INNOVATIVE DESIGN. **CLASSIC RESULTS.**

PRELIMINARY/FINAL DRAINAGE REPORT
FOR
REDTAIL RANCH FILING 1

NOVEMBER 2018

Prepared for:
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Prepared by:
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Job no. 2525.00

PCD Project No. SP-18-004/SF-18-021

PRELIMINARY/FINAL DRAINAGE REPORT FOR
REDTAIL RANCH FILING NO. 1

DESIGN 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 report and said report is in conformity with the applicable master plan and 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

OWNERS/DEVELOPER'S STATEMENT:
I, the owner/developer, have read and will comply with all of the requirements specified in this drainage report and plan.

Name: Michael S. Ludwig

Title:

Address: 4255 Arrowhead Drive

Colorado Springs, CO 80908

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. Date
County Engineer / ECM Administrator

Conditions:

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PRELIMINARY/FINAL DRAINAGE REPORT FOR
REDTAIL RANCH FILING NO. 1

TABLE OF CONTENTS:

APPENDICES

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PRELIMINARY\FINAL DRAINAGE REPORT FOR REDTAIL RANCH FILING NO. 1

PURPOSE

This document is the Preliminary/Final Drainage Report for Redtail Ranch Filing No. 1. The purpose of this report is to address on-site and off-site drainage patterns and improvements required for this development to minimize impacts to the adjacent properties.

GENERAL DESCRIPTION

This development is made up of multiple parcels all owned by a single property owner. The total acreage for the site is 67.9 acres and is located in the county of El Paso within Section 9, Township 12 South, Range 65 West of the Sixth Principal Meridian, El Paso County, Colorado. The site is bounded on the north, west and south by existing platted and unplatted residential properties (RR-5 Zone) and to the east by existing Vollmer Road. The overall site is proposed for 12 single-family 5-acre minimum lots and paved rural roads. The current zoning of the property is RR-5 (5-acre Residential Zoning).

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

EXISTING DRAINAGE CONDITIONS

This property sits at the very top of two major drainage basins – Upper Black Squirrel to the east and Kettle Creek to the west. Thus, a major ridge-line runs through the middle of the property from north to south. The existing drainage patterns generally run in a southwesterly and southeasterly direction in several natural drainage corridors at slopes ranging from 2% to 5%. Multiple stock ponds exist on the property within these natural drainageways. There are two culvert crossings at Vollmer Road that the east half of the property drain towards. Much of the property was burned in the Black Forest fire several years back. The property owner has cleaned up most of the burn debris leaving some sparse treed areas remaining along the ridgeline. The remainder of the property is covered with native

grasses. The west portion of the property is currently platted as Walker Place, Lots 1 & 2. Several home structures have recently been removed from the site leaving multiple well heads and some gravel paths remaining throughout the property. Current access to and from the property exists in multiple locations. Driveway access from the north off of Ward Lane and driveway access from the south off of Linwood Lane (private road). The public access proposed along with this development is the continuation of Ward Lane (paved) into the site from the north connected with a new east-west public roadway accessing Vollmer Road.

Design Point H1 (Q_5 = 3 cfs and Q_{100} = 18 cfs) consists of pre-development flows from Basins OS-1 and EX-1 within the Kettle Creek Basin. These historic flows travel in a westerly direction within a natural drainageway towards the west boundary and then head off-site.

Design Point H2 (Q_5 = 4 cfs and Q_{100} = 19 cfs) consists of pre-development flows from Basin EX-2 within the Kettle Creek Basin. These historic flows travel in a southwesterly direction within a natural drainageway towards the west boundary where they are collected in an existing stock pond. As mentioned in the previous Walker Place Drainage Report, this facility collects the minor flows while a grass-lined overflow swale directs the pond outflows around the earthen embankment located near the property line. This facility is planned to remain in place within Lot 3 of the proposed development with ownership and maintenance by the lot owner.

Design Point H3 (Q_5 = 5 cfs and Q_{100} = 25 cfs) consists of pre-development flows from Basin EX-3 within the Kettle Creek Basin. These historic flows travel in a southwesterly direction within a natural drainageway. Currently, a good portion of this historic basin is collected into another stock pond just east of the existing gravel driveway. This facility was also mentioned in the Walker Place Drainage Report as collecting the pre-developed flows and then releasing them through an 18" pond outfall. This existing facility is proposed to be replaced with a formal BMP to handle the developed flows at this location. (See Developed Conditions)

Design Point H4 (Q_5 = 0.3 cfs and Q_{100} = 1.9 cfs) consists of pre-development flows from Basin EX-4 within the Kettle Creek Basin. These historic sheet flows travel in a southwesterly direction towards the southwest corner of the property. No development is proposed within this small basin.

Design Point H5 (Q_5 = 8 cfs and Q_{100} = 43 cfs) consists of pre-development flows from Basins OS-2, OS-3, OS-4, EX-5 and EX-7 within the Upper Black Squirrel Basin. These historic flows sheet flow in a south easterly direction towards multiple stock ponds at the southeast corner of the property. These historic flows travel to the existing stock pond facilities with an ultimate release point at an existing 18" CMP crossing Vollmer Road.

Design Point H6 (Q_5 = 2 cfs and Q_{100} = 10 cfs) consists of pre-development flows from Basin EX-8 within the Upper Black Squirrel Basin. These historic sheet flows travel in a easterly direction towards Vollmer Road where an existing 24" CMP conveys the flows under Vollmer Road.

As mentioned earlier, this site was previously studied as part of the Walker Place Subdivision, prepared by ADP, Inc., approved January 2010. This report generally described the drainage characteristics for the majority of the west half of the property. Along with this Walker Place Final Plat, drainage fees in the amount of $1,904.76 were previously paid within the Kettle Creek Basin for the two lots currently platted.

DEVELOPED DRAINAGE CONDITIONS
(KETTLE CREEK BASIN)

The attached developed conditions drainage map contains several design points related to proposed culvert crossings and BMP facilities. All proposed culverts have been designed for the 100-yr. developed flows. All proposed storm facilities within the public Right-of-way (roadside ditches and culverts) will be public with ownership and maintenance by El Paso County. All proposed BMP facilities within easements will be owned and maintained by the individual lot owner.

Design Point D1 (Q_5 = 3 cfs and Q_{100} = 16 cfs) consists of developed flows from Basins OS-1 and A. These existing off-site and on-site developed flows travel in a westerly direction within a natural drainageway towards the west boundary and then head off-site. With the reduction in tributary area due to the extension of Ward Lane, the developed flows at this location are equal to or below the pre-development conditions. Therefore, no further improvements within this basin are proposed at this time. The additional imperviousness with the construction of Ward Lane is collected in a sideroad ditch and conveyed south towards Pond 1.

Design Point D2 (Q_5 = 3 cfs and Q_{100} = 17 cfs) consists of developed flows from Basin B. These on-site developed flows travel in a westerly direction within a natural drainageway towards the west boundary and the existing stock pond. With the reduction in tributary area due to the extension of Ward Lane, the developed flows at this location are below the pre-development conditions. Therefore, no further improvements within this basin are proposed at this time. The additional imperviousness with the construction of Ward Lane is collected in a sideroad ditch and conveyed south towards Pond 1. The existing stock pond facility is planned to remain in place within Lot 3 with ownership and maintenance by the lot owner.

Design Point D3 (Q_5 = 3 cfs and Q_{100} = 13 cfs) consists of developed flows from Basin E. These on-site developed flows sheet flow towards the extension of Ward Lane and then travel in a southerly direction within the sideroad ditch towards D3. At this location a 24" RCP culvert is proposed to convey these flows under the roadway. (See Appendix for Culvert Design)

Design Point D4 (Q_5 = 7 cfs and Q_{100} = 28 cfs) consists of developed flows from Basins D, F and Design Point D3 and represents the total inflow to Pond 1. At this location, the existing stock pond is proposed to be replaced with a formal BMP as described below:

Pond 1 (Sand Filter Basin) has the following design parameters as a full-spectrum facility:

(See UD-Detention in Appendix)

Facility sized to release pre-development acreage of 14.8 ac. (Basin EX-3)

0.09 Ac.-ft. WQCV required

0.12 Ac.-ft. EURV required

0.19 Ac.-ft. EURV design with 4:1 max. slopes

0.45 Ac.-ft. 100-yr. storage

Total In-flow:	**Q_5 = 7 cfs, Q_{100} = 28 cfs**
Pond Design Release:	**Q_5 = 0.18 cfs, Q_{100} = 15.3 cfs**
Pre-development Release:	**Q_5 = 0.30 cfs, Q_{100} = 17.6 cfs**

This facility will be constructed within a drainage easement with ownership and maintenance by the HOA for the subdivision. The O&M Plan for this project will further specify maintenance responsibilities for this facility.

Design Point D5 (Q_5 = 1.7 cfs and Q_{100} = 24 cfs) consists of developed flows from Basin C and the outflow from Pond 1. These on-site developed flows travel in a southwesterly direction within a natural drainageway and existing 30' drainage easement towards the south boundary. With the reduction in tributary area due to the extension of Ward Lane and the proposed Pond 1, the developed flows at this location are at or below the pre-development conditions. Therefore, no further improvements within this basin are proposed at this time.

DEVELOPED DRAINAGE CONDITIONS
(UPPER BLACK SQUIRREL BASIN)

Design Point D6 (Q_5 = 6 cfs and Q_{100} = 29 cfs) consists of developed flows from Basins OS-2, OS-3, EX-5 and G. These off and on-site developed flows sheet flow towards the sideroad ditch along the north side of the proposed public road (Sanctuary Pine Dr.) and then in an easterly direction towards Design Point D6. At this location, the existing stock pond will be removed along with the road construction

and a 30" RCP culvert is proposed to convey these flows under the roadway. (See Appendix for Culvert Design)

Design Point D7 (Q_5 = 10 cfs and Q_{100} = 46 cfs) consists of developed flows from Basins OS-4, H and Design Point D6 and represents the total inflow to Pond 2. At this location, the existing stock pond is proposed to be replaced with a formal BMP as described below:

Pond 2 (Sand Filter Basin) has the following design parameters as a full-spectrum facility:
(See UD-Detention in Appendix)

0.12 Ac.-ft. WQCV required

0.13 Ac.-ft. EURV required

0.22 Ac.-ft. EURV design with 4:1 max. slopes

0.78 Ac.-ft. 100-yr. storage

Total In-flow:	**Q_5 = 10 cfs, Q_{100} = 46 cfs**
Pond Design Release:	**Q_5 = 0.22 cfs, Q_{100} = 22.1 cfs**
Pre-development Release:	**Q_5 = 0.49 cfs, Q_{100} = 29.9 cfs**

This facility will be constructed within a drainage easement with ownership and maintenance by the HOA for the subdivision. The O&M Plan for this project will further specify maintenance responsibilities for this facility.

Design Point D8 (Q_5 = 2 cfs and Q_{100} = 10 cfs) consists of developed flows from Basin L. With a reduction of tributary area based on the proposed grading and only a single home anticipated to be built on lot 8 in this basin, the developed flows at Design Point 8 will not see any significant change from the pre-developed condition. These developed sheet flows continue to travel in an easterly direction towards Vollmer Road and the existing 24" CMP under Vollmer Road. With no significant change in flows at this location, this existing culvert will continue to adequately convey the developed flows under Vollmer Road. The necessary ponding at this culvert location is all contained within the

proposed ROW or future 40' ROW easement. Therefore, no further improvements within this basin are proposed at this time.

Design Point D9 (Q_5 = 1 cfs and Q_{100} = 4 cfs) consists of developed flows from Basin I. These on-site developed flows travel as sideroad ditch flows in an easterly direction towards Vollmer Road. At this location an 18" RCP culvert is proposed to convey these flows under the roadway. (See Appendix for Culvert Design) Sediment control will be provided with on-site grading operations and remain until site development is complete and vegetation within sideroad ditch is at 75% growth.

Design Point D10 (Q_5 = 2 cfs and Q_{100} = 29 cfs) consists of developed flows from Basins I, J and K and the proposed outflow from Pond 2. With the construction of Sanctuary Pine Drive to divert the majority of the developed flows within this existing drainage corridor into the proposed Pond 2, the developed flows at Design Point 10 will be significantly lower than the pre-developed condition. These developed sheet flows continue to travel in an easterly direction towards Vollmer Road and the existing 24" CMP under Vollmer Road. With a significant reduction in the flows seen at this location, this existing culvert will continue to adequately convey the developed flows under Vollmer Road. The necessary ponding at this culvert location is all contained within the proposed ROW or future 40' ROW easement. Therefore, no further improvements within this basin are proposed at this time.

HYDROLOGIC CALCULATIONS

Hydrologic calculations were performed using the City of Colorado Springs/El Paso County Drainage Criteria Manual, as revised in November 1991 and 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. Individual on-site developed basin design used for culvert sizing and system routing was calculated using the Rational Method. BMP design was calculated using the UD-Detention (Version 3.07) spreadsheet developed by the Urban Drainage and Flood Control District.

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:** Development of project site is proposed large lot single family residential (5.0 ac. min.) with homes and associated landscaping. Proposed impervious areas (roof tops, patios) will sheet flow across landscaped ground and through large open areas within the lots across natural vegetation to slow runoff and increase time of concentration prior to being conveyed to the proposed public roads and adjacent properties. This will minimize directly connected impervious areas within the project site.

2. **Stabilize Drainageways:** This site will utilize roadside ditches with culvert crossings throughout the site. These facilities will then direct the on-site development flows to the multiple BMPs, designed to release at or below historic rates into the Kettle Creek and Upper Black Squirrel drainage basins. Based upon the proposed reduction in released flows compared to the pre-developed flows, no impact to downstream drainageways is anticipated.

3. **Provide Water Quality Capture Volume (WQCV):** Runoff from the impervious road areas of this development will be treated through capture and slow release of the WQCV in two permanent Sand Filter Basins designed per current El Paso County drainage criteria.

4. **Consider need for Industrial and Commercial BMPs**: No industrial or commercial uses are proposed within this development. However, a site specific storm water quality and erosion control plan and narrative is being submitted concurrently with this report and development. Details such as site specific source control construction BMP's as well as permanent BMP's are detailed in this plan and narrative to protect receiving waters. The described BMP's will be constructed and maintained by the developer upon approval by El Paso County Staff.

FLOODPLAIN STATEMENT

No portion of this site is located within a FEMA floodplain as determined by the Flood Insurance Rate Maps (F.I.R.M.) Map Numbers 08041C 0325F, with effective date of March 17, 1997 (See Appendix).

EROSION CONTROL PLAN

The Drainage Criteria Manual specifies an Erosion Control Plan and associated cost estimate be submitted with the Final Drainage Report. We respectfully request that the Erosion Control Plan and cost estimate be submitted in conjunction with the Grading and Erosion Control Plan and construction assurances posted prior to obtaining a grading permit.

DRAINAGE & BRIDGE FEES

This site lies within two major drainage basins: Kettle Creek and Upper Black Squirrel. The total acreage for the property is 67.9 acres. The acreage within each drainage basin equals:

Kettle Creek Basin – 32.17 Ac. (Basin Fees as calculated below)

Upper Black Squirrel Basin – 35.69 Ac. (No current Basin Fees)

As mentioned previously, a portion of this site within the Kettle Creek Drainage Basin was platted as Lots 1 and 2 or Walker Subdivision. This previously platted acreage equals 19.91 ac. Fees were paid at that time in the amount of $1,904.76. This acreage will be removed from the total fee acreage within the Kettle Creek Basin. The fees are calculated using the following impervious acreage method approved by El Paso County with current zoning of RR-5 (5-ac. residential land use). Thus, the percent imperviousness for this subdivision is calculated as follows:

RR-5 Zone Area

(Per El Paso County Percent Impervious Chart for 5.0 ac. lots: 7**%**)

32.17 – 19.91 Ac. x 7% = **0.86 Impervious Ac.**

The following calculations are based on the 2018 drainage/bridge fees for the Kettle Creek Drainage Basin:

FEE TOTALS (prior to reduction):

Bridge Fees - None

Drainage Fees (Kettle Creek)

$ 9,287.00 x 0.86 Impervious Ac. = $ 7,986.82

Per the ECM 3.10.2a, this development requests a 25% reduction of drainage fees based on the low density lots proposed (5 ac. min lot size). This reduction is as follows:

Low Density Lot Reduction (25%) $ 7,986.82 x 25% = $ 1,996.71

FEE TOTALS (with reduction):

Bridge Fees - None

Drainage Fees (Kettle Creek)

$ 7,986.82 - 1,976.71 = $ 5,990.11

Upper Black Squirrel currently has no bridge or drainage fees.

SUMMARY

This proposed development remains consistent with pre-development drainage conditions with the construction of the proposed on-site Sand Filter Basins. These proposed facilities meet current criteria and provide full spectrum design. The proposed development will not adversely impact surrounding developments.

PREPARED BY:
Classic Consulting Engineers & Surveyors, LLC

Marc A. Whorton, P.E.
Project Manager

mw/252500/Reports/FDR.doc

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CONSULTING
ENGINEERS & SURVEYORS

REFERENCES

1. City of Colorado Springs/County of El Paso Drainage Criteria Manual, as revised in November 1991 and 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. Soil Survey of El Paso County Area, Colorado Soil Conservation Service, June 1981.

3. "Preliminary/Final Drainage Report for Walker Place Subdivision", by ADP, Inc., approved January 2010.

APPENDIX

VICINITY MAP

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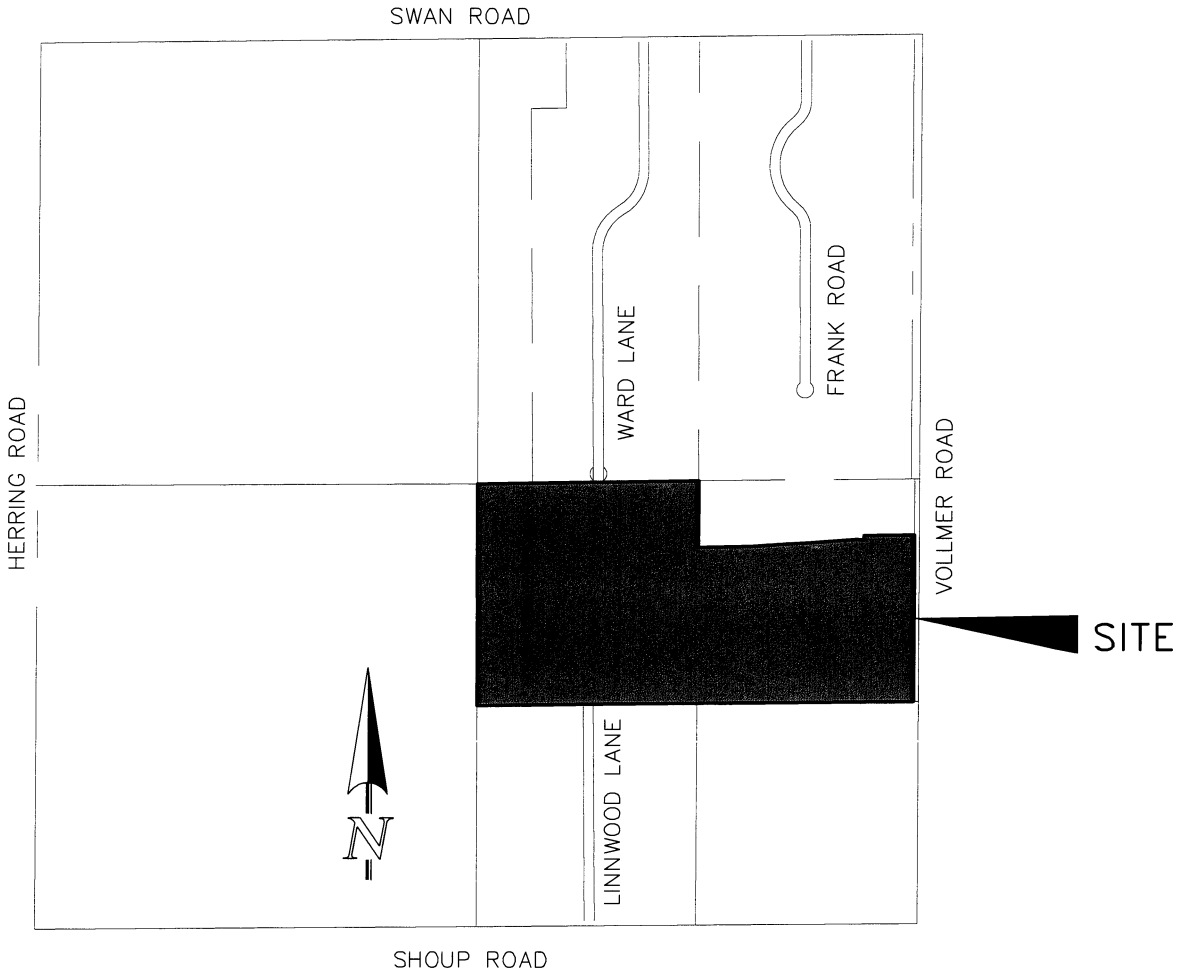

VICINITY MAP

N.T.S.

SOILS MAP

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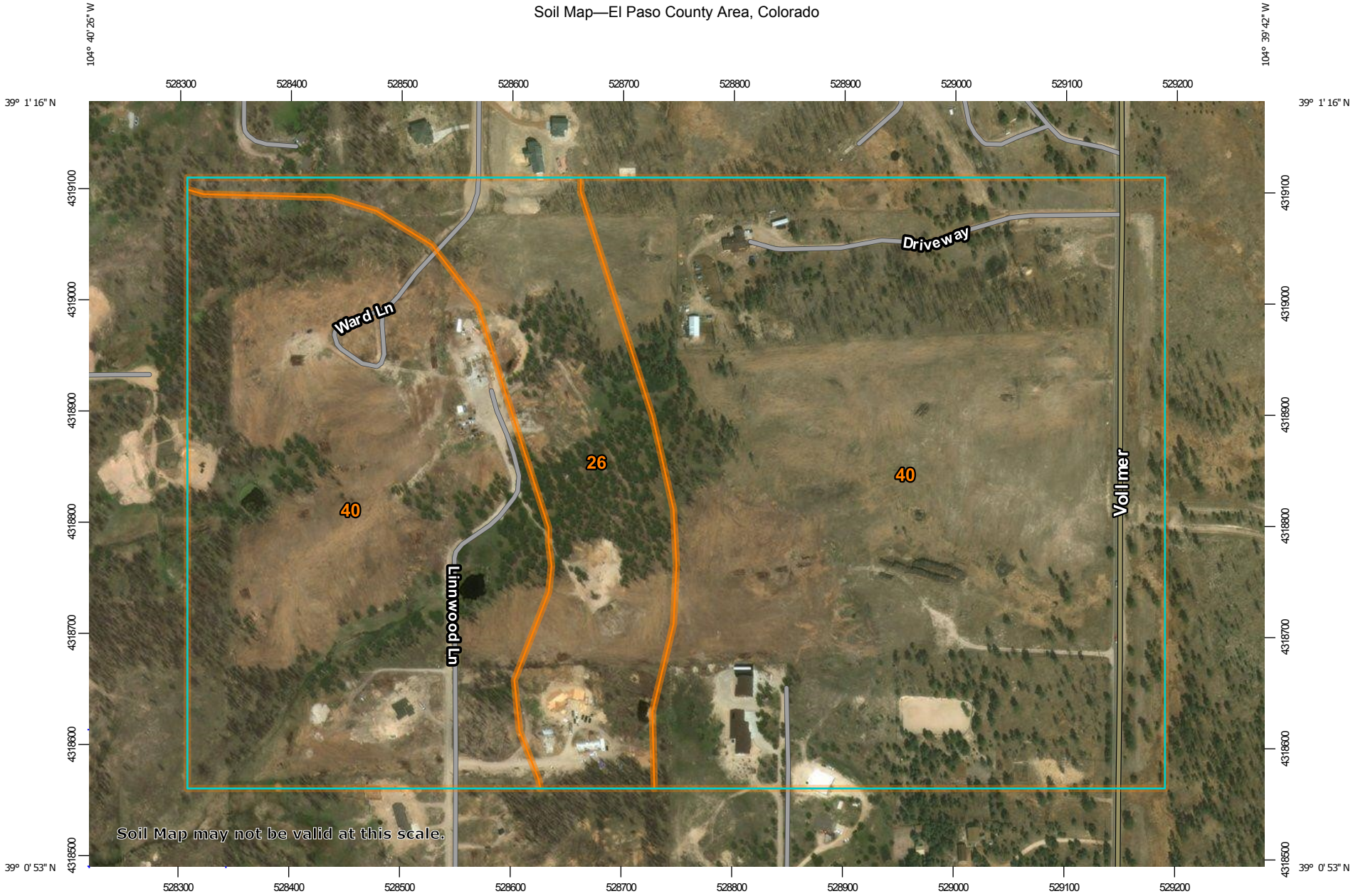

Map Scale: 1:4,850 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 200 400 800 1200

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

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 15, Oct 10, 2017

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

Date(s) aerial images were photographed: May 22, 2016—Mar 9, 2017

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
26	Elbeth sandy loam, 8 to 15 percent slopes	18.3	15.2%
40	Kettle gravelly loamy sand, 3 to 8 percent slopes	102.1	84.8%
Totals for Area of Interest		**120.4**	**100.0%**

El Paso County Area, Colorado

26—Elbeth sandy loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 367y
Elevation: 7,300 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Elbeth and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Elbeth

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from arkose

Typical profile

A - 0 to 3 inches: sandy loam
E - 3 to 23 inches: loamy sand
Bt - 23 to 68 inches: sandy clay loam
C - 68 to 74 inches: sandy clay loam

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 15, Oct 10, 2017

El Paso County Area, Colorado

40—Kettle gravelly loamy sand, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 368g
Elevation: 7,000 to 7,700 feet
Farmland classification: Not prime farmland

Map Unit Composition

Kettle and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kettle

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium derived from arkose

Typical profile

E - 0 to 16 inches: gravelly loamy sand
Bt - 16 to 40 inches: gravelly sandy loam
C - 40 to 60 inches: extremely gravelly loamy sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 15, Oct 10, 2017

FEMA MAP

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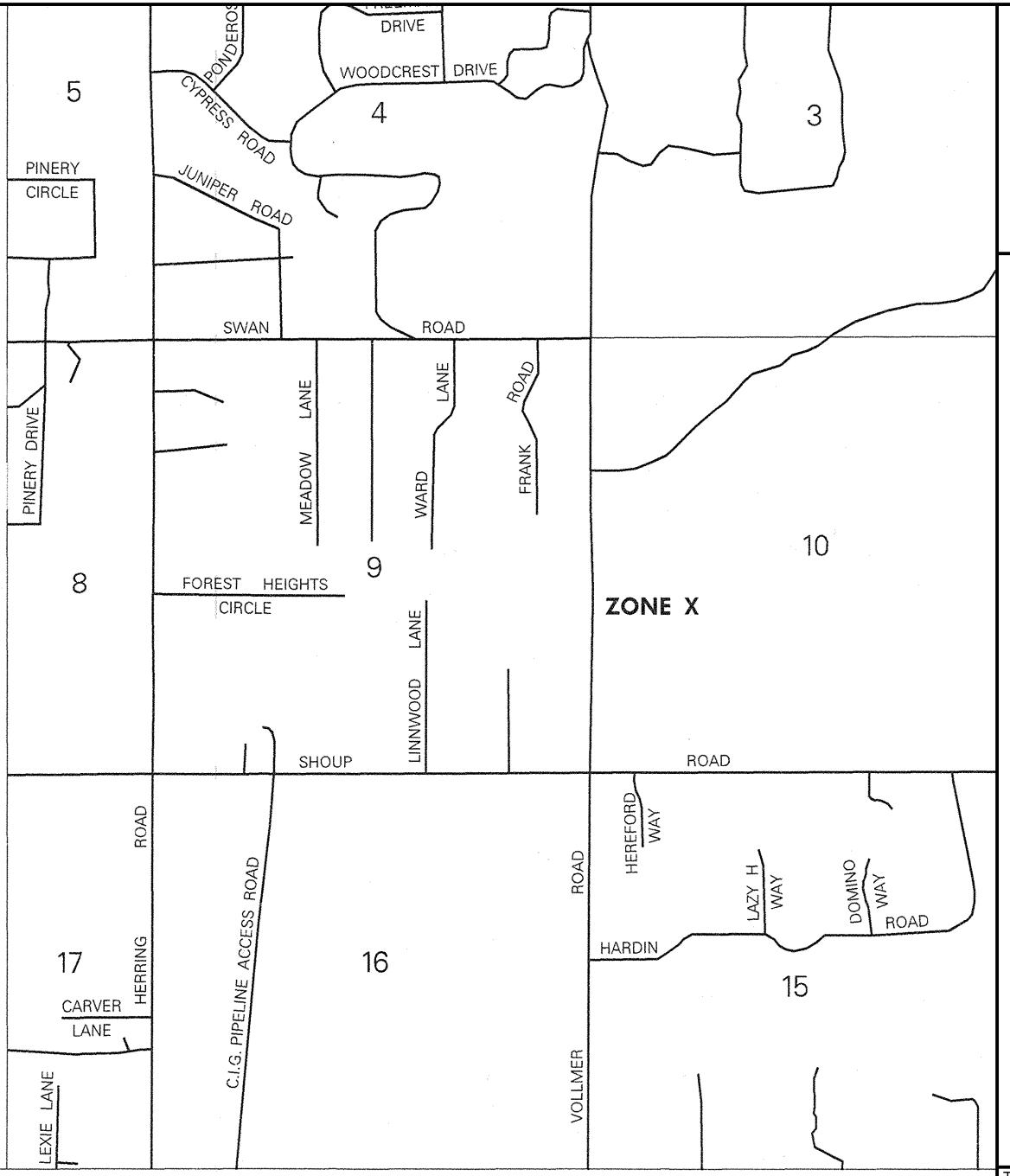

APPROXIMATE SCALE IN FEET

2000 0 2000

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 325 OF 1300

(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS: COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY, UNINCORPORATED AREAS	080059	0325	F

MAP NUMBER
08041C0325 F

EFFECTIVE DATE:
MARCH 17, 1997

Federal Emergency Management Agency

HYDROLOGIC/HYDRAULIC CALCULATIONS

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JOB NAME: *REDTAIL RANCH FILING NO. 1*
JOB NUMBER: *2525.00*
DATE: *11/14/18*
CALCULATED BY: *MAW*

FINAL DRAINAGE REPORT ~ BASIN RUNOFF COEFFICIENT SUMMARY

		IMPERVIOUS AREA / STREETS				LANDSCAPE/UNDEVELOPED AREAS				WEIGHTED			WEIGHTED CA		
BASIN	TOTAL AREA (AC)	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)
EX-1	6.1	0.12	0.57	0.59	0.70	5.98	0.03	0.09	0.36	0.04	0.10	0.37	**0.25**	**0.61**	**2.24**
EX-2	10.1	1.00	0.57	0.59	0.70	9.10	0.03	0.09	0.36	0.08	0.14	0.39	**0.84**	**1.41**	**3.98**
EX-3	14.8	1.20	0.57	0.59	0.70	13.60	0.03	0.09	0.36	0.07	0.13	0.39	**1.09**	**1.93**	**5.74**
EX-4	0.9	0.00	0.89	0.90	0.96	0.90	0.03	0.09	0.36	0.03	0.09	0.36	**0.03**	**0.08**	**0.32**
EX-5	2.0	0.00	0.89	0.90	0.96	2.00	0.03	0.09	0.36	0.03	0.09	0.36	**0.06**	**0.18**	**0.72**
EX-6	1.5	0.00	0.89	0.90	0.96	1.50	0.03	0.09	0.36	0.03	0.09	0.36	**0.05**	**0.14**	**0.54**
EX-7	26.4	1.10	0.57	0.59	0.70	25.30	0.03	0.09	0.36	0.05	0.11	0.37	**1.39**	**2.93**	**9.88**
EX-8	6.1	0.10	0.57	0.59	0.70	6.00	0.03	0.09	0.36	0.04	0.10	0.37	**0.24**	**0.60**	**2.23**
OS-1	3.5	0.30	0.57	0.59	0.70	3.20	0.05	0.12	0.39	0.09	0.16	0.42	**0.33**	**0.56**	**1.46**
OS-2	1.3	0.10	0.57	0.59	0.70	1.20	0.05	0.12	0.39	0.09	0.16	0.41	**0.12**	**0.20**	**0.54**
OS-3	1.7	0.10	0.57	0.59	0.70	1.60	0.05	0.12	0.39	0.08	0.15	0.41	**0.14**	**0.25**	**0.69**
OS-4	1.2	0.00	0.57	0.59	0.70	1.20	0.05	0.12	0.39	0.05	0.12	0.39	**0.06**	**0.14**	**0.47**
A	5.0	0.00	0.89	0.90	0.96	5.00	0.05	0.12	0.39	0.05	0.12	0.39	**0.25**	**0.60**	**1.95**
B	8.9	0.00	0.89	0.90	0.96	8.90	0.05	0.12	0.39	0.05	0.12	0.39	**0.45**	**1.07**	**3.47**
C	5.1	0.00	0.89	0.90	0.96	5.10	0.05	0.12	0.39	0.05	0.12	0.39	**0.26**	**0.61**	**1.99**
D	1.4	0.40	0.89	0.90	0.96	1.00	0.05	0.12	0.39	0.29	0.34	0.55	**0.41**	**0.48**	**0.77**
E	5.1	0.50	0.89	0.90	0.96	4.60	0.05	0.12	0.39	0.13	0.20	0.45	**0.68**	**1.00**	**2.27**
F	5.8	0.30	0.89	0.90	0.96	5.50	0.05	0.12	0.39	0.09	0.16	0.42	**0.54**	**0.93**	**2.43**
G	13.3	0.30	0.89	0.90	0.96	13.00	0.05	0.12	0.39	0.07	0.14	0.40	**0.92**	**1.83**	**5.36**
H	9.1	0.50	0.89	0.90	0.96	8.60	0.05	0.12	0.39	0.10	0.16	0.42	**0.88**	**1.48**	**3.83**
I	1.6	0.17	0.89	0.90	0.96	1.43	0.05	0.12	0.39	0.14	0.20	0.45	**0.22**	**0.32**	**0.72**
J	0.7	0.10	0.89	0.90	0.96	0.60	0.05	0.12	0.39	0.17	0.23	0.47	**0.12**	**0.16**	**0.33**
K	2.1	0.08	0.57	0.59	0.70	2.02	0.05	0.12	0.39	0.07	0.14	0.40	**0.15**	**0.29**	**0.84**
L	5.4	0.25	0.57	0.59	0.70	5.15	0.05	0.12	0.39	0.07	0.14	0.40	**0.40**	**0.77**	**2.18**

JOB NAME: ***REDTAIL RANCH FILING NO. 1***
JOB NUMBER: ***2525.00***
DATE: ***11/14/18***
CALC'D BY: ***MAW***

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \qquad V = C_v S_w^{0.5} \qquad \text{Tc=L/V}$$

$$t_c = \frac{L}{180} + 10$$

Table 6-7. Conveyance Coefficient, C_v

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

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

FINAL DRAINAGE REPORT ~ BASIN RUNOFF SUMMARY

BASIN	WEIGHTED			OVERLAND				STREET / CHANNEL FLOW				Tc	INTENSITY			TOTAL FLOWS		
	CA(2)	CA(5)	CA(100)	C(5)	Length (ft)	Height (ft)	Tc (min)	Length (ft)	Slope (%)	Velocity (fps)	Tc (min)	TOTAL (min)	I(2) (in/hr)	I(5) (in/hr)	I(100) (in/hr)	Q(2) (cfs)	Q(5) (cfs)	Q(100) (cfs)
OS-1	0.33	0.56	1.46	0.12	300	14	18.4					18.4	2.57	3.21	5.39	0.8	2	8
OS-2	0.12	0.20	0.54	0.12	300	16	17.6					17.6	2.62	3.28	5.50	0.3	0.7	3
OS-3	0.14	0.25	0.69	0.12	300	12	19.4					19.4	2.51	3.14	5.26	0.3	0.8	4
OS-4	0.06	0.14	0.47	0.12	270	12	17.8					17.8	2.61	3.27	5.48	0.2	0.5	3
A	0.25	0.60	1.95	0.12	300	18	17.0	250	3.6%	1.3	3.1	20.1	2.46	3.08	5.17	1	2	10
B	0.45	1.07	3.47	0.12	300	14	18.4	300	4.5%	1.5	3.4	21.8	2.37	2.96	4.97	1	3	17
C	0.26	0.61	1.99	0.12	300	15	18.0	350	3.6%	1.3	4.4	22.4	2.33	2.92	4.90	1	2	10
D	0.41	0.48	0.77	0.12	150	8	12.5	230	2.0%	1.4	2.7	15.2	2.80	3.50	5.88	1	2	5
E	0.68	1.00	2.27	0.12	300	22	15.9	100	3.0%	1.2	1.4	17.3	2.65	3.31	5.56	2	3	13
F	0.54	0.93	2.43	0.12	300	18	17.0	300	4.0%	1.4	3.6	20.5	2.44	3.05	5.12	1	3	12
G	0.92	1.83	5.36	0.12	300	9	21.3	1100	3.0%	1.7	10.6	31.9	1.91	2.39	4.01	2	4	21
H	0.88	1.48	3.83	0.12	300	12	19.4	650	3.0%	1.7	6.3	25.7	2.17	2.72	4.56	2	4	17
I	0.22	0.32	0.72	0.12	165	8	13.5	375	6.0%	2.4	2.6	16.1	2.73	3.42	5.74	0.6	1.1	4
J	0.12	0.16	0.33	0.12								5.0	4.12	5.17	8.68	0.5	0.8	3
K	0.15	0.29	0.84	0.12	300	22	15.9	100	4.0%	1.4	1.2	17.1	2.66	3.33	5.58	0.4	1.0	5
L	0.40	0.77	2.18	0.12	300	13	18.9	480	3.1%	1.2	6.5	25.4	2.19	2.73	4.59	1	2	10

JOB NAME: *REDTAIL RANCH FILING NO. 1*
JOB NUMBER: *2525.00*
DATE: *11/14/18*
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)	
H1	OS-1, EX-1 (9.6 AC.)	1.17	3.69	21.9	2.95	4.96	3	18	
H2	EX-2 (10.1 AC.)	1.41	3.98	24.3	2.80	4.70	4	19	
H3	EX-3 (14.8 AC.)	1.93	5.74	27.8	2.59	4.35	5	25	
H4	EX-4 (0.9 AC.)	0.08	0.32	15.9	3.43	5.76	0.3	1.9	
H5	OS-2, OS-3, OS-4, EX-5, EX-7 (32.6 AC.)	3.70	12.30	39.3	2.08	3.48	8	43	
H6	EX-8 (6.1 AC.)	0.60	2.23	26.0	2.70	4.53	2	10	
D1	A, OS-1 (8.5 AC.)	1.05	3.12	20.1	3.08	5.17	3	16	
D2	B (8.9 AC.)	1.07	3.47	21.8	2.96	4.97	3	17	
D3	E (5.1 AC.)	1.00	2.27	17.3	3.31	5.56	3	13	24" RCP CULVERT
D4	**DP-D3, D, F (12.3 AC.) (POND 1)**	**2.41**	**5.48**	**20.5**	**3.05**	**5.12**	**7**	**28**	**POND 1**
D5	Pond 1 Outfall, Basin C (17.4 AC.)	SEE POND PACK MODEL					1.7	24	
D6	OS-2, OS-3, EX-5, G (18.3 AC.)	2.46	7.31	31.9	2.39	4.01	6	29	30" RCP CULVERT
D7	**DP-D6, OS-4, H (28.6 AC.) (POND 2)**	**4.09**	**11.61**	**32.9**	**2.34**	**3.93**	**10**	**46**	**POND 2**
D8	L (5.4 AC.)	0.77	2.18	25.4	2.73	4.59	2	10	
D9	I (1.6 AC.)	0.32	0.72	16.1	3.42	5.74	1	4	18" RCP CULVERT
D10	Pond 2 Outfall, Basins I, J, K (33.0 AC.)	SEE POND PACK MODEL					2.4	29	

CLASSIC CONSULTING ENGINEERS & SURVEYORS
619 N. Cascade Avenue, Suite 200
Colorado Springs, CO 80903

Project: Redtail Ranch
Date: 6/27/18
Contact:
Phone:
By: MFW

NOTES
- ❑ Telephone Record
- ❑ Note to the File
- ❑ Job Information
- ❑ Meeting Minutes
- ❑ _____

Pond 1 Imperviousness calcs.

Basin D 1.4 ac. total

0.40 ac. asphalt, 1.0 ac sac. lots

0.40 x 100% + 1.0 x 7% / 1.4 ac. = 34%

Basin E 5.1 ac total

0.50 ac. asphalt, 4.6 ac sac lots

0.50 x 100% + 4.6 x 7% / 5.1 ac. = 16%

Basin F 5.8 ac. total

0.30 ac. asphalt, 5.5 ac sac lots

0.30 x 100% + 5.5 x 7% / 5.8 ac. = 12%

* 2.5 ac. x 7% (to match pre-dev. basin)

* Total Basin ac. = 12.3 ac. + 2.5 = 14.8 ac.

1.4 x 34% + 5.1 x 16% + 5.8 x 12% + 2.5 x 7% / 14.8 ac.

Pond 1 Imp. = 14.6%

CLASSIC CONSULTING ENGINEERS & SURVEYORS SM
619 N. Cascade Avenue, Suite 200
Colorado Springs, CO 80903

Project: Redtail Ranch
Date: 6/29/18
Contact:
Phone:
By: MFW

NOTES
- ❑ Telephone Record
- ❑ Note to the File
- ❑ Job Information
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- ❑ _____

Pond 2 Imp. calcs.

Basin OS-2 1.3 ac. total — all 5 ac. lot area
1.3 x 7% = 7% Imp.

Basin Ex-5 and OS-3 ac. total 2.0 ac. + 1.7 ac.
all 5 ac. lot area 7% Imp.

Basin G 13.2 ac. total
0.30 ac. asphalt, 12.9 ac. 5 ac. lots
0.3 x 100% + 12.9 x 7% / 13.2 = 9.1%

Basin H 11.5 ac. total
0.50 ac asphalt, 11.0 ac. 5 ac. lots
0.50 x 100% + 11.0 x 7% / 11.5 = 11%

Total Basin ac = 29.7 ac.

$$\frac{1.3 \times 7\% + 2.0 \times 7\% + 1.7 \times 7\% + 13.2 \times 9.1\% + 11.5 \times 11\%}{29.7 \text{ ac.}}$$

Pond 2 Imp. = 9.5%

Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Jun 29 2018

DESIGN POINT D3

Invert Elev Dn (ft)	=	7608.50
Pipe Length (ft)	=	70.00
Slope (%)	=	1.00
Invert Elev Up (ft)	=	7609.20
Rise (in)	=	24.0
Shape	=	Circular
Span (in)	=	24.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

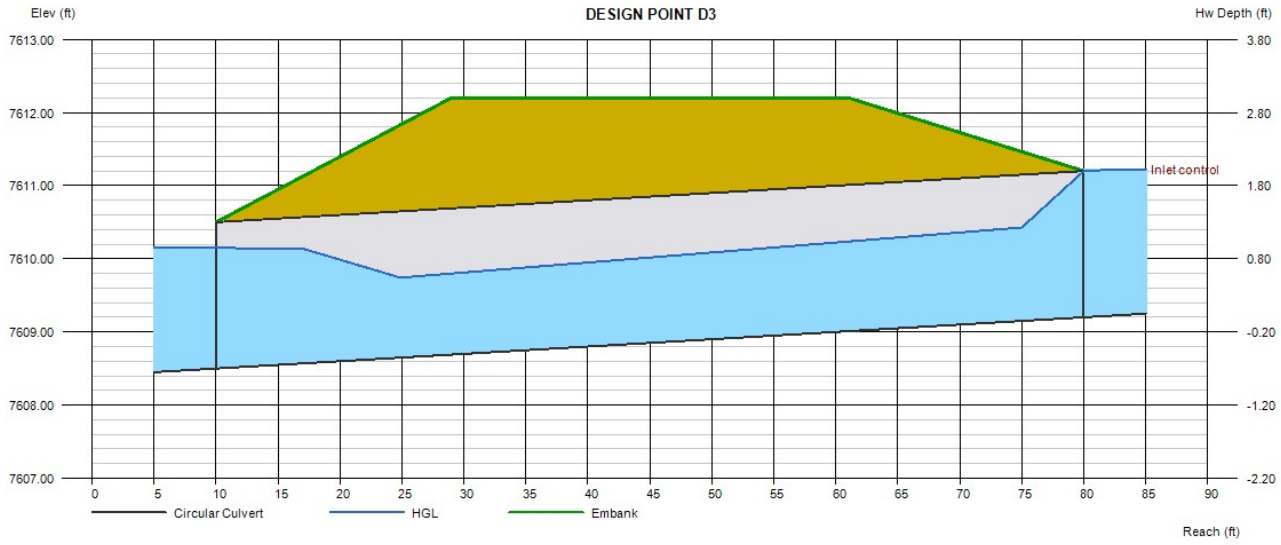
Top Elevation (ft)	=	7612.20
Top Width (ft)	=	32.00
Crest Width (ft)	=	50.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	13.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	13.00
Qpipe (cfs)	=	13.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	4.69
Veloc Up (ft/s)	=	6.03
HGL Dn (ft)	=	7610.15
HGL Up (ft)	=	7610.50
Hw Elev (ft)	=	7611.22
Hw/D (ft)	=	1.01
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Nov 14 2018

DESIGN POINT D6

Invert Elev Dn (ft)	=	7600.19
Pipe Length (ft)	=	65.00
Slope (%)	=	1.00
Invert Elev Up (ft)	=	7600.84
Rise (in)	=	30.0
Shape	=	Circular
Span (in)	=	30.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

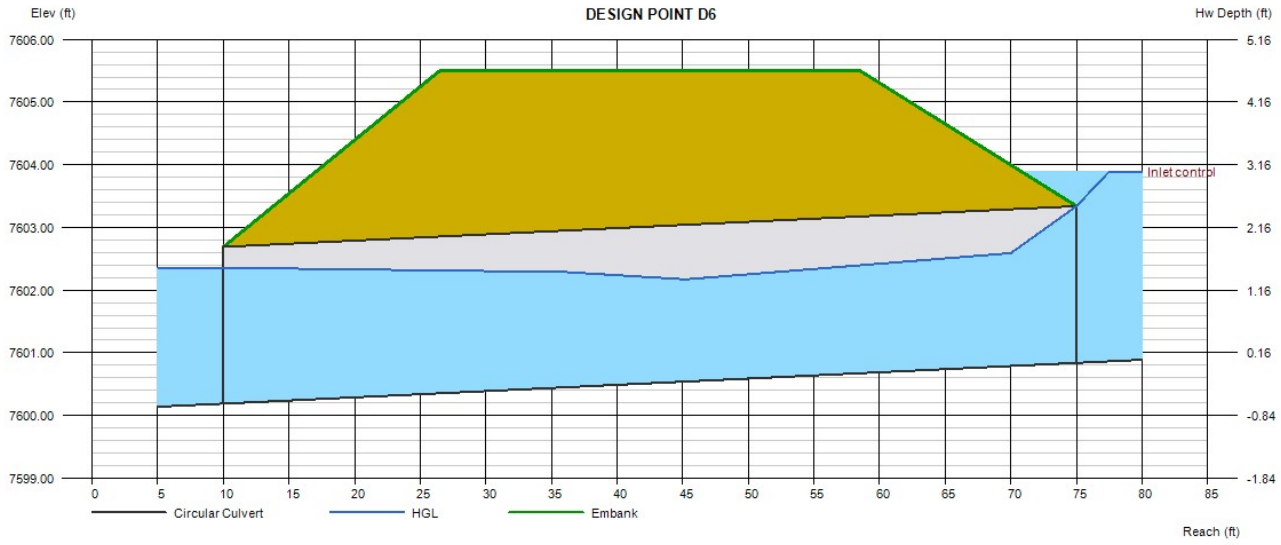
Top Elevation (ft)	=	7605.50
Top Width (ft)	=	32.00
Crest Width (ft)	=	50.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	29.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	29.00
Qpipe (cfs)	=	29.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	6.41
Veloc Up (ft/s)	=	7.51
HGL Dn (ft)	=	7602.36
HGL Up (ft)	=	7602.67
Hw Elev (ft)	=	7603.89
Hw/D (ft)	=	1.22
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Nov 14 2018

DESIGN POINT D8 - Exist. 24in. Culvert

Invert Elev Dn (ft)	=	7588.00
Pipe Length (ft)	=	50.00
Slope (%)	=	2.00
Invert Elev Up (ft)	=	7589.00
Rise (in)	=	24.0
Shape	=	Circular
Span (in)	=	24.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

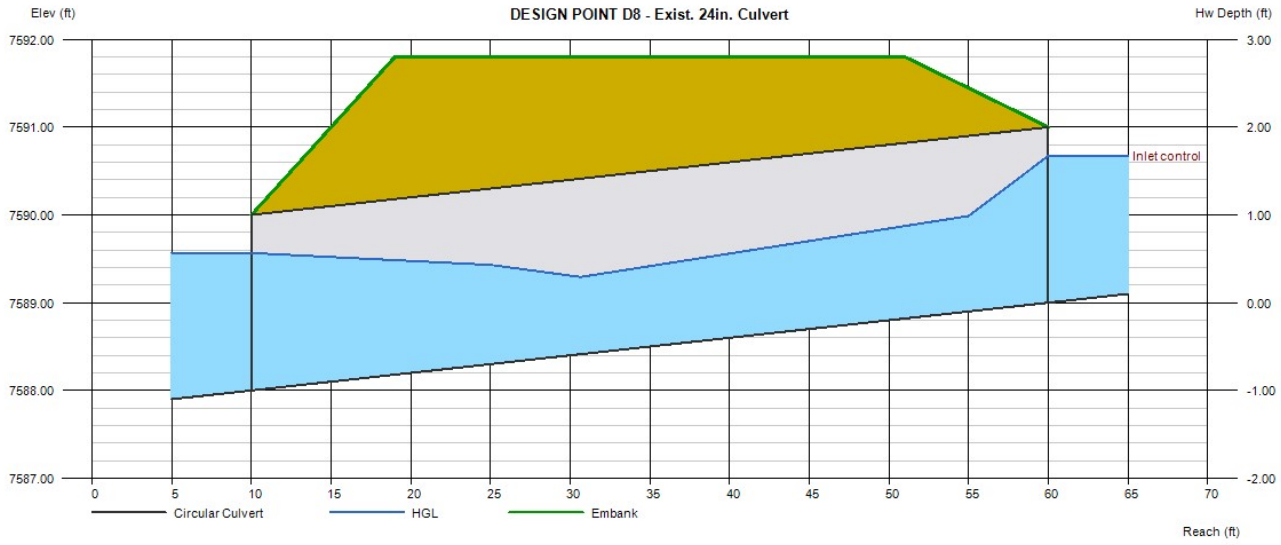
Top Elevation (ft)	=	7591.80
Top Width (ft)	=	32.00
Crest Width (ft)	=	50.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	10.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	10.00
Qpipe (cfs)	=	10.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	3.79
Veloc Up (ft/s)	=	5.46
HGL Dn (ft)	=	7589.57
HGL Up (ft)	=	7590.13
Hw Elev (ft)	=	7590.67
Hw/D (ft)	=	0.84
Flow Regime	=	Inlet Control



Culvert Report

DESIGN POINT D9

Invert Elev Dn (ft)	=	7586.50
Pipe Length (ft)	=	70.00
Slope (%)	=	1.00
Invert Elev Up (ft)	=	7587.20
Rise (in)	=	18.0
Shape	=	Circular
Span (in)	=	18.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

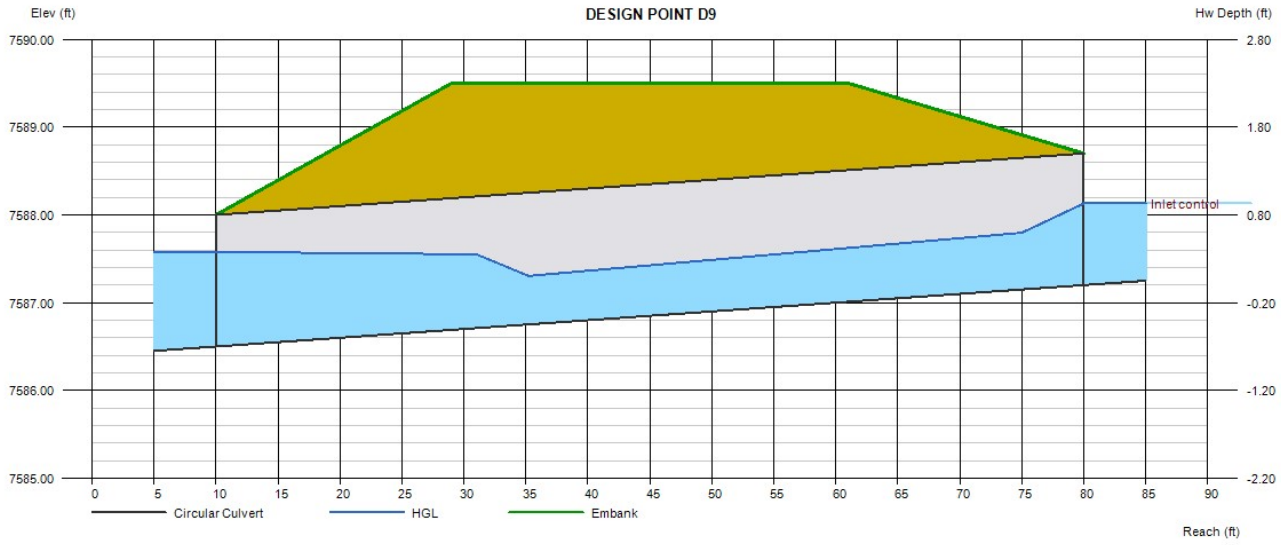
Top Elevation (ft)	=	7589.50
Top Width (ft)	=	32.00
Crest Width (ft)	=	50.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	3.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	3.00
Qpipe (cfs)	=	3.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	2.20
Veloc Up (ft/s)	=	4.02
HGL Dn (ft)	=	7587.58
HGL Up (ft)	=	7587.86
Hw Elev (ft)	=	7588.13
Hw/D (ft)	=	0.62
Flow Regime	=	Inlet Control



Culvert Report

DESIGN POINT D10 - Exist. 24in. Culvert

Invert Elev Dn (ft)	=	7582.00
Pipe Length (ft)	=	45.00
Slope (%)	=	1.00
Invert Elev Up (ft)	=	7582.45
Rise (in)	=	24.0
Shape	=	Circular
Span (in)	=	24.0
No. Barrels	=	2
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

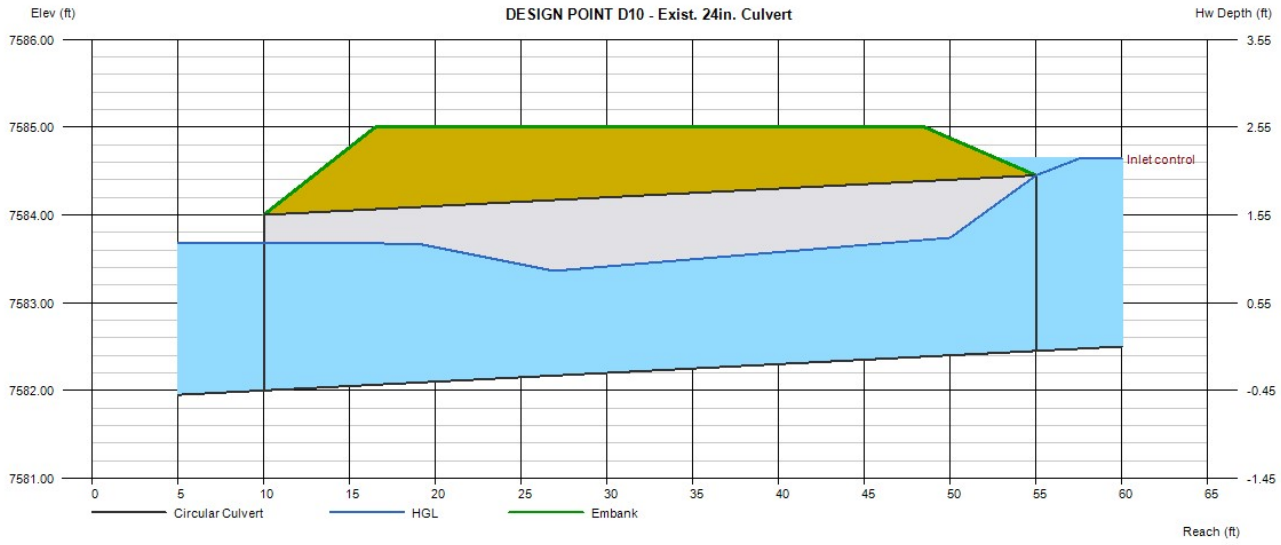
Top Elevation (ft)	=	7585.00
Top Width (ft)	=	32.00
Crest Width (ft)	=	50.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	29.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	29.00
Qpipe (cfs)	=	29.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	5.13
Veloc Up (ft/s)	=	6.32
HGL Dn (ft)	=	7583.69
HGL Up (ft)	=	7583.82
Hw Elev (ft)	=	7584.64
Hw/D (ft)	=	1.09
Flow Regime	=	Inlet Control



BMP FACILITY DESIGN CALCULATIONS

CLASSIC SM
CONSULTING
ENGINEERS & SURVEYORS

Design Procedure Form: Sand Filter (SF)

UD-BMP (Version 3.06, November 2016)

Designer: Marc A. Whorton, P.E.
Company: Classic Consulting
Date: November 14, 2018
Project: Redtail Ranch Filing No. 1 (Pond 1)
Location: Black Forest, CO

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a (100% if all paved and roofed areas upstream of sand filter): I_a = 14.6 %

B) Tributary Area's Imperviousness Ratio (i = I_a/100): i = 0.146

C) Water Quality Capture Volume (WQCV) Based on 12-hour Drain Time
WQCV= 0.8 * (0.91* i^3 - 1.19 * i^2 + 0.78 * i): WQCV = 0.07 watershed inches

D) Contributing Watershed Area (including sand filter area): Area = 644,688 sq ft

E) Water Quality Capture Volume (WQCV) Design Volume
V_{WQCV} = WQCV / 12 * Area: V_{WQCV} = 3,926 cu ft

F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm: d_6 = 0.42 in

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume: $V_{WQCV\ OTHER}$ = 3,835 cu ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired): $V_{WQCV\ USER}$ = _____ cu ft

2. Basin Geometry

A) WQCV Depth: D_{WQCV} = 0.6 ft

B) Sand Filter Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred). Use "0" if sand filter has vertical walls.: Z = 4.00 ft / ft

C) Minimum Filter Area (Flat Surface Area): A_{Min} = 1177 sq ft

D) Actual Filter Area: A_{Actual} = 6421 sq ft

E) Volume Provided: V_T = 7043 cu ft

3. Filter Material

Choose One
- (●) 18" CDOT Class B or C Filter Material
- ( ) Other (Explain):

4. Underdrain System

A) Are underdrains provided?

Choose One
- (●) YES
- ( ) NO

B) Underdrain system orifice diameter for 12 hour drain time

i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice: y = 1.5 ft

ii) Volume to Drain in 12 Hours: Vol_{12} = 3,835 cu ft

iii) Orifice Diameter, 3/8" Minimum: D_O = 1 - 1 / 2 in

Design Procedure Form: Sand Filter (SF)

Designer: Marc A. Whorton, P.E.
Company: Classic Consulting
Date: November 14, 2018
Project: Redtail Ranch Filing No. 1 (Pond 1)
Location: Black Forest, CO

5. Impermeable Geomembrane Liner and Geotextile Separator Fabric A) Is an impermeable liner provided due to proximity of structures or groundwater contamination?	Choose One ○ YES ◉ NO
6-7. Inlet / Outlet Works A) Describe the type of energy dissipation at inlet points and means of conveying flows in excess of the WQCV through the outlet	Rip-Rap at inlet points Concrete Box Structure for detention and release of 100 yr. flows

Notes:

Design Procedure Form: Sand Filter (SF)

UD-BMP (Version 3.06, November 2016)

Designer: Marc A. Whorton, P.E.
Company: Classic Consulting
Date: November 14, 2018
Project: Redtail Ranch Filing No. 1 (Pond 2)
Location: Black Forest, CO

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a (100% if all paved and roofed areas upstream of sand filter): I_a = 9.5 %

B) Tributary Area's Imperviousness Ratio (i = I_a/100): i = 0.095

C) Water Quality Capture Volume (WQCV) Based on 12-hour Drain Time
WQCV= 0.8 * (0.91* i^3 - 1.19 * i^2 + 0.78 * i): WQCV = 0.05 watershed inches

D) Contributing Watershed Area (including sand filter area): Area = 1,245,816 sq ft

E) Water Quality Capture Volume (WQCV) Design Volume
V_{WQCV} = WQCV / 12 * Area: V_{WQCV} = 5,327 cu ft

F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm: d_6 = 0.42 in

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume: $V_{WQCV\ OTHER}$ = 5,203 cu ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired): $V_{WQCV\ USER}$ = _____ cu ft

2. Basin Geometry

A) WQCV Depth: D_{WQCV} = 0.6 ft

B) Sand Filter Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred). Use "0" if sand filter has vertical walls.: Z = 4.00 ft / ft

C) Minimum Filter Area (Flat Surface Area): A_{Min} = 1479 sq ft

D) Actual Filter Area: A_{Actual} = 7895 sq ft

E) Volume Provided: V_T = 5410 cu ft

3. Filter Material

Choose One
- (●) 18" CDOT Class B or C Filter Material
- ( ) Other (Explain):

4. Underdrain System

A) Are underdrains provided?

Choose One
- (●) YES
- ( ) NO

B) Underdrain system orifice diameter for 12 hour drain time

i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice: y = 1.5 ft

ii) Volume to Drain in 12 Hours: Vol_{12} = 5,203 cu ft

iii) Orifice Diameter, 3/8" Minimum: D_O = 1 - 3 / 4 in

Design Procedure Form: Sand Filter (SF)

Designer: Marc A. Whorton, P.E.
Company: Classic Consulting
Date: November 14, 2018
Project: Redtail Ranch Filing No. 1 (Pond 2)
Location: Black Forest, CO

5. Impermeable Geomembrane Liner and Geotextile Separator Fabric A) Is an impermeable liner provided due to proximity of structures or groundwater contamination?	Choose One ○ YES ◉ NO
6-7. Inlet / Outlet Works A) Describe the type of energy dissipation at inlet points and means of conveying flows in excess of the WQCV through the outlet	Rip-Rap at Inflow Concrete Box Outlet for 100 Yr. flows

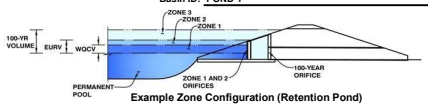
Notes:

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: REDTAIL RANCH FILING NO. 1

Basin ID: POND 1



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	SF		
Watershed Area =	14.80	acres	
Watershed Length =	1,200	ft	
Watershed Slope =	0.020	ft/ft	
Watershed Imperviousness =	14.60%	percent	
Percentage Hydrologic Soil Group A =	0.0%	percent	
Percentage Hydrologic Soil Group B =	100.0%	percent	
Percentage Hydrologic Soil Groups C/D =	0.0%	percent	
Desired WQCV Drain Time =	12.0	hours	
Location for 1-hr Rainfall Depths =	User Input		
Water Quality Capture Volume (WQCV) =	0.090	acre-feet	Optional User Override 1-hr Precipitation
Excess Urban Runoff Volume (EURV) =	0.209	acre-feet	
2-yr Runoff Volume (P1 = 1.19 in.) =	0.149	acre-feet	1.19 inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.225	acre-feet	1.50 inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.436	acre-feet	1.75 inches
25-yr Runoff Volume (P1 = 2 in.) =	0.983	acre-feet	2.00 inches
50-yr Runoff Volume (P1 = 2.25 in.) =	1.328	acre-feet	2.25 inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.780	acre-feet	2.52 inches
500-yr Runoff Volume (P1 = 3.85 in.) =	3.262	acre-feet	3.85 inches
Approximate 2-yr Detention Volume =	0.139	acre-feet	
Approximate 5-yr Detention Volume =	0.211	acre-feet	
Approximate 10-yr Detention Volume =	0.378	acre-feet	
Approximate 25-yr Detention Volume =	0.494	acre-feet	
Approximate 50-yr Detention Volume =	0.521	acre-feet	
Approximate 100-yr Detention Volume =	0.657	acre-feet	

Stage-Storage Calculation

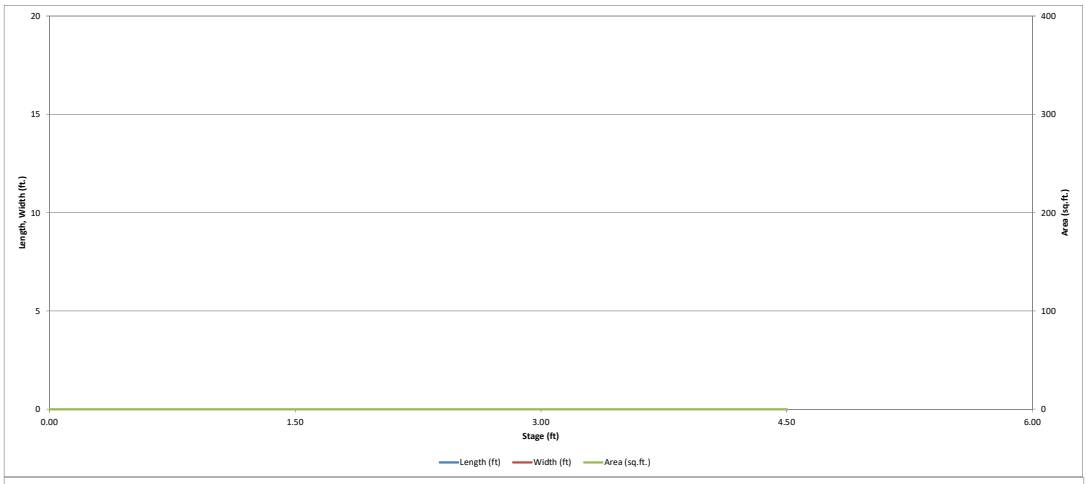
Zone 1 Volume (WQCV) =	0.090	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.119	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.448	acre-feet
Total Detention Basin Volume =	0.657	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	N/A	ft
Slope of Trickle Channel (S_{TC}) =	N/A	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

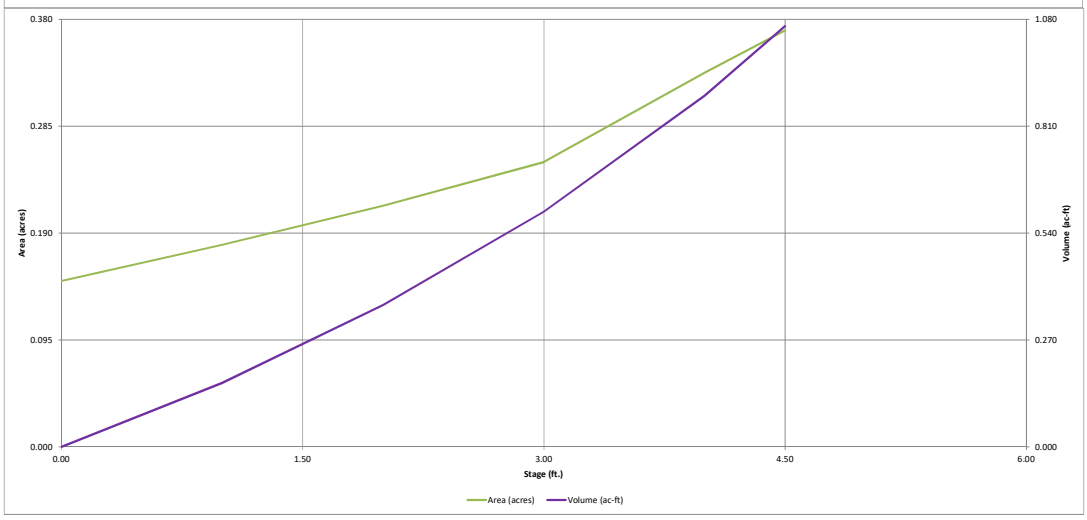
Depth Increment = 0.5 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Media Surface	--	0.00	--	--	--	6,421	0.147		
	--	1.00	--	--	--	7,821	0.180	7,043	0.162
	--	2.00	--	--	--	9,335	0.214	15,606	0.358
	--	3.00	--	--	--	11,027	0.253	25,880	0.594
	--	4.00	--	--	--	14,490	0.333	38,638	0.887
	--	4.50	--	--	--	16,129	0.370	46,293	1.063

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)



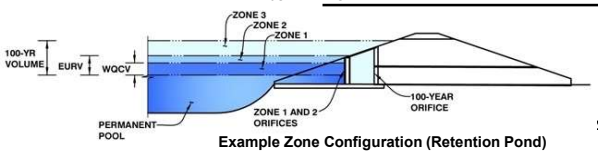


Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: REDTAIL RANCH FILING NO. 1

Basin ID: POND 1



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.58	0.090	Filtration Media
Zone 2 (EURV)	1.25	0.119	Orifice Plate
Zone 3 (100-year)	3.24	0.448	Weir&Pipe (Restrict)
		0.657	Total

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	1.50	ft (distance below the filtration media surface)	Underdrain Orifice Area =	0.0	ft^2
Underdrain Orifice Diameter =	1.64	inches	Underdrain Orifice Centroid =	0.07	feet

Calculated Parameters for Underdrain

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

Invert of Lowest Orifice =	0.58	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	1.250E-02	ft^2
Depth at top of Zone using Orifice Plate =	2.25	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	6.68	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	1.80	sq. inches (diameter = 1-1/2 inches)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.58	1.14	1.69					
Orifice Area (sq. inches)	1.80	1.80	1.80					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected			Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

Calculated Parameters for Vertical Orifice

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.25	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	2.25	N/A	feet
Overflow Weir Front Edge Length =	4.00	N/A	feet	Over Flow Weir Slope Length =	4.00	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)	Grate Open Area / 100-yr Orifice Area =	8.78	N/A	should be ≥ 4
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	12.00	N/A	ft^2
Overflow Grate Open Area % =	75%	N/A	%, grate open area/total area	Overflow Grate Open Area w/ Debris =	6.00	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	1.37	N/A	ft^2
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.60	N/A	feet
Restrictor Plate Height Above Pipe Invert =	13.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	2.03	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.50	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.96	feet
Spillway Crest Length =	10.00	feet	Stage at Top of Freeboard =	4.46	feet
Spillway End Slopes =	3.00	H:V	Basin Area at Top of Freeboard =	0.37	acres
Freeboard above Max Water Surface =		feet			

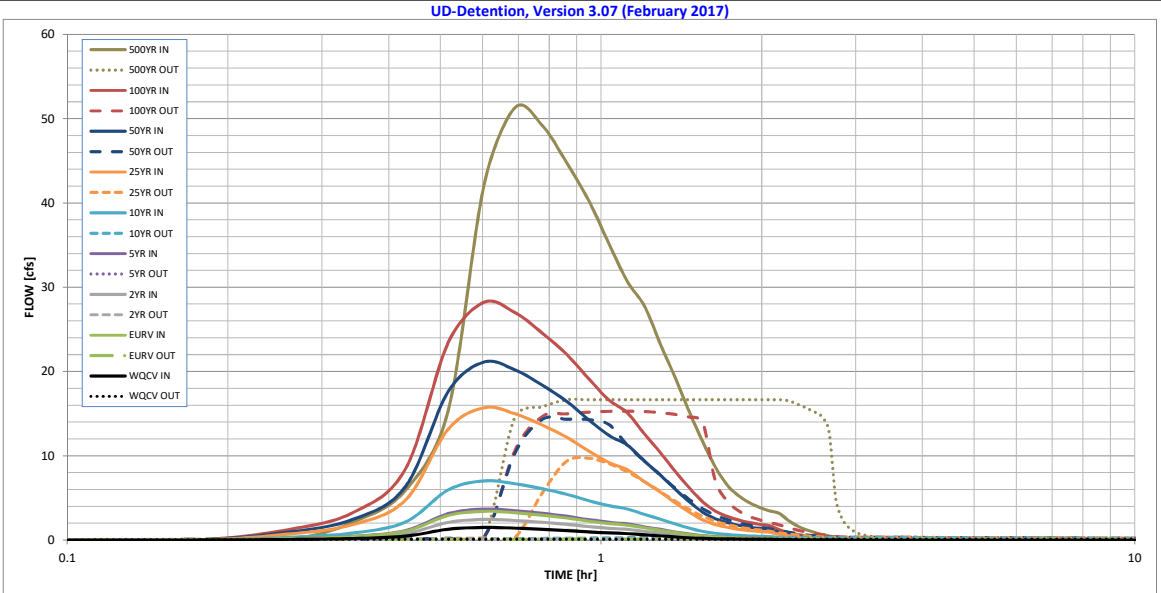
Calculated Parameters for Spillway

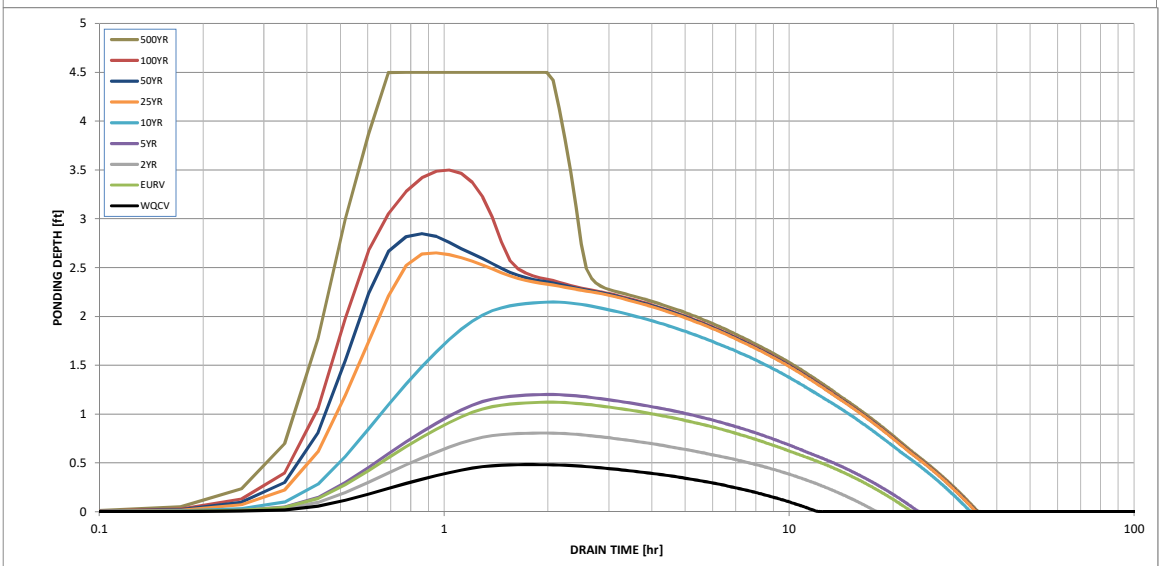
Routed Hydrograph Results

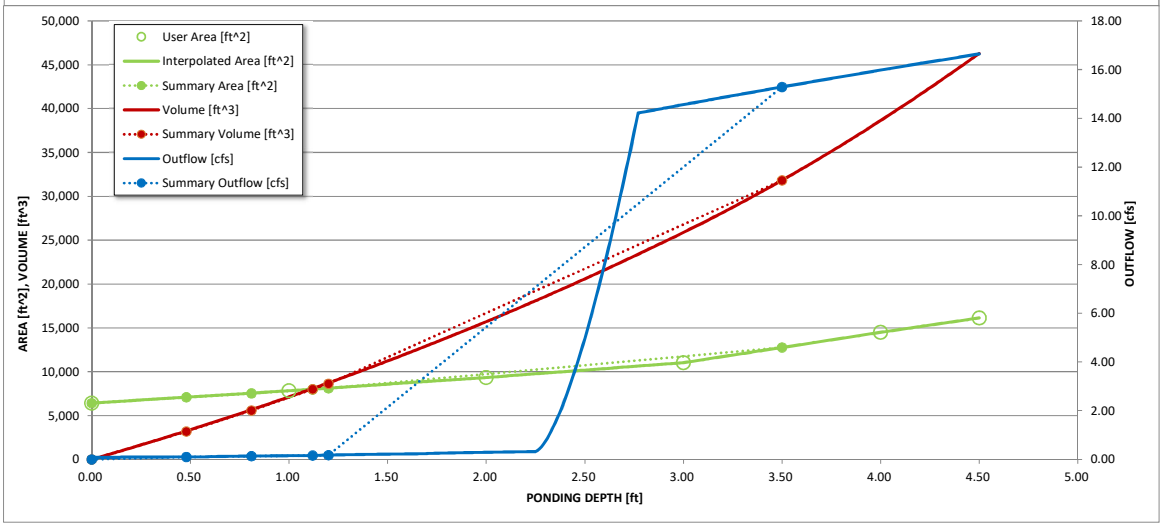
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.85
Calculated Runoff Volume (acre-ft) =	0.090	0.209	0.149	0.225	0.436	0.983	1.328	1.780	3.262
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.090	0.209	0.149	0.225	0.435	0.981	1.326	1.777	3.259
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.19	0.64	0.88	1.19	2.16
Predevelopment Peak Q (cfs) =	0.0	0.0	0.2	0.295	2.8	9.4	13.1	17.6	31.9
Peak Inflow Q (cfs) =	1.5	3.4	2.4	3.7	7.0	15.7	21.1	28.2	51.3
Peak Outflow Q (cfs) =	0.1	0.2	0.1	0.177	0.3	9.7	14.3	15.3	16.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.6	0.1	1.0	1.1	0.9	0.5
Structure Controlling Flow =	Filtration Media	Plate	Plate	Plate	Plate	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	N/A
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.8	1.2	1.2	1.3
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	12	22	17	23	32	31	30	28	23
Time to Drain 99% of Inflow Volume (hours) =	**12**	22	18	23	33	33	33	33	31
Maximum Ponding Depth (ft) =	0.48	1.12	0.81	1.20	2.15	2.65	2.85	3.50	4.50
Area at Maximum Ponding Depth (acres) =	0.16	0.18	0.17	0.19	0.22	0.24	0.25	0.29	0.37
Maximum Volume Stored (acre-ft) =	0.074	0.185	0.128	0.200	0.391	0.506	0.554	0.731	1.063

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







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

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename:

Storm Inflow Hydrographs **UD-Detention, Version 3.07 (February 2017)**

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

Time Interval	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.17 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrograph Constant	0:10:20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:15:31	0.07	0.15	0.11	0.17	0.31	0.69	0.92	1.22	2.16
0.966	0:20:41	0.18	0.41	0.30	0.44	0.84	1.86	2.50	3.32	5.97
	0:25:51	0.47	1.06	0.76	1.14	2.16	4.78	6.41	8.52	15.32
	0:31:01	1.28	2.91	2.09	3.13	5.94	13.14	17.60	23.39	42.02
	0:36:11	1.48	3.40	2.44	3.66	7.01	15.69	21.11	28.20	51.29
	0:41:22	1.41	3.24	2.31	3.49	6.68	14.99	20.19	27.00	49.22
	0:46:32	1.28	2.94	2.10	3.17	6.08	13.65	18.38	24.57	44.79
	0:51:42	1.13	2.61	1.86	2.82	5.42	12.21	16.47	22.05	40.32
	0:56:52	0.96	2.24	1.59	2.41	4.67	10.57	14.29	19.15	35.20
	1:02:02	0.84	1.96	1.39	2.11	4.07	9.20	12.42	16.64	30.69
	1:07:13	0.76	1.77	1.26	1.91	3.69	8.34	11.26	15.09	27.75
	1:12:23	0.61	1.44	1.02	1.56	3.03	6.91	9.36	12.57	23.21
	1:17:33	0.49	1.17	0.82	1.26	2.47	5.66	7.69	10.36	19.20
	1:22:43	0.36	0.88	0.62	0.95	1.89	4.39	5.99	8.11	15.16
	1:27:53	0.26	0.64	0.45	0.70	1.40	3.29	4.53	6.16	11.66
	1:33:04	0.19	0.47	0.33	0.51	1.02	2.38	3.30	4.52	8.67
	1:38:14	0.15	0.37	0.26	0.40	0.79	1.84	2.53	3.44	6.53
	1:43:24	0.13	0.31	0.21	0.33	0.65	1.51	2.07	2.80	5.27
	1:48:34	0.11	0.26	0.18	0.28	0.55	1.28	1.75	2.37	4.44
	1:53:44	0.10	0.23	0.16	0.25	0.49	1.12	1.53	2.07	3.87
	1:58:55	0.09	0.21	0.15	0.22	0.44	1.01	1.37	1.86	3.46
	2:04:05	0.08	0.19	0.14	0.21	0.41	0.93	1.26	1.71	3.17
	2:09:15	0.06	0.14	0.10	0.15	0.30	0.68	0.93	1.26	2.36
	2:14:25	0.04	0.10	0.07	0.11	0.22	0.50	0.68	0.92	1.71
	2:19:35	0.03	0.08	0.05	0.08	0.16	0.37	0.50	0.67	1.26
	2:24:46	0.02	0.05	0.04	0.06	0.12	0.27	0.37	0.50	0.94
	2:29:56	0.02	0.04	0.03	0.04	0.08	0.19	0.27	0.36	0.68
	2:35:06	0.01	0.03	0.02	0.03	0.06	0.14	0.19	0.26	0.49
	2:40:16	0.01	0.02	0.01	0.02	0.04	0.10	0.14	0.19	0.36
	2:45:26	0.00	0.01	0.01	0.01	0.03	0.07	0.09	0.13	0.25
	2:50:37	0.00	0.01	0.00	0.01	0.02	0.04	0.06	0.08	0.16
	2:55:47	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.04	0.09
	3:00:57	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.04
	3:06:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	3:11:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:16:28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:21:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:26:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:31:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:37:08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:42:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:47:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:52:39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:57:49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:02:59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:08:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:13:20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:18:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:23:40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:28:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:34:01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:39:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:44:21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:49:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:54:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:59:52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:36:03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:41:13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:46:23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:51:34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:56:44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:01:54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:07:04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:12:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
MEDIA SURFACE	0.00	6,421	0.147	0	0.000	0.00
WQVC	0.48	7,079	0.163	3,172	0.073	0.10
2 YR.	0.81	7,541	0.173	5,585	0.128	0.13
EURV	1.12	7,988	0.183	7,990	0.183	0.16
5 YR.	1.20	8,109	0.186	8,634	0.198	0.17
100 YR.	3.50	12,758	0.293	31,826	0.731	15.29

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

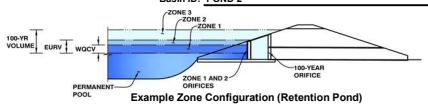
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: REDTAIL RANCH FILING NO. 1

Basin ID: POND 2



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	SF		
Watershed Area =	28.60	acres	
Watershed Length =	2,000	ft	
Watershed Slope =	0.020	ft/ft	
Watershed Imperviousness =	9.50%	percent	
Percentage Hydrologic Soil Group A =	0.0%	percent	
Percentage Hydrologic Soil Group B =	100.0%	percent	
Percentage Hydrologic Soil Groups C/D =	0.0%	percent	
Desired WQCV Drain Time =	12.0	hours	
Location for 1-hr Rainfall Depths =	User Input		
Water Quality Capture Volume (WQCV) =	0.122	acre-feet	
Excess Urban Runoff Volume (EURV) =	0.254	acre-feet	
2-yr Runoff Volume (P1 = 1.19 in.) =	0.174	acre-feet	
5-yr Runoff Volume (P1 = 1.5 in.) =	0.272	acre-feet	
10-yr Runoff Volume (P1 = 1.75 in.) =	0.635	acre-feet	
25-yr Runoff Volume (P1 = 2 in.) =	1.715	acre-feet	
50-yr Runoff Volume (P1 = 2.25 in.) =	2.389	acre-feet	
100-yr Runoff Volume (P1 = 2.52 in.) =	3.270	acre-feet	
500-yr Runoff Volume (P1 = 3.85 in.) =	6.102	acre-feet	
Approximate 2-yr Detention Volume =	0.161	acre-feet	
Approximate 5-yr Detention Volume =	0.254	acre-feet	
Approximate 10-yr Detention Volume =	0.540	acre-feet	
Approximate 25-yr Detention Volume =	0.761	acre-feet	
Approximate 50-yr Detention Volume =	0.795	acre-feet	
Approximate 100-yr Detention Volume =	1.030	acre-feet	

Optional User Override 1-hr Precipitation

1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
3.85	inches

Stage-Storage Calculation

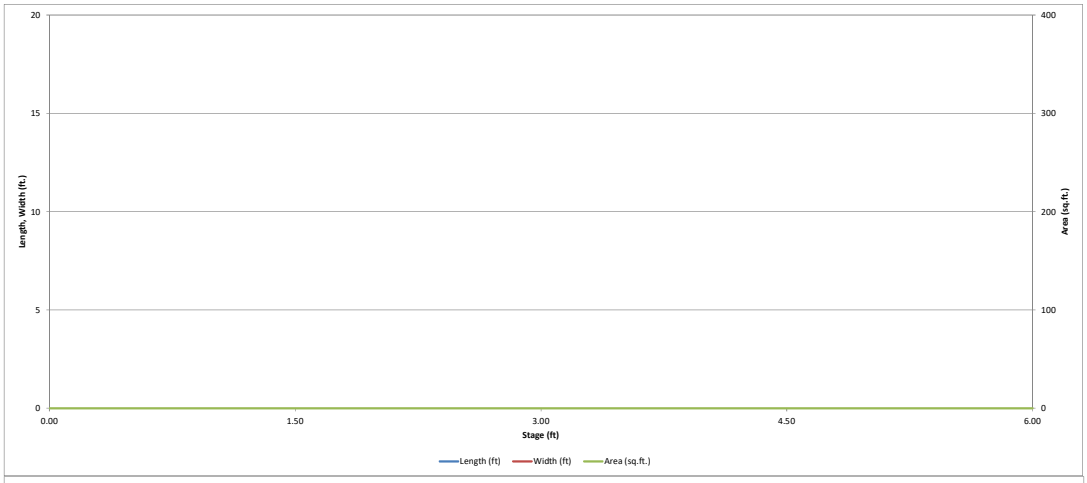
Zone 1 Volume (WQCV) =	0.122	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.132	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.776	acre-feet
Total Detention Basin Volume =	1.030	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	N/A	ft
Slope of Trickle Channel (S_{TC}) =	N/A	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

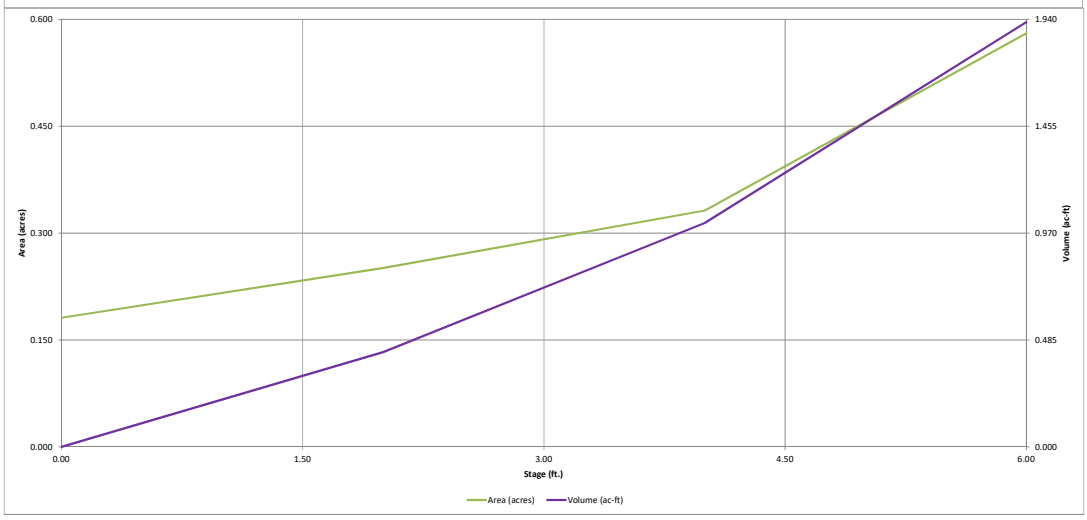
Depth Increment = 1 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Media Surface	--	0.00	--	--	--	7,895	0.181		
	--	2.00	--	--	--	10,942	0.251	18,728	0.430
	--	4.00	--	--	--	14,446	0.332	44,225	1.015
	--	6.00	--	--	--	25,278	0.580	83,949	1.927

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)



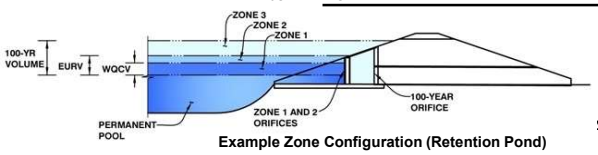


Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: REDTAIL RANCH FILING NO. 1

Basin ID: POND 2



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.64	0.122	Filtration Media
Zone 2 (EURV)	1.26	0.132	Orifice Plate
Zone 3 (100-year)	4.05	0.776	Weir&Pipe (Restrict)
		1.030	Total

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	1.50	ft (distance below the filtration media surface)	Underdrain Orifice Area =	0.0	ft^2
Underdrain Orifice Diameter =	1.92	inches	Underdrain Orifice Centroid =	0.08	feet

Calculated Parameters for Underdrain

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

Invert of Lowest Orifice =	0.64	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	1.736E-02	ft^2
Depth at top of Zone using Orifice Plate =	2.50	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	7.44	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	2.50	sq. inches (diameter = 1-3/4 inches)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.64	1.20	1.85					
Orifice Area (sq. inches)	2.50	2.50	2.50					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected			Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

Calculated Parameters for Vertical Orifice

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.50	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	2.50	N/A	feet
Overflow Weir Front Edge Length =	4.00	N/A	feet	Over Flow Weir Slope Length =	4.00	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)	Grate Open Area / 100-yr Orifice Area =	6.79	N/A	should be ≥ 4
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	12.00	N/A	ft^2
Overflow Grate Open Area % =	75%	N/A	%, grate open area/total area	Overflow Grate Open Area w/ Debris =	6.00	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	1.77	N/A	ft^2
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.75	N/A	feet
Restrictor Plate Height Above Pipe Invert =	18.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.83	feet
Spillway Crest Length =	18.00	feet	Stage at Top of Freeboard =	5.83	feet
Spillway End Slopes =	3.00	H:V	Basin Area at Top of Freeboard =	0.56	acres
Freeboard above Max Water Surface =		feet			

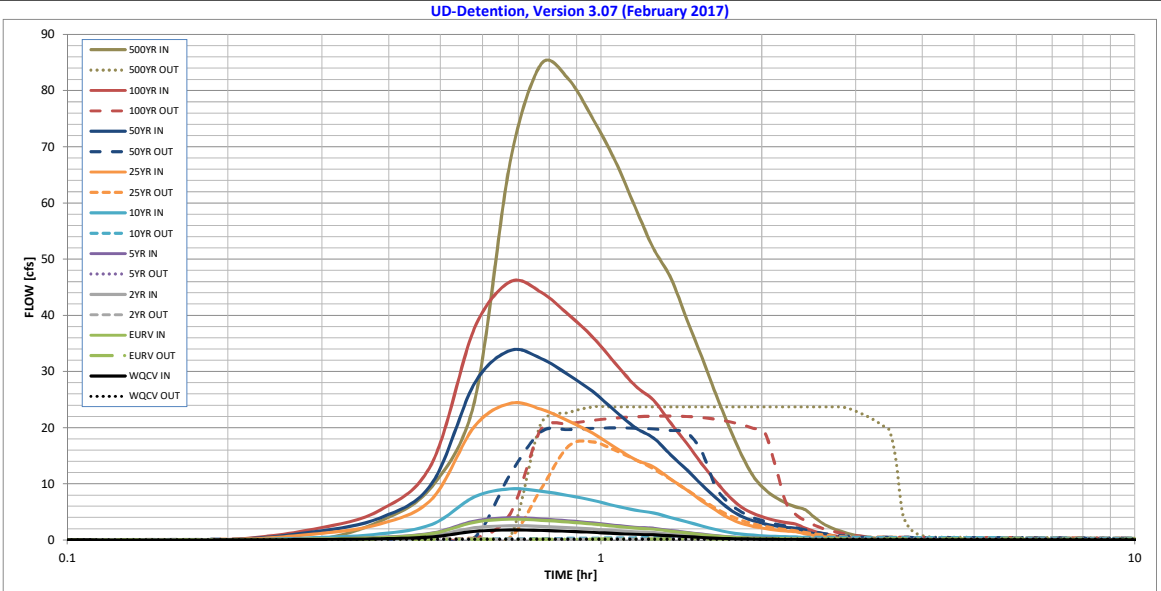
Calculated Parameters for Spillway

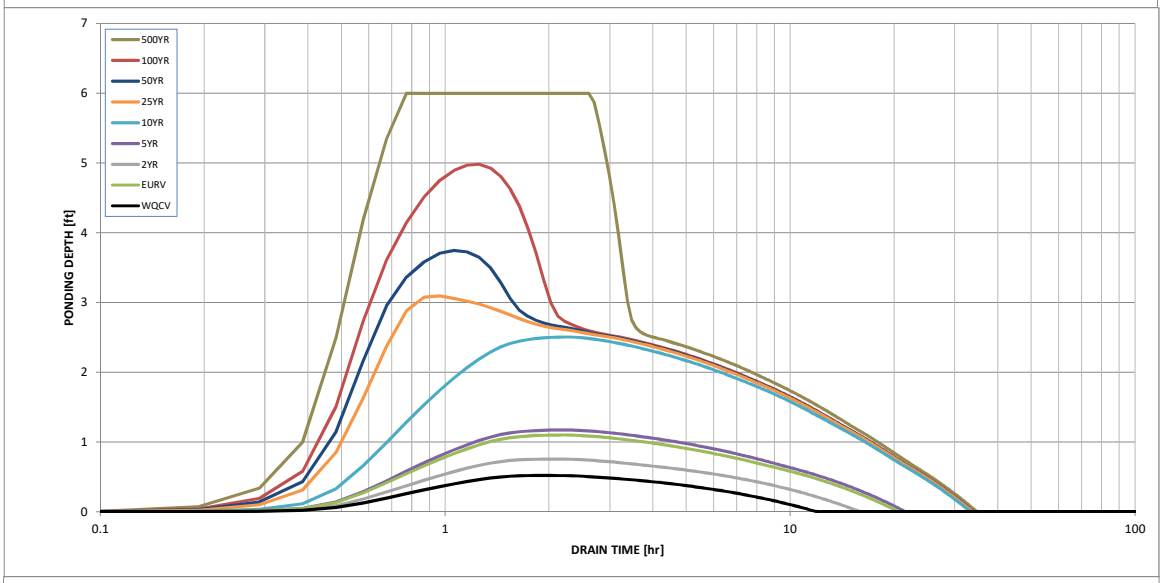
Routed Hydrograph Results

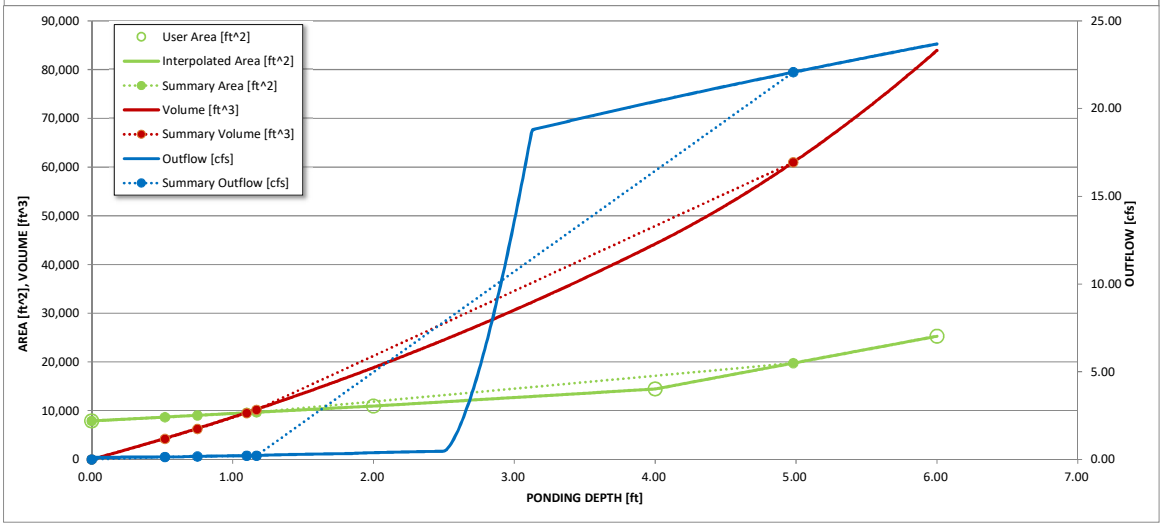
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.85
Calculated Runoff Volume (acre-ft) =	0.122	0.254	0.174	0.272	0.635	1.715	2.389	3.270	6.102
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.121	0.254	0.174	0.272	0.635	1.715	2.390	3.271	6.104
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.16	0.56	0.77	1.05	1.90
Predevelopment Peak Q (cfs) =	0.0	0.0	0.3	0.494	4.7	15.9	22.1	29.9	54.4
Peak Inflow Q (cfs) =	1.8	3.7	2.5	3.9	9.1	24.3	33.7	46.0	84.7
Peak Outflow Q (cfs) =	0.1	0.2	0.2	0.217	0.5	17.5	19.9	22.1	23.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.4	0.1	1.1	0.9	0.7	0.4
Structure Controlling Flow =	Filtration Media	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	N/A
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	1.4	1.6	1.8	1.9
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	12	20	15	21	32	29	27	25	19
Time to Drain 99% of Inflow Volume (hours) =	**12**	21	16	21	33	32	32	31	29
Maximum Ponding Depth (ft) =	0.52	1.10	0.75	1.17	2.50	3.09	3.75	4.98	6.00
Area at Maximum Ponding Depth (acres) =	0.20	0.22	0.21	0.22	0.27	0.30	0.32	0.45	0.58
Maximum Volume Stored (acre-ft) =	0.097	0.218	0.146	0.236	0.563	0.730	0.930	1.400	1.927

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







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

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename:

Storm Inflow Hydrographs **UD-Detention, Version 3.07 (February 2017)**

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

	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.79 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrograph Constant	0:11:35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:17:22	0.08	0.17	0.12	0.18	0.40	1.05	1.44	1.94	3.37
0.864	0:23:10	0.22	0.44	0.31	0.47	1.09	2.86	3.95	5.35	9.56
	0:28:57	0.56	1.14	0.79	1.22	2.79	7.35	10.14	13.72	24.55
	0:34:44	1.53	3.14	2.17	3.35	7.67	20.18	27.83	37.65	67.23
	0:40:32	1.78	3.69	2.54	3.94	9.10	24.31	33.73	45.95	84.68
	0:46:19	1.69	3.51	2.41	3.75	8.69	23.27	32.32	44.10	82.07
	0:52:07	1.54	3.19	2.19	3.41	7.91	21.18	29.42	40.13	74.99
	0:57:54	1.36	2.84	1.94	3.03	7.06	19.00	26.44	36.12	67.60
	1:03:41	1.16	2.43	1.66	2.60	6.10	16.50	23.02	31.54	59.30
	1:09:29	1.01	2.13	1.45	2.27	5.31	14.34	20.03	27.50	51.86
	1:15:16	0.92	1.92	1.31	2.05	4.81	13.00	18.14	24.86	46.67
	1:21:04	0.74	1.57	1.07	1.68	3.97	10.83	15.14	20.79	39.30
	1:26:51	0.60	1.27	0.86	1.36	3.24	8.92	12.50	17.21	32.63
	1:32:38	0.45	0.96	0.65	1.03	2.50	6.98	9.83	13.59	26.01
	1:38:26	0.32	0.71	0.47	0.76	1.86	5.30	7.52	10.45	20.19
	1:44:13	0.24	0.52	0.35	0.55	1.35	3.89	5.55	7.77	15.19
	1:50:01	0.19	0.40	0.27	0.43	1.04	2.96	4.20	5.85	11.32
	1:55:48	0.16	0.33	0.23	0.36	0.86	2.41	3.41	4.72	9.04
	2:01:35	0.13	0.28	0.19	0.30	0.73	2.04	2.87	3.98	7.60
	2:07:23	0.12	0.25	0.17	0.27	0.64	1.78	2.51	3.47	6.59
	2:13:10	0.11	0.23	0.15	0.24	0.58	1.60	2.25	3.10	5.89
	2:18:58	0.10	0.21	0.14	0.22	0.53	1.47	2.06	2.84	5.38
	2:24:45	0.07	0.15	0.10	0.16	0.39	1.08	1.53	2.11	4.06
	2:30:32	0.05	0.11	0.08	0.12	0.29	0.79	1.11	1.53	2.93
	2:36:20	0.04	0.08	0.06	0.09	0.21	0.58	0.82	1.13	2.17
	2:42:07	0.03	0.06	0.04	0.06	0.15	0.43	0.61	0.84	1.61
	2:47:55	0.02	0.04	0.03	0.05	0.11	0.31	0.44	0.61	1.19
	2:53:42	0.01	0.03	0.02	0.03	0.08	0.22	0.31	0.44	0.86
	2:59:29	0.01	0.02	0.01	0.02	0.06	0.16	0.23	0.32	0.62
	3:05:17	0.01	0.01	0.01	0.01	0.04	0.11	0.16	0.22	0.44
	3:11:04	0.00	0.01	0.00	0.01	0.02	0.07	0.10	0.14	0.29
	3:16:52	0.00	0.00	0.00	0.00	0.01	0.04	0.05	0.08	0.17
	3:22:39	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.04	0.08
	3:28:26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02
	3:34:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:51:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:57:23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:03:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:08:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:14:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:26:20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:32:08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:37:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:43:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:49:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:01:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:06:52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:12:40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:18:27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:24:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:41:37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:47:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:53:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:58:59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:04:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:10:34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:16:21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:22:08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:27:56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:33:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:39:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:45:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:51:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:56:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
Media Surface	0.00	7,895	0.181	0	0.000	0.00
WQCV	0.52	8,672	0.199	4,225	0.097	0.13
2 YR.	0.75	9,022	0.207	6,259	0.144	0.17
EURV	1.10	9,556	0.219	9,511	0.218	0.21
5 YR.	1.17	9,662	0.222	10,183	0.234	0.22
100 YR.	4.98	19,754	0.453	60,983	1.400	22.07

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

Project Summary	
Title	Redtail Ranch Filing No. 1
Engineer	MAW
Company	CCES
Date	7/2/2018

Notes	5 Year

Table of Contents

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
Basin C	Post-Development 5 YR	5	0.055	0.350	1.70
Basin K	Post-Development 5 YR	5	0.024	0.300	0.98
Basins E, D, F	Post-Development 5 YR	5	0.211	0.350	7.29
Basins I, J	Post-Development 5 YR	5	0.033	0.250	1.38
Basins OS-2, EX-5, OS-3, OS-4, G, H	Post-Development 5 YR	5	0.430	0.550	9.47

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
D10	Post-Development 5 YR	5	0.297	0.950	2.39
D5	Post-Development 5 YR	5	0.166	0.350	1.74

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Pond 1 (IN)	Post-Development 5 YR	5	0.211	0.350	7.29	(N/A)	(N/A)
Pond 1 (OUT)	Post-Development 5 YR	5	0.111	0.700	0.22	7,601.27	0.208
Pond 2 (IN)	Post-Development 5 YR	5	0.430	0.550	9.47	(N/A)	(N/A)
Pond 2 (OUT)	Post-Development 5 YR	5	0.240	0.950	2.39	7,596.56	0.378

Subsection: I-D-F Table
Label: CO SPRINGS

Return Event: 5 years
Storm Event: CO SPRINGS - 5 Year

I-D-F Curve

Time (hours)	Intensity (in/h)
0.083	5.170
0.167	4.130
0.250	3.520
0.333	3.090
0.417	2.750
0.500	2.480
0.583	2.250
0.667	2.050
0.750	1.870
0.833	1.710
0.917	1.570
1.000	1.440

Subsection: Elevation-Area Volume Curve
Label: Pond 1

Return Event: 5 years
Storm Event: CO SPRINGS - 5 Year

Elevation (ft)	Planimeter (ft^2)	Area (acres)	A1+A2+sqr (A1*A2) (acres)	Volume (ac-ft)	Volume (Total) (ac-ft)
7,600.00	0.000	0.144	0.000	0.000	0.000
7,601.00	0.000	0.174	0.476	0.159	0.159
7,602.00	0.000	0.206	0.569	0.190	0.349
7,603.00	0.000	0.241	0.670	0.223	0.572
7,604.00	0.000	0.333	0.857	0.286	0.858

Subsection: Elevation-Area Volume Curve
Label: Pond 2

Return Event: 5 years
Storm Event: CO SPRINGS - 5 Year

Elevation (ft)	Planimeter (ft^2)	Area (acres)	A1+A2+sqr (A1*A2) (acres)	Volume (ac-ft)	Volume (Total) (ac-ft)
7,595.00	0.000	0.215	0.000	0.000	0.000
7,596.00	0.000	0.249	0.695	0.232	0.232
7,597.00	0.000	0.286	0.802	0.267	0.499
7,598.00	0.000	0.325	0.916	0.305	0.804
7,599.00	0.000	0.424	1.120	0.373	1.178
7,600.00	0.000	0.579	1.498	0.499	1.677

Index

Project Summary	
Title	Redtail Ranch Filing No. 1
Engineer	MAW
Company	CCES
Date	7/2/2018

Notes	100 Year

Table of Contents

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
Basin C	Post-Development 100 YR	100	0.303	0.350	9.26
Basin K	Post-Development 100 YR	100	0.127	0.300	4.61
Basins E, D, F	Post-Development 100 YR	100	0.804	0.350	27.79
Basins I, J	Post-Development 100 YR	100	0.099	0.250	4.20
Basins OS-2, EX-5, OS-3, OS-4, G, H	Post-Development 100 YR	100	2.064	0.550	45.41

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
D10	Post-Development 100 YR	100	2.098	0.750	29.07
D5	Post-Development 100 YR	100	1.003	0.450	24.57

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Pond 1 (IN)	Post-Development 100 YR	100	0.804	0.350	27.79	(N/A)	(N/A)
Pond 1 (OUT)	Post-Development 100 YR	100	0.700	0.500	16.87	7,602.51	0.457
Pond 2 (IN)	Post-Development 100 YR	100	2.064	0.550	45.41	(N/A)	(N/A)
Pond 2 (OUT)	Post-Development 100 YR	100	1.872	0.750	29.07	7,598.35	0.925

Subsection: I-D-F Table
Label: CO SPRINGS

Return Event: 100 years
Storm Event: CO SPRINGS - 100 Year

I-D-F Curve

Time (hours)	Intensity (in/h)
0.083	8.680
0.167	6.930
0.250	5.910
0.333	5.190
0.417	4.620
0.500	4.160
0.583	3.780
0.667	3.440
0.750	3.140
0.833	2.880
0.917	2.640
1.000	2.420

Subsection: Elevation-Area Volume Curve
Label: Pond 1

Return Event: 100 years
Storm Event: CO SPRINGS - 100 Year

Elevation (ft)	Planimeter (ft^2)	Area (acres)	A1+A2+sqr (A1*A2) (acres)	Volume (ac-ft)	Volume (Total) (ac-ft)
7,600.00	0.000	0.144	0.000	0.000	0.000
7,601.00	0.000	0.174	0.476	0.159	0.159
7,602.00	0.000	0.206	0.569	0.190	0.349
7,603.00	0.000	0.241	0.670	0.223	0.572
7,604.00	0.000	0.333	0.857	0.286	0.858

Subsection: Elevation-Area Volume Curve
Label: Pond 2

Return Event: 100 years
Storm Event: CO SPRINGS - 100 Year

Elevation (ft)	Planimeter (ft^2)	Area (acres)	A1+A2+sqr (A1*A2) (acres)	Volume (ac-ft)	Volume (Total) (ac-ft)
7,595.00	0.000	0.215	0.000	0.000	0.000
7,596.00	0.000	0.249	0.695	0.232	0.232
7,597.00	0.000	0.286	0.802	0.267	0.499
7,598.00	0.000	0.325	0.916	0.305	0.804
7,599.00	0.000	0.424	1.120	0.373	1.178
7,600.00	0.000	0.579	1.498	0.499	1.677

Index

Sand Filter T-6

Description

A sand filter is a filtering or infiltrating BMP that consists of a surcharge zone underlain by a sand bed with an underdrain system. During a storm, accumulated runoff collects in the surcharge zone and gradually infiltrates into the underlying sand bed, filling the void spaces of the sand. The underdrain gradually dewaters the sand bed and discharges the runoff to a nearby channel, swale, or storm drain. It is similar to a BMP designed for bioretention in that it utilizes filtering, but differs in that it is not specifically designed for vegetative growth. The absence of vegetation in a sand filter allows for active maintenance at the surface of the filter, (i.e., raking for removing a layer of sediment). For this reason, sand filter criteria allows for a larger contributing area and greater depth of storage. A sand filter is also a dry basin, which can be designed to include the flood control volume above the WQCV or EURV. Sand filters can also be placed in a vault. Underground sand filters have additional requirements. See Fact Sheet T-11 for additional discussion on underground BMPs.

Photograph SF-1. This sand filter, constructed on two sides of a parking garage, is accessible for maintenance, yet screened from public view by a landscape buffer.

Sand/Media Filter	
Functions	
LID/Volume Red.	Yes
WQCV Capture	Yes
WQCV+Flood Control	Yes
Fact Sheet Includes EURV Guidance	No
Typical Effectiveness for Targeted Pollutants[3]	
Sediment/Solids	Very Good[1]
Nutrients	Good
Total Metals	Good
Bacteria	Moderate
Other Considerations	
Life-cycle Costs[4]	Moderate

[1] Not recommended for watersheds with high sediment yields (unless pretreatment is provided).

[3] Based primarily on data from the International Stormwater BMP Database (www.bmpdatabase.org).

[4] Based primarily on BMP-REALCOST available at www.udfcd.org. Analysis based on a single installation (not based on the maximum recommended watershed tributary to each BMP).

Site Selection

Sand filters require a stable watershed. When the watershed includes phased construction, sparsely vegetated areas, or steep slopes in sandy soils, consider another BMP or provide pretreatment before runoff from these areas reach the rain garden.

When sand filters (and other BMPs used for infiltration) are located adjacent to buildings or pavement areas, protective measures should be implemented to avoid adverse impacts to these structures. Oversaturated subgrade soil underlying a structure can cause the structure to settle or result in moisture-related problems. Wetting of expansive soils or bedrock can cause swelling, resulting in structural movements. A geotechnical engineer should evaluate the potential impact of the BMP on adjacent structures based on an evaluation of the subgrade soil, groundwater, and bedrock conditions at the site.

In locations where potentially expansive soils or bedrock exist, placement of a sand filter adjacent to a structure should only be considered if the BMP includes a drainage layer (with underdrain)

structure, and is lined with an impermeable geomembrane liner designed to restrict seepage.

Designing for Maintenance

Recommended maintenance practices for all BMPs are provided in Chapter 6 of this manual. During design, the following should be considered to ensure ease of maintenance over the long-term:

- Do not put a filter sock on the underdrain. This is not necessary and can cause the BMP to clog.
- Install cleanouts. Cleanouts can be used for inspection (by camera) immediately following construction to ensure that the underdrain pipe was not crushed during construction. They can also be used to for ongoing maintenance practices. Consider locating cleanouts in the side slopes of the basin and above the depth of ponding.
- Provide vegetated side slopes to pre-treat runoff by filtering (straining). This will reduce the frequency of maintenance.

Benefits

- Filtering BMPs provide effective water quality enhancement including phosphorus removal.

Limitations

- This BMP may clog and require maintenance if a moderate to high level of silts and clays are allowed to flow into the facility.
- This BMP should not be located within 10 feet of a building foundation without an impermeable membrane. See *Bioretention* (BMP Fact Sheet T-3) of this manual for additional information.
- The sand filter should not be put into operation while construction or major landscaping activities are taking place in the watershed.

Design Procedure and Criteria

The following steps outline the design procedure and criteria for a sand filter.

1. **Basin Storage Volume**: Provide a storage volume above the sand bed of the basin equal to the WQCV based on a 12-hour drain time.
   - Determine the imperviousness of the tributary area (or effective imperviousness where LID techniques are implemented). Determine the required WQCV (watershed inches of runoff) using Figure 3-2 in Chapter 3 of this manual. The volume should be based on a drain time of 12 hours.
   - Calculate the design volume as follows:

$$V = \left[\frac{\text{WQCV}}{12}\right] A \qquad \text{Equation SF-1}$$

   Where:

   V = design volume (ft^3)

   A = watershed area tributary to the sand filter (ft^2)

2. **Basin Geometry:** Use equation SF-2 to calculate the minimum filter area, which is the flat surface of the sand filter. Sediment will reside on the filter area of the sand filter. Therefore, if the filter area is too small, the filter may clog prematurely. If this is of particular concern, increasing the filter area will decrease the frequency of maintenance. The following equation provides the minimum filter area allowing for some of the volume to be stored beyond the area of the filter. **Note that the total**

volume must also equal or exceed the design volume.

The side slopes of the basin should be stable and maintainable. For vegetated side slopes, a 4:1 (horizontal: vertical) minimum slope is recommended. Use vertical walls where side slopes are steeper than 3:1

$$A_F = 0.0125AI \qquad \text{Equation SF-2}$$

Where:

A_F = minimum filter area (flat surface area) (ft^2)

A = area tributary to the sand filter (ft^2)

I = imperviousness of area tributary to the sand filter (percent expressed as a decimal)

Filter Material: Provide, at a minimum, an 18-inch layer of CDOT Class B or C filter material (see Table SF-1). Maintain a flat surface on the top of the sand bed.

Table SF-1. Gradation specifications for CDOT Class B or C filter material
(Source: CDOT Table 703-7)

	CDOT Class B filter material	CDOT Class C filter material
Sieve Size	Mass Percent Passing Square Mesh Sieves	
37.5 mm (1.5")	100	
19.0 mm (0.75")		100
4.75 mm (No.4)	20-60	60-100
1.18 um (No. 16)	10-30	
300 um (No. 50)	0-10	10-30
150 um (No. 100)		0-10
75 um (No. 200)	0-3	0-3

4. **Underdrain System**: Underdrains are typically required for sand filters and should be provided if infiltration tests show rates slower than 2 times that required to drain the WQCV over 12 hours, or where required to divert water away from structures as determined by a professional engineer. Infiltration tests should be performed or supervised by a licensed professional engineer and conducted at a minimum depth equal to the bottom of the sand filter. Additionally, underdrains are required where impermeable membranes are used. There are three basic types of sand filters:

   - **No-Infiltration Section**: This section includes an underdrain and an impermeable liner that prevents infiltration of stormwater into the subgrade soils. Consider using this section when any of the following conditions exist:
     - The site is a stormwater hotspot and infiltration could result in contamination of groundwater.
     - The site is located over contaminated soils and infiltration could mobilize these contaminants.
     - The facility is located over potentially expansive soils or bedrock that could swell due to infiltration and potentially damage adjacent structures (e.g., building foundation or pavement).
   - **Partial Infiltration Section**: This section does not include an impermeable liner, and allows some infiltration. Stormwater that does not infiltrate is collected and removed by an underdrain system.
   - **Full Infiltration Section**: This section is designed to infiltrate the water stored in the basin into the subgrade below. UDFCD recommends a minimum infiltration rate of 2 times the rate needed to drain the WQCV over 12 hours. A conservative design could utilize the partial infiltration section with the addition of a valve at the underdrain outlet. In the event that infiltration does not remain adequate following construction, the valve could be opened and allow this section to operate as a partial infiltration section. It is rare that sand filters are designed to fully infiltrate.

When using an underdrain system, provide a control orifice sized to drain the design volume in approximately 12 hours or more (see Equation SF-3). Use a minimum orifice size of 3/8 inch to avoid clogging. This will provide detention and slow release of the WQCV to offset hydromodification. Provide cleanouts to allow inspection of the drainpipe system during and after construction to ensure that the pipe was not crushed or disconnected during construction and to allow for maintenance of the underdrain. Space underdrain pipes a maximum of 20 feet on-center.

$$D_{12\text{ hour drain time}} = \sqrt{\frac{V}{1414\, y^{0.41}}} \qquad \text{Equation SF-3}$$

Where:

D = orifice diameter (in)

y = distance from the lowest elevation of the storage volume (ft) (i.e., surface of the filter) to the center of the orifice

V = volume to drain in 12 hours (WQCV) (ft^3)

In previous versions of this manual, UDFCD recommended that the underdrain be placed in an aggregate layer and that a geotextile (separator fabric) be placed between this aggregate and the growing medium. This version of the manual replaces that section with materials that, when used

together, eliminate the need for a separator fabric.

The underdrain system should be placed below the 18-inch (minimum) filter layer. The underdrain system should be placed within an 5-inch-thick section of CDOT Class C filter material meeting the gradation in Table SF-1. Areas of the underdrain layer may be deeper due to the slope of the underdrain. If no underdrain is required, the minimum section can be reduced to the 18-inch filter layer. Use slotted pipe that meets the slot dimensions provided in Table SF-2.

Table SF-2. Dimensions for Slotted Pipe[1]

Pipe Size	Slot Length	Maximum Slot Width	Slot Centers	Open Area (per foot)
4"	1-1/16"	0.032"	0.413"	1.90 in^2
6"	1-3/8"	0.032"	0.516"	1.98 in^2

[1] Pipe must conform to requirements of ASTM designation F949. There shall be no evidence of splitting, cracking, or breaking when the pipe is tested per ASTM test method D2412 in accordance with F949 section 7.5 and ASTM F794 section 8.5. Contech A-2000 slotted pipe (or equal).

Table SF-3. Physical Requirements for Separator Fabric[1]

Property	Class B		Test Method
	Elongation < 50%[2]	Elongation > 50%[2]	
Grab Strength, N (lbs)	800 (180)	510 (115)	ASTM D 4632
Puncture Resistance, N (lbs)	310 (70)	180 (40)	ASTM D 4833
Trapezoidal Tear Strength, N (lbs)	310 (70)	180 (40)	ASTM D 4533
Apparent Opening Size, mm (US Sieve Size)	AOS < 0.3mm (US Sieve Size No. 50)		ASTM D 4751
Permittivity, sec^{-1}	0.02 default value, must also be greater than that of soil		ASTM D 4491
Permeability, cm/sec	k fabric > k soil for all classes		ASTM D 4491
Ultraviolet Degradation at 500 hours	50% strength retained for all classes		ASTM D 4355

[1] Strength values are in the weaker principle direction
[2] As measured in accordance with ASTM D 4632

5. **Impermeable Geomembrane Liner and Geotextile Separator Fabric:** For no-infiltration sections, install a minimum 30-mil thick PVC geomembrane liner, per Table SF-4, on the bottom and sides of the basin, extending up at least to the top of the underdrain layer. Provide at least 9 inches (12 inches if possible) of cover over the membrane where it is attached to the wall to protect the membrane from UV deterioration. The geomembrane should be field-seamed using a dual track welder, which allows for non-destructive testing of almost all field seams. A small amount of single track and/or adhesive seaming should be allowed in limited areas to seam around pipe perforations, to patch seams removed for destructive seam testing, and for limited repairs. The liner should be installed with slack to prevent tearing due to backfill, compaction, and settling. Place CDOT Class B geotextile separator fabric above the geomembrane to protect it from being punctured during the placement of the filter material above the liner. If the subgrade contains angular rocks or other material that could puncture the geomembrane, smooth-roll the surface to create a suitable surface. If smooth-rolling the surface does not provide a suitable surface, also place the separator fabric between the geomembrane and the underlying subgrade. This should only be done when necessary because fabric placed under the geomembrane can increase seepage losses through pinholes or other geomembrane defects. Connect the geomembrane to perimeter concrete walls around the basin perimeter, creating a watertight seal between the geomembrane and the walls using a continuous batten bar and anchor connection (see Figure SF-3). Where the need for the impermeable membrane is not as critical, the membrane can be attached with a nitrile-based vinyl adhesive. Use watertight PVC boots for underdrain pipe penetrations through the liner (see Figure SF-2).

Table SF-4. Physical Requirements for Geomembrane

Property	Thickness 0.76 mm (30 mil)	Test Method
Thickness, % Tolerance	±5	ASTM D 1593
Tensile Strength, kN/m (lbs/in) width	12.25 (70)	ASTM D 882, Method B
Modulus at 100% Elongation, kN/m (lbs/in)	5.25 (30)	ASTM D 882, Method B
Ultimate Elongation, %	350	ASTM D 882, Method A
Tear Resistance, N (lbs)	38 (8.5)	ASTM D 1004
Low Temperature Impact, °C (°F)	-29 (-20)	ASTM D 1790
Volatile loss, % max.	0.7	ASTM D 1203, Method A
Pinholes, No. Per 8 m^2 (No. per 10 sq. yds.) max.	1	N/A
Bonded Seam Strength, % of tensile strength	80	N/A

6. **Inlet Works**: Provide energy dissipation and a forebay at all locations where concentrated flows enter the basin. Use an impact basin for pipes and a baffle chute or grouted sloping boulder drop if a channel or swale is used, or install a Type VL or L riprap basin underlain with geotextile fabric at the inlet (see Figure SF-1). Fill all rock voids with the filter material specified in Table SF-1.

7. **Outlet Works**: Slope the underdrain into a larger outlet structure. As discussed in Step 4, use an orifice plate to drain the WQCV over approximately 12 hours. Flows exceeding the WQCV should also drain into the outlet structure. Additional flow restrictions may be incorporated to provide full spectrum detention, as discussed in the *Storage* chapter of Volume 2, or peak reduction for other specific storm events.

   For full spectrum detention, perform reservoir routing calculations to design the outlet structure. The *UD-Detention* workbook, available at www.udfcd.org, can be used for this purpose. The design could include a second orifice located at the WQCV elevation or could include a downstream point of control designed to drain the full excess urban runoff volume (EURV).

Construction Considerations

Proper construction of sand filters involves careful attention to material specifications and construction details. For a successful project, do the following:

- Protect area from excessive sediment loading during construction. The portion of the site draining to the sand filter must be stabilized before allowing flow into the sand filter.
- When using an impermeable liner, ensure enough slack in the liner to allow for backfill, compaction, and settling without tearing the liner.

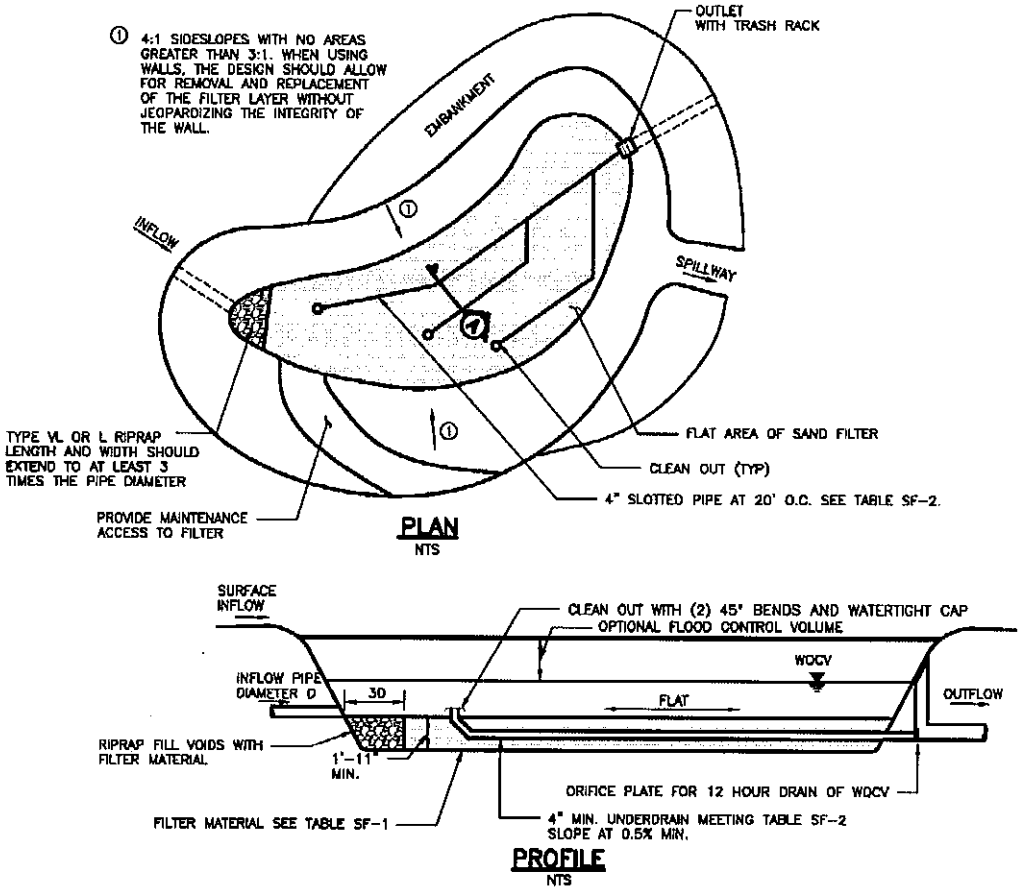


Figure SF-1. Sand Filter Plan and Sections

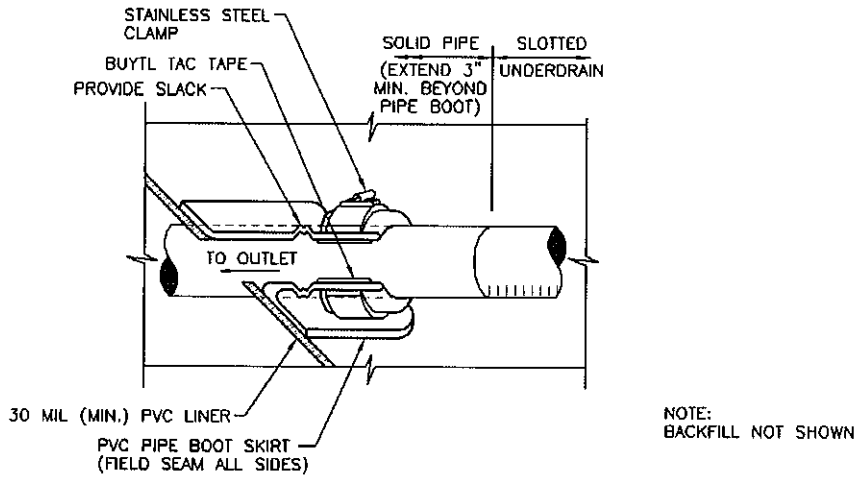


Figure SF-2. Geomembrane Liner/Underdrain Penetration Detail

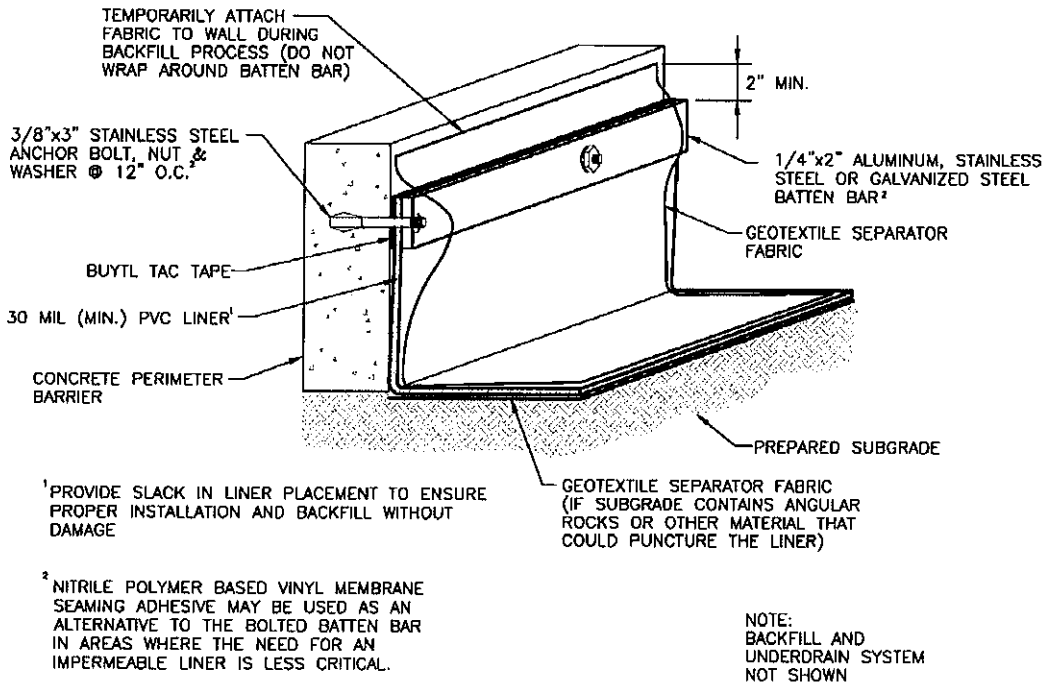


Figure SF-3. Geomembrane Liner/Concrete Connection Detail

DRAINAGE MAPS

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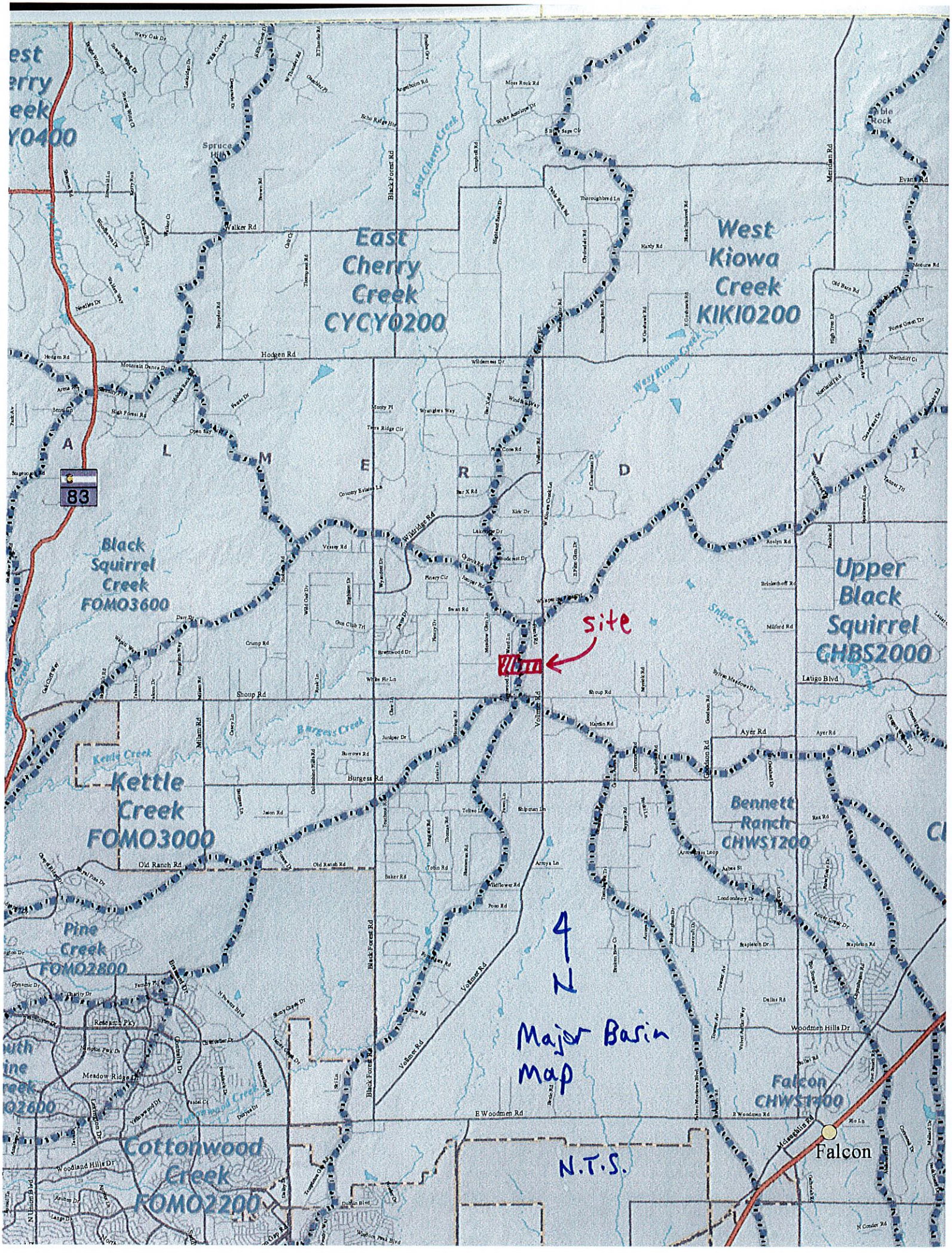
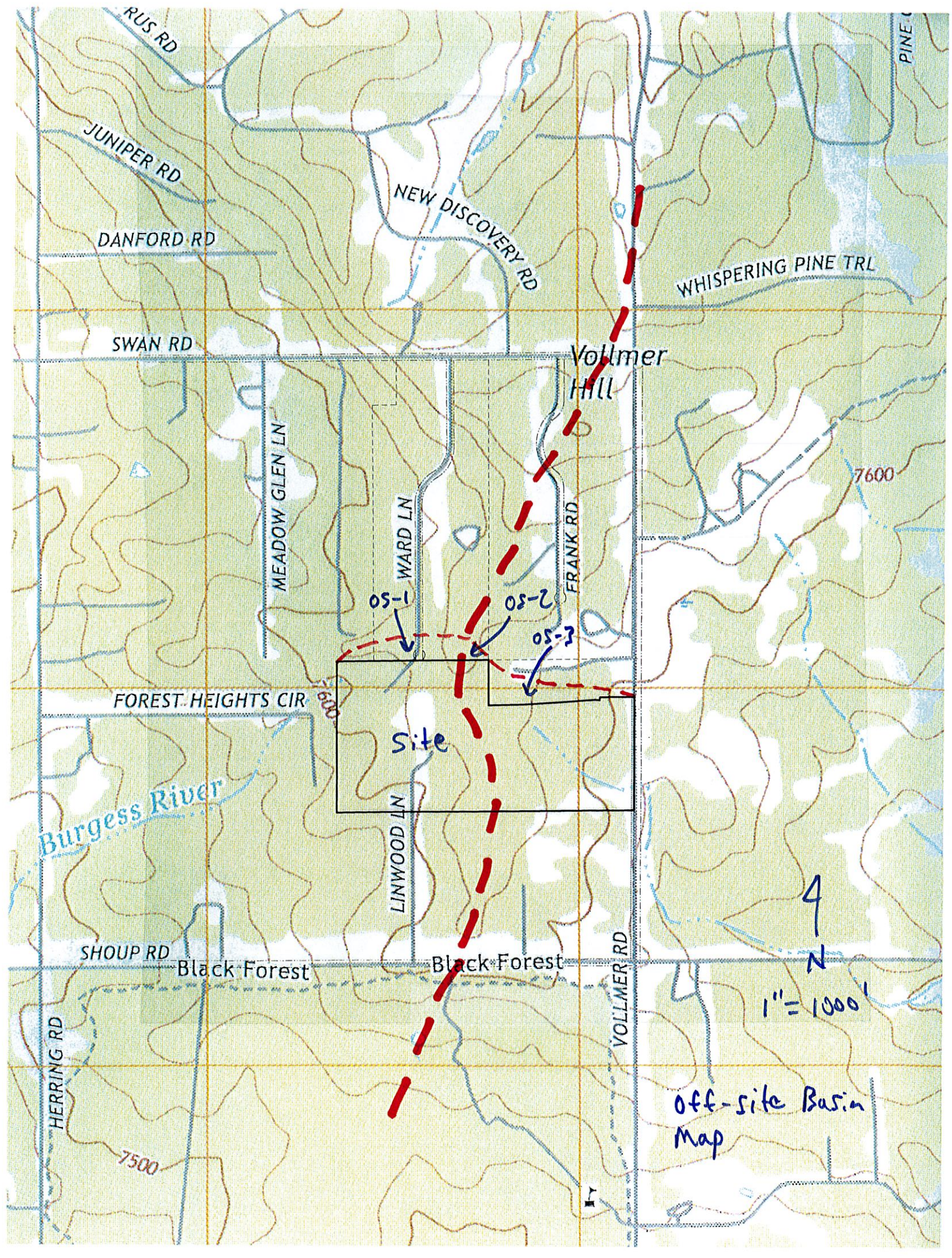

East Cherry Creek CYCY0200
West Kiowa Creek KIKI0200
Black Squirrel Creek FOMO3600
Upper Black Squirrel CHBS2000
Kettle Creek FOMO3000
Bennett Ranch CHWS1200
Pine Creek FOMO2800
Falcon CHWS1400
Cottonwood Creek FOMO2200
site
4 N
Major Basin Map
N.T.S.
Falcon
ALMER D
83
Walker Rd
Hodgen Rd
Shoup Rd
Burgess Rd
Old Ranch Rd
Black Forest Rd
Volmer Rd
Ayer Rd
Latigo Blvd
E Woodmen Rd
Woodmen Hills Dr
Research Pky
Meridian Rd
Evans Rd
Falcon


RUS RD
JUNIPER RD
DANFORD RD
NEW DISCOVERY RD
WHISPERING PINE TRL
SWAN RD
Vollmer Hill
MEADOW GLEN LN
WARD LN
FRANK RD
7600
OS-1
OS-2
OS-3
FOREST HEIGHTS CIR
7600
Site
Burgess River
LINWOOD LN
SHOUP RD
Black Forest
Black Forest
VOLLMER RD
HERRING RD
7500
N
1" = 1000'
Off-site Basin Map

FINAL DRAINAGE REPORT ~ BASIN RUNOFF COEFFICIENT SUMMARY

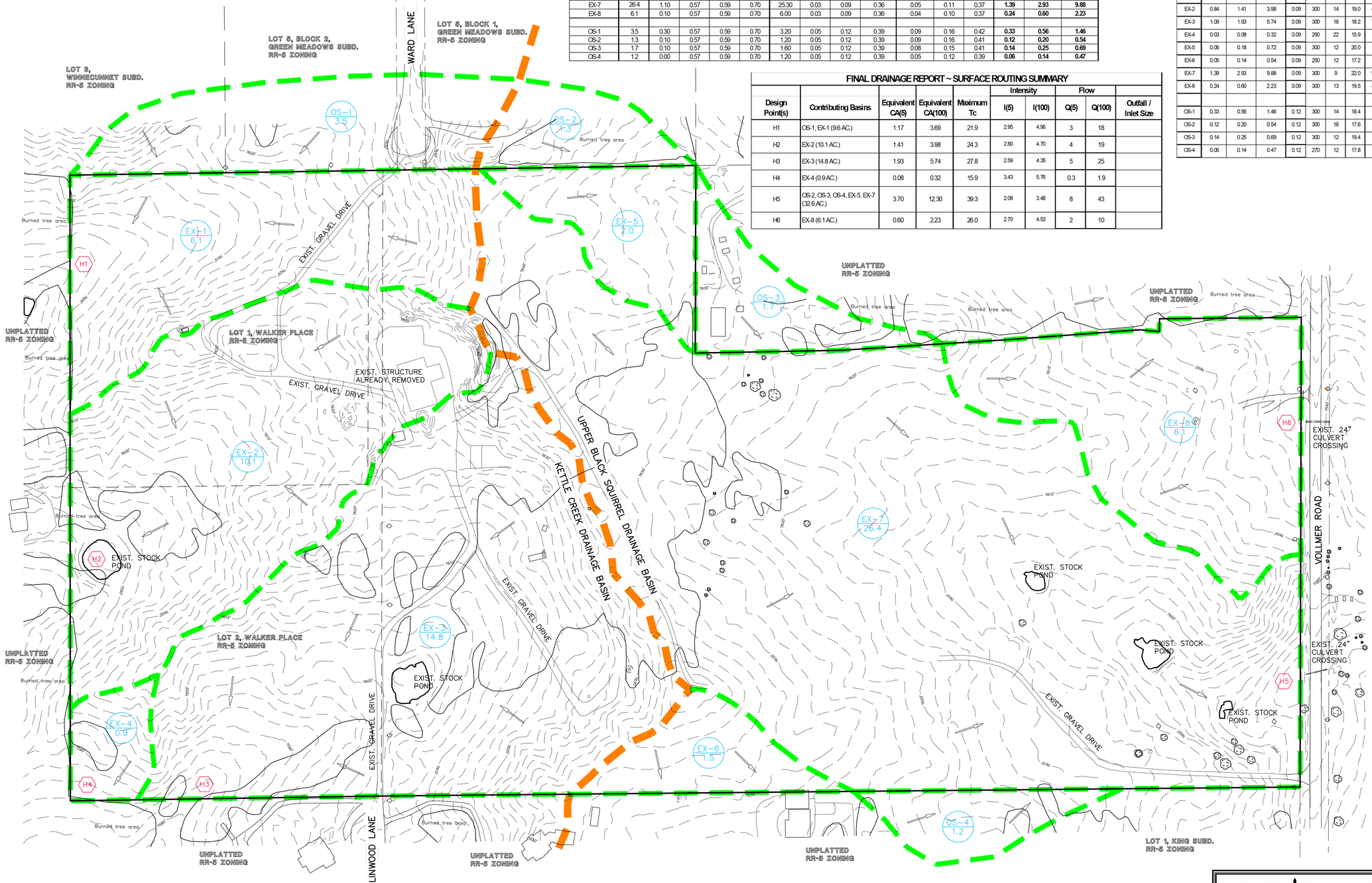
BASIN	TOTAL AREA (AC)	IMPERVIOUS AREA / STREETS				LANDSCAPE/UNDEVELOPED AREAS				WEIGHTED			WEIGHTED CA		
		AREA (AC)	C(2)	C(5)	C(100)	AREA (AC)	C(2)	C(5)	C(100)	C(2)	C(5)	C(100)	CA(2)	CA(5)	CA(100)
EX-1	6.1	0.12	0.57	0.59	0.70	5.98	0.03	0.09	0.36	0.04	0.10	0.37	**0.25**	**0.61**	**2.24**
EX-2	10.1	1.00	0.57	0.59	0.70	9.10	0.03	0.09	0.36	0.08	0.14	0.39	**0.84**	**1.41**	**3.98**
EX-3	14.8	1.20	0.57	0.59	0.70	13.60	0.03	0.09	0.36	0.07	0.13	0.39	**1.09**	**1.93**	**5.74**
EX-4	0.9	0.00	0.89	0.90	0.96	0.90	0.03	0.09	0.36	0.03	0.09	0.36	**0.03**	**0.08**	**0.32**
EX-5	2.0	0.00	0.89	0.90	0.96	2.00	0.03	0.09	0.36	0.03	0.09	0.36	**0.06**	**0.18**	**0.72**
EX-6	1.5	0.00	0.89	0.90	0.96	1.50	0.03	0.09	0.36	0.03	0.09	0.36	**0.05**	**0.14**	**0.54**
EX-7	26.4	1.10	0.57	0.59	0.70	25.30	0.03	0.09	0.36	0.05	0.11	0.37	**1.39**	**2.93**	**9.88**
EX-8	6.1	0.10	0.57	0.59	0.70	6.00	0.03	0.09	0.36	0.04	0.10	0.37	**0.24**	**0.60**	**2.23**
OS-1	3.5	0.30	0.57	0.59	0.70	3.20	0.05	0.12	0.39	0.09	0.16	0.42	**0.33**	**0.56**	**1.46**
OS-2	1.3	0.10	0.57	0.59	0.70	1.20	0.05	0.12	0.39	0.09	0.16	0.41	**0.12**	**0.20**	**0.54**
OS-3	1.7	0.10	0.57	0.59	0.70	1.60	0.05	0.12	0.39	0.08	0.15	0.41	**0.14**	**0.25**	**0.69**
OS-4	1.2	0.00	0.57	0.59	0.70	1.20	0.05	0.12	0.39	0.05	0.12	0.39	**0.06**	**0.14**	**0.47**

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)	
H1	OS-1, EX-1 (9.6 AC.)	1.17	3.69	21.9	2.95	4.96	3	18	
H2	EX-2 (10.1 AC.)	1.41	3.98	24.3	2.80	4.70	4	19	
H3	EX-3 (14.8 AC.)	1.93	5.74	27.8	2.59	4.35	5	25	
H4	EX-4 (0.9 AC.)	0.08	0.32	15.9	3.43	5.76	0.3	1.9	
H5	OS-2, OS-3, OS-4, EX-5, EX-7 (32.6 AC.)	3.70	12.30	39.3	2.08	3.48	8	43	
H6	EX-8 (6.1 AC.)	0.60	2.23	26.0	2.70	4.53	2	10	

FINAL DRAINAGE REPORT ~ BASIN RUNOFF SUMMARY

BASIN	WEIGHTED			OVERLAND			STREET / CHANNEL FLOW				Tc	INTENSITY			TOTAL FLOWS		
	CA(2)	CA(5)	CA(100)	C(5)	Length (ft)	Height (ft)	Tc (min)	Length (ft)	Slope (%)	Velocity (fps)	Tc (min)	TOTAL (min)	I(2) (in/hr)	I(5) (in/hr)	I(100) (in/hr)	Q(2) (cfs)	Q(5) (cfs)	Q(100) (cfs)
EX-1	0.25	0.61	2.24	0.09	300	18	17.5	350	3.6%	1.3	4.4	21.9	2.36	2.95	4.96	1	**2**	**11**
EX-2	0.84	1.41	3.98	0.09	300	14	19.0	470	4.5%	1.5	5.3	24.3	2.24	2.80	4.70	2	**4**	**19**
EX-3	1.09	1.93	5.74	0.09	300	16	18.2	770	3.6%	1.3	9.7	27.8	2.08	2.59	4.35	2	**5**	**25**
EX-4	0.03	0.08	0.32	0.09	290	22	15.9					15.9	2.74	3.43	5.76	0.1	**0.3**	**1.9**
EX-5	0.05	0.18	0.72	0.09	300	12	20.0	100	2.5%	1.1	1.5	21.5	2.38	2.98	5.00	0.1	**0.5**	**4**
EX-6	0.05	0.14	0.54	0.09	250	12	17.2					17.2	2.65	3.32	5.57	0.1	**0.4**	**3**
EX-7	1.39	2.93	9.88	0.09	300	9	22.0	1800	3.0%	1.7	17.3	39.3	1.67	2.08	3.48	2	**6**	**34**
EX-8	0.24	0.60	2.23	0.09	300	13	19.5	480	3.1%	1.2	6.5	26.0	2.16	2.70	4.53	1	**2**	**10**
OS-1	0.33	0.56	1.46	0.12	300	14	18.4					18.4	2.57	3.21	5.39	0.8	**2**	**8**
OS-2	0.12	0.20	0.54	0.12	300	16	17.6					17.6	2.62	3.28	5.50	0.3	**0.7**	**3**
OS-3	0.14	0.25	0.69	0.12	300	12	19.4					19.4	2.51	3.14	5.26	0.3	**0.8**	**4**
OS-4	0.05	0.14	0.47	0.12	270	12	17.8					17.8	2.61	3.27	5.48	0.2	**0.5**	**3**



LEGEND

DESCRIPTION	SYMBOL
EXISTING GROUND CONTOUR	6910
MAJOR BASIN BOUNDARY	
BASIN BOUNDARY	
BASIN IDENTIFIER / AREA IN ACRES	H-1 / 10.0
DESIGN POINT	H2
EXISTING TREES / SHRUBS	
EXISTING FORESTED AREA OUTLINE	

N

100 50 0 100 200

SCALE: 1" = 100'

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

REDTAIL RANCH
PRELIMINARY/FINAL DRAINAGE REPORT
PRE-DEVELOPMENT DRAINAGE MAP

DESIGNED BY	MAW	SCALE		DATE	7-3-18
DRAWN BY	MAW	(H) 1"= 100'		SHEET	1 OF 2
CHECKED BY		(V) 1"= N/A		JOB NO.	2525.00

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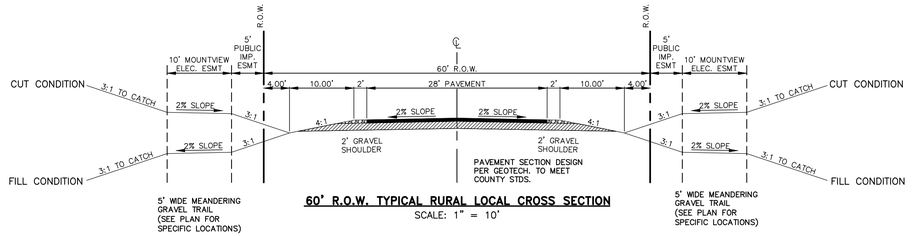


60' R.O.W. TYPICAL RURAL LOCAL CROSS SECTION

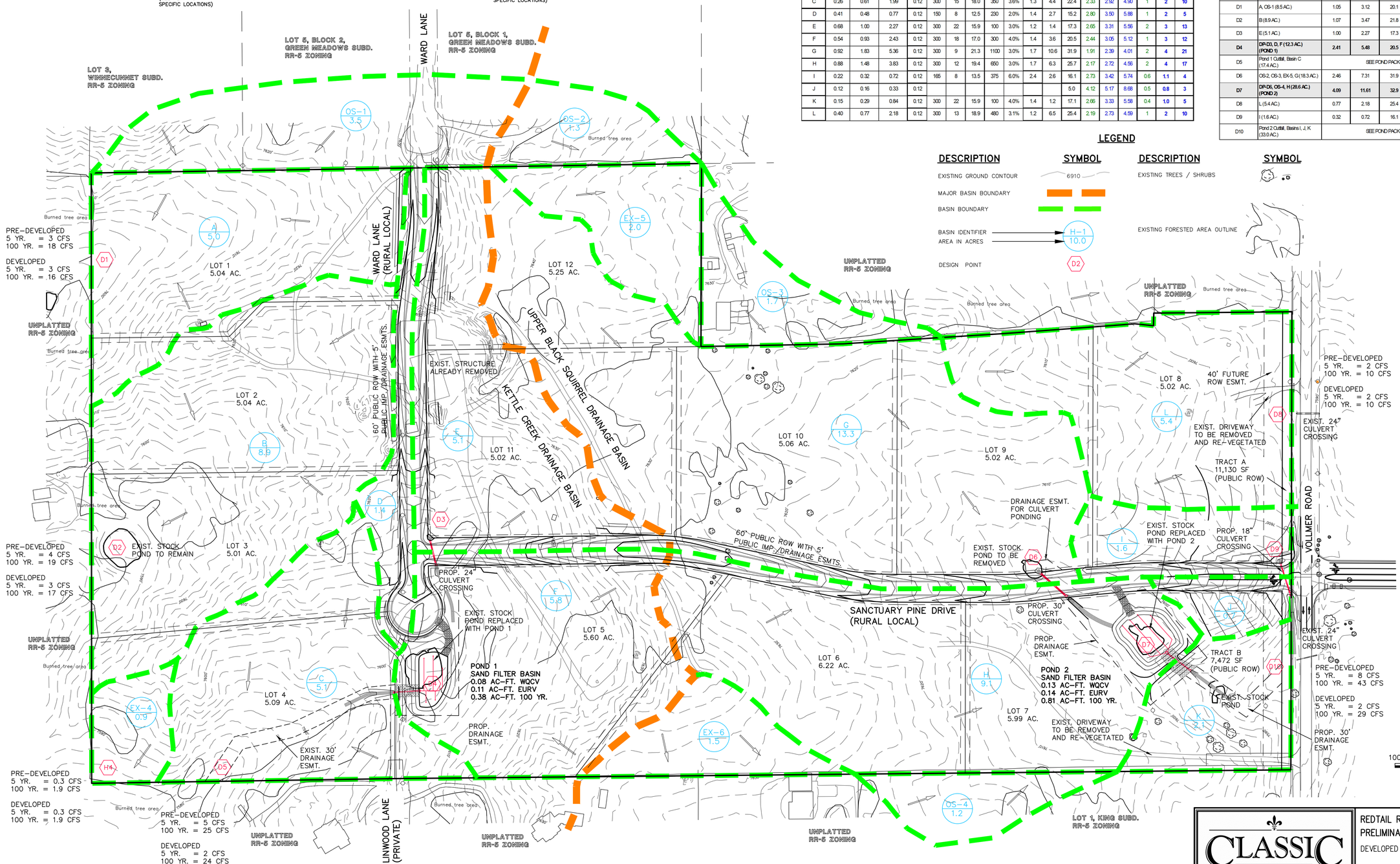
SCALE: 1" = 10'

FINAL DRAINAGE REPORT ~ BASIN RUNOFF SUMMARY

BASIN	CA(2)	CA(5)	CA(100)	C(5)	WEIGHTED Length (ft)	OVERLAND Height (ft)	OVERLAND Tc (min)	STREET / CHANNEL FLOW Length (ft)	Slope (%)	Velocity (fps)	Tc (min)	Tc: TOTAL (min)	INTENSITY I(2) (in/hr)	I(5) (in/hr)	I(100) (in/hr)	TOTAL FLOWS Q(2) (cfs)	Q(5) (cfs)	Q(100) (cfs)
OS-1	0.33	0.66	1.46	0.12	300	14	18.4					18.4	2.57	3.21	5.39	0.8	**2**	**8**
OS-2	0.12	0.20	0.54	0.12	300	16	17.6					17.6	2.62	3.28	5.50	0.3	**0.7**	**3**
OS-3	0.14	0.25	0.69	0.12	300	12	19.4					19.4	2.51	3.14	5.26	0.3	**0.8**	**4**
OS-4	0.06	0.14	0.47	0.12	270	12	17.8					17.8	2.61	3.27	5.48	0.2	**0.5**	**3**
A	0.25	0.60	1.95	0.12	300	18	17.0	250	3.6%	1.3	3.1	20.1	2.45	3.08	5.17	1	**2**	**10**
B	0.45	1.07	3.47	0.12	300	14	18.4	300	4.5%	1.5	3.4	21.8	2.37	2.96	4.97	1	**3**	**17**
C	0.26	0.61	1.99	0.12	300	15	18.0	350	3.6%	1.3	4.4	22.4	2.33	2.92	4.90	1	**2**	**10**
D	0.41	0.48	0.77	0.12	150	8	12.5	230	2.0%	1.4	2.7	15.2	2.80	3.50	5.88	1	**2**	**5**
E	0.68	1.00	2.27	0.12	300	22	15.9	100	3.0%	1.2	1.4	17.3	2.65	3.31	5.56	2	**3**	**13**
F	0.54	0.93	2.43	0.12	300	18	17.0	300	4.0%	1.4	3.6	20.5	2.44	3.05	5.12	1	**3**	**12**
G	0.92	1.83	5.36	0.12	300	9	21.3	1100	3.0%	1.7	10.6	31.9	1.91	2.39	4.01	2	**4**	**21**
H	0.88	1.48	3.83	0.12	300	12	19.4	650	3.0%	1.7	6.3	25.7	2.17	2.72	4.56	2	**4**	**17**
I	0.22	0.32	0.72	0.12	165	8	13.5	375	6.0%	2.4	2.6	16.1	2.73	3.42	5.74	0.6	**1.1**	**4**
J	0.12	0.16	0.33	0.12								5.0	4.12	5.17	8.68	0.5	**0.8**	**3**
K	0.15	0.29	0.84	0.12	300	22	15.9	100	4.0%	1.4	1.2	17.1	2.66	3.33	5.58	0.4	**1.0**	**5**
L	0.40	0.77	2.18	0.12	300	13	18.9	480	3.1%	1.2	6.5	25.4	2.19	2.73	4.59	1	**2**	**10**

FINAL DRAINAGE REPORT ~ SURFACE ROUTING SUMMARY

Design Point(s)	Contributing Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity I(5)	Intensity I(100)	Flow Q(5)	Flow Q(100)	Outfall / Inlet Size
H1	OS-1, EX-1 (9.6 AC.)	1.17	3.69	21.9	2.95	4.96	3	18	
H2	EX-2 (10.1 AC.)	1.41	3.98	24.3	2.80	4.70	4	19	
H3	EX-3 (14.8 AC.)	1.93	5.74	27.8	2.59	4.35	5	25	
H4	EX-4 (0.9 AC.)	0.08	0.32	15.9	3.43	5.76	0.3	1.9	
H5	OS-2, OS-3, OS-4, EX-5, EX-7 (32.6 AC.)	3.70	12.30	39.3	2.08	3.48	8	43	
H6	EX-8 (6.1 AC.)	0.60	2.23	26.0	2.70	4.53	2	10	
D1	A, OS-1 (8.5 AC.)	1.05	3.12	20.1	3.08	5.17	3	16	
D2	B (8.9 AC.)	1.07	3.47	21.8	2.96	4.97	3	17	
D3	E (5.1 AC.)	1.00	2.27	17.3	3.31	5.56	3	13	24" RCP CULVERT
D4	**DP-D3, D, F (12.3 AC.) (POND 1)**	**2.41**	**5.48**	**20.5**	**3.05**	**5.12**	**7**	**28**	**POND 1**
D5	Pond 1 Outfall, Basin C (17.4 AC.)	SEE POND PACK MODEL					1.7	24	
D6	OS-2, OS-3, EX-5, G (18.3 AC.)	2.46	7.31	31.9	2.39	4.01	6	29	30" RCP CULVERT
D7	**DP-D6, OS-4, H (28.6 AC.) (POND 2)**	**4.09**	**11.61**	**32.9**	**2.34**	**3.93**	**10**	**46**	**POND 2**
D8	L (5.4 AC.)	0.77	2.18	25.4	2.73	4.59	2	10	
D9	I (1.6 AC.)	0.32	0.72	16.1	3.42	5.74	1	4	18" RCP CULVERT
D10	Pond 2 Outfall, Basins I, J, K (33.0 AC.)	SEE POND PACK MODEL					2.4	29	



LEGEND

DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL
EXISTING GROUND CONTOUR	6910	EXISTING TREES / SHRUBS	
MAJOR BASIN BOUNDARY			
BASIN BOUNDARY		EXISTING FORESTED AREA OUTLINE	
BASIN IDENTIFIER / AREA IN ACRES	H-1 10.0		
DESIGN POINT	D2		

CLASSIC CONSULTING ENGINEERS & SURVEYORS	REDTAIL RANCH PRELIMINARY/FINAL DRAINAGE REPORT DEVELOPED DRAINAGE MAP				CLASSIC CONSULTING ENGINEERS & SURVEYORS
619 N. Cascade Avenue, Suite 200 (719)785-0790 Colorado Springs, Colorado 80903 (719)785-0799 (Fax)	DESIGNED BY	MAW	SCALE	DATE	7-3-18
	DRAWN BY	MAW	(H) 1"= 100'	SHEET	2 OF 2
	CHECKED BY		(V) 1"= N/A	JOB NO.	2525.00

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