



INNOVATIVE DESIGN. **CLASSIC RESULTS.**

**FINAL DRAINAGE REPORT
ADDENDUM NO. 2
BENT GRASS RESIDENTIAL FILING NO. 1
FOR
BENT GRASS EAST COMMERCIAL
FILING NO. 3**

Prepared for:

LAND FIRST INC.

1378 PROMONTORY BLUFF VIEW
COLORADO SPRINGS, CO 80921
Contact: Ron Waldthausen

Prepared by:

CLASSIC CONSULTING

619 N. CASCADE AVE., SUITE 200
COLORADO SPRINGS, CO 80903
(719) 785-0790

PCD File No. SP-20-010

Job no. 2177.64



**FINAL DRAINAGE REPORT ADDENDUM NO. 2 BENT GRASS RESIDENTIAL FILING NO. 1
FOR BENT GRASS EAST COMMERCIAL FILING NO. 3**

DRAINAGE REPORT 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 applicable master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors, or omissions on my part in preparing this report.



Marc A. Whorton, Colorado P.E. #37155

5/10/2021

Date

OWNER'S/DEVELOPER'S STATEMENT:

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

Business Name: Land First Inc.


Title: President

Address: 1378 Promontory Bluff View

Colorado Springs, CO 80921

EL PASO COUNTY:

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

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

Conditions:

APPROVED
Engineering Department


04/21/2022 9:02:25 AM

**EPC Planning & Community
Development Department**

APPROVED
Engineering Department


11/02/2021 11:19:16 AM

**EPC Planning & Community
Development Department**

amended 4/21/22



**FINAL DRAINAGE REPORT ADDENDUM NO. 2 BENT GRASS RESIDENTIAL FILING NO. 1
FOR BENT GRASS EAST COMMERCIAL FILING NO. 3**

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FINAL DRAINAGE REPORT ADDENDUM NO. 2 BENT GRASS RESIDENTIAL FILING NO. 1 FOR BENT GRASS EAST COMMERCIAL FILING NO. 3

PURPOSE

This portion of the Bent Grass East Commercial development was previously platted as Tract B within Bent Grass East Commercial Filing No. 2B. However, it was previously analyzed from a drainage standpoint and included in the Bent Grass Residential Filing No. 1 Final Drainage Report and latest Addendum filed in 2015. The previous drainage basins K, L and M1 encompass the proposed development and re-plat of Tract B. The purpose of this report is to confirm that the existing adjacent pond indeed accounted for this development and to better define the exact routing of the proposed storm sewer into the pond and associated concrete forebay design.

GENERAL DESCRIPTION

Tract B, Bent Grass East Commercial Filing No. 2B contains a total area of 219,877 SF (5.05 AC.), located in the county of El Paso within Section 1, Township 13 South, Range 65 West of the Sixth Principal Meridian, El Paso County, Colorado. The site is bounded on the north by Bent Grass Meadows Dr., on the east by Meridian Park Dr., on the west Bent Grass Residential Filing No. 1 and to the south by the existing detention pond within Tract A of the Bent Grass East Commercial development.

The average soil condition reflects Hydrologic Group "A" (Columbine gravelly sandy loam), as determined by the "Soil Survey of El Paso County Area," prepared by the Soil Conservation Service. (See Appendix) For the purposes of the hydrologic calculations within this report, the soil type A was utilized.

EXISTING/DEVELOPED DRAINAGE CONDITIONS

The entire proposed development area was previously overlot graded along with the adjacent developments. The revegetation consists of native grasses with slopes of 2%-4%. The entire property sheet flows in a southerly direction directly into the existing detention pond 2 just south of the property.



The proposed development plans to construct a private roadway in order to provide vehicular access to the 6 lots. This private road will connect to both Bent Grass Meadows Dr. to the north and Meridian Park Dr. to the east. High points are planned at each of these two connection points with a low point near the middle of the property. (See Developed Drainage Map in Appendix)

Design Point 1 ($Q_5 = 4$ cfs and $Q_{100} = 8$ cfs) represents developed flows from Basin A (lots 2 and 3 and north half of the private road). These flows will be routed towards Design Point 1 where a private 5' Type R Sump Inlet will completely collect both the 5 and 100 yr. developed flows.

Design Point 2 ($Q_5 = 1$ cfs and $Q_{100} = 3$ cfs) represents developed flows from Basin B (portion of lots 4 and 5 and south half of the private road). These flows will be routed towards Design Point 2 where a private 5' Type R Sump Inlet will completely collect both the 5 and 100 yr. developed flows.

Design Point 3 ($Q_5 = 7$ cfs and $Q_{100} = 13$ cfs) represents developed flows from Basin C (lots 4 and 6) and a portion of off-site Basin K (existing residential development to the west). These flows will be routed towards Design Point 3 where a private 24" RCP storm stub will collect both the 5 and 100 yr. developed flows. The individual site plans for each of these lots will show how curb and gutter will collect these developed flows and route them towards the provided 24" RCP private storm stub. These flows remain consistent with Basins L ($Q_5 = 18$ cfs and $Q_{100} = 35$ cfs) and K ($Q_5 = 2$ cfs and $Q_{100} = 4$ cfs) from the previous report. (See Appendix)

Design Point 4 ($Q_5 = 11$ cfs and $Q_{100} = 22$ cfs) represents the total developed flows that will enter the existing pond at this location (Basins A, B, C and a portion of Basin K). A concrete forebay is proposed within the existing pond at this location with the following criteria:
(See Appendix)

Per UD-BMP Spreadsheet – **Concrete Forebay sizing**

0.003 Ac.-ft. or 131 SF min. Forebay with 12" high walls OR **88 SF min. with 18" high walls**

4.5" wide notch at end of forebay

Basin E ($Q_5 = 0.3$ cfs and $Q_{100} = 1.0$ cfs) represents developed flows from Basin E (landscape/setback area within lots 1, 2 and 3) that will continue to sheet flow in a northeasterly direction and directly into Bent Grass Meadows Dr. This minor developed flow was accounted for and remains consistent with the previously approved report. Also, per ECM I.7.1.C.1.a this basin of 0.3 ac. is not practical to be captured and will not drain towards the downstream control measures.

Basin D ($Q_5 = 3$ cfs and $Q_{100} = 6$ cfs) represents developed flows from Basin D (lots 1 and a portion of 5 and a portion of the private road). These flows will continue to sheet flow directly into Meridian Park Dr. They then travel as curb and gutter flows to the existing sump inlet within the cul-de-sac and then directly into the existing pond. These flows were accounted for in the previously approved drainage report and remain consistent with Basin M1 ($Q_5 = 6$ cfs and $Q_{100} = 11$ cfs) from the previous report. (See Appendix)

DRAINAGE CRITERIA

Hydrologic calculations were performed using the City of Colorado Springs/El Paso County Drainage Criteria Manual, as revised in November 1991 and October 1994 with County adopted Chapter 6 and Section 3.2.1 of Chapter 13 of the City of Colorado Springs/El Paso County Drainage Criteria Manual as revised in May 2014 along with the El Paso County Engineering Criteria Manual, updated October 2020. Individual on-site developed basin design used for detention/SWQ basin sizing, inlet sizing and storm system routing was calculated using the Rational Method. Runoff Coefficients are based on the imperviousness of the particular land

use and the hydrologic soil type in accordance with Table 6-6. The average rainfall intensity, by recurrence interval found in the Intensity-Duration-Frequency (IDF) curves in Figure 6-5. (See Appendix)

The City of Colorado Springs/El Paso County DCM requires the Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainage ways, and implementing long-term source controls. The Four Step Process pertains to management of smaller, frequently occurring storm events, as opposed to larger storms for which drainage and flood control infrastructure are sized. Implementation of these four steps helps to achieve storm water permit requirements.

This site adheres to this **Four Step Process** as follows:

1. **Employ Runoff Reduction Practices:** Proposed urban commercial lot impervious areas (roof tops, parking lots, drive aisles, etc.) will to the extent possible, sheet flow across landscaped areas to slow runoff and increase time of concentration prior to being conveyed to the proposed private storm systems and stormwater quality facilities. This will minimize directly connected impervious areas within the project site.
2. **Stabilize Drainageways:** After developed flows utilize the runoff reduction practices through landscaped areas, developed flows will travel via curb and gutter and buried storm sewer systems. These collected flows are then routed directly to the existing stormwater quality facility adjacent to the site (Pond 2) that was originally constructed with Bent Grass Residential Filing No. 1.
3. **Provide Water Quality Capture Volume (WQCV):** Runoff from this development will be treated through capture and slow release of the WQCV in the existing stormwater quality facility (Pond 2).

4. **Consider need for Industrial and Commercial BMPs:** No industrial uses are proposed within this development. However, a site specific storm water quality and erosion control plan and narrative will be submitted along with the grading and erosion control plan. Details such as site specific sediment and erosion control construction BMP's as well as temporary and permanent BMP's will be detailed in this plan and narrative to protect receiving waters. BMP's will be constructed and maintained as the development has been graded and erosion control methods employed.

FLOODPLAIN STATEMENT

No portion of this site is located within a FEMA floodplain as determined by the Flood Insurance Rate Map (F.I.R.M.) Map Number 08041C0553G, with effective date of December, 7 2018. (See Appendix)

DRAINAGE AND BRIDGE FEES

This site lies entirely within the Falcon Drainage Basin boundaries.

The fees are calculated using the following impervious acreage method approved by El Paso County. Bent Grass East Commercial Filing No. 3 has a total area of 5.048 acres with a commercial land use designation.

The percent imperviousness for this subdivision is calculated as follows:

Fees for Commercial Land Use

(Per El Paso County Percent Impervious Chart: 95%)

5.048 Ac. x 95% = 4.796 **Impervious Ac.**

The following calculations are based on the ~~2020~~ ²⁰²¹ Falcon drainage/bridge fees:

APPROVED
Engineering Department

04/21/2022 9:01:22 AM

dsdnijkamp

**EPC Planning & Community
Development Department**



ESTIMATED FEES:

Bridge Fees

$$\begin{array}{rcl} \$ \del{4,232.00} \times 4.796 \text{ Impervious Ac.} & = & \$ \del{20,296.67} \\ 4,380.00 & & \$ 21,006.48 \end{array}$$

Drainage Fees

$$\begin{array}{rcl} \$ \del{30,807.00} \times 4.796 \text{ Impervious Ac.} & = & \$ \del{147,750.37} \\ 31,885.00 & & \$152,920.46 \end{array}$$

Per the ECM 3.10.4.a, this development requests a reduction of drainage fees based on the on-site detention pond 2 that was constructed as a part of the Bent Grass Residential Filing No. 1 development. This facility within the Falcon Drainage Basin seems to meet the following criteria for this reduction:

1. *Allowed only where regional system is not yet in place – no downstream regional facility in place yet*
2. *The pond is less than 15 acre-feet in volume from the lowest outlet structure to the crest of the emergency spillway – The existing pond 2 has a volume of 2.32 ac.-ft.*
3. *The on-site pond is not part of the regional plan (for approval ponds that are part of the regional plan, developers are given 100% credit) – Pond 2 is not a part of the regional plan*
4. *The outlet of the pond must be designed to release at historic levels for all precipitation events from the 2 yr. storm to the 100 yr. storm. A smaller outlet may be required by the County if adequate downstream channel improvement are not in place to protect residents from the 2 yr. storm – Pond 2 was designed as a full spectrum facility*
5. *County approves design and construction – County approved the design and construction of Pond 2 along with the Bent Grass Residential Filing No. 1 development*
6. *Landowners assume responsibility for maintenance – Pond 2 is owned and maintained by the Bent Grass Metro. District*

Per Bent Grass East Commercial Filing No. 2 Final Drainage Report – Dated Aug. 2014

| | | |
|---|---|----------------------|
| Construction of Detention Pond 2 (Full Spectrum on-site Facility) | = | \$75,000 * |
| 50% credit was taken against drainage fees owed (See Appendix) | = | \$37,500 – 26,860.65 |
| Credit remaining within the Falcon Basin | = | \$10,639.35 |

**Developer to provide receipts for previous pond const. and apply for drainage reimbursement in order to receive credit.*

TOTAL DRAINAGE FEES (after reduction):

Drainage Fees

| | | |
|--------------------------------------|---|----------------------------|
| \$ 147,750.37 – 10,639.35 | = | \$ 137,111.02 * |
| \$152,920.46 | | \$142,281.11* |

SUMMARY

The proposed grading plan, drainage patterns and quantities remain consistent with the previously approved final drainage report for Bent Grass Residential Filing No. 1 and associated addendum. The proposed development will not adversely impact surrounding properties.

PREPARED BY:

Classic Consulting Engineers & Surveyors, LLC



Marc A. Whorton, P.E.
Project Manager

mw/217764/Reports/217764FDR Addendum.doc

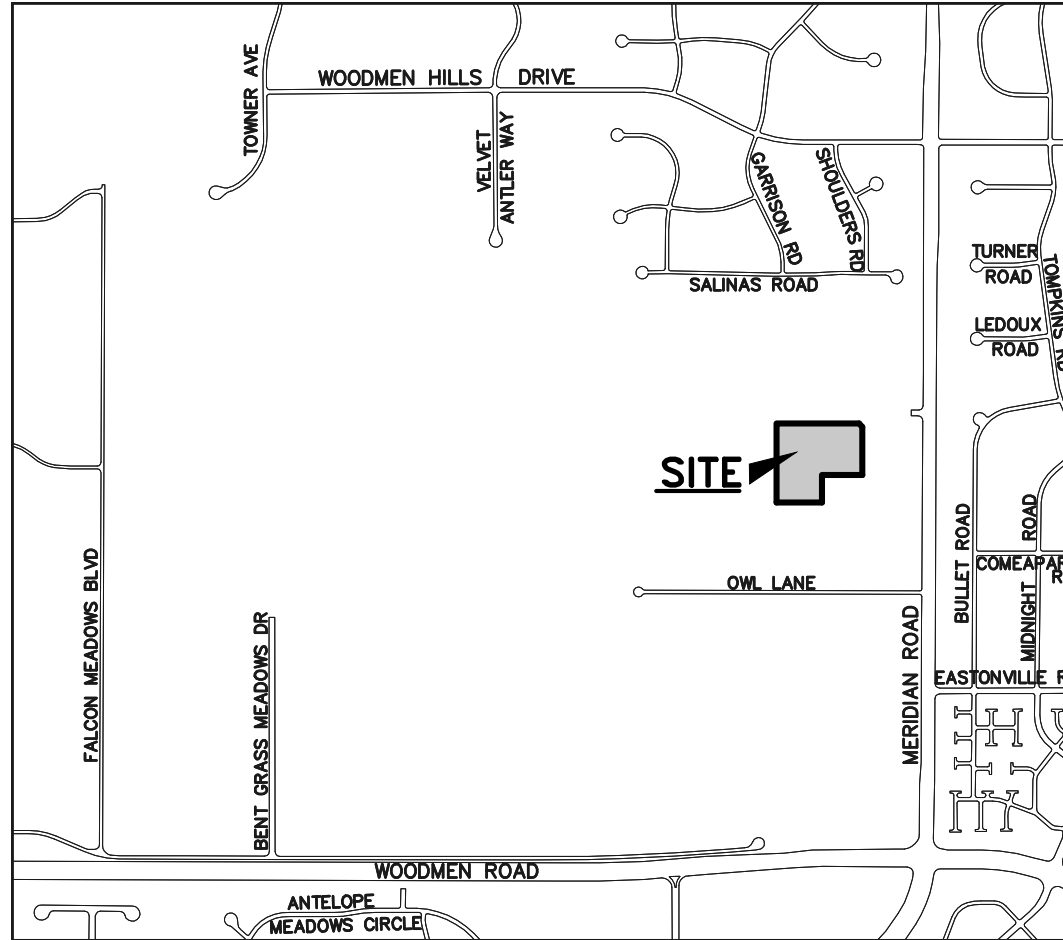


REFERENCES

1. City of Colorado Springs/County of El Paso Drainage Criteria Manual as revised in November 1991 and October 1994 with County adopted Chapter 6 and Section 3.2.1 of Chapter 13 of the City of Colorado Springs/El Paso County Drainage Criteria Manual as revised in May 2014.
2. "Urban Storm Drainage Criteria Manual Volume 1, 2 & 3" Urban Drainage and Flood Control District, dated January 2016.
3. "Falcon Drainage Basin Planning Study - Update," by Matrix Design Group, dated August 2013.
4. "Preliminary Drainage Report for Bent Grass East Commercial – Phase 1 and Final Drainage Report for Bent Grass East Commercial Filing No. 1 – Lot 1", by Classic Consulting, dated May 2013
5. "Final Drainage Report for Bent Grass East Commercial Filing No. 2", by Classic Consulting, dated May 2014.
6. "Final Drainage Report for Bent Grass Residential Filing No. 1", by Classic Consulting, Sept. 2014.
7. "Final Drainage Report Addendum for Bent Grass Residential Filing No. 1", by Classic Consulting, August 2015.

APPENDIX

VICINITY MAP



VICINITY MAP

N.T.S.

SOILS MAP (S.C.S. SURVEY)

Soil Map—El Paso County Area, Colorado



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: Sep 11, 2018—Oct 20, 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 |
|------------------------------------|--|--------------|----------------|
| 19 | Columbine gravelly sandy loam, 0 to 3 percent slopes | 22.5 | 100.0% |
| Totals for Area of Interest | | 22.5 | 100.0% |

El Paso County Area, Colorado

19—Columbine gravelly sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 367p

Elevation: 6,500 to 7,300 feet

Mean annual precipitation: 14 to 16 inches

Mean annual air temperature: 46 to 50 degrees F

Frost-free period: 125 to 145 days

Farmland classification: Not prime farmland

Map Unit Composition

Columbine and similar soils: 97 percent

Minor components: 3 percent

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

Description of Columbine

Setting

Landform: Fans, flood plains, fan terraces

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Alluvium

Typical profile

A - 0 to 14 inches: gravelly sandy loam

C - 14 to 60 inches: very gravelly loamy sand

Properties and qualities

Slope: 0 to 3 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Well drained

Runoff class: Very low

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Available water capacity: Very low (about 2.5 inches)

Interpretive groups

Land capability classification (irrigated): 4e

Land capability classification (nonirrigated): 6e

Hydrologic Soil Group: A

Ecological site: R049XB215CO - Gravelly Foothill

Hydric soil rating: No

Minor Components

Pleasant

Percent of map unit: 1 percent

Landform: Depressions

Hydric soil rating: Yes

Other soils

Percent of map unit: 1 percent

Hydric soil rating: No

Fluvaquentic haplaquolls

Percent of map unit: 1 percent

Landform: Swales

Hydric soil rating: Yes

Data Source Information

Soil Survey Area: El Paso County Area, Colorado

Survey Area Data: Version 18, Jun 5, 2020

F.E.M.A MAP

NOTES TO USERS

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

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

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

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

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

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

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

NGS Information Services
NOAA/NMCS-12
National Geodetic Survey
SSMC-3 #5202
1315 East-West Highway
Silver Spring, MD 20910-3282

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

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

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

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

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

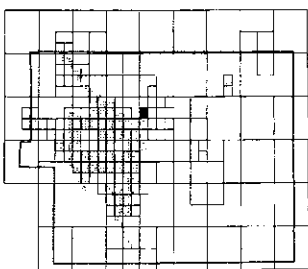
Contact FEMA Map Service Center (MSC) via the FEMA Map Information Exchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The MSC may also be reached by Fax at 1-800-358-9520 and its website at <http://www.msc.fema.gov/>.

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

El Paso County Vertical Datum Offset Table

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

Panel Location Map



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



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

LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

ZONE D Areas in which flood hazards are underlined out of process.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

- Foodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different base flood elevations, flood depths or flood velocities
- Base Flood Elevation line and water elevation in feet (1:12.5)
- Base Flood Elevation value where uniform within zone, elevation in feet

* Referenced to the North American Vertical Datum of 1988 (NAVD88).

- Cross section line
- Traverse line
- Geographic coordinates referenced to the North American Datum of 1983 (NAD83)
- 1000-meter Universal Transverse Mercator grid ticks, zone 13
- 5000-foot grid ticks, Colorado State Plane coordinate system, north zone (FIPS2020 datum)
- Landmark Conformation Projection
- Bench mark (see explanation in Notes to Users section of the FIS report)
- Water line
- MAP REPOSITORIES
- Refer to Map Repository List on Map Index

EFFECTIVE DATE OF REVISIONS TO THIS PANEL:
DECEMBER 7, 2018: To update corporate limits to change Base Flood Elevations and Special Flood Hazard Areas to comply with FEMA's 1% annual chance flood and to incorporate any newly identified areas of Special Flood Hazard.

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

To determine if flood insurance is available in the community, contact your insurance agent or call the National Flood Insurance Program at 1-800-358-9520.

MAP SCALE 1" = 500'



PANEL 0553G

FIRM

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

PANEL 553 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS

COMMUNITY NUMBER PANEL SWATCH

EL PASO COUNTY 30006 1551 6

NOTES TO USER: This map was revised on 05-10-2020 by FEMA and the State of Colorado. This map is intended to be used for insurance purposes only. It is not to be used for any other purpose without the express written consent of FEMA.

MAP NUMBER
08041C0553G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency



CALCULATIONS

JOB NAME: BENT GRASS EAST COMMERCIAL FILING NO. 3
 JOB NUMBER: 2177.64
 DATE: 11/04/20
 CALCULATED BY: MAW

FINAL DRAINAGE REPORT ~ BASIN RUNOFF COEFFICIENT SUMMARY

| BASIN | TOTAL AREA (AC) | IMPERVIOUS AREA / STREETS | | | | LANDSCAPE/UNDEVELOPED AREAS | | | | WEIGHTED | | | WEIGHTED CA | | |
|-------|--------------------|---------------------------|------|------|--------|-----------------------------|------|------|--------|----------|------|--------|-------------|-------|---------|
| | | AREA (AC) | C(2) | C(5) | C(100) | AREA (AC) | C(2) | C(5) | C(100) | C(2) | C(5) | C(100) | CA(2) | CA(5) | CA(100) |
| A | 1.4 | 1.10 | 0.89 | 0.90 | 0.96 | 0.30 | 0.02 | 0.08 | 0.35 | 0.70 | 0.72 | 0.83 | 0.99 | 1.01 | 1.16 |
| B | 0.4 | 0.30 | 0.89 | 0.90 | 0.96 | 0.10 | 0.02 | 0.08 | 0.35 | 0.67 | 0.70 | 0.81 | 0.27 | 0.28 | 0.32 |
| C | 2.0 | 1.60 | 0.89 | 0.90 | 0.96 | 0.40 | 0.02 | 0.08 | 0.35 | 0.72 | 0.74 | 0.84 | 1.43 | 1.47 | 1.68 |
| D | 0.9 | 0.75 | 0.89 | 0.90 | 0.96 | 0.15 | 0.02 | 0.08 | 0.35 | 0.75 | 0.76 | 0.86 | 0.67 | 0.69 | 0.77 |
| E | 0.3 | 0.05 | 0.89 | 0.90 | 0.96 | 0.25 | 0.02 | 0.08 | 0.35 | 0.17 | 0.22 | 0.45 | 0.05 | 0.07 | 0.14 |
| K | 1.0 | 0.35 | 0.89 | 0.90 | 0.96 | 0.65 | 0.02 | 0.08 | 0.35 | 0.32 | 0.37 | 0.56 | 0.32 | 0.37 | 0.56 |
| | | | | | | | | | | | | | | | |

JOB NAME: BENT GRASS EAST COMMERCIAL FILING NO. 3
 JOB NUMBER: 2177.64
 DATE: 11/04/20
 CALC'D BY: MAW

Table 6-7. Conveyance Coefficient, C_v

| Type of Land Surface | C_v |
|---|-------|
| Heavy meadow | 2.5 |
| Tillage/field | 5 |
| Riprap (not buried)* $t_c = \frac{L}{180} + 10$ | 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.

$$t_i = \frac{0.395(1.1 - C_s)\sqrt{L}}{S^{0.33}} \quad V = C_v S_w^{0.5} \quad T_c = L/V$$

FINAL DRAINAGE REPORT ~ BASIN RUNOFF SUMMARY

| BASIN | TOTAL AREA (AC) | WEIGHTED | | | OVERLAND | | | | STREET / CHANNEL FLOW | | | | Tc TOTAL (min) | INTENSITY | | | TOTAL FLOWS | | |
|-------|--------------------|----------|-------|---------|----------|----------------|----------------|-------------|-----------------------|--------------|-------------------|-------------|----------------------|-----------------|-----------------|-------------------|---------------|---------------|-----------------|
| | | CA(2) | CA(5) | CA(100) | C(5) | Length (ft) | Height (ft) | Tc (min) | Length (ft) | Slope (%) | Velocity (fps) | Tc (min) | | I(2) (in/hr) | I(5) (in/hr) | I(100) (in/hr) | Q(2) (cfs) | Q(5) (cfs) | Q(100) (cfs) |
| | | | | | | | | | | | | | | | | | | | |
| A | 1.4 | 0.99 | 1.01 | 1.16 | 0.08 | 30 | 2 | 5.4 | 250 | 2.0% | 1.0 | 4.2 | 9.6 | 3.34 | 4.19 | 7.03 | 3 | 4 | 8 |
| B | 0.4 | 0.27 | 0.28 | 0.32 | 0.08 | 10 | 0.2 | 4.6 | 100 | 1.5% | 0.9 | 1.9 | 6.6 | 3.79 | 4.76 | 7.99 | 1 | 1 | 3 |
| C | 2.0 | 1.43 | 1.47 | 1.68 | 0.08 | 30 | 1.5 | 5.9 | 400 | 2.0% | 1.0 | 6.7 | 12.7 | 3.01 | 3.77 | 6.34 | 4 | 6 | 11 |
| D | 0.9 | 0.67 | 0.69 | 0.77 | 0.08 | 10 | 0.2 | 4.6 | 200 | 2.0% | 1.4 | 2.4 | 7.0 | 3.72 | 4.67 | 7.83 | 2 | 3 | 6 |
| E | 0.3 | 0.05 | 0.07 | 0.14 | 0.08 | 25 | 0.5 | 7.3 | | | | | 7.3 | 3.67 | 4.60 | 7.72 | 0.2 | 0.3 | 1.0 |
| K | 1.0 | 0.32 | 0.37 | 0.56 | 0.08 | 65 | 3 | 9.0 | | | | | 9.0 | 3.43 | 4.29 | 7.21 | 1 | 2 | 4 |
| | | | | | | | | | | | | | | | | | | | |

JOB NAME: BENT GRASS EAST COMMERCIAL FILING NO. 3
 JOB NUMBER: 2177.64
 DATE: 11/04/20
 CALCULATED BY: MAW

FINAL DRAINAGE REPORT ~ SURFACE ROUTING SUMMARY

| Design Point(s) | Contributing Basins | Equivalent CA(5) | Equivalent CA(100) | Maximum Tc | Intensity | | Flow | | Outfall / Inlet Size |
|-----------------|---------------------|------------------|--------------------|------------|-----------|--------|------|--------|----------------------|
| | | | | | I(5) | I(100) | Q(5) | Q(100) | |
| 1 | A | 1.01 | 1.16 | 9.6 | 4.19 | 7.03 | 4 | 8 | 5' Type R Sump Inlet |
| 2 | B | 0.28 | 0.32 | 6.6 | 4.76 | 7.99 | 1 | 3 | 5' Type R Sump Inlet |
| 3 | C, 70% K | 1.73 | 2.07 | 12.7 | 3.77 | 6.34 | 7 | 13 | 24" RCP Stub |
| 4 | A, B, C, 70% K | 3.02 | 3.55 | 12.8 | 3.76 | 6.32 | 11 | 22 | Concrete Forebay |

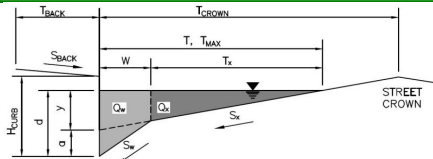
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

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

Project:

BENT GRASS EAST COMMERCIAL FILING NO. 3

Inlet ID:

DP1**Gutter Geometry (Enter data in the blue cells)**

Maximum Allowable Width for Spread Behind Curb

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

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

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

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

Street Longitudinal Slope - Enter 0 for sump condition

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

Max. Allowable Spread for Minor & Major Storm

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

Check boxes are not applicable in SUMP conditions

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

$T_{BACK} = 7.0$ ft
 $S_{BACK} = 0.020$ ft/ft
 $n_{BACK} = 0.020$

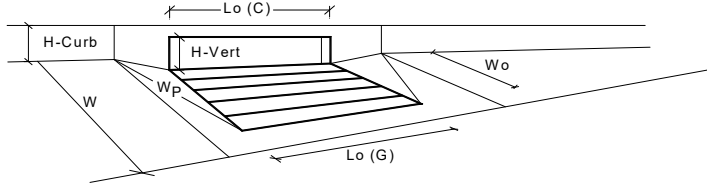
$H_{CURB} = 6.00$ inches
 $T_{CROWN} = 14.0$ ft
 $W = 2.00$ ft
 $S_x = 0.020$ ft/ft
 $S_w = 0.083$ ft/ft
 $S_o = 0.000$ ft/ft
 $n_{STREET} = 0.016$

| | Minor Storm | Major Storm | |
|-------------|--------------------------|--------------------------|--------|
| $T_{MAX} =$ | 14.0 | 14.0 | 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 | 12.0 | inches |
| Grate Information | | | 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 | |
| Curb Opening Information | | | 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 | |
| Low Head Performance Reduction (Calculated) | | | MINOR | MAJOR | |
| Depth for Grate Midwidth | | d_{Grate} = | N/A | N/A | ft |
| Depth for Curb Opening Weir Equation | | d_{Curb} = | 0.33 | 0.83 | ft |
| Combination Inlet Performance Reduction Factor for Long Inlets | | $RF_{Combination}$ = | 0.77 | 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 | |
| Total Inlet Interception Capacity (assumes clogged condition) | | | MINOR | MAJOR | |
| Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK) | | Q_a = | 5.4 | 12.3 | cfs |
| | | $Q_{PEAK REQUIRED}$ = | 4.0 | 8.0 | cfs |

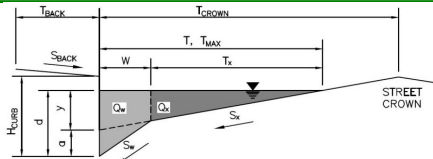
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

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

Project:

BENT GRASS EAST COMMERCIAL FILING NO. 3

Inlet ID:

DP2**Gutter Geometry (Enter data in the blue cells)**

Maximum Allowable Width for Spread Behind Curb

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

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

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

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

Street Longitudinal Slope - Enter 0 for sump condition

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

Max. Allowable Spread for Minor & Major Storm

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

Check boxes are not applicable in SUMP conditions

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

$T_{BACK} = 7.0$ ft
 $S_{BACK} = 0.020$ ft/ft
 $n_{BACK} = 0.020$

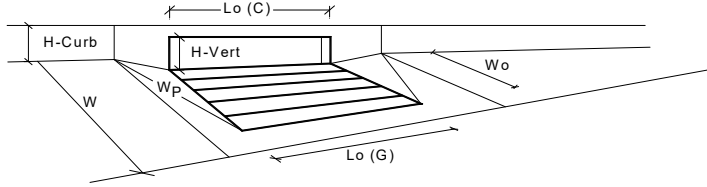
$H_{CURB} = 6.00$ inches
 $T_{CROWN} = 14.0$ ft
 $W = 2.00$ ft
 $S_X = 0.020$ ft/ft
 $S_W = 0.083$ ft/ft
 $S_D = 0.000$ ft/ft
 $n_{STREET} = 0.016$

| | Minor Storm | Major Storm | |
|-------------|--------------------------|--------------------------|--------|
| $T_{MAX} =$ | 14.0 | 14.0 | 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



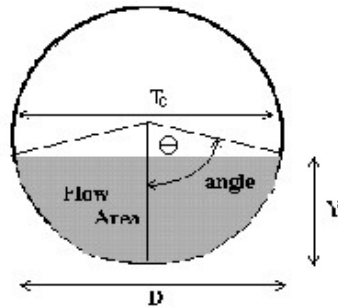
| Design Information (Input) | | MINOR | | MAJOR | |
|--|--------------------------|-----------------------|--------------------------|-------|---|
| Type of Inlet | CDOT Type R Curb Opening | Type = | CDOT Type R Curb Opening | | |
| Local Depression (additional to continuous gutter depression 'a' from 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 | 12.0 | inches |
| Grate Information | | | 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 | |
| Curb Opening Information | | | 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 | |
| Low Head Performance Reduction (Calculated) | | | MINOR | MAJOR | |
| Depth for Grate Midwidth | | d_{Grate} = | N/A | N/A | ft |
| Depth for Curb Opening Weir Equation | | d_{Curb} = | 0.33 | 0.83 | ft |
| Combination Inlet Performance Reduction Factor for Long Inlets | | $RF_{Combination}$ = | 0.77 | 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 | |
| Total Inlet Interception Capacity (assumes clogged condition) | | | MINOR | MAJOR | |
| Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK) | | Q_a = | 5.4 | 12.3 | cfs |
| | | $Q_{PEAK REQUIRED}$ = | 1.0 | 3.0 | cfs |

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: **BENT GRASS EAST COMMERCIAL FILING NO. 3**

Pipe ID: **24" RCP (DP-1)**



Design Information (Input)

| | | | |
|------------------------|---------|--------|--------|
| Pipe Invert Slope | $S_o =$ | 0.0100 | ft/ft |
| Pipe Manning's n-value | $n =$ | 0.0130 | |
| Pipe Diameter | $D =$ | 24.00 | inches |
| Design discharge | $Q =$ | 8.00 | cfs |

Full-Flow Capacity (Calculated)

| | | | |
|----------------------------|------------|-------|---------|
| Full-flow area | $A_f =$ | 3.14 | sq ft |
| Full-flow wetted perimeter | $P_f =$ | 6.28 | ft |
| Half Central Angle | $\theta =$ | 3.14 | radians |
| Full-flow capacity | $Q_f =$ | 22.68 | cfs |

Calculation of Normal Flow Condition

| | | | |
|--|-----------------|-------|---------------|
| Half Central Angle ($0 < \theta < 3.14$) | $\theta =$ | 1.39 | radians |
| Flow area | $A_n =$ | 1.21 | sq ft |
| Top width | $T_n =$ | 1.97 | ft |
| Wetted perimeter | $P_n =$ | 2.78 | ft |
| Flow depth | $Y_n =$ | 0.82 | ft |
| Flow velocity | $V_n =$ | 6.59 | fps |
| Discharge | $Q_n =$ | 8.00 | cfs |
| Percent of Full Flow | $\text{Flow} =$ | 35.3% | of full flow |
| Normal Depth Froude Number | $Fr_n =$ | 1.48 | supercritical |

Calculation of Critical Flow Condition

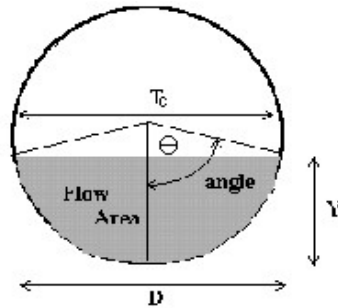
| | | | |
|--|--------------|------|---------|
| Half Central Angle ($0 < \theta_c < 3.14$) | $\theta_c =$ | 1.58 | radians |
| Critical flow area | $A_c =$ | 1.58 | sq ft |
| Critical top width | $T_c =$ | 2.00 | ft |
| Critical flow depth | $Y_c =$ | 1.01 | ft |
| Critical flow velocity | $V_c =$ | 5.05 | fps |
| Critical Depth Froude Number | $Fr_c =$ | 1.00 | |

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: **BENT GRASS EAST COMMERCIAL FILING NO. 3**

Pipe ID: **24" RCP (DP-1 & DP-2)**



Design Information (Input)

| | | | |
|------------------------|---------|--------|--------|
| Pipe Invert Slope | $S_o =$ | 0.0100 | ft/ft |
| Pipe Manning's n-value | $n =$ | 0.0130 | |
| Pipe Diameter | $D =$ | 24.00 | inches |
| Design discharge | $Q =$ | 10.00 | cfs |

Full-Flow Capacity (Calculated)

| | | | |
|----------------------------|------------------|-------|---------|
| Full-flow area | $A_f =$ | 3.14 | sq ft |
| Full-flow wetted perimeter | $P_f =$ | 6.28 | ft |
| Half Central Angle | $\text{Theta} =$ | 3.14 | radians |
| Full-flow capacity | $Q_f =$ | 22.68 | cfs |

Calculation of Normal Flow Condition

| | | | |
|--|------------------|-------|---------------|
| Half Central Angle ($0 < \text{Theta} < 3.14$) | $\text{Theta} =$ | 1.50 | radians |
| Flow area | $A_n =$ | 1.43 | sq ft |
| Top width | $T_n =$ | 2.00 | ft |
| Wetted perimeter | $P_n =$ | 3.00 | ft |
| Flow depth | $Y_n =$ | 0.93 | ft |
| Flow velocity | $V_n =$ | 6.99 | fps |
| Discharge | $Q_n =$ | 10.00 | cfs |
| Percent of Full Flow | $\text{Flow} =$ | 44.1% | of full flow |
| Normal Depth Froude Number | $Fr_n =$ | 1.46 | supercritical |

Calculation of Critical Flow Condition

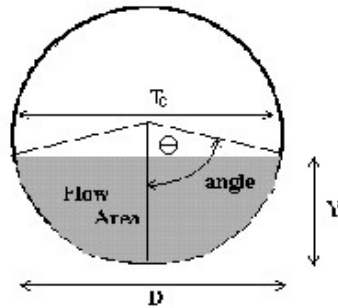
| | | | |
|--|--------------------|------|---------|
| Half Central Angle ($0 < \text{Theta-c} < 3.14$) | $\text{Theta-c} =$ | 1.70 | radians |
| Critical flow area | $A_c =$ | 1.83 | sq ft |
| Critical top width | $T_c =$ | 1.98 | ft |
| Critical flow depth | $Y_c =$ | 1.13 | ft |
| Critical flow velocity | $V_c =$ | 5.46 | fps |
| Critical Depth Froude Number | $Fr_c =$ | 1.00 | |

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: **BENT GRASS EAST COMMERCIAL FILING NO. 3**

Pipe ID: **24" RCP (DP-3)**



Design Information (Input)

| | | | |
|------------------------|---------|--------|--------|
| Pipe Invert Slope | $S_o =$ | 0.0100 | ft/ft |
| Pipe Manning's n-value | $n =$ | 0.0130 | |
| Pipe Diameter | $D =$ | 24.00 | inches |
| Design discharge | $Q =$ | 13.00 | cfs |

Full-Flow Capacity (Calculated)

| | | | |
|----------------------------|------------|-------|---------|
| Full-flow area | $A_f =$ | 3.14 | sq ft |
| Full-flow wetted perimeter | $P_f =$ | 6.28 | ft |
| Half Central Angle | $\theta =$ | 3.14 | radians |
| Full-flow capacity | $Q_f =$ | 22.68 | cfs |

Calculation of Normal Flow Condition

| | | | |
|--|-----------------|-------|---------------|
| Half Central Angle ($0 < \theta < 3.14$) | $\theta =$ | 1.66 | radians |
| Flow area | $A_n =$ | 1.74 | sq ft |
| Top width | $T_n =$ | 1.99 | ft |
| Wetted perimeter | $P_n =$ | 3.31 | ft |
| Flow depth | $Y_n =$ | 1.09 | ft |
| Flow velocity | $V_n =$ | 7.47 | fps |
| Discharge | $Q_n =$ | 13.00 | cfs |
| Percent of Full Flow | $\text{Flow} =$ | 57.3% | of full flow |
| Normal Depth Froude Number | $Fr_n =$ | 1.41 | supercritical |

Calculation of Critical Flow Condition

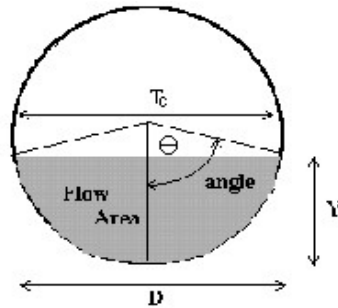
| | | | |
|--|--------------|------|---------|
| Half Central Angle ($0 < \theta_c < 3.14$) | $\theta_c =$ | 1.87 | radians |
| Critical flow area | $A_c =$ | 2.16 | sq ft |
| Critical top width | $T_c =$ | 1.91 | ft |
| Critical flow depth | $Y_c =$ | 1.30 | ft |
| Critical flow velocity | $V_c =$ | 6.03 | fps |
| Critical Depth Froude Number | $Fr_c =$ | 1.00 | |

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: **BENT GRASS EAST COMMERCIAL FILING NO. 3**

Pipe ID: **30" RCP (DP-4)**



Design Information (Input)

| | | | |
|------------------------|---------|--------|--------|
| Pipe Invert Slope | $S_o =$ | 0.0100 | ft/ft |
| Pipe Manning's n-value | $n =$ | 0.0130 | |
| Pipe Diameter | $D =$ | 30.00 | inches |
| Design discharge | $Q =$ | 22.00 | cfs |

Full-Flow Capacity (Calculated)

| | | | |
|----------------------------|------------|-------|---------|
| Full-flow area | $A_f =$ | 4.91 | sq ft |
| Full-flow wetted perimeter | $P_f =$ | 7.85 | ft |
| Half Central Angle | $\theta =$ | 3.14 | radians |
| Full-flow capacity | $Q_f =$ | 41.13 | cfs |

Calculation of Normal Flow Condition

| | | | |
|--|-----------------|-------|---------------|
| Half Central Angle ($0 < \theta < 3.14$) | $\theta =$ | 1.61 | radians |
| Flow area | $A_n =$ | 2.58 | sq ft |
| Top width | $T_n =$ | 2.50 | ft |
| Wetted perimeter | $P_n =$ | 4.03 | ft |
| Flow depth | $Y_n =$ | 1.30 | ft |
| Flow velocity | $V_n =$ | 8.52 | fps |
| Discharge | $Q_n =$ | 22.00 | cfs |
| Percent of Full Flow | $\text{Flow} =$ | 53.5% | of full flow |
| Normal Depth Froude Number | $Fr_n =$ | 1.48 | supercritical |

Calculation of Critical Flow Condition

| | | | |
|--|--------------|------|---------|
| Half Central Angle ($0 < \theta_c < 3.14$) | $\theta_c =$ | 1.85 | radians |
| Critical flow area | $A_c =$ | 3.31 | sq ft |
| Critical top width | $T_c =$ | 2.40 | ft |
| Critical flow depth | $Y_c =$ | 1.59 | ft |
| Critical flow velocity | $V_c =$ | 6.66 | fps |
| Critical Depth Froude Number | $Fr_c =$ | 1.00 | |

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Sheet 1 of 3

Designer: Marc A. Whorton, P.E.
Company: Classic Consulting
Date: November 4, 2020
Project: Bent Grass East Commercial Filing No. 3
Location: Exist. Pond - Proposed Forebay for Commercial Development

1. Basin Storage Volume

- A) Effective Imperviousness of Tributary Area, I_a
- B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)
- C) Contributing Watershed Area
- D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm
- E) Design Concept
(Select EURV when also designing for flood control)
- F) Design Volume (WQCV) Based on 40-hour Drain Time
($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * \text{Area})$)
- G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume
($V_{WQCV\ OTHER} = (d_s * (V_{DESIGN} / 0.43))$)
- 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)

$I_a = 90.0$ %

$i = 0.900$

Area = 4.500 ac

$d_s = 0.42$ in

Choose One

☐ Water Quality Capture Volume (WQCV)

☒ Excess Urban Runoff Volume (EURV)

$V_{DESIGN} =$ ac-ft

$V_{DESIGN\ OTHER} = 0.147$ ac-ft

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

HSG A = 0 %

HSG B = 100 %

HSG C/D = 0 %

$EURV_{DESIGN} = 0.455$ ac-ft

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

2. Basin Shape: Length to Width Ratio

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

L : W = 2.0 : 1

3. Basin Side Slopes

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

Z = 4.00 ft / ft

4. Inlet

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

5. Forebay

- A) Minimum Forebay Volume
($V_{MIN} = 2\%$ 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

$V_{MIN} = 0.003$ ac-ft

$V_F = 0.003$ ac-ft

$D_F = 18.0$ in

$Q_{100} = 22.00$ cfs

$Q_F = 0.44$ cfs

Choose One

☐ Berm With Pipe

☒ Wall with Rect. Notch

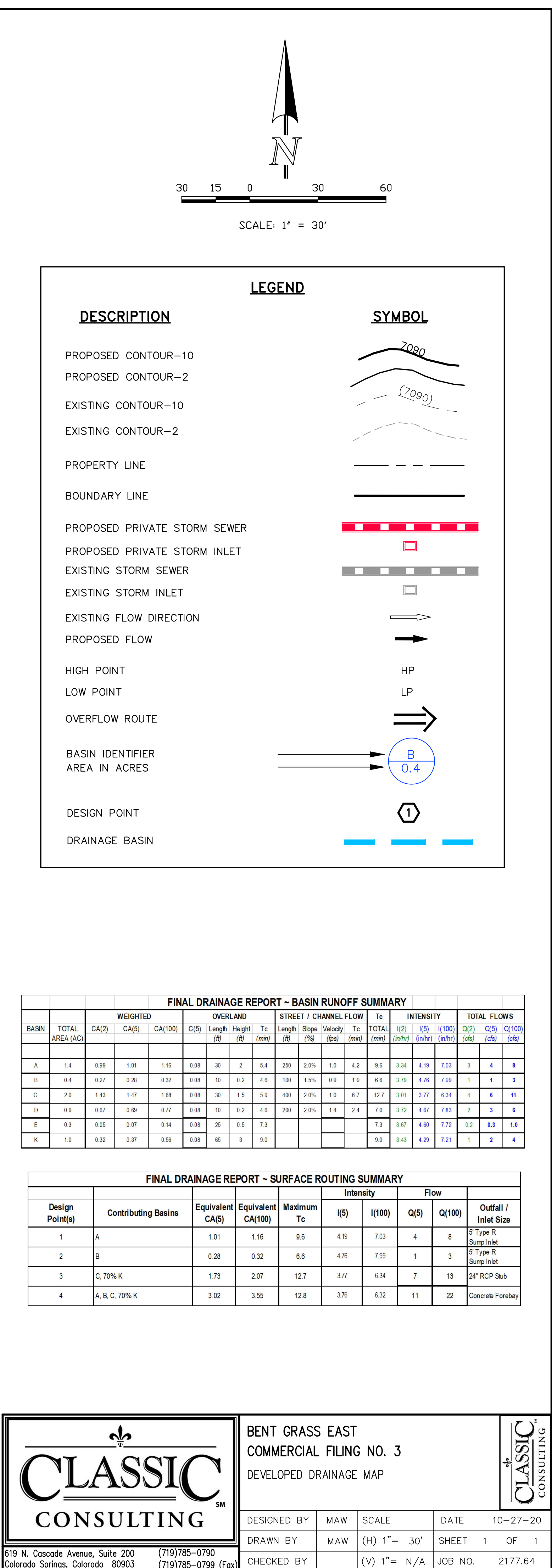
☐ Wall with V-Notch Weir

Flow too small for berm w/ pipe

Calculated $D_P =$ in

Calculated $W_N = 4.5$ in

DEVELOPED DRAINAGE MAP



**PREVIOUS DRAINAGE MAP
(BENT GRASS RESIDENTIAL FILING NO. 1)**



Innovative Design. Classic Results.

SP149

**FINAL DRAINAGE REPORT
FOR
BENT GRASS EAST COMMERCIAL FILING NO. 2**

**MAY 2014
REVISED JULY 2014**

*RETURN TO
ENGINEERING
LIBRARY*

Prepared for:

LAND FIRST, INC.
154 DEL ORO CIRCLE
COLORADO SPRINGS, CO 80919
Contact: Ron Waldthasuen

Prepared by:
CLASSIC CONSULTING ENGINEERS & SURVEYORS, LLC
6385 CORPORATE DRIVE, SUITE 101
COLORADO SPRINGS, CO 80919
(719) 785-0790

RECEIVED VERSION
AUG 20 2014 2

Job no. 2177.53




**FINAL DRAINAGE REPORT
FOR BENT GRASS EAST COMMERCIAL FILING NO. 2**

DRAINAGE REPORT 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 Drainage Criteria Manual for the City of Colorado Springs and El Paso County. I accept responsibility for any liability caused by any negligent acts, errors, or omissions on my part in preparing this report.



Marc A. Whorton, Colorado P.E. #37155


6/20/14
Date

DEVELOPER'S STATEMENT:

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

Business Name: Land First, Inc.

Title:

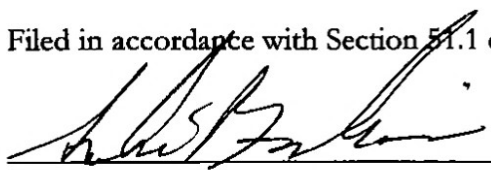

Pres.

Address:

154 Del Oro Circle
Colorado Springs, CO 80919

EL PASO COUNTY:

Filed in accordance with Section 51.1 of the El Paso Land Development Code, as amended.


For El Paso County Engineer/Director

8-24-14
Date

Conditions:



The following calculations are based on the 2014 drainage/bridge fees:

Bridge Fees

$$\$3,115 \times 3.31 \text{ Impervious Ac.} = \underline{\$ 10,310.65}$$

Drainage Fees

$$\$8,115 \times 3.31 \text{ Impervious Ac.} = \underline{\$ 26,860.65}$$

Fee Reduction (50% reasonable const. costs for detention facility)

$$\text{Detention Pond 2 (Full Spectrum on-site facility)} \quad \$75,000 \times 50\% = \$37,500.00$$

(See FAE for Pond estimate)

$$\text{Drainage Fee Total } \$26,860.65 - \$37,500.00 = \underline{\text{N/A}}$$

$$\text{Bridge Fee Total } \underline{\$10,310.65}$$

SUMMARY

All detention facilities have been designed to release at or below historic rates. The proposed development will not adversely impact surrounding developments.

PREPARED BY:

Classic Consulting Engineers & Surveyors, LLC

Marc A. Whorton, P.E.
Project Manager

mw/217753/Reports/217753FDR.doc

