



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

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(719) 785-0790

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

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: _____

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

Date

Conditions:



**FINAL DRAINAGE REPORT ADDENDUM NO. 2 BENT GRASS RESIDENTIAL FILING NO. 1
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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 acreage 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 overlotted 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 drive in order to provide vehicular access to the 6 lots. This private drive 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 drive). These flows will be routed towards Design Point 1 where a 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 drive). These flows will be routed towards Design Point 2 where a 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 24" RCP storm stub will collect both the 5 and 100 yr. developed flows. 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 into Bent Grass Meadows Dr.

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 drive). These flows will continue to sheet flow directly into Meridian Park Dr. These flows remain consistent with Basin M1 ($Q_5 = 6$ cfs and $Q_{100} = 11$ cfs) from the previous report. (See Appendix)

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 Falcon drainage/bridge fees:

ESTIMATED FEES:

Bridge Fees

$$\text{\$ } 4,232.00 \times 4.796 \text{ Impervious Ac.} = \text{\$ } \underline{20,296.67}$$

Drainage Fees

$$\text{\$ } 30,807.00 \times 4.796 \text{ Impervious Ac.} = \text{\$ } \underline{147,750.37}$$

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 East Commercial Filing 2 development. The following facilities within the Falcon Drainage Basin seem to meet the criteria for this reduction:

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	=	\$37,500 – 26,860.65
Credit remaining within the Falcon Basin	=	\$10,639.35

TOTAL DRAINAGE FEES (after reduction):

Drainage Fees

$$\text{\$ } 147,750.37 - 10,639.35 = \text{\$ } \underline{137,111.02}$$



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

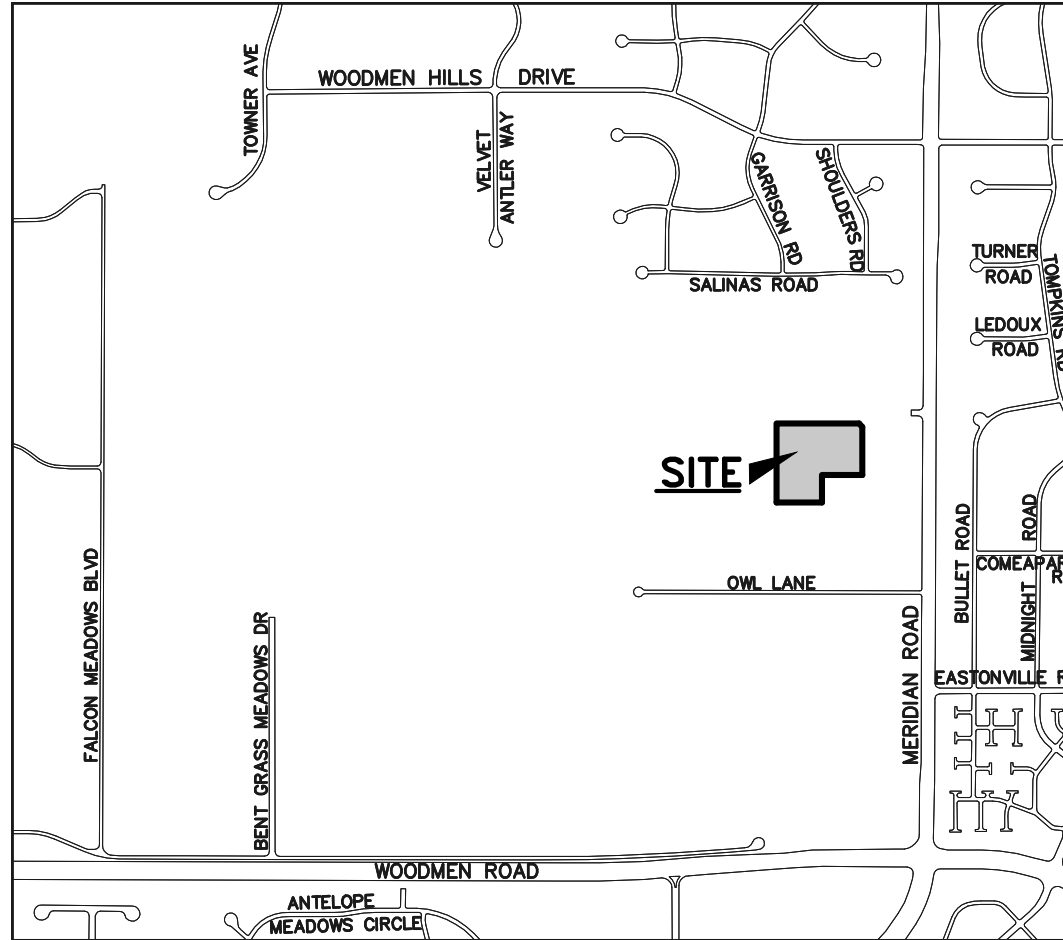


REFERENCES

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.

APPENDIX

VICINITY MAP



VICINITY MAP

N.T.S.

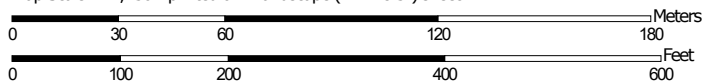
SOILS MAP (S.C.S. SURVEY)

Soil Map—El Paso County Area, Colorado



Soil Map may not be valid at this scale.

Map Scale: 1:2,130 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84



**Natural Resources
Conservation Service**

Web Soil Survey
National Cooperative Soil Survey


11/4/2020
Page 1 of 3


MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

Special Point Features



Blowout



Borrow Pit



Clay Spot



Closed Depression



Gravel Pit



Gravelly Spot



Landfill



Lava Flow



Marsh or swamp



Mine or Quarry



Miscellaneous Water



Perennial Water



Rock Outcrop



Saline Spot



Sandy Spot



Severely Eroded Spot



Sinkhole



Slide or Slip



Sodic Spot



Spoil Area



Stony Spot



Very Stony Spot



Wet Spot



Other



Special Line Features

Water Features



Streams and Canals

Transportation



Rails



Interstate Highways



US Routes



Major Roads



Local Roads

Background



Aerial Photography

MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service

Web Soil Survey URL:

Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: El Paso County Area, Colorado

Survey Area Data: Version 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 structural 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/NMFS-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.

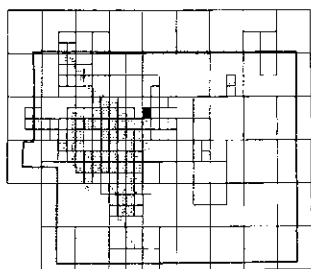
Contact FEMA Map Service Center (MSC) via the FEMA Map Information Exchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. 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, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

- ZONE A** No Base Flood Elevations determined.
- ZONE AE** Base Flood Elevations determined.
- ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding). Base Flood Elevations determined.
- ZONE AO** Flood depths of 1 to 3 feet (usually 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 V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevation determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel or 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 undetermined or possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

- Floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary

Boundary dividing Special Flood Hazard Areas of different base flood elevations, flood depths or flood velocities.

Base Flood Elevation line and water elevation in feet.

Base Flood Elevation value where uniform within zone, elevation in feet.

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

— Cross section line

— Transsect line

Geographic coordinates referenced to the North American Datum of 1983 (NAD83).

1000-meter Universal Transverse Mercator grid ticks.

5000-foot grid ticks. Colorado State Plane coordinate system, datum zone F1983 (NAD83).

Landmark Conformal Cone Projection.

Bench mark (see explanation in Notes to Users' section of the FIS report).

Map Repository

Refer to Map Repository for Map Index.

EFFECTIVE DATE OF COUNTY-WIDE FLOOD INSURANCE RATE MAP

MARCH 17, 1997

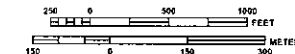
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL:

DECEMBER 7, 2018: To update corporate limits to change Base Flood Elevations and Special Flood Hazard Areas to comply with FEMA's new flood insurance rate map and to incorporate any newly added areas of flood insurance.

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)

COMMUNITY	NUMBER	PANEL	SHEET
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 informational purposes only. It is not intended to be used for any other purpose.

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

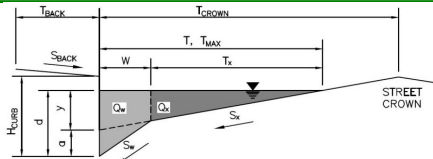
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(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
 $n_{BACK} = 0.020$

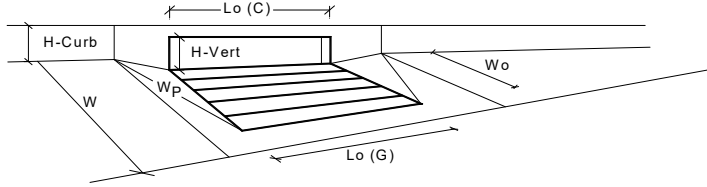
$H_{CURB} = 6.00$ inches
 $T_{CROWN} = 14.0$ ft
 $W = 2.00$ ft
 $S_X = 0.020$ ft/ft
 $S_W = 0.083$ ft/ft
 $S_O = 0.000$ ft/ft
 $n_{STREET} = 0.016$

	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

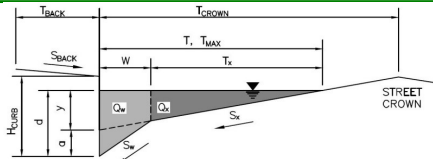
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(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
 $n_{BACK} = 0.020$

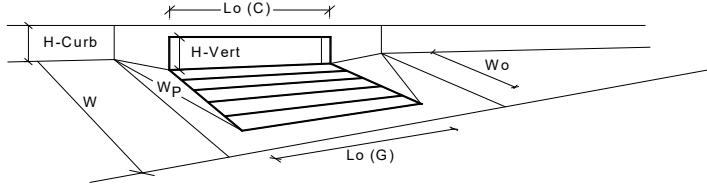
$H_{CURB} = 6.00$ inches
 $T_{CROWN} = 14.0$ ft
 $W = 2.00$ ft
 $S_X = 0.020$ ft/ft
 $S_W = 0.083$ ft/ft
 $S_D = 0.000$ ft/ft
 $n_{STREET} = 0.016$

	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		$L_o (C)$ =	5.00	5.00	feet	
Height of Vertical Curb Opening in Inches		H_{vert} =	6.00	6.00	inches	
Height of Curb Orifice Throat in Inches		H_{throat} =	6.00	6.00	inches	
Angle of Throat (see USDCM Figure ST-5)		Theta =	63.40	63.40	degrees	
Side Width for Depression Pan (typically the gutter width of 2 feet)		W_p =	2.00	2.00	feet	
Clogging Factor for a Single Curb Opening (typical value 0.10)		$C_r (C)$ =	0.10	0.10		
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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	

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
($V_{WQCV \text{ OTHER}} = (d_s * (V_{DESIGN} / 0.43))$)
- 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

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

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

HSG A = 0 %

HSG B = 100 %

HSG C/D = 0 %

$EURV_{DESIGN} = 0.455$ ac-ft

$EURV_{DESIGN \text{ USER}} =$ 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

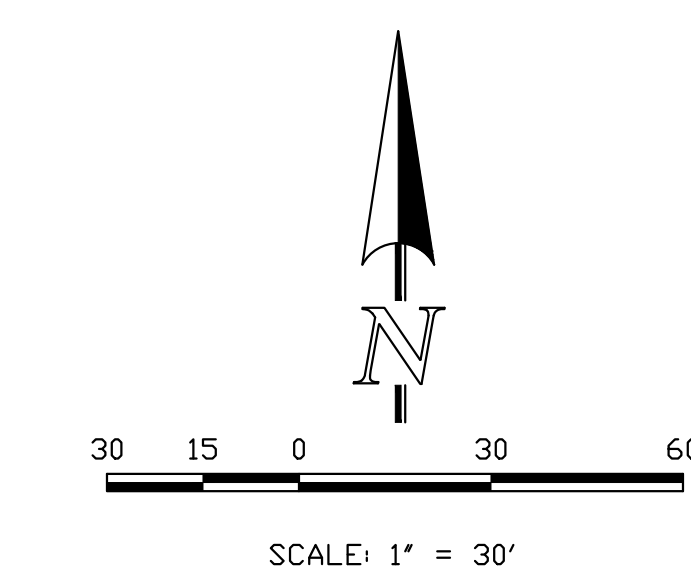
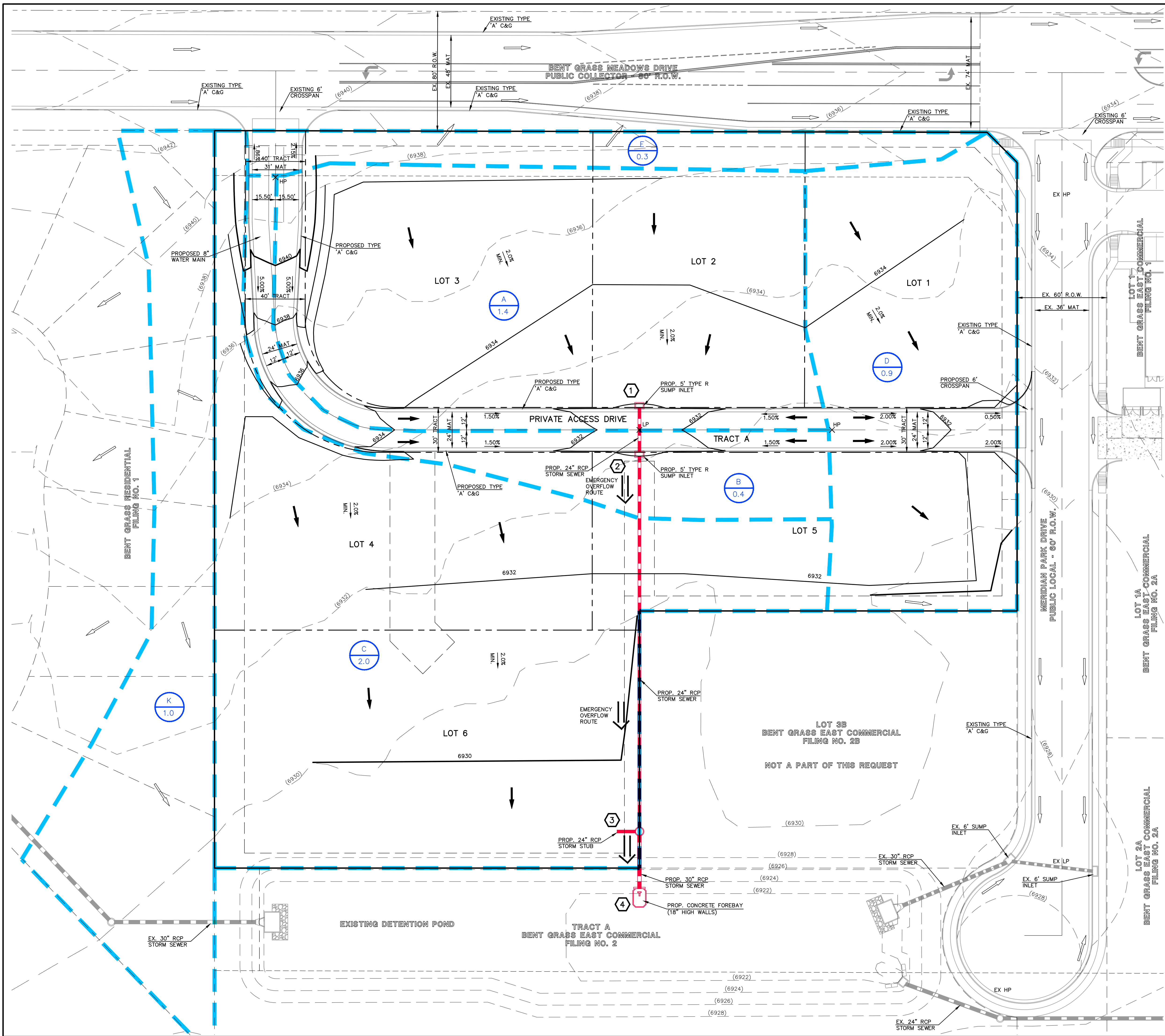
- ☐ Berm With Pipe
☒ Wall with Rect. Notch
☐ Wall with V-Notch Weir

Flow too small for berm w/ pipe

Calculated $D_P =$ in

Calculated $W_N = 4.5$ in

DEVELOPED DRAINAGE MAP



LEGEND

DESCRIPTION	SYMBOL
PROPOSED CONTOUR-10	
PROPOSED CONTOUR-2	
EXISTING CONTOUR-10	
EXISTING CONTOUR-2	
PROPERTY LINE	
BOUNDARY LINE	
PROPOSED STORM SEWER	
PROPOSED STORM INLET	
EXISTING STORM SEWER	
EXISTING STORM INLET	
EXISTING FLOW DIRECTION	
PROPOSED FLOW	
HIGH POINT	HP
LOW POINT	LP
OVERFLOW ROUTE	
BASIN IDENTIFIER	
AREA IN ACRES	
DESIGN POINT	
DRAINAGE BASIN	

CLASSIC CONSULTING
619 N. Cascade Avenue, Suite 200
Colorado Springs, Colorado 80903
(719)785-0790
(719)785-0799 (Fax)

**BENT GRASS EAST
COMMERCIAL FILING NO. 3**
DEVELOPED DRAINAGE MAP

DESIGNED BY	MAW	SCALE	DATE	10-27-20
DRAWN BY	MAW	(H) 1"= 30'	SHEET	1 OF 1
CHECKED BY		(V) 1"= N/A	JOB NO.	2177.64

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

