

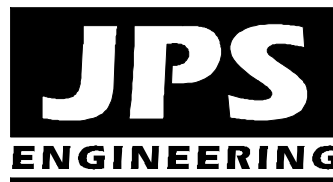
**PRELIMINARY & FINAL DRAINAGE REPORT**  
**for**  
**CATHEDRAL ROCK COMMONS COMMERCIAL**

**Prepared for:**

**Cathedral Rock Investments LLC**  
6035 Erin Park Drive  
Colorado Springs, CO 80918

September 30, 2021  
Revised October 14, 2022  
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Revised March 8, 2023

**Prepared by:**



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**JPS Project No. 062102**  
**PCD Project No. SP221 / SF2210**

**CATHEDRAL ROCK COMMONS COMMERCIAL  
FINAL DRAINAGE REPORT  
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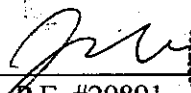
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## DRAINAGE STATEMENT

### Engineer's Statement:

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

  
John P. Schwab, P.E. #29891



### Developer's Statement:

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

By: 

Printed Name: Marvin Boyd, Manager  
Cathedral Rock Investments LLC  
6035 Erin Park Drive, Colorado Springs, CO 80918

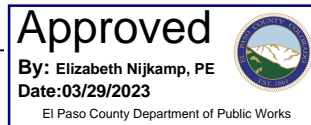
3-8-23

Date

### El Paso County's Statement

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

Joshua Palmer, P.E.  
County Engineer / ECM Administrator



Date

Conditions:

## **I. GENERAL LOCATION AND DESCRIPTION**

### **A. Background**

Cathedral Rock Commons Commercial is a proposed 3-lot commercial minor subdivision located in northern El Paso County, Colorado. The minor subdivision will create three commercial lots on the existing 10.2-acre parcel (El Paso County Assessor's Number 71360-02-035) located at the northeast corner of Struthers Road and Spanish Bit Drive. There are no improvements proposed to the existing Big R Retail Store on the north side of the property, which will be platted as Lot 1. The proposed Lot 2 will be developed as a 1.8-acre commercial lot and the proposed Lot 3 will be developed as a 1.0-acre commercial lot. Tract A will be dedicated as a tract for the existing on-site private detention pond.

### **B. Scope**

This report will provide a summary of site drainage issues impacting the proposed commercial minor subdivision. The report will analyze upstream drainage patterns, site-specific developed drainage patterns, and impacts on downstream facilities. This report is based on the guidelines and criteria presented in the El Paso County Drainage Criteria Manual, and the report is intended to fulfill the requirements for a "Final Drainage Report" in support of the Final Plat process for this property.

### **C. Site Location and Description**

Cathedral Rock Commons Commercial Subdivision is located in the Northeast Quarter of the Southeast Quarter of Section 36, Township 11 South, Range 67 West of the 6th Principal Meridian. The 10.2-acre parcel is currently a developed commercial property with an existing Big R Retail Store along with several sheds and accessory structures, and associated parking areas. The developed north side of the parcel will be platted as the 6.2-acre Lot 1, and the vacant area on the south side of the parcel will be platted as two vacant commercial lots for future development.

The property is zoned CC (community commercial), and the proposed minor subdivision is fully in conformance with the existing zoning of the site. Access to the three lots will be provided by driveway connections to Spanish Bit Drive and the existing shared private access drive between the proposed Lots 2 and 3.

The site is bordered by developed rural residential properties on the north and east sides (Lots 27 and 28, Chaparral Hills). Struthers Road is a fully improved, asphalt-paved arterial public street along the west boundary of the site, and Spanish Bit Drive is a partially improved local public street along the southeast boundary of the site. A vacant 6.6-acre parcel zoned R-4 is located across Spanish Bit Drive to the south.



The site is located in the Jackson Creek Drainage Basin, and surface drainage from this site sheet flows southwesterly to an existing public storm sewer along the west boundary of the property and an existing culvert crossing Struthers Road at the southwest corner of the site.

The terrain is relatively flat with average grades ranging from 1 to 4 percent sloping to the southwest. Ground elevations within the site range from approximately 6,800 feet above mean sea level at the northeast corner of the site down to approximately 6,765 at the southwest corner of the property.

#### **D. General Soil Conditions**

According to the Custom Soil Resource Report for this site (see details in Appendix A) provided by the Natural Resources Conservation Service (NRCS), on-site soils are comprised of “Type 68: Peyton-Pring complex” soils. These soils are classified as hydrologic soils group “B” (moderate infiltration rate).

#### **E. References**

City of Colorado Springs & El Paso County “Drainage Criteria Manual,” revised October 31, 2018.

City of Colorado Springs “Drainage Criteria Manual, Volumes 1 and 2,” revised October 31, 2018.

El Paso County “Engineering Criteria Manual,” revised December 13, 2016.

FEMA, Flood Insurance Rate Map (FIRM) Number 08041C0287G, December 7, 2018.

M&S Civil Consultants, Inc., “Big R – Retail Center Final Drainage Report,” February 2012.

Nolte Associates, Inc., “Struthers Road Final Drainage Report from Struthers Ranch to Baptist Road,” May 16, 2005.

## **II. DRAINAGE BASINS AND SUB-BASINS**

#### **A. Major Basin Description**

The proposed development lies within the Jackson Creek Drainage Basin (FOM 04400) as classified by El Paso County. There is currently no Drainage Basin Planning Study (DBPS) on file for this basin.

#### **B. Floodplain Impacts**

This site is not impacted by any FEMA 100-year floodplain limits. The delineated floodplain limits in vicinity of the site are shown in FEMA Flood Insurance Rate Map (FIRM) Number 08041C0287G, dated December 7, 2018 (see FIRMette exhibit in Appendix E).

### **C. Sub-Basin Description**

Drainage planning for this site was previously studied in the “Big R – Retail Center Final Drainage Report” by M&S Civil Consultants, Inc. dated February 2012. As depicted in the “Big R Drainage Plan” by M&S (enclosed in Appendix E), the site has been delineated as six on-site sub-basins (A-F), with several adjoining off-site drainage basins (OS1-OS6).

The existing Big R Retail Center (proposed Lot 1) covers Basins A-E, and Basin F covers the proposed Lots 2 and 3, as well as the Detention Pond in Tract A.

As described in the M&S FDR, Basin A consists of the westerly fringe of the Big R property, which sheet flows west into the existing curb and gutter and public storm sewer system along the east side of Struthers Road. Basins B-C consist of the existing building and north service drive, which flow through an existing on-site 24” private storm sewer (“Pipe Run 1”) connecting to an existing 30” RCP storm sewer flowing west across Struthers Road (see “Big R Drainage Plan” by M&S enclosed in Appendix E).

Basins D-F sheet flow southwesterly across the Big R parking lot into an existing private detention / water quality pond at the southwest corner of the property. The pond outlet pipe drains into existing dual 36” RCP culverts flowing south across Spanish Bit Drive.

Off-site Basins OS4-OS6 have been delineated as the off-site areas of rural residential lots to the northeast, which flow southwesterly along the roadside ditch on the north side of Spanish Bit Drive to the existing dual 36” culvert crossing on the west side of Struthers Road.

Developed runoff in the proposed minor subdivision will continue to follow the drainage paths established in the M&S FDR.

## **III. DRAINAGE DESIGN CRITERIA**

### **A. Development Criteria Reference**

This report is based on the guidelines and criteria presented in the El Paso County Drainage Criteria Manual.

Drainage planning for this site was previously studied in the “Big R – Retail Center Final Drainage Report” by M&S Civil Consultants, Inc. dated February 2012, which depicts the majority of the developed site flowing to an on-site private detention / water quality pond as the southwest corner of the site.

### **B. Hydrologic Criteria**

The tributary drainage basins impacting this site are all less than 100 acres, so Rational Method Hydrology procedures were utilized for calculation of peak flows.

Rational Method hydrologic calculations were based on the following assumptions:

- |                                      |                            |             |
|--------------------------------------|----------------------------|-------------|
| • Design storm (minor)               | 5-year                     |             |
| • Design storm (major)               | 100-year                   |             |
| • Rainfall Intensities               | El Paso County I-D-F Curve |             |
| • Hydrologic soil type               | B                          |             |
|                                      | <u>C5</u>                  | <u>C100</u> |
| • Runoff Coefficients - undeveloped: |                            |             |
| Meadow / Forest areas                | 0.08                       | 0.35        |
| • Runoff Coefficients - developed:   |                            |             |
| Proposed Building / Pavement Areas   | 0.90                       | 0.96        |
- (see composite runoff coefficient calculations in Appendix B)

Hydrologic calculations are enclosed in Appendix B, and peak design flows are identified on the drainage plan drawings.

#### IV. DRAINAGE PLANNING FOUR STEP PROCESS

El Paso County Drainage Criteria require drainage planning to include a Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long-term source controls.

As stated in ECM Appendix I.7., the Four Step Process is applicable to all new and re-development projects with construction activities that disturb 1 acre or greater or that disturb less than 1 acre but are part of a larger common plan of development. The Four Step Process has been implemented as follows in the planning of this project:

##### Step 1: Employ Runoff Reduction Practices

- Extended Detention Basin: The majority of developed flows will be routed through the on-site detention basin, which will be grass-lined to encourage stormwater infiltration.

##### Step 2: Stabilize Drainageways

- There are no drainageways directly adjacent to this project site. Implementation of the on-site drainage improvements and detention basin will minimize downstream drainage impacts from this site.
- Drainage basin fees will be paid at the time of recording of the subdivision plat, and these fees provide the applicable cost contribution towards regional drainage improvements.

##### Step 3: Provide Water Quality Capture Volume (WQCV)

- EDB: The majority of the developed site will drain through an on-site Private Extended Detention Basin (EDB) at the southwest corner of the property. The extended detention basin which will capture and slowly release the WQCV over an extended release period.

#### Step 4: Consider Need for Industrial and Commercial BMPs

- No industrial uses are proposed for this site.
- The commercial properties within this project will implement a Stormwater Management Plan including proper housekeeping practices and spill containment procedures.
- On-site drainage will be routed through the Extended Detention Basin (EDB) to minimize introduction of contaminants to the County's public drainage system.

### **V. GENERAL DRAINAGE RECOMMENDATIONS**

The developed drainage plan for the site is to provide and maintain positive drainage away from structures and conform to the established drainage patterns for the overall site. JPS Engineering recommends that positive drainage be established and maintained away from all structures within the site in conformance with applicable building codes and geotechnical engineering recommendations.

Individual lot grading is the sole responsibility of the individual builders and property owners. Final grading of each building site should establish proper protective slopes and positive drainage in accordance with HUD guidelines and building codes. In general, main floor elevations for each building should be established a minimum of 2 feet above the top of curb of the adjoining street.

In general, we recommend a minimum of 6 inches clearance from the top of concrete foundation walls to adjacent finished site grades. Positive drainage slopes should be maintained away from all structures, with a minimum recommended slope of 5 percent for the first 10 feet away from buildings in landscaped areas, a minimum recommended slope of 2 percent for the first 10 feet away from buildings in paved areas, and a minimum slope of 1 percent for paved areas beyond buildings.

### **VI. DRAINAGE FACILITY DESIGN**

#### **A. General Concept**

Development of the proposed subdivision replat will not require any public improvements, as access to the two lots will be provided by private access drive connections to the existing Green Acres Lane along the west boundary of the subdivision. The general concept for management of developed storm runoff is to establish site grading to provide positive drainage away from the building pads and divert runoff to drainage swales following historic drainage patterns.

#### **B. Specific Details**

##### **1. Existing Drainage Conditions**

Existing site drainage conditions are depicted on the "Big R Drainage Plan" by M&S Civil Consultants, Inc. (Appendix E). The north side of the proposed subdivision property is currently developed as the Big R Retail Center, and the south side of the site is currently

vacant. Existing drainage facilities within the property include a private storm sewer system serving the Big R Retail Center site and an existing private stormwater detention pond at the southwest corner of the property.

As detailed in the M&S FDR, Basins OS1, OS2, and A (west edge of site) flow to an existing 15' Type R Inlet along the east side of Struthers Road (Design Point #1;  $Q_5 = 14.3$  cfs and  $Q_{100} = 31.1$  cfs). Basins B and C (Big R Retail Building and north driveway) flow to an existing Storm Inlet at the northwest corner of the site (Design Point #2;  $Q_5 = 2.3$  cfs and  $Q_{100} = 4.7$  cfs), and a 24" Private Storm Sewer conveys these flows south along the western site boundary to an existing storm manhole connecting to a 30" RCP culvert crossing Struthers Road. The previous M&S drainage report identified the existing public storm sewer facilities as having adequate capacity to accept the developed flows from Basins A-C within the Big R site.

Drainage from off-site Basins OS4 and OS5 sheet flows southwesterly to the existing roadside ditch along the north side of Spanish Bit Drive, with calculated peak flows of  $Q_5 = 22.2$  cfs and  $Q_{100} = 51.7$  cfs at Design Point #3. The roadside ditch along the north side of Spanish Bit Drive flows southwesterly to the existing depression at the northeast corner of the Struthers Road intersection, where this flow enters the existing dual 36-inch culverts crossing Struthers Road at Design Point #7.

Basin D comprises the southwest parking lot of the Big R site, which sheet flows to an existing 8-foot D10R sump inlet at the southwest corner of the parking lot (Design Point #4;  $Q_5 = 9.8$  cfs and  $Q_{100} = 19.4$  cfs per M&S report). An existing 24" Private Storm Sewer conveys the flow from DP4 south into the detention basin at the southwest corner of the site.

The M&S FDR identifies Design Point #5 as the developed area consisting of Basins E and F which enters the east side of the detention pond. The M&S report calculated peak flows of  $Q_5 = 25.9$  cfs and  $Q_{100} = 48.9$  cfs at Design Point #5.

Design Point #6 represents the combined developed flow from DP4 and DP5, with total calculated peak flows of  $Q_5 = 32.8$  cfs and  $Q_{100} = 62.7$  cfs entering the detention pond.

Design Point #7 has been identified as the combination of flow in the roadside ditch along the northwest side of Spanish Bit Drive from DP3 and Basin OS6 (north side of Spanish Bit Drive), with calculated peak flows of  $Q_5 = 24.0$  cfs and  $Q_{100} = 56.0$  cfs.

The M&S FDR identifies Design Point #8 as the combined flow from DP7 and the detention pond outlet structure (DP6-detained), with calculated peak flows of  $Q_5 = 31.2$  cfs and  $Q_{100} = 73.9$  cfs. M&S concludes that the total flow reaching the existing depression at the northeast corner of Struthers Road and Spanish Bit Drive is "approximately equal to that of the historic value ( $Q_5 = 31.6$  cfs and  $Q_{100} = 73.9$  cfs). Therefore, historic flow values have been adhered to..."

## 2. Developed Drainage Conditions

As shown on the enclosed Drainage Plan (Figure D1, Appendix E), the site has been delineated as six on-site drainage basins matching the previous M&S FDR. Developed flows have been calculated based on the impervious areas associated with the proposed building and parking improvements.

Surface drainage swales and a private storm sewer system will convey developed flows from Basins D, E, and F1-F3 to the extended detention basin (EDB) at the corner of the site. Site grades will slope to storm inlets and curb openings at selected locations, collecting surface drainage and conveying stormwater to the detention basin. The proposed Minor Subdivision has no impact on the previously developed Big R Site drainage patterns (Basins A-E) on the north side of the property.

Basin F in the M&S FDR has been divided into Sub-Basins F1-F4 to provide further detail on final drainage patterns for the proposed commercial development areas comprising Lots 2 and 3. The proposed building pads on Lots 2 and 3 will be graded with protective slopes to provide positive drainage away from the buildings, and a private storm sewer system will convey developed flows southwesterly into Detention Basin F.

Private Storm Inlet F1A (5' Type R) will intercept surface drainage from the north side of Lot 2, and Private Storm Sewer F1A (12" HDPE) will flow southeasterly to Inlet F1B (5' Type R) in the southwest corner Lot 2. Private Storm Sewer F1B (18" HDPE) will convey the combined flow southwesterly to Inlet F2 on Lot 3.

Private Storm Inlet F2A (10' Type R) will intercept surface drainage from the parking area on the south side of Lot 3 (Basins E and F2), and Private Storm Sewer F2A (24" HDPE) will convey the combined flow westerly into a new forebay on the east side of Extended Detention Basin F. Developed peak flows at Design Point #5 (combined Basins E, F1, and F2) are calculated as  $Q_5 = 16.0$  cfs and  $Q_{100} = 30.4$  cfs.

The existing detention pond within Tract A has been delineated as Basin F3. Developed peak flows entering Detention Basin F (combined flows from Basins D, E, and F1-F3 at Design Point #6) are calculated as  $Q_5 = 23.2$  cfs and  $Q_{100} = 45.5$  cfs. After routing through Extended Detention Basin F, detained peak flows at Design Point #6d are calculated as  $Q_5 = 0.3$  cfs and  $Q_{100} = 11.3$  cfs (see Detention Pond Calculations in Appendix D). The existing 18" discharge pipe from Detention Basin F will continue to flow southwest into the existing dual 36" RCP public culverts crossing Struthers Road.

The narrow landscaped area within the property along the west edge (downstream) of the detention pond has been delineated as Basin F4 (0.11 acres), which sheet flows southwesterly into the existing curb and gutter along the east side of Struthers Road. Developed peak flows at Design Point #F4 are calculated as  $Q_5 = 0.04$  cfs and  $Q_{100} = 0.3$  cfs.

Basin F4 is excluded from permanent water quality requirements based on ECM Appendix I.7.1.C.1, which allows for 20%, not to exceed 1 acre, of the applicable development site area to not be captured.

Total detained peak flows at Design Point #8d are calculated as  $Q_5 = 24.9$  cfs and  $Q_{100} = 65.5$  cfs. As discussed in the “Big R – Retail Center Final Drainage Report” by M&S, the existing double 36” RCP culverts have been determined as adequate to convey the previously identified DP8 100-year flow of 73.9 cfs, so the existing culverts provide an adequate outfall for the design flows.

The roadway area of Spanish Bit Drive along the frontage of the property has been delineated as Basin OS6 (1.18 acres), which flows southwesterly along an existing roadside ditch to the existing culvert crossing on the east side of the Struthers Road intersection. Developed peak flows at Design Point #OS6 are calculated as  $Q_5 = 3.5$  cfs and  $Q_{100} = 7.8$  cfs (per M&S FDR).

This project will include upgrade of the Spanish Bit Drive roadway with new curb, gutter, and asphalt paving along the frontage of the site. The impervious area of the proposed roadway improvements within Basin OS6 is limited to approximately 0.46 acres, and the total area of Sub-Basin OS6.1 (basin area within limits of this project) is 0.88 acres. The combined area of Basin F4 and Sub-Basin OS6.1 is 0.99 acres. As such, these combined areas qualify for exclusion from permanent water quality requirements per ECM Appendix I.7.1.C.1, which allows for 20%, not to exceed 1 acre, of the applicable development site area to not be captured.

A new 16-foot Type D10R Storm Inlet will be installed at the upstream project limit to intercept the off-site flows at Design Point #3 and a 30” RCP storm sewer will convey the flow from Inlet-DP3 into the roadside ditch flowing southwest along the frontage of the site. The 36” RCP culvert crossing the existing Big R access drive will also be extended on each end to accommodate the new sidewalk improvements at the driveway intersection.

Hydrologic calculations for the site are detailed in the attached spreadsheets (Appendix B), and peak flows are identified on Figure D1 (Appendix E).

### **C. On-Site Drainage Facility Design**

Developed drainage basins and drainage patterns are depicted on the enclosed Developed Drainage Plan (Sheet D1). Private storm inlets and storm sewer pipes will convey developed flows from Lots 2 and 3 to Detention Basin F. As discussed above, the existing double 36” RCP public culverts crossing Spanish Bit Drive on the east side of Struthers Road provide an adequate outfall in accordance with ECM Section 3.2.4.

## **VII. EROSION CONTROL / SEDIMENT CONTROL**

Contractors and Owners will need to implement and maintain proper Best Management Practices (BMP's) and control measures for erosion and sediment control during and after construction. Erosion control measures should include installation of silt fence at the toe of disturbed areas, sediment control logs protecting drainage ditches, vehicle tracking control pads at access points, riprap protection at culvert outlets, and revegetation of disturbed areas. Cut slopes will need to be stabilized during excavation as necessary and vegetation will need to be re-established as soon as possible for stabilization of graded areas.

## **VIII. STORMWATER DETENTION AND WATER QUALITY**

A private stormwater detention pond was constructed at the southwest corner of the site during initial development of this site for the Big R Retail Center. Proposed drainage improvements will include upgrades to the existing private Extended Detention Basin (EDB) to meet current full-spectrum detention design standards. The upgraded detention facility has been designed to provide the required stormwater detention and water quality mitigation for the overall site in accordance with current El Paso County drainage criteria. The required on-site detention volume has been calculated based on the developed impervious area of the site.

As detailed in the detention pond hydraulic calculations in Appendix D, the required 100-year Full-Spectrum Detention Volume has been calculated as 1.0 acre-feet. The proposed upgrades to the existing on-site Extended Detention Basin (EDB) include enlarging the existing pond to the east to provide a storage volume of 1.1 acre-feet, which meets the required full-spectrum detention volume.

Additional detention pond upgrades include a new forebay and trickle channel on the east side of the detention pond and upgrades to the existing outlet structure to provide a new water quality orifice plate and maintain discharges below the allowable release rates.

The upgraded pond outlet structure has been designed using the Mile High Flood District's "MH-Detention" calculation spreadsheets, providing for a 40-hour release of the WQCV, and outlet structure sizing to maintain maximum allowable release rates from the pond. The EDB will have a grass-lined bottom to encourage infiltration of stormwater prior to discharging into the downstream public drainage system.

The previous Final Drainage Report by M&S identified allowable release rates for the detention pond as  $Q_5 = 6.1$  cfs and  $Q_{100} = 16.6$  cfs. As detailed in the detention basin calculations in Appendix D, detained peak flows from the upgraded Detention Basin F are calculated as  $Q_5 = 0.3$  cfs and  $Q_{100} = 11.3$  cfs, well below the previous estimates.

The existing stormwater detention facility will continue to be owned and maintained by the property owners, and maintenance access will be provided from the adjacent Lot 1 parking lot.



### Areas Excluded from Water Quality Facilities

The landscaped area at the southwest corner of the site (Basin F4; 0.11 acres) and the area of roadway improvements along Spanish Bit Drive (Sub-Basin OS6.1; 0.88 acres) are excluded from water quality requirements based on ECM Appendix I.7.1.C.1 (see previous discussion in Paragraph VI.B.2 for details).

## **IX. DRAINAGE COSTS AND DRAINAGE FEES**

The developer will finance all costs for required subdivision improvements, and there are no reimbursable public drainage facilities proposed as part of this minor subdivision plat.

The property is located entirely within the Jackson Creek Drainage Basin (FOMO4400), which has a 2023 drainage basin fee of \$9,135 per impervious acre and a bridge fee of \$0 per impervious acre. Applicable drainage basin fees are calculated as follows:

Minor Subdivision Area =	10.246 acres
New Lot 2-3 Area =	2.9 acres
Calculated Impervious Area (Basins F1-F2 per Appendix D) =	2.36 acres

Drainage Basin Fee = (2.36 ac.) @ \$9,135/ac. = \$21,558.60

Bridge Fee = (2.36 ac.) @ \$0/ac. = \$0

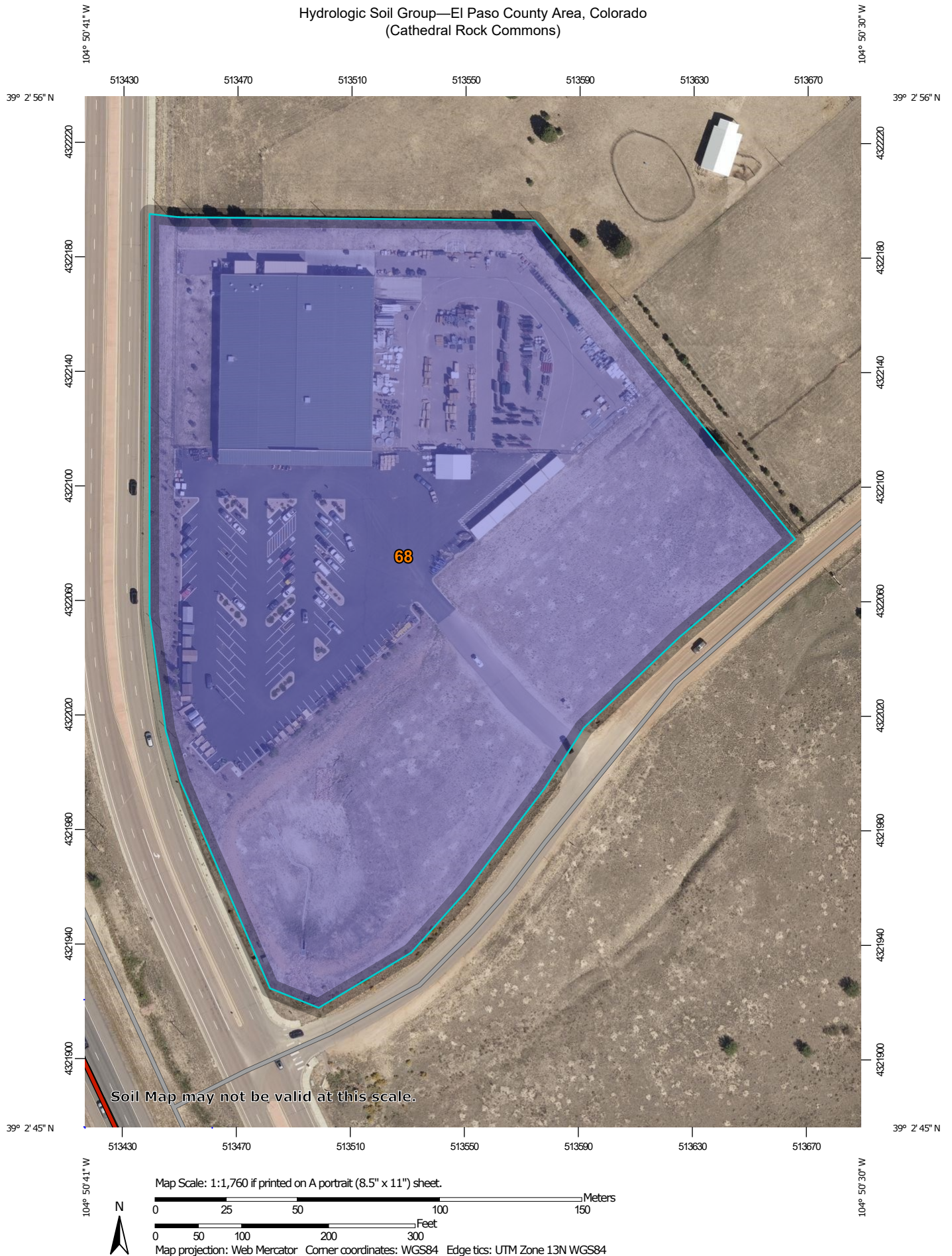
## **X. SUMMARY**

The developed drainage patterns associated with the proposed Cathedral Rock Commons Commercial subdivision at the northeast corner of Struthers Road and Spanish Bit Drive will remain consistent with existing conditions and the overall drainage plan for area. Developed flows from the site will drain through a Private Stormwater Detention Pond at the southwest corner of the property prior to discharging to the existing downstream public drainage system.

The on-site stormwater detention and water quality facilities have been designed to mitigate developed flow impacts and meet the County's stormwater detention and water quality requirements. Construction and proper maintenance of the on-site drainage facilities and Extended Detention Basin, in conjunction with proper erosion control practices, will ensure that this developed site has no significant adverse drainage impact on downstream or surrounding areas.

**APPENDIX A**  
**SOILS INFORMATION**

Hydrologic Soil Group—El Paso County Area, Colorado  
(Cathedral Rock Commons)



MAP LEGEND

**Area of Interest (AOI)**

Area of Interest (AOI)

**Soils**

**Soil Rating Polygons**

A

A/D

B

B/D

C

C/D

D

Not rated or not available

**Soil Rating Lines**

A

A/D

B

B/D

C

C/D

D

Not rated or not available

**Soil Rating Points**

A

A/D

B

B/D

**Water Features**

Streams and Canals

**Transportation**

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

**Background**

Aerial Photography

C

C/D

D

Not rated or not available

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 18, Jun 5, 2020

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

Date(s) aerial images were photographed: Aug 19, 2018—Sep 23, 2018

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

## Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
68	Peyton-Pring complex, 3 to 8 percent slopes	B	10.2	100.0%
<b>Totals for Area of Interest</b>			<b>10.2</b>	<b>100.0%</b>

## Description

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

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

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

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

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

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

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

## Rating Options

*Aggregation Method:* Dominant Condition

*Component Percent Cutoff:* None Specified

*Tie-break Rule:* Higher





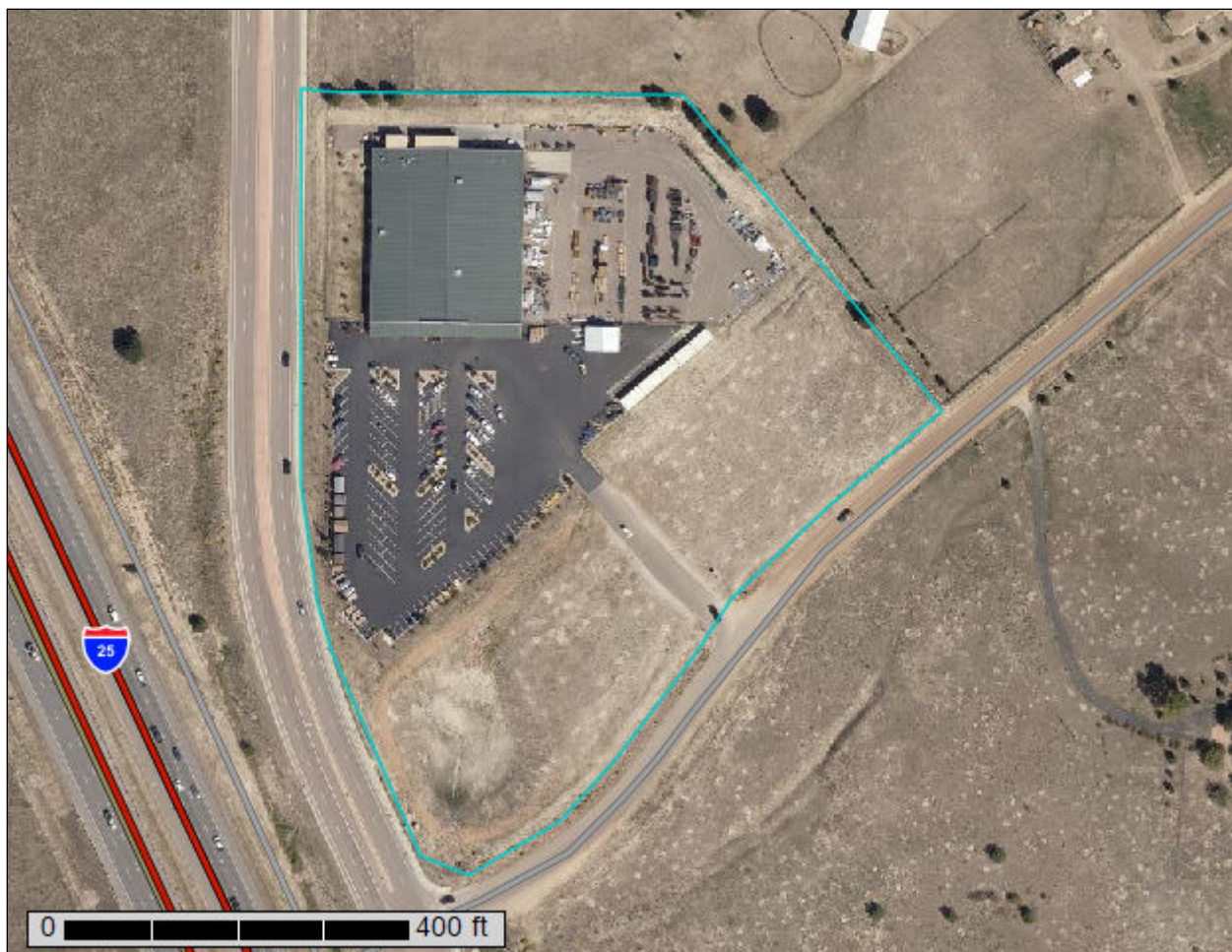
United States  
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Agriculture

NRCS

Natural  
Resources  
Conservation  
Service

A product of the National  
Cooperative Soil Survey,  
a joint effort of the United  
States Department of  
Agriculture and other  
Federal agencies, State  
agencies including the  
Agricultural Experiment  
Stations, and local  
participants

# Custom Soil Resource Report for El Paso County Area, Colorado



July 13, 2021

# Preface

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Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (<http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/>) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (<https://offices.sc.egov.usda.gov/locator/app?agency=nrcs>) or your NRCS State Soil Scientist ([http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2\\_053951](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951)).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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# How Soil Surveys Are Made

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Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

## Custom Soil Resource Report

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

# Soil Map

---

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

# Custom Soil Resource Report Soil Map



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 18, Jun 5, 2020

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

Date(s) aerial images were photographed: Aug 19, 2018—Sep 23, 2018

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
68	Peyton-Pring complex, 3 to 8 percent slopes	10.2	100.0%
<b>Totals for Area of Interest</b>		<b>10.2</b>	<b>100.0%</b>

## Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

## Custom Soil Resource Report

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

## El Paso County Area, Colorado

### 68—Peyton-Pring complex, 3 to 8 percent slopes

#### Map Unit Setting

*National map unit symbol:* 369f

*Elevation:* 6,800 to 7,600 feet

*Farmland classification:* Not prime farmland

#### Map Unit Composition

*Peyton and similar soils:* 40 percent

*Pring and similar soils:* 30 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Peyton

##### Setting

*Landform:* Hills

*Landform position (three-dimensional):* Side slope

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Parent material:* Arkosic alluvium derived from sedimentary rock and/or arkosic residuum weathered from sedimentary rock

##### Typical profile

*A - 0 to 12 inches:* sandy loam

*Bt - 12 to 25 inches:* sandy clay loam

*BC - 25 to 35 inches:* sandy loam

*C - 35 to 60 inches:* sandy loam

##### Properties and qualities

*Slope:* 3 to 5 percent

*Depth to restrictive feature:* More than 80 inches

*Drainage class:* Well drained

*Runoff class:* Low

*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high (0.20 to 0.60 in/hr)

*Depth to water table:* More than 80 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Available water capacity:* Moderate (about 7.3 inches)

##### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 4c

*Hydrologic Soil Group:* B

*Ecological site:* R049XB216CO - Sandy Divide

*Hydric soil rating:* No

#### Description of Pring

##### Setting

*Landform:* Hills

*Landform position (three-dimensional):* Side slope

*Down-slope shape:* Linear

*Across-slope shape:* Linear

## Custom Soil Resource Report

*Parent material:* Arkosic alluvium derived from sedimentary rock

### Typical profile

*A - 0 to 14 inches:* coarse sandy loam

*C - 14 to 60 inches:* gravelly sandy loam

### Properties and qualities

*Slope:* 3 to 8 percent

*Depth to restrictive feature:* More than 80 inches

*Drainage class:* Well drained

*Runoff class:* Low

*Capacity of the most limiting layer to transmit water (Ksat):* High (2.00 to 6.00 in/hr)

*Depth to water table:* More than 80 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Available water capacity:* Low (about 6.0 inches)

### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 3e

*Hydrologic Soil Group:* B

*Ecological site:* R048AY222CO

*Hydric soil rating:* No

### Minor Components

#### Pleasant

*Percent of map unit:*

*Landform:* Depressions

*Hydric soil rating:* Yes

#### Other soils

*Percent of map unit:*

*Hydric soil rating:* No

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**APPENDIX B**

**HYDROLOGIC CALCULATIONS**

**Table 6-6. Runoff Coefficients for Rational Method**  
(Source: UDFCD 2001)

Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.60	0.65	0.62	0.68
Residential													
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.57	0.62	0.59	0.65
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.43	0.52	0.47	0.57
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.41	0.51	0.46	0.56
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.40	0.50	0.44	0.55
Industrial													
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Heavy Areas	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
Undeveloped Areas													
Historic Flow Analysis-- Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59
Streets													
Paved	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Drive and Walks	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Roofs	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

### 3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration ( $t_c$ ) consists of an initial time or overland flow time ( $t_i$ ) plus the travel time ( $t_r$ ) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time ( $t_i$ ) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion ( $t_r$ ) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.



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

Where:

$t_c$  = time of concentration (min)

$t_i$  = overland (initial) flow time (min)

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

### 3.2.1 Overland (Initial) Flow Time

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

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

Where:

$t_i$  = overland (initial) flow time (min)

$C_5$  = runoff coefficient for 5-year frequency (see Table 6-6)

$L$  = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)

$S$  = average basin slope (ft/ft)

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

### 3.2.2 Travel Time

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

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

Where:

$V$  = velocity (ft/s)

$C_v$  = conveyance coefficient (from Table 6-7)

$S_w$  = watercourse slope (ft/ft)

**Table 6-7. Conveyance Coefficient,  $C_v$** 

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

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

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

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

### 3.2.3 First Design Point Time of Concentration in Urban Catchments

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

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

Where:

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

$L$  = waterway length (ft)

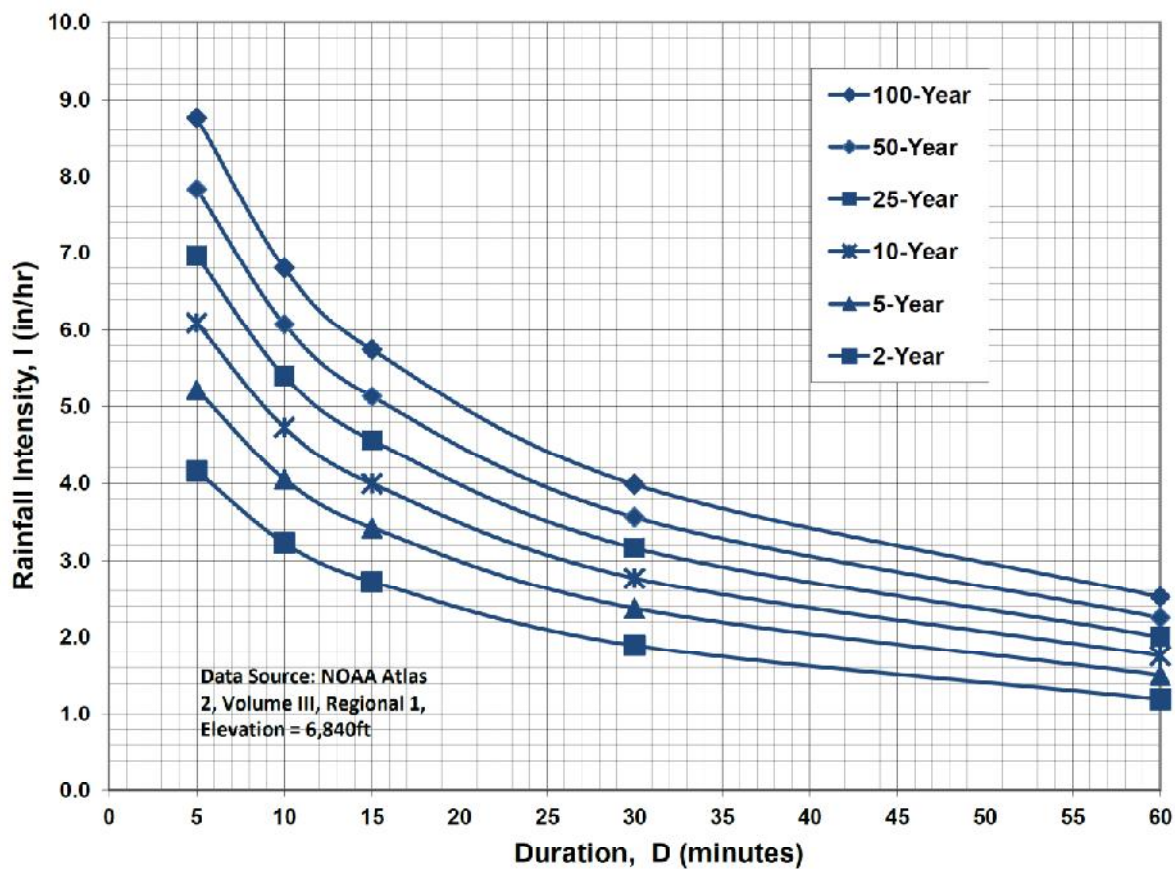
Equation 6-10 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional “calibration” of the Rational Method. Normally, Equation 6-10 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed.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

### 3.2.4 Minimum Time of Concentration

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

### 3.2.5 Post-Development Time of Concentration

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

**Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency****IDF Equations**

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

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

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

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

$$I_5 = -1.50 \ln(D) + 7.583$$

$$I_2 = -1.19 \ln(D) + 6.035$$

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

# BIG R - RETAIL CENTER FINAL DRAINAGE REPORT (Area Drainage Summary)

BASIN			OVERLAND			STREET / CHANNEL FLOW					Time of Travel (T <sub>t</sub> )		INTENSITY *			TOTAL FLOWS		CA <sub>5</sub>	Basin	CA <sub>100</sub>	
AREA TOTAL (acres)	C <sub>s</sub>	C <sub>100</sub>	C <sub>s</sub>	Length (ft)	Height (ft)	T <sub>c</sub> (min)	Length (ft)	Slope (%)	Velocity (fps)	T <sub>t</sub> (min)	TOTAL (min)	I <sub>2</sub> (in/hr)	I <sub>100</sub> (in/hr)	Q <sub>2</sub> (cfs)	Q <sub>100</sub> (cfs)						
																					From NCEM Table 3-1
A	0.47	0.25	0.35	15	0.4	4.5	0	0.0%	0.0	0.0	5.0	5.1	9.1	0.6	1.5			0.12	A	0.16	
B	0.54	0.85	0.95	0	0	0.0	380	1.0%	3.5	1.8	5.0	5.1	9.1	2.3	4.7			0.46	B	0.51	
C	0.80	0.85	0.95								5.0	5.1	9.1	3.5	6.9			0.68	C	0.76	
BUILDING ROOF																					
D	2.25	0.85	0.95	10	1	2.4	500	3.3%	6.4	1.3	5.0	5.1	9.1	9.8	19.4			1.91	D	2.14	
E	2.02	0.85	0.90	25	10	2.4	350	3.5%	6.5	0.9	5.0	5.1	9.1	8.8	16.5			1.72	E	1.82	
F	3.96	0.85	0.90	10	1	2.4	550	3.5%	6.5	1.4	5.0	5.1	9.1	17.2	32.4			3.37	F	3.56	
OS1	3.50	0.29	0.38	460	14	22.5	0	0.0%	0.0	0.0	22.5	2.8	5.0	2.9	6.7			1.02	OS1	1.33	
OS2	2.20	0.90	0.95	0	0	0.0	1620	3.6%	6.6	4.1	5.0	5.1	9.1	10.1	19.0			1.98	OS2	2.09	
OS3	8.80	0.29	0.38	1000	60	26.5	550	3.3%	6.4	1.4	28.0	2.5	4.5	6.4	15.0			2.55	OS3	3.34	
OS4	7.10	0.29	0.38	1000	80	25.3	360	3.4%	6.5	0.9	26.2	2.6	4.6	5.4	12.5			2.06	OS4	2.70	
OS5	22.30	0.29	0.38	1000	90	24.3	820	3.4%	6.5	2.1	26.5	2.6	4.6	16.8	39.2			6.47	OS5	8.47	
OS6	1.18	0.60	0.80	15	3	2.3	1525	4.0%	7.0	3.6	5.9	4.9	8.7	3.5	8.2			0.71	OS6	0.94	

\* Intensity equations assume a minimum travel time of 5 minutes.

Calculated by: VAS

Date: 2/28/2012

Checked by:

# BIG R - RETAIL CENTER FINAL DRAINAGE REPORT (Surface Routing Summary)

Design Point(s)	Contributing Basins/Design Points	Equivalent CA <sub>5</sub>	Equivalent CA <sub>100</sub>	Maximum T <sub>C</sub>	Intensity		Flow		Comments
					I <sub>5</sub>	I <sub>100</sub>	Q <sub>5</sub>	Q <sub>100</sub>	
1	OS1, OS2, OS3 & A	5.66	6.93	28.0	2.5	4.5	14.3	31.1	ex 15' Type R Sump Inlet
2	B	0.46	0.51	5.0	5.1	9.1	2.3	4.7	prop Type C Grated Inlet
3	OS4, OS5	8.53	11.17	26.5	2.6	4.6	22.2	51.7	off-site into roadside ditch
4	D	1.91	2.14	5.0	5.1	9.1	9.8	19.4	prop 8' Sump D-10-R Inlet
5	E & F	5.08	5.38	5.0	5.1	9.1	25.9	48.9	prop detention/WQ pond
6	DP4 & DP5	7.00	7.52	6.8	4.7	8.3	32.8	62.7	total inflow to detention/WQ pond
7	DP3 & OS6	9.23	12.12	26.5	2.6	4.6	24.0	56.0	total inflow to ex depression
8	DP6 (OUTLET) & DP7	(SEE DETENTION/WQ POND CALCULATIONS)					31.2	73.9	prop flow into ex system

Calculated by: VAS

Date: 2/28/2012

Checked by:

CATHEDRAL ROCK COMMONS COMMERCIAL  
COMPOSITE RUNOFF COEFFICIENTS

DEVELOPED CONDITIONS									
5-YEAR C VALUES									
BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	SUB-AREA 3 DEVELOPMENT/ COVER	WEIGHTED C VALUE
D	2.25	2.00	PAVED/IMPERVIOUS	0.9	0.25	LANDSCAPED	0.08		0.809
E	2.02	1.70	PAVED/IMPERVIOUS	0.9	0.32	LANDSCAPED	0.08		0.770
F1	1.93	1.70	PAVED/IMPERVIOUS	0.9	0.23	LANDSCAPED	0.08		0.802
F2	1.07	0.66	PAVED/IMPERVIOUS	0.9	0.41	LANDSCAPED	0.08		0.586
E,F2	3.09								0.706
E,F1,F2	5.02								0.743
F3	0.96	0.96	LANDSCAPED	0.08					0.080
D-F3	8.23								0.684
DP3 (OS4+OS5)	29.4								0.290
OS6	1.18								0.600
DP7 (DP3+OS6)	30.58								0.302
DP8 (DP6+DP7)	38.81								0.383
100-YEAR C VALUES									
BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	SUB-AREA 3 DEVELOPMENT/ COVER	WEIGHTED C VALUE
D	2.25	2.00	PAVED/IMPERVIOUS	0.96	0.25	LANDSCAPED	0.35		0.892
E	2.02	1.70	PAVED/IMPERVIOUS	0.96	0.32	LANDSCAPED	0.35		0.863
F1	1.93	1.70	PAVED/IMPERVIOUS	0.96	0.23	LANDSCAPED	0.35		0.887
F2	1.07	0.66	PAVED/IMPERVIOUS	0.96	0.41	LANDSCAPED	0.35		0.726
E,F2	3.09								0.816
E,F1,F2	5.02								0.843
F3	0.96	0.96	LANDSCAPED	0.35					0.350
D-F3	8.23								0.799
DP3 (OS4+OS5)	29.4								0.380
OS6	1.18								0.800
DP7 (DP3+OS6)	30.58								0.396
DP8 (DP6+DP7)	38.81								0.481

**CATHEDRAL ROCK COMMONS COMMERCIAL  
RATIONAL METHOD**

**DEVELOPED CONDITIONS**

BASIN	DESIGN POINT	AREA (AC)	C		Overland Flow			Channel flow					TOTAL		INTENSITY <sup>(5)</sup>		PEAK FLOW	
			5-YEAR	100-YEAR	LENGTH (FT)	SLOPE (FT/FT)	T <sub>co</sub> <sup>(1)</sup> (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS <sup>(2)</sup> VELOCITY (FT/S)	T <sub>t</sub> <sup>(3)</sup> (MIN)	T <sub>c</sub> <sup>(4)</sup> (MIN)	T <sub>c</sub> <sup>(4)</sup> (MIN)	5-YR (IN/HR)	100-YR (IN/HR)	Q <sub>5</sub> <sup>(6)</sup> (CFS)	Q <sub>100</sub> <sup>(6)</sup> (CFS)
D	4	2.25	0.809	0.892	10	0.100	0.8	500	20	0.033	3.63	2.3	3.1	5.0	5.17	8.68	9.41	17.42
E	E	2.02	0.770	0.863	25	0.400	0.9	350	20	0.035	3.74	1.6	2.4	5.0	5.17	8.68	8.04	15.13
F1	F1	1.93	0.802	0.887	100	0.030	3.8	400	20	0.025	3.16	2.1	5.9	5.9	4.92	8.27	7.62	14.15
F2	F2	1.07	0.586	0.726	100	0.020	7.5	160	20	0.038	3.90	0.7	8.2	8.2	4.44	7.45	2.78	5.78
E,F2	F2A	3.09	0.706	0.816									8.2	8.2	4.44	7.45	9.68	18.78
E,F1,F2	5	5.02	0.743	0.843			0.0	200	20	0.035	3.74	0.9	9.0	9.0	4.28	7.19	15.96	30.41
F3		0.96	0.080	0.350			0.0	210	15	0.052	3.42	1.0	1.0					
D-F3	6	8.23	0.684	0.799									10.1	10.1	4.12	6.92	23.19	45.47
F4	F4	0.11	0.080	0.350	50	0.080	6.6	155	20	0.01	2.00	1.3	7.9	7.9	4.48	7.53	0.04	0.29
OS4-OS5 *	3	29.4	0.290	0.380									26.5	26.5	2.67	4.48	22.74	50.01
OS6 *		1.18	0.600	0.800									5.9	5.9	4.92	8.26	3.48	7.80
OS4-OS6 *	7	30.58	0.302	0.396									26.5	26.5	2.67	4.48	24.63	54.21
OS4-OS6,D-F3 *	8	38.81	0.383	0.481									26.5	26.5	2.67	4.48	39.65	83.57

\* REFER TO "BIG R RETAIL CENTER FINAL DRAINAGE REPORT" BY M&S CIVIL CONSULTANTS, INC. DATED FEB. 2012

**DETAILED CONDITIONS**

BASIN	DESIGN POINT	AREA (AC)	C		Overland Flow			Channel flow					TOTAL		INTENSITY <sup>(5)</sup>		PEAK FLOW	
			5-YEAR	100-YEAR	LENGTH (FT)	SLOPE (FT/FT)	T <sub>co</sub> <sup>(1)</sup> (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS <sup>(2)</sup> VELOCITY (FT/S)	T <sub>t</sub> <sup>(3)</sup> (MIN)	T <sub>c</sub> <sup>(4)</sup> (MIN)	T <sub>c</sub> <sup>(4)</sup> (MIN)	5-YR (IN/HR)	100-YR (IN/HR)	Q <sub>5</sub> <sup>(6)</sup> (CFS)	Q <sub>100</sub> <sup>(6)</sup> (CFS)
POND F OUTFLOW	6d	8.23															0.30	11.30
OS4-OS6,D-F3	8d	38.81															24.93	65.51

1) OVERLAND FLOW T<sub>co</sub> = (0.395<sup>(1)</sup> / (1.1-RUNOFF COEFFICIENT)) \* (OVERLAND FLOW LENGTH<sup>(0.5)</sup> / (SLOPE<sup>(0.333)</sup>))

2) SCS VELOCITY = C \* ((SLOPE(FT/FT))<sup>0.5</sup>)

C = 2.5 FOR HEAVY MEADOW

C = 5 FOR TILLAGE/FIELD

C = 7 FOR SHORT PASTURE AND LAWNS

C = 10 FOR NEARLY BARE GROUND

C = 15 FOR GRASSED WATERWAY

C = 20 FOR PAVED AREAS AND SHALLOW PAVED SWALES

3) MANNING'S CHANNEL TRAVEL TIME = L/V (WHEN CHANNEL VELOCITY IS KNOWN)

4) T<sub>c</sub> = T<sub>co</sub> + T<sub>t</sub>

\*\*\* IF TOTAL TIME OF CONCENTRATION IS LESS THAN 5 MINUTES, THEN 5 MINUTES IS USED

5) INTENSITY BASED ON I-D-F EQUATIONS IN CITY OF COLORADO SPRINGS DRAINAGE CRITERIA MANUAL

$$I_5 = -1.5 * \ln(T_c) + 7.583$$

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

6) Q = C I A

**APPENDIX C**

**HYDRAULIC CALCULATIONS**



CATHEDRAL ROCK COMMONS COMMERCIAL  
STORM INLET SIZING SUMMARY

	BASIN FLOW			INLET FLOW						
INLET	DP	Q5 FLOW (CFS)	Q100 FLOW (CFS)	INLET FLOW % OF BASIN	Q5 FLOW (CFS)	Q100 FLOW (CFS)		INLET CONDITION / TYPE	INLET SIZE (FT)	INLET CAPACITY (CFS)
F1A	F1	7.6	14.2	35	2.7	5.0		SUMP TYPE R	5.0	12.3
F1B	F1	7.6	14.2	65	4.9	9.2		SUMP TYPE R	5.0	12.3
F2A	F2A	9.7	18.8	100	9.7	18.8		SUMP TYPE R	10.0	23.5
DP3	DP3	22.7	50.0	100	22.7	50.0		SUMP TYPE D10R	16.0	49.6

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

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

Project:

Cathedral Rock Commons Commercial - Inlets F1A-F1B

Inlet ID:

Inlets F1A-F1B

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

Maximum Allowable Width for Spread Behind Curb

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

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

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

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

Street Longitudinal Slope - Enter 0 for sump condition

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

Max. Allowable Spread for Minor &amp; Major Storm

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

Check boxes are not applicable in SUMP conditions

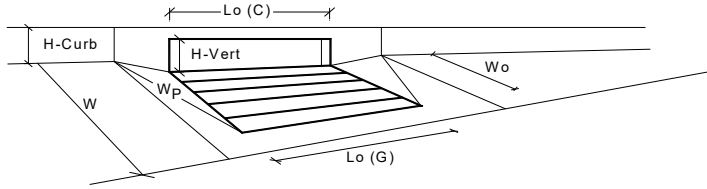
**MINOR STORM** Allowable Capacity is based on Depth Criterion**MAJOR STORM** Allowable Capacity is based on Depth Criterion $T_{BACK} = 4.0$  ft $S_{BACK} = 0.020$  ft/ft $n_{BACK} = 0.020$  $H_{CURB} = 6.00$  inches $T_{CROWN} = 30.0$  ft $W = 2.00$  ft $S_X = 0.010$  ft/ft $S_W = 0.083$  ft/ft $S_O = 0.000$  ft/ft $n_{STREET} = 0.016$ 

	Minor Storm	Major Storm	
$T_{MAX} =$	30.0	30.0	ft
$d_{MAX} =$	6.0	12.0	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

	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)		$a_{local}$ =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	5.4	12.0	inches
<b>Grate Information</b>			MINOR	MAJOR	<input checked="" type="checkbox"/> Override Depths
Length of a Unit Grate		$L_g (G)$ =	N/A	N/A	feet
Width of a Unit Grate		$W_o$ =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		$A_{ratio}$ =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		$C_r (G)$ =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		$C_w (G)$ =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		$C_o (G)$ =	N/A	N/A	
<b>Curb Opening Information</b>			MINOR	MAJOR	
Length of a Unit Curb Opening		$L_c (C)$ =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches		$H_{vert}$ =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		$H_{throat}$ =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		$W_p$ =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		$C_r (C)$ =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		$C_w (C)$ =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		$C_o (C)$ =	0.67	0.67	
<b>Low Head Performance Reduction (Calculated)</b>			MINOR	MAJOR	
Depth for Grate Midwidth		$d_{Grate}$ =	N/A	N/A	ft
Depth for Curb Opening Weir Equation		$d_{Curb}$ =	0.28	0.83	ft
Combination Inlet Performance Reduction Factor for Long Inlets		$RF_{Combination}$ =	0.69	1.00	
Curb Opening Performance Reduction Factor for Long Inlets		$RF_{Curb}$ =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets		$RF_{Grate}$ =	N/A	N/A	
<b>Total Inlet Interception Capacity (assumes clogged condition)</b>			MINOR	MAJOR	
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)		$Q_a$ =	4.1	12.3	cfs
		$Q_{PEAK REQUIRED}$ =	3.4	6.9	cfs

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

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

Project:

Cathedral Rock Commons Commercial - Inlet F2

Inlet ID:

Inlet F2

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

Maximum Allowable Width for Spread Behind Curb

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

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

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

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

Street Longitudinal Slope - Enter 0 for sump condition

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

Max. Allowable Spread for Minor &amp; Major Storm

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

Check boxes are not applicable in SUMP conditions

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

$T_{BACK} = 4.0$  ft  
 $S_{BACK} = 0.020$  ft/ft  
 $n_{BACK} = 0.020$

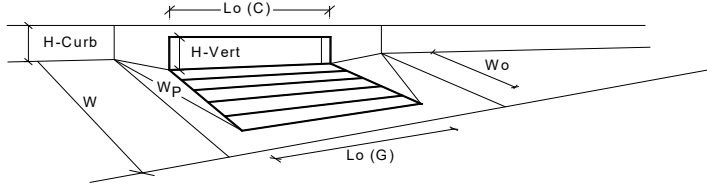
$H_{CURB} = 6.00$  inches  
 $T_{CROWN} = 30.0$  ft  
 $W = 2.00$  ft  
 $S_x = 0.025$  ft/ft  
 $S_w = 0.083$  ft/ft  
 $S_o = 0.000$  ft/ft  
 $n_{STREET} = 0.016$

	Minor Storm	Major Storm	
$T_{MAX} =$	30.0	30.0	ft
$d_{MAX} =$	6.0	12.0	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

	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)		$a_{local}$ =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	6.0	10.4	inches
<b>Grate Information</b>			MINOR	MAJOR	<input type="checkbox"/> Override Depths
Length of a Unit Grate		$L_g (G)$ =	N/A	N/A	feet
Width of a Unit Grate		$W_o$ =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		$A_{ratio}$ =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		$C_r (G)$ =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		$C_w (G)$ =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		$C_o (G)$ =	N/A	N/A	
<b>Curb Opening Information</b>			MINOR	MAJOR	
Length of a Unit Curb Opening		$L_c (C)$ =	10.00	10.00	feet
Height of Vertical Curb Opening in Inches		$H_{vert}$ =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		$H_{throat}$ =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		$W_p$ =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		$C_r (C)$ =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		$C_w (C)$ =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		$C_o (C)$ =	0.67	0.67	
<b>Low Head Performance Reduction (Calculated)</b>			MINOR	MAJOR	
Depth for Grate Midwidth		$d_{grate}$ =	N/A	N/A	ft
Depth for Curb Opening Weir Equation		$d_{curb}$ =	0.33	0.70	ft
Combination Inlet Performance Reduction Factor for Long Inlets		$RF_{combination}$ =	0.57	0.98	
Curb Opening Performance Reduction Factor for Long Inlets		$RF_{curb}$ =	0.93	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets		$RF_{grate}$ =	N/A	N/A	
<b>Total Inlet Interception Capacity (assumes clogged condition)</b>			MINOR	MAJOR	
<b>WARNING: Inlet Capacity less than Q Peak for Minor Storm</b>		$Q_a$ =	8.3	23.5	cfs
		$Q_{PEAK REQUIRED}$ =	9.6	18.3	cfs

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

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

Project:

Cathedral Rock Commons Commercial - Inlet DP3

Inlet ID:

Inlet DP3

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

Maximum Allowable Width for Spread Behind Curb

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

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

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

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

Street Longitudinal Slope - Enter 0 for sump condition

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

Max. Allowable Spread for Minor &amp; Major Storm

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

Check boxes are not applicable in SUMP conditions

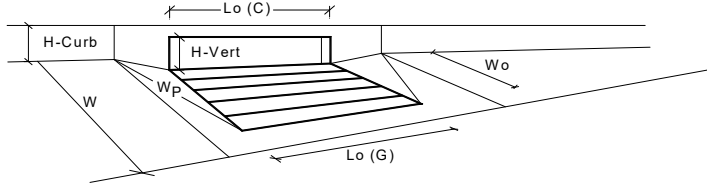
**MINOR STORM** Allowable Capacity is based on Depth Criterion**MAJOR STORM** Allowable Capacity is based on Depth Criterion $T_{BACK} = 10.0$  ft $S_{BACK} = 0.020$  ft/ft $n_{BACK} = 0.020$  $H_{CURB} = 6.00$  inches $T_{CROWN} = 17.0$  ft $W = 2.00$  ft $S_x = 0.020$  ft/ft $S_W = 0.083$  ft/ft $S_0 = 0.000$  ft/ft $n_{STREET} = 0.016$ 

	Minor Storm	Major Storm	
$T_{MAX} =$	17.0	17.0	ft
$d_{MAX} =$	6.0	12.0	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

	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	Colorado Springs D-10-R	Type =	Colorado Springs D-10-R		
Local Depression (additional to continuous gutter depression 'a' from above)		$a_{local}$ =	4.00	4.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	5.6	12.0	inches
<b>Grate Information</b>			MINOR	MAJOR	<input checked="" type="checkbox"/> Override Depths
Length of a Unit Grate		$L_g (G)$ =	N/A	N/A	feet
Width of a Unit Grate		$W_o$ =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		$A_{ratio}$ =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		$C_r (G)$ =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		$C_w (G)$ =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		$C_o (G)$ =	N/A	N/A	
<b>Curb Opening Information</b>			MINOR	MAJOR	
Length of a Unit Curb Opening		$L_o (C)$ =	16.00	16.00	feet
Height of Vertical Curb Opening in Inches		$H_{vert}$ =	8.00	8.00	inches
Height of Curb Orifice Throat in Inches		$H_{throat}$ =	8.00	8.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	81.00	81.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		$W_p$ =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		$C_r (C)$ =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		$C_w (C)$ =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		$C_o (C)$ =	0.67	0.67	
<b>Low Head Performance Reduction (Calculated)</b>			MINOR	MAJOR	
Depth for Grate Midwidth		$d_{Grate}$ =	N/A	N/A	ft
Depth for Curb Opening Weir Equation		$d_{Curb}$ =	0.30	0.83	ft
Combination Inlet Performance Reduction Factor for Long Inlets		$RF_{Combination}$ =	0.53	1.00	
Curb Opening Performance Reduction Factor for Long Inlets		$RF_{Curb}$ =	0.76	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets		$RF_{Grate}$ =	N/A	N/A	
<b>Total Inlet Interception Capacity (assumes clogged condition)</b>			MINOR	MAJOR	
<b>WARNING: Inlet Capacity less than Q Peak for Minor and Major Storms</b>		$Q_a$ =	8.5	49.6	cfs
		$Q_{PEAK REQUIRED}$ =	22.2	51.7	cfs

**CATHEDRAL ROCK COMMONS COMMERCIAL  
STORM SEWER SIZING SUMMARY**

PIPE FLOW				PIPE CAPACITY		
PIPE	DESIGN POINT	Q5 FLOW (CFS)	Q100 FLOW (CFS)	PIPE SIZE	MIN. PIPE SLOPE	PIPE CAPACITY (CFS)
F1A	F1A	2.7	5.0	12	2.0%	5.0
F1B	F1	7.6	14.2	18	1.9%	14.5
F2A	DP5	16.0	30.4	24	2.0%	32.0
DP3	DP3	22.7	50.0	30	1.5%	50.2

**ASSUMPTIONS:**

1. STORM DRAIN PIPE ASSUMED TO BE RCP OR HDPE



# Hydraulic Analysis Report

## Project Data

Project Title: Project - Cathedral Rock Commons Commercial

Designer: JPS

Project Date: Friday, October 1, 2021

Project Units: U.S. Customary Units

Notes:

## Channel Analysis: SD-F1A

Notes:

## Input Parameters

Channel Type: Circular

Pipe Diameter: 1.0000 ft

Longitudinal Slope: 0.0200 ft/ft

Manning's n: 0.0130

Depth: 1.0000 ft

## Result Parameters

Flow: 5.0386 cfs

Area of Flow: 0.7854 ft<sup>2</sup>

Wetted Perimeter: 3.1416 ft

Hydraulic Radius: 0.2500 ft

Average Velocity: 6.4153 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 0.9189 ft

Critical Velocity: 6.6702 ft/s

Critical Slope: 0.0174 ft/ft

Critical Top Width: 0.55 ft

Calculated Max Shear Stress: 1.2480 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 0.3120 lb/ft<sup>2</sup>

## **Channel Analysis: SD-F1B**

Notes:

### **Input Parameters**

Channel Type: Circular

Pipe Diameter: 1.5000 ft

Longitudinal Slope: 0.0190 ft/ft

Manning's n: 0.0130

Depth: 1.5000 ft

### **Result Parameters**

Flow: 14.4792 cfs

Area of Flow: 1.7671 ft<sup>2</sup>

Wetted Perimeter: 4.7124 ft

Hydraulic Radius: 0.3750 ft

Average Velocity: 8.1936 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.3938 ft

Critical Velocity: 8.4583 ft/s

Critical Slope: 0.0164 ft/ft

Critical Top Width: 0.77 ft

Calculated Max Shear Stress: 1.7784 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 0.4446 lb/ft<sup>2</sup>

## Channel Analysis: SD-F2A

Notes:

### Input Parameters

Channel Type: Circular

Pipe Diameter: 2.0000 ft

Longitudinal Slope: 0.0200 ft/ft

Manning's n: 0.0130

Depth: 2.0000 ft

### Result Parameters

Flow: 31.9929 cfs

Area of Flow: 3.1416 ft<sup>2</sup>

Wetted Perimeter: 6.2832 ft

Hydraulic Radius: 0.5000 ft

Average Velocity: 10.1837 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.8896 ft

Critical Velocity: 10.4088 ft/s

Critical Slope: 0.0173 ft/ft

Critical Top Width: 0.91 ft

Calculated Max Shear Stress: 2.4960 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 0.6240 lb/ft<sup>2</sup>

## Channel Analysis: SD-DP3

Notes:

### Input Parameters

Channel Type: Circular

Pipe Diameter: 2.5000 ft

Longitudinal Slope: 0.0150 ft/ft

Manning's n: 0.0130

Depth: 2.5000 ft

### Result Parameters

Flow: 50.2355 cfs

Area of Flow: 4.9087 ft<sup>2</sup>

Wetted Perimeter: 7.8540 ft

Hydraulic Radius: 0.6250 ft

Average Velocity: 10.2339 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 2.3022 ft

Critical Velocity: 10.6255 ft/s

Critical Slope: 0.0130 ft/ft

Critical Top Width: 1.35 ft

Calculated Max Shear Stress: 2.3400 lb/ft<sup>2</sup>

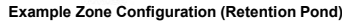
Calculated Avg Shear Stress: 0.5850 lb/ft<sup>2</sup>

## **APPENDIX D**

### **DETENTION POND CALCULATIONS**

[illegible]

*MHFD-Detention, Version 4.04 (February 2021)*

Basin ID: F

Total Detention Basin Volume =  acre-feet

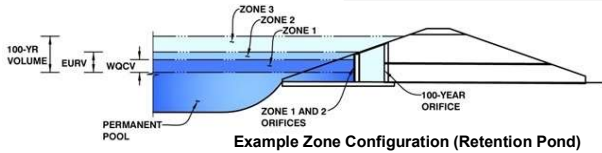
## Optional User Overrides

# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-DETENTION, Version 4.04 (February 2021)

Project: **Cathedral Rock Commons**

Basin ID: **F**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.58	0.200	Orifice Plate
Zone 2 (EURV)	4.48	0.467	Orifice Plate
Zone 3 (100-year)	5.64	0.369	Weir&Pipe (Restrict)
Total (all zones)		1.037	

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 =  ft<sup>2</sup>  
Underdrain Orifice Centroid =  feet

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

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

Calculated Parameters for Plate

WQ Orifice Area per Row =  ft<sup>2</sup>  
Elliptical Half-Width =  feet  
Elliptical Slot Centroid =  feet  
Elliptical Slot Area =  ft<sup>2</sup>

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	1.49	2.99					
Orifice Area (sq. inches)	1.15	1.05	3.00					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

Vertical Orifice Area =  ft<sup>2</sup>  
Vertical Orifice Centroid =  feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir (and No Outlet Pipe)

Overflow Weir Front Edge Height, H<sub>o</sub> =  ft (relative to basin bottom at Stage = 0 ft)  
Overflow Weir Front Edge Length =  feet  
Overflow Weir Grate Slope =  H:V  
Horiz. Length of Weir Sides =  feet  
Overflow Grate Type =   
Debris Clogging % =  %

Calculated Parameters for Overflow Weir

Height of Grate Upper Edge, H<sub>u</sub> =  feet  
Overflow Weir Slope Length =  feet  
Grate Open Area / 100-yr Orifice Area =   
Overflow Grate Open Area w/o Debris =  ft<sup>2</sup>  
Overflow Grate Open Area w/ Debris =  ft<sup>2</sup>

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

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

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

Outlet Orifice Area =  ft<sup>2</sup>  
Outlet Orifice Centroid =  feet  
Half-Central Angle of Restrictor Plate on Pipe =  radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway

Spillway Design Flow Depth =  feet  
Stage at Top of Freeboard =  feet  
Basin Area at Top of Freeboard =  acres  
Basin Volume at Top of Freeboard =  acre-ft

Routed Hydrograph Results

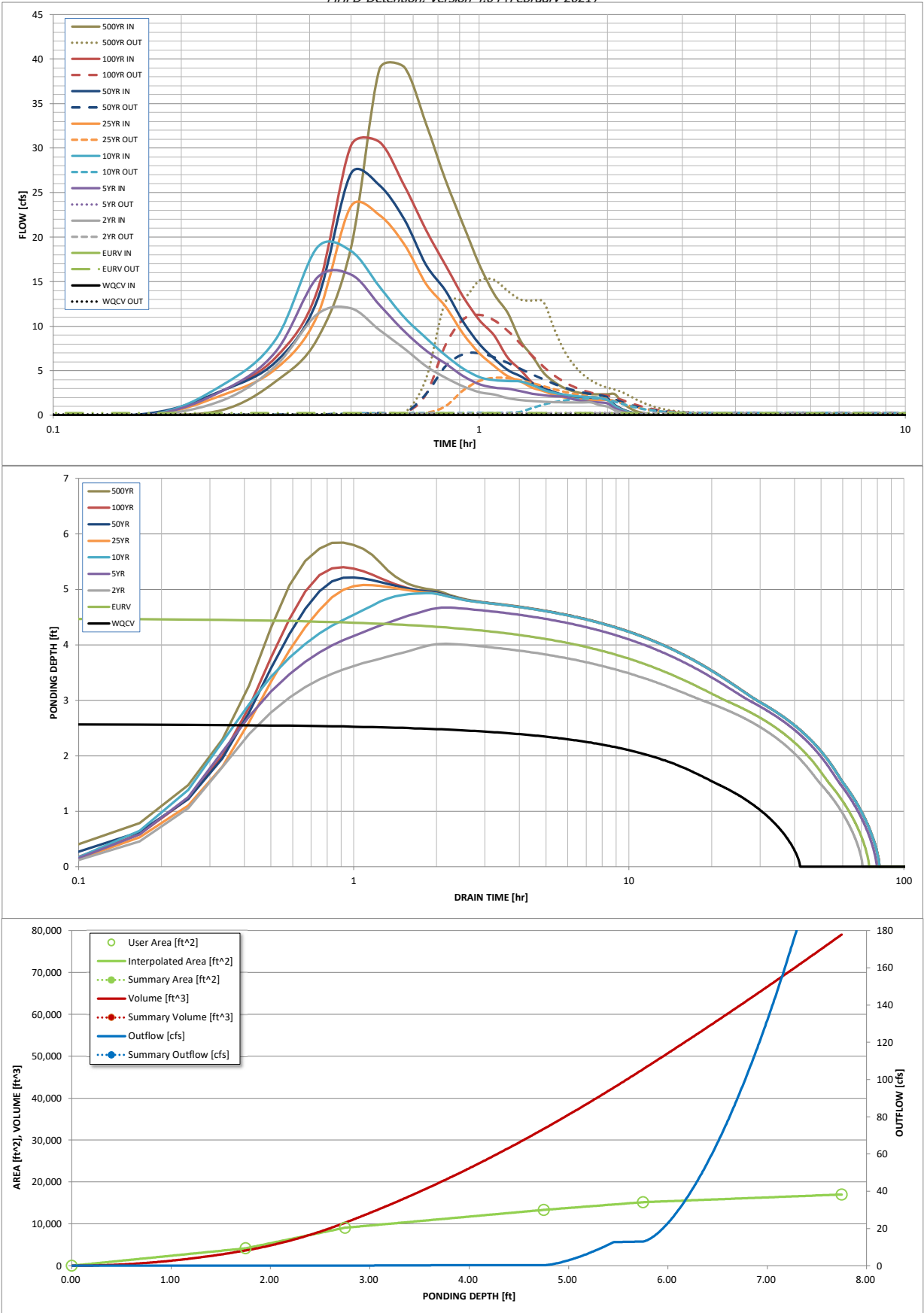
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
One-Hour Rainfall Depth (in) =	0.200	0.668	0.572	0.765	0.927	1.114	1.282	1.480	1.907
CUHP Runoff Volume (acre-ft) =	N/A	N/A	0.572	0.765	0.927	1.114	1.282	1.480	1.907
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.2	3.2	4.7	8.4	10.5	13.1	18.2
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A							
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.14	0.39	0.58	1.02	1.27	1.59	2.22
Peak Inflow Q (cfs) =	N/A	N/A	12.0	15.8	18.8	23.5	27.1	30.7	39.1
Peak Outflow Q (cfs) =	0.1	0.3	0.2	0.3	1.9	4.2	7.0	11.3	15.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.4	0.5	0.7	0.9	0.8
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.2	0.6	1.0	1.6	1.8
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) =	38	66	63	70	70	68	67	65	62
Time to Drain 99% of Inflow Volume (hours) =	40	71	67	75	76	76	75	74	73
Maximum Ponding Depth (ft) =	2.58	4.48	4.02	4.67	4.93	5.08	5.22	5.40	5.84
Area at Maximum Ponding Depth (acres) =	0.19	0.29	0.27	0.30	0.31	0.32	0.33	0.33	0.35
Maximum Volume Stored (acre-ft) =	0.202	0.669	0.537	0.725	0.806	0.850	0.895	0.954	1.108



DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)



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

# DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

## Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.02	0.61
	0:15:00	0.00	0.00	1.69	2.76	3.41	2.29	2.80	2.78	3.83
	0:20:00	0.00	0.00	5.57	7.16	8.56	5.22	6.02	6.52	8.52
	0:25:00	0.00	0.00	11.33	15.43	18.83	11.12	12.87	13.91	18.83
	0:30:00	0.00	0.00	12.00	15.81	18.44	23.46	27.14	30.27	38.84
	0:35:00	0.00	0.00	9.57	12.40	14.44	22.47	25.82	30.69	39.09
	0:40:00	0.00	0.00	7.49	9.44	11.00	19.21	22.00	25.81	32.77
	0:45:00	0.00	0.00	5.53	7.27	8.70	14.76	16.90	20.81	26.43
	0:50:00	0.00	0.00	4.23	5.82	6.74	12.22	14.00	16.87	21.44
	0:55:00	0.00	0.00	3.24	4.41	5.26	9.16	10.51	13.34	16.97
	1:00:00	0.00	0.00	2.60	3.49	4.29	6.98	8.03	10.71	13.64
	1:05:00	0.00	0.00	2.33	3.11	3.95	5.54	6.39	8.98	11.49
	1:10:00	0.00	0.00	1.93	2.98	3.84	4.40	5.08	6.47	8.37
	1:15:00	0.00	0.00	1.72	2.71	3.80	3.78	4.38	5.08	6.63
	1:20:00	0.00	0.00	1.60	2.43	3.40	3.10	3.58	3.66	4.78
	1:25:00	0.00	0.00	1.53	2.25	2.86	2.71	3.13	2.87	3.74
	1:30:00	0.00	0.00	1.48	2.15	2.52	2.27	2.61	2.37	3.07
	1:35:00	0.00	0.00	1.45	2.09	2.31	2.01	2.29	2.06	2.68
	1:40:00	0.00	0.00	1.44	1.79	2.18	1.85	2.10	1.90	2.47
	1:45:00	0.00	0.00	1.44	1.60	2.09	1.77	2.00	1.85	2.39
	1:50:00	0.00	0.00	1.44	1.49	2.05	1.72	1.94	1.83	2.36
	1:55:00	0.00	0.00	1.15	1.44	1.94	1.70	1.92	1.83	2.36
	2:00:00	0.00	0.00	0.98	1.32	1.72	1.69	1.91	1.83	2.36
	2:05:00	0.00	0.00	0.58	0.79	1.03	1.02	1.15	1.10	1.42
	2:10:00	0.00	0.00	0.35	0.47	0.61	0.61	0.69	0.66	0.85
	2:15:00	0.00	0.00	0.19	0.26	0.34	0.35	0.39	0.37	0.48
	2:20:00	0.00	0.00	0.10	0.15	0.19	0.20	0.22	0.21	0.27
	2:25:00	0.00	0.00	0.04	0.07	0.08	0.09	0.10	0.10	0.13
	2:30:00	0.00	0.00	0.01	0.02	0.02	0.03	0.03	0.03	0.04
	2:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

# Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Sheet 1 of 3

Designer: JPS  
 Company: JPS  
 Date: October 14, 2022  
 Project: Cathedral Rock Commons Commercial  
 Location: Detention Basin F

## 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  
( $V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN} / 0.43))$ )
- H) User Input of Water Quality Capture Volume (WQCV) Design Volume  
(Only if a different WQCV Design Volume is desired)
- I) 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)

$I_a = 73.6$  %

$i = 0.736$

Area = 8.230 ac

$d_6 =$  in

Choose One

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

$V_{DESIGN} = 0.200$  ac-ft

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

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

HSG A = 0 %

HSG B = 100 %

HSG C/D = 0 %

$EURV_{DESIGN} = 0.670$  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 = 3.0 : 1

## 3. Basin Side Slopes

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

Z = 3.00 ft / ft

DIFFICULT TO MAINTAIN, INCREASE WHERE POSSIBLE

## 4. Inlet

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

Concrete Forebays

## 5. Forebay

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

- B) Actual Forebay Volume

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

- D) Forebay Discharge

- i) Undetained 100-year Peak Discharge

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

- E) Forebay Discharge Design

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

- G) Rectangular Notch Width

$V_{MIN} = 0.006$  ac-ft

$V_F = 0.006$  ac-ft

$D_F = 18.0$  in

$Q_{100} = 45.47$  cfs

$Q_F = 0.91$  cfs

Choose One

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

Flow too small for berm w/ pipe

Calculated  $D_P =$  in

Calculated  $W_N = 5.4$  in

Existing Forebay D Vol = 0.002 af  
 New Forebay F2 Vol = 0.004 af  
 Total Forebay Vol = 0.006 af

# Design Procedure Form: Extended Detention Basin (EDB)

Sheet 2 of 3

Designer: JPS  
 Company: JPS  
 Date: October 14, 2022  
 Project: Cathedral Rock Commons Commercial  
 Location: Detention Basin F

## 6. Trickle Channel

A) Type of Trickle Channel

F) Slope of Trickle Channel

Choose One  
☒ Concrete  
☐ Soft Bottom

S = 0.0050 ft / ft

## 7. Micropool and Outlet Structure

A) Depth of Micropool (2.5-foot minimum)

B) Surface Area of Micropool (10 ft<sup>2</sup> minimum)

C) Outlet Type

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

E) Total Outlet Area

D<sub>M</sub> = 2.5 ft

A<sub>M</sub> = sq ft

Choose One  
☒ Orifice Plate  
☐ Other (Describe):

D<sub>orifice</sub> = 1.00 inches

A<sub>orifice</sub> = 5.20 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<sub>IS</sub> = 4 in

V<sub>IS</sub> = 26 cu ft

V<sub>s</sub> = cu ft

## 9. Trash Rack

A) Water Quality Screen Open Area: A<sub>t</sub> = A<sub>orifice</sub> \* 38.5\*(e<sup>-0.095D</sup>)

B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open area to the total screen area for the material specified.)

Other (Y/N): N

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

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

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

F) Height of Water Quality Screen (H<sub>TR</sub>)

G) Width of Water Quality Screen Opening (W<sub>opening</sub>) (Minimum of 12 inches is recommended)

A<sub>t</sub> = 182 square inches

S.S. Well Screen with 60% Open Area

User Ratio =

A<sub>total</sub> = 303 sq. in.

H = 4.48 feet

H<sub>TR</sub> = 81.76 inches

W<sub>opening</sub> = 12.0 inches

VALUE LESS THAN RECOMMENDED MIN. WIDTH. WIDTH HAS BEEN SET TO 12 INCHES.

# Design Procedure Form: Extended Detention Basin (EDB)

Sheet 3 of 3

**Designer:** JPS  
**Company:** JPS  
**Date:** October 14, 2022  
**Project:** Cathedral Rock Commons Commercial  
**Location:** Detention Basin F

## 10. Overflow Embankment

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

Riprap Spillway

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

Ze = 4.00 ft / ft

## 11. Vegetation

Choose One

☐ Irrigated

☒ Not Irrigated

## 12. Access

A) Describe Sediment Removal Procedures

Periodic inspection and removal as needed; Access ramp provided to pond bottom

Notes:

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## **APPENDIX E**

### **FIGURES**

# National Flood Hazard Layer FIRMeTte



104°50'54"W 39°3'2"N



0 250 500 1,000 1,500 2,000 Feet 1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

## Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth Zone AE, AO, AH, VE, AR
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
		Future Conditions 1% Annual Chance Flood Hazard Zone X
		Area with Reduced Flood Risk due to Levee. See Notes. Zone X
		Area with Flood Risk due to Levee Zone D
OTHER AREAS		NO SCREEN Area of Minimal Flood Hazard Zone X
		Effective LOMRs
		Area of Undetermined Flood Hazard Zone D
GENERAL STRUCTURES		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
		17.5
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
		Coastal Transect Baseline
MAP PANELS		Digital Data Available
		No Digital Data Available
		Unmapped



The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 9/28/2021 at 12:34 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.



# BIG R DRAINAGE PLAN (ON-SITE)

BASIN SUMMARY			
BASIN	AREA (Acres)	Q <sub>5</sub> (c.f.s.)	Q <sub>100</sub> (c.f.s.)
A	0.47	0.6	1.5
B	0.54	2.3	4.7
C	0.08	3.5	6.9
D	2.25	9.8	19.4
E	2.02	8.8	16.5
F	3.96	17.2	32.4
OS1	3.50	2.9	6.7
OS2	2.20	10.1	19.0
OS3	8.80	6.4	15.0
OS4	7.10	5.4	12.5
OS5	22.30	16.8	39.2
OS6	1.18	3.5	8.2

DESIGN POINT SUMMARY			
DESIGN POINT	Q <sub>5</sub> (c.f.s.)	Q <sub>100</sub> (c.f.s.)	STRUCTURE
1	14.3	31.1	EX 15" TYPE R SUMP INLET
2	2.3	4.7	PROP TYPE C GRATED INLET
3	22.2	51.7	PROP ROADSIDE DITCH
4	9.8	19.4	PROP 8" SUMP TYPE D-10-R INLET
5	25.9	48.9	PROP DETENTION/WQ POND
6	32.8	62.7	TOTAL INFLOW TO POND
7	24.0	56.0	TOTAL INFLOW TO EX 2-36" RCP'S
8	31.2	73.9	PROP FLOW INTO EX SYSTEM

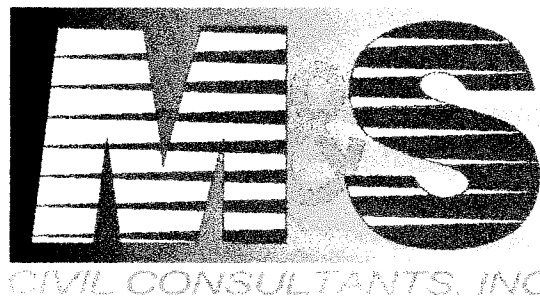
CHANNEL SUMMARY					
NO.	SLOPE (%)	Q <sub>5</sub> (c.f.s.)	Q <sub>100</sub> (c.f.s.)	MAJOR STORM DEPTH	HEIGHT
1	1	6.4	15.0	1.2'	2.0'
2	1	5.4	12.5	1.1'	2.0'
3	2.5	22.2	51.7	1.6'	2.0'
4	2.5	17.2	32.4	1.4'	2.0'
SPD DITCH	4	24.0	56.0	1.4'	2.0'

PIPE RUN SUMMARY				
PIPE RUN	SLOPE (%)	Q <sub>5</sub> (c.f.s.)	Q <sub>100</sub> (c.f.s.)	STRUCTURE
1	1.0	5.8	11.6	24" PIPE
2	2.0	9.8	19.4	24" PIPE

LEGEND	
A	BASIN DESCRIPTION
0.10	BASIN AREA, ACRES
3	DESIGN POINT

DETENTION/WQ FACILITY SUMMARY		
WQCV REQUIRED	0.57	ACRE-FT
WQCV PROVIDED	0.74	ACRE-FT
DETENTION VOLUME REQUIRED	1.08	ACRE-FT
DETENTION VOLUME PROVIDED	1.43	ACRE-FT
Q100 INFLOW	60.8	CFS
Q5 INFLOW	34.1	CFS
Q100 RELEASE ALLOWED	16.6	CFS
Q100 RELEASE PROVIDED	16.6	CFS
Q5 RELEASE ALLOWED	6.3	CFS
Q5 RELEASE PROVIDED	6.1	CFS

RECEIVED  
MAR 06 2012  
EPC DEVELOPMENT SERVICES

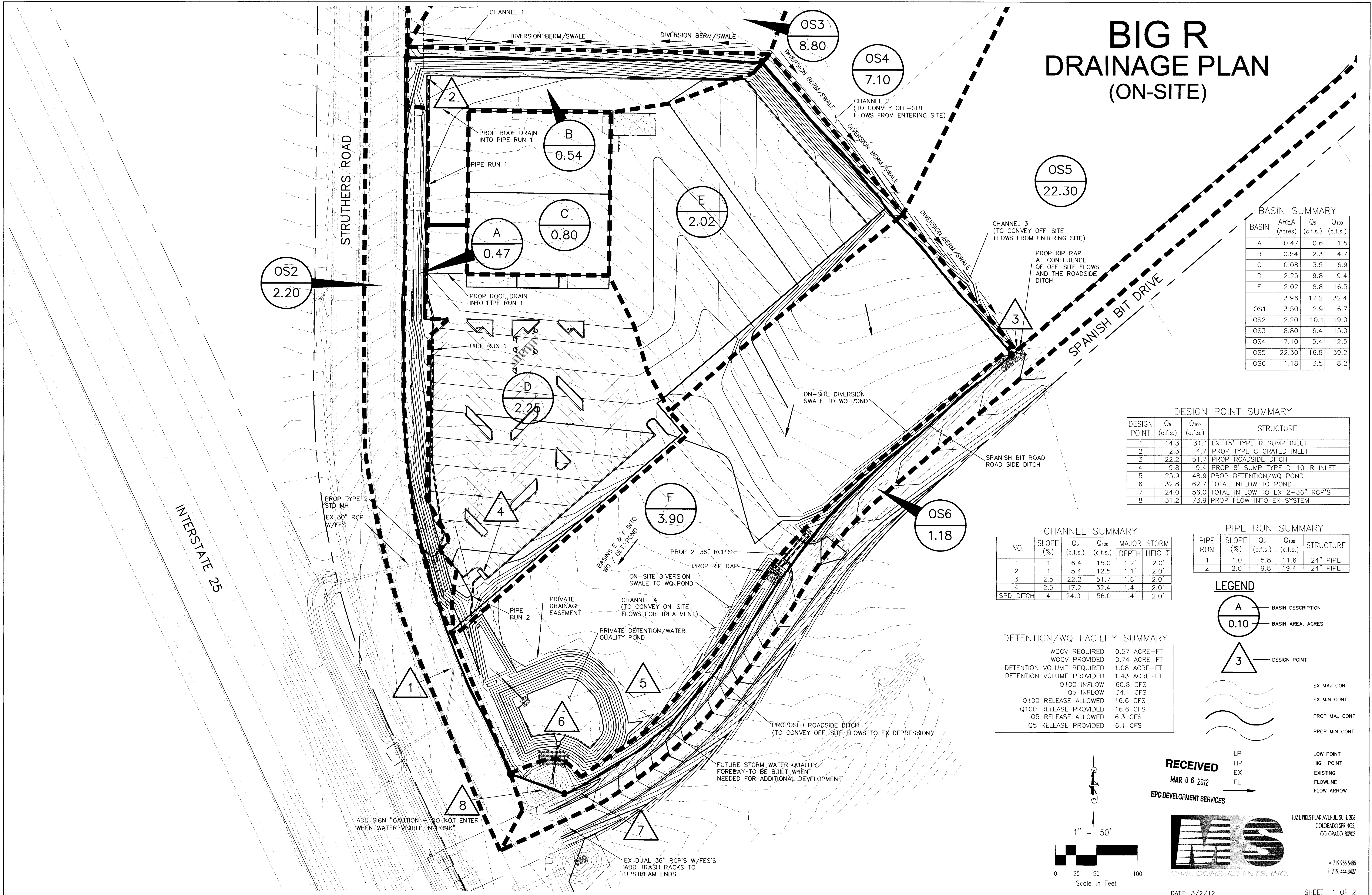


102 E PIKES PEAK AVENUE, SUITE 306  
COLORADO SPRINGS,  
COLORADO 80903

v 719.955.5485  
f 719.444.8427

DATE: 3/2/12

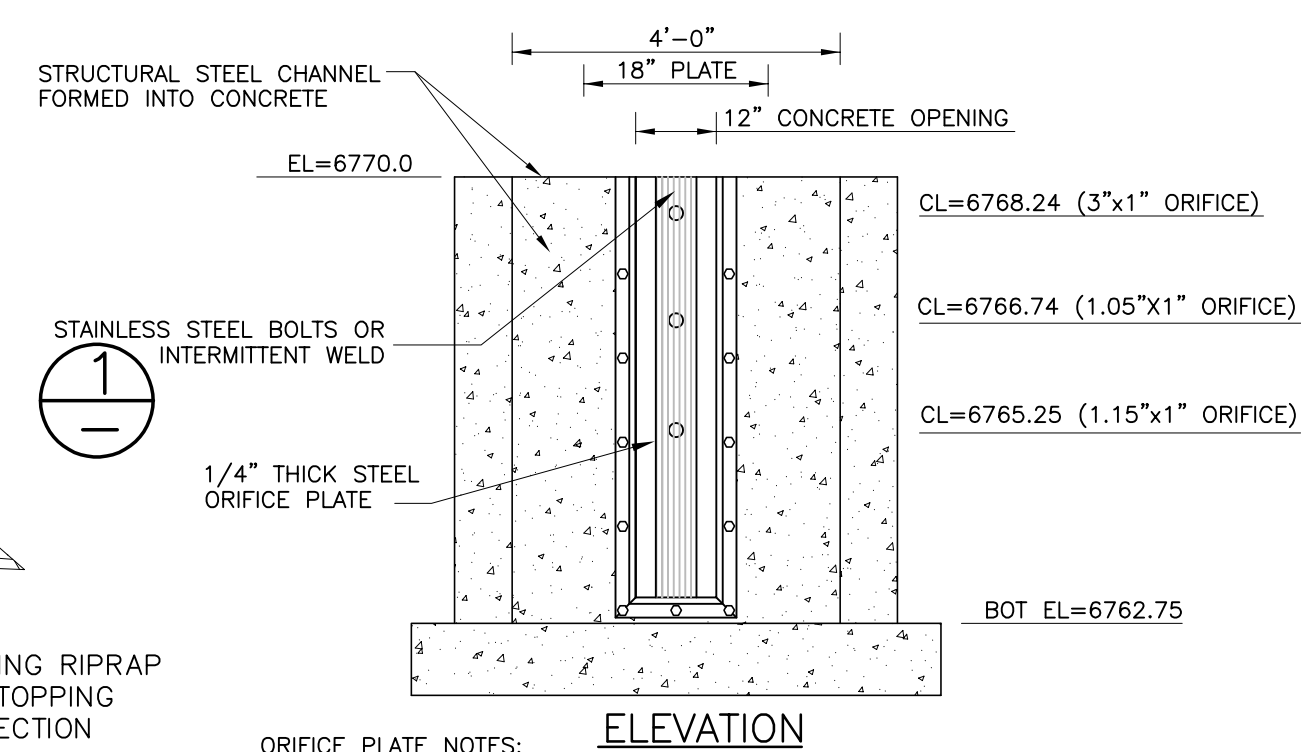
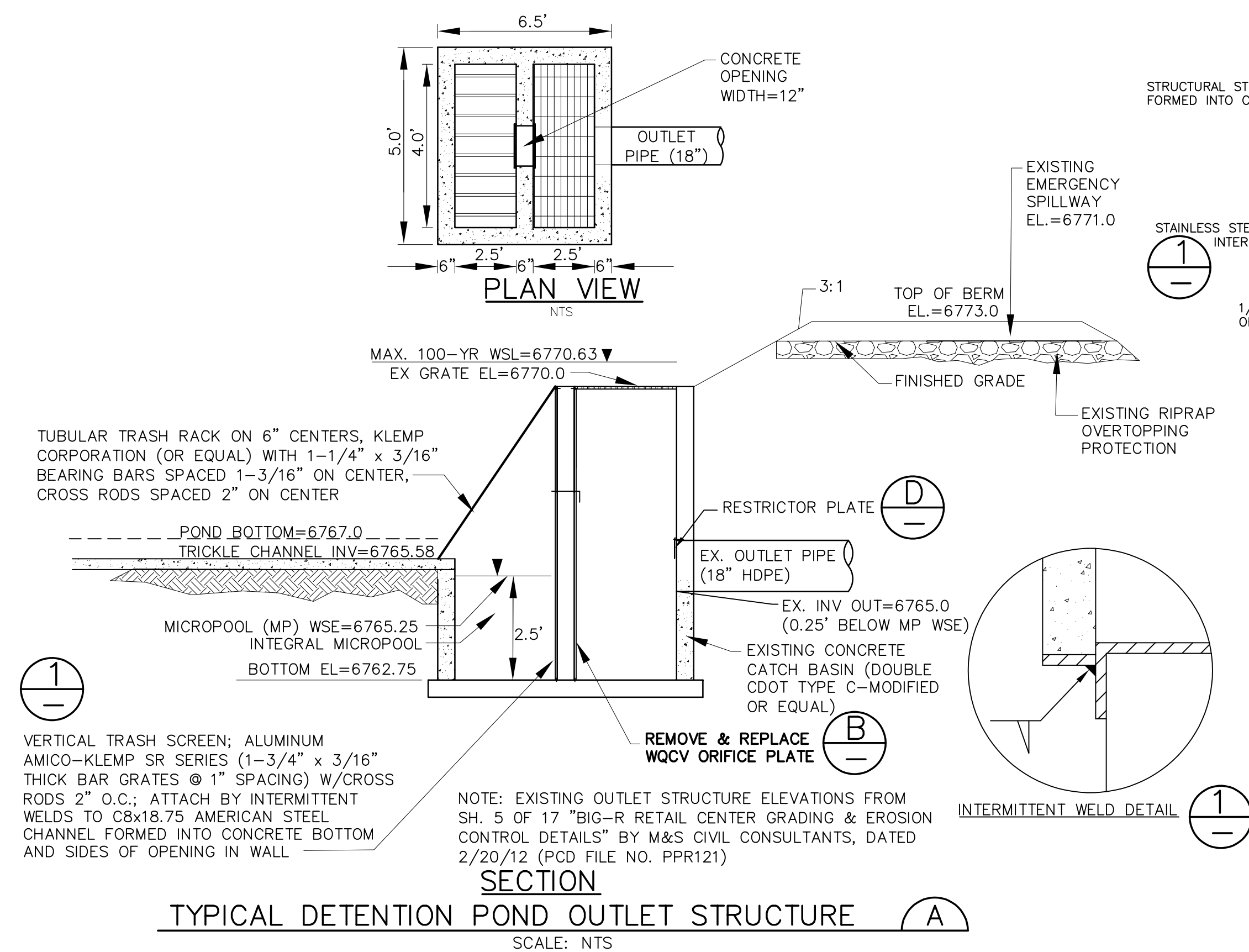
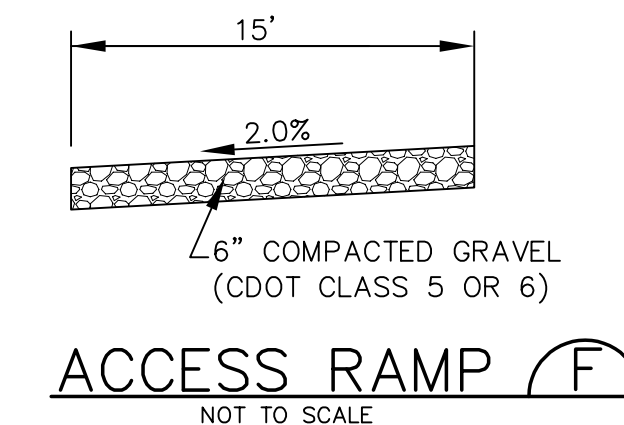
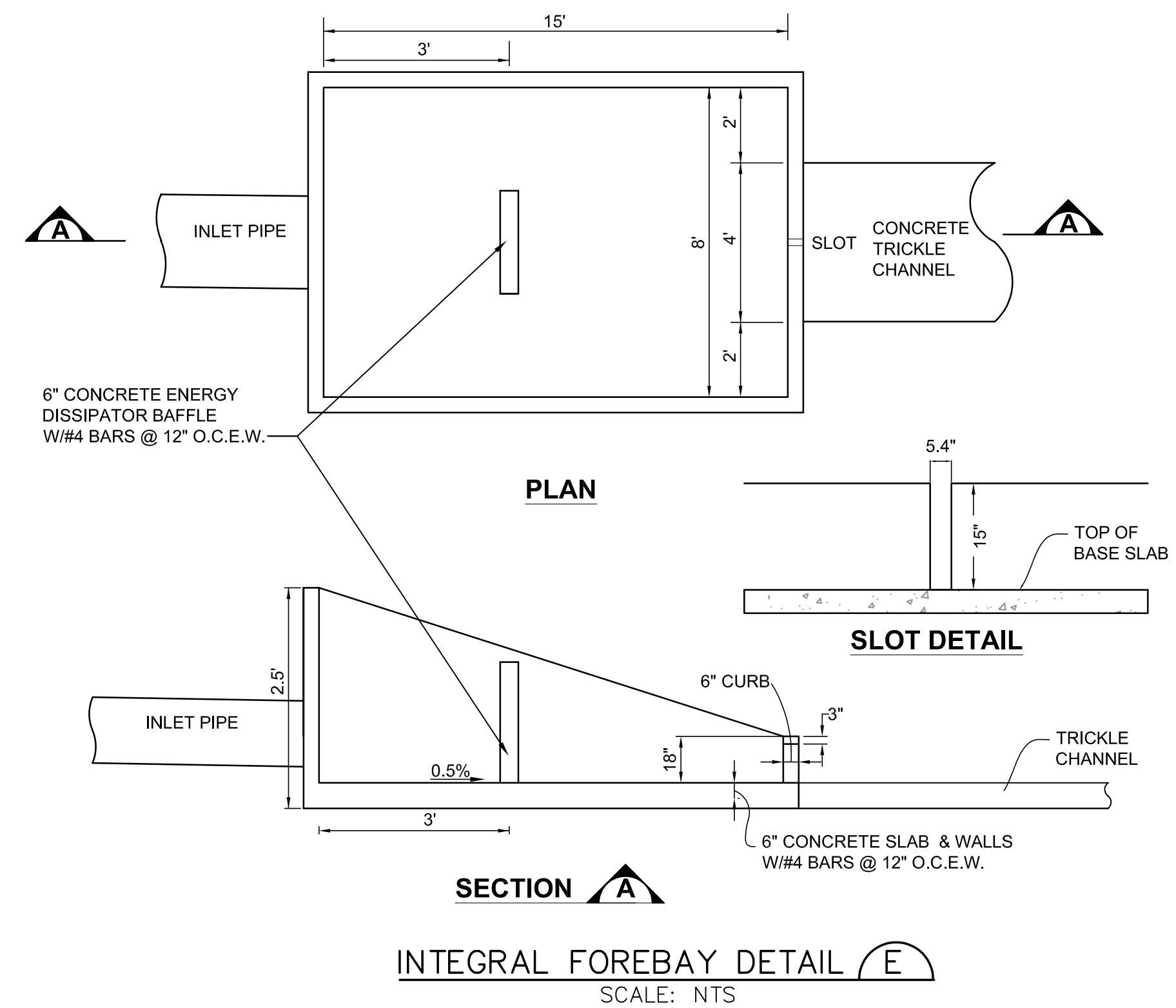
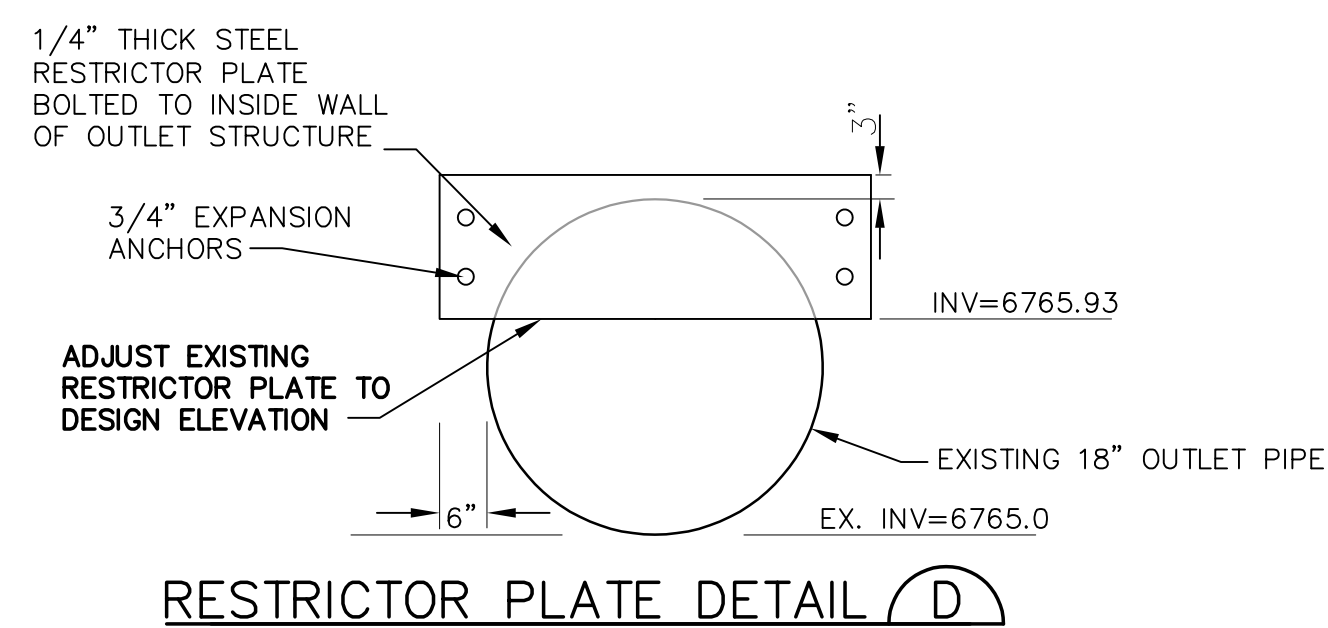
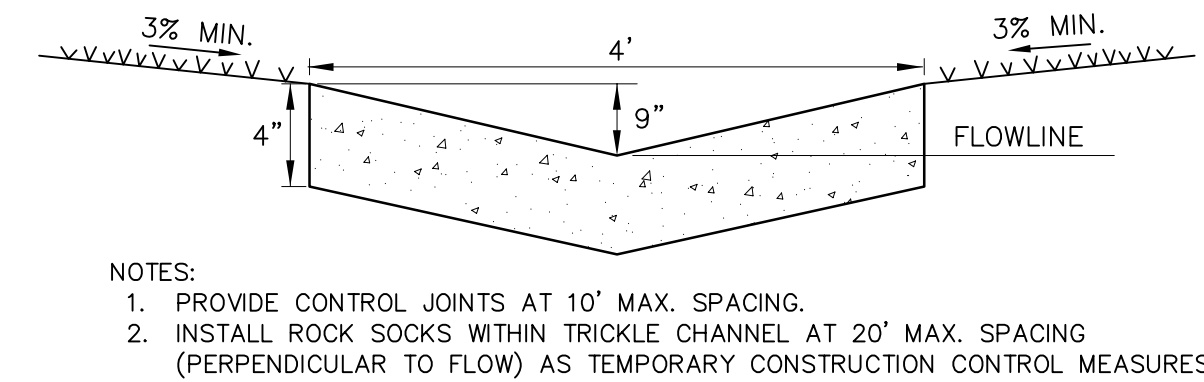
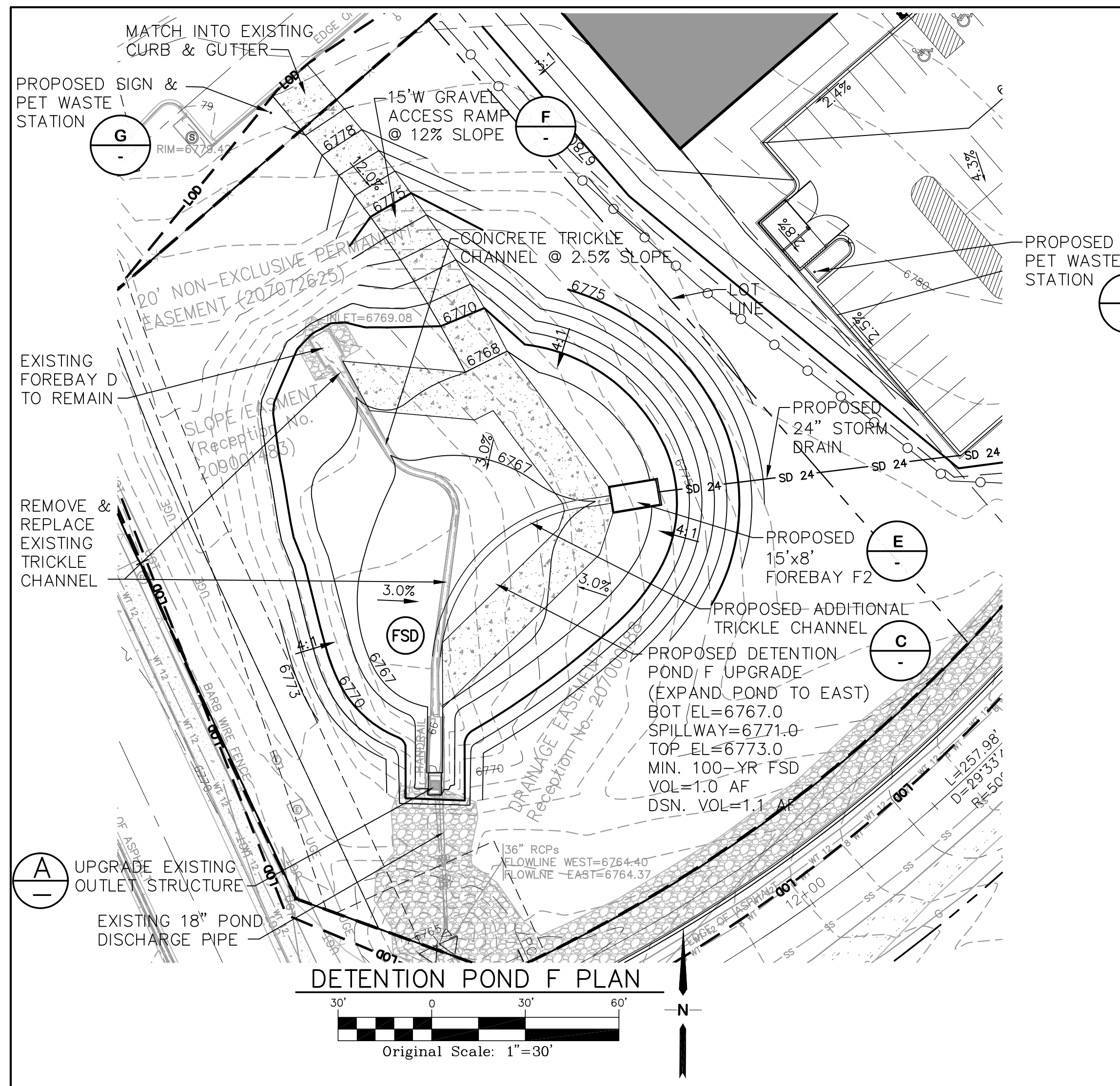
VERSION # 2  
DATE 3/6/12  
SHEET 1 OF 2











**POND SIGNAGE NOTE:**

TWO SIGNS, EACH WITH A MINIMUM AREA OF 3 SQUARE FEET, SHALL BE PROVIDED AROUND THE PERIMETER OF ALL DETENTION FACILITIES. THE SIGNS SHALL BE FABRICATED OF DURABLE MATERIALS, SUCH AS METAL OR PLASTIC, USING RED LETTERING ON A WHITE BACKGROUND WITH THE FOLLOWING MESSAGE:

**WARNING**

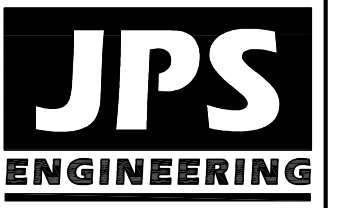
**THIS AREA IS A STORMWATER FACILITY  
AND IS SUBJECT TO PERIODIC FLOODING  
PLEASE CLEAN UP PET WASTE**

NOTE: INSTALL PET WASTE STATIONS AT EACH POND SIGN LOCATION.



# CATHEDRAL ROCK COMMONS COMMERCIAL

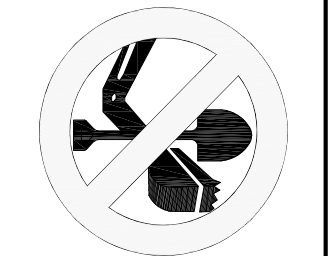
## DETENTION POND F PLAN & DETAILS



19 E. Willamette Ave.  
Colorado Springs, CO  
80903

PH: 719-477-9429  
FAX: 719-471-0766  
[www.jpsengr.com](http://www.jpsengr.com)

PH: 719-477-9429  
FAX: 719-471-0766  
www.jpsengr.com



CALL UTILITY NOTIFICATION  
CENTER OF COLORADO  
1-800-922-1987  
CALL 2-BUSINESS DAYS IN ADVANCE  
BEFORE YOU DIG, GRADE, OR EXCAVATE  
FOR THE MARKING OF UNDERGROUND  
MEMBER UTILITIES.

No.	REVISION	BY	DATE

HORIZ. SCALE: 1" = 30'	DRAWN: BJJ
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: LDC	CHECKED: JPS
CREATED: 7/20/21	LAST MODIFIED: 3/8/23
PROJECT NO: 062102	MODIFIED BY: BJJ

PCD PROJECT NO. SP221/SF2210