

Red River Civil Engineering, Inc.
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January 18, 2018

El Paso County Planning & Community Development
2880 International Circle, Suite 110
Colorado Springs, CO 80910-3127

RE: Drainage Letter for Dancing Wolf Estates Replat (EA-16-128)

The site of the subject project is at the northeast corner of State Highway 83 and Hodgen Road, within the SE $\frac{1}{4}$ of Section 22, T11S, R66W, 6th P.M., El Paso County, Colorado. The entire property is just over 40 acres. Ground cover consists of mostly native grasses with some trees on the north and east sides of the property, and soil in the area is mostly silty sand. The site slopes generally east and west toward a surface drainage way interior to the property that flows south to north. The drainage way ultimately exits the property on the north property line, and from there continues under SH 83 and ultimately to Cherry Creek and the South Platte River. The site is on FEMA map 08041C0285F, which indicates it is in Zone X outside of the 500 year floodplain.

The property is currently subdivided into approximately 5 acre lots. The applicant desires to further subdivide some lots into approximately 2.5 acre lots. When the property was originally platted, the applicant was instructed to outline a no-build area along the existing drainage way. The no-build area was simply drawn along the existing topography without drainage calculations to support the required location or width of the no-build area. **The purpose of this drainage letter is to determine requirements for culverts and/or channels to convey the existing surface drainage and use that information to locate a revised no-build area.**

All 100-year storm runoff flows are taken from data in the original drainage report and exhibit for the development, titled "Final Drainage Report, Dancing Wolf Estates" by Phil Weinert Engineering in July, 1996. See attached excerpts from this report for your reference. Drainage calculations for this project consist of sizing trapezoidal channels to convey the existing 100 year storm runoff, plus one foot of freeboard in the channel. A culvert is also sized as an alternate to the channel to convey 100-year flows through existing Lot 1, which could eliminate the requirement for the no-build zone when the commercial parcel is developed.

See the drawing showing the proposed no-build area that corresponds with the trapezoidal channel calculations, and the reports from FlowMaster which include a channel cross section and all input for the calculations. The channel sizing includes a 1' freeboard, therefore the minimum no-build zone widths are the same size as the channel width calculations. The proposed new no-build zone shown on the drawing utilizes the minimum widths calculated for the channels, with some areas being wider to avoid short line segments in delineating the no-build zone.

Channels are sized as follows, with all lot numbers corresponding to the original plat lot numbers:

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Lot 1: From the existing 30" culvert under Hodgen Road west of Dancing Wolf Way, to the confluence with the flows coming from the southeast under Dancing Wolf Way, a 2.33' deep channel, 21.6' wide is required to convey the 100-year flow and maintain a 1' freeboard in the channel. It is proposed that during development of the commercial parcel currently part of existing Lot 1, the no-build easement may be eliminated for this channel if the 30" culvert is extended from Hodgen to the confluence with the downstream channel coming from the southeast under Dancing Wolf Way.

Lot 2: From the confluence of the two channels at the northeast portion of Lot 1 through Lot 2, a 3.3' deep channel, 44.6' wide is required to convey the 100-year flow and maintain a 1' freeboard in the channel.

Lot 3/4: From the confluence of the two channels at the northeast portion of Lot 2 through Lots 3 and 4, a 3.63' deep channel, 48.6' wide is required to convey the 100-year flow and maintain a 1' freeboard in the channel.

This report complies with the El Paso County Drainage Criteria Manual guidance, including the Flowmaster program output for culvert and trapezoidal channel sizing, which is attached.

Sincerely,



Sandee C. Miller, P.E.
Colorado Professional Engineer 35741



Cross Section for Trapezoidal Channel - 1 from 83 to north 100 yr flow

Project Description

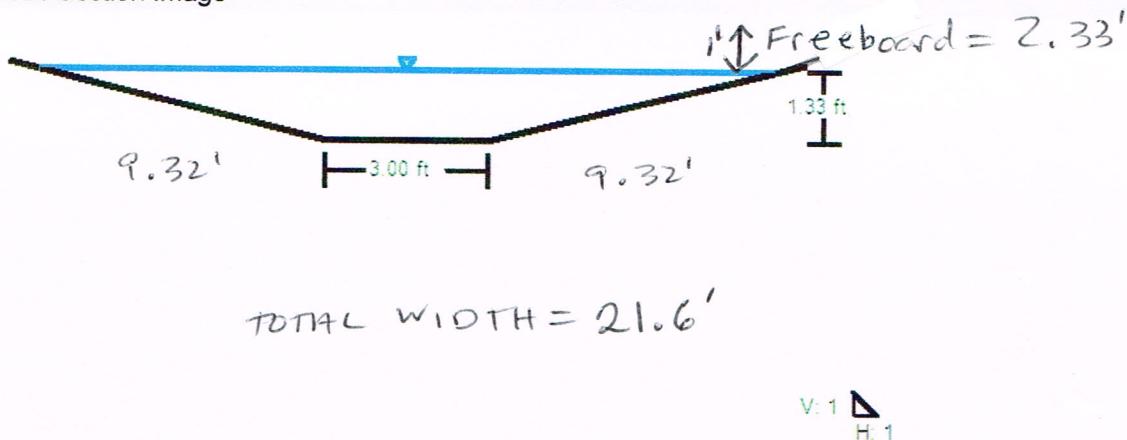
Friction Method Manning Formula

Solve For Normal Depth

Input Data

Roughness Coefficient	0.035
Channel Slope	0.05000 ft/ft
Normal Depth	1.33 ft
Left Side Slope	4.00 ft/ft (H:V)
Right Side Slope	4.00 ft/ft (H:V)
Bottom Width	3.00 ft
Discharge	90.00 ft³/s

Cross Section Image



Worksheet for Trapezoidal Channel - 1 from 83 to north 100 yr flow

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035
Channel Slope	0.05000 ft/ft
Left Side Slope	4.00 ft/ft (H:V)
Right Side Slope	4.00 ft/ft (H:V)
Bottom Width	3.00 ft
Discharge	90.00 ft ³ /s

Results

Normal Depth	1.33	ft
Flow Area	11.07	ft ²
Wetted Perimeter	13.97	ft
Hydraulic Radius	0.79	ft
Top Width	13.64	ft
Critical Depth	1.66	ft
Critical Slope	0.01856	ft/ft
Velocity	8.13	ft/s
Velocity Head	1.03	ft
Specific Energy	2.36	ft
Froude Number	1.59	
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	1.33	ft
Critical Depth	1.66	ft
Channel Slope	0.05000	ft/ft
Critical Slope	0.01856	ft/ft

Worksheet for Circular Pipe - 1 thru ex lot 1 RCP option 30"

Project Description

Friction Method Manning Formula

Solve For Channel Slope

Input Data

Roughness Coefficient	0.013
Normal Depth	2.05 ft
Diameter	2.50 ft
Discharge	90.00 ft³/s

Results

Channel Slope	0.04815 ft/ft
Flow Area	4.31 ft²
Wetted Perimeter	5.66 ft
Hydraulic Radius	0.76 ft
Top Width	1.92 ft
Critical Depth	2.48 ft
Percent Full	82.0 %
Critical Slope	0.04454 ft/ft
Velocity	20.90 ft/s
Velocity Head	6.79 ft
Specific Energy	8.84 ft
Froude Number	2.46
Maximum Discharge	96.82 ft³/s
Discharge Full	90.00 ft³/s
Slope Full	0.04815 ft/ft
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
Average End Depth Over Rise	0.00 %
Normal Depth Over Rise	81.96 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.05 ft
Critical Depth	2.48 ft
Channel Slope	0.04815 ft/ft
Critical Slope	0.04454 ft/ft

Cross Section for Trapezoidal Channel - 2 after confluence from 2-48s

Project Description

Friction Method

Manning Formula

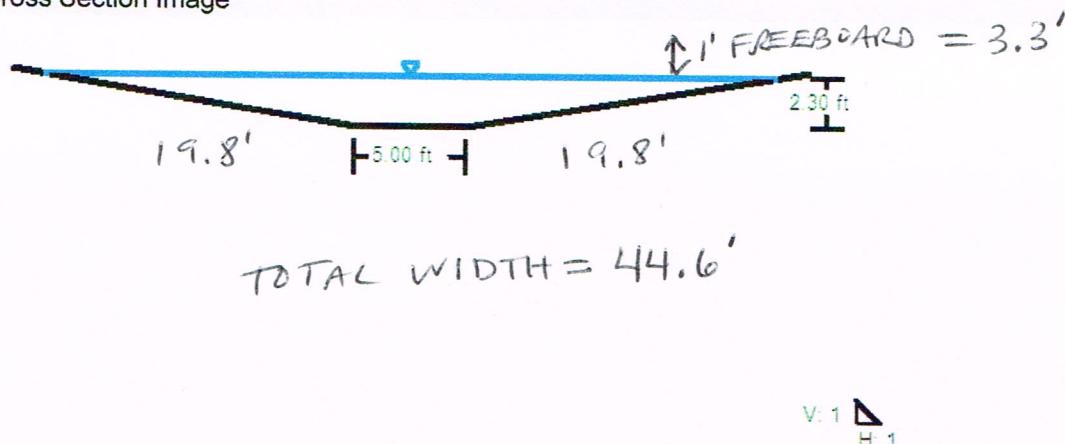
Solve For

Normal Depth

Input Data

Roughness Coefficient	0.035
Channel Slope	0.03000 ft/ft
Normal Depth	2.30 ft
Left Side Slope	6.00 ft/ft (H:V)
Right Side Slope	6.00 ft/ft (H:V)
Bottom Width	5.00 ft
Discharge	379.00 ft³/s

Cross Section Image



V: 1
H: 1

Worksheet for Trapezoidal Channel - 2 after confluence from 2-48s 100

Project Description

Input Data

Roughness Coefficient	0.035
Channel Slope	0.03000 ft/ft
Left Side Slope	6.00 ft/ft (H:V)
Right Side Slope	6.00 ft/ft (H:V)
Bottom Width	5.00 ft
Discharge	379.00 ft ³ /s

Results

Normal Depth	2.30	ft
Flow Area	43.09	ft ²
Wetted Perimeter	32.92	ft
Hydraulic Radius	1.31	ft
Top Width	32.54	ft
Critical Depth	2.63	ft
Critical Slope	0.01586	ft/ft
Velocity	8.80	ft/s
Velocity Head	1.20	ft
Specific Energy	3.50	ft
Froude Number	1.35	
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	2.30	ft
Critical Depth	2.63	ft
Channel Slope	0.03000	ft/ft
Critical Slope	0.01586	ft/ft

Cross Section for Trapezoidal Channel - 3 north of lot 2 100 yr flow

Project Description

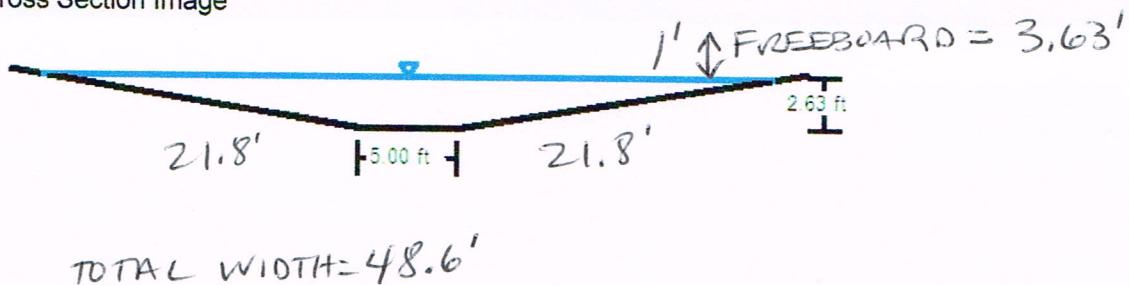
Friction Method Manning Formula

Solve For Normal Depth

Input Data

Roughness Coefficient	0.035
Channel Slope	0.02000 ft/ft
Normal Depth	2.63 ft
Left Side Slope	6.00 ft/ft (H:V)
Right Side Slope	6.00 ft/ft (H:V)
Bottom Width	5.00 ft
Discharge	427.00 ft³/s

Cross Section Image



V: 1 H: 1

Worksheet for Trapezoidal Channel - 3 north of lot 2 100 yr flow thru

Project Description

Friction Method

Manning Formula

Solve For

Normal Depth

Input Data

Roughness Coefficient	0.035
Channel Slope	0.02000 ft/ft
Left Side Slope	6.00 ft/ft (H:V)
Right Side Slope	6.00 ft/ft (H:V)
Bottom Width	5.00 ft
Discharge	427.00 ft ³ /s

Results

Normal Depth	2.63	ft
Flow Area	54.78	ft ²
Wetted Perimeter	37.04	ft
Hydraulic Radius	1.48	ft
Top Width	36.60	ft
Critical Depth	2.78	ft
Critical Slope	0.01561	ft/ft
Velocity	7.79	ft/s
Velocity Head	0.94	ft
Specific Energy	3.58	ft
Froude Number	1.12	
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	2.63	ft
Critical Depth	2.78	ft
Channel Slope	0.02000	ft/ft
Critical Slope	0.01561	ft/ft

**FINAL
DRAINAGE
REPORT**

Dancing Wolf Estates

El Paso County

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contribution from the east. Downstream characteristics do not impact on the drainage requirements for this subdevelopment. Drainageways downstream are unimproved, naturally formed gullies.

Drainage Design Criteria

Development Criteria Reference

As mentioned previously, there are no development plans that set parameters for drainage in this area, hence this final plan is based on the criteria in the City/County Drainage Manual.

Hydrologic Criteria

The design rainfall for ten years is I=24 inches per hour and the rainfall for 100 years is I=38 inches per hour. Calculations are shown at Appendix B. Runoff is calculated by the rational method. No detention is required because the negligible difference between historic and developed flows is compensated for by the change in grade for the seven building sites and road embankment.

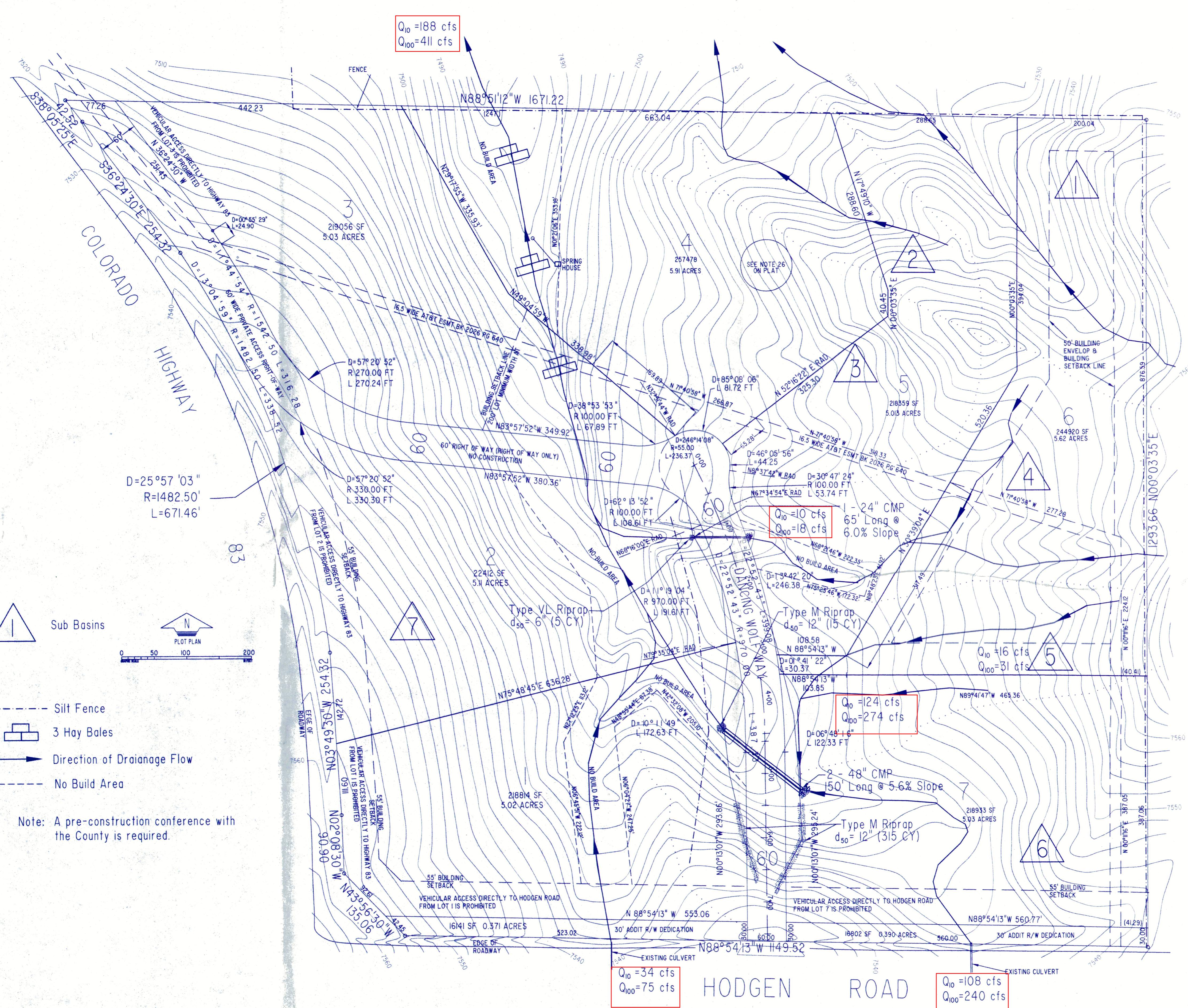
Drainage Facility Design

General Concept

As discussed earlier, the point of discharge of surface runoff from this property is into a unimproved arroyo that continues on undeveloped land to where it crosses Hwy. 83 to the north. This development does not change the traditional drainage patterns. Sheet 2 of the drawings is the plan and reflects the general concept.

Specific Details

From the south there is a hundred year flow entering the subdivision of approximately 315 cfs. The added flow from this subdevelopment is 54cfs. The difference between developed and historic flows is approximately 1/10 of the cfs for the 10 year event and 2/10 cfs for the 100 year event. This subdevelopment does not materially impact areas downstream. Flows from the south, however, significantly contribute to the need for drainage structures. These are shown on the drainage plan in their proper alignment and on the road profile. Primary impact of drainage is the two culverts shown. Rip-rap will be provided at both the culvert inlets and outlets. Of the two culverts, number one is the most significant.



Notes Regarding January 2018 No-Build Zone Evaluation:

The 100 year storm drainage flows on this drainage plan were used as a guide to evaluate the 100-year flow through the drainage way. The 10 and 100 year flow are highlighted with a red rectangle on this plan for easier reference.

Sandee Miller, P.E.
January 18, 2018