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**FINAL DRAINAGE LETTER
FOR
BENT GRASS MEADOWS DRIVE EAST
(INTERIM STREET PLANS)**

Prepared for:
BENT GRASS METROPOLITAN DISTRICT
660 SOUTHPOINTE COURT, SUITE 210
COLORADO SPRINGS CO 80906
(719) 579-6500

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

Job no. 2177.31



**FINAL DRAINAGE LETTER FOR
BENT GRASS MEADOWS DRIVE EAST (Interim Street Plans)**

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 El Paso County for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors, or omissions on my part in preparing this report.



Marc A Whorton, Colorado P.E. #37155

4/30/12

Date

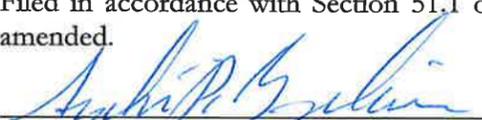
DEVELOPER'S STATEMENT:

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

Business Name: Bent Grass Metropolitan District
By: by Paul W. Basell president
Title: President
Address: 102 E. Pikes Peak Ave., #200
Colo. Spgs., Co 80903

EL PASO COUNTY:

Filed in accordance with Section 51.1 of the El Paso County Land Development Code, 1980, as amended.



County Engineer

6-11-12

Date

Conditions:



PURPOSE

This document is the Final Drainage Letter for Bent Grass Meadows Drive East (Interim Street Plans). The purpose of this report is to identify onsite and offsite drainage patterns, storm sewer, inlet locations, and areas tributary to the site, and to safely route developed storm water runoff to adequate outfall facilities.

GENERAL DESCRIPTION

Bent Grass Meadows Drive East is an 80' ROW future collector road just east of Meridian Road located in a portion of Section 1 Township 13 South, Range 65 West of the Sixth Principal Meridian, County of El Paso, State of Colorado. The site is bounded on the north by unplatted future commercial property and the existing Willmore residence, to the West by unplatted future residential property, the east by Meridian Road and to the south unplatted future commercial property. This site is 2.5 acres made up of approximately 1400 L.F. of 80' future ROW.

The Bent Grass Metropolitan District owns the property slated for the 80' future ROW for Bent Grass Meadows Drive as shown on the Bent Grass Preliminary Plan, approved March 2007. The intent of this first phase of road development is to two-fold: first to provide public access off of Meridian Road for marketing the future Bent Grass development parcels and secondly, to provide a driveway access for the existing Willmore residence just north of said property. The recent El Paso County/PPRTA project for this stretch of Meridian Road was just completed and provided the north-bound left turn movement into the property. This project also provided an interim natural ditch along the west side of Meridian Road and the culvert crossing at this future intersection. The requested additional 75' of ROW was also deeded to the County for future Meridian Road drainage/road improvements.

This first phase of road construction will only be the first 1400 LF of Bent Grass Meadows Drive west of Meridian Road and will not connect to the existing Bent Grass Meadows Drive at the extreme west end of the property. The required fire turn-around will be provided at the end of this phase of construction. This first phase plan set will reflect both this interim road section design along with the final design based on the horizontal alignment depicted on the Bent Grass Preliminary Plan. The interim plan will include a 36' wide pavement section only with side-road ditches as appropriate to handle the historic sheet flows. No Final Plat is being filed at this time, thus, the Bent Grass Metropolitan District will own and maintain this interim road until it is platted and accepted by the County.

The average soil condition reflects Hydrologic Group "B" (Blakeland Series loamy sand and Columbine Series gravelly sand loam) as determined by the "Soil Survey of El Paso County Area," prepared by the Soil Conservation Service.

EXISTING DRAINAGE CONDITIONS

The site is located within the Middle Tributary Basin within the Falcon Drainage Basin. This site has been previously studied as part of the "Master Development Drainage Plan and Preliminary Drainage Plan for the Bent Grass Subdivision", prepared by Kiowa Engineering Corp., approved September 2007.

This portion of the Bent Grass property gently drains in a southeast direction towards Meridian Road at grades of 2.0% – 2.5%. Some site disturbance was recently made along with the Meridian Road improvements, as material was allowed to be stockpiled on site, just south of the proposed Bent Grass Meadows Drive alignment. The stockpile and other disturbed areas have now been re-seeded and only a gravel driveway exists within the future 80' ROW area. Barbed-wire fencing also exists defining the various different ownership parcels.

The historic flows from the site travel as sheet flow in this southeasterly direction and are then conveyed via a natural ditch along the west side of Meridian Road. Three 36" equivalent elliptical RCP's and associated rip-rap were installed by the El Paso County/PPRTA project at the intersection with Meridian Road. All on-site drainage flows travel in a southerly direction within this channel towards downstream facilities.

PROPOSED DRAINAGE CONDITIONS

The development of this interim phase of the Bent Grass Meadows Drive road improvements will not significantly alter the historic rates or flow patterns. No land-use plans are being proposed at this time and therefore the following basins are assumed to be undeveloped at this stage. A future final drainage report accounting for any development in this area will be required to better define the ultimate flows within this roadway.

Basin A-1 ($Q_5 = 10$ cfs, $Q_{100} = 26$ cfs) continues to drain in a southeast direction and with this interim phase of road construction will be captured by a side road ditch. Basin A-2 ($Q_5 = 3$ cfs, $Q_{100} = 6$ cfs) consists of



developed flow from the north half of the 36' wide interim pavement section. These flows sheet flow into the ditch along the north side of the road and combine with the historic flows from Basin A-1. This ditch has the following dimensions: Trapezoidal with 3.0' bottom width, 3:1 side slopes and max. depth of 2.0'. The majority of this road side ditch will follow the same grade as the road (1.5% slope). After collecting approximately half of Basins A-1 and A-2 ($Q_5 = 6$ cfs, $Q_{100} = 14$ cfs) the velocity of these flows at the 1.5% slope remains under 4 ft/sec. which is allowable for this soil type. (See Appendix) The planned re-seeding and straw bales within the ditch will also help control the velocity and minimize any erosion. The total on-site flow from these two basins at Design Point 1 equals ($Q_5 = 12$ cfs, $Q_{100} = 29$ cfs). At the approach to this location, the side road ditch flattens out to allow the direct connection to the existing channel along the west side of Meridian Road. The grade of the ditch through this stretch will be approx. 0.6%. The velocity of this total flow remains below 4 ft/sec. (See Appendix) An 8'x8' rip-rap dissipater will be installed at this location. (Type VL, $d_{50} = 6"$, $D = 2d_{50} = 1.0'$) These flow quantities and patterns are consistent with the proposed K1 and K2 basins shown in the previously mentioned MDDP.

Basin A-3 ($Q_5 = 4$ cfs, $Q_{100} = 7$ cfs) consists of developed flows from the south side of the 36' wide interim pavement section. These minimal flows will be allowed to sheet flow in a southeasterly direction and combine with the historic flows to the south. These sheet flows will continue to travel in a south easterly direction towards the natural channel along Meridian Road. These flow quantities and patterns are also consistent with the proposed K3 and S1 basins shown in the previously mentioned MDDP.

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. The Rational Method was used to estimate stormwater runoff anticipated from design storms for the 5 year and 100 year recurrence interval.

FLOODPLAIN STATEMENT

The Flood Insurance Rate Maps (FIRM) for El Paso County Flood Insurance Study (FIS) panel 08041CO575F dated November 2003 was reviewed to determine if any regulatory floodplains pass through the property. There is a portion of the West Tributary (referred to on the FIRM panel as the Unnamed



Tributary to Black Squirrel Creek No. 2) that has been delineated by FEMA within the Bent Grass property. However, no portion of this specific street plan development is within this area. (See Appendix).

DRAINAGE AND BRIDGE FEES

This area lies within Falcon Drainage Basin. No plat is being processed with this interim road and therefore no drainage or bridge fees due at this time.

SUMMARY

Developed flows created by this interim road construction design will not significantly affect downstream facilities. All erosion control measures will be handled on-site to minimize any downstream impacts. All drainage facilities were sized using the current City of Colorado Springs/El Paso County Drainage Criteria Manual and will safely discharge storm water runoff to adequate outfalls.

PREPARED BY:

Classic Consulting Engineers & Surveyors, LLC



Marc A. Whorton, P.E.
Project Manager

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REFERENCES

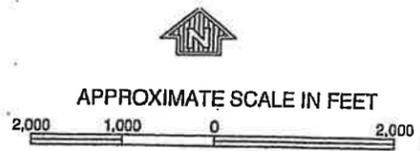
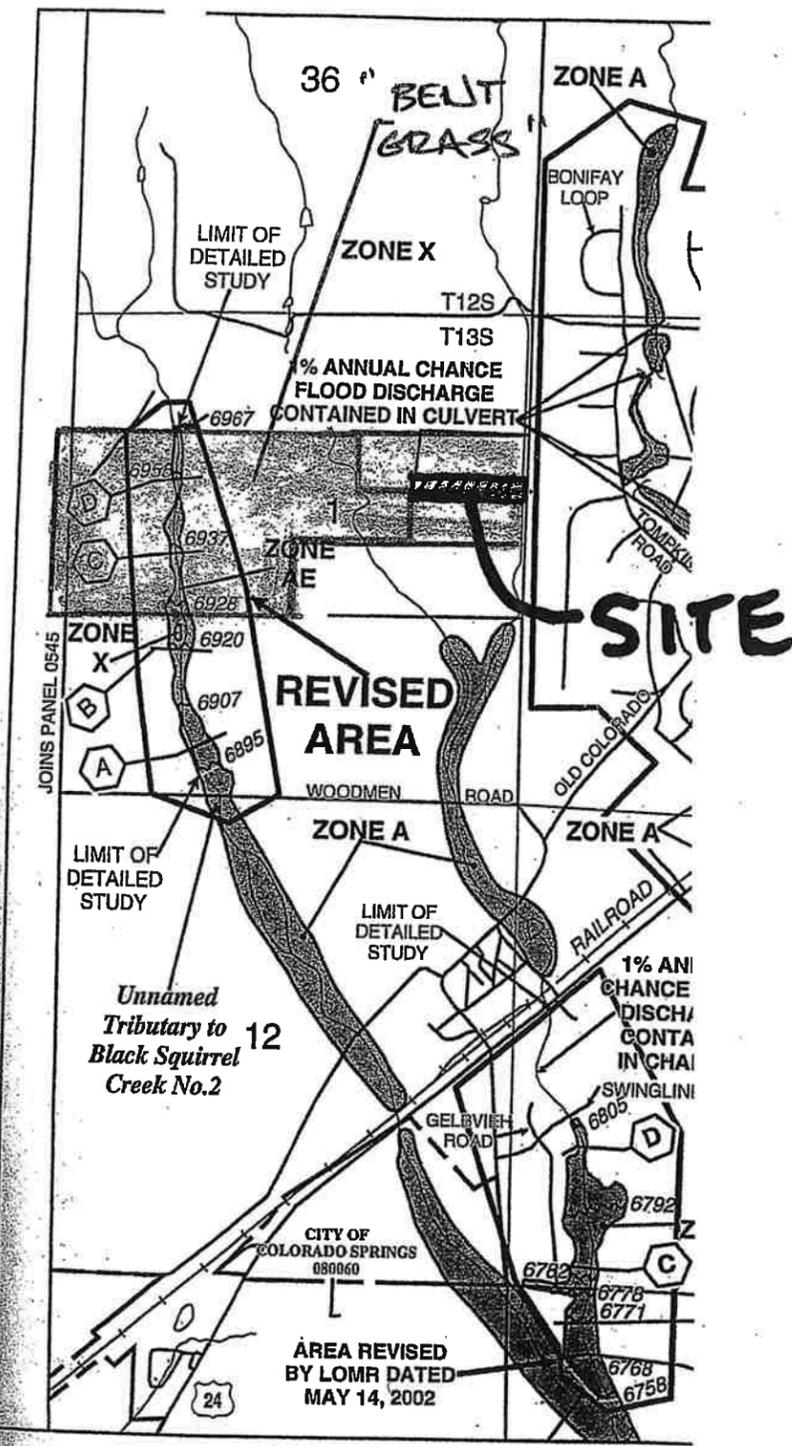
1. City of Colorado Springs/County of El Paso Drainage Criteria Manual dated October 1991.
2. "Master Development Drainage Plan and Preliminary Drainage Plan for Bent Grass Subdivision", prepared by Kiowa Engineering Corp., dated Sept. 2007.



APPENDIX

F.E.M.A. MAP





NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

EL PASO COUNTY,
COLORADO
AND INCORPORATED AREAS

PANEL 575 OF 1300
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

COMMUNITY	NUMBER	PANEL SUFFIX
EL PASO COUNTY, UNINCORPORATED AREAS	080050	0575 F
COLORADO SPRINGS, CITY OF	080060	0575 F

REVISED TO REFLECT LOMR DATED NOV 26 2002

MAP NUMBER
08041C0575 F

EFFECTIVE DATE:
MARCH 17, 1997

Federal Emergency Management Agency

FLOODPLAIN INFORMATION

HYDROLOGIC / HYDRAULIC CALCULATIONS

JOB NAME: Bent Grass Meadows Drive (Interim Plans)
 JOB NUMBER: 2177.31
 DATE: 02/06/12
 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(5)	C(100)	AREA (AC)	C(5)	C(100)	C(5)	C(100)	CA(5)	CA(100)	
A-1	20.43	0.00	0.90	0.95	20.43	0.25	0.35	0.25	0.35	5.11	7.15	
A-2	1.24	0.70	0.90	0.95	0.54	0.25	0.35	0.62	0.69	0.77	0.85	
A-3	1.23	0.70	0.90	0.95	0.53	0.25	0.35	0.62	0.69	0.76	0.85	

JOB NAME: Bent Grass Meadows Drive (Interim Plans)
 JOB NUMBER: 2177.31
 DATE: 02/06/12
 CALC'D BY: MAW

FINAL DRAINAGE REPORT ~ BASIN RUNOFF SUMMARY

BASIN	WEIGHTED		OVERLAND			STREET / CHANNEL FLOW			Tc		INTENSITY		TOTAL FLOWS		
	CA(5)	CA(100)	C(5)	Length (ft)	Height (ft)	Tc (min)	Length (ft)	Slope (%)	Velocity (fps)	Tc (min)	TOTAL (min)	I(5) (in/hr)	I(100) (in/hr)	Q(5) (cfs)	Q(100) (cfs)
A-1	5.11	7.15	0.25	900	20	36.6	900	1.0%	3.5	4.3	40.9	2.02	3.58	10	26
A-2	0.77	0.85	0.25	20	0.4	5.7	1200	1.0%	3.5	5.7	11.4	3.90	6.93	3	6
A-3	0.76	0.85	0.25	20	0.4	5.7	0	0.0%	0.0	0.0	5.7	4.94	8.78	4	7

JOB NAME: Bent Grass Meadows Drive (Interim Plans)
 JOB NUMBER: 2177.31
 DATE: 02/06/12
 CALCULATED BY: MAW

FINAL DRAINAGE REPORT ~ SURFACE ROUTING SUMMARY

Design Point(s)	Contributing Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity		Flow		Inlet Size
					I(5)	I(100)	Q(5)	Q(100)	
1	A-1, A-2	5.87	8.00	40.9	2.02	3.58	12	29	(3) Exist. 36" equiv. RCP

North curb line with full basin flow (Initial Storm)

Project Description

Solve For Spread

Input Data

Channel Slope	0.01500	ft/ft
Discharge	12.00	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.06	ft/ft
Road Cross Slope	0.02	ft/ft
Spread	15.25	ft
Roughness Coefficient	0.013	

Cross Section Image



V: 4
H: 1

North curb line with full basin flow (Major Storm)

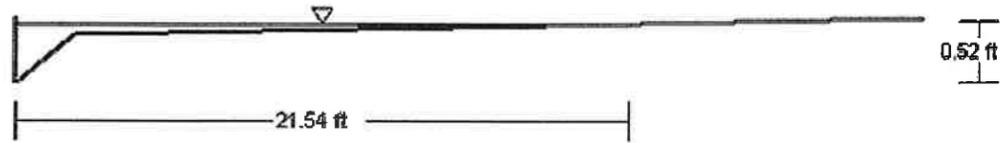
Project Description

Solve For Spread

Input Data

Channel Slope	0.01500	ft/ft
Discharge	29.00	ft ³ /s
Gutter Width	2.00	ft
Gutter Cross Slope	0.06	ft/ft
Road Cross Slope	0.02	ft/ft
Spread	21.54	ft
Roughness Coefficient	0.013	

Cross Section Image



V: 4
H: 1

North road side ditch @ 1/2 basin flow & 1.5% slope

Project Description

Friction Method Manning Formula
Solve For Normal Depth

Input Data

Roughness Coefficient 0.027
Channel Slope 0.01500 ft/ft
Left Side Slope 3.00 ft/ft (H:V)
Right Side Slope 4.00 ft/ft (H:V)
Bottom Width 3.00 ft
Discharge 14.00 ft³/s

Results

Normal Depth 0.66 ft
Flow Area 3.53 ft²
Wetted Perimeter 7.84 ft
Hydraulic Radius 0.45 ft
Top Width 7.65 ft
Critical Depth 0.67 ft
Critical Slope 0.01414 ft/ft
Velocity 3.96 ft/s
Velocity Head 0.24 ft
Specific Energy 0.91 ft
Froude Number 1.03
Flow Type Supercritical

GVF Input Data

Downstream Depth 0.00 ft
Length 0.00 ft
Number Of Steps 0

GVF Output Data

Upstream Depth 0.00 ft
Profile Description
Profile Headloss 0.00 ft
Downstream Velocity Infinity ft/s
Upstream Velocity Infinity ft/s
Normal Depth 0.66 ft
Critical Depth 0.67 ft
Channel Slope 0.01500 ft/ft

North road side ditch @ 1/2 basin flow & 1.5% slope

GVF Output Data

Critical Slope

0.01414 ft/ft

North road side ditch @ DP 1

Project Description

Friction Method Manning Formula
Solve For Normal Depth

Input Data

Roughness Coefficient	0.027
Channel Slope	0.00600 ft/ft
Left Side Slope	3.00 ft/ft (H:V)
Right Side Slope	4.00 ft/ft (H:V)
Bottom Width	3.00 ft
Discharge	29.00 ft ³ /s

Results

Normal Depth	1.18 ft
Flow Area	8.42 ft ²
Wetted Perimeter	11.60 ft
Hydraulic Radius	0.73 ft
Top Width	11.27 ft
Critical Depth	0.99 ft
Critical Slope	0.01278 ft/ft
Velocity	3.44 ft/s
Velocity Head	0.18 ft
Specific Energy	1.37 ft
Froude Number	0.70
Flow Type	Subcritical

GVE Input Data

Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0

GVE Output Data

Upstream Depth	0.00 ft
Profile Description	
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	1.18 ft
Critical Depth	0.99 ft
Channel Slope	0.00600 ft/ft

North road side ditch @ DP 1

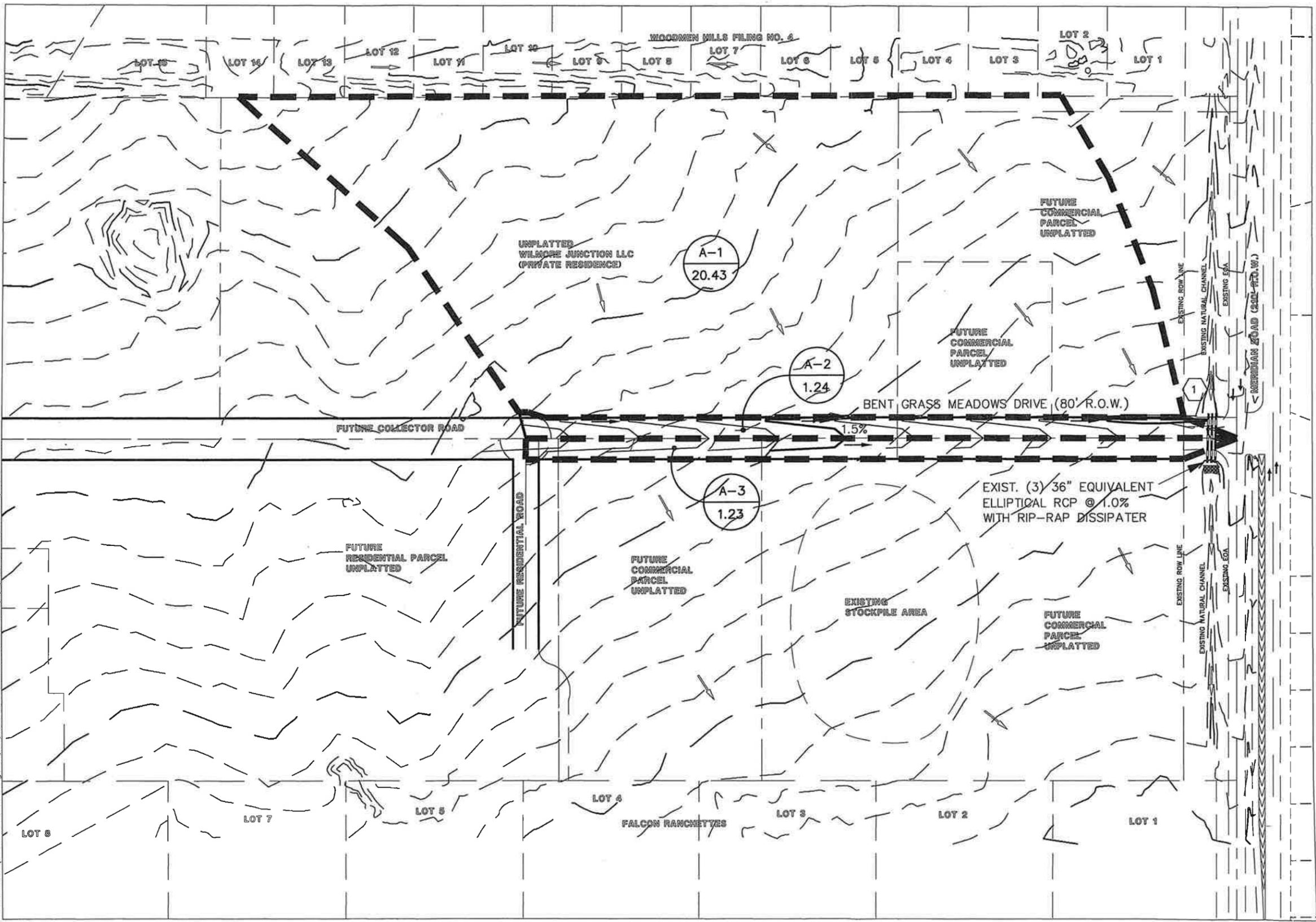
CVF Output Data

Critical Slope

0.01278 ft/ft

DRAINAGE MAP

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LEGEND

- EXISTING GROUND CONTOUR 5910
- PROPOSED FINISHED CONTOUR 5910
- PROPERTY BOUNDARY
- PROPOSED BASIN BOUNDARY
- EXISTING STORM SEWER
- BASIN IDENTIFIER
- AREA IN ACRES
- DESIGN POINT

BASIN SUMMARY:

BASIN	Q(5)-CFS	Q(100)-CFS
A-1	10	26
A-2	3	6
A-3	4	7

DESIGN POINT FLOW (CFS)

Q5 = 12 CFS
 Q100 = 29 CFS
 (ON-SITE DEVELOPED FLOW)



1" = 200'

BENT GRASS MEADOWS DRIVE
 DRAINAGE MAP
 JOB NO. 2177.31
 JANUARY 31, 2012
 SHEET 1 OF 1

