basins: C1.15-C1.16

Upstream flowby: 0cfs

Inlet/MH Number: Inlet DP-11

Total Street Flow: 3.7cfs

Flow Intercepted: 3.7cfs

Flow Bypassed: 0

Inlet Size: 15' type R, sump

Street Capacity: Street slope = 0.7%, capacity = 7.5cfs, capacity okay

(100-year storm)

Tributary Basins: C1.15-C1.16

Upstream flowby: 0cfs

Inlet/MH Number: Inlet DP-11

Total Street Flow: 8.3cfs

Flow Intercepted: 8.3cfs

Flow Bypassed: 0

Inlet Size: 15' type R, sump

Street Capacity: Street slope = 0.7%, capacity = 31.2cfs (half street) is okay

Design Point 12

Design Point 12 is located south of Castor Drive and west of Maidford Drive and Design Point 11. This design point was added to verify flow to Inlet DP-12 from Basin C1.17. The total flow in the backyard swale is 2.9cfs and 6.3cfs in the 5/100-year storm events from Basins C1.17. A CDOT type D inlet will capture the flow at this design point and convey it via storm sewer to Pond C1-R.

Design Point 13

Design Point 13 is located on the north of Castor Drive and is the total flow in storm sewer entering Pond C1-R from Design Point 11 & 12. The total flow in the storm sewer is 6.3cfs and 14.1cfs in the 5/100-year storm events from Basins C1.15 – C1.17.

Design Point 14

Design Point 14 is located on the north of Castor Drive and is the total flow in storm sewer entering Pond C1-R from Design Point 6 & 10. The total flow in the storm sewer is 14.5cfs and 32.1cfs in the 5/100-year storm events from Basins C1.6 – C1.14.

Design Point 14a

Design Point 14a is located on the south side of Castor Drive and is the total flow from the outlet structure for Pond C1-R. The total outflow is 10.0cfs and 138.0cfs in the 5/100-year storm events from Pond C1-R per the full spectrum EDB worksheets.

Design Point 15

Design Point 15 is located at a low point in Yazoo Drive.

(5-year storm)

Tributary Basins: C5.1

Upstream flowby: 0cfs

Inlet/MH Number: Inlet DP-15

Total Street Flow: 2.2cfs

Flow Intercepted: 2.2cfs

Inlet Size: 5' type R, sump

Flow Bypassed: 0

Street Capacity: Street slope = 0.7%, capacity = 7.5cfs, capacity okay

(100-year storm)

Tributary Basins: C5.1

Upstream flowby: 0cfs

Inlet/MH Number: Inlet DP-15

Total Street Flow: 3.7cfs

Flow Intercepted: 3.7cfs

Inlet Size: 5' type R, sump

Flow Bypassed: 0

Street Capacity: Street slope = 0.7%, capacity = 31.2cfs (half street) is okay

Design Point 15a

Design Point 15a is located south side of Yazoo Drive and is the total flow from the outlet structure for Pond CR3. The total outflow is 0.07cfs and 2.5cfs in the 5/100-year storm events from Pond CR3 per the full spectrum EDB/SFB worksheets.

Design Point 16

Design Point 16 is located south of Castor Drive and west of Winnicut Drive. This design point was added to verify flow to Design Point 16 from Basin D1.1 in a swale. The total flow in the backyard swale is 2.1cfs and 4.6cfs in the 5/100-year storm events from Basins D1.1. An 18" storm sewer and end section will capture the flow at this design point and convey it via south in storm sewer to Design Point 24 .

Design Point 17

Design Point 17 is located on the north side of Castor Drive and is west of Tensas Drive. This design point was added to verify the street capacity of Castor Drive. The total street flow is 2.8cfs and 5.3cfs in the 5/100-year storm events from Basins D1.2 & D1.3. The street capacity of Castor Drive at 0.85% slope is 8cfs (5-yr) and 33.4cfs (100-yr). The street capacity is not exceeded.

Design Point 18

Design Point 18 is located on the west side of Castor Drive and is southwest of Design Point 17. This design point was added to verify the street capacity of Castor Drive. The total street flow is 4.2cfs and 8.6cfs in the 5/100-year storm events from Basins D1.2 - D1.4. The street capacity of Castor Drive at 0.8% slope is 8.2cfs (5-yr) and 34.4cfs (100-yr). The street capacity is not exceeded.

Design Point 19

Design Point 19 is located on the south end of Castor Drive in the cul-de-sac. This design point was added to verify the street capacity of Castor Drive in the cul-de-sac from the west. The total street flow is 5.2cfs and 10.9cfs in the 5/100-year storm events from Basins D1.2 - D1.5. The street capacity of Castor Drive at 0.8% slope is 8cfs (5-yr) and 33.4cfs (100-yr). The street capacity is not exceeded.

Design Point 20

Design Point 20 is located on the north side of Winnicut Drive at Castor Drive south of Design Point 16. This design point was added to verify the street capacity of Castor/Winnicut Drive. The total street flow is 4.3cfs and 9.4cfs in the 5/100-year storm events from Basins D1.6 - D1.7. The street capacity at 0.8% slope is 8cfs (5-yr) and 33.4cfs (100-yr). The street capacity is not exceeded.

Design Point 21

Design Point 21 is located on the south side of Winnicut Drive at Castor Drive south of Design Point 20. This design point was added to verify the street capacity of Castor Drive. The total street flow is 5.9cfs and 12.9cfs in the 5/100-year storm events from Basins D1.6 - D1.8. The street capacity at 0.8% slope is 8cfs (5-yr) and 33.4cfs (100-yr). The street capacity is not exceeded.

Design Point 22

Design Point 22 is located on the south end of Castor Drive in the cul-de-sac. This design point was added to verify the street capacity of Castor Drive in the cul-de-sac from the east. The total street flow is 6.0cfs and 13.3cfs in the 5/100-year storm events from Basins D1.6 - D1.9. The street capacity of Castor Drive at 0.8% slope is 8cfs (5-yr) and 33.4cfs (100-yr). The street capacity is not exceeded.

Design Point 23

Design Point 23 is located at a low point in Castor Drive in the cul-de-sac at the very south end from Design Points 19 and 22.

(5-year storm)

Tributary Basins: D1.2-D1.9

Upstream flowby: 0cfs

Inlet/MH Number: Inlet DP-23

Total Street Flow: 10.8cfs

Flow Intercepted: 10.8cfs

Flow Bypassed: 0

Inlet Size: 20' type R, sump

Street Capacity: Street slope = 0.8%, capacity = 8.0cfs, capacity okay since half is from each side

(100-year storm)

Tributary Basins: D1.2-D1.9

Upstream flowby: 0cfs

Inlet/MH Number: Inlet DP-23

Total Street Flow: 23.1cfs

Flow Intercepted: 23.1cfs

Flow Bypassed: 0

Inlet Size: 20' type R, sump

Street Capacity: Street slope = 0.8%, capacity = 33.4cfs (half street) is okay

Design Point 24

Design Point 24 is located south of Castor Drive and Design Point 23. This design point was added to calculate the total flow from the "D1" basins in the storm sewer entering Pond CR2. The total flow in the storm sewer is 12.4cfs and 26.7cfs in the 5/100-year storm events from the Basins D1 basins. A 24" storm sewer at this design point will convey flow south in this storm sewer to Pond CR2.

Design Point 24a

Design Point 24a is located south of the Castor Drive cul-de-sac and is the total flow from the outlet structure for Pond CR2. The total outflow is 0.2cfs and 10.4cfs in the 5/100-year storm events from Pond CR2 per the full spectrum EDB worksheets.

6.0 DETENTION AND WATER QUALITY PONDS

Detention and Storm Water Quality for Creekside at Lorson Ranch Filing No. 1 is required per El Paso County criteria. We have implemented the Full Spectrum approach for detention for Creekside at Lorson Ranch Filing No. 1 per the Denver Urban Drainage Districts specifications. There is one existing detention pond, one proposed detention pond, and one sand filter basin with full spectrum detention for this project site. Nearly all runoff from this site will flow to ponds and will incorporate storm water quality features prior to discharge into the East Tributary. There are some area comprising of backyard runoff that will flow directly to Jimmy Camp Creek or the Etrib which will require a deviation for Water Quality Grass Buffer submitted with this preliminary plan.

Full Spectrum Pond Construction Requirements

Design calculations for full spectrum ponds will include a 10' wide gravel access road on a 15' wide bench at a maximum 10% slope to the pond outlet structures. The final design of the full spectrum ponds consists of an outlet structure, storm sewer outfall to the East Tributary, concrete low flow channels (in new ponds), sediment forebays, and overflow weirs to the East Tributary. Soil borings, embankment, slope, and compaction requirements for detention ponds can be found in the geotechnical report for the Creekside prepared by RMG.

Detention Pond C1-R (Full Spectrum Design)

Pond C1-R formerly known as Pond C1 (Lorson Ranch MDDP1, Allegiant at Lorson Ranch), is an existing pond constructed in 2010 to serve residential subdivisions north of Lorson Boulevard. Pond C1-R included a traditional outlet structure, forebays, low flow channels, and was sized to accommodate residential areas north of Lorson Boulevard and most of the runoff from Creekside at Lorson Ranch Filing No. 1. Since full spectrum detention is now required on new developments we are proposing to remove the old outlet structure and construct a new full spectrum outlet structure to meet current detention requirements. The existing forebays, low flow channels will remain and new forebays/low flow channels will be constructed to accommodate additional storm sewer outfalls to the pond. Based on the overall tributary area to Pond C1-R and the existing as-built pond volumes it appears that the pond was built large enough in 2010 and does not need additional volume to serve the new drainage areas in Creekside. Pond C1-R is designed using the UDCF Full Spectrum spreadsheets. The outlet structure is a standard 17' long x 7' wide full spectrum sloped outlet structure to match pre-developed rates. The full spectrum print outs are in the appendix of this report. See map in appendix for watershed areas.

17'x7'?

- Watershed Area: 119.5 acres
- Watershed Imperviousness: 55%
- Hydrologic Soils Group C (80%) and B (20%)
- Zone 1 WQCV: 2.025 ac-ft, WSEL: 5686.89, 1.0 cfs
- Zone 2 EURV: 5.775 ac-ft, WSEL: 5688.71, Top EURV wall set at 5689.23, 22'x4' outlet with 4:1 slope, 5.0 cfs
- (5-yr): 7.468 ac-ft, WSEL: 5689.46, 9.6 cfs
- Zone 3 (100-yr): 11.939 ac-ft, WSEL: 5691.24, 140.50 cfs
- Pipe Outlet: 54" RCP at 0.3% with restrictor plate 44" up.
- Overflow Spillway: overtops roadway, elevation=5693.60
- Pre-development release rate into creek compliance from full spectrum pond spreadsheets
- Pond Bottom Elevation: 5683.80

The emergency overflow for Pond C1-R flows across Castor Drive. Per DCM Volume 1, Chapter 13, Figure 13-12a, the overflow depth across the road must be less than 1' deep under undetained fully developed flow conditions. The downstream embankment must be protected with rip rap designed in accordance with Equation 13-9. The minimum rip rap size is 6" but we are proposing to use rip rap salvaged from the old spillway which has a size of 12" D50 rip rap. The flow depth across Castor Drive is located in a vertical curve and was approximated using circular weir calculations and a full developed flow rate of 294cfs resulting in a 0.88' flow depth.

Detention Pond CR2 (Full Spectrum Design)

This is an on-site permanent full spectrum extended detention pond that includes water quality and discharges directly into the East Tributary. Pond CR2 is designed using the UDCF Full Spectrum spreadsheets. The outlet structure is a standard 3'x64' full spectrum sloped outlet structure and the overflow spillway is a weir set above the outlet structure designed by the full spectrum spreadsheets to match pre-developed rates. The full spectrum print outs are in the appendix of this report. See map in appendix for watershed areas.

- Watershed Area: 10.0 acres
- Watershed Imperviousness: 52%
- Hydrologic Soils Group B
- Forebay: 0.004ac-ft, 18" depth
- Zone 1 WQCV: 0.162ac-ft, WSEL: 5683.29, 0.1cfs
- Zone 2 EURV: 0.525ac-ft, WSEL: 5684.75, Top EURV wall set at 5685.00, 4'x4' outlet with 4:1 slope, 0.2cfs
- (5-yr): 0.582ac-ft, WSEL: 5684.93, 0.2cfs
- Zone 3 (100-yr): 0.957ac-ft, WSEL: 5686.04, 10.4cfs
- Pipe Outlet: 18" RCP at 1.0% with restrictor plate up 10"
- Overflow Spillway: 10' wide bottom, elevation=5687.00, 4:1 side slopes, flow depth=0.71'
- Pre-development release rate into creek compliance from full spectrum pond spreadsheets
- Pond Bottom Elevation: 5681.00


68"

3'x68"?

Detention Pond CR3 (Full Spectrum Design, Sand Filter Basin)

This is an on-site permanent full spectrum sand filter basin pond that includes water quality, full spectrum detention, and discharges directly into the East Tributary. Pond CR3 is designed using the UDCF Full Spectrum spreadsheets. Water quality is provided by a Sand Filter Basin and full spectrum detention is provided by a CDOT Type C drainage structure modified to meet full spectrum requirements. The primary overflow structure is a CDOT Type D drainage structure connected to the full spectrum structure. The primary overflow structure will collect the incoming undetained developed flows of 7.7cfs at a depth of 0.45' deep and a top elevation of 5688.00 and convey it to the East Tributary via an 18" storm sewer pipe. The secondary overflow structure is a trapezoidal swale set at elevation 5688.50 and a top elevation of 5689.00. The full spectrum outlet structure and spreadsheets are designed to match pre-developed rates. The full spectrum print outs are in the appendix of this report. See map in appendix for watershed areas.

- Watershed Area: 2.66 acres
- Watershed Imperviousness: 40%
- Hydrologic Soils Group B
- Forebay: 0.00165ac-ft
- Sand Filter Area: 756sf, 11/16" orifice for underdrain restrictor plate
- Zone 1 WQCV: 0.028ac-ft, WSEL: 5685.13, 0.02cfs

- Zone 2 EURV: 0.07ac-ft, WSEL: 5686.45, Top EURV wall set at 5687.00, 3'x3' CDOT Type C outlet, flat top, 0.07cfs
- EURV Orifice = 6.2" orifice, 2.3' below sand filter (5684.00)
- (5-yr): 0.113ac-ft, WSEL: 5686.60, 0.07cfs
- Zone 3 (100-yr): 0.239ac-ft, WSEL: 5687.95, 2.5cfs
- Pipe Outlet: 18" RCP at 1.56%
- Overflow Spillway: 6' wide bottom, elevation=5688.50, 4:1 side slopes, flow depth=0.38'
- Pre-development release rate into creek compliance from full spectrum pond spreadsheets
- Pond Bottom Elevation: 5683.80  84.00?

Water Quality Design

Water quality will be provided by two permanent extended detention basins (Pond C1-R, CR2) and one Sand Filter Basin (Pond CR3) for 98.9% of the 83.085acre site. Approximately 0.91 acres (1.1% of the total 83.085-acre preliminary plan area) consists of backyards that drain directly to the East Tributary or Jimmy Camp Creek over grass buffers. A deviation from county criteria to use a grass buffer bmp to treat runoff from these backyard drainage areas is submitted. The backyards draining to the grass buffer is broken into three separate areas and the largest of the three areas is 0.4 acres which generates a 2yr runoff of 0.43cfs. Using the grass buffer worksheets the resultant grass buffer width is 9' wide at maximum of 10% slope. All three grass buffers will be a minimum of 9' wide.

7.0 FOUR STEP PROCESS

The site has been developed to minimize wherever possible the rate of developed runoff that will leave the site and to provide water quality management for the runoff produced by the site as proposed on the development plan. The following four step process should be considered and incorporated into the storm water collection system and storage facilities where applicable.

Step 1: Employ Runoff Reduction Practices

Creekside at Lorson Ranch Filing No. 1 has employed several methods of reducing runoff.

- The street configuration was laid out to minimize the length of streets. Many streets are straight and perpendicular resulting in lots with less wasted space.
- Large open space tracts of land act as a buffer between lots and the East Tributary of Jimmy Camp Creek
- East Tributary of Jimmy Camp Creek with a natural sand bottom and vegetated slopes has been preserved through this site
- Only a small portion of lots on the south side of the site discharge runoff south over an open space buffer prior to discharge into the creek. The remainder of lots drain to WQ ponds.
- Lorson Ranch Metro District requires homeowners to maintain landscaping on lots
- Full Spectrum Detention Pond C1-R, CR2, and CR3 (sand filter basin) will be constructed. The full spectrum detention ponds mimics existing storm discharges

Step 2: Implement BMP's that Slowly Release the Water Quality Capture Volume

Treatment and slow release of the water quality capture volume (WQCV) is required. Creekside at Lorson Ranch Filing No. 1 will utilize Pond C1-R, CR2, and CR3 which are full spectrum stormwater detention ponds which includes Water Quality Volumes and WQ outlet structures. Pond CR3 has a sand filter basin for WQ treatment.

Step 3: Stabilize Drainageways

East Tributary of Jimmy Camp Creek is a major drainageway located within this site. The East Tributary of JCC will be stabilized per county criteria for this subdivision. The design includes a low flow channel bottom and selectively armored sides. Kiowa Engineering is providing the East Tributary design.

Step 4: Implement Site Specific & Source Control BMP's

There are no potential sources of contaminants that could be introduced to the County's MS4. During construction the source control will be provided with the proper installation of erosion control BMPs to limit erosion and transport of sediment. Area disturbed by construction will be seeded and mulched. Cut and fill slopes will be reseeded, and the slopes equal to or greater than three-to-one will be protected with erosion control fabric. Silt fences will be placed at the bottom of re-vegetated and rough graded slopes. Inlet protection will be used around proposed inlets. In addition, temporary sediment basins will be constructed so runoff will be treated prior to discharge. Construction BMPs in the form of vehicle tracking control, sediment basins, concrete washout area, rock socks, buffers, and silt fences will be utilized to protect receiving waters.

Based on 4,600 SF lots the
imperviousness is about 57.6%

8.0 DRAINAGE AND BRIDGE FEES

Creekside at Lorson Ranch Filing No. 1 is located within the Jimmy Camp Creek drainage basin which is currently a fee basin in El Paso County. Current El Paso County regulations require drainage and bridge fees to be paid for platting of land as part of the plat recordation process. Lorson Ranch Metro District will be constructing the major drainage infrastructure as part of the district improvements.

Creekside at Lorson Ranch Filing No. 1 contains 83.088 acres. This project consists of 43.514 acres of open space (2% impervious), and the remaining 39.574 acres is residential (50% impervious). The 2019 drainage fees are \$18,350, bridge fees are \$858 and Drainage Surety fees are \$7,285 per impervious acre per Resolution 18-470. The drainage and bridge fees are calculated when the final plat is submitted. The fees are due at plat recordation. The following table details the drainage fees for the platted area.

Table 1: Drainage/Bridge Fees

| Type of Land Use | Total Area (ac) | Imperviousness | Drainage Fee | Bridge Fee | Surety Fee |
|-------------------------------|-----------------|----------------|--------------|------------|------------|
| Residential Area | 39.574 | 50% | \$363,091 | \$16,977 | \$144,148 |
| Open Space, Landscape Tracts, | 43.514 | 2% | \$15,970 | \$746 | \$6,340 |
| | | | | | |
| Total | | | \$379,061 | \$17,723 | \$150,488 |

Table 7.1: Public Drainage Facility Costs (non-reimbursable)

| Item | Quantity | Unit | Unit Cost | Item Total |
|-----------|----------|------|-----------|------------|
| Rip Rap | 200 | CY | \$50/CY | \$10,000 |
| Manholes | 1 | EA | \$3000/EA | \$3,000 |
| 18" Storm | 1226 | LF | \$35 | \$42,910 |
| 24" Storm | 286 | LF | \$40 | \$11,440 |

| | | | | |
|---------|---|----|-----------------|-----------|
| 18" FES | 1 | EA | \$200 | \$200 |
| Inlets | 8 | EA | \$3,000 | \$24,000 |
| | | | Subtotal | \$91,550 |
| | | | Eng/Cont 15%) | \$13,750 |
| | | | Total Est. Cost | \$105,300 |

Table 7.2: Lorson Ranch Metro District Drainage Facility Costs (non-reimbursable)

| Item | Quantity | Unit | Unit Cost | Item Total |
|--------------------------------|----------|------|-----------------|------------|
| Full Spectrum Ponds and Outlet | 2.5 | EA | \$70,000 | \$175,000 |
| | | | Subtotal | \$175,000 |
| | | | Eng/Cont (15%) | \$26,250 |
| | | | Total Est. Cost | \$201,250 |

Table 7.3: Future Lorson Ranch Metro District Drainage Facility Costs (Potential Reimbursable)

| Item | Quantity | Unit | Unit Cost | Item Total |
|---|----------|------|-----------------|------------|
| E. Tributary Channel Improvements-Kiowa | 1 | LS | \$800,000 | \$800,000 |
| | | | Subtotal | \$800,000 |
| | | | | |
| | | | Total Est. Cost | \$800,000 |

9.0 CONCLUSIONS

This drainage report has been prepared in accordance with the City of Colorado Springs/El Paso County Drainage Criteria Manual. The proposed development and drainage infrastructure will not cause adverse impacts to adjacent properties or properties located downstream. Several key aspects of the development discussed above are summarized as follows:

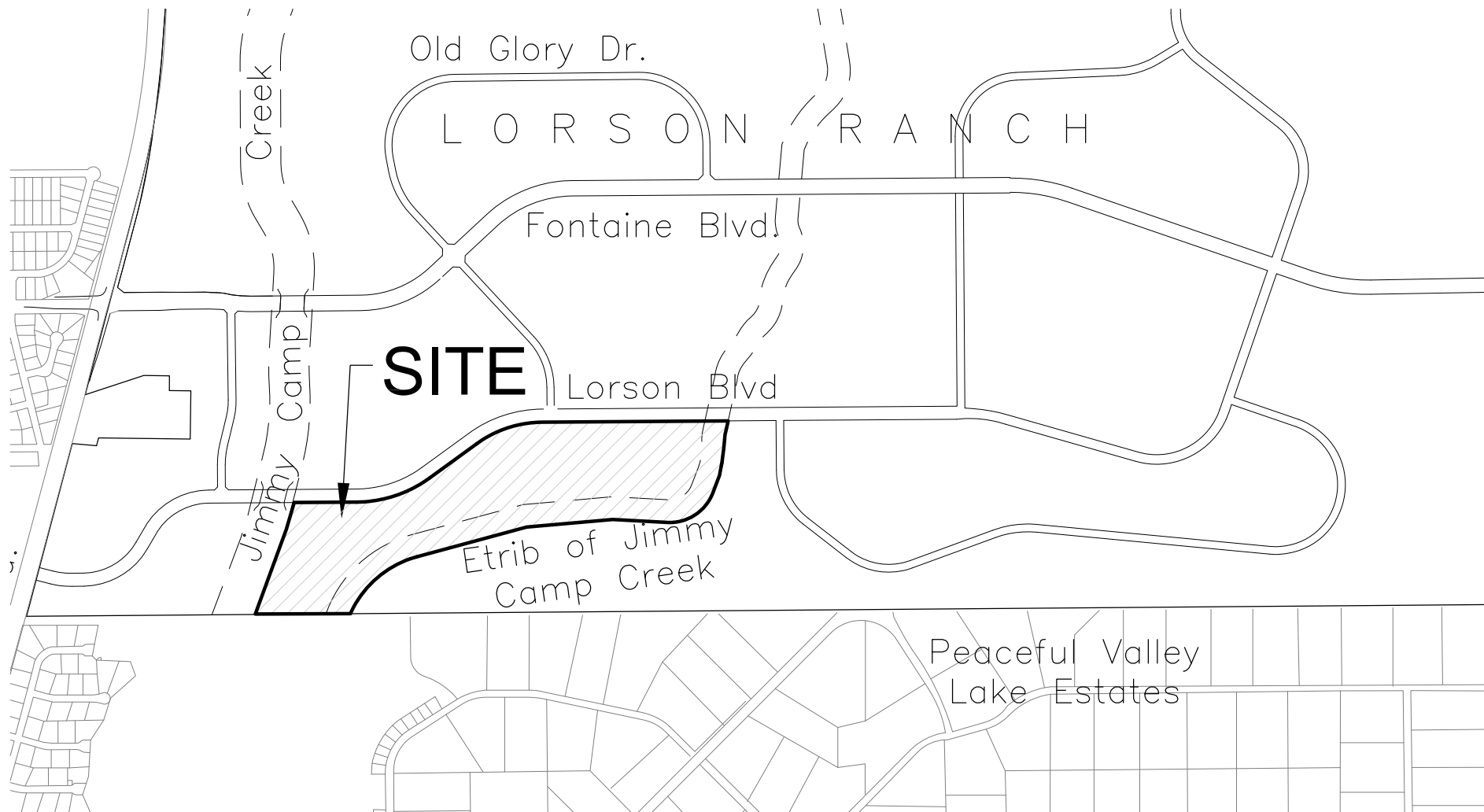
- Developed runoff will be conveyed via curb/gutter and storm sewer facilities
- The East Tributary of Jimmy Camp Creek will be reconstructed within this study area
- Detention and water quality for this preliminary plan area will be provided in two permanent ponds and one sand filter basin.

clarify

10.0 REFERENCES

1. City of Colorado Springs/El Paso County Drainage Criteria Manual DCM, dated November, 1991
2. Soil Survey of El Paso County Area, Colorado by USDA, SCS
3. Jimmy Camp Creek Drainage Basin Planning Study, Dated March 9, 2015, by Kiowa Engineering Corporation
4. City of Colorado Springs "Drainage Criteria Manual, Volume 2
5. El Paso County "Engineering Criteria Manual"
6. Lorson Ranch MDDP1, October 26, 2006 by Pentacor Engineering.
7. El Paso County Resolution #15-042, El Paso County adoption of Chapter 6 and Section 3.2.1 of the City of Colorado Springs Drainage Criteria Manual dated May, 2014.

APPENDIX A – VICINTIY MAP, SOILS MAP, FEMA MAP



VICINITY MAP
NO SCALE



CORE
ENGINEERING GROUP

15004 1ST AVE. S.
BURNSVILLE, MN 55306
PH: 719.570.1100

CONTACT: RICHARD L. SCHINDLER, P.E.
EMAIL: Rich@ceg1.com

CREEKSIDE AT LORSON RANCH FILING NO. 1
VICINITY MAP

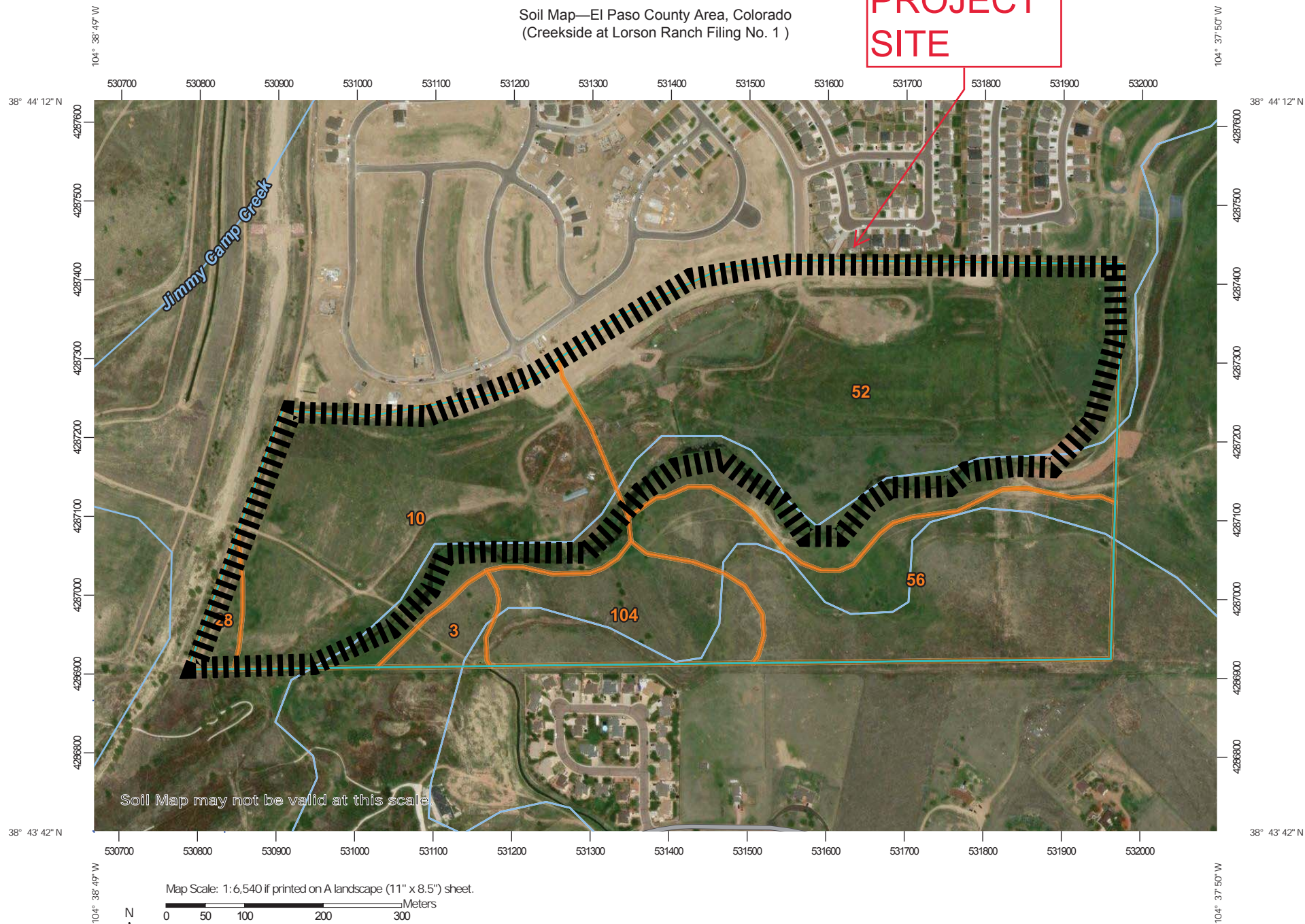
SCALE:
NTS

DATE:
AUGUST, 2018

FIGURE NO.
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Soil Map—El Paso County Area, Colorado
(Creekside at Lorson Ranch Filing No. 1)

PROJECT
SITE




Natural Resources
Conservation Service

Web Soil Survey
National Cooperative Soil Survey

6/23/2018
Page 1 of 3

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

Special Point Features



Blowout



Borrow Pit



Clay Spot



Closed Depression



Gravel Pit



Gravelly Spot



Landfill



Lava Flow



Marsh or swamp



Mine or Quarry



Miscellaneous Water



Perennial Water



Rock Outcrop



Saline Spot



Sandy Spot



Severely Eroded Spot



Sinkhole



Slide or Slip



Sodic Spot



Spoil Area



Stony Spot



Very Stony Spot



Wet Spot



Other



Special Line Features

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: Nov 7, 2015—Mar 9, 2017

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

Map Unit Legend

| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
|------------------------------------|--|--------------|----------------|
| 3 | Ascalon sandy loam, 3 to 9 percent slopes | 2.4 | 2.0% |
| 10 | Blendon sandy loam, 0 to 3 percent slopes | 31.3 | 26.0% |
| 28 | Ellicott loamy coarse sand, 0 to 5 percent slopes | 1.5 | 1.2% |
| 52 | Manzanst clay loam, 0 to 3 percent slopes | 51.4 | 42.7% |
| 56 | Nelson-Tassel fine sandy loams, 3 to 18 percent slopes | 23.4 | 19.4% |
| 104 | Vona sandy loam, warm, 0 to 3 percent slopes | 10.4 | 8.7% |
| Totals for Area of Interest | | 120.5 | 100.0% |

Native vegetation is dominantly western wheatgrass, side-oats grama, and needleandthread. This soil is best suited to deep-rooted grasses.

Proper range management is necessary to prevent excessive removal of plant cover from the soil. Interseeding improves the existing vegetation. Deferment of grazing in spring increases plant vigor and soil stability. Proper location of livestock watering facilities helps to control grazing.

Windbreaks and environmental plantings are fairly well suited to this soil. Blowing sand and low available water capacity are the main limitations for the establishment of trees and shrubs. The soil is so loose that trees need to be planted in shallow furrows and plant cover needs to be maintained between the rows. Supplemental irrigation may be needed to insure survival. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, and Siberian elm. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

This soil is suited to wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

This soil has good potential for urban development. Soil blowing is a hazard if protective vegetation is removed. Special erosion control practices must be provided to minimize soil losses. Capability subclass VIe.

9—Blakeland complex, 1 to 9 percent slopes. This complex is on uplands, mostly in the Falcon area. The average annual precipitation is about 15 inches, the average annual air temperature is about 47 degrees F, and the frost-free period is about 135 days.

This complex is about 60 percent Blakeland loamy sand, about 30 percent Fluvaquentic Haplaquolls, and 10 percent other soils.

Included with these soils in mapping are areas of Columbine gravelly sandy loam, 0 to 3 percent slopes, Ellicott loamy coarse sand, 0 to 5 percent slopes, and Ustic Torrifluvents, loamy.

The Blakeland soil is in the more sloping areas. It is deep and somewhat excessively drained. It formed in sandy alluvium and eolian material derived from arkosic sedimentary rock. Typically, the surface layer is dark grayish brown loamy sand about 11 inches thick. The substratum, to a depth of 27 inches, is brown loamy sand; it grades to pale brown sand that extends to a depth of 60 inches or more.

Permeability of the Blakeland soil is rapid. The effective rooting depth is more than 60 inches. The available water capacity is moderate to low. Surface runoff is slow, and the hazard of erosion is moderate.

The Fluvaquentic Haplaquolls are in swale areas. They are deep, poorly drained soils. They formed in alluvium derived from arkosic sedimentary rock. Typically, the surface layer is brown. The texture is variable throughout. The water table is at a depth of 0 to 3 feet.

The Blakeland soil is well suited to deep-rooted grasses. Native vegetation is dominantly western wheatgrass, side-oats grama, and needleandthread. Rangeland vegetation on the Fluvaquentic Haplaquolls is dominantly tall grasses, including sand bluestem, switchgrass, prairie cordgrass, little bluestem, and sand reedgrass. Cattails and bulrushes are common in the swampy areas.

Proper range management is needed to prevent excess removal of plant cover from these soils. It is also needed to maintain the productive grasses. Interseeding improves the existing vegetation. Deferment of grazing during the growing season increases plant vigor and soil stability, and it helps to maintain and improve range condition. Proper location of livestock watering facilities helps to control grazing of animals.

Windbreaks and environmental plantings are fairly well suited to these soils. Blowing sand and low available water capacity are the main limitations to the establishment of trees and shrubs. The soils are so loose that trees need to be planted in shallow furrows and plant cover needs to be maintained between the rows. Supplemental irrigation may be needed to insure survival. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, and Siberian elm. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

The Blakeland soil is well suited to wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed. Wetland wildlife can be attracted to the Fluvaquentic Haplaquolls and the wetland habitat can be enhanced by several means. Shallow water developments can be created by digging or by blasting potholes to create open-water areas. Fencing to control livestock grazing is beneficial, and it allows wetland plants such as cattails, reed canarygrass, and rushes to grow. Control of unplanned burning and prevention of drainage that would remove water from the wetlands are good practices. Openland wildlife use the vegetation on these soils for nesting and escape cover. These shallow marsh areas are especially important for winter cover if natural vegetation is allowed to grow.

The Blakeland soil has good potential for homesites, roads, and streets. It needs to be protected from erosion when vegetation has been removed from building sites. The Fluvaquentic Haplaquolls have poor potential for homesites. Their main limitations for this use are the high water table and the hazard of flooding. Capability subclass VIe.

10—Blendon sandy loam, 0 to 3 percent slopes. This deep, well drained soil formed in sandy arkosic alluvium on alluvial fans and terraces. The average annual precipitation is about 15 inches, the mean annual air temperature is about 47 degrees F, and the average frost-free period is about 135 days.

Typically, the surface layer is dark grayish brown sandy loam about 10 inches thick. The subsoil is dark grayish brown and brown sandy loam about 26 inches thick. The substratum is light brownish gray gravelly sandy loam.

Included with this soil in mapping are small areas of Blakeland loamy sand, 1 to 9 percent slopes; Bresser sandy loam, 0 to 3 percent slopes; Truckton sandy loam, 0 to 3 percent slopes; Ellicott loamy coarse sand, 0 to 5 percent slopes; and Ustic Torrifluvents, loamy.

Permeability of this Blendon soil is moderately rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, and the hazards of erosion and soil blowing are moderate.

Most areas of this soil are used as rangeland, but some small areas are cultivated. Some homesite development has taken place on this soil.

Native vegetation is mainly cool- and warm-season grasses such as western wheatgrass, side-oats grama, and needleandthread.

Proper range management is needed to prevent excessive removal of plant cover from the soil. Interseeding improves the existing vegetation. Deferment of grazing in spring increases plant vigor and soil stability. Proper location of livestock watering facilities helps to control grazing.

Windbreaks and environmental plantings are generally suited to this soil. Soil blowing is the principal limitation to the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation may be needed when planting and during dry periods. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

This soil is well suited to wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. In cropland areas, habitat favorable for ring-necked pheasant, mourning dove, and many nongame species can be developed by establishing areas for nesting and escape cover. For pheasant, the provision of undisturbed nesting cover is vital and should be included in plans for habitat development. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

This soil has good potential for homesites. The main limitation for the construction of local roads and streets is a moderate frost action potential. Roads can be designed to overcome this limitation. Capability subclass IIIe.

11—Bresser sandy loam, 0 to 3 percent slopes. This deep, well drained soil formed in arkosic alluvium and residuum on terraces and uplands. Elevation ranges from 6,000 to 6,800 feet. The average annual precipitation is about 15 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 135 days.

Typically, the surface layer is grayish brown sandy loam about 5 inches thick. The subsoil is brown sandy clay loam about 31 inches thick. The substratum is light yellowish brown loamy coarse sand to a depth of 60 inches.

Included with this soil in mapping are small areas of Truckton sandy loam, 0 to 3 percent slopes; Ascalon sandy loam, 1 to 3 percent slopes; Fort Collins loam, 0 to 3 percent slopes; and Yoder gravelly sandy loam, 1 to 8 percent slopes. Some areas of Ustic Torrifluvents, loamy, occur along narrow drainageways.

Permeability of this Bresser soil is moderate. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, the hazard of erosion is slight to moderate, and the hazard of soil blowing is moderate.

Most areas of this soil are cultivated. The remaining acreage is used as rangeland.

A rotation of winter wheat and fallow is used because precipitation is insufficient for annual cropping. A feed-grain crop such as millet or sorghum can be substituted for wheat in some years. Crop residue management and minimum tillage are needed to control erosion.

Native vegetation is mainly cool- and warm-season grasses such as western wheatgrass, side-oats grama, and needleandthread.

Proper range management is needed to prevent excessive removal of plant cover from the soil. Interseeding improves the existing vegetation. Deferment of grazing in spring increases plant vigor and soil stability. Proper location of livestock watering facilities helps to control grazing.

Windbreaks and environmental plantings are generally suited to this soil. Soil blowing is the principal limitation to the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation may be needed when planting and during dry periods. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

This soil is well suited to wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. In cropland areas, habitat favorable for ring-necked pheasant, mourning dove, and many nongame species can be developed by establishing areas for nesting and escape cover. For pheasant, the provision of undisturbed nesting cover is vital and should be included in plans for habitat development. This is especially true in areas of intensive farming. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

This soil has good potential for homesites. Limiting the disturbance of the soil and the removal of existing plant cover during construction helps to control erosion. Capability subclass IIIc.

B2t—8 to 21 inches; grayish brown (10YR 5/2) sandy loam, dark grayish brown (10YR 4/2) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; very hard, firm, slightly sticky; thin patchy clay films on faces of peds; neutral; clear smooth boundary.

B3—21 to 28 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 4/3) moist; weak coarse prismatic structure parting to weak fine and medium subangular blocky; slightly hard, very friable; neutral; clear smooth boundary.

C1—28 to 60 inches; pale brown (10YR 6/3) loamy coarse sand, dark brown (10YR 4/3) moist; massive; hard, very friable; neutral.

The solum ranges from 21 to 40 inches in thickness. It is 0 to 15 percent coarse fragments. It ranges from slightly acid to mildly alkaline. The A1 horizon is brown or grayish brown sandy loam or loamy sand. The B2t horizon is brown or grayish brown sandy loam to coarse sandy loam. The C horizon is pale brown or brown.

Blakeland series

The Blakeland series consists of deep, somewhat excessively drained soils. These soils formed in arkosic sandy alluvium and eolian sediment on uplands. They have slopes of 1 to 20 percent. Average annual precipitation is about 15 inches, and average annual air temperature is about 47 degrees F.

Blakeland soils are similar to Chaseville, Columbine, and Connerton soils. They are near Bresser and Truckton soils. Chaseville soils have hue of 7.5YR to 10R. Columbine soils have hue of 5Y to 7.5YR and have a control section that is 18 to 35 percent clay. Bresser soils have a B2t horizon that is 18 to 35 percent clay. Truckton soils have a B2t horizon that is 5 to 18 percent clay.

Typical pedon of Blakeland loamy sand, 1 to 9 percent slopes, 1,990 feet north and 1,730 feet west of the southeast corner of sec. 4, T. 14 S., R. 65 W.:

A1—0 to 11 inches; dark grayish brown (10YR 4/2) loamy sand, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, very friable; slightly acid; clear smooth boundary.

AC—11 to 27 inches; brown (10YR 5/3) loamy sand, dark brown (10YR 4/3) moist; weak coarse prismatic structure parting to weak fine granular; very hard, very friable; neutral; gradual smooth boundary.

C—27 to 60 inches; pale brown (10YR 6/3) sand, brown (10YR 5/3) moist; massive; very hard, very friable; neutral.

The solum ranges from 8 to 20 inches in thickness. It is 0 to 15 percent coarse fragments. It ranges from slightly acid to mildly alkaline. The A1 horizon is dark grayish brown or brown. The AC horizon is brown loamy sand or loamy coarse sand. The C horizon is pale brown to light yellowish brown.

Blendon series

The Blendon series consists of deep, well drained soils that formed in sandy arkosic alluvium. These soils are on terraces, on flood plains, and in drainageways. They have slopes of 0 to 3 percent. Average annual precipitation is about 15 inches, and average annual air temperature is about 47 degrees F.

Blendon soils are similar to Bresser and Truckton soils. They are near Bijou and Blakeland soils. Bresser, Truckton, and Blakeland soils have a mollic epipedon less than 20 inches thick. Bresser soils have a B2t horizon that

is 18 to 35 percent clay. Blakeland soils have an AC horizon. Bijou soils lack a mollic epipedon.

Typical pedon of Blendon sandy loam, 0 to 3 percent slopes, about 780 feet east and 30 feet south of fence and east of road that intersects the section line near the northwest quarter of sec. 21, T. 13 S., R. 65 W.:

A11—0 to 6 inches; dark grayish brown (10YR 4/2) sandy loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable; 5 percent fine gravel; slightly acid; clear smooth boundary.

A12—6 to 10 inches; dark grayish brown (10YR 3/2) sandy loam, very dark brown (10YR 2/2) moist; weak medium and fine subangular blocky structure parting to moderate medium and fine granular; hard, very friable; 5 percent gravel; neutral; gradual smooth boundary.

B2—10 to 23 inches; dark grayish brown (10YR 4/2) sandy loam, very dark brown (10YR 2/2) moist; weak coarse prismatic structure parting to weak medium subangular blocky; extremely hard, friable; 10 percent gravel; neutral; gradual smooth boundary.

B3—23 to 36 inches; brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) moist; weak coarse subangular blocky structure; very hard, very friable; 10 percent gravel; neutral; clear wavy boundary.

C—36 to 60 inches; light brownish gray (10YR 6/2) gravelly sandy loam, grayish brown (10YR 5/2) moist; massive; hard, friable; 30 percent gravel; neutral.

The solum ranges from 26 to 40 inches in thickness. It is 0 to 20 percent coarse fragments. It is slightly acid or neutral. The A1 horizon is dark grayish brown or brown sandy loam or fine sandy loam. The B2 horizon is dark grayish brown or brown sandy loam to fine sandy loam. The C horizon is light brownish gray or pale brown.

Bresser series

The Bresser series consists of deep, well drained soils that formed in alluvium and residuum derived from arkosic sedimentary rock. These soils are on uplands. They have slopes of 0 to 20 percent. Average annual precipitation is about 15 inches, and average annual air temperature is about 47 degrees F.

Bresser soils are similar to Ascalon and Satanta soils and are near Blakeland and Truckton soils. Ascalon and Satanta soils are calcareous in part of the solum and in the C horizon. Blakeland soils do not have a B2t horizon and are coarse textured throughout. Truckton soils have a B2t horizon that is less than 18 percent clay.

Typical pedon of Bresser sandy loam, 3 to 5 percent slopes, about 0.1 mile south and 200 feet east of the northwest corner of sec. 9, T. 11 S., R. 62 W.:

A1—0 to 5 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; soft, very friable; neutral; clear smooth boundary.

B1—5 to 8 inches thick; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, very friable; few thin patchy clay films on faces of peds; neutral; clear smooth boundary.

B2t—8 to 12 inches; brown (10YR 4/3) sandy clay loam, dark brown (10YR 3/3) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; thin continuous clay films on faces of peds; neutral; gradual smooth boundary.

B22t—12 to 27 inches; brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) moist; moderate medium prismatic structure parting to moderate to strong subangular blocky; very hard, friable, slightly

Woodland wildlife, such as mule deer and wild turkey, is attracted to this soil because of its potential to produce ponderosa pine, Gambel oak, and various grasses and shrubs. Water developments, such as guzzlers, would enhance populations of wild turkey as well as other kinds of wildlife. Where wildlife and livestock share the same range, proper grazing management is needed to prevent overuse and to reduce competition. Livestock watering facilities would also benefit wildlife on this soil.

This soil has good potential for use as homesites. The main limitation is the moderate shrink-swell potential in the subsoil and frost action potential. Special road design is necessary on this soil to overcome these limitations. Slope is also a limitation. Special planning is needed on this soil to minimize site disturbance and tree and seedling damage. During seasons of low precipitation, fire may become a hazard to homesites on this soil. The hazard can be minimized by installing firebreaks and reducing the amount of potential fuel on the forest floor. Capability subclass VIe.

27—Elbeth-Pring complex, 5 to 30 percent slopes. These moderately sloping to steep soils are on upland side slopes and ridges. Elevation ranges from 7,200 to 7,400 feet. The average annual precipitation is about 18 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 120 days.

The Elbeth soil makes up about 60 percent of the complex, the Pring about 20 percent, and other soils about 20 percent. The Elbeth soil has slopes of 5 to 15 percent, and the Pring soil has slopes of 5 to 30 percent.

Included with these soils in mapping are areas of Peyton-Pring complex, 8 to 15 percent slopes, Kettle-Rock outcrop complex, and ridges that are covered with gravel and cobbles.

The Elbeth soil is deep and well drained. It formed in material transported from arkose deposits. Typically, the surface layer is very dark grayish brown sandy loam about 3 inches thick. The subsurface layer is light gray loamy sand about 20 inches thick. The subsoil is brown sandy clay loam about 45 inches thick. The substratum is light brown sandy clay loam.

Permeability of the Elbeth soil is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is medium to rapid, and the hazard of erosion is moderate to high. Deep gullies occur throughout areas of this soil. Some soil slippage occurs on some of the steeper slopes.

The Pring soil is deep and well drained. It formed in arkosic sediment. Typically, the surface layer is dark grayish brown coarse sandy loam about 4 inches thick. The next layer is dark grayish brown coarse sandy loam about 10 inches thick. The underlying material is pale brown gravelly sandy loam to a depth of 60 inches.

Permeability of the Pring soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, and the hazard of erosion is moderate.

The soils in this complex are used for woodland, recreation, livestock grazing, and homesites.

The Elbeth soil is suited to the production of ponderosa pine. It is capable of producing about 2,240 cubic feet, or 4,900 board feet (International rule), of merchantable timber per acre from a fully stocked, even-aged stand of 80-year-old trees. Conventional methods can be used for harvesting, but operations may be restricted during wet periods. Reforestation, after harvesting, must be carefully managed to reduce competition of undesirable understory plants.

The Pring soil is suited to the production of native vegetation suitable for grazing by cattle and sheep. Rangeland vegetation is mainly mountain muhly, little bluestem, needleandthread, Parry oatgrass, and junegrass.

Deferral of grazing in spring promotes plant vigor and reproduction of the cool-season bunchgrasses. Fencing and proper location of livestock watering facilities may be needed to obtain proper distribution of grazing. Locating salt blocks in areas not generally grazed increases the use of the available forage.

Woodland wildlife such as mule deer and wild turkey is attracted to the Elbeth soil because of its potential to produce ponderosa pine, Gambel oak, and various grasses and shrubs. Water developments, such as guzzlers, would enhance populations of wild turkey as well as other kinds of wildlife. Where wildlife and livestock share the same range, proper grazing management is needed to prevent overuse and to reduce competition. Livestock watering facilities would also benefit wildlife on this soil.

The Pring soil is suited to wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

The main limitations of this complex for construction are the moderate shrink-swell potential in the subsoil of the Elbeth soil and the steep slopes of both soils. Special site or building designs for dwellings and roads are required to offset these limitations. Special practices must be used to minimize surface runoff and keep soil erosion to a minimum. Capability subclass VIe.

28—Ellicott loamy coarse sand, 0 to 5 percent slopes. This deep, somewhat excessively drained soil is on terraces and flood plains (fig. 1). The average annual precipitation is about 14 inches, the average annual air temperature is about 48 degrees F, and the average frost-free period is about 135 days.

Typically, the surface layer is grayish brown loamy coarse sand about 4 inches thick. The underlying material to a depth of 60 inches is light brownish gray coarse sand stratified with layers of loamy sand, loamy coarse sand, and coarse sandy loam.

Included with this soil in mapping are small areas of Ustic Torrifluvents, loamy; Fluvaquent Haploquolls, nearly level; Blakeland loamy sand, 1 to 9 percent slopes; Blendon sandy loam; and Truckton sandy loam, 0 to 3 percent slopes.

Permeability of this Ellicott soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is low. Surface runoff is slow, the hazard of erosion is high, and the hazard of soil blowing is moderate.

Almost all areas of this soil are used as rangeland.

The rangeland vegetation on this soil is mainly switchgrass, needleandthread, sand bluestem, and prairie sand reedgrass.

Seeding is a good practice if the range is in poor condition. Seeding of the native grasses is desirable. Yellow or white sweetclover may be added to the seeding mixture to provide a source of nitrogen for the grasses. Too much clover can create a danger of bloat by grazing animals. This soil is subject to flooding and should be managed to keep a heavy cover of grass to protect the soil. Fencing is a necessary practice in range management. Brush control and grazing management may help to improve deteriorated range.

Windbreaks and environmental plantings are fairly well suited to this soil. Blowing sand and low available water capacity are the principal limitations for the establishment of trees and shrubs. The soil is so loose that trees need to be planted in shallow furrows and plant cover needs to be maintained between the rows. Supplemental irrigation may be needed to insure survival of trees. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, and Siberian elm. Shrubs that are best suited to skunkbush sumac, lilac, and Siberian peashrub.

Rangeland wildlife, such as antelope, cottontail, coyote, and scaled quail, is best adapted to life on this droughty soil. Forage production is typically low, and proper livestock grazing management is needed if wildlife and livestock share the range. Livestock watering developments are also important and are used by various wildlife species.

The main limitation of this soil for construction is the hazard of flooding. All construction on this soil should be kept off the flood plain as much as possible. Capability subclass VIw.

29—Fluvaquentic Haplaquolls, nearly level. These deep, poorly drained soils are in marshes, in swales, and on creek bottoms. The average annual precipitation is about 14 inches, and the average annual air temperature is about 47 degrees F.

Included with these soils in mapping are small areas of Ustic Torrifluvents, loamy; Blakeland loamy sand, 1 to 9 percent slopes; Columbine gravelly sandy loam, 0 to 3 percent slopes; and Ellicott loamy coarse sand, 0 to 5 percent slopes.

These soils are stratified. Typically, the surface layer is light gray to very dark gray loamy fine sand to gravelly loam 2 to 6 inches thick. The underlying material, 48 to 58 inches thick, is very pale brown to gray, stratified heavy sandy clay loam to sand and gravel. The lower part of some of the soils, at depths ranging from 18 to 48 inches, ranges from light blueish gray to greenish gray. The water table is usually at a depth of less than 48 inches, and it is on the surface during part of the year.

Permeability of these soils is moderate. Effective rooting depth is limited by the water table. Available water capacity is moderate. Surface runoff is slow, and the hazard of erosion is slight. At times overflow deposits a damaging amount of silt and sand in the lower lying areas.

These soils are in meadow. They are used for native hay or for grazing.

These soils are well suited to the production of native vegetation suitable for grazing. The vegetation is mainly switchgrass, indiangrass, sedges, rushes, prairie cordgrass, western wheatgrass, and bluegrass. Cattails and bulrushes commonly grow in the swampy areas.

Management of distribution of livestock and stocking rates is necessary on these soils to avoid abuse of the range. In large areas, fences should be used to control grazing.

Wetland wildlife can be attracted to these soils and the wetland habitat enhanced by several means. Shallow water developments can be created by digging or by blasting potholes to create open-water areas. Fencing to control livestock use is beneficial, and it allows wetland plants such as cattails, reed canarygrass, and rushes to grow. Control of unplanned burning and prevention of drainage that would remove water from the wetlands are also good practices. These shallow marsh areas are often especially important for winter cover if natural vegetation is allowed to grow.

These soils are severely limited for use as homesites. The main limitations are a high water table and a hazard of periodic flooding. Community sewerage systems are needed because the high water table prevents septic tank absorption fields from functioning properly. Roads must also be designed to prevent frost-heave damage. Capability subclass Vw.

30—Fort Collins loam, 0 to 3 percent slopes. This deep, well drained soil formed in medium textured alluvium on uplands. Elevation ranges from 5,200 to 6,500 feet. The average annual precipitation ranges from about 13 inches at the lower elevations to about 15 inches at the higher elevations; the average annual temperature is about 49 degrees F; and the average frost-free period is about 145 days.

Typically, the surface layer is brown loam about 6 inches thick. The subsoil is brown clay loam about 15 inches thick. The substratum is pale brown loam.

Included with this soil in mapping are small areas of Stoneham sandy loam, 3 to 8 percent slopes; Keith silt loam, 0 to 3 percent slopes; Olney sandy loam, 0 to 3 percent slopes; Bresser sandy loam, 0 to 3 percent slopes; and Wiley silt loam, 1 to 3 percent slopes.

Permeability of this Fort Collins soil is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used as rangeland and for dryland farming. Wheat and feed grains such as millet are the crops commonly grown. Crop residue management, minimum tillage,

percent. Average annual precipitation is about 18 inches, and average annual air temperature is about 43 degrees F.

Elbeth soils are similar to Coldcreek, Fortwingate, and Tecolote soils and are near Kettle, Crowfoot, Pring, and Tomah soils. Coldcreek and Tecolote soils have a B2t horizon that is more than 35 percent coarse fragments. Coldcreek soils have bedrock at a depth of 20 to 40 inches. Fortwingate soils have a B2t horizon that is more than 35 percent clay and has hue of 5YR to 10R. Crowfoot, Pring, and Tomah soils have a mollic epipedon. Tomah and Kettle soils have a B2t horizon in which clay has accumulated as lamellae.

Typical pedon of Elbeth sandy loam, 8 to 15 percent slopes (fig. 9), at the southeast corner of the intersection of Frank Road and Swan Road in the NE1/4NE1/4 of sec. 9, T. 12 S., R. 65 W.:

- A1—0 to 3 inches; very dark grayish brown (10YR 3/2) sandy loam, black (10YR 2/1) moist; moderate fine granular structure; soft, very friable; slightly acid; clear smooth boundary.
- A2—3 to 23 inches; light gray (10YR 7/2) loamy sand, grayish brown (10YR 5/2) moist; weak medium subangular blocky structure; soft, very friable; slightly acid; clear wavy boundary.
- B2t—23 to 32 inches; brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; extremely hard, firm, sticky and plastic; thin coatings of A2 material on faces of peds; continuous clay films on faces of peds; slightly acid; clear smooth boundary.
- B22t—32 to 52 inches; brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; very hard, firm, sticky and plastic; continuous clay films on faces of peds; neutral; gradual smooth boundary.
- B3—52 to 68 inches; reddish yellow (7.5YR 6/6) sandy clay loam, strong brown (7.5YR 5/6) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; very hard, firm, slightly sticky and slightly plastic; thin patchy clay films on faces of peds; neutral; gradual smooth boundary.
- C—68 to 74 inches; light yellowish brown (10YR 6/4) sandy clay loam, yellowish brown (10YR 5/4) moist; massive; hard, friable, slightly sticky; neutral.

The solum ranges from 24 to 60 inches in thickness. It is 0 to 15 percent coarse fragments. It ranges from strongly acid to neutral. The A1 horizon is very dark grayish brown or dark grayish brown. The A2 horizon is loamy sand or sand. The B2t horizon is brown or yellowish brown. The C horizon is light yellowish brown or pale brown.

Ellicott series

The Ellicott series consists of deep, somewhat excessively drained soils that formed in noncalcareous stratified sandy alluvium derived from arkose beds of granite. These soils are on terraces and flood plains. They have slopes of 0 to 5 percent. Average annual precipitation is about 14 inches, and average annual air temperature is about 48 degrees F.

Ellicott soils are similar to Ustic Torrifluvents, loamy, and are near Blakeland and Wigton soils. Ustic Torrifluvents, loamy, have stratified layers containing a higher percentage of clay and have a darker surface layer than Ellicott soils. Blakeland soils have a dark colored surface layer and are not stratified. Wigton soils are not stratified.

Typical pedon of Ellicott loamy coarse sand, 0 to 5 percent slopes, about 300 feet west and 1,650 feet south of the northeast corner of the NW1/4 of sec. 16, T. 14 S., R. 62 W.:

- A1—0 to 4 inches; grayish brown (10YR 5/2) loamy coarse sand, dark grayish brown (10YR 4/2) moist; single grained; loose; 10 percent fine gravel; neutral; clear smooth boundary.
- C—4 to 60 inches; light brownish gray (10YR 6/2) coarse sand stratified with layers of loamy sand, loamy coarse sand, and coarse sandy loam, dark grayish brown (10YR 4/2) moist; single grained; loose; 15 percent fine gravel; neutral.

The solum ranges from 2 to 8 inches in thickness. It is 0 to 35 percent coarse fragments. It ranges from slightly acid to mildly alkaline. The A1 horizon is grayish brown or brown loamy coarse sand or coarse sand. The C horizon is light brownish gray or pale brown.

Fort Collins series

The Fort Collins series consists of deep, well drained soils that formed in medium textured alluvium. These soils are on terraces and uplands. They have slopes of 0 to 8 percent. Average annual precipitation is about 13 inches, and average annual air temperature is about 49 degrees F.

Fort Collins soils are similar to Cushman, Olney, and Stoneham soils and are near the competing Olney and Stoneham soils. The Cushman soils have a paralithic contact at a depth of 20 to 40 inches. Olney soils have more than 35 percent fine or coarser sand in the B2t and C horizons. Stoneham soils are less than 15 inches deep to the base of any B3ca horizon.

Typical pedon of Fort Collins loam, 0 to 3 percent slopes, about 0.45 mile south and 400 feet east of the northwest corner of sec. 19, T. 17 S., R. 63 W.:

- A1—0 to 6 inches; brown (10YR 5/3) loam, dark grayish brown (10YR 4/2) moist; moderate fine granular structure; soft, very friable; neutral; clear smooth boundary.
- B1—6 to 9 inches; brown (10YR 5/3) loam, dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure; slightly hard, very friable; few thin patchy clay films on faces of peds; mildly alkaline; clear smooth boundary.
- B2t—9 to 16 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky; thin continuous clay films on faces of peds; few fine pebbles; mildly alkaline; clear smooth boundary.
- B3ca—16 to 21 inches; brown (10YR 5/3) light clay loam, grayish brown (10YR 5/2) moist; weak coarse prismatic structure parting to weak medium subangular blocky; hard, friable, slightly sticky; some visible calcium carbonate occurring as soft masses; calcareous; mildly alkaline; gradual smooth boundary.
- C1ca—21 to 29 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; slightly hard, very friable; visible calcium carbonate occurring as soft masses and in thin seams and streaks; calcareous; moderately alkaline; diffuse smooth boundary.
- C2ca—29 to 60 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; massive; soft, very friable; contains less visible calcium carbonate than the above horizon; calcareous; moderately alkaline.

The solum ranges from 15 to 30 inches in thickness. Its content of coarse fragments ranges from 0 to 15 percent but commonly is less than 5 percent. It is neutral or mildly alkaline. The A1 horizon is grayish brown or brown loam or fine sandy loam. The B2t horizon is brown or

Included with this soil in mapping are small areas of Nunn clay loam, 0 to 3 percent slopes; Sampson loam, 0 to 3 percent slopes; and Ustic Torrifluvents, loamy.

Permeability of this Manzanola soil is slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, and the hazard of erosion is moderate.

Most areas of this soil are used for irrigated crops. The main crops are alfalfa, corn, small grain, and pasture. Use of deep-rooted crops, timely tillage, and crop residue to keep the soil in good tilth are necessary on this soil. A small acreage of this soil is used for the production of forage sorghum or sudangrass for feed crops. The remaining acreage is used as nonirrigated cropland and rangeland.

This soil is well suited to plants for suitable grazing, and both grasses and legumes grow well if the soil is irrigated.

The native vegetation is mainly alkali sacaton, vine-mesquite, western wheatgrass, blue grama, and lesser amounts of switchgrass. Big bluestem, switchgrass, and junegrass are also present where this soil occurs in the northern part of the survey area.

Stocking rates and distribution of grazing should be controlled to facilitate uniform grazing. Fencing and properly locating livestock watering facilities help to control grazing. With good range management, this soil produces good quantities of forage.

Windbreaks and environmental plantings are generally well suited to this soil. Summer fallow a year prior to planting and continued cultivation for weed control are needed to insure the establishment and survival of plantings. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, Siberian peashrub, and American plum.

This soil is suited to wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. In cropland areas, habitat favorable for ring-necked pheasant, mourning dove, and many nongame species can be developed by establishing wildlife areas for nesting and escape cover. For pheasant, undisturbed nesting cover is vital and should be provided for in plans for habitat development. This is especially true in areas of intensive farming. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

The main limitations for urban use of this soil are slow permeability and shrink-swell potential. Septic tank absorption fields do not function well because of the slow permeability. Special designs for buildings and roads are required to overcome the limitation of the shrink-swell potential. Capability subclasses IIs, irrigated, and IVE, nonirrigated.

52—Manzanola clay loam, 1 to 3 percent slopes. This deep, well drained soil formed in calcareous loamy alluvi-

um on fans and terraces. Elevation ranges from about 5,200 to 6,000 feet. The average annual precipitation is about 13 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 145 days.

Typically, the surface layer is grayish brown clay loam about 6 inches thick. The subsoil is grayish brown heavy clay loam about 26 inches thick. The substratum is grayish brown clay loam to a depth of 60 inches or more. The lower part of the subsoil and the substratum contain visible soft masses of lime.

Included with this soil in mapping are small areas of Manzanola clay loam, 0 to 1 percent slopes; Nunn clay loam, 0 to 3 percent slopes; and Sampson loam, 0 to 3 percent slopes.

Permeability of this Manzanola soil is slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is medium, and the hazard of erosion is moderate.

About 50 percent of the acreage of this soil is used for irrigated crops. The main crops are alfalfa, corn, small grain, and pasture. Use of deep-rooted crops, timely tillage, and crop residue to keep the soil in good tilth is necessary. A small percentage of this soil is used for the production of forage sorghum or sudangrass for feed crops. The remaining acreage is used as rangeland.

This soil is well suited to plants suitable for grazing, and grass and legumes grow well if it is irrigated.

The native vegetation is mainly alkali sacaton, vine-mesquite, western wheatgrass, blue grama, and lesser amounts of switchgrass. Big bluestem, switchgrass, and junegrass are also present where this soil occurs in the northern part of the survey area.

Stocking rates and distribution of grazing should be controlled to facilitate uniform grazing. Fences and proper location of livestock watering facilities help to control grazing. With good range management, this soil produces good quantities of forage.

Windbreaks and environmental plantings generally are well suited to this soil. Summer fallow a year prior to planting and continued cultivation for weed control are needed to insure the establishment and survival of plantings. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, Siberian peashrub, and American plum.

This soil is suited to wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. In cropland areas, habitat favorable for ring-necked pheasant, mourning dove, and many nongame species can be developed by establishing areas for nesting and escape cover. For pheasant, undisturbed nesting cover is vital and should be provided for in plans for habitat development. This is especially true in areas of intensive farming. Rangeland wildlife, such as pronghorn antelope, can be assisted by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

The main limitations for urban use of this soil are slow permeability and high shrink-swell potential. Septic tank absorption fields do not function well as a result of the slow permeability. Special designs for buildings and roads are required to overcome the limitation of the high shrink-swell potential. Capability subclasses IVe, nonirrigated, and IIe, irrigated.

53—Manzanola clay loam, 3 to 9 percent slopes. This deep, well drained soil formed in calcareous loamy alluvium on fans, terraces, and valley side slopes. Elevation ranges from about 5,200 to 6,000 feet. The average annual precipitation is about 13 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 145 days.

Typically, the surface layer is grayish brown clay loam about 6 inches thick. The subsoil is grayish brown heavy clay loam about 26 inches thick. The substratum is grayish brown clay loam to a depth of 60 inches or more. The lower part of the subsoil and the substratum contain visible soft masses of lime.

Included with this soil in mapping are small areas of Manvel loam, 3 to 9 percent slopes; Neville-Rednun complex, 3 to 9 percent slopes; and Satanta-Neville complex, 3 to 8 percent slopes.

Permeability of this Manzanola soil is slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is rapid, and the hazard of erosion is high.

Most areas of this soil are used as rangeland and for military maneuvers.

This soil is well suited to the production of native vegetation suitable for grazing. The native vegetation is mainly blue grama, western wheatgrass, side-oats grama, dropseed, and galleta. Production varies from year to year, depending on amount of precipitation.

Fencing and properly locating livestock watering facilities help to control grazing. Deferment of grazing may be necessary to maintain a needed balance between livestock use and forage production. In areas where the plant cover has been depleted, pitting can be used to help the native vegetation recover. Chemical control practices may be needed in disturbed areas where dense stands of pricklypear occur. Ample amounts of litter and forage need to be left on the soil because of the high hazard of soil blowing.

Windbreaks and environmental plantings generally are well suited to this soil. Summer fallow a year prior to planting and continued cultivation for weed control are needed to insure the establishment and survival of plantings. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, Siberian peashrub, and American plum.

This soil is suited to wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly

managing livestock grazing, and reseeding range where needed.

The main limitations of this soil for urban uses are slow permeability and high shrink-swell potential. Septic tank absorption fields do not function well because of the slow permeability. Special designs for buildings and roads are required to overcome the limitation of high shrink-swell potential. Capability subclass VIe.

54—Midway clay loam, 3 to 25 percent slopes. This shallow, well drained soil formed in residuum derived from calcareous shale on uplands. Elevation ranges from 5,200 to 6,200 feet. The average annual precipitation is about 13 inches, the average annual air temperature is about 49 degrees F, and the frost-free period is about 145 days.

Typically, the surface layer is light yellowish brown clay loam about 4 inches thick. The underlying material is light yellowish brown clay about 4 inches thick and grayish brown clay that contains 50 percent soft shale fragments and is about 5 inches thick. Shale is at a depth of 13 inches.

Included with this soil in mapping are small areas of Louviers silty clay loam, 3 to 18 percent slopes; Nelsco Tassel fine sandy loams, 3 to 18 percent slopes; and Raz clay loam, 3 to 9 percent slopes.

Permeability of this Midway soil is slow. Effective rooting depth is less than 20 inches. Available water capacity is low. Surface runoff is medium to rapid, and the hazard of erosion is moderate to high.

Most areas of this soil are used as rangeland.

The native vegetation is mainly blue grama, galleta, alkali sacaton, western wheatgrass, and fourwing saltbush. Little bluestem, side-oats grama, and needleandthread are also present where this soil occurs in the northern part of the survey area. The presence of princesplume, two-groove milkvetch, and Fremont goldenweed indicates that selenium-bearing plants are in the stand.

This soil is difficult to revegetate, and it is therefore especially important that livestock grazing be carefully managed. Excessive removal of vegetation can result in severe erosion. Properly locating livestock watering facilities helps to control grazing.

Windbreak and environmental plantings generally are not suited to this soil. Onsite investigation is needed to determine if plantings are feasible.

This treeless soil produces little vegetation, especially in times of drought, when annual production may be as low as 300 pounds per acre. Rangeland wildlife, such as antelope and scaled quail, can be encouraged by properly managing livestock grazing, installing livestock watering facilities, and reseeding range where necessary.

The main limitations for the use of this soil as sites for buildings and homes are shallow depth to shale and high shrink-swell potential. Septic tank absorption fields do not function properly because of the slow permeability of this soil. Practices are needed to reduce surface runoff and thus keep erosion to a minimum. Special designs for buildings and roads are needed because of the shallow

Manzanola series

The Manzanola series consists of deep, well drained soils that formed in calcareous loamy alluvium. These soils are on fans, terraces, and sides of valleys. The have slopes of 0 to 9 percent. Average annual precipitation is about 13 inches, and average annual air temperature is about 49 degrees F.

The Manzanola soils are similar to Stoneham and Cushman soils and are near Nunn and Razor soils. Stoneham soils have a solum less than 15 inches thick and have a B2t horizon that is 18 to 35 percent clay. Cushman soils have interbedded sandstone and shale at a depth of 20 to 40 inches. Nunn soils have a mollic epipedon. Razor soils have a B2 horizon and have shale at a depth of 20 to 40 inches.

Typical pedon of Manzanola clay loam, 1 to 3 percent slopes, about 1,450 feet east and 20 feet north of the southwest corner of sec. 9, T. 16 S., R. 65 W.:

- Ap—0 to 6 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; hard, firm, slightly sticky and slightly plastic; mildly alkaline; clear smooth boundary.
- B2t—6 to 10 inches; brown (10YR 5/3) heavy clay loam, dark grayish brown (2.5Y 4/2) moist; weak medium prismatic structure parting to moderate medium subangular blocky; extremely hard, very firm, very sticky and very plastic; thin patchy clay films on faces of peds; calcareous; moderately alkaline; clear smooth boundary.
- B2t—10 to 17 inches; grayish brown (2.5Y 5/2) heavy clay loam, dark grayish brown (2.5Y 4/2) moist; weak medium subangular blocky structure; very hard, very firm, very sticky and very plastic; thin continuous clay films on faces of peds; few indistinct lime threads; calcareous; moderately alkaline; clear smooth boundary.
- B3ca—17 to 32 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak medium subangular blocky structure; very hard, very firm, slightly sticky and slightly plastic; thin patchy clay films on faces of peds; visible lime threads; calcareous; moderately alkaline; clear smooth boundary.
- C—32 to 60 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive; extremely hard, very firm, sticky and plastic; 5 percent gravel; threads and soft masses of lime; calcareous; moderately alkaline.

The solum ranges from 20 to 36 inches in thickness. It is 0 to 15 percent coarse fragments. It ranges from mildly alkaline to strongly alkaline. The A1 or Ap horizon is grayish brown or light brownish gray. The B2t horizon is brown or grayish brown heavy clay loam or light clay. The C horizon is light brownish gray or grayish brown.

Midway series

The Midway series consists of shallow, well drained soils that formed in residuum derived from calcareous shale. These soils are on uplands. They have slopes of 3 to 50 percent. Average annual precipitation is about 13 inches, and average annual air temperature is about 49 degrees F.

Midway soils are similar to Louviers soils and are near Razor soils. Louviers soils are noncalcareous throughout. Razor soils have a B2 horizon and have shale bedrock at a depth of 20 to 40 inches.

Typical pedon of Midway clay loam, 3 to 25 percent slopes, near the southwest corner of sec. 13, T. 16 S., R. 65 W.:

A1—0 to 4 inches; light yellowish brown (2.5Y 6/4) clay loam, light olive brown (2.5Y 5/4) moist; weak thin platy structure parting to weak fine granular; soft, very friable, sticky and plastic; calcareous; moderately alkaline; clear smooth boundary.

AC—4 to 8 inches; light yellowish brown (2.5Y 6/4) clay, light olive brown (2.5Y 5/4) moist; weak thick platy structure parting to weak fine subangular blocky; soft, very friable, sticky and plastic; calcareous; strongly alkaline; clear smooth boundary.

C1—8 to 13 inches; grayish brown (2.5Y 5/2) clay, light olive brown (2.5Y 5/4) moist; weak thick platy structure; hard, friable, sticky and plastic; 50 percent shale fragments; calcareous; strongly alkaline.

C2r—13 inches; light olive brown (2.5Y 5/4) shale.

Depth to shale is 10 to 20 inches. The solum ranges from 8 to 20 inches in thickness. It is moderately alkaline or strongly alkaline. The A1 horizon is silty clay loam or clay loam. The C horizon is light brownish gray or grayish brown.

Nederland series

The Nederland series consists of deep, well drained soils that formed in cobbly and gravelly alluvium or outwash. These soils are on upland fans and terraces. They have slopes of 9 to 25 percent. Average annual precipitation is about 15 inches, and average annual air temperature is about 47 degrees F.

Nederland soils are similar to Stroupe soils and are near Neville and Chaseville soils. Stroupe soils have a B2t horizon that is more than 35 percent clay and have hard bedrock at a depth of 20 to 40 inches. Neville soils have a control section that is less than 15 percent coarse fragments. Chaseville soils do not have a B2t horizon and have less than 18 percent clay in the control section.

Typical pedon of Nederland cobbly sandy loam, 9 to 25 percent slopes, about 900 feet southwest of Highway 115 on the southwest bank of Rock Creek in sec. 31, T. 15 S., R. 66 W.:

A1—0' to 5 inches; brown (7.5YR 4/2) cobbly sandy loam, dark brown (7.5YR 3/2) moist; moderate fine granular structure; soft, very friable; 5 percent gravel and 15 percent cobbles; slightly acid; clear smooth boundary.

B1—5 to 11 inches; brown (7.5YR 5/2) very cobbly loam, dark brown (7.5YR 3/2) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few thin patchy clay films on faces of peds; 15 percent gravel and 25 percent cobbles; neutral; clear smooth boundary.

B2t—11 to 28 inches; reddish brown (5YR 5/4) very cobbly clay loam, reddish brown (5YR 4/4) moist; weak medium prismatic structure parting to moderate fine subangular blocky; hard, firm, sticky and plastic; thin clay films on faces of peds; 55 percent gravel and cobbles; neutral; gradual wavy boundary.

C—28 to 60 inches; reddish brown (5YR 5/4) very cobbly sandy loam, reddish brown (5YR 4/4) moist; massive; hard, friable; 45 percent cobbles and gravel; neutral.

The solum ranges from 17 to 30 inches in thickness. It is 35 to 60 percent coarse fragments. It ranges from slightly acid to mildly alkaline. The A1 horizon is brown or dark brown. The B2t horizon is reddish brown or light reddish brown very cobbly sandy clay loam to very cobbly clay loam. The C horizon is reddish brown or light reddish brown.

Legend

- 1% annual chance (100-Year) Floodplain
- 1% annual chance (100-Year) Floodway
- 0.2% annual chance (500-Year) Floodplain



APPROXIMATE SCALE IN FEET

500 0 500

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

EL PASO COUNTY,
COLORADO AND
INCORPORATED AREAS

REVISED TO
REFLECT LOMR
EFFECTIVE: January 29, 2015

PANEL 957 OF 1300

(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
|-------------------------------------|--------|-------|--------|
| COLORADO SPRINGS, CITY OF | 080060 | 0957 | F |
| EL PASO COUNTY UNINCORPORATED AREAS | 080059 | 0957 | F |
| FOUNTAIN, CITY OF | 080061 | 0957 | F |

MAP NUMBER
08041C0957 F

EFFECTIVE DATE:
MARCH 17, 1997



Federal Emergency Management Agency

JOINS PANEL 0769

104°37'30"
38°45'00"

NOTE: MAP AREA SHOWN ON THIS
PANEL IS LOCATED WITHIN TOWNSHIP
15 SOUTH, RANGE 65 WEST.

CITY OF
COLORADO SPRINGS
080060

Jimmy Camp Creek
East Tributary

REVISED
AREA

ZONE AE

EL PASO COUNTY
UNINCORPORATED AREAS
080059

AREA REVISED BY LOMR
DATED AUGUST 29, 2007.

floodplain modified
by
lomr #14-08-0534P,
January 29, 2015

PROFILE
BASELINE

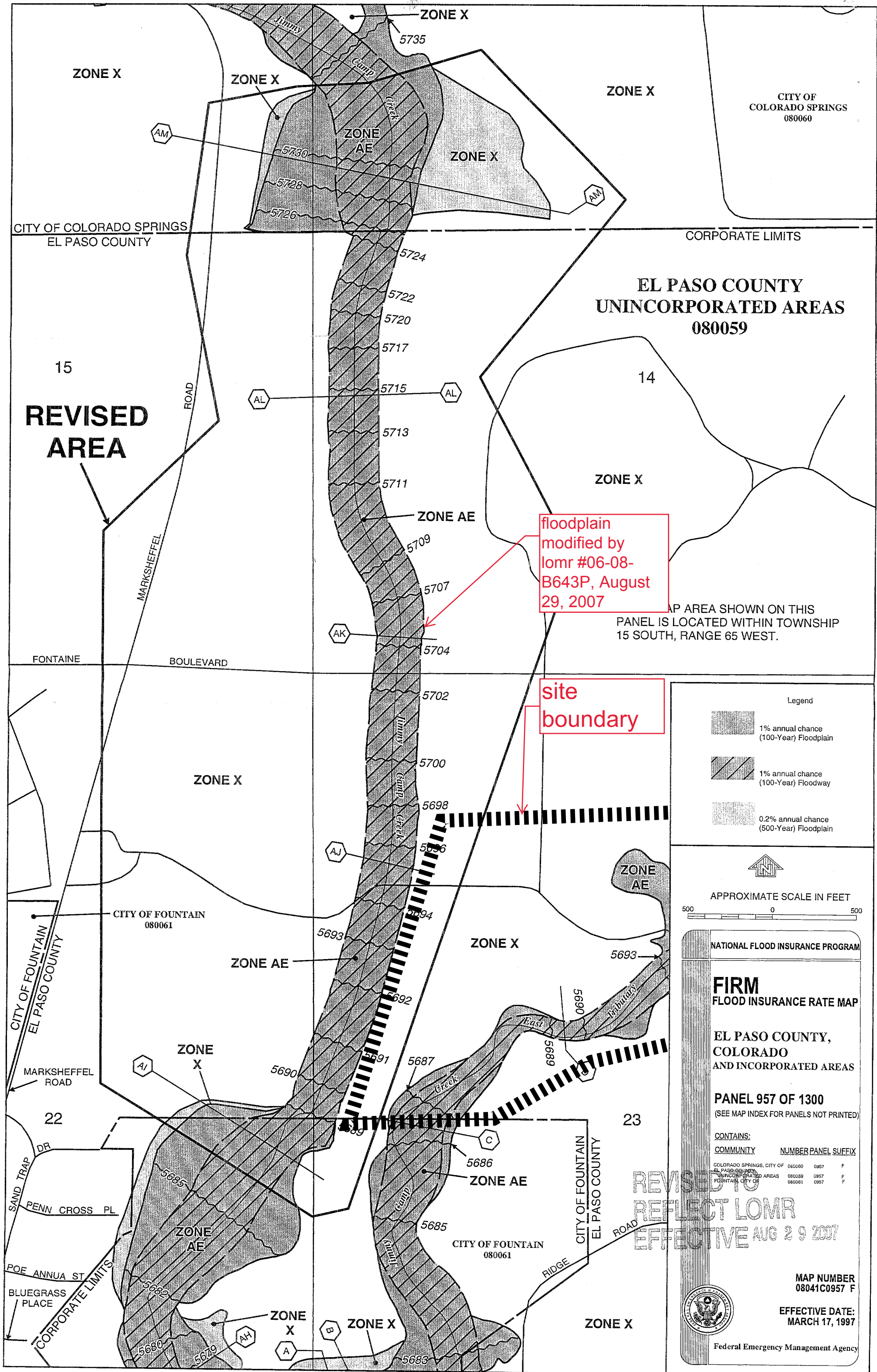
Jimmy Camp Creek
East Tributary

SITE

ZONE AE

ZONE
AE

site
boundary



APPENDIX B – HYDROLOGY CALCULATIONS



Job No: 100.045
Project: Creekside Filing No. 1
Design Storm: **100 - Year Event, Existing Conditions**

P:\100\100.045\Drainage\100.045-FinalDrain Calc's 8/2/2018 1 of 2

Standard Form SF-2. Storm Drainage System Design (Rational Method Procedure)

Calculated By: Leonard Beasley

Job No: 100.045

Date: Oct 20, 2018

Project: Creekside Filing No. 1

Checked By: Leonard Beasley

Design Storm: **5 - Year Event, Proposed Conditions**

| Street or Basin | Design Point | Direct Runoff | | | | | | | Total Runoff | | | | Street | | Pipe | | | Travel Time | | | Remarks |
|-----------------|--------------|---------------|----------|-------------------|----------------|------|-------|-----|----------------|--------|-------|------|--------|-------------|-------------|-------|-----------|-------------|----------|----------------|---------|
| | | Area Design | Area (A) | Runoff Coeff. (C) | t _c | CA | i | Q | t _c | Σ (CA) | i | Q | Slope | Street Flow | Design Flow | Slope | Pipe Size | Length | Velocity | t _t | |
| | | | ac. | | min. | | in/hr | cfs | min | | in/hr | cfs | % | cfs | cfs | % | in | ft | ft/sec | min | |
| C1.1 | | | 2.27 | 0.49 | 16.46 | 1.11 | 3.38 | 3.8 | | | | | | | | | | | | | |
| C1.2 | | | 3.35 | 0.49 | 17.36 | 1.64 | 3.30 | 5.4 | | | | | 1.0% | 3.8 | | | | | | | |
| (C1.1&C1.2) | 1 | | 5.62 | | | | | | 17.4 | 2.75 | 3.30 | 9.1 | 0.9% | 5.4 | | | | | | | |
| C1.3 | | | 1.10 | 0.49 | 10.47 | 0.54 | 4.06 | 2.2 | | | | | L.P. | 9.1 | 9.1 | 1.0% | 24" | 35' | 5.3 | 0.1 | |
| C1.4 | | | 2.41 | 0.49 | 12.59 | 1.18 | 3.78 | 4.5 | | | | | 1.0% | 1.8 | | | | | | | |
| (C1.3&C1.4) | 2 | | 3.51 | | | | | | 17.5 | 1.72 | 3.29 | 5.7 | 1.1% | 4.5 | | | | | | | |
| C1.5 | | | 0.19 | 0.49 | 6.56 | 0.09 | 4.76 | 0.4 | | | | | L.P. | 5.3 | | | | | | | |
| (C1.3-C1.5) | 3 | | 3.70 | | | | | | 17.5 | 1.81 | 3.29 | 6.0 | 1.3% | 0.4 | | | | | | | |
| (C1.1-C1.5) | 4 | | 9.32 | | | | | | 17.5 | 4.57 | 3.29 | 15.0 | L.P. | 5.6 | | | | | | | |
| C1.6 | | | 0.73 | 0.49 | 9.81 | 0.36 | 4.16 | 1.5 | | | | | L.P. | 14.7 | 14.7 | 2.3% | 24" | 132' | 6.5 | 0.3 | |
| C1.7 | | | 1.92 | 0.45 | 14.53 | 0.86 | 3.57 | 3.1 | | | | | 0.8% | 1.5 | | | | | | | |
| C1.8 | | | 0.77 | 0.47 | 8.47 | 0.36 | 4.38 | 1.6 | | | | | 0.6% | 3.1 | | | | | | | |
| (C1.7&C1.8) | 5 | | 2.69 | | | | | | 16.6 | 1.23 | 3.37 | 4.1 | 1.0% | 1.6 | | | | | | | |
| (C1.6-C1.8) | 6 | | 3.42 | | | | | | 16.6 | 1.58 | 3.37 | 5.3 | L.P. | 4.1 | | | | | | | |
| C1.9 | | | 2.90 | 0.49 | 16.04 | 1.42 | 3.42 | 4.9 | | | | | L.P. | 5.3 | | | | | | | |
| C1.10 | | | 0.18 | 0.49 | 9.30 | 0.09 | 4.24 | 0.4 | | | | | 0.8% | 3.5 | | | | | | | |
| C1.11 | | | 0.17 | 0.49 | 6.72 | 0.08 | 4.73 | 0.4 | | | | | 0.8% | 0.4 | | | | | | | |

Standard Form SF-2. Storm Drainage System Design (Rational Method Procedure)

Calculated By: Leonard Beasley

Job No: 100.045

Date: Oct 20, 2018

Project: Creekside Filing No. 1

Checked By: Leonard Beasley

Design Storm: **5 - Year Event, Proposed Conditions**

| Street or Basin | Design Point | Direct Runoff | | | | | | | Total Runoff | | | | Street | | Pipe | | | Travel Time | | | Remarks |
|-----------------|--------------|---------------|----------|-------------------|----------------|------|-------|-----|----------------|--------|-------|------|--------|-------------|-------------|-------|-----------|-------------|----------|----------------|---------|
| | | Area Design | Area (A) | Runoff Coeff. (C) | t _c | CA | i | Q | t _c | Σ (CA) | i | Q | Slope | Street Flow | Design Flow | Slope | Pipe Size | Length | Velocity | t _t | |
| | | | ac. | | min. | | in/hr | cfs | min | | in/hr | cfs | % | cfs | cfs | % | in | ft | ft/sec | min | |
| (C1.9-C1.11) | 7 | | 3.25 | | | | | | 16.0 | 1.59 | 3.42 | 5.4 | | | | | | | | | |
| C1.12 | | | 1.42 | 0.49 | 14.53 | 0.70 | 3.57 | 2.5 | | | | | 0.8% | 4.1 | | | | | | | |
| (C1.9-C1.12) | 8 | | 4.67 | | | | | | 20.8 | 2.29 | 3.03 | 6.9 | | | | | | | | | |
| C1.13 | | | 0.71 | 0.45 | 9.25 | 0.32 | 4.25 | 1.4 | | | | | L.P. | 5.2 | | | | | | | |
| C1.14 | | | 1.27 | 0.46 | 11.74 | 0.58 | 3.89 | 2.3 | | | | | 0.7% | 1.4 | | | | | | | |
| (C1.13&C1.14) | 9 | | 1.98 | | | | | | 15.3 | 0.90 | 3.49 | 3.2 | | | | | | | | | |
| (C1.9-C1.14) | 10 | | 6.65 | | | | | | 20.8 | 3.19 | 3.03 | 9.7 | | | | | | | | | |
| C1.15 | | | 1.40 | 0.49 | 10.96 | 0.69 | 3.99 | 2.7 | | | | | L.P. | 7.9 | | | | | | | |
| C1.16 | | | 0.50 | 0.49 | 7.61 | 0.25 | 4.54 | 1.1 | | | | | 1.0% | 1.6 | | | | | | | |
| (C1.15&C1.16) | 11 | | 1.30 | | | | | | 11.0 | 0.93 | 3.99 | 3.7 | | | | | | | | | |
| C1.17 | 12 | | 1.38 | 0.49 | 9.44 | 0.68 | 4.22 | 2.9 | | | | | 1.3% | 1.1 | | | | | | | |
| (C1.15-C1.17) | 13 | | 2.68 | | | | | | 11.4 | 1.61 | 3.94 | 6.3 | | | | | | | | | |
| C1.18 | | | 5.81 | 0.27 | 13.91 | 1.57 | 3.63 | 5.7 | | | | | | | 5.2 | 1.6% | 18" | 185' | 2.9 | 1.1 | |
| | 14 | | | | | | | | 20.8 | 4.78 | 3.03 | 14.5 | | | | | | | | | |
| C2 | | | 3.44 | 0.49 | 8.54 | 1.69 | 4.37 | 7.4 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| C4 | | | 1.84 | 0.47 | 6.48 | 0.86 | 4.78 | 4.1 | | | | | | | | | | | | | |



Standard Form SF-2. Storm Drainage System Design (Rational Method Procedure)

Calculated By: Leonard Beasley

Job No: 100.045

Date: Oct 20, 2018

Project: Creekside Filing No. 1

Checked By: Leonard Beasley

Design Storm: **5 - Year Event, Proposed Conditions**

| Street or Basin | Design Point | Direct Runoff | | | | | | | Total Runoff | | | | Street | | Pipe | | | Travel Time | | | Remarks |
|-----------------|--------------|---------------|----------|-------------------|----------------|------|-------|-----|----------------|--------|-------|-----|--------|-------------|-------------|-------|-----------|-------------|----------|----------------|---------|
| | | Area Design | Area (A) | Runoff Coeff. (C) | t _c | CA | i | Q | t _c | Σ (CA) | i | Q | Slope | Street Flow | Design Flow | Slope | Pipe Size | Length | Velocity | t _t | |
| | | | ac. | | min. | | in/hr | cfs | min | | in/hr | cfs | % | cfs | cfs | % | in | ft | ft/sec | min | |
| C5.1 | 15 | | 1.14 | 0.45 | 9.02 | 0.51 | 4.28 | 2.2 | | | | | | | | | | | | | |
| C5.2 | | | 0.72 | 0.45 | 9.85 | 0.32 | 4.15 | 1.3 | | | | | L.P. | 1.3 | 1.3 | 1.0% | 18" | 34' | 1.2 | 0.0 | |
| C5 | | | 1.86 | | | | | | 9.9 | 0.84 | 4.15 | 3.5 | | | | | | | | | |
| C6 | | | 0.80 | 0.45 | 9.85 | 0.36 | 4.15 | 1.5 | | | | | | | | | | | | | |
| D1.1 | 16 | | 1.21 | 0.45 | 12.00 | 0.54 | 3.86 | 2.1 | | | | | | | | | | | | | |
| D1.2 | | | 0.55 | 0.90 | 8.36 | 0.50 | 4.40 | 2.2 | | | | | | | 2.1 | 1.0% | 18" | 385' | 1.2 | 5.3 | |
| D1.3 | | | 0.42 | 0.45 | 10.41 | 0.19 | 4.07 | 0.8 | | | | | | | | | | | | | |
| (D1.2&D1.3) | 17 | | 0.97 | | | | | | 10.4 | 0.68 | 4.07 | 2.8 | | | | | | | | | |
| D1.4 | | | 1.13 | 0.45 | 9.53 | 0.51 | 4.20 | 2.1 | | | | | 1.1% | 2.8 | | | | | | | |
| (D1.2-D1.4) | 18 | | 2.10 | | | | | | 14.9 | 1.19 | 3.53 | 4.2 | 1.3% | 2.1 | | | | | | | |
| D1.5 | | | 1.07 | 0.45 | 11.63 | 0.48 | 3.90 | 1.9 | | | | | 1.0% | 4.2 | | | | | | | |
| (D1.2-D1.5) | 19 | | 3.17 | | | | | | 19.6 | 1.67 | 3.12 | 5.2 | 0.9% | 1.5 | | | | | | | |
| D1.6 | | | 1.26 | 0.45 | 12.39 | 0.57 | 3.81 | 2.2 | | | | | L.P. | 4.9 | 12.1 | 3.0% | 24" | 50' | 3.9 | 0.2 | |
| D1.7 | | | 1.39 | 0.45 | 14.42 | 0.63 | 3.58 | 2.2 | | | | | 1.1% | 2.2 | | | | | | | |
| (D1.6&D1.7) | 20 | | 2.65 | | | | | | 14.4 | 1.19 | 3.58 | 4.3 | 0.7% | 2.2 | | | | | | | |
| D1.8 | | | 1.05 | 0.45 | 14.94 | 0.47 | 3.53 | 1.7 | | | | | 0.7% | 4.3 | | | | | | | |
| (D1.6-D1.8) | 21 | | 3.70 | | | | | | 14.9 | 1.67 | 3.53 | 5.9 | 0.8% | 1.7 | | | | | | | |

Standard Form SF-2. Storm Drainage System Design (Rational Method Procedure)

 Calculated By: Leonard Beasley

 Date: Oct 20, 2018

 Checked By: Leonard Beasley

 Job No: 100.045

 Project: Creekside Filing No. 1

 Design Storm: **100 - Year Event, Proposed Conditions**

| Street or Basin | Design Point | Direct Runoff | | | | | | | Total Runoff | | | | Street | | Pipe | | | Travel Time | | | Remarks |
|-----------------|--------------|---------------|----------|-------------------|----------------|------|-------|------|----------------|--------|-------|------|--------|-------------|-------------|-------|-----------|-------------|----------|----------------|---------|
| | | Area Design | Area (A) | Runoff Coeff. (C) | t _c | CA | i | Q | t _c | Σ (CA) | i | Q | Slope | Street Flow | Design Flow | Slope | Pipe Size | Length | Velocity | t _t | |
| | | | ac. | | min. | | in/hr | cfs | min | | in/hr | cfs | % | cfs | cfs | % | in | ft | ft/sec | min | |
| C1.1 | | | 2.27 | 0.65 | 16.46 | 1.48 | 5.68 | 8.4 | | | | | | | | | | | | | |
| C1.2 | | | 3.35 | 0.65 | 17.36 | 2.18 | 5.54 | 12.1 | | | | | 1.0% | 8.4 | | | | | | | |
| (C1.1&C1.2) | 1 | | 5.62 | | | | | | 17.4 | 3.65 | 5.54 | 20.2 | 0.9% | 12.1 | | | | | | | |
| C1.3 | | | 1.10 | 0.65 | 10.47 | 0.72 | 6.82 | 4.9 | | | | | L.P. | 20.2 | 20.2 | 1.0% | 24" | 35' | 7.5 | 0.1 | |
| C1.4 | | | 2.41 | 0.65 | 12.59 | 1.57 | 6.35 | 10.0 | | | | | 1.0% | 4.0 | | | | | | | |
| (C1.3&C1.4) | 2 | | 3.51 | | | | | | 17.5 | 2.28 | 5.52 | 12.6 | 1.1% | 10.0 | | | | | | | |
| C1.5 | | | 0.19 | 0.65 | 6.56 | 0.12 | 7.99 | 1.0 | | | | | L.P. | 11.9 | | | | | | | |
| (C1.3-C1.5) | 3 | | 3.70 | | | | | | 17.5 | 2.41 | 5.52 | 13.3 | 1.3% | 1.0 | | | | | | | |
| (C1.1-C1.5) | 4 | | 9.32 | | | | | | 17.5 | 6.06 | 5.52 | 33.4 | L.P. | 12.6 | | | | | | | |
| C1.6 | | | 0.73 | 0.65 | 9.81 | 0.47 | 6.98 | 3.3 | | | | | L.P. | 32.7 | 32.7 | 2.3% | 24" | 132' | 10.4 | 0.2 | |
| C1.7 | | | 1.92 | 0.59 | 14.53 | 1.13 | 5.99 | 6.8 | | | | | 0.8% | 3.3 | | | | | | | |
| C1.8 | | | 0.77 | 0.62 | 8.47 | 0.48 | 7.35 | 3.5 | | | | | 0.6% | 6.8 | | | | | | | |
| (C1.7&C1.8) | 5 | | 2.69 | | | | | | 16.6 | 1.61 | 5.65 | 9.1 | 1.0% | 3.5 | | | | | | | |
| (C1.6-C1.8) | 6 | | 3.42 | | | | | | 16.6 | 2.08 | 5.65 | 11.8 | L.P. | 9.1 | | | | | | | |
| C1.9 | | | 2.90 | 0.65 | 16.04 | 1.89 | 5.74 | 10.8 | | | | | L.P. | 11.8 | | | | | | | |
| C1.10 | | | 0.18 | 0.65 | 9.30 | 0.12 | 7.12 | 0.8 | | | | | 0.8% | 7.8 | | | | | | | |
| C1.11 | | | 0.17 | 0.65 | 6.72 | 0.11 | 7.93 | 0.9 | | | | | 0.8% | 0.9 | | | | | | | |

Standard Form SF-2. Storm Drainage System Design (Rational Method Procedure)

 Calculated By: Leonard Beasley

 Date: Oct 20, 2018

 Checked By: Leonard Beasley

 Job No: 100.045

 Project: Creekside Filing No. 1

 Design Storm: **100 - Year Event, Proposed Conditions**

| Street or Basin | Design Point | Direct Runoff | | | | | | | Total Runoff | | | | Street | | Pipe | | | Travel Time | | | Remarks |
|-----------------|--------------|---------------|----------|-------------------|----------------|------|-------|------|----------------|--------|-------|------|--------|-------------|-------------|-------|-----------|-------------|----------|----------------|---------|
| | | Area Design | Area (A) | Runoff Coeff. (C) | t _c | CA | i | Q | t _c | Σ (CA) | i | Q | Slope | Street Flow | Design Flow | Slope | Pipe Size | Length | Velocity | t _t | |
| | | | ac. | | min. | | in/hr | cfs | min | | in/hr | cfs | % | cfs | cfs | % | in | ft | ft/sec | min | |
| (C1.9-C1.11) | 7 | | 3.25 | | | | | | 16.0 | 2.11 | 5.74 | 12.1 | 0.8% | 9.1 | | | | | | | |
| C1.12 | | | 1.42 | 0.65 | 14.53 | 0.92 | 5.99 | 5.5 | | | | | | 4.1 | | | | | | | |
| (C1.9-C1.12) | 8 | | 4.67 | | | | | | 20.8 | 3.04 | 5.08 | 15.4 | L.P. | 11.6 | | | | | | | |
| C1.13 | | | 0.71 | 0.59 | 9.25 | 0.42 | 7.13 | 3.0 | | | | | | 3.0 | | | | | | | |
| C1.14 | | | 1.27 | 0.61 | 11.74 | 0.77 | 6.53 | 5.1 | | | | | 0.7% | 5.1 | | | | | | | |
| (C1.13&C1.14) | 9 | | 1.98 | | | | | | 15.3 | 1.19 | 5.86 | 7.0 | | 7.0 | | | | | | | |
| (C1.9-C1.14) | 10 | | 6.65 | | | | | | 20.8 | 4.23 | 5.08 | 21.5 | L.P. | 16.7 | | | | | | | |
| C1.15 | | | 1.40 | 0.65 | 10.96 | 0.91 | 6.70 | 6.1 | | | | | | 3.5 | | | | | | | |
| C1.16 | | | 0.50 | 0.65 | 7.61 | 0.33 | 7.62 | 2.5 | | | | | 1.3% | 2.5 | | | | | | | |
| (C1.15&C1.16) | 11 | | 1.90 | | | | | | 11.0 | 1.24 | 6.70 | 8.3 | | 5.7 | | | | | | | |
| C1.17 | 12 | | 1.38 | 0.65 | 9.44 | 0.90 | 7.08 | 6.3 | | | | | | | | | | | | | |
| (C1.15-C1.17) | 13 | | 3.28 | | | | | | 11.4 | 2.13 | 6.61 | 14.1 | | | 11.5 | 1.6% | 18" | 185' | 6.5 | 0.5 | |
| C1.18 | | | 5.81 | 0.55 | 13.91 | 3.20 | 6.10 | 19.5 | | | | | | | | | | | | | |
| | 14 | | | | | | | | 20.8 | 6.31 | 5.09 | 32.1 | | | | | | | | | |
| C2 | | | 3.44 | 0.65 | 8.54 | 2.24 | 7.33 | 16.4 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| C4 | | | 1.84 | 0.62 | 6.48 | 1.14 | 8.03 | 9.2 | | | | | | | | | | | | | |

Standard Form SF-2. Storm Drainage System Design (Rational Method Procedure)

 Calculated By: Leonard Beasley

 Date: Oct 20, 2018

 Checked By: Leonard Beasley

 Job No: 100.045

 Project: Creekside Filing No. 1

 Design Storm: **100 - Year Event, Proposed Conditions**

| Street or Basin | Design Point | Direct Runoff | | | | | | | Total Runoff | | | | Street | | Pipe | | | Travel Time | | | Remarks |
|-----------------------|--------------|---------------|----------|----------------------|----------------|------|-------|-----|----------------|--------|-------|------|--------|----------------|----------------|-------|--------------|-------------|----------|----------------|---------|
| | | Area Design | Area (A) | Runoff Coeff. (C) | t _c | CA | i | Q | t _c | Σ (CA) | i | Q | Slope | Street Flow | Design Flow | Slope | Pipe Size | Length | Velocity | t _t | |
| | | | ac. | | min. | | in/hr | cfs | min | | in/hr | cfs | % | cfs | cfs | % | in | ft | ft/sec | min | |
| C5.1 | 15 | | 1.14 | 0.45 | 9.02 | 0.51 | 7.19 | 3.7 | | | | | L.P. | 2.2 | 2.2 | 1.0% | 18" | 34' | 2.7 | 0.0 | |
| C5.2 | | | 0.72 | 0.45 | 9.85 | 0.32 | 6.97 | 2.3 | | | | | | | | | | | | | |
| C5 | | | 1.86 | | | | | | 9.0 | 0.84 | 7.19 | 6.0 | | | | | | | | | |
| C6 | | | 0.80 | 0.59 | 9.85 | 0.47 | 6.97 | 3.3 | | | | | | | | | | | | | |
| D1.1 | 16 | | 1.21 | 0.59 | 12.00 | 0.71 | 6.47 | 4.6 | | | | | | | 4.6 | 1.0% | 18" | 385' | 2.6 | 2.5 | |
| D1.2 | | | 0.55 | 0.96 | 8.36 | 0.53 | 7.38 | 3.9 | | | | | | | | | | | | | |
| D1.3 | | | 0.42 | 0.59 | 10.41 | 0.25 | 6.83 | 1.7 | | | | | | | | | | | | | |
| (D1.2&D1.3) | 17 | | 0.97 | | | | | | 10.4 | 0.78 | 6.83 | 5.3 | | | | | | | | | |
| D1.4 | | | 1.13 | 0.59 | 9.53 | 0.67 | 7.05 | 4.7 | | | | | 1.1% | 5.3 | | | | | | | |
| (D1.2-D1.4) | 18 | | 2.10 | | | | | | 14.9 | 1.44 | 5.93 | 8.6 | 1.3% | 4.7 | | | | | | | |
| D1.5 | | | 1.07 | 0.59 | 11.63 | 0.63 | 6.55 | 4.1 | | | | | 1.0% | 8.6 | | | | | | | |
| (D1.2-D1.5) | 19 | | 3.17 | | | | | | 19.6 | 2.07 | 5.24 | 10.9 | 0.9% | 3.4 | | | | | | | |
| D1.6 | | | 1.26 | 0.59 | 12.39 | 0.74 | 6.39 | 4.8 | | | | | L.P. | 10.3 | 26.1 | 3.0% | 24" | 50' | 8.3 | 0.1 | |
| D1.7 | | | 1.39 | 0.59 | 14.42 | 0.82 | 6.01 | 4.9 | | | | | 1.1% | 4.8 | | | | | | | |
| (D1.6&D1.7) | 20 | | 2.65 | | | | | | 14.4 | 1.56 | 6.01 | 9.4 | 0.7% | 4.9 | | | | | | | |
| D1.8 | | | 1.05 | 0.59 | 14.94 | 0.62 | 5.92 | 3.7 | | | | | 0.7% | 9.4 | | | | | | | |
| (D1.6-D1.8) | 21 | | 3.70 | | | | | | 14.9 | 2.18 | 5.92 | 12.9 | 0.8% | 3.7 | | | | | | | |



CORE
ENGINEERING GROUP

Job No: 100.045

Project: Creekside Filing No. 1

Design Storm: 100 - Year Event, Proposed Conditions

[illegible]



Standard Form SF-1. Time of Concentration-Proposed

Calculated By: Leonard Beasley

Job No: 100.045

Date: June 29, 2018

Project: Creekside Filing No. 1

Checked By: Leonard Beasley

| Sub-Basin Data | | | | Initial Overland Time (ti) | | | | Travel Time (tt) | | | | | tc Check (urbanized Basins) | | Final tc |
|-----------------------|----------------|----------------------|-----------------|----------------------------|-------------------|---------------------------|---------------|-----------------------|-------------------|---------------------------|---------------|---------------------------|-----------------------------|---|--|
| BASIN or DESIGN | C ₅ | AREA (A) acres | NRCS Convey. | LENGTH (L) feet | SLOPE (S) % | VELOCITY (V) ft/sec | ti minutes | LENGTH (L) feet | SLOPE (S) % | VELOCITY (V) ft/sec | tt minutes | Computed tc Minutes | TOTAL LENGTH (L) feet | Regional tc tc=(L/180)+10 minutes | USDCM Recommended tc=ti+tt (min) |
| C1.1 | 0.49 | 2.27 | 20 | 86.00 | 2.10% | 0.18 | 8.00 | 1076.0 | 1.05% | 2.05 | 8.75 | 16.75 | 1162.00 | 16.46 | 16.46 |
| C1.2 | 0.49 | 3.35 | 20 | 59.00 | 1.90% | 0.14 | 6.84 | 1265.0 | 0.94% | 1.94 | 10.87 | 17.72 | 1324.00 | 17.36 | 17.36 |
| DP-1 | 0.49 | 5.62 | 20 | 59.00 | 1.90% | 0.14 | 6.84 | 1265.0 | 0.94% | 1.94 | 10.87 | 17.72 | 1324.00 | 17.36 | 17.36 |
| C1.3 | 0.49 | 0.90 | 20 | 76.00 | 2.00% | 0.17 | 7.64 | 340.0 | 1.00% | 2.00 | 2.83 | 10.47 | 416.00 | 12.31 | 10.47 |
| C1.4 | 0.49 | 2.41 | 20 | 36.00 | 2.80% | 0.13 | 4.70 | 1010.0 | 1.14% | 2.14 | 7.88 | 12.59 | 1046.00 | 15.81 | 12.59 |
| DP-2 | 0.49 | 3.31 | 20 | 76.00 | 2.00% | 0.17 | 7.64 | 1280.0 | 1.00% | 2.00 | 10.67 | 18.30 | 1356.00 | 17.53 | 17.53 |
| C1.5 | 0.49 | 0.19 | 20 | 45.00 | 2.00% | 0.13 | 5.88 | 93.0 | 1.29% | 2.27 | 0.68 | 6.56 | 138.00 | 10.77 | 6.56 |
| DP-3 | 0.49 | 3.50 | 20 | 76.00 | 2.00% | 0.17 | 7.64 | 1280.0 | 1.00% | 2.00 | 10.67 | 18.30 | 1356.00 | 17.53 | 17.53 |
| C1.6 | 0.49 | 0.73 | 20 | 28.00 | 2.00% | 0.10 | 4.64 | 559.0 | 0.81% | 1.80 | 5.18 | 9.81 | 587.00 | 13.26 | 9.81 |
| C1.7 | 0.45 | 1.92 | 20 | 100.00 | 2.00% | 0.18 | 9.34 | 716.0 | 0.63% | 1.59 | 7.52 | 16.85 | 816.00 | 14.53 | 14.53 |
| C1.8 | 0.47 | 0.77 | 20 | 20.00 | 2.00% | 0.08 | 4.05 | 520.0 | 0.96% | 1.96 | 4.42 | 8.47 | 540.00 | 13.00 | 8.47 |
| DP-5 | 0.46 | 2.69 | 20 | 100.00 | 2.00% | 0.18 | 9.19 | 1093.0 | 0.73% | 1.71 | 10.66 | 19.85 | 1193.00 | 16.63 | 16.63 |
| C1.9 | 0.49 | 2.10 | 20 | 50.00 | 2.00% | 0.13 | 6.20 | 1057.0 | 0.80% | 1.79 | 9.85 | 16.04 | 1107.00 | 16.15 | 16.04 |
| C1.10 | 0.49 | 0.18 | 20 | 100.00 | 2.30% | 0.20 | 8.37 | 100.0 | 0.80% | 1.79 | 0.93 | 9.30 | 200.00 | 11.11 | 9.30 |
| C1.11 | 0.49 | 0.17 | 20 | 42.00 | 2.00% | 0.12 | 5.68 | 116.0 | 0.86% | 1.85 | 1.04 | 6.72 | 158.00 | 10.88 | 6.72 |
| C1.12 | 0.49 | 1.42 | 20 | 98.00 | 2.45% | 0.20 | 8.11 | 717.0 | 0.71% | 1.69 | 7.09 | 15.20 | 815.00 | 14.53 | 14.53 |
| DP-8 | 0.49 | 3.50 | 20 | 50.00 | 2.00% | 0.13 | 6.20 | 1902.0 | 0.76% | 1.74 | 18.18 | 24.38 | 1952.00 | 20.84 | 20.84 |



Standard Form SF-1. Time of Concentration-Proposed

Calculated By: Leonard Beasley

Job No: 100.045

Date: June 29, 2018

Project: Creekside Filing No. 1

Checked By: Leonard Beasley

| Sub-Basin Data | | | | Initial Overland Time (ti) | | | | Travel Time (tt) | | | | | tc Check (urbanized Basins) | | Final tc |
|-----------------|----------------|----------------|--------------|----------------------------|-------------|---------------------|------------|------------------|-------------|---------------------|------------|---------------------|-----------------------------|-----------------------------------|----------------------------------|
| BASIN or DESIGN | C ₅ | AREA (A) acres | NRCS Convey. | LENGTH (L) feet | SLOPE (S) % | VELOCITY (V) ft/sec | ti minutes | LENGTH (L) feet | SLOPE (S) % | VELOCITY (V) ft/sec | tt minutes | Computed tc Minutes | TOTAL LENGTH (L) feet | Regional tc tc=(L/180)+10 minutes | USDCM Recommended tc=ti+tt (min) |
| C1.13 | 0.45 | 0.71 | 20 | 42.00 | 3.33% | 0.14 | 5.11 | 400.0 | 0.65% | 1.61 | 4.13 | 9.25 | 442.00 | 12.46 | 9.25 |
| C1.14 | 0.46 | 1.27 | 20 | 34.00 | 2.00% | 0.11 | 5.36 | 641.0 | 0.70% | 1.67 | 6.38 | 11.74 | 675.00 | 13.75 | 11.74 |
| DP-9 | 0.46 | 1.98 | 20 | 42.00 | 3.33% | 0.14 | 5.03 | 1002.0 | 0.66% | 1.62 | 10.28 | 15.31 | 1044.00 | 15.80 | 15.31 |
| C1.15 | 0.49 | 0.80 | 20 | 85.00 | 2.47% | 0.19 | 7.53 | 401.0 | 0.95% | 1.95 | 3.43 | 10.96 | 486.00 | 12.70 | 10.96 |
| C1.16 | 0.49 | 0.50 | 20 | 37.00 | 2.00% | 0.12 | 5.33 | 315.0 | 1.33% | 2.31 | 2.28 | 7.61 | 352.00 | 11.96 | 7.61 |
| C1.17 | 0.49 | 1.38 | 15 | 77.00 | 3.25% | 0.20 | 6.55 | 300.0 | 1.33% | 1.73 | 2.89 | 9.44 | 377.00 | 12.09 | 9.44 |
| DP-12 | 0.49 | 2.68 | 20 | 85.00 | 2.47% | 0.19 | 7.53 | 401.0 | 0.95% | 1.95 | 3.43 | | | | |
| | | | 18" RCP | | | | | 185.0 | 1.62% | 7.57 | 0.41 | 11.37 | 671.00 | 13.73 | 11.37 |
| C1.18 | 0.27 | 5.81 | 15 | 100.00 | 3.00% | 0.16 | 10.43 | 38.0 | 23.68% | 7.30 | 0.09 | | | | |
| | | | 20 | | | | | 565.0 | 0.50% | 1.41 | 6.66 | 17.17 | 703.00 | 13.91 | 13.91 |
| C1 | 0.49 | 26.51 | 20 | 50.00 | 2.00% | 0.13 | 6.20 | 1902.0 | 0.76% | 1.74 | 18.18 | 24.38 | 1952.00 | 20.84 | 20.84 |
| C2 | 0.49 | 5.44 | 15 | 100.00 | 4.00% | 0.24 | 6.97 | 150.0 | 1.13% | 1.59 | 1.57 | 8.54 | 250.00 | 11.39 | 8.54 |
| | | | | | | | | | | | | | | | |
| C4 | 0.47 | 1.84 | 15 | 30.00 | 2.00% | 0.10 | 4.96 | 236.0 | 2.97% | 2.59 | 1.52 | 6.48 | 266.00 | 11.48 | 6.48 |
| C5.1 | 0.45 | 1.14 | 20 | 80.00 | 2.50% | 0.17 | 7.76 | 197.0 | 1.68% | 2.59 | 1.27 | 9.02 | 277.00 | 11.54 | 9.02 |
| C5.2 | 0.45 | 0.72 | 15 | 100.00 | 2.00% | 0.18 | 9.34 | 79.0 | 6.33% | 3.77 | 0.35 | | | | |
| | | | 15 | | | | | 58.0 | 15.52% | 5.91 | 0.16 | 9.85 | 237.00 | 11.32 | 9.85 |



Standard Form SF-1. Time of Concentration-Proposed

Calculated By: Leonard Beasley

Job No: 100.045

Date: June 29, 2018

Project: Creekside Filing No. 1

Checked By: Leonard Beasley

| Sub-Basin Data | | | | Initial Overland Time (t _i) | | | | Travel Time (t _t) | | | | | t _c Check (urbanized Basins) | | Final t _c |
|-----------------------|----------------|----------------------|-----------------|---|-------------------|---------------------------|---------------------------|-------------------------------|-------------------|---------------------------|---------------------------|---------------------------------------|---|---|--|
| BASIN or DESIGN | C ₅ | AREA (A) acres | NRCS Convey. | LENGTH (L) feet | SLOPE (S) % | VELOCITY (V) ft/sec | t _i minutes | LENGTH (L) feet | SLOPE (S) % | VELOCITY (V) ft/sec | t _t minutes | Computed t _c Minutes | TOTAL LENGTH (L) feet | Regional t _c tc=(L/180)+10 minutes | USDCM Recommended tc=ti+tt (min) |
| C5 | 0.45 | 1.86 | 15 | 100.00 | 2.00% | 0.18 | 9.34 | 79.0 | 6.33% | 3.77 | 0.35 | | | | |
| | | | 15 | | | | | 58.0 | 15.52% | 5.91 | 0.16 | 9.85 | 237.00 | 11.32 | 9.85 |
| C6 | 0.45 | 0.80 | 15 | 100.00 | 2.00% | 0.18 | 9.34 | 120.0 | 6.67% | 3.87 | 0.52 | 9.85 | 220.00 | 11.22 | 9.85 |
| D1.1 | 0.45 | 1.21 | 15 | 90.00 | 2.67% | 0.19 | 8.05 | 445.0 | 1.57% | 1.88 | 3.95 | 12.00 | 535.00 | 12.97 | 12.00 |
| D1.2 | 0.90 | 0.55 | 20 | 30.00 | 2.00% | 0.32 | 1.57 | 681.0 | 0.70% | 1.67 | 6.78 | 8.36 | 711.00 | 13.95 | 8.36 |
| D1.3 | 0.45 | 0.42 | 20 | 100.00 | 2.00% | 0.18 | 9.34 | 135.0 | 1.10% | 2.10 | 1.07 | 10.41 | 235.00 | 11.31 | 10.41 |
| D1.4 | 0.45 | 1.13 | 20 | 46.00 | 3.26% | 0.14 | 5.39 | 556.0 | 1.25% | 2.24 | 4.14 | 9.53 | 602.00 | 13.34 | 9.53 |
| DP-16 | 0.57 | 2.10 | 20 | 30.00 | 2.00% | 0.12 | 4.17 | 1289.0 | 1.01% | 2.01 | 10.69 | 14.86 | 1319.00 | 17.33 | 14.86 |
| D1.5 | 0.45 | 0.87 | 20 | 61.00 | 1.64% | 0.13 | 7.79 | 433.0 | 0.88% | 1.88 | 3.85 | 11.63 | 494.00 | 12.74 | 11.63 |
| DP-17 | 0.53 | 2.97 | 20 | 30.00 | 2.00% | 0.11 | 4.48 | 1771.0 | 0.96% | 1.96 | 15.06 | 19.55 | 1801.00 | 20.01 | 19.55 |
| D1.6 | 0.45 | 1.26 | 20 | 47.00 | 2.00% | 0.12 | 6.40 | 736.0 | 1.05% | 2.05 | 5.99 | 12.39 | 783.00 | 14.35 | 12.39 |
| D1.7 | 0.45 | 1.39 | 20 | 100.00 | 3.50% | 0.21 | 7.76 | 696.0 | 0.72% | 1.70 | 6.84 | 14.60 | 796.00 | 14.42 | 14.42 |
| DP-18 | 0.45 | 2.65 | 20 | 100.00 | 3.50% | 0.21 | 7.76 | 696.0 | 0.72% | 1.70 | 6.84 | 14.60 | 796.00 | 14.42 | 14.42 |
| D1.8 | 0.45 | 1.05 | 20 | 100.00 | 2.00% | 0.18 | 9.34 | 789.0 | 0.79% | 1.78 | 7.40 | 16.73 | 889.00 | 14.94 | 14.94 |
| DP-19 | 0.45 | 3.70 | 20 | 100.00 | 2.00% | 0.18 | 9.34 | 789.0 | 0.79% | 1.78 | 7.40 | 16.73 | 889.00 | 14.94 | 14.94 |
| D1.9 | 0.45 | 0.24 | 20 | 39.00 | 3.08% | 0.13 | 5.06 | 206.0 | 1.12% | 2.12 | 1.62 | 6.68 | 245.00 | 11.36 | 6.68 |
| DP-20 | 0.45 | 3.94 | 20 | 100.00 | 2.00% | 0.18 | 9.34 | 1029.0 | 0.86% | 1.85 | 9.25 | 18.58 | 1129.00 | 16.27 | 16.27 |



Job No: 100.045

Project: Creekside Filing No. 1

Checked By: Leonard Beasley

P:\100\100.045\Drainage\100.045-FinalDrain Calc's

APPENDIX C – HYDRAULIC CALCULATIONS

Channel Report

Pond CR3 collection swale

Triangular

Side Slope (z:1) = 4.00
Total Depth (ft) = 1.00

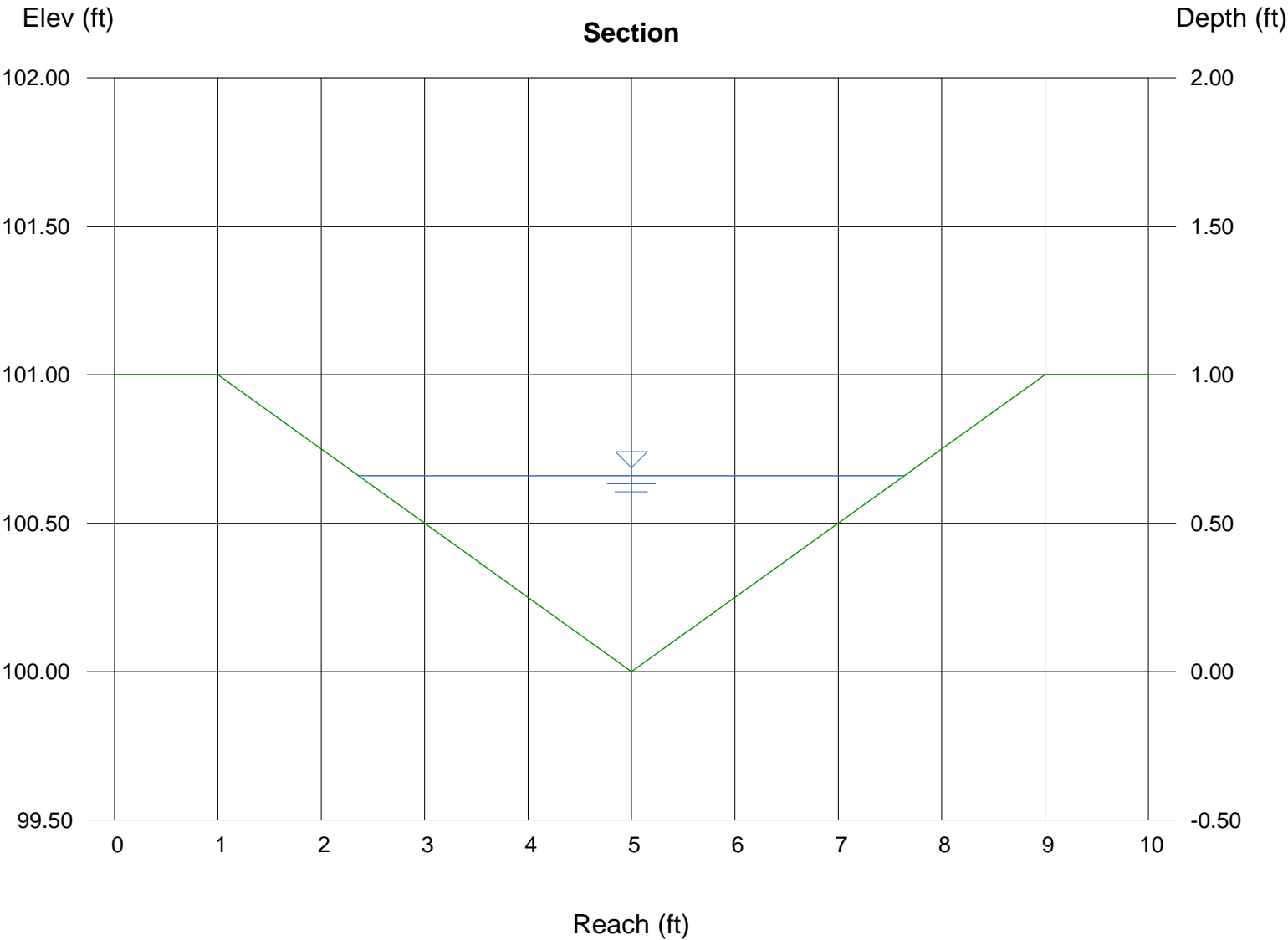
Invert Elev (ft) = 100.00
Slope (%) = 0.50
N-Value = 0.025

Calculations

Compute by: Known Q
Known Q (cfs) = 3.30

Highlighted

Depth (ft) = 0.66
Q (cfs) = 3.300
Area (sqft) = 1.74
Velocity (ft/s) = 1.89
Wetted Perim (ft) = 5.44
Crit Depth, Yc (ft) = 0.54
Top Width (ft) = 5.28
EGL (ft) = 0.72



Channel Report

trickle channel pond cr2

Rectangular

Botom Width (ft) = 2.00
Total Depth (ft) = 0.50

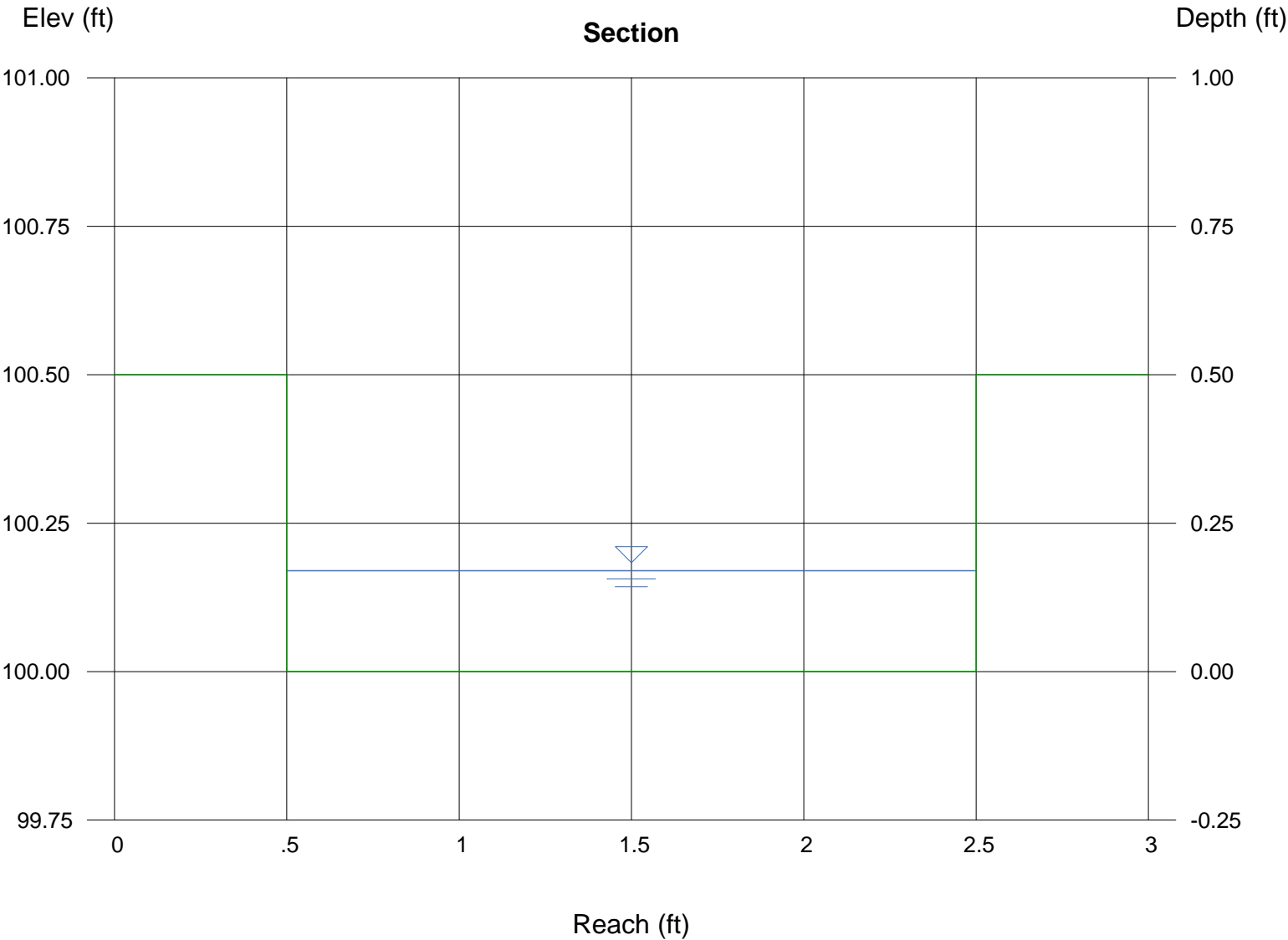
Invert Elev (ft) = 100.00
Slope (%) = 1.00
N-Value = 0.013

Calculations

Compute by: Known Q
Known Q (cfs) = 1.00

Highlighted

Depth (ft) = 0.17
Q (cfs) = 1.000
Area (sqft) = 0.34
Velocity (ft/s) = 2.94
Wetted Perim (ft) = 2.34
Crit Depth, Yc (ft) = 0.20
Top Width (ft) = 2.00
EGL (ft) = 0.30



Channel Report

Overflow from Des. Pt 4 (Alsea Dr) to Pond C1-R

Trapezoidal

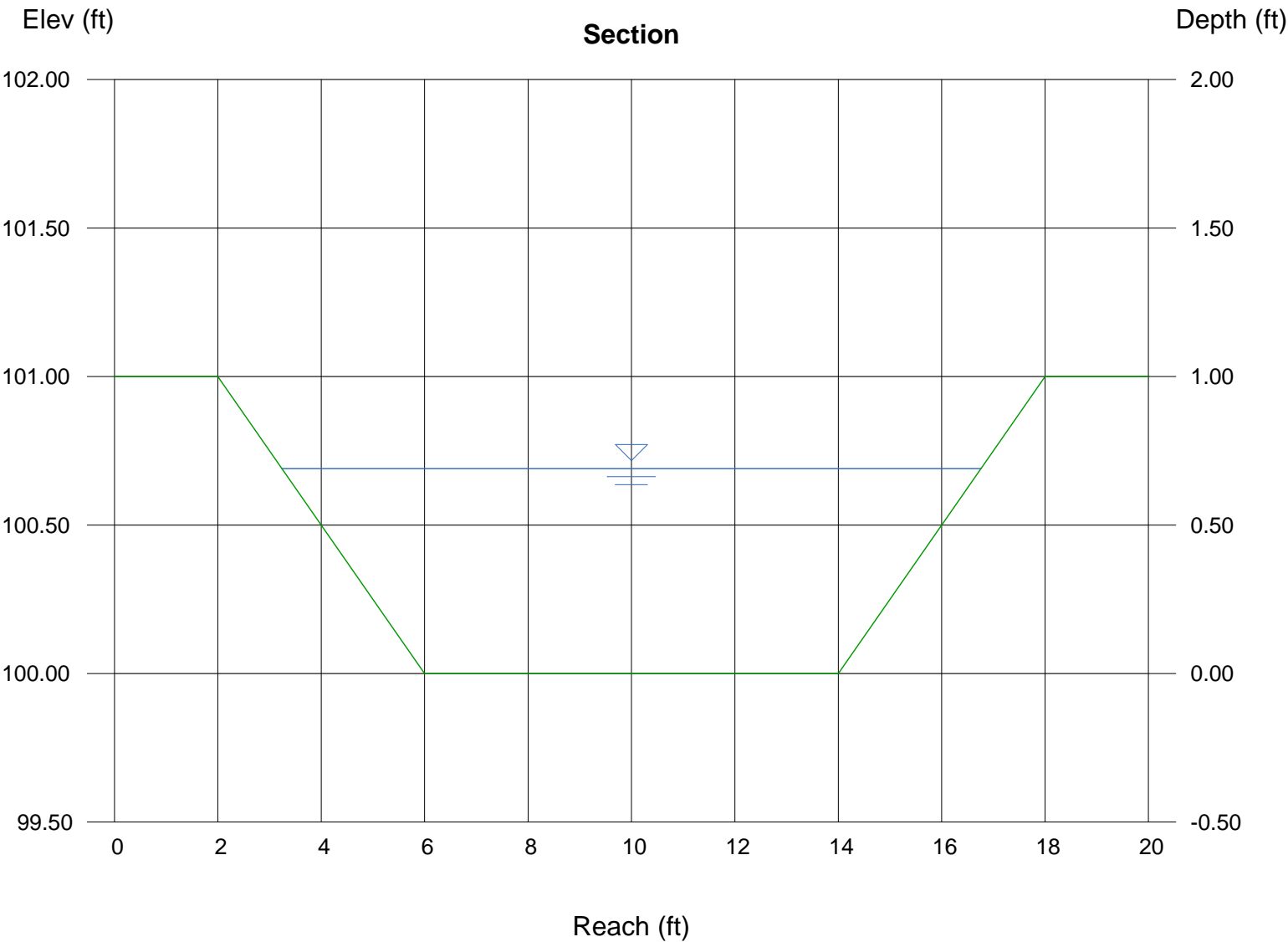
Botom Width (ft) = 8.00
Side Slope (z:1) = 4.00
Total Depth (ft) = 1.00
Invert Elev (ft) = 100.00
Slope (%) = 1.30
N-Value = 0.025

Calculations

Compute by: Known Q
Known Q (cfs) = 33.40

Highlighted

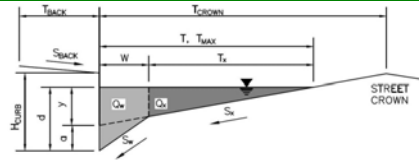
Depth (ft) = 0.69
Q (cfs) = 33.40
Area (sqft) = 7.42
Velocity (ft/s) = 4.50
Wetted Perim (ft) = 13.69
Crit Depth, Yc (ft) = 0.72
Top Width (ft) = 13.52
EGL (ft) = 1.00



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

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

Project: Creekside Filing No. 1, Lorson Ranch, El Paso County, CO #100.045
 Inlet ID: Inlet #DP-1

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

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

$T_{BACK} = 8.0$ ft
 $S_{BACK} = 0.020$ ft/ft
 $n_{BACK} = 0.015$

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

$H_{CURB} = 9.00$ inches
 $T_{CROWN} = 17.0$ ft
 $W = 2.00$ ft
 $S_X = 0.020$ ft/ft
 $S_W = 0.083$ ft/ft
 $S_D = 0.000$ ft/ft
 $n_{STREET} = 0.016$

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

| | Minor Storm | Major Storm | |
|-----------|--------------------------|--------------------------|--------|
| T_{MAX} | 15.0 | 17.0 | ft |
| d_{MAX} | 9.0 | 12.6 | inches |
| | <input type="checkbox"/> | <input type="checkbox"/> | |

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (Eq. ST-2)
 Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")
 Gutter Depression ($d_c - (W \cdot S_x \cdot 12)$)
 Water Depth at Gutter Flowline
 Allowable Spread for Discharge outside the Gutter Section W (T - W)
 Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)
 Discharge outside the Gutter Section W, carried in Section T_X
 Discharge within the Gutter Section W ($Q_T - Q_X$)
 Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

| | Minor Storm | Major Storm | |
|-------------|-------------|-------------|--------|
| y | 3.60 | 4.08 | inches |
| d_c | 2.0 | 2.0 | inches |
| a | 1.51 | 1.51 | inches |
| d | 5.11 | 5.59 | inches |
| T_X | 13.0 | 15.0 | ft |
| E_0 | 0.397 | 0.350 | |
| Q_{TX} | 0.0 | 0.0 | cfs |
| Q_{TW} | 0.0 | 0.0 | cfs |
| Q_{BACK} | 0.0 | 0.0 | cfs |
| Q_T | SUMP | SUMP | cfs |
| V | 0.0 | 0.0 | fps |
| $V \cdot d$ | 0.0 | 0.0 | |

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread
 Theoretical Spread for Discharge outside the Gutter Section W (T - W)
 Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)
 Theoretical Discharge outside the Gutter Section W, carried in Section T_{XTH}
 Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})
 Discharge within the Gutter Section W ($Q_d - Q_X$)
 Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
 Total Discharge for Major & Minor Storm (Pre-Safety Factor)
 Average Flow Velocity Within the Gutter Section
 $V \cdot d$ Product: Flow Velocity Times Gutter Flowline Depth
 Slope-Based Depth Safety Reduction Factor for Major & Minor ($d \geq 6"$) Storm
Max Flow Based on Allowable Depth (Safety Factor Applied)
 Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)
 Resultant Flow Depth at Street Crown (Safety Factor Applied)

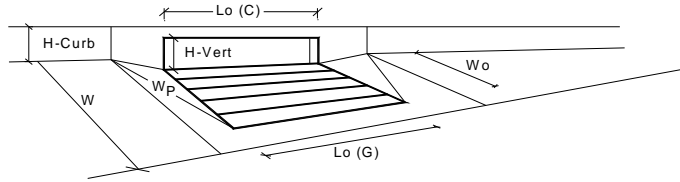
| | Minor Storm | Major Storm | |
|-------------|-------------|-------------|--------|
| T_{TH} | 31.2 | 46.2 | ft |
| T_{XTH} | 29.2 | 44.2 | ft |
| E_0 | 0.186 | 0.123 | |
| Q_{XTH} | 0.0 | 0.0 | cfs |
| Q_X | 0.0 | 0.0 | cfs |
| Q_{TW} | 0.0 | 0.0 | cfs |
| Q_{BACK} | 0.0 | 0.0 | cfs |
| Q | 0.0 | 0.0 | cfs |
| V | 0.0 | 0.0 | fps |
| $V \cdot d$ | 0.0 | 0.0 | |
| R | SUMP | SUMP | |
| Q_d | SUMP | SUMP | cfs |
| d | | | inches |
| d_{CROWN} | | | 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) | | 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} = | 0.00 | 0.00 | inches |
| Number of Unit Inlets (Grate or Curb Opening) | | No = | 1 | 1 | |
| Water Depth at Flowline (outside of local depression) | | Ponding Depth = | 5.9 | 8.0 | inches |
| Grate Information | | MINOR | | MAJOR | |
| Length of a Unit Grate | | L _g (G) = | N/A | N/A | feet |
| Width of a Unit Grate | | W _g = | 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 ₁ (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) = | 15.00 | 15.00 | 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 ₁ (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 | |
| Grate Flow Analysis (Calculated) | | MINOR | | MAJOR | |
| Clogging Coefficient for Multiple Units | | Coef = | N/A | N/A | |
| Clogging Factor for Multiple Units | | Clog = | N/A | N/A | |
| Grate Capacity as a Weir (based on Modified HEC22 Method) | | MINOR | | MAJOR | |
| Interception without Clogging | | Q _{we} = | N/A | N/A | cfs |
| Interception with Clogging | | Q _{we} = | N/A | N/A | cfs |
| Grate Capacity as an Orifice (based on Modified HEC22 Method) | | MINOR | | MAJOR | |
| Interception without Clogging | | Q _{or} = | N/A | N/A | cfs |
| Interception with Clogging | | Q _{or} = | N/A | N/A | cfs |
| Grate Capacity as Mixed Flow | | MINOR | | MAJOR | |
| Interception without Clogging | | Q _{mi} = | N/A | N/A | cfs |
| Interception with Clogging | | Q _{mi} = | N/A | N/A | cfs |
| Resulting Grate Capacity (assumes clogged condition) | | MINOR | | MAJOR | |
| | | Q _{Grate} = | N/A | N/A | cfs |
| Curb Opening Flow Analysis (Calculated) | | MINOR | | MAJOR | |
| Clogging Coefficient for Multiple Units | | Coef = | 1.31 | 1.31 | |
| Clogging Factor for Multiple Units | | Clog = | 0.04 | 0.04 | |
| Curb Opening as a Weir (based on Modified HEC22 Method) | | MINOR | | MAJOR | |
| Interception without Clogging | | Q _{we} = | 9.5 | 21.2 | cfs |
| Interception with Clogging | | Q _{we} = | 9.1 | 20.2 | cfs |
| Curb Opening as an Orifice (based on Modified HEC22 Method) | | MINOR | | MAJOR | |
| Interception without Clogging | | Q _{or} = | 20.8 | 26.8 | cfs |
| Interception with Clogging | | Q _{or} = | 19.8 | 25.7 | cfs |
| Curb Opening Capacity as Mixed Flow | | MINOR | | MAJOR | |
| Interception without Clogging | | Q _{mi} = | 13.1 | 22.2 | cfs |
| Interception with Clogging | | Q _{mi} = | 12.5 | 21.2 | cfs |
| Resulting Curb Opening Capacity (assumes clogged condition) | | MINOR | | MAJOR | |
| | | Q _{Curb} = | 9.1 | 20.2 | cfs |
| Resultant Street Conditions | | MINOR | | MAJOR | |
| Total Inlet Length | | L = | 15.00 | 15.00 | feet |
| Resultant Street Flow Spread (based on street geometry from above) | | T = | 18.1 | 27.0 | ft. > T-Crown |
| Resultant Flow Depth at Street Crown | | d _{CROWN} = | 0.3 | 2.4 | inches |
| 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} = | 0.32 | 0.50 | ft |
| Combination Inlet Performance Reduction Factor for Long Inlets | | RF _{Combination} = | 0.55 | 0.75 | |
| Curb Opening Performance Reduction Factor for Long Inlets | | RF _{Curb} = | 0.78 | 0.89 | |
| Grated Inlet Performance Reduction Factor for Long Inlets | | RF _{Grate} = | N/A | N/A | |
| Total Inlet Interception Capacity (assumes clogged condition) | | MINOR | | MAJOR | |
| | | Q _s = | 9.1 | 20.2 | cfs |
| Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK) | | MINOR | | MAJOR | |
| | | Q _{PEAK REQUIRED} = | 9.1 | 20.2 | cfs |

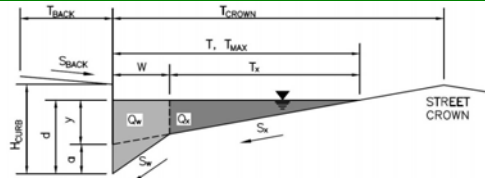
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

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

Project: Creekside Filing No. 1, Lorson Ranch, El Paso County, CO

#100.045

Inlet ID: Inlet #DP-3

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

Maximum Allowable Width for Spread Behind Curb

 $T_{BACK} = 8.0$ ft

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

 $S_{BACK} = 0.020$ ft/ft

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

 $n_{BACK} = 0.015$

Height of Curb at Gutter Flow Line

 $H_{CURB} = 9.00$ inches

Distance from Curb Face to Street Crown

 $T_{CROWN} = 17.0$ ft

Gutter Width

 $W = 2.00$ ft

Street Transverse Slope

 $S_x = 0.020$ ft/ft

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

 $S_w = 0.083$ ft/ft

Street Longitudinal Slope - Enter 0 for sump condition

 $S_o = 0.000$ ft/ft

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

 $n_{STREET} = 0.016$

Max. Allowable Spread for Minor & Major Storm

| | Minor Storm | Major Storm | |
|-----------|-------------|-------------|--------|
| T_{MAX} | 15.0 | 17.0 | ft |
| d_{MAX} | 9.0 | 12.6 | inches |

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

Check boxes are not applicable in SUMP conditions

☐ ☐
Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (Eq. ST-2)

| | Minor Storm | Major Storm | |
|-----|-------------|-------------|--------|
| y | 3.60 | 4.08 | inches |

Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")

 $d_c = 2.0$ inchesGutter Depression ($d_c - (W \cdot S_x \cdot 12)$) $a = 1.51$ inches

Water Depth at Gutter Flowline

 $d = 5.11$ inchesAllowable Spread for Discharge outside the Gutter Section W ($T - W$) $T_x = 13.0$ ft

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

 $E_o = 0.397$ Discharge outside the Gutter Section W , carried in Section T_x $Q_x = 0.0$ cfsDischarge within the Gutter Section W ($Q_d - Q_x$) $Q_w = 0.0$ cfs

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

 $Q_{BACK} = 0.0$ cfs**Maximum Flow Based On Allowable Spread**

Flow Velocity within the Gutter Section

 $Q_T = \text{SUMP}$ cfs $V \cdot d$ Product: Flow Velocity times Gutter Flowline Depth $V = 0.0$ fps $V \cdot d = 0.0$ **Maximum Capacity for 1/2 Street based on Allowable Depth**

Theoretical Water Spread

| | Minor Storm | Major Storm | |
|----------|-------------|-------------|----|
| T_{TH} | 31.2 | 46.2 | ft |

Theoretical Spread for Discharge outside the Gutter Section W ($T - W$) $T_{XTH} = 29.2$ ft

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

 $E_o = 0.186$ Theoretical Discharge outside the Gutter Section W , carried in Section T_{XTH} $Q_{XTH} = 0.0$ cfsActual Discharge outside the Gutter Section W , (limited by distance T_{CROWN}) $Q_x = 0.0$ cfsDischarge within the Gutter Section W ($Q_d - Q_x$) $Q_w = 0.0$ cfs

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

 $Q_{BACK} = 0.0$ cfs

Total Discharge for Major & Minor Storm (Pre-Safety Factor)

 $Q = 0.0$ cfs

Average Flow Velocity Within the Gutter Section

 $V = 0.0$ fps $V \cdot d$ Product: Flow Velocity Times Gutter Flowline Depth $V \cdot d = 0.0$ Slope-Based Depth Safety Reduction Factor for Major & Minor ($d \geq 6"$) Storm $R = \text{SUMP}$ **Max Flow Based on Allowable Depth (Safety Factor Applied)**

Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)

 $Q_d = \text{SUMP}$ cfs

Resultant Flow Depth at Street Crown (Safety Factor Applied)

 $d =$ inches $d_{CROWN} =$ inches

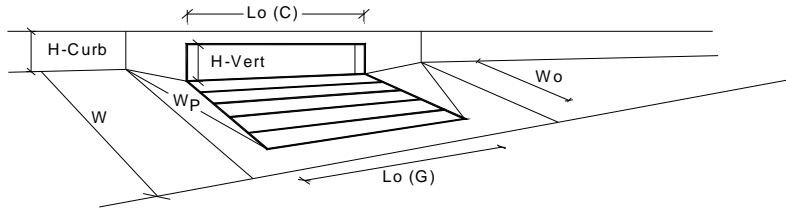
MINOR STORM Allowable Capacity is based on Depth Criterion

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)

CDOT Type R Curb Opening

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)

| | MINOR | MAJOR | |
|-----------------------|--------------------------|-------|---|
| Type = | CDOT Type R Curb Opening | | |
| a _{local} = | 0.00 | 0.00 | inches |
| No = | 1 | 1 | |
| Ponding Depth = | 5.2 | 7.1 | inches |
| | MINOR | MAJOR | <input checked="" type="checkbox"/> 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 | |

Grate Flow Analysis (Calculated)

Clogging Coefficient for Multiple Units
Clogging Factor for Multiple Units

Grate Capacity as a Weir (based on Modified HEC22 Method)

Interception without Clogging
Interception with Clogging

Grate Capacity as a Orifice (based on Modified HEC22 Method)

Interception without Clogging
Interception with Clogging

Grate Capacity as Mixed Flow

Interception without Clogging
Interception with Clogging

Resulting Grate Capacity (assumes clogged condition)

| | MINOR | MAJOR | |
|----------------------|-------|-------|-----|
| Coef = | N/A | N/A | |
| Clog = | N/A | N/A | |
| | MINOR | MAJOR | |
| Q _{wi} = | N/A | N/A | cfs |
| Q _{wa} = | N/A | N/A | cfs |
| | MINOR | MAJOR | |
| Q _{oi} = | N/A | N/A | cfs |
| Q _{oa} = | N/A | N/A | cfs |
| | MINOR | MAJOR | |
| Q _{mi} = | N/A | N/A | cfs |
| Q _{ma} = | N/A | N/A | cfs |
| Q _{Grate} = | N/A | N/A | cfs |

Curb Opening Flow Analysis (Calculated)

Clogging Coefficient for Multiple Units
Clogging Factor for Multiple Units

Curb Opening as a Weir (based on Modified HEC22 Method)

Interception without Clogging
Interception with Clogging

Curb Opening as an Orifice (based on Modified HEC22 Method)

Interception without Clogging
Interception with Clogging

Curb Opening Capacity as Mixed Flow

Interception without Clogging
Interception with Clogging

Resulting Curb Opening Capacity (assumes clogged condition)

| | MINOR | MAJOR | |
|---------------------|-------|-------|-----|
| Coef = | 1.31 | 1.31 | |
| Clog = | 0.04 | 0.04 | |
| | MINOR | MAJOR | |
| Q _{wi} = | 6.8 | 15.8 | cfs |
| Q _{wa} = | 6.5 | 15.1 | cfs |
| | MINOR | MAJOR | |
| Q _{oi} = | 18.5 | 24.5 | cfs |
| Q _{oa} = | 17.7 | 23.4 | cfs |
| | MINOR | MAJOR | |
| Q _{mi} = | 10.4 | 18.3 | cfs |
| Q _{ma} = | 10.0 | 17.5 | cfs |
| Q _{Curb} = | 6.5 | 15.1 | cfs |

Resultant Street Conditions

Total Inlet Length
Resultant Street Flow Spread (based on street geometry from above)
Resultant Flow Depth at Street Crown

| | MINOR | MAJOR | |
|----------------------|-------|-------|---------------|
| L = | 15.00 | 15.00 | feet |
| T = | 15.4 | 23.3 | ft. > T-Crown |
| d _{CROWN} = | 0.0 | 1.5 | inches |

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

| | MINOR | MAJOR | |
|-----------------------------|-------|-------|----|
| d _{Grate} = | N/A | N/A | ft |
| d _{Curb} = | 0.27 | 0.43 | ft |
| RF _{Combination} = | 0.49 | 0.67 | |
| RF _{Curb} = | 0.73 | 0.85 | |
| RF _{Grate} = | N/A | N/A | |

Total Inlet Interception Capacity (assumes clogged condition)

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

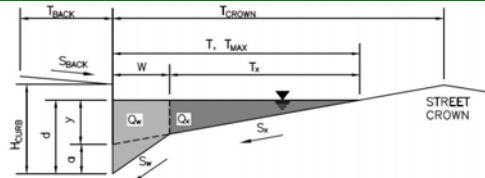
| | MINOR | MAJOR | |
|------------------------------|-------|-------|-----|
| Q _a = | 6.5 | 15.1 | cfs |
| Q _{PEAK REQUIRED} = | 6.0 | 13.3 | cfs |

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

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

Project: Creekside Filing No. 1, Lorson Ranch, El Paso County, CO #100.045

Inlet ID: Inlet #DP-6

**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)

 $T_{BACK} = 8.0$ ft
 $S_{BACK} = 0.200$ ft/ft
 $n_{BACK} = 0.015$
 $H_{CURB} = 9.00$ inches
 $T_{CROWN} = 17.0$ ft
 $W = 2.00$ ft
 $S_x = 0.020$ ft/ft
 $S_w = 0.083$ ft/ft
 $S_o = 0.000$ ft/ft
 $n_{STREET} = 0.016$

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

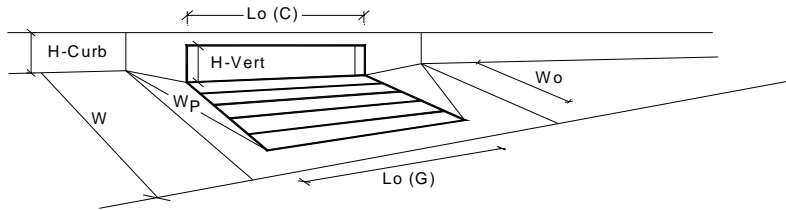
| | Minor Storm | Major Storm | |
|-------------|--------------------------|--------------------------|--------|
| $T_{MAX} =$ | 15.0 | 17.0 | ft |
| $d_{MAX} =$ | 9.0 | 12.6 | inches |
| | <input type="checkbox"/> | <input type="checkbox"/> | |

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)

Grate Flow Analysis (Calculated)

Clogging Coefficient for Multiple Units
Clogging Factor for Multiple Units

Grate Capacity as a Weir (based on Modified HEC22 Method)

Interception without Clogging
Interception with Clogging

Grate Capacity as a Orifice (based on Modified HEC22 Method)

Interception without Clogging
Interception with Clogging

Grate Capacity as Mixed Flow

Interception without Clogging
Interception with Clogging

Resulting Grate Capacity (assumes clogged condition)

Curb Opening Flow Analysis (Calculated)

Clogging Coefficient for Multiple Units
Clogging Factor for Multiple Units

Curb Opening as a Weir (based on Modified HEC22 Method)

Interception without Clogging
Interception with Clogging

Curb Opening as an Orifice (based on Modified HEC22 Method)

Interception without Clogging
Interception with Clogging

Curb Opening Capacity as Mixed Flow

Interception without Clogging
Interception with Clogging

Resulting Curb Opening Capacity (assumes clogged condition)

Resultant Street Conditions

Total Inlet Length
Resultant Street Flow Spread (based on street geometry from above)
Resultant Flow Depth at Street Crown

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)

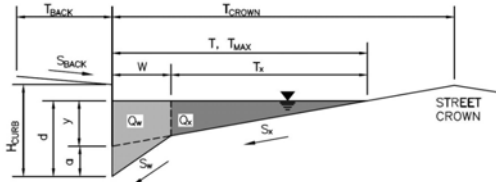
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)

| | MINOR | MAJOR | |
|------------------------------|--------------------------|-------|-------------|
| Type = | CDOT Type R Curb Opening | | |
| a _{local} = | 0.00 | 0.00 | inches |
| No = | 1 | 1 | |
| Ponding Depth = | 5.1 | 6.9 | inches |
| | MINOR | MAJOR | |
| L _o (G) = | N/A | N/A | feet |
| W _o = | N/A | N/A | feet |
| A _{ratio} = | N/A | N/A | |
| C _l (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 _l (C) = | 0.10 | 0.10 | |
| C _w (C) = | 3.60 | 3.60 | |
| C _o (C) = | 0.67 | 0.67 | |
| | MINOR | MAJOR | |
| Coef = | N/A | N/A | |
| Clog = | N/A | N/A | |
| | MINOR | MAJOR | |
| Q _{wi} = | N/A | N/A | cfs |
| Q _{wa} = | N/A | N/A | cfs |
| | MINOR | MAJOR | |
| Q _{oi} = | N/A | N/A | cfs |
| Q _{oa} = | N/A | N/A | cfs |
| | MINOR | MAJOR | |
| Q _{mi} = | N/A | N/A | cfs |
| Q _{ma} = | N/A | N/A | cfs |
| Q _{Grate} = | N/A | N/A | cfs |
| | MINOR | MAJOR | |
| Coef = | 1.25 | 1.25 | |
| Clog = | 0.06 | 0.06 | |
| | MINOR | MAJOR | |
| Q _{wi} = | 5.7 | 12.6 | cfs |
| Q _{wa} = | 5.3 | 11.8 | cfs |
| | MINOR | MAJOR | |
| Q _{oi} = | 12.1 | 16.0 | cfs |
| Q _{oa} = | 11.3 | 15.0 | cfs |
| | MINOR | MAJOR | |
| Q _{mi} = | 7.7 | 13.2 | cfs |
| Q _{ma} = | 7.2 | 12.4 | cfs |
| Q _{Curb} = | 5.3 | 11.8 | cfs |
| | MINOR | MAJOR | |
| L = | 10.00 | 10.00 | feet |
| T = | 15.0 | 22.5 | ft.>T-Crown |
| d _{CROWN} = | 0.0 | 1.3 | inches |
| | MINOR | MAJOR | |
| d _{Grate} = | N/A | N/A | ft |
| d _{Curb} = | 0.26 | 0.41 | ft |
| RF _{Combination} = | 0.48 | 0.65 | |
| RF _{Curb} = | 0.88 | 0.98 | |
| RF _{Grate} = | N/A | N/A | |
| | MINOR | MAJOR | |
| Q _a = | 5.3 | 11.8 | cfs |
| Q _{PEAK REQUIRED} = | 5.3 | 11.8 | cfs |

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

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

Project: **Creekside Filing No. 1, Lorson Ranch, El Paso County, CO** #100.045
 Inlet ID: **Inlet #DP-10**

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

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

T_{BACK} = 8.0 ft
 S_{BACK} = 0.020 ft/ft
 n_{BACK} = 0.015

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

H_{CURB} = 9.00 inches
 T_{CROWN} = 17.0 ft
 W = 2.00 ft
 S_X = 0.020 ft/ft
 S_W = 0.083 ft/ft
 S_O = 0.000 ft/ft
 n_{STREET} = 0.016

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} | 15.0 | 17.0 | ft |
| d_{MAX} | 9.0 | 12.6 | inches |
| | <input type="checkbox"/> | <input type="checkbox"/> | |

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (Eq. ST-2)
 Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")
 Gutter Depression ($d_c - (W * S_x * 12)$)
 Water Depth at Gutter Flowline
 Allowable Spread for Discharge outside the Gutter Section W ($T - W$)
 Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)
 Discharge outside the Gutter Section W , carried in Section T_X
 Discharge within the Gutter Section W ($Q_T - Q_X$)
 Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

| | Minor Storm | Major Storm | |
|------------|-------------|-------------|--------|
| y | 3.60 | 4.08 | inches |
| d_c | 2.0 | 2.0 | inches |
| a | 1.51 | 1.51 | inches |
| d | 5.11 | 5.59 | inches |
| T_X | 13.0 | 15.0 | ft |
| E_0 | 0.397 | 0.350 | |
| Q_X | 0.0 | 0.0 | cfs |
| Q_W | 0.0 | 0.0 | cfs |
| Q_{BACK} | 0.0 | 0.0 | cfs |
| Q_T | SUMP | SUMP | cfs |
| V | 0.0 | 0.0 | fps |
| $V*d$ | 0.0 | 0.0 | |

Maximum Flow Based On Allowable Spread

Flow Velocity within the Gutter Section
 $V*d$ Product: Flow Velocity times Gutter Flowline Depth

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread
 Theoretical Spread for Discharge outside the Gutter Section W ($T - W$)
 Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)
 Theoretical Discharge outside the Gutter Section W , carried in Section T_{XTH}
 Actual Discharge outside the Gutter Section W , (limited by distance T_{CROWN})
 Discharge within the Gutter Section W ($Q_d - Q_X$)
 Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
 Total Discharge for Major & Minor Storm (Pre-Safety Factor)
 Average Flow Velocity Within the Gutter Section
 $V*d$ Product: Flow Velocity Times Gutter Flowline Depth
 Slope-Based Depth Safety Reduction Factor for Major & Minor ($d \geq 6"$) Storm

| | Minor Storm | Major Storm | |
|-------------|-------------|-------------|--------|
| T_{TH} | 31.2 | 46.2 | ft |
| T_{XTH} | 29.2 | 44.2 | ft |
| E_0 | 0.186 | 0.123 | |
| Q_{XTH} | 0.0 | 0.0 | cfs |
| Q_X | 0.0 | 0.0 | cfs |
| Q_W | 0.0 | 0.0 | cfs |
| Q_{BACK} | 0.0 | 0.0 | cfs |
| Q | 0.0 | 0.0 | cfs |
| V | 0.0 | 0.0 | fps |
| $V*d$ | 0.0 | 0.0 | |
| R | SUMP | SUMP | |
| Q_d | SUMP | SUMP | cfs |
| d | | | inches |
| d_{CROWN} | | | inches |

Max Flow Based on Allowable Depth (Safety Factor Applied)

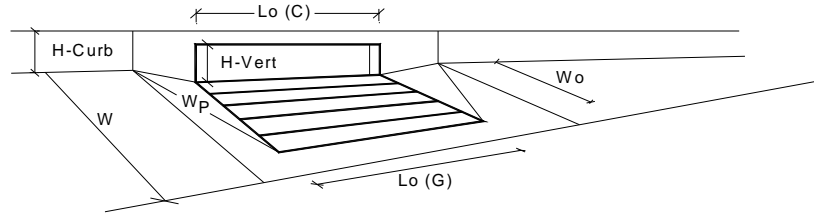
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)
 Resultant Flow Depth at Street Crown (Safety Factor Applied)

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)

CDOT Type R Curb Opening

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)

Grate Flow Analysis (Calculated)

Clogging Coefficient for Multiple Units

Clogging Factor for Multiple Units

Grate Capacity as a Weir (based on Modified HEC22 Method)

Interception without Clogging

Interception with Clogging

Grate Capacity as a Orifice (based on Modified HEC22 Method)

Interception without Clogging

Interception with Clogging

Grate Capacity as Mixed Flow

Interception without Clogging

Interception with Clogging

Resulting Grate Capacity (assumes clogged condition)

Curb Opening Flow Analysis (Calculated)

Clogging Coefficient for Multiple Units

Clogging Factor for Multiple Units

Curb Opening as a Weir (based on Modified HEC22 Method)

Interception without Clogging

Interception with Clogging

Curb Opening as an Orifice (based on Modified HEC22 Method)

Interception without Clogging

Interception with Clogging

Curb Opening Capacity as Mixed Flow

Interception without Clogging

Interception with Clogging

Resulting Curb Opening Capacity (assumes clogged condition)

Resultant Street Conditions

Total Inlet Length

Resultant Street Flow Spread (based on street geometry from above)

Resultant Flow Depth at Street Crown

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)

WARNING: Inlet Capacity less than Q Peak for Minor Storm

| | MINOR | MAJOR | |
|-----------------|--------------------------|-------|---|
| Type = | CDOT Type R Curb Opening | | |
| a_{local} = | 0.00 | 0.00 | inches |
| No = | 1 | 1 | |
| Ponding Depth = | 5.9 | 8.9 | inches |
| | MINOR | MAJOR | <input checked="" type="checkbox"/> Override Depths |
| L_o (G) = | N/A | N/A | feet |
| W_o = | N/A | N/A | feet |
| A_{ratio} = | N/A | N/A | |
| C_l (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_l (C) = | 0.10 | 0.10 | |
| C_w (C) = | 3.60 | 3.60 | |
| C_o (C) = | 0.67 | 0.67 | |

| | MINOR | MAJOR | |
|---------------|-------|-------|-----|
| Coef = | N/A | N/A | |
| Clog = | N/A | N/A | |
| | MINOR | MAJOR | |
| Q_{wl} = | N/A | N/A | cfs |
| Q_{wa} = | N/A | N/A | cfs |
| | MINOR | MAJOR | |
| Q_{oi} = | N/A | N/A | cfs |
| Q_{oa} = | N/A | N/A | cfs |
| | MINOR | MAJOR | |
| Q_{mi} = | N/A | N/A | cfs |
| Q_{ma} = | N/A | N/A | cfs |
| Q_{Grate} = | N/A | N/A | cfs |

| | MINOR | MAJOR | |
|--------------|-------|-------|-----|
| Coef = | 1.31 | 1.31 | |
| Clog = | 0.04 | 0.04 | |
| | MINOR | MAJOR | |
| Q_{wl} = | 9.7 | 27.2 | cfs |
| Q_{wa} = | 9.3 | 26.0 | cfs |
| | MINOR | MAJOR | |
| Q_{oi} = | 20.9 | 29.0 | cfs |
| Q_{oa} = | 20.0 | 27.8 | cfs |
| | MINOR | MAJOR | |
| Q_{mi} = | 13.2 | 26.1 | cfs |
| Q_{ma} = | 12.7 | 25.0 | cfs |
| Q_{Curb} = | 9.3 | 25.0 | cfs |

| | MINOR | MAJOR | |
|---------------|-------|-------|---------------|
| L = | 15.00 | 15.00 | feet |
| T = | 18.3 | 30.8 | ft. > T-Crown |
| d_{CROWN} = | 0.3 | 3.3 | inches |

| | MINOR | MAJOR | |
|----------------------|-------|-------|----|
| d_{Grate} = | N/A | N/A | ft |
| d_{Curb} = | 0.33 | 0.58 | ft |
| $RF_{Combination}$ = | 0.56 | 0.84 | |
| RF_{Curb} = | 0.78 | 0.93 | |
| RF_{Grate} = | N/A | N/A | |

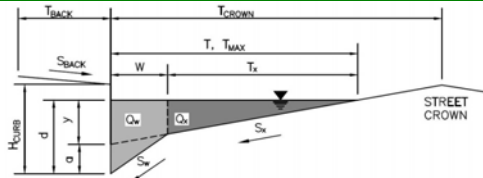
| | MINOR | MAJOR | |
|-----------------------|-------|-------|-----|
| Q_a = | 9.3 | 25.0 | cfs |
| $Q_{PEAK REQUIRED}$ = | 9.7 | 21.5 | cfs |

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

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

Project: Creekside Filing No. 1, Lorson Ranch, El Paso County, CO #100.045

Inlet ID: Inlet #DP-11

**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)

 $T_{BACK} = 8.0$ ft
 $S_{BACK} = 0.020$ ft/ft
 $n_{BACK} = 0.015$
 $H_{CURB} = 9.00$ inches
 $T_{CROWN} = 17.0$ ft
 $W = 2.00$ ft
 $S_x = 0.020$ ft/ft
 $S_w = 0.083$ ft/ft
 $S_o = 0.000$ ft/ft
 $n_{STREET} = 0.016$

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

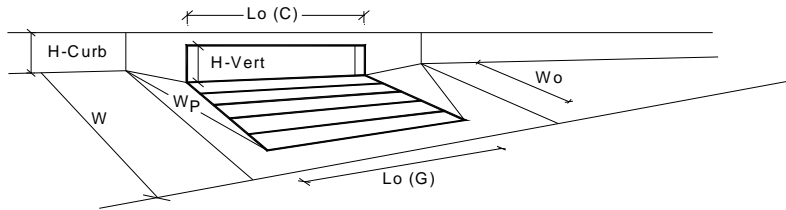
| | Minor Storm | Major Storm | |
|-------------|--------------------------|--------------------------|--------|
| $T_{MAX} =$ | 15.0 | 17.0 | ft |
| $d_{MAX} =$ | 9.0 | 12.6 | inches |
| | <input type="checkbox"/> | <input type="checkbox"/> | |

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)

Grate Flow Analysis (Calculated)

Clogging Coefficient for Multiple Units
Clogging Factor for Multiple Units

Grate Capacity as a Weir (based on Modified HEC22 Method)

Interception without Clogging
Interception with Clogging

Grate Capacity as a Orifice (based on Modified HEC22 Method)

Interception without Clogging
Interception with Clogging

Grate Capacity as Mixed Flow

Interception without Clogging
Interception with Clogging

Resulting Grate Capacity (assumes clogged condition)

Curb Opening Flow Analysis (Calculated)

Clogging Coefficient for Multiple Units
Clogging Factor for Multiple Units

Curb Opening as a Weir (based on Modified HEC22 Method)

Interception without Clogging
Interception with Clogging

Curb Opening as an Orifice (based on Modified HEC22 Method)

Interception without Clogging
Interception with Clogging

Curb Opening Capacity as Mixed Flow

Interception without Clogging
Interception with Clogging

Resulting Curb Opening Capacity (assumes clogged condition)

Resultant Street Conditions

Total Inlet Length
Resultant Street Flow Spread (based on street geometry from above)
Resultant Flow Depth at Street Crown

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)

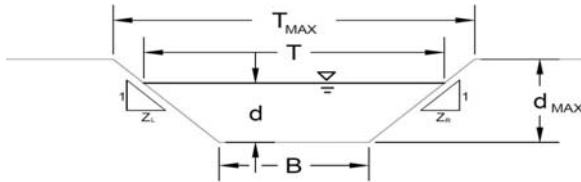
| | MINOR | MAJOR | |
|------------------------------|--------------------------|-------|---------------|
| Type = | CDOT Type R Curb Opening | | |
| a _{local} = | 0.00 | 0.00 | inches |
| No = | 1 | 1 | |
| Ponding Depth = | 4.4 | 6.2 | inches |
| | MINOR | MAJOR | |
| L _o (G) = | N/A | N/A | feet |
| W _o = | N/A | N/A | feet |
| A _{ratio} = | N/A | N/A | |
| C _l (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 _l (C) = | 0.10 | 0.10 | |
| C _w (C) = | 3.60 | 3.60 | |
| C _o (C) = | 0.67 | 0.67 | |
| | MINOR | MAJOR | |
| Coef = | N/A | N/A | |
| Clog = | N/A | N/A | |
| | MINOR | MAJOR | |
| Q _{wi} = | N/A | N/A | cfs |
| Q _{wa} = | N/A | N/A | cfs |
| | MINOR | MAJOR | |
| Q _{oi} = | N/A | N/A | cfs |
| Q _{oa} = | N/A | N/A | cfs |
| | MINOR | MAJOR | |
| Q _{mi} = | N/A | N/A | cfs |
| Q _{ma} = | N/A | N/A | cfs |
| Q _{Grate} = | N/A | N/A | cfs |
| | MINOR | MAJOR | |
| Coef = | 1.31 | 1.31 | |
| Clog = | 0.04 | 0.04 | |
| | MINOR | MAJOR | |
| Q _{wi} = | 4.0 | 11.1 | cfs |
| Q _{wa} = | 3.9 | 10.6 | cfs |
| | MINOR | MAJOR | |
| Q _{oi} = | 15.3 | 21.8 | cfs |
| Q _{oa} = | 14.6 | 20.9 | cfs |
| | MINOR | MAJOR | |
| Q _{mi} = | 7.3 | 14.5 | cfs |
| Q _{ma} = | 7.0 | 13.9 | cfs |
| Q _{Curb} = | 3.9 | 10.6 | cfs |
| | MINOR | MAJOR | |
| L = | 15.00 | 15.00 | feet |
| T = | 12.0 | 19.5 | ft. > T-Crown |
| d _{CROWN} = | 0.0 | 0.6 | inches |
| | MINOR | MAJOR | |
| d _{Grate} = | N/A | N/A | ft |
| d _{Curb} = | 0.20 | 0.35 | ft |
| RF _{Combination} = | 0.42 | 0.58 | |
| RF _{Curb} = | 0.67 | 0.80 | |
| RF _{Grate} = | N/A | N/A | |
| | MINOR | MAJOR | |
| Q _a = | 3.9 | 10.6 | cfs |
| Q _{PEAK REQUIRED} = | 3.7 | 8.3 | cfs |

AREA INLET IN A SWALE

Creekside Filing No. 1, Lorson Ranch, El Paso County, CO

#100.045

Inlet #DP-12 (C1.17)



This worksheet uses the NRCS
vegetal retardance method to
determine Manning's n.

For more information see
Section 7.2.3 of the USDCM.

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}) |
|--------------|-----------------------------------|------------------------------------|
| Non-Cohesive | 5.0 fps | 0.60 |
| Cohesive | 7.0 fps | 0.80 |
| Paved | N/A | N/A |

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

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

A, B, C, D or E

| | |
|------------------|-------------------|
| A, B, C, D or E | C |
| n = | see details below |
| S ₀ = | 0.0133 ft/ft |
| B = | 0.00 ft |
| Z1 = | 30.00 ft/ft |
| Z2 = | 30.00 ft/ft |

Choose One:

- ☒ Non-Cohesive
☐ Cohesive
☐ Paved

| | Minor Storm | Major Storm | |
|--------------------|-------------|-------------|------|
| T _{MAX} = | 60.00 | 60.00 | feet |
| d _{MAX} = | 0.80 | 1.00 | 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} = | 60.00 | 60.00 | ft |
| d = | 1.00 | 1.00 | ft |
| A = | 30.00 | 30.00 | sq ft |
| P = | 60.03 | 60.03 | ft |
| R = | 0.50 | 0.50 | ft |
| n = | 0.215 | 0.215 | |
| V = | 0.50 | 0.50 | fps |
| VR = | 0.25 | 0.25 | ft ² /s |
| D = | 0.50 | 0.50 | ft |
| Fr = | 0.13 | 0.13 | |
| Q _T = | 15.1 | 15.1 | 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 | 1.00 | feet |
| T = | 48.00 | 60.00 | feet |
| A = | 19.20 | 30.00 | square feet |
| P = | 48.03 | 60.03 | feet |
| R = | 0.40 | 0.50 | feet |
| n = | 0.430 | 0.215 | |
| V = | 0.22 | 0.50 | fps |
| VR = | 0.09 | 0.25 | ft ² /s |
| D = | 0.40 | 0.50 | feet |
| Fr = | 0.06 | 0.13 | |
| Q _d = | 4.2 | 15.1 | 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} = | 4.2 | 15.1 | cfs |
| d _{allow} = | 0.80 | 1.00 | 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 _o = | 2.9 | 6.3 | cfs |
| d = | 0.70 | 0.91 | feet |
| T = | 41.91 | 54.69 | feet |
| A = | 14.64 | 24.92 | square feet |
| P = | 41.93 | 54.72 | feet |
| R = | 0.35 | 0.46 | feet |
| n = | 0.430 | 0.402 | |
| V = | 0.20 | 0.25 | fps |
| VR = | 0.07 | 0.12 | ft ² /s |
| D = | 0.35 | 0.46 | feet |
| Fr = | 0.06 | 0.07 | |

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'

AREA INLET IN A SWALE

Creeside Filing No. 1, Lorson Ranch, El Paso County, CO

#100.045

Inlet #DP-12 (C1.17)

Inlet Design Information (Input)

Type of Inlet

CDOT Type C (Depressed)

Inlet Type =

CDOT Type C (Depressed)

Angle of Inclined Grate (must be ≤ 30 degrees)

Width of Grate

Length of Grate

Open Area Ratio

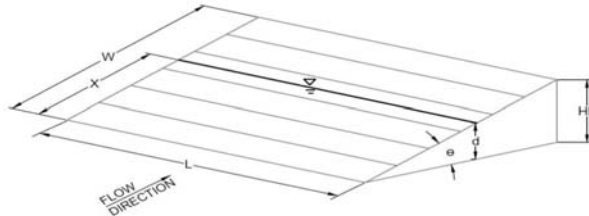
Height of Inclined Grate

Clogging Factor

Grate Discharge Coefficient

Orifice Coefficient

Weir Coefficient

 $\theta =$ 0.00 degrees

W = 3.00 feet

L = 3.00 feet

A_{RATIO} = 0.70H_B = 0.00 feetC_l = 0.50C_d = 0.84C_o = 0.56C_w = 1.81

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

| | MINOR | MAJOR |
|-----|-------|-------|
| d = | 1.70 | 1.91 |

Grate Capacity as a Weir

Submerged Side Weir Length

Inclined Side Weir Flow

Base Weir Flow

Interception without Clogging

Interception with Clogging

| | MINOR | MAJOR | |
|-------------------|-------|-------|------|
| X = | 3.00 | 3.00 | feet |
| Q _{ws} = | 21.0 | 25.1 | cfs |
| Q _{wb} = | 30.0 | 35.8 | cfs |
| Q _{wi} = | 72.0 | 85.9 | cfs |
| Q _{wa} = | 36.0 | 43.0 | cfs |

Grate Capacity as an Orifice

Interception without Clogging

Interception with Clogging

| | | | |
|-------------------|------|------|-----|
| Q _{oi} = | 37.1 | 39.3 | cfs |
| Q _{oi} = | 18.5 | 19.7 | cfs |

Total Inlet Interception Capacity (assumes clogged condition)

| | | | |
|--|------|------|-----|
| Q _a = | 18.5 | 19.7 | cfs |
| Bypassed Flow, Q _b = | 0.0 | 0.0 | cfs |
| Capture Percentage = Q _a /Q _o = C% | 100 | 100 | % |

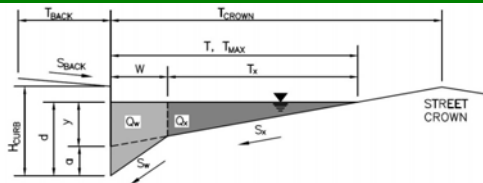
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

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

Project: Creekside Filing No. 1, Lorton Ranch, El Paso County, CO

#100.045

Inlet ID: Inlet #DP-15

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

Maximum Allowable Width for Spread Behind Curb

 $T_{BACK} = 8.0$ ft

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

 $S_{BACK} = 0.020$ ft/ft

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

 $n_{BACK} = 0.015$

Height of Curb at Gutter Flow Line

 $H_{CURB} = 9.00$ inches

Distance from Curb Face to Street Crown

 $T_{CROWN} = 17.0$ ft

Gutter Width

 $W = 2.00$ ft

Street Transverse Slope

 $S_x = 0.020$ ft/ft

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

 $S_w = 0.083$ ft/ft

Street Longitudinal Slope - Enter 0 for sump condition

 $S_o = 0.000$ ft/ft

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

 $n_{STREET} = 0.016$

Max. Allowable Spread for Minor & Major Storm

| | Minor Storm | Major Storm | |
|-------------|-------------|-------------|--------|
| $T_{MAX} =$ | 15.0 | 17.0 | ft |
| $d_{MAX} =$ | 9.0 | 12.6 | inches |

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

Check boxes are not applicable in SUMP conditions

**Maximum Capacity for 1/2 Street based On Allowable Spread**

Water Depth without Gutter Depression (Eq. ST-2)

| | Minor Storm | Major Storm | |
|--------------|-------------|-------------|--------|
| $y =$ | 3.60 | 4.08 | inches |
| $d_c =$ | 2.0 | 2.0 | inches |
| $a =$ | 1.51 | 1.51 | inches |
| $d =$ | 5.11 | 5.59 | inches |
| $T_x =$ | 13.0 | 15.0 | ft |
| $E_o =$ | 0.397 | 0.350 | |
| $Q_x =$ | 0.0 | 0.0 | cfs |
| $Q_w =$ | 0.0 | 0.0 | cfs |
| $Q_{BACK} =$ | 0.0 | 0.0 | cfs |
| $Q_T =$ | SUMP | SUMP | cfs |
| $V =$ | 0.0 | 0.0 | fps |
| $V*d =$ | 0.0 | 0.0 | |

Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")

Gutter Depression ($d_c - (W * S_x * 12)$)

Water Depth at Gutter Flowline

Allowable Spread for Discharge outside the Gutter Section W (T - W)

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

Discharge outside the Gutter Section W, carried in Section T_x Discharge within the Gutter Section W ($Q_d - Q_x$)

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

Maximum Flow Based On Allowable Spread

Flow Velocity within the Gutter Section

 $V*d$ Product: Flow Velocity times Gutter Flowline Depth**Maximum Capacity for 1/2 Street based on Allowable Depth**

Theoretical Water Spread

| | Minor Storm | Major Storm | |
|---------------|-------------|-------------|--------|
| $T_{TH} =$ | 31.2 | 46.2 | ft |
| $T_{XTH} =$ | 29.2 | 44.2 | ft |
| $E_o =$ | 0.186 | 0.123 | |
| $Q_{XTH} =$ | 0.0 | 0.0 | cfs |
| $Q_x =$ | 0.0 | 0.0 | cfs |
| $Q_w =$ | 0.0 | 0.0 | cfs |
| $Q_{BACK} =$ | 0.0 | 0.0 | cfs |
| $Q =$ | 0.0 | 0.0 | cfs |
| $V =$ | 0.0 | 0.0 | fps |
| $V*d =$ | 0.0 | 0.0 | |
| $R =$ | SUMP | SUMP | |
| $Q_d =$ | SUMP | SUMP | cfs |
| $d =$ | | | inches |
| $d_{CROWN} =$ | | | inches |

Theoretical Spread for Discharge outside the Gutter Section W (T - W)

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

Theoretical Discharge outside the Gutter Section W, carried in Section T_{XTH} Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})Discharge within the Gutter Section W ($Q_d - Q_x$)

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

Total Discharge for Major & Minor Storm (Pre-Safety Factor)

Average Flow Velocity Within the Gutter Section

 $V*d$ Product: Flow Velocity Times Gutter Flowline DepthSlope-Based Depth Safety Reduction Factor for Major & Minor ($d \geq 6"$) Storm**Max Flow Based on Allowable Depth (Safety Factor Applied)**

Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)

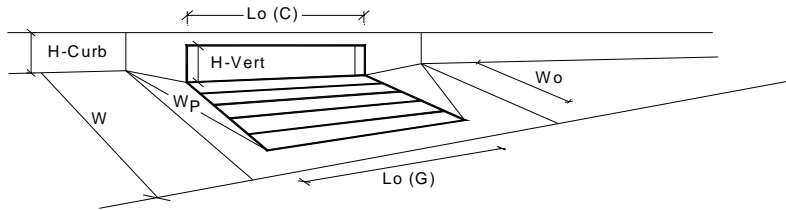
Resultant Flow Depth at Street Crown (Safety Factor Applied)

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

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

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)

Type of Inlet CDOT 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)

Grate Flow Analysis (Calculated)

Clogging Coefficient for Multiple Units
 Clogging Factor for Multiple Units
Grate Capacity as a Weir (based on Modified HEC22 Method)

Interception without Clogging
 Interception with Clogging

Grate Capacity as a Orifice (based on Modified HEC22 Method)

Interception without Clogging
 Interception with Clogging

Grate Capacity as Mixed Flow

Interception without Clogging
 Interception with Clogging

Resulting Grate Capacity (assumes clogged condition)

Curb Opening Flow Analysis (Calculated)

Clogging Coefficient for Multiple Units
 Clogging Factor for Multiple Units
Curb Opening as a Weir (based on Modified HEC22 Method)

Interception without Clogging
 Interception with Clogging

Curb Opening as an Orifice (based on Modified HEC22 Method)

Interception without Clogging
 Interception with Clogging

Curb Opening Capacity as Mixed Flow

Interception without Clogging
 Interception with Clogging

Resulting Curb Opening Capacity (assumes clogged condition)

Resultant Street Conditions

Total Inlet Length
 Resultant Street Flow Spread (based on street geometry from above)
 Resultant Flow Depth at Street Crown

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} = | 0.00 | 0.00 | inches |
| N_o = | 1 | 1 | |
| Ponding Depth = | 4.2 | 5.1 | 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 | |
| $C_l (G)$ = | 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 |
| Θ = | 63.40 | 63.40 | degrees |
| W_p = | 2.00 | 2.00 | feet |
| $C_l (C)$ = | 0.10 | 0.10 | |
| $C_w (C)$ = | 3.60 | 3.60 | |
| $C_o (C)$ = | 0.67 | 0.67 | |
| | MINOR | MAJOR | |
| Coef = | N/A | N/A | |
| Clog = | N/A | N/A | |
| | MINOR | MAJOR | |
| Q_{wi} = | N/A | N/A | cfs |
| Q_{wa} = | N/A | N/A | cfs |
| | MINOR | MAJOR | |
| Q_{oi} = | N/A | N/A | cfs |
| Q_{oa} = | N/A | N/A | cfs |
| | MINOR | MAJOR | |
| Q_{mi} = | N/A | N/A | cfs |
| Q_{ma} = | N/A | N/A | cfs |
| Q_{Grate} = | N/A | N/A | cfs |
| | MINOR | MAJOR | |
| Coef = | 1.00 | 1.00 | |
| Clog = | 0.10 | 0.10 | |
| | MINOR | MAJOR | |
| Q_{wi} = | 2.5 | 4.2 | cfs |
| Q_{wa} = | 2.2 | 3.7 | cfs |
| | MINOR | MAJOR | |
| Q_{oi} = | 4.8 | 6.1 | cfs |
| Q_{oa} = | 4.3 | 5.5 | cfs |
| | MINOR | MAJOR | |
| Q_{mi} = | 3.2 | 4.7 | cfs |
| Q_{ma} = | 2.9 | 4.2 | cfs |
| Q_{Curb} = | 2.2 | 3.7 | cfs |
| | MINOR | MAJOR | |
| L = | 5.00 | 5.00 | feet |
| T = | 11.3 | 15.1 | ft |
| d_{CROWN} = | 0.0 | 0.0 | inches |
| | MINOR | MAJOR | |
| d_{Grate} = | N/A | N/A | ft |
| d_{Curb} = | 0.19 | 0.26 | ft |
| $RF_{Combination}$ = | 0.54 | 0.66 | |
| RF_{Curb} = | 1.00 | 1.00 | |
| RF_{Grate} = | N/A | N/A | |
| | MINOR | MAJOR | |
| Q_a = | 2.2 | 3.7 | cfs |
| $Q_{PEAK REQUIRED}$ = | 2.2 | 3.7 | cfs |

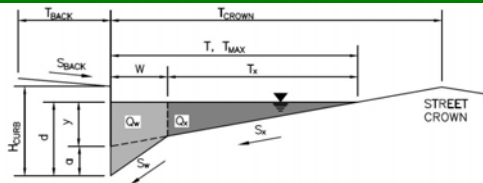
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

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

Project: Creekside Filing No. 1, Lorton Ranch, El Paso County, CO

#100.045

Inlet ID: Inlet #DP-23

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

Maximum Allowable Width for Spread Behind Curb

 $T_{BACK} = 8.0$ ft

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

 $S_{BACK} = 0.020$ ft/ft

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

 $n_{BACK} = 0.015$

Height of Curb at Gutter Flow Line

 $H_{CURB} = 9.00$ inches

Distance from Curb Face to Street Crown

 $T_{CROWN} = 17.0$ ft

Gutter Width

 $W = 2.00$ ft

Street Transverse Slope

 $S_x = 0.020$ ft/ft

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

 $S_w = 0.083$ ft/ft

Street Longitudinal Slope - Enter 0 for sump condition

 $S_o = 0.000$ ft/ft

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

 $n_{STREET} = 0.016$

Max. Allowable Spread for Minor & Major Storm

| | Minor Storm | Major Storm | |
|-------------|-------------|-------------|--------|
| $T_{MAX} =$ | 15.0 | 17.0 | ft |
| $d_{MAX} =$ | 9.0 | 12.6 | inches |

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

Check boxes are not applicable in SUMP conditions

**Maximum Capacity for 1/2 Street based On Allowable Spread**

Water Depth without Gutter Depression (Eq. ST-2)

| | Minor Storm | Major Storm | |
|--------------|-------------|-------------|--------|
| $y =$ | 3.60 | 4.08 | inches |
| $d_c =$ | 2.0 | 2.0 | inches |
| $a =$ | 1.51 | 1.51 | inches |
| $d =$ | 5.11 | 5.59 | inches |
| $T_x =$ | 13.0 | 15.0 | ft |
| $E_o =$ | 0.397 | 0.350 | |
| $Q_x =$ | 0.0 | 0.0 | cfs |
| $Q_w =$ | 0.0 | 0.0 | cfs |
| $Q_{BACK} =$ | 0.0 | 0.0 | cfs |
| $Q_T =$ | SUMP | SUMP | cfs |
| $V =$ | 0.0 | 0.0 | fps |
| $V*d =$ | 0.0 | 0.0 | |

Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")

Gutter Depression ($d_c - (W * S_x * 12)$)

Water Depth at Gutter Flowline

Allowable Spread for Discharge outside the Gutter Section W (T - W)

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

Discharge outside the Gutter Section W, carried in Section T_x Discharge within the Gutter Section W ($Q_T - Q_x$)

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

Maximum Flow Based On Allowable Spread

Flow Velocity within the Gutter Section

 $V*d$ Product: Flow Velocity times Gutter Flowline Depth**Maximum Capacity for 1/2 Street based on Allowable Depth**

Theoretical Water Spread

| | Minor Storm | Major Storm | |
|---------------|-------------|-------------|--------|
| $T_{TH} =$ | 31.2 | 46.2 | ft |
| $T_{XTH} =$ | 29.2 | 44.2 | ft |
| $E_o =$ | 0.186 | 0.123 | |
| $Q_{XTH} =$ | 0.0 | 0.0 | cfs |
| $Q_x =$ | 0.0 | 0.0 | cfs |
| $Q_w =$ | 0.0 | 0.0 | cfs |
| $Q_{BACK} =$ | 0.0 | 0.0 | cfs |
| $Q =$ | 0.0 | 0.0 | cfs |
| $V =$ | 0.0 | 0.0 | fps |
| $V*d =$ | 0.0 | 0.0 | |
| $R =$ | SUMP | SUMP | |
| $Q_d =$ | SUMP | SUMP | cfs |
| $d =$ | | | inches |
| $d_{CROWN} =$ | | | inches |

Theoretical Spread for Discharge outside the Gutter Section W (T - W)

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

Theoretical Discharge outside the Gutter Section W, carried in Section T_{XTH} Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})Discharge within the Gutter Section W ($Q_d - Q_x$)

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

Total Discharge for Major & Minor Storm (Pre-Safety Factor)

Average Flow Velocity Within the Gutter Section

 $V*d$ Product: Flow Velocity Times Gutter Flowline DepthSlope-Based Depth Safety Reduction Factor for Major & Minor ($d \geq 6"$) Storm**Max Flow Based on Allowable Depth (Safety Factor Applied)**

Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)

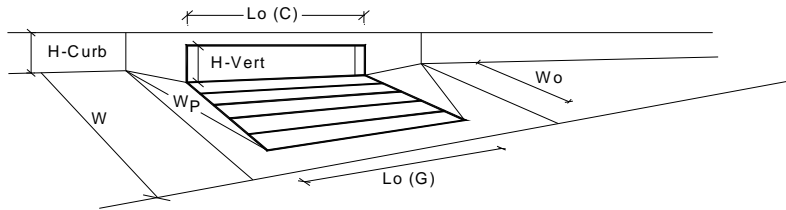
Resultant Flow Depth at Street Crown (Safety Factor Applied)

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

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

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)

Type of Inlet CDOT 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)

Grate Flow Analysis (Calculated)

Clogging Coefficient for Multiple Units
 Clogging Factor for Multiple Units

Grate Capacity as a Weir (based on Modified HEC22 Method)

Interception without Clogging
 Interception with Clogging

Grate Capacity as a Orifice (based on Modified HEC22 Method)

Interception without Clogging
 Interception with Clogging

Grate Capacity as Mixed Flow

Interception without Clogging
 Interception with Clogging

Resulting Grate Capacity (assumes clogged condition)

Curb Opening Flow Analysis (Calculated)

Clogging Coefficient for Multiple Units
 Clogging Factor for Multiple Units

Curb Opening as a Weir (based on Modified HEC22 Method)

Interception without Clogging
 Interception with Clogging

Curb Opening as an Orifice (based on Modified HEC22 Method)

Interception without Clogging
 Interception with Clogging

Curb Opening Capacity as Mixed Flow

Interception without Clogging
 Interception with Clogging

Resulting Curb Opening Capacity (assumes clogged condition)

Resultant Street Conditions

Total Inlet Length
 Resultant Street Flow Spread (based on street geometry from above)
 Resultant Flow Depth at Street Crown

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} = | 0.00 | 0.00 | inches |
| No = | 1 | 1 | |
| Ponding Depth = | 6.2 | 8.4 | inches |
| | MINOR | MAJOR | <input checked="" type="checkbox"/> Override Depths |
| L _o (G) = | N/A | N/A | feet |
| W _o = | N/A | N/A | feet |
| A _{ratio} = | N/A | N/A | |
| C _i (G) = | N/A | N/A | |
| C _w (G) = | N/A | N/A | |
| C _o (G) = | N/A | N/A | |
| | MINOR | MAJOR | |
| L _o (C) = | 20.00 | 20.00 | 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 _i (C) = | 0.10 | 0.10 | |
| C _w (C) = | 3.60 | 3.60 | |
| C _o (C) = | 0.67 | 0.67 | |
| | MINOR | MAJOR | |
| Coef = | N/A | N/A | |
| Clog = | N/A | N/A | |
| | MINOR | MAJOR | |
| Q _{wi} = | N/A | N/A | cfs |
| Q _{wa} = | N/A | N/A | cfs |
| | MINOR | MAJOR | |
| Q _{oi} = | N/A | N/A | cfs |
| Q _{oa} = | N/A | N/A | cfs |
| | MINOR | MAJOR | |
| Q _{mi} = | N/A | N/A | cfs |
| Q _{ma} = | N/A | N/A | cfs |
| Q _{Grate} = | N/A | N/A | cfs |
| | MINOR | MAJOR | |
| Coef = | 1.33 | 1.33 | |
| Clog = | 0.03 | 0.03 | |
| | MINOR | MAJOR | |
| Q _{wi} = | 14.0 | 29.8 | cfs |
| Q _{wa} = | 13.5 | 28.8 | cfs |
| | MINOR | MAJOR | |
| Q _{oi} = | 29.0 | 37.0 | cfs |
| Q _{oa} = | 28.1 | 35.7 | cfs |
| | MINOR | MAJOR | |
| Q _{mi} = | 18.7 | 30.8 | cfs |
| Q _{ma} = | 18.1 | 29.8 | cfs |
| Q _{Curb} = | 13.5 | 28.8 | cfs |
| | MINOR | MAJOR | |
| L = | 20.00 | 20.00 | feet |
| T = | 19.5 | 28.5 | ft.>T-Crown |
| d _{CROWN} = | 0.6 | 2.8 | inches |
| | MINOR | MAJOR | |
| d _{Grate} = | N/A | N/A | ft |
| d _{Curb} = | 0.35 | 0.53 | ft |
| RF _{Combination} = | 0.58 | 0.79 | |
| RF _{Curb} = | 0.80 | 0.91 | |
| RF _{Grate} = | N/A | N/A | |
| | MINOR | MAJOR | |
| Q _a = | 13.5 | 28.8 | cfs |
| Q _{PEAK REQUIRED} = | 10.8 | 23.1 | cfs |

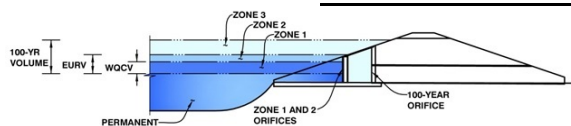
APPENDIX D – POND CALCULATIONS

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Creekside at Lorson Ranch

Basin ID: Pond C1-R



Example Zone Configuration (Retention Pond)

| | Stage (ft) | Zone Volume (ac-ft) | Outlet Type |
|---------------|------------|---------------------|----------------------|
| Zone 1 (WQCV) | 3.18 | 2.195 | Orifice Plate |
| Zone 2 (EURV) | 5.21 | 4.233 | Rectangular Orifice |
| (100+1/2WQCV) | 7.74 | 6.308 | Weir&Pipe (Restrict) |
| | | 12.736 | 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 = sq. inches (use rectangular openings)

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 | 1.10 | 2.20 | | | | | |
| Orifice Area (sq. inches) | 7.10 | 7.10 | 7.10 | | | | | |

| | 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)

| | Zone 2 Rectangular | Not Selected | |
|---|--------------------|--------------|---|
| Invert of Vertical Orifice = | 3.30 | N/A | ft (relative to basin bottom at Stage = 0 ft) |
| Depth at top of Zone using Vertical Orifice = | 5.21 | N/A | ft (relative to basin bottom at Stage = 0 ft) |
| Vertical Orifice Height = | 8.00 | N/A | inches |
| Vertical Orifice Width = | 12.00 | | inches |

Calculated Parameters for Vertical Orifice

| | Zone 2 Rectangular | Not Selected | |
|-----------------------------|--------------------|--------------|-----------------|
| Vertical Orifice Area = | 0.67 | N/A | ft ² |
| Vertical Orifice Centroid = | 0.33 | N/A | feet |

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

| | Zone 3 Weir | Not Selected | |
|---------------------------------------|-------------|--------------|---|
| Overflow Weir Front Edge Height, Ho = | 5.43 | N/A | ft (relative to basin bottom at Stage = 0 ft) |
| Overflow Weir Front Edge Length = | 17.00 | N/A | feet |
| Overflow Weir Slope = | 7.00 | N/A | H:V (enter zero for flat grate) |
| Horiz. Length of Weir Sides = | 7.00 | N/A | feet |
| Overflow Grate Open Area % = | 70% | N/A | %, grate open area/total area |
| Debris Clogging % = | 50% | N/A | % |

Calculated Parameters for Overflow Weir

| | Zone 3 Weir | Not Selected | |
|--|-------------|--------------|-----------------|
| Height of Grate Upper Edge, H ₁ = | 6.43 | N/A | feet |
| Over Flow Weir Slope Length = | 7.07 | N/A | feet |
| Grate Open Area / 100-yr Orifice Area = | 6.06 | N/A | should be ≥ 4 |
| Overflow Grate Open Area w/o Debris = | 84.15 | N/A | ft ² |
| Overflow Grate Open Area w/ Debris = | 42.07 | N/A | ft ² |

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

| | Zone 3 Restrictor | Not Selected | |
|---|-------------------|--------------|--|
| Depth to Invert of Outlet Pipe = | 0.00 | N/A | ft (distance below basin bottom at Stage = 0 ft) |
| Outlet Pipe Diameter = | 54.00 | N/A | inches |
| Restrictor Plate Height Above Pipe Invert = | 44.00 | | inches |

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

| | Zone 3 Restrictor | Not Selected | |
|--|-------------------|--------------|-----------------|
| Outlet Orifice Area = | 13.88 | N/A | ft ² |
| Outlet Orifice Centroid = | 1.99 | N/A | feet |
| Half-Central Angle of Restrictor Plate on Pipe = | 2.25 | N/A | 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

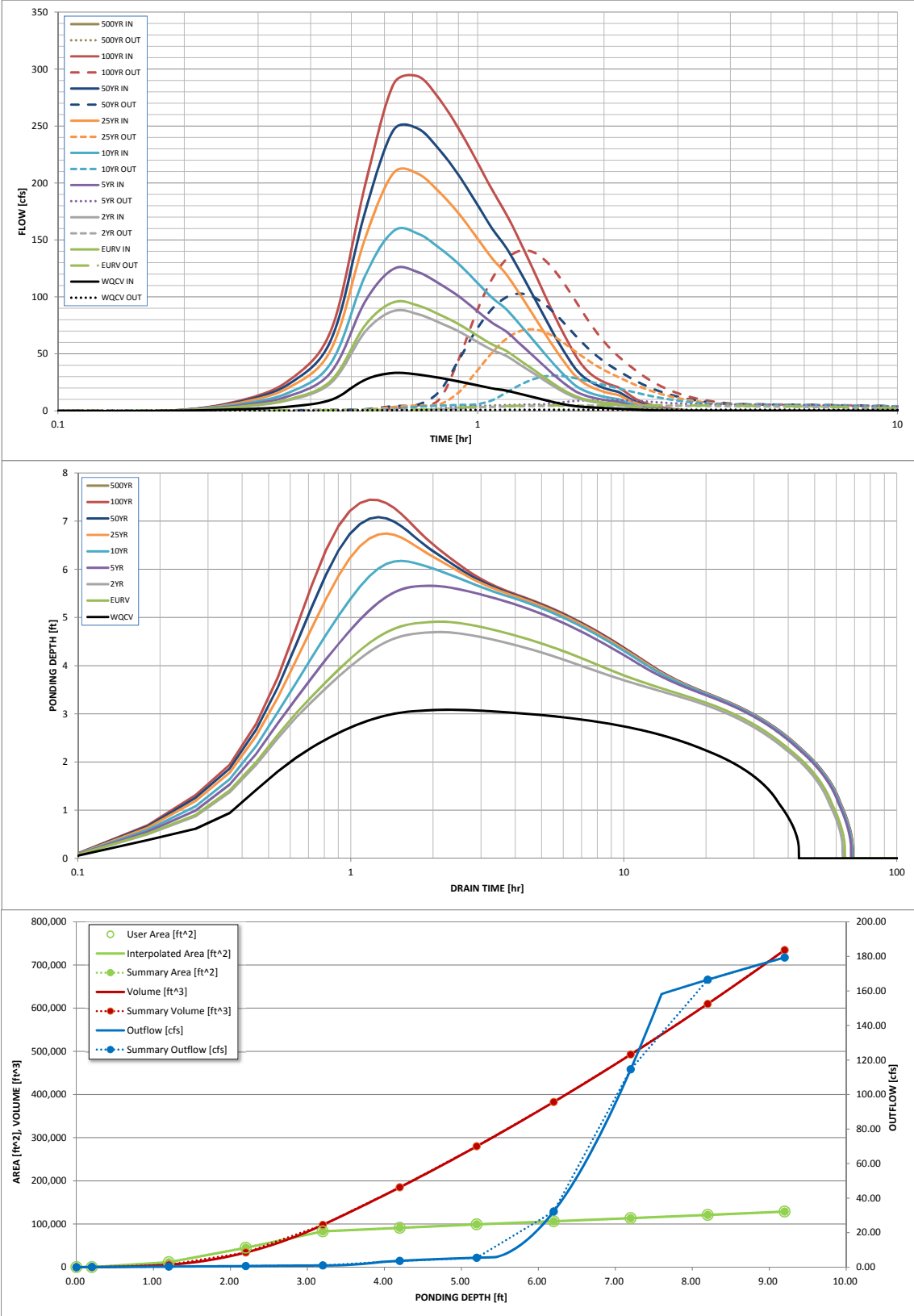
Spillway Design Flow Depth = feet
Stage at Top of Freeboard = feet
Basin Area at Top of Freeboard = acres

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 | 0.00 |
| Calculated Runoff Volume (acre-ft) = | 2.195 | 6.428 | 5.894 | 8.460 | 10.797 | 14.428 | 17.170 | 20.616 | 0.000 |
| OPTIONAL Override Runoff Volume (acre-ft) = | | | | | | | | | |
| Inflow Hydrograph Volume (acre-ft) = | 2.194 | 6.418 | 5.888 | 8.452 | 10.787 | 14.419 | 17.153 | 20.601 | #N/A |
| Predevelopment Unit Peak Flow, q (cfs/acre) = | 0.00 | 0.00 | 0.01 | 0.10 | 0.29 | 0.71 | 0.95 | 1.25 | 0.00 |
| Predevelopment Peak Q (cfs) = | 0.0 | 0.0 | 1.6 | 11.4 | 34.4 | 85.2 | 113.5 | 149.1 | 0.0 |
| Peak Inflow Q (cfs) = | 33.2 | 95.3 | 87.7 | 124.6 | 157.9 | 208.7 | 247.8 | 293.7 | #N/A |
| Peak Outflow Q (cfs) = | 1.0 | 5.0 | 4.7 | 9.6 | 31.0 | 71.5 | 102.9 | 140.5 | #N/A |
| Ratio Peak Outflow to Predevelopment Q = | N/A | N/A | N/A | 0.8 | 0.9 | 0.8 | 0.9 | 0.9 | #N/A |
| Structure Controlling Flow = | Plate | Vertical Orifice 1 | Vertical Orifice 1 | Overflow Grate 1 | Overflow Grate 1 | Overflow Grate 1 | Overflow Grate 1 | Overflow Grate 1 | #N/A |
| Max Velocity through Grate 1 (fps) = | N/A | N/A | N/A | 0.0 | 0.3 | 0.8 | 1.1 | 1.6 | #N/A |
| 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) = | 40 | 55 | 55 | 57 | 56 | 53 | 52 | 49 | #N/A |
| Time to Drain 99% of Inflow Volume (hours) = | 42 | 61 | 60 | 63 | 62 | 61 | 60 | 59 | #N/A |
| Maximum Ponding Depth (ft) = | 3.09 | 4.91 | 4.70 | 5.66 | 6.18 | 6.74 | 7.08 | 7.44 | #N/A |
| Area at Maximum Ponding Depth (acres) = | 1.80 | 2.22 | 2.18 | 2.35 | 2.43 | 2.53 | 2.59 | 2.65 | #N/A |
| Maximum Volume Stored (acre-ft) = | 2.025 | 5.775 | 5.291 | 7.468 | 8.712 | 10.127 | 10.997 | 11.939 | #N/A |

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)

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.

| | Stage | Area | Area | Volume | Volume | Total |
|--|-------|------|------|--------|--------|-------|
|--|-------|------|------|--------|--------|-------|

[illegible]

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Sheet 1 of 3

Designer: Richard Schindler
 Company: Core Engineering Group
 Date: December 11, 2018
 Project: Creekside at Lorson Ranch Filing No. 1
 Location: Pond CR1

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
($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area)$)
- G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume
($V_{WQCV\ OTHER} = (d_b * (V_{DESIGN} / 0.43))$)
- H) User Input of Water Quality Capture Volume (WQCV) Design Volume
(Only if a different WQCV Design Volume is desired)
- I) NRCS Hydrologic Soil Groups of Tributary Watershed
 i) Percentage of Watershed consisting of Type A Soils
 ii) Percentage of Watershed consisting of Type B Soils
 iii) Percentage of Watershed consisting of Type C/D Soils
- 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: $EURV_{C/D} = 1.20 * i^{1.08}$
- K) User Input of Excess Urban Runoff Volume (EURV) Design Volume
(Only if a different EURV Design Volume is desired)

$I_a =$ 55.0 %

$i =$ 0.550

Area = 119.500 ac

$d_b =$ in

Choose One

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

$V_{DESIGN} =$ 2.195 ac-ft

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

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

HSG $A =$ %

HSG $B =$ %

HSG $C/D =$ %

$EURV_{DESIGN} =$ ac-ft

$EURV_{DESIGN\ USER} =$ ac-ft

2. Basin Shape: Length to Width Ratio

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

$L : W =$ 2.0 : 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:

5. Forebay

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

$V_{FMN} =$ 0.066 ac-ft

- B) Actual Forebay Volume

$V_F =$ 0.070 ac-ft

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

$D_F =$ 30.0 in

- D) Forebay Discharge

i) Undetained 100-year Peak Discharge

$Q_{100} =$ 288.00 cfs

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

$Q_F =$ 5.76 cfs

- E) Forebay Discharge Design

Choose One

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

ROUND UP TO NEAREST PIPE SIZE

- F) Discharge Pipe Size (minimum 8-inches)

Calculated $D_P =$ 13 in

- G) Rectangular Notch Width

Calculated $W_N =$ in

Design Procedure Form: Extended Detention Basin (EDB)

Sheet 2 of 3

Designer: Richard Schindler
 Company: Core Engineering Group
 Date: December 11, 2018
 Project: Creekside at Lorson Ranch Filing No. 1
 Location: Pond CR1

6. Trickle Channel

A) Type of Trickle Channel

F) Slope of Trickle Channel

Choose One

☐ Concrete

☒ Soft Bottom

PROVIDE A CONSISTENT LONGITUDINAL
 SLOPE FROM FOREBAY TO MICROPOOL
 WITH NO MEANDERING. RIPRAP AND
 SOIL RIPRAP LINED CHANNELS ARE
 NOT RECOMMENDED.
 MINIMUM DEPTH OF 1.5 FEET

S = 0.0050 ft / ft

7. Micropool and Outlet Structure

A) Depth of Micropool (2.5-feet minimum)

B) Surface Area of Micropool (10 ft² minimum)

C) Outlet Type

D_M = 2.5 ft

A_M = 65 sq ft

Choose One

☒ Orifice Plate

☐ Other (Describe):

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

E) Total Outlet Area

D_{orifice} = 2.60 inches

A_{or} = 20.34 square inches

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} = 4 in

V_{IS} = 287 cu ft

V_s = 21.7 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): y

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 = 612 square inches

Other (Please describe below)

wellscreen stainless

User Ratio = 0.6

A_{total} = 1020 sq. in. Based on type 'Other' screen ratio

H = 3.16 feet

H_{TR} = 65.92 inches

W_{opening} = 15.5 inches

Weir Report

Pond C1-R Overflow across Castor

Circular Weir

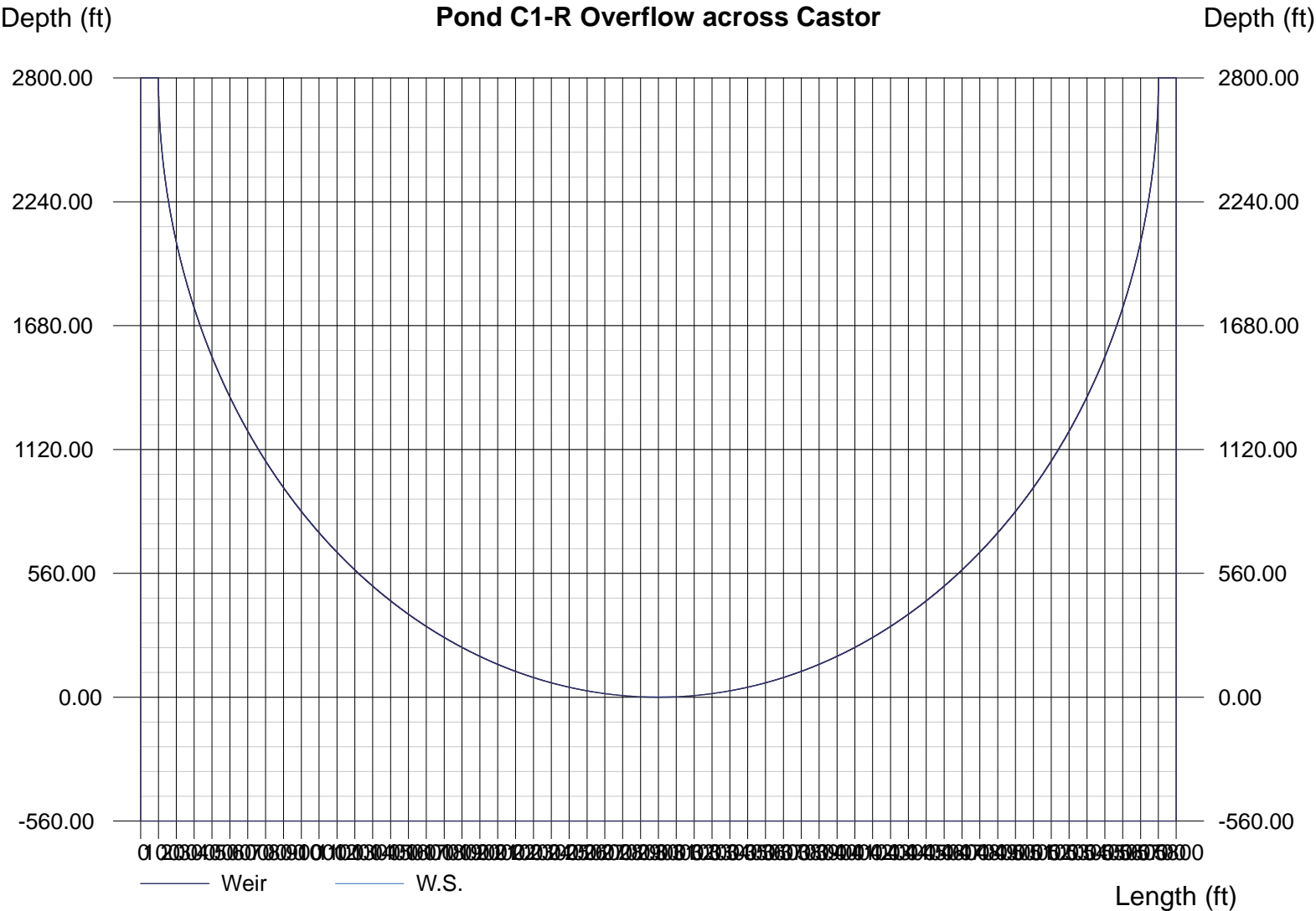
Crest = Sharp
Diameter (ft) = 5600.00
Total Depth (ft) = 2800.00

Highlighted

Depth (ft) = 0.88
Q (cfs) = 294.00
Area (sqft) = 141.09
Velocity (ft/s) = 2.08
Top Width (ft) = 167.97

Calculations

Weir Coeff. Cw = 3.33
Compute by: Known Q
Known Q (cfs) = 294.00



Rip Rap Embankment Protection Sizing

Per OCM Vol #1, Equation 13-9

$$D_{50} = 5.23 S^{0.43} (1.35 C_f g)^{0.56}$$

$$S = 0.25, 4:1 \text{ Slope}$$

$$C_f = 2.0$$

$$g = 288 \text{ cfs} / 140 \text{ ft} = 2 \text{ cfs/ft}$$

$$D_{50} = 5.23 \times 0.25^{0.43} (1.35 \times 2 \times 2)^{0.43}$$

$$D_{50} = 5.95''$$

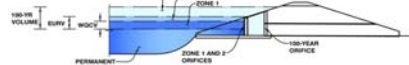
⇒ We propose to use existing 12" D_{50} Rip Rap that will be removed/salvaged. The existing rip rap functioned as the overflow spillway for the existing pond. Thickness of soil riprap = 24"

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Basin ID: Pond CR2

ZONE 3
ZONE 2



Example Zone Configuration (Retention Pond)

Required Volume Calculation _____

| | | |
|---|------------|-----------|
| Selected BMP Type = | EDB | |
| Watershed Area = | 10.00 | acres |
| Watershed Length = | 1.000 | ft |
| Watershed Slope = | 0.013 | ft/ft |
| Watershed Imperviousness = | 52.00% | percent |
| Percentage Hydrologic Soil Group A = | 0.0% | percent |
| Percentage Hydrologic Soil Group B = | 100.0% | percent |
| Percentage Hydrologic Soil Groups C/D = | 0.0% | percent |
| Desired WQCV Drain Time = | 40.0 | hours |
| Location for 1-Hr Rainfall Depths = | User Input | |
| Water Quality Capture Volume (WQCV) = | 0.176 | acre-feet |
| Excess Urban Runoff Volume (EURV) = | 0.451 | acre-feet |
| 2-yr Urban Runoff Volume (P = 1.5%) = | 0.615 | acre-feet |
| 5-yr Runoff Volume (P1 = 1.5%) = | 0.615 | acre-feet |
| 50-yr Runoff Volume (P1 = 1.75%) = | 0.825 | acre-feet |
| 25-yr Runoff Volume (P1 = 2%) = | 1.135 | acre-feet |
| 50-yr Runoff Volume (P1 = 2.25%) = | 1.352 | acre-feet |
| 100-yr Runoff Volume (P1 = 2.52%) = | 1.636 | acre-feet |
| 50-yr Runoff Volume (P1 = 0%) = | 0.000 | acre-feet |
| Approximate 2-yr Detention Volume = | 0.422 | acre-feet |
| Approximate 5-yr Detention Volume = | 0.577 | acre-feet |
| Approximate 10-yr Detention Volume = | 0.760 | acre-feet |
| Approximate 25-yr Detention Volume = | 0.829 | acre-feet |
| Approximate 50-yr Detention Volume = | 0.866 | acre-feet |
| Approximate 100-yr Detention Volume = | 0.962 | acre-feet |

| Water Quality Capture Volume (WQCV) = | 0.176 | acre-feet | Optional User Override 1-hr Precipitation |
|--|------------------------------------|-----------|--|
| Excess Urban Runoff Volume (EVRV) = | 0.558 <td>acre-feet</td> <td></td> | acre-feet | |
| 2-yr Runoff Volume (P1 = 1.19 in.) = | 0.451 | acre-feet | 1.19 inches |
| 5-yr Runoff Volume (P1 = 1.5 in.) = | 0.615 | acre-feet | 1.50 inches |
| 10-yr Runoff Volume (P1 = 1.75 in.) = | 0.825 | acre-feet | 1.75 inches |
| 25-yr Runoff Volume (P1 = 2 in.) = | 1.135 | acre-feet | 2.00 inches |
| 50-yr Runoff Volume (P1 = 2.25 in.) = | 1.352 | acre-feet | 2.25 inches |
| 100-yr Runoff Volume (P1 = 2.52 in.) = | 1.636 | acre-feet | 2.52 inches |
| 500-yr Runoff Volume (P1 = 0 in.) = | 0.000 | acre-feet | inches |

Stage-Storage Calculation

| | | |
|---|-------|-----------------|
| Zone 1 Volume (V_{QVC1}) | 0.176 | acre-feet |
| Zone 2 Volume ($V_{EURV} - \text{Zone } 1$) | 0.381 | acre-feet |
| Zone 3 ($100\text{yr} + 1/2 V_{QVCV} - \text{Zones } 1 \& 2$) | 0.493 | acre-feet |
| Total Detention Basin Volume | 1.051 | acre-feet |
| Initial Surcharge Volume (ISV) | user | ft ³ |
| Initial Surcharge Depth (ISD) | user | ft |
| Total Available Detention Depth (H_{DAV}) | 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_{MAV}) | user | ft-V |
| Basin Length-to-Width Ratio ($R_{L/W}$) | user | |
| Initial Surcharge Area (A_{IS}) | user | ft ² |
| Surcharge Volume Length (L_{SV}) | user | ft |
| Surcharge Volume Width (W_{SV}) | user | ft |
| Depth of Basin Floor ($H_{1,100}$) | user | ft |
| Length of Basin Floor ($L_{1,100}$) | user | ft |
| Width of Basin Floor ($W_{1,100}$) | user | ft |
| Area of Basin Floor ($A_{1,100}$) | user | ft ² |
| Volume of Basin Floor ($V_{1,100}$) | user | ft ³ |
| Depth of Main Basin (H_{MAV}) | user | ft |
| Length of Main Basin (L_{MAV}) | user | ft |
| Width of Main Basin (W_{MAV}) | user | ft |
| Area of Main Basin (A_{MAV}) | user | ft ² |
| Volume of Main Basin (V_{MAV}) | user | ft ³ |
| Calculated Total Basin Volume (V_{TAV}) | user | acre-feet |

Depth Increment = 0.2 ft

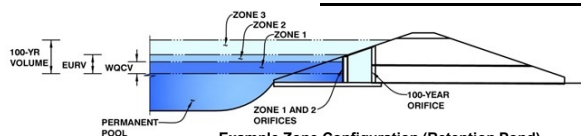
[illegible]

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Creekside at Lorson Ranch

Basin ID: Pond CR2



Example Zone Configuration (Retention Pond)

| | Stage (ft) | Zone Volume (ac-ft) | Outlet Type |
|---------------|------------|---------------------|----------------------|
| Zone 1 (WQCV) | 2.35 | 0.176 | Orifice Plate |
| Zone 2 (EURV) | 3.85 | 0.381 | Rectangular Orifice |
| (100+1/2WQCV) | 5.29 | 0.493 | Weir&Pipe (Restrict) |
| | | 1.051 | 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 = sq. inches (diameter = 7/8 inch)

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 | 0.78 | 1.57 | | | | | |
| Orifice Area (sq. inches) | 0.58 | 0.58 | 0.58 | | | | | |

| | 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)

Zone 2 Rectangular Not Selected 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 Height = inches
Vertical Orifice Width = inches

Calculated Parameters for Vertical Orifice

Zone 2 Rectangular Not Selected ft²
Vertical Orifice Area = ft²
Vertical Orifice Centroid = feet

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

Zone 3 Weir Not Selected 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 % = %
Debris Clogging % = %

Calculated Parameters for Overflow Weir

Zone 3 Weir Not Selected feet
Height of Grate Upper Edge, H₁ = 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)

Zone 3 Restrictor Not Selected ft (distance below basin bottom at Stage = 0 ft)
Depth to Invert of Outlet Pipe = inches
Outlet Pipe Diameter = inches
Restrictor Plate Height Above Pipe Invert = inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

Zone 3 Restrictor Not Selected ft²
Outlet Orifice Area = ft²
Outlet Orifice Centroid = radians
Half-Central Angle of Restrictor Plate on Pipe =

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway

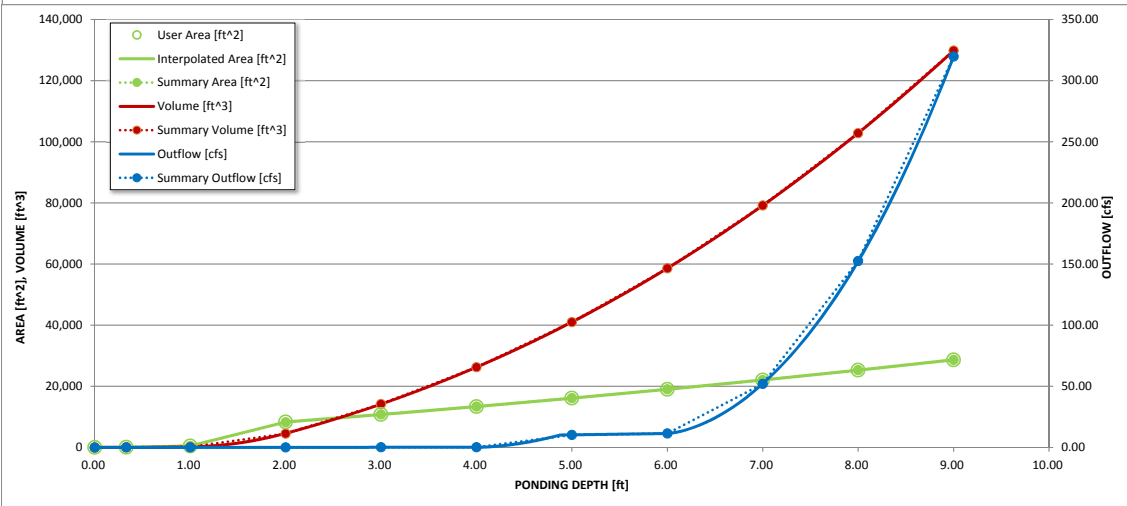
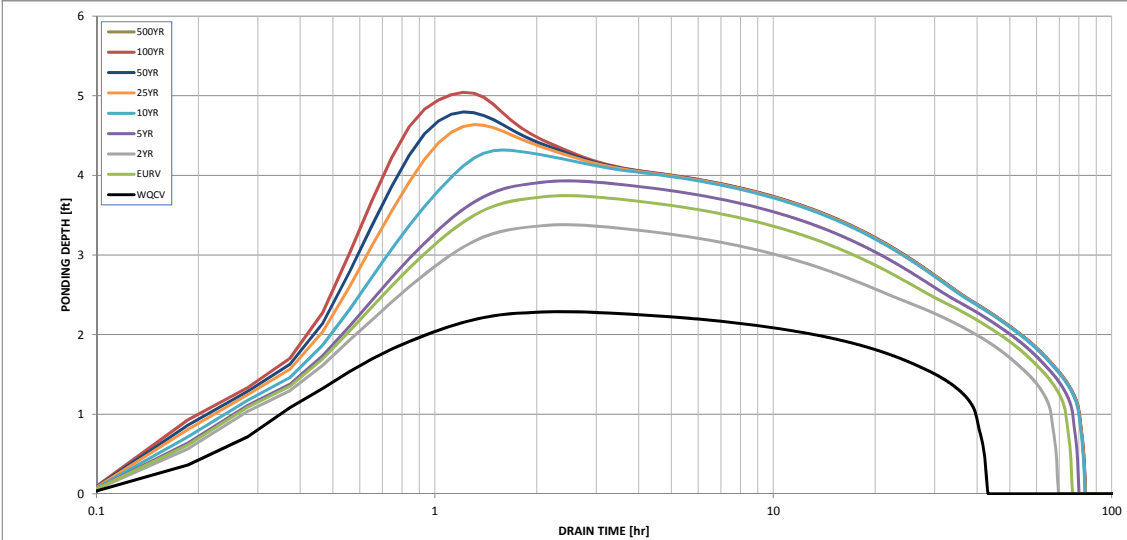
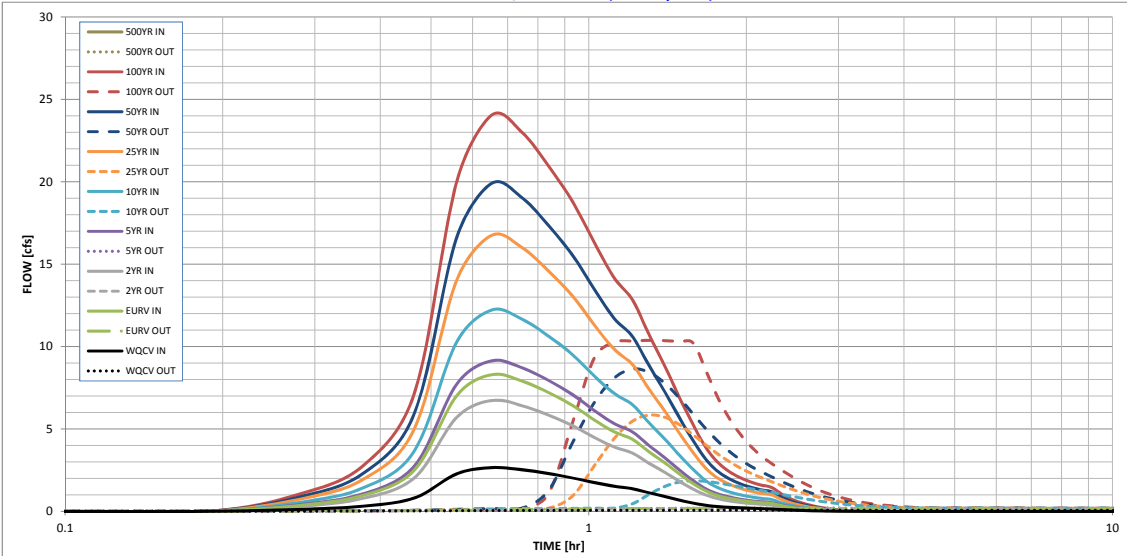
Spillway Design Flow Depth = feet
Stage at Top of Freeboard = feet
Basin Area at Top of Freeboard = acres

Routed Hydrograph Results

| | WQCV | EURV | 2 Year | 5 Year | 10 Year | 25 Year | 50 Year | 100 Year | 500 Year |
|---|-------|--------------------|--------------------|--------------------|------------------|------------------|------------------|----------------|----------|
| Design Storm Return Period = | 0.53 | 1.07 | 1.19 | 1.50 | 1.75 | 2.00 | 2.25 | 2.52 | 0.00 |
| One-Hour Rainfall Depth (in) = | 0.176 | 0.558 | 0.451 | 0.615 | 0.825 | 1.135 | 1.352 | 1.636 | 0.000 |
| Calculated Runoff Volume (acre-ft) = | | | | | | | | | |
| OPTIONAL Override Runoff Volume (acre-ft) = | | | | | | | | | |
| Inflow Hydrograph Volume (acre-ft) = | 0.176 | 0.557 | 0.451 | 0.615 | 0.825 | 1.135 | 1.352 | 1.636 | #N/A |
| Predevelopment Unit Peak Flow, q (cfs/acre) = | 0.00 | 0.00 | 0.01 | 0.02 | 0.17 | 0.58 | 0.81 | 1.10 | 0.00 |
| Predevelopment Peak Q (cfs) = | 0.0 | 0.0 | 0.1 | 0.2 | 1.7 | 5.8 | 8.1 | 11.0 | 0.0 |
| Peak Inflow Q (cfs) = | 2.7 | 8.3 | 6.7 | 9.1 | 12.2 | 16.8 | 19.9 | 24.0 | #N/A |
| Peak Outflow Q (cfs) = | 0.1 | 0.2 | 0.2 | 0.2 | 1.9 | 5.8 | 8.6 | 10.4 | #N/A |
| Ratio Peak Outflow to Predevelopment Q = | N/A | N/A | N/A | 1.1 | 1.1 | 1.0 | 1.1 | 0.9 | #N/A |
| Structure Controlling Flow = | Plate | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Overflow Grate 1 | Overflow Grate 1 | Overflow Grate 1 | Outlet Plate 1 | #N/A |
| Max Velocity through Grate 1 (fps) = | N/A | N/A | N/A | N/A | 0.1 | 0.5 | 0.7 | 0.8 | #N/A |
| 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 | 69 | 63 | 72 | 73 | 70 | 69 | 66 | #N/A |
| Time to Drain 99% of Inflow Volume (hours) = | 41 | 73 | 66 | 76 | 79 | 78 | 77 | 76 | #N/A |
| Maximum Ponding Depth (ft) = | 2.29 | 3.75 | 3.38 | 3.93 | 4.32 | 4.64 | 4.80 | 5.04 | #N/A |
| Area at Maximum Ponding Depth (acres) = | 0.21 | 0.29 | 0.27 | 0.30 | 0.33 | 0.35 | 0.36 | 0.37 | #N/A |
| Maximum Volume Stored (acre-ft) = | 0.162 | 0.525 | 0.424 | 0.582 | 0.701 | 0.809 | 0.866 | 0.957 | #N/A |

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]

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Sheet 1 of 3

Designer: Richard Schindler
 Company: Core Engineering Group
 Date: December 11, 2018
 Project: Creekside at Lorson Ranch Filing No. 1
 Location: Pond CR2

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
($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area)$)
- G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume
($V_{WQCV\ OTHER} = (d_b * (V_{DESIGN} / 0.43))$)
- H) User Input of Water Quality Capture Volume (WQCV) Design Volume
(Only if a different WQCV Design Volume is desired)
- I) NRCS Hydrologic Soil Groups of Tributary Watershed
 i) Percentage of Watershed consisting of Type A Soils
 ii) Percentage of Watershed consisting of Type B Soils
 iii) Percentage of Watershed consisting of Type C/D Soils
- 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: $EURV_{C/D} = 1.20 * i^{1.08}$
- K) User Input of Excess Urban Runoff Volume (EURV) Design Volume
(Only if a different EURV Design Volume is desired)

$I_a =$ 52.0 %

$i =$ 0.520

Area = 10.000 ac

$d_b =$ in

Choose One

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

$V_{DESIGN} =$ 0.176 ac-ft

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

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

HSG $A =$ %

HSG $B =$ %

HSG $C/D =$ %

$EURV_{DESIGN} =$ ac-ft

$EURV_{DESIGN\ USER} =$ ac-ft

2. Basin Shape: Length to Width Ratio

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

$L : W =$ 2.0 : 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:

5. Forebay

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

$V_{FMN} =$ 0.005 ac-ft

- B) Actual Forebay Volume

$V_F =$ 0.005 ac-ft

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

$D_F =$ 18.0 in

- D) Forebay Discharge

i) Undetained 100-year Peak Discharge

$Q_{100} =$ 23.40 cfs

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

$Q_F =$ 0.47 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 $W_N =$ 4.5 in

Design Procedure Form: Extended Detention Basin (EDB)

Sheet 2 of 3

Designer: Richard Schindler
 Company: Core Engineering Group
 Date: December 11, 2018
 Project: Creekside at Lorson Ranch Filing No. 1
 Location: Pond CR2

| | |
|--|---|
| 6. Trickle Channel A) Type of Trickle Channel F) Slope of Trickle Channel | Choose One <input checked="" type="radio"/> Concrete <input type="radio"/> Soft Bottom S = <input type="text" value="0.0100"/> ft / ft |
| 7. Micropool and Outlet Structure A) Depth of Micropool (2.5-feet minimum) B) Surface Area of Micropool (10 ft ² minimum) C) Outlet Type D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention) E) Total Outlet Area | D _M = <input type="text" value="2.5"/> ft A _M = <input type="text" value="56"/> sq ft Choose One <input checked="" type="radio"/> Orifice Plate <input type="radio"/> Other (Describe): <hr/> <hr/> <hr/> D _{orifice} = <input type="text" value="0.57"/> inches A _{orifice} = <input type="text" value="1.71"/> square inches |
| 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} = <input type="text" value="4"/> in V _{IS} = <input type="text" value="23"/> cu ft V _s = <input type="text" value="18.7"/> 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): <input type="text" value="y"/> 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 = <input type="text" value="62"/> square inches <div style="border: 1px solid black; padding: 2px; margin: 5px 0;">Other (Please describe below)</div> wellscreen stainless <hr/> <hr/> User Ratio = <input type="text" value="0.6"/> A _{total} = <input type="text" value="104"/> sq. in. Based on type 'Other' screen ratio H = <input type="text" value="2.23"/> feet H _{TR} = <input type="text" value="54.76"/> inches W _{opening} = <input type="text" value="12.0"/> inches VALUE LESS THAN RECOMMENDED MIN. WIDTH. WIDTH HAS BEEN SET TO 12 INCHES. |

Channel Report

POND CR2 OVERFLOW CHANNEL

Trapezoidal

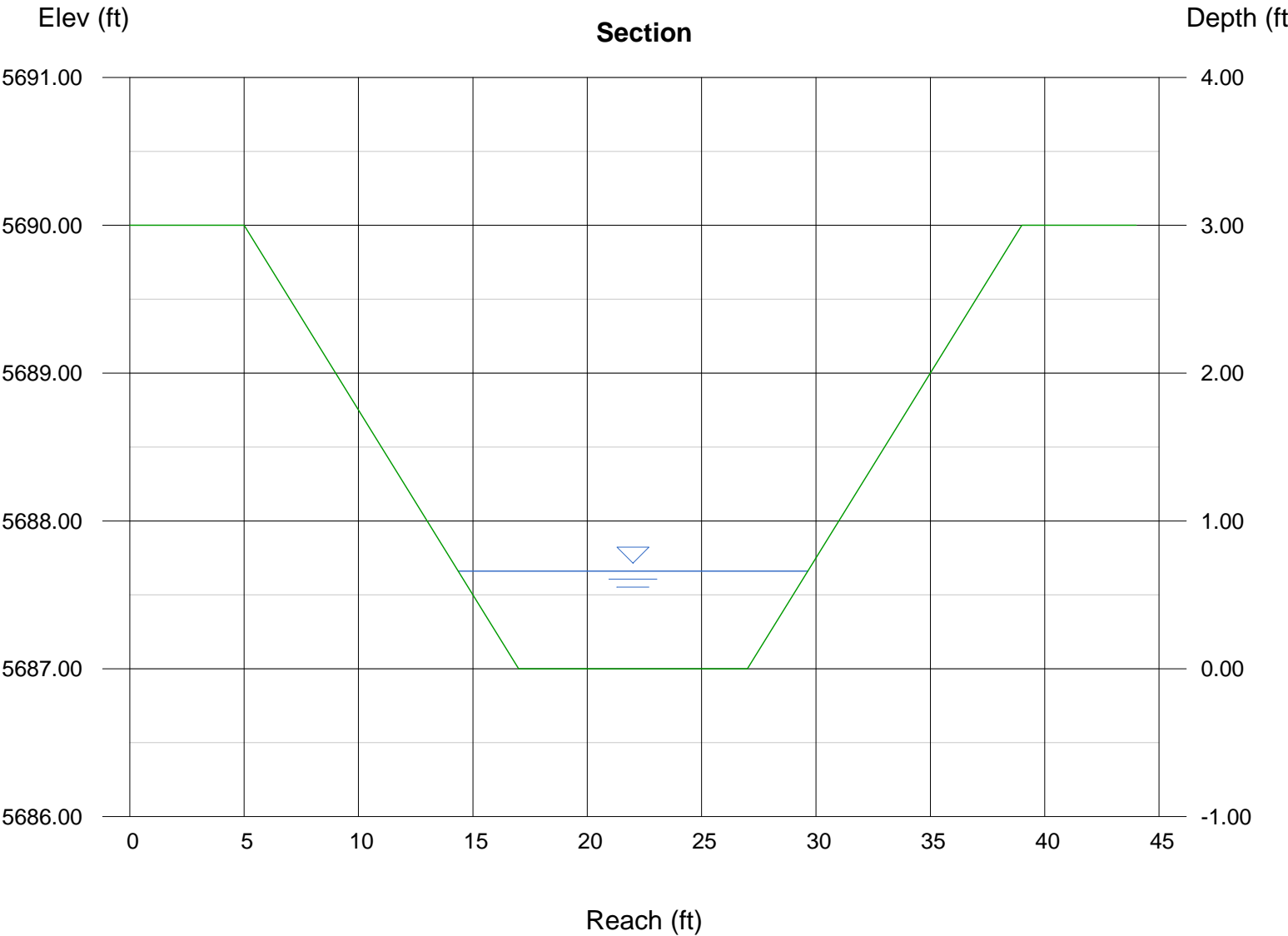
Botom Width (ft) = 10.00
Side Slope (z:1) = 4.00
Total Depth (ft) = 3.00
Invert Elev (ft) = 5687.00
Slope (%) = 0.50
N-Value = 0.025

Calculations

Compute by: Known Q
Known Q (cfs) = 23.00

Highlighted

Depth (ft) = 0.66
Q (cfs) = 24.00
Area (sqft) = 8.34
Velocity (ft/s) = 2.76
Wetted Perim (ft) = 15.44
Crit Depth, Yc (ft) = 0.52
Top Width (ft) = 15.28
EGL (ft) = 0.78

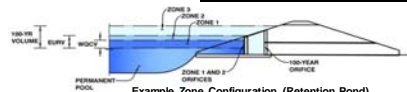


DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Creekside at Lorson Ranch

Basin ID: Pond CR3



Example Zone Configuration (Retention Pond)

Required Volume Calculation

| |
|--|
| |
|--|

| Selected BMP Type = | SF | |
|---|-----------|-----------|
| Watershed Area = | 2.66 | acres |
| Watershed Length = | 400 | ft |
| Watershed Slope = | 0.025 | ft/ft |
| Watershed Imperviousness = | 40.00% | percent |
| Percentage Hydrologic Soil Group A = | 0.0% | percent |
| Percentage Hydrologic Soil Group B = | 100.0% | percent |
| Percentage Hydrologic Soil Groups C/D = | 0.0% | percent |
| Desired WQCV Drain Time = | 12.0 | hours |
| Location for 1-hr Rainfall Depths = | Use Input | |
| Water Quality Capture Volume (WQCV) = | 0.032 | acre-feet |
| Excess Urban Runoff Volume (EURV) = | 0.112 | acre-feet |
| 2-yr Runoff Volume (P1 = 1.19 in.) = | 0.088 | acre-feet |
| 5-yr Runoff Volume (P1 = 1.5 in.) = | 0.123 | acre-feet |
| 10-yr Runoff Volume (P1 = 1.75 in.) = | 0.174 | acre-feet |
| 25-yr Runoff Volume (P1 = 2.0 in.) = | 0.262 | acre-feet |
| 50-yr Runoff Volume (P1 = 2.25 in.) = | 0.321 | acre-feet |
| 100-yr Runoff Volume (P1 = 2.52 in.) = | 0.398 | acre-feet |
| 500-yr Runoff Volume (P1 = 0 in.) = | 0.000 | acre-feet |
| Approximate 2-yr Detention Volume = | 0.082 | acre-feet |
| Approximate 5-yr Detention Volume = | 0.115 | acre-feet |
| Approximate 10-yr Detention Volume = | 0.158 | acre-feet |
| Approximate 25-yr Detention Volume = | 0.177 | acre-feet |
| Approximate 50-yr Detention Volume = | 0.186 | acre-feet |
| Approximate 100-yr Detention Volume = | 0.213 | acre-feet |

| Water Quality Capture Volume (WQCV) | | Optional User Override |
|--------------------------------------|-----------------|------------------------|
| Excess Unrunoff Volume (EURV) | | 1-hr Precipitation |
| 2-yr Runoff Volume (P1 = 1.19 in.) | 0.088 acre-feet | 1.19 inches |
| 5-yr Runoff Volume (P1 = 1.51 in.) | 0.123 acre-feet | 1.50 inches |
| 10-yr Runoff Volume (P1 = 2.1 in.) | 0.174 acre-feet | 1.75 inches |
| 25-yr Runoff Volume (P1 = 2.1 in.) | 0.262 acre-feet | 2.00 inches |
| 50-yr Runoff Volume (P1 = 2.25 in.) | 0.321 acre-feet | 2.25 inches |
| 100-yr Runoff Volume (P1 = 2.52 in.) | 0.398 acre-feet | 2.52 inches |
| 500-yr Runoff Volume (P1 = 0 in.) | 0.000 acre-feet | inches |

Stage-Storage Calculation

| | | |
|---|-------|----------------------|
| Zone 1 Volume (V_{QVC1}) | 0.032 | acre-feet |
| Zone 2 Volume ($V_{EURV} - \text{Zone 1}$) | 0.080 | acre-feet |
| Zone 3 ($100y + 1/2 V_{QVC} - \text{Zones 1 \& 2}$) | 0.117 | acre-feet |
| Total Detention Basin Volume (V_{DB}) | 0.229 | acre-feet |
| Initial Surcharge Volume (V_{SV}) | N/A | acre-ft ³ |
| Initial Surcharge Depth (ISD) | N/A | ft |
| Total Available Detention Depth (H_{DAV}) | user | ft |
| Depth of Trickle Channel (H_{TC}) | N/A | ft |
| Slope of Trickle Channel (S_{TC}) | user | ft/ft |
| Slopes of Main Basin Sides (S_{MB}) | N/A | ft/V |
| Basin Length-to-Width Ratio ($R_{L/W}$) | user | |
| Initial Surcharge Area (A_{SV}) | user | ft ² |
| Surcharge Volume Length (L_{SV}) | user | ft |
| Surcharge Volume Width (W_{SV}) | user | ft |
| Depth of Basin Floor ($H_{1,COB}$) | user | ft |
| Length of Basin Floor ($L_{1,COB}$) | user | ft |
| Width of Basin Floor ($W_{1,COB}$) | user | ft |
| Area of Basin Floor ($A_{1,COB}$) | user | ft ² |
| Volume of Basin Floor ($V_{1,COB}$) | user | acre-ft ³ |
| Depth of Main Basin (H_{MB}) | user | ft |
| Length of Main Basin (L_{MB}) | user | ft |
| Width of Main Basin (W_{MB}) | user | ft |
| Area of Main Basin (A_{MB}) | user | ft ² |
| Volume of Main Basin (V_{MB}) | user | acre-ft ³ |
| Calculated Total Basin Volume (V_{MB}) | user | acre-feet |

Depth Increment = 0.1 ft

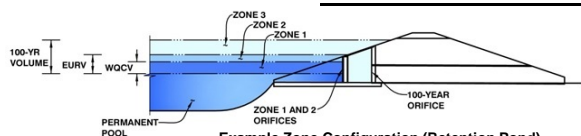
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Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Creekside at Lorson Ranch

Basin ID: Pond CR3



Example Zone Configuration (Retention Pond)

| | Stage (ft) | Zone Volume (ac-ft) | Outlet Type |
|---------------|------------|---------------------|----------------------|
| Zone 1 (WQCV) | 1.13 | 0.032 | Filtration Media |
| Zone 2 (EURV) | 2.57 | 0.080 | Rectangular Orifice |
| (100+1/2WQCV) | 3.86 | 0.117 | Weir&Pipe (Circular) |
| | | 0.229 | Total |

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

| | | |
|-----------------------------------|------|--|
| Underdrain Orifice Invert Depth = | 1.97 | ft (distance below the filtration media surface) |
| Underdrain Orifice Diameter = | 0.69 | inches |

Calculated Parameters for Underdrain

| | | |
|-------------------------------|------|-----------------|
| Underdrain Orifice Area = | 0.0 | ft ² |
| Underdrain Orifice Centroid = | 0.03 | 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 = | N/A | ft (relative to basin bottom at Stage = 0 ft) |
| Depth at top of Zone using Orifice Plate = | N/A | ft (relative to basin bottom at Stage = 0 ft) |
| Orifice Plate: Orifice Vertical Spacing = | N/A | inches |
| Orifice Plate: Orifice Area per Row = | N/A | inches |

Calculated Parameters for Plate

| | | |
|----------------------------|-----|-----------------|
| WQ Orifice Area per Row = | N/A | ft ² |
| Elliptical Half-Width = | N/A | feet |
| Elliptical Slot Centroid = | N/A | feet |
| Elliptical Slot Area = | N/A | ft ² |

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

| | Row 1 (optional) | 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) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Orifice Area (sq. inches) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

| | 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) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Orifice Area (sq. inches) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

User Input: Vertical Orifice (Circular or Rectangular)

| | Zone 2 Rectangular | Not Selected | |
|---|--------------------|--------------|---|
| Invert of Vertical Orifice = | 1.13 | N/A | ft (relative to basin bottom at Stage = 0 ft) |
| Depth at top of Zone using Vertical Orifice = | 2.57 | N/A | ft (relative to basin bottom at Stage = 0 ft) |
| Vertical Orifice Height = | 1.50 | N/A | inches |
| Vertical Orifice Width = | 0.70 | | inches |

Calculated Parameters for Vertical Orifice

| | Zone 2 Rectangular | Not Selected | |
|-----------------------------|--------------------|--------------|-----------------|
| Vertical Orifice Area = | 0.01 | N/A | ft ² |
| Vertical Orifice Centroid = | 0.06 | N/A | feet |

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

| | Zone 3 Weir | Not Selected | |
|---------------------------------------|-------------|--------------|---|
| Overflow Weir Front Edge Height, Ho = | 3.00 | N/A | ft (relative to basin bottom at Stage = 0 ft) |
| Overflow Weir Front Edge Length = | 3.00 | N/A | feet |
| Overflow Weir Slope = | 0.00 | N/A | H:V (enter zero for flat grate) |
| Horiz. Length of Weir Sides = | 3.00 | N/A | feet |
| Overflow Grate Open Area % = | 70% | N/A | %, grate open area/total area |
| Debris Clogging % = | 50% | N/A | % |

Calculated Parameters for Overflow Weir

| | Zone 3 Weir | Not Selected | |
|--|-------------|--------------|-----------------|
| Height of Grate Upper Edge, H ₁ = | 3.00 | N/A | feet |
| Over Flow Weir Slope Length = | 3.00 | N/A | feet |
| Grate Open Area / 100-yr Orifice Area = | 30.05 | N/A | should be ≥ 4 |
| Overflow Grate Open Area w/o Debris = | 6.30 | N/A | ft ² |
| Overflow Grate Open Area w/ Debris = | 3.15 | N/A | ft ² |

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

| | Zone 3 Circular | Not Selected | |
|----------------------------------|-----------------|--------------|--|
| Depth to Invert of Outlet Pipe = | 2.30 | N/A | ft (distance below basin bottom at Stage = 0 ft) |
| Circular Orifice Diameter = | 6.20 | N/A | inches |

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

| | Zone 3 Circular | Not Selected | |
|--|-----------------|--------------|-----------------|
| Outlet Orifice Area = | 0.21 | N/A | ft ² |
| Outlet Orifice Centroid = | 0.26 | N/A | feet |
| Half-Central Angle of Restrictor Plate on Pipe = | N/A | N/A | radians |

User Input: Emergency Spillway (Rectangular or Trapezoidal)

| | | |
|-------------------------------------|------|---|
| Spillway Invert Stage = | 4.50 | ft (relative to basin bottom at Stage = 0 ft) |
| Spillway Crest Length = | 6.00 | feet |
| Spillway End Slopes = | 4.00 | H:V |
| Freeboard above Max Water Surface = | 0.40 | feet |

Calculated Parameters for Spillway

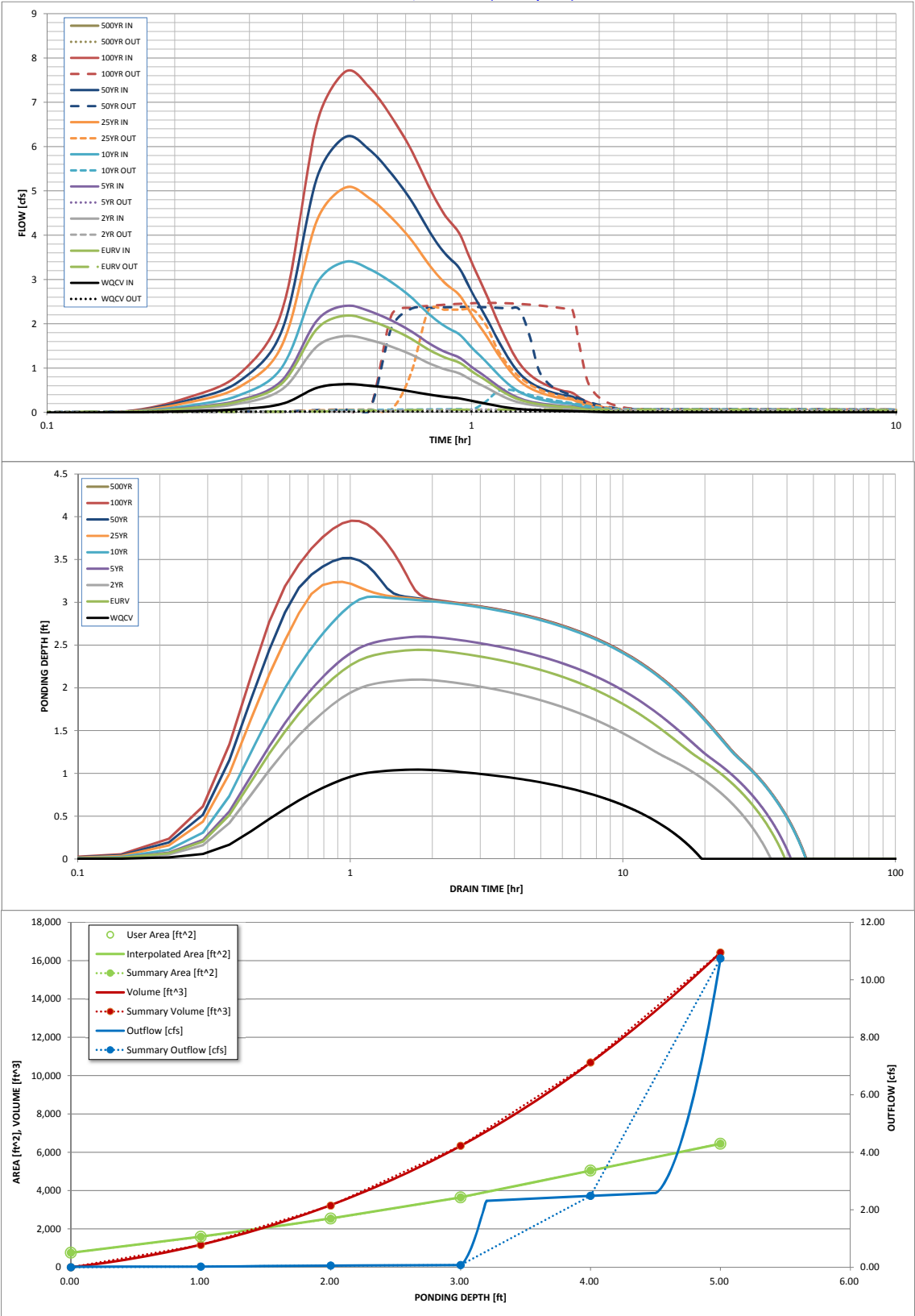
| | | |
|----------------------------------|------|-------|
| Spillway Design Flow Depth = | 0.38 | feet |
| Stage at Top of Freeboard = | 5.28 | feet |
| Basin Area at Top of Freeboard = | 0.15 | acres |

Routed Hydrograph Results

| | WQCV | EURV | 2 Year | 5 Year | 10 Year | 25 Year | 50 Year | 100 Year | 500 Year |
|---|------------------|--------------------|--------------------|--------------------|------------------|----------------|----------------|----------------|----------|
| Design Storm Return Period = | 0.53 | 1.07 | 1.19 | 1.50 | 1.75 | 2.00 | 2.25 | 2.52 | 0.00 |
| One-Hour Rainfall Depth (in) = | 0.032 | 0.112 | 0.088 | 0.123 | 0.174 | 0.262 | 0.321 | 0.398 | 0.000 |
| OPTIONAL Override Runoff Volume (acre-ft) = | | | | | | | | | |
| Inflow Hydrograph Volume (acre-ft) = | 0.032 | 0.111 | 0.087 | 0.122 | 0.174 | 0.261 | 0.321 | 0.398 | #N/A |
| Predevelopment Unit Peak Flow, q (cfs/acre) = | 0.00 | 0.00 | 0.01 | 0.03 | 0.25 | 0.79 | 1.10 | 1.46 | 0.00 |
| Predevelopment Peak Q (cfs) = | 0.00 | 0.00 | 0.04 | 0.067 | 0.7 | 2.1 | 2.9 | 3.9 | 0.0 |
| Peak Inflow Q (cfs) = | 0.6 | 2.2 | 1.7 | 2.4 | 3.4 | 5.1 | 6.2 | 7.7 | #N/A |
| Peak Outflow Q (cfs) = | 0.02 | 0.07 | 0.06 | 0.07 | 0.5 | 2.3 | 2.4 | 2.5 | #N/A |
| Ratio Peak Outflow to Predevelopment Q = | N/A | N/A | N/A | 1.0 | 0.8 | 1.1 | 0.8 | 0.6 | #N/A |
| Structure Controlling Flow = | Filtration Media | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Overflow Grate 1 | Outlet Plate 1 | Outlet Plate 1 | Outlet Plate 1 | #N/A |
| Max Velocity through Grate 1 (fps) = | N/A | N/A | N/A | N/A | 0.1 | 0.4 | 0.4 | 0.4 | #N/A |
| 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) = | 19 | 37 | 33 | 39 | 43 | 42 | 41 | 39 | #N/A |
| Time to Drain 99% of Inflow Volume (hours) = | 19 | 39 | 34 | 41 | 46 | 45 | 45 | 44 | #N/A |
| Maximum Ponding Depth (ft) = | 1.04 | 2.45 | 2.10 | 2.60 | 3.07 | 3.24 | 3.52 | 3.95 | #N/A |
| Area at Maximum Ponding Depth (acres) = | 0.04 | 0.07 | 0.06 | 0.07 | 0.09 | 0.09 | 0.10 | 0.11 | #N/A |
| Maximum Volume Stored (acre-ft) = | 0.028 | 0.103 | 0.080 | 0.113 | 0.151 | 0.166 | 0.192 | 0.239 | #N/A |

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)

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.

| | Stage | Area | Area | Volume | Volume | Total |
|--|-------|------|------|--------|--------|-------|
|--|-------|------|------|--------|--------|-------|

[illegible]

Design Procedure Form: Sand Filter (SF)

UD-BMP (Version 3.07, March 2018)

Sheet 1 of 2

Designer: Richard Schindler
Company: Core Engineering
Date: October 16, 2018
Project: Creekside
Location: Pond CR3

1. Basin Storage Volume

- A) Effective Imperviousness of Tributary Area, I_a
(100% if all paved and roofed areas upstream of sand filter)
- B) Tributary Area's Imperviousness Ratio ($i = I_a/100$)
- C) Water Quality Capture Volume (WQCV) Based on 12-hour Drain Time
 $WQCV = 0.8 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i)$
- D) Contributing Watershed Area (including sand filter area)
- E) Water Quality Capture Volume (WQCV) Design Volume
 $V_{WQCV} = WQCV / 12 * \text{Area}$
- F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm
- G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume
- H) User Input of Water Quality Capture Volume (WQCV) Design Volume
(Only if a different WQCV Design Volume is desired)

$I_a =$ %

$i =$

WQCV = watershed inches

Area = sq ft

$V_{WQCV} =$ cu ft

$d_e =$ in

$V_{WQCV \text{ OTHER}} =$ cu ft

$V_{WQCV \text{ USER}} =$ cu ft

2. Basin Geometry

- A) WQCV Depth
- B) Sand Filter Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred). Use "0" if sand filter has vertical walls.
- C) Minimum Filter Area (Flat Surface Area)
- D) Actual Filter Area
- E) Volume Provided

$D_{WQCV} =$ ft

$Z =$ ft / ft

$A_{Min} =$ sq ft

$A_{Actual} =$ sq ft

$V_T =$ cu ft

3. Filter Material

Choose One

☒ 18" CDOT Class B or C Filter Material

☐ Other (Explain):

4. Underdrain System

- A) Are underdrains provided?
- B) Underdrain system orifice diameter for 12 hour drain time
- i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice
- ii) Volume to Drain in 12 Hours
- iii) Orifice Diameter, 3/8" Minimum

Choose One

☒ YES

☐ NO

$y =$ ft

$Vol_{12} =$ cu ft

$D_o =$ in

Design Procedure Form: Sand Filter (SF)

Sheet 2 of 2

Designer: Richard Schindler

Company: Core Engineering

Date: October 16, 2018

Project: Creekside

Location: Pond CR3

5. Impermeable Geomembrane Liner and Geotextile Separator Fabric

- A) Is an impermeable liner provided due to proximity of structures or groundwater contamination?

Choose One



YES



NO

6. Inlet / Outlet Works

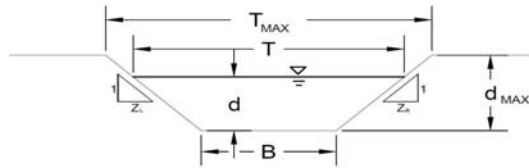
- A) Describe the type of energy dissipation at inlet points and means of conveying flows in excess of the WQCV through the outlet

Notes:

AREA INLET IN A SWALE

Creekside

Pond CR3 type D Emergency Overflow Structure



This worksheet uses the NRCS
vegetal retardance method to
determine Manning's n.

For more information see
Section 7.2.3 of the USDCM.

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}) |
|--------------|-----------------------------|------------------------------|
| Non-Cohesive | 5.0 fps | 0.60 |
| Cohesive | 7.0 fps | 0.80 |
| Paved | N/A | N/A |

A, B, C, D or E

| |
|--------------------|
| A |
| see details below |
| $n =$ 0.0050 ft/ft |
| $B =$ 27.00 ft |
| $Z1 =$ 4.00 ft/ft |
| $Z2 =$ 4.00 ft/ft |

Choose One:

- ☒ Non-Cohesive
☐ Cohesive
☐ Paved

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

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

| | Minor Storm | Major Storm | |
|-------------|-------------|-------------|------|
| $T_{MAX} =$ | 60.00 | 70.00 | feet |
| $d_{MAX} =$ | 0.70 | 1.00 | feet |

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 | |
|---------------|-------------|-------------|-----|
| $Q_{allow} =$ | 5.3 | 8.8 | cfs |
| $d_{allow} =$ | 0.70 | 1.00 | ft |

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow

Water Depth

| | | | |
|---------|------|------|------|
| $Q_o =$ | 2.4 | 7.7 | cfs |
| $d =$ | 0.41 | 0.91 | feet |

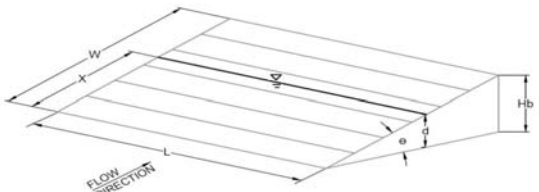
Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

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

AREA INLET IN A SWALE

Creekside

Pond CR3 type D Emergency Overflow Structure

| Inlet Design Information (Input) | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---------|-------|---------|-----|------|------|------|------|------------------|----------------------|------|-----|---------------------------------|------|------|------------------|--|-----|------------------|------|--|------------------|------|--|------------------|------|--|
| Type of Inlet | <div style="border: 1px solid black; padding: 2px; display: inline-block;">CDOT TYPE D (Parallel)</div> <div style="margin-left: 20px;">Inlet Type = <div style="border: 1px solid black; padding: 2px; display: inline-block;">CDOT TYPE D (Parallel)</div></div> | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Angle of Inclined Grate (must be <= 30 degrees) | <div style="display: flex; align-items: center;"> <div style="flex: 1;">  </div> <div style="flex: 1;"> <table style="width: 100%; border-collapse: collapse;"> <tr><td style="text-align: right;">θ =</td><td style="border: 1px solid black; text-align: center;">0.00</td><td style="text-align: left;">degrees</td></tr> <tr><td style="text-align: right;">W =</td><td style="border: 1px solid black; text-align: center;">6.00</td><td style="text-align: left;">feet</td></tr> <tr><td style="text-align: right;">L =</td><td style="border: 1px solid black; text-align: center;">3.00</td><td style="text-align: left;">feet</td></tr> <tr><td style="text-align: right;">A_{RATIO} =</td><td style="border: 1px solid black; text-align: center;">0.70</td><td></td></tr> <tr><td style="text-align: right;">H_B =</td><td style="border: 1px solid black; text-align: center;">0.00</td><td style="text-align: left;">feet</td></tr> <tr><td style="text-align: right;">C₁ =</td><td style="border: 1px solid black; text-align: center;">0.38</td><td></td></tr> <tr><td style="text-align: right;">C_d =</td><td style="border: 1px solid black; text-align: center;">0.76</td><td></td></tr> <tr><td style="text-align: right;">C_o =</td><td style="border: 1px solid black; text-align: center;">0.50</td><td></td></tr> <tr><td style="text-align: right;">C_w =</td><td style="border: 1px solid black; text-align: center;">1.62</td><td></td></tr> </table> </div> </div> | θ = | 0.00 | degrees | W = | 6.00 | feet | L = | 3.00 | feet | A _{RATIO} = | 0.70 | | H _B = | 0.00 | feet | C ₁ = | 0.38 | | C _d = | 0.76 | | C _o = | 0.50 | | C _w = | 1.62 | |
| θ = | 0.00 | degrees | | | | | | | | | | | | | | | | | | | | | | | | | | |
| W = | 6.00 | feet | | | | | | | | | | | | | | | | | | | | | | | | | | |
| L = | 3.00 | feet | | | | | | | | | | | | | | | | | | | | | | | | | | |
| A _{RATIO} = | 0.70 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| H _B = | 0.00 | feet | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C ₁ = | 0.38 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C _d = | 0.76 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C _o = | 0.50 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C _w = | 1.62 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Width of Grate | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Length of Grate | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Open Area Ratio | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Height of Inclined Grate | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Clogging Factor | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Grate Discharge Coefficient | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Orifice Coefficient | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Weir Coefficient | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Water Depth at Inlet (for depressed inlets, 1 foot is added for depression) | <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th></th> <th style="text-align: center;">MINOR</th> <th style="text-align: center;">MAJOR</th> <th></th> </tr> </thead> <tbody> <tr> <td style="text-align: right;">d =</td> <td style="border: 1px solid black; text-align: center;">0.41</td> <td style="border: 1px solid black; text-align: center;">0.91</td> <td></td> </tr> <tr> <td style="text-align: right;">Q_a =</td> <td style="border: 1px solid black; text-align: center;">6.8</td> <td style="border: 1px solid black; text-align: center;">22.3</td> <td style="text-align: right;">cfs</td> </tr> <tr> <td style="text-align: right;">Bypassed Flow, Q_b =</td> <td style="border: 1px solid black; text-align: center;">0.0</td> <td style="border: 1px solid black; text-align: center;">0.0</td> <td style="text-align: right;">cfs</td> </tr> <tr> <td style="text-align: right;">Capture Percentage = Q_a/Q_o = C%</td> <td style="border: 1px solid black; text-align: center;">100</td> <td style="border: 1px solid black; text-align: center;">100</td> <td style="text-align: right;">%</td> </tr> </tbody> </table> | | MINOR | MAJOR | | d = | 0.41 | 0.91 | | Q _a = | 6.8 | 22.3 | cfs | Bypassed Flow, Q _b = | 0.0 | 0.0 | cfs | Capture Percentage = Q _a /Q _o = C% | 100 | 100 | % | | | | | | | |
| | MINOR | MAJOR | | | | | | | | | | | | | | | | | | | | | | | | | | |
| d = | 0.41 | 0.91 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Q _a = | 6.8 | 22.3 | cfs | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bypassed Flow, Q _b = | 0.0 | 0.0 | cfs | | | | | | | | | | | | | | | | | | | | | | | | | |
| Capture Percentage = Q _a /Q _o = C% | 100 | 100 | % | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total Inlet Interception Capacity (assumes clogged condition) | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Warning 02: Depth (d) exceeds USDCM Volume I recommendation.

| Calculation of Peak Runoff using Rational Method | |
|--|--|
|--|--|

$$Q(cfs) = CIA$$
[illegible]

Design Procedure Form: Grass Buffer (GB)

UD-BMP (Version 3.06, November 2016)

Sheet 1 of 1

Designer: _____
Company: Core Engineering Group
Date: December 11, 2018
Project: Creekside at Lorson Ranch East Filing No. 1
Location: Lorson Ranch

| | |
|---|---|
| <p>1. Design Discharge</p> <p>A) 2-Year Peak Flow Rate of the Area Draining to the Grass Buffer</p> | <p>$Q_2 =$ <u>0.4</u> cfs</p> |
| <p>2. Minimum Width of Grass Buffer</p> | <p>$W_G =$ <u>9</u> ft</p> |
| <p>3. Length of Grass Buffer (14' or greater recommended)</p> | <p>$L_G =$ <u>45</u> ft</p> |
| <p>4. Buffer Slope (in the direction of flow, not to exceed 0.1 ft / ft)</p> | <p>$S_G =$ <u>0.100</u> ft / ft</p> |
| <p>5. Flow Characteristics (sheet or concentrated)</p> <p>A) Does runoff flow into the grass buffer across the entire width of the buffer?</p> <p>B) Watershed Flow Length</p> <p>C) Interface Slope (normal to flow)</p> <p>D) Type of Flow Sheet Flow: $F_L * S_i \leq 1$ Concentrated Flow: $F_L * S_i > 1$</p> | <p>Choose One <input checked="" type="radio"/> Yes <input type="radio"/> No</p> <p>$F_L =$ <u>45</u> ft</p> <p>$S_i =$ <u>0.010</u> ft / ft</p> <p style="background-color: #d9ead3; padding: 2px; text-align: center;">SHEET FLOW</p> |
| <p>6. Flow Distribution for Concentrated Flows</p> | <p>Choose One</p> <p><input type="radio"/> None (sheet flow)</p> <p><input type="radio"/> Slotted Curbing</p> <p><input type="radio"/> Level Spreader</p> <p><input type="radio"/> Other (Explain):</p> <p>_____</p> <p>_____</p> |
| <p>7. Soil Preparation (Describe soil amendment)</p> | <p><u>4" topsoil</u></p> <p>_____</p> <p>_____</p> |
| <p>8. Vegetation (Check the type used or describe "Other")</p> | <p>Choose One</p> <p><input checked="" type="radio"/> Existing Xeric Turf Grass</p> <p><input type="radio"/> Irrigated Turf Grass</p> <p><input type="radio"/> Other (Explain):</p> <p>_____</p> <p>_____</p> |
| <p>9. Irrigation (*Select None if existing buffer area has 80% vegetation AND will not be disturbed during construction.)</p> | <p>Choose One</p> <p><input type="radio"/> Temporary</p> <p><input type="radio"/> Permanent</p> <p><input checked="" type="radio"/> None*</p> |
| <p>10. Outflow Collection (Check the type used or describe "Other")</p> | <p>Choose One</p> <p><input type="radio"/> Grass Swale</p> <p><input type="radio"/> Street Gutter</p> <p><input type="radio"/> Storm Sewer Inlet</p> <p><input checked="" type="radio"/> Other (Explain):</p> <p><u>Etrib of Jimmy Camp Creek or Jimmy Camp Creek</u></p> <p>_____</p> <p>_____</p> |
| <p>Notes: _____</p> <p>_____</p> <p>_____</p> <p>_____</p> | |

Hydraflow Plan View



Storm Sewer Summary Report

| Line No. | Line ID | Flow rate (cfs) | Line size (in) | Line length (ft) | Invert EL Dn (ft) | Invert EL Up (ft) | Line slope (%) | HGL down (ft) | HGL up (ft) | Minor loss (ft) | HGL Junct (ft) | Dns line No. |
|---|--------------|-----------------|----------------|------------------|-------------------|-------------------|--------------------|---------------|-------------|----------------------|----------------|--------------|
| 1 | L2 - 24" RCP | 15.00 | 24 c | 129.0 | 5686.90 | 5690.77 | 3.000 | 5688.90 | 5692.14 | n/a | 5692.14 j | End |
| 2 | L3 - 24" RCP | 9.10 | 24 c | 36.0 | 5691.27 | 5691.99 | 2.001 | 5692.67 | 5693.06 | n/a | 5693.06 j | 1 |
| Project File: Stm-1, Pond C1-R to DP-1, Alsea Dr, 5yr.stm | | | | | | | Number of lines: 2 | | | Run Date: 12-11-2018 | | |
| NOTES: c = cir; e = ellip; b = box; Return period = 5 Yrs. ; j - Line contains hyd. jump. | | | | | | | | | | | | |

Storm Sewer Summary Report

| Line No. | Line ID | Flow rate (cfs) | Line size (in) | Line length (ft) | Invert EL Dn (ft) | Invert EL Up (ft) | Line slope (%) | HGL down (ft) | HGL up (ft) | Minor loss (ft) | HGL Junct (ft) | Dns line No. |
|--|--------------|-----------------|----------------|------------------|-------------------|-------------------|--------------------|---------------|-------------|----------------------|----------------|--------------|
| 1 | L2 - 24" RCP | 33.40 | 24 c | 129.0 | 5686.90 | 5690.77 | 3.000 | 5688.81 | 5692.68 | n/a | 5692.68 | End |
| 2 | L3 - 24" RCP | 20.20 | 24 c | 36.0 | 5691.27 | 5691.99 | 2.001 | 5693.73 | 5693.99 | 0.64 | 5694.63 | 1 |
| Project File: Stm-1, Pond C1-R to DP-1, Alsea Dr, 100yr.stm | | | | | | | Number of lines: 2 | | | Run Date: 12-11-2018 | | |
| NOTES: c = cir; e = ellip; b = box; Return period = 100 Yrs. | | | | | | | | | | | | |

Hydraflow Plan View



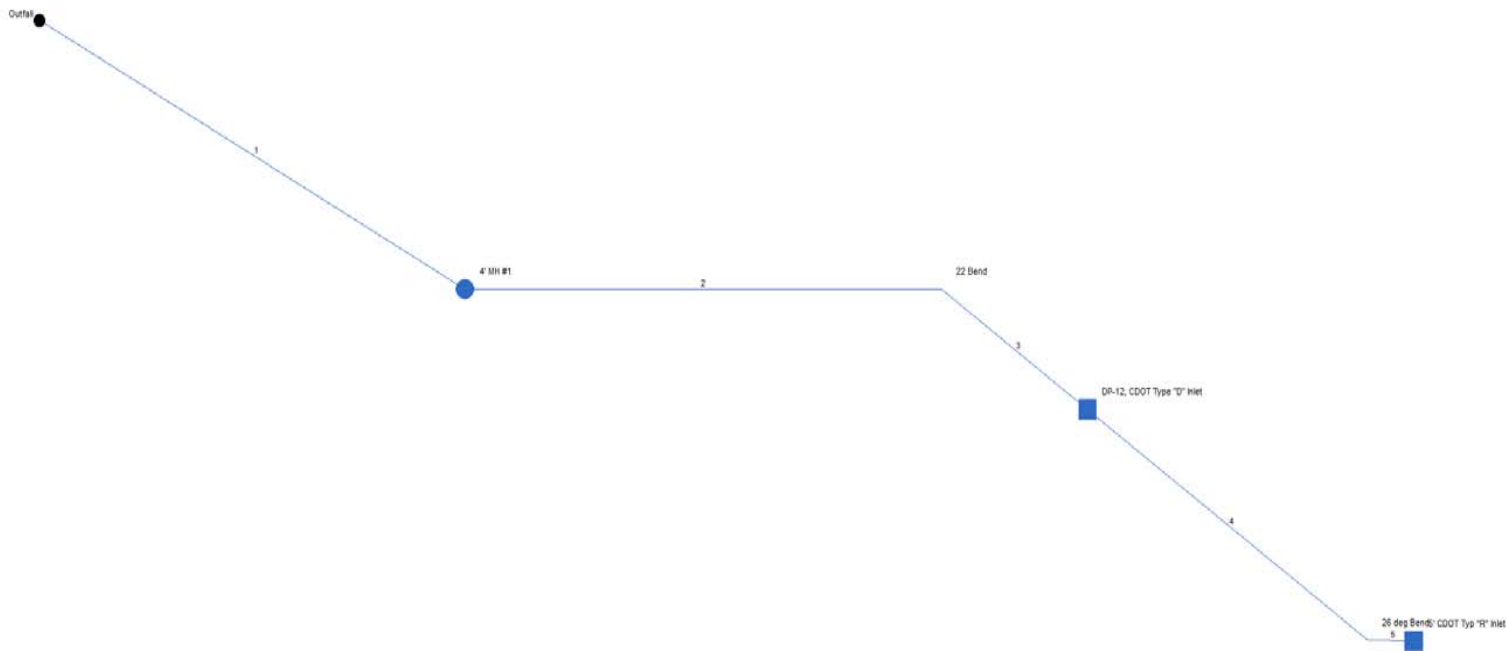
Storm Sewer Summary Report

| Line No. | Line ID | Flow rate (cfs) | Line size (in) | Line length (ft) | Invert EL Dn (ft) | Invert EL Up (ft) | Line slope (%) | HGL down (ft) | HGL up (ft) | Minor loss (ft) | HGL Junct (ft) | Dns line No. |
|---|--------------|-----------------|----------------|------------------|-------------------|-------------------|--------------------|---------------|-------------|----------------------|----------------|--------------|
| 1 | L1 - 24" RCP | 14.50 | 24 c | 46.0 | 5684.63 | 5687.30 | 5.804 | 5685.98 | 5688.65 | n/a | 5688.65 | End |
| 2 | L2 - 24" RCP | 9.70 | 24 c | 35.0 | 5687.80 | 5688.85 | 3.001 | 5689.14 | 5689.95 | n/a | 5689.95 j | 1 |
| Project File: Stm-2, Pond C1-R to DP-10, Castor Dr, 5yr.stm | | | | | | | Number of lines: 2 | | | Run Date: 12-11-2018 | | |
| NOTES: c = cir; e = ellip; b = box; Return period = 5 Yrs. ; j - Line contains hyd. jump. | | | | | | | | | | | | |

Storm Sewer Summary Report

| Line No. | Line ID | Flow rate (cfs) | Line size (in) | Line length (ft) | Invert EL Dn (ft) | Invert EL Up (ft) | Line slope (%) | HGL down (ft) | HGL up (ft) | Minor loss (ft) | HGL Junct (ft) | Dns line No. |
|---|--------------|-----------------|----------------|------------------|-------------------|-------------------|--------------------|---------------|-------------|----------------------|----------------|--------------|
| 1 | L1 - 24" RCP | 32.10 | 24 c | 46.0 | 5684.63 | 5687.30 | 5.804 | 5686.52 | 5689.19 | n/a | 5689.19 | End |
| 2 | L2 - 24" RCP | 21.50 | 24 c | 35.0 | 5687.80 | 5688.85 | 3.001 | 5690.16 | 5690.49 | n/a | 5690.49 j | 1 |
| Project File: Stm-2, Pond C1-R to DP-10, Castor Dr, 100yr.stm | | | | | | | Number of lines: 2 | | | Run Date: 12-11-2018 | | |
| NOTES: c = cir; e = ellip; b = box; Return period = 100 Yrs. ; j - Line contains hyd. jump. | | | | | | | | | | | | |

Hydraflow Plan View



Storm Sewer Summary Report

| Line No. | Line ID | Flow rate (cfs) | Line size (in) | Line length (ft) | Invert EL Dn (ft) | Invert EL Up (ft) | Line slope (%) | HGL down (ft) | HGL up (ft) | Minor loss (ft) | HGL Junct (ft) | Dns line No. |
|---|------------|-----------------|----------------|------------------|-------------------|-------------------|--------------------|---------------|-------------|----------------------|----------------|--------------|
| 1 | L1-18" RCP | 6.30 | 24 c | 223.0 | 5684.70 | 5687.82 | 1.399 | 5685.66 | 5688.71 | n/a | 5688.71 j | End |
| 2 | L2-18" RCP | 6.30 | 24 c | 216.0 | 5688.12 | 5690.28 | 1.000 | 5688.99 | 5691.17 | 0.22 | 5691.17 | 1 |
| 3 | L3-18"RCP | 6.30 | 24 c | 83.0 | 5690.28 | 5691.11 | 1.000 | 5691.45 | 5692.00 | n/a | 5692.00 j | 2 |
| 4 | L4-18" RCP | 3.70 | 18 c | 159.0 | 5691.61 | 5693.20 | 1.000 | 5692.27 | 5693.94 | 0.18 | 5693.94 | 3 |
| 5 | L5-18" RCP | 3.70 | 18 c | 21.0 | 5693.20 | 5693.41 | 1.000 | 5694.16 | 5694.15 | n/a | 5694.43 j | 4 |
| Project File: Stm-2A, Pond C1-R to DP-11, Maidford Dr, 5yr.stm | | | | | | | Number of lines: 5 | | | Run Date: 12-11-2018 | | |
| NOTES: c = cir; e = ellip; b = box; Return period = 5 Yrs. ; j - Line contains hyd. jump. | | | | | | | | | | | | |

Storm Sewer Summary Report

| Line No. | Line ID | Flow rate (cfs) | Line size (in) | Line length (ft) | Invert EL Dn (ft) | Invert EL Up (ft) | Line slope (%) | HGL down (ft) | HGL up (ft) | Minor loss (ft) | HGL Junct (ft) | Dns line No. |
|---|------------|-----------------|----------------|------------------|-------------------|-------------------|--------------------|---------------|-------------|----------------------|----------------|--------------|
| 1 | L1-18" RCP | 14.10 | 24 c | 223.0 | 5684.70 | 5687.82 | 1.399 | 5686.09 | 5689.15 | n/a | 5689.15 j | End |
| 2 | L2-18" RCP | 14.10 | 24 c | 216.0 | 5688.12 | 5690.28 | 1.000 | 5689.46 | 5691.61 | n/a | 5691.61 j | 1 |
| 3 | L3-18"RCP | 14.10 | 24 c | 83.0 | 5690.28 | 5691.11 | 1.000 | 5691.92 | 5692.44 | n/a | 5692.44 j | 2 |
| 4 | L4-18" RCP | 8.30 | 18 c | 159.0 | 5691.61 | 5693.20 | 1.000 | 5692.73 | 5694.30 | n/a | 5694.30 j | 3 |
| 5 | L5-18" RCP | 8.30 | 18 c | 21.0 | 5693.20 | 5693.41 | 1.000 | 5694.51 | 5694.51 | n/a | 5695.07 j | 4 |
| Project File: Stm-2A, Pond C1-R to DP-11, Maidford Dr, 100yr.stm | | | | | | | Number of lines: 5 | | | Run Date: 12-11-2018 | | |
| NOTES: c = cir; e = ellip; b = box; Return period = 100 Yrs. ; j - Line contains hyd. jump. | | | | | | | | | | | | |

Hydraflow Plan View



1

Storm Sewer Summary Report

| Line No. | Line ID | Flow rate (cfs) | Line size (in) | Line length (ft) | Invert EL Dn (ft) | Invert EL Up (ft) | Line slope (%) | HGL down (ft) | HGL up (ft) | Minor loss (ft) | HGL Junct (ft) | Dns line No. |
|---|--------------|-----------------|----------------|------------------|-------------------|-------------------|--------------------|---------------|-------------|----------------------|----------------|--------------|
| 1 | L1 - 18" RCP | 2.20 | 18 c | 141.0 | 5684.30 | 5689.94 | 4.000 | 5684.87 | 5690.51 | n/a | 5690.51 j | End |
| Project File: Stm-3, Pond CR3 to DP-15, Yazoo Dr, 5yr.stm | | | | | | | Number of lines: 1 | | | Run Date: 10-17-2018 | | |
| NOTES: c = cir; e = ellip; b = box; Return period = 5 Yrs. ; j - Line contains hyd. jump. | | | | | | | | | | | | |

Storm Sewer Summary Report

| Line No. | Line ID | Flow rate (cfs) | Line size (in) | Line length (ft) | Invert EL Dn (ft) | Invert EL Up (ft) | Line slope (%) | HGL down (ft) | HGL up (ft) | Minor loss (ft) | HGL Junct (ft) | Dns line No. |
|--|--------------|-----------------|----------------|------------------|-------------------|-------------------|--------------------|---------------|-------------|----------------------|----------------|--------------|
| 1 | L1 - 18" RCP | 3.70 | 18 c | 141.0 | 5684.30 | 5689.94 | 4.000 | 5685.03 | 5690.67 | 0.29 | 5690.67 | End |
| Project File: Stm-3, Pond CR3 to DP-15, Yazoo Dr, 100yr.stm | | | | | | | Number of lines: 1 | | | Run Date: 10-17-2018 | | |
| NOTES: c = cir; e = ellip; b = box; Return period = 100 Yrs. | | | | | | | | | | | | |

Hydraflow Plan View



Storm Sewer Summary Report

| Line No. | Line ID | Flow rate (cfs) | Line size (in) | Line length (ft) | Invert EL Dn (ft) | Invert EL Up (ft) | Line slope (%) | HGL down (ft) | HGL up (ft) | Minor loss (ft) | HGL Junct (ft) | Dns line No. |
|---|--------------|-----------------|----------------|------------------|-------------------|-------------------|--------------------|---------------|-------------|----------------------|----------------|--------------|
| 1 | L4 - 24" RCP | 12.40 | 24 c | 40.0 | 5682.30 | 5683.50 | 3.000 | 5683.55 | 5684.75 | n/a | 5684.75 | End |
| 2 | L2 - 18" RCP | 2.10 | 18 c | 103.0 | 5684.00 | 5685.85 | 1.796 | 5685.29 | 5686.40 | n/a | 5686.40 j | 1 |
| 3 | L3 - 18" RCP | 2.10 | 18 c | 247.0 | 5685.85 | 5690.30 | 1.802 | 5686.58 | 5690.85 | n/a | 5690.85 j | 2 |
| 4 | L4 - 18" RCP | 2.10 | 18 c | 33.0 | 5690.30 | 5690.89 | 1.789 | 5691.03 | 5691.44 | n/a | 5691.44 j | 3 |
| Project File: Stm-4, Pond CR2 to DP-16, Castor Dr, 5yr.stm | | | | | | | Number of lines: 4 | | | Run Date: 12-11-2018 | | |
| NOTES: c = cir; e = ellip; b = box; Return period = 5 Yrs. ; j - Line contains hyd. jump. | | | | | | | | | | | | |

Storm Sewer Summary Report

| Line No. | Line ID | Flow rate (cfs) | Line size (in) | Line length (ft) | Invert EL Dn (ft) | Invert EL Up (ft) | Line slope (%) | HGL down (ft) | HGL up (ft) | Minor loss (ft) | HGL Junct (ft) | Dns line No. |
|---|--------------|-----------------|----------------|------------------|-------------------|-------------------|--------------------|---------------|-------------|----------------------|----------------|--------------|
| 1 | L4 - 24" RCP | 26.70 | 24 c | 40.0 | 5682.30 | 5683.50 | 3.000 | 5684.10 | 5685.30 | 0.90 | 5685.30 | End |
| 2 | L2 - 18" RCP | 4.60 | 18 c | 103.0 | 5684.00 | 5685.85 | 1.796 | 5686.44 | 5686.67 | n/a | 5686.67 j | 1 |
| 3 | L3 - 18" RCP | 4.60 | 18 c | 247.0 | 5685.85 | 5690.30 | 1.802 | 5686.90 | 5691.12 | n/a | 5691.12 j | 2 |
| 4 | L4 - 18" RCP | 4.60 | 18 c | 33.0 | 5690.30 | 5690.89 | 1.789 | 5691.35 | 5691.71 | 0.34 | 5691.71 | 3 |
| Project File: Stm-4, Pond CR2 to DP-16, Castor Dr, 100yr.stm | | | | | | | Number of lines: 4 | | | Run Date: 12-11-2018 | | |
| NOTES: c = cir; e = ellip; b = box; Return period = 100 Yrs. ; j - Line contains hyd. jump. | | | | | | | | | | | | |

APPENDIX F – not used

MAP POCKET

| DESIGN POINT | EAST TRIBUTARY FEMA FLOW DATA | | EAST TRIBUTARY DBPS FLOW DATA | |
|--------------|-------------------------------|---------------------|-------------------------------|---------------------|
| | RUNOFF 10 YR (CFS) | RUNOFF 100 YR (CFS) | RUNOFF 2 YR (CFS) | RUNOFF 100 YR (CFS) |
| ET3 | 2800 | 5500 | 110 | 4570 |
| ET4 | 2800 | 5500 | 120 | 4600 |
| | | | | |

FLOW DATA FROM LORSON RANCH
EAST MDDP

LEGEND

--- BASIN BOUNDARY



BASIN DESIGN POINT

BASIN I.D.
ACREAGE
5 YR/100 YR CFS



DIRECTION OF FLOW

6690

EXISTING CONTOUR

--- TIME OF CONCENTRATION

PRELIMINARY PLAN SITE AREA

--- 100-YR FLOODPLAIN

100-YR FLOODPLAIN



CORE ENGINEERING GROUP
15004 1ST AVENUE S.
DENVER, CO 80232
PHONE: 303.750.1100
CONTACT: RICHARD L. SCHNITLER, P.E.
EMAIL: Rich@cegi.com

DATE: _____

DESCRIPTION: _____

NO.: _____

DRAWN: _____ LAB
DESIGNED: _____ LAB
CHECKED: _____ RLS

PROJECT: CREEKSIDE FILING NO. 1
CREEKSIDE FILING NO. 1
LORSON BLVD - OLD GLORY DRIVE
EL PASO COUNTY, COLORADO

PREPARED FOR: LORSON LLC
212 NORTH WAHATCH AVE, SUITE 301
COLORADO SPRINGS, COLORADO 80903 (719) 635-3200
CONTACT: JEFF MARK

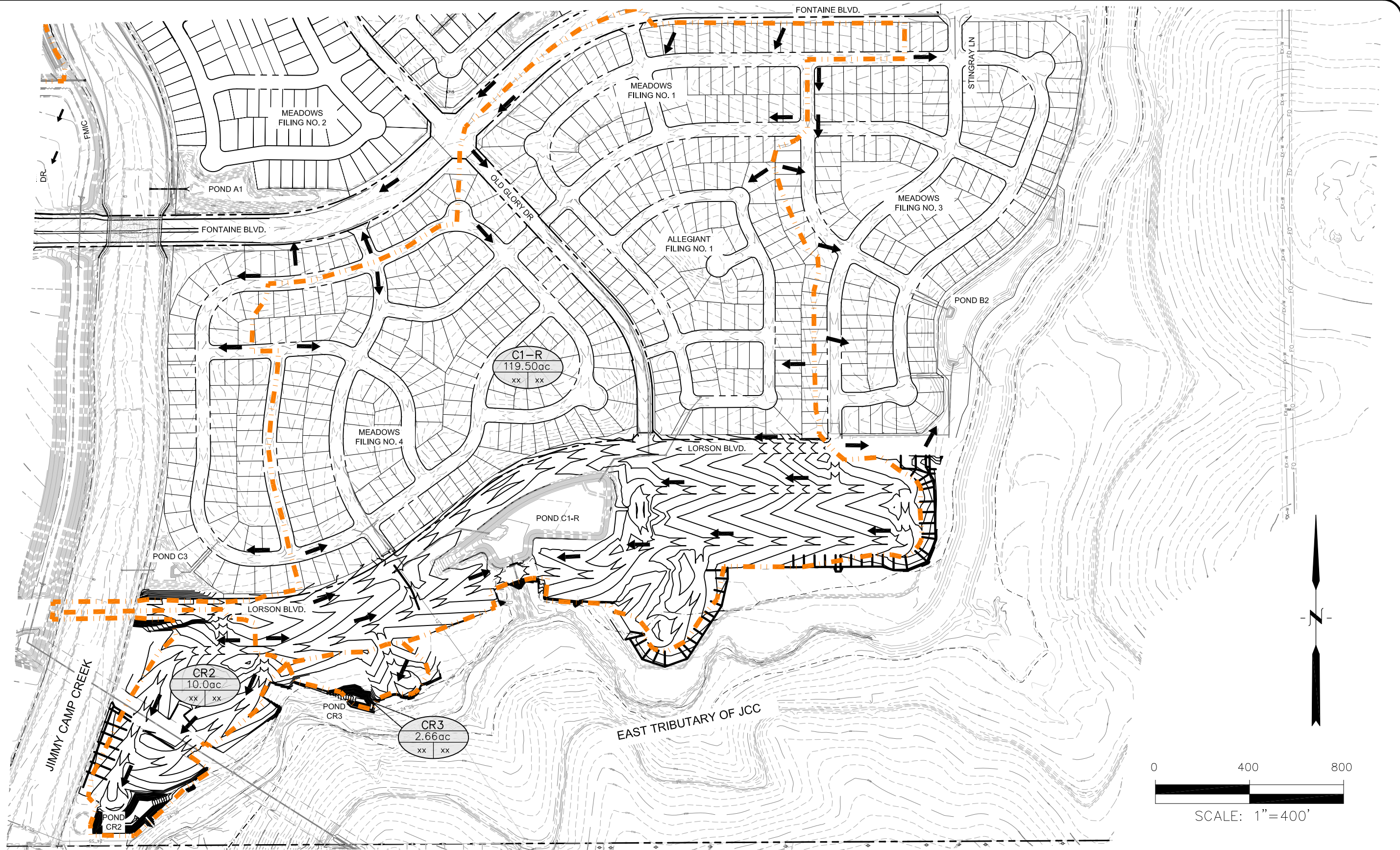
EXISTING CONDITIONS
CREEKSIDE AT LORSON RANCH FIL. NO. 1

DATE: DECEMBER 5, 2018

PROJECT NO. 100.045

SHEET NUMBER 1

TOTAL SHEETS: 1



**CORE
ENGINEERING GROUP**
15004 1ST AVENUE S.
BURNSVILLE, MN 55306
PH: 719.570.1100
CONTACT: RICHARD L. SCHINDLER, P.E.
EMAIL: Rich@ceg1.com

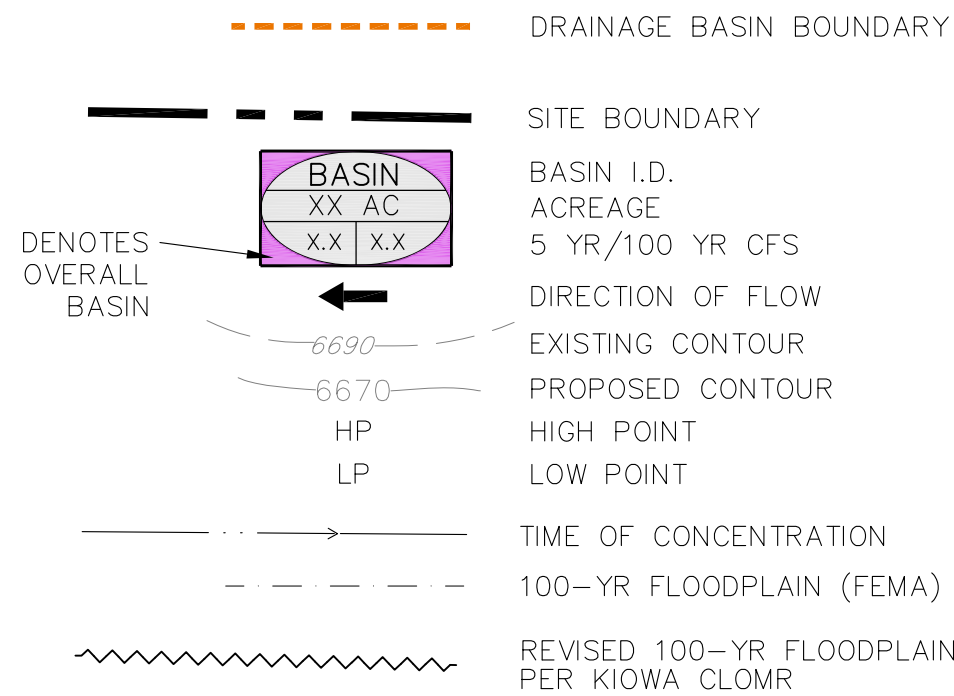
**CREEKSIDE AT LORSON RANCH FILING NO. 1
WATER QUALITY & POND TRIBUTARY AREAS**

SCALE:
NTS

DATE:
DECEMBER 5, 2018

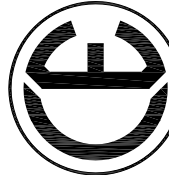
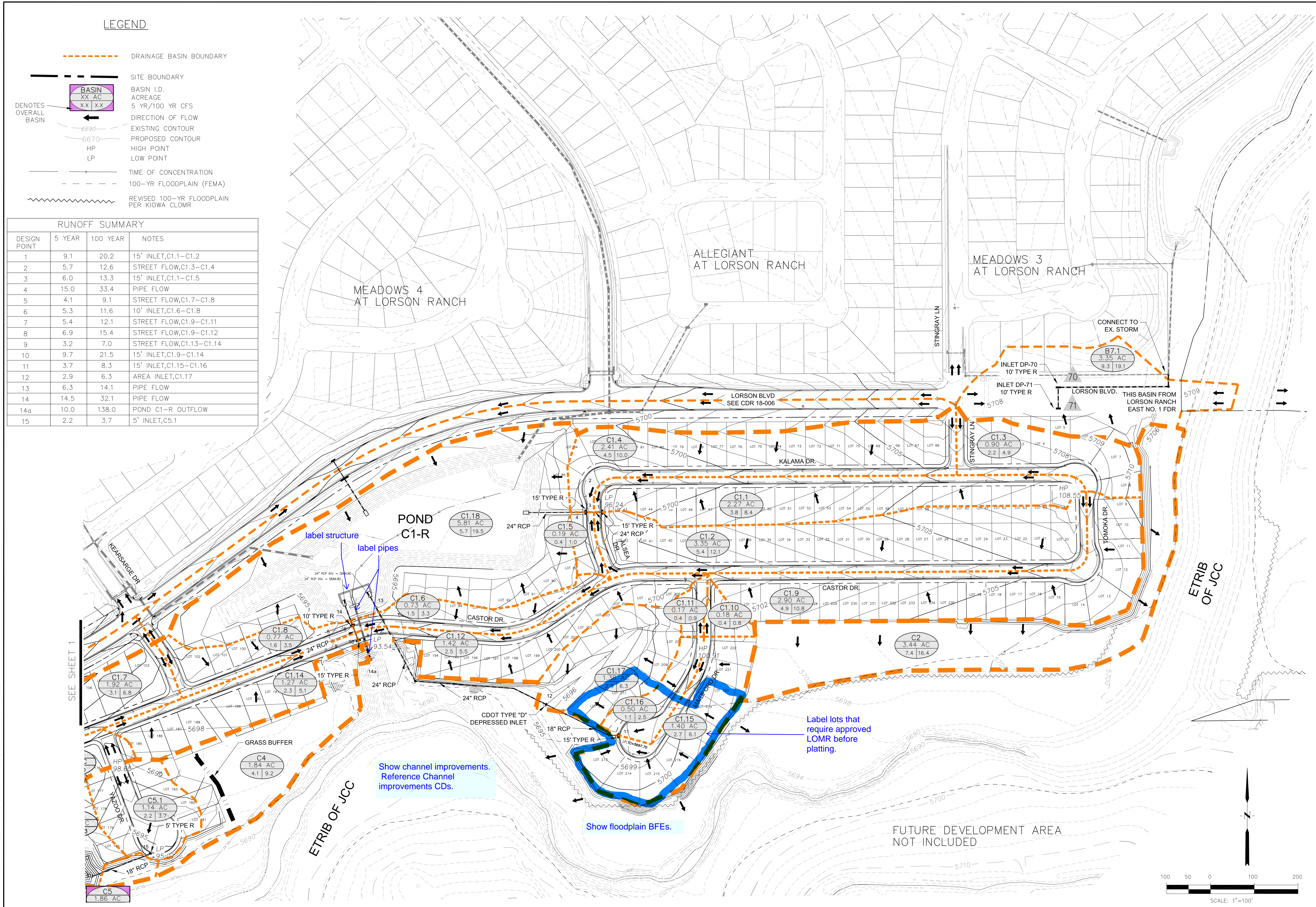
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LEGEND



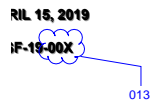
RUNOFF SUMMARY

| DESIGN POINT | 5 YEAR | 100 YEAR | NOTES |
|--------------|--------|----------|-------------------------|
| 1 | 9.1 | 20.2 | 15' INLET,C1.1-C1.2 |
| 2 | 5.7 | 12.6 | STREET FLOW,C1.3-C1.4 |
| 3 | 6.0 | 13.3 | 15' INLET,C1.1-C1.5 |
| 4 | 15.0 | 33.4 | PIPE FLOW |
| 5 | 4.1 | 9.1 | STREET FLOW,C1.7-C1.8 |
| 6 | 5.3 | 11.6 | 10' INLET,C1.6-C1.8 |
| 7 | 5.4 | 12.1 | STREET FLOW,C1.9-C1.11 |
| 8 | 6.9 | 15.4 | STREET FLOW,C1.9-C1.12 |
| 9 | 3.2 | 7.0 | STREET FLOW,C1.13-C1.14 |
| 10 | 9.7 | 21.5 | 15' INLET,C1.9-C1.14 |
| 11 | 3.7 | 8.3 | 15' INLET,C1.15-C1.16 |
| 12 | 2.9 | 6.3 | AREA INLET,C1.17 |
| 13 | 6.3 | 14.1 | PIPE FLOW |
| 14 | 14.5 | 32.1 | PIPE FLOW |
| 14a | 10.0 | 138.0 | POND C1-R OUTFLOW |
| 15 | 2.2 | 3.7 | 5' INLET,C5.1 |



ENG-SF1913-R1-FDR-Redlines.pdf Markup Summary

1 (2)

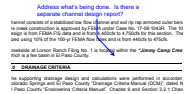


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5 (1)



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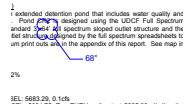
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17'x7'?

19 (2)



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Space:
Page Label: 19

68"

outs are in the appendix of this report. See map

3'x68"?

3.29, 0.1cfs
84.75, Top EURV wall set at 5685.00, 4'x4' out
1cfs
386.04, 10.4cfs
riotor state up 10"

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Page Index: 19
Date: 6/18/2019 12:12:57 PM
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Color: ■
Layer:
Space:
Page Label: 19

3'x68"?

20 (1)

3.2' office, 2.3' below sand filter (5684.00)
A, WSEL: 5688.00, 0.07cfs
0.23sec-ft, WSEL: 5687.95, 2.5cfs
RCP at 1.50%
4' 6" wide bottom, elevation=5688.50, 4:1 side slopes, 60
f, release path into creek, compliance from full
uration: 5688.50, 84.00?

(by two permanent extended detention basins (Pond C1+1
for 85.8% of the 63.058-acre site. Approximately 9.91 ac
plan area) consists of backyards that drain directly to the
as buffers. A deviation from county criteria to use a gas
yard drainage area is submitted. The backyards drain
to the creek.

Subject: Cloud+
Page Index: 20
Date: 6/18/2019 12:18:07 PM
Author: dsdrice
Color: ■
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Page Label: 20

84.00?

21 (1)

into wetland areas, such as wetlands, and all berms

Based on 4,600 SF into the
imperviousness is about 57.6%

but within the Jimmy Camp Creek drainage basin which
meets 63.058-acre site. Approximately 9.91 ac
plan area) consists of backyards that drain directly to the
as buffers. A deviation from county criteria to use a gas
yard drainage area is submitted. The backyards drain
to the creek.

in 63.058 acres. This project consists of 43,514 acres of
the 63.058-acre site is submitted. The backyards drain
to the creek. The following table shows the drainage flow for

Subject: Cloud+
Page Index: 21
Date: 6/17/2019 3:26:38 PM
Author: dsdrice
Color: ■
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Page Label: 21

Based on 4,600 SF lots the imperviousness is
about 57.6%

22 (2)

7.3' Future Lorson Ran
Item Qual
tributary Channel

Subject: Cloud+
Page Index: 22
Date: 6/18/2019 11:20:16 AM
Author: dsdrice
Color: ■
Layer:
Space:
Page Label: 22

?

in project area. Several key
identified as follows:
urbanization and other facilities
as will be reconstructed within this study area
eliminate the need for a gas yard drainage area is submitted. The backyards drain
to the creek.

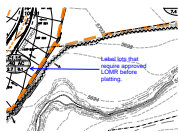
Subject: Cloud+
Page Index: 22
Date: 6/18/2019 11:21:02 AM
Author: dsdrice
Color: ■
Layer:
Space:
Page Label: 22

clarify

125 (6)

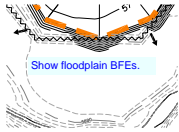


Subject: Highlight
Page Index: 125
Date: 6/18/2019 10:44:39 AM
Author: dsdrice
Color: ■
Layer:
Space:
Page Label: 125



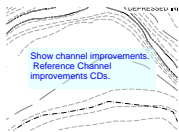
Subject: Callout
Page Index: 125
Date: 6/18/2019 10:45:05 AM
Author: dsdrice
Color: ■
Layer:
Space:
Page Label: 125

Label lots that require approved LOMR before platting.



Subject: Text Box
Page Index: 125
Date: 6/18/2019 10:45:54 AM
Author: dsdrice
Color: ■
Layer:
Space:
Page Label: 125

Show floodplain BFEs.



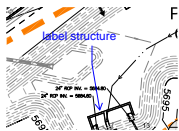
Subject: Text Box
Page Index: 125
Date: 6/18/2019 10:46:38 AM
Author: dsdrice
Color: ■
Layer:
Space:
Page Label: 125

Show channel improvements. Reference Channel improvements CDs.



Subject: Callout
Page Index: 125
Date: 6/18/2019 11:31:59 AM
Author: dsdrice
Color: ■
Layer:
Space:
Page Label: 125

label pipes



Subject: Callout
Page Index: 125
Date: 6/18/2019 11:33:10 AM
Author: dsdrice
Color: ■
Layer:
Space:
Page Label: 125

label structure