INNOVATIVE DESIGN. **CLASSIC RESULTS.**

PRELIMINARY/FINAL DRAINAGE REPORT
FOR
REDTAIL RANCH FILING 1

ADDENDUM NO. 1
APRIL 2020

Prepared for:
MICHAEL S. LUDWIG
4255 ARROWHEAD DRIVE
COLORADO SPRINGS, CO 80908

Prepared by:
CLASSIC CONSULTING
619 N. CASCADE AVE., SUITE 200
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(719) 785-0790

Job no. 2525.00

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

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

COLORADO REGISTERED PROFESSIONAL ENGINEER MARC ALAN WHORTON 37155

6/8/2020

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: owner/developer

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.
County Engineer / ECM Administrator

Conditions:

Approved
By: Elizabeth Nijkamp
Date:06/15/2020
El Paso County Planning & Community Development

CLASSIC CONSULTING ENGINEERS & SURVEYORS

PRELIMINARY/FINAL DRAINAGE REPORT FOR
REDTAIL RANCH FILING NO. 1 (Addendum No. 1)

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PURPOSE

This document is Addendum No. 1 of Preliminary/Final Drainage Report for Redtail Ranch Filing No. 1. The purpose of this addendum is to revise the two stormwater quality facilities from Sand Filter Basins to Extended Detention Basins. All hydrology, pond sizing and locations remain the same as previously approved. (Reference Preliminary/Final Drainage Report Redtail Ranch Filing No. 1)

DEVELOPED DRAINAGE CONDITIONS
(KETTLE CREEK BASIN)

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. Prior to the developed flows entering Pond 1, pretreatment by permanent rock check dams will be provided. At this location, the existing stock pond is proposed to be replaced with a formal BMP as described below:

Pond 1 (Extended Detention 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)

0.113 Ac.-ft. WQCV required

0.097 Ac.-ft. EURV required

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

0.448 Ac.-ft. 100-yr. storage

Total In-flow:	**Q_5 = 7 cfs, Q_{100} = 28 cfs**
Pond Design Release:	**Q_5 = 0.05 cfs, Q_{100} = 13.8 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.

DEVELOPED DRAINAGE CONDITIONS
(UPPER BLACK SQUIRREL BASIN)

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. Prior to the developed flows entering Pond 2, pretreatment by permanent rock check dams will be provided. At this location, the existing stock pond is proposed to be replaced with a formal BMP as described below:

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

0.153 Ac.-ft. WQCV required

0.101 Ac.-ft. EURV required

0.254 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 = 0.10 cfs, Q_{100} = 20.7 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.

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 Extended Detention 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 construction BMP’s as well as permanent sediment control BMP’s are detailed in this plan and narrative to protect receiving waters. Roadside ditch stabilization,

in the form of erosion control blanketing, turf reinforcement matting and permanent rock check dams (as specified on the plans) are also proposed. (See appendix for calculations) 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 0320G, with effective date of December 7, 2018 (See Appendix).

DRAINAGE & BRIDGE FEES

All fees previously paid prior to plat recordation in December 2019.

SUMMARY

This proposed development remains consistent with pre-development drainage conditions with the construction of the proposed on-site Extended Detention 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 Addendum 1.doc

CLASSIC 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.

4. "Preliminary/Final Drainage Report for Redtail Ranch Filing No. 1", by Classic Consulting, approved December 2019.

APPENDIX

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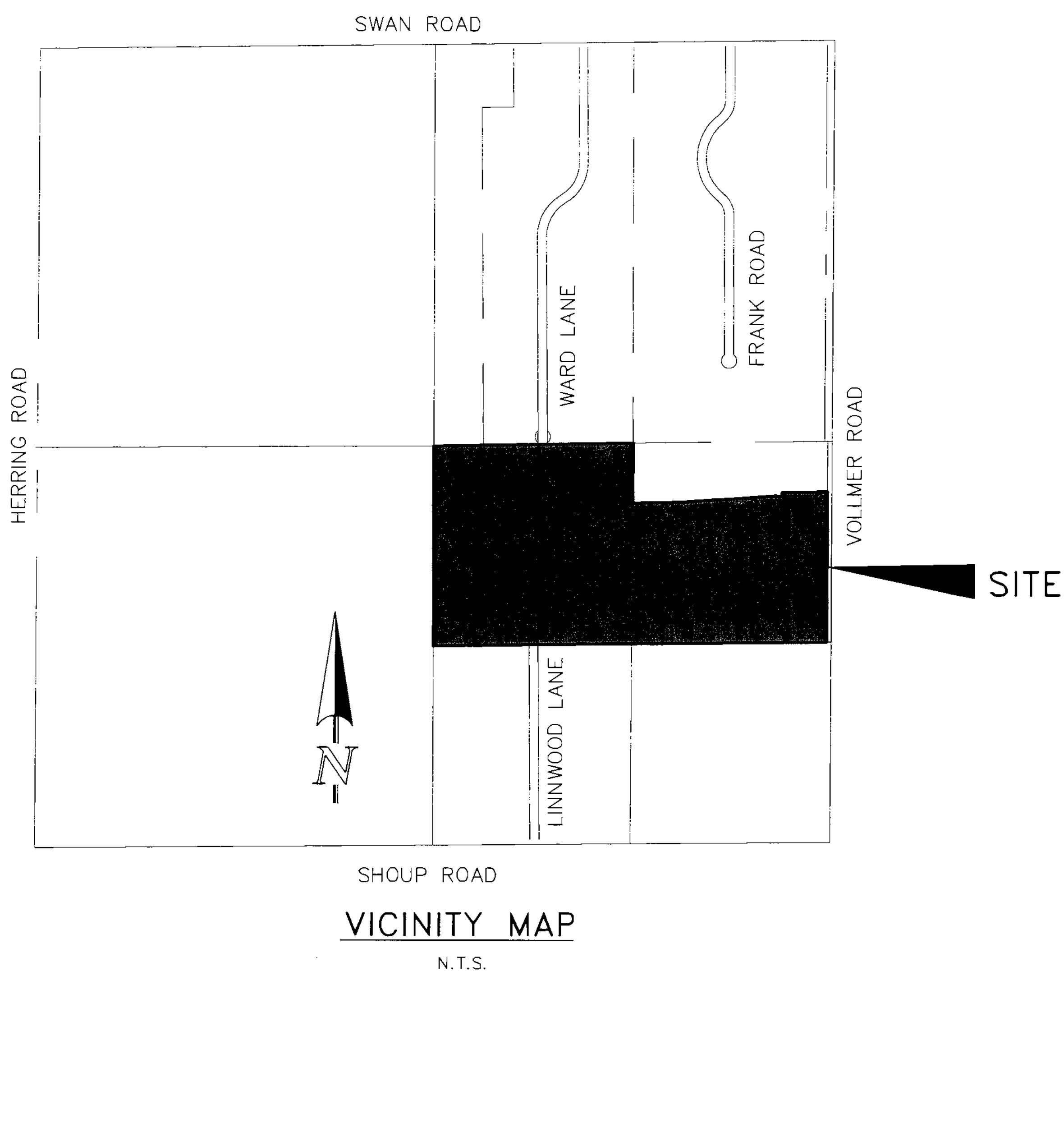
VICINITY MAP



VICINITY MAP

N.T.S.

BMP FACILITY DESIGN CALCULATIONS

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Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.06, November 2016)

Designer:	**Marc A. Whorton, P.E.**
Company:	**Classic Consulting**
Date:	**April 28, 2020**
Project:	**Redtail Ranch Filing No. 1 (Pond 1)**
Location:	**Black Forest, CO**

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a	I_a = 14.6 %
B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	i = 0.146
C) Contributing Watershed Area	Area = 14.800 ac
D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = 0.42 in
E) Design Concept (Select EURV when also designing for flood control)	Choose One ○ Water Quality Capture Volume (WQCV) ◉ Excess Urban Runoff Volume (EURV)
F) Design Volume (WQCV) Based on 40-hour Drain Time ($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area)$	V_{DESIGN}= 0.113 ac-ft
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume ($V_{WQCV\ OTHER} = (d_6*(V_{DESIGN}/0.43))$	$V_{DESIGN\ OTHER}$= 0.110 ac-ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{DESIGN\ USER}$= ______ ac-ft
I) Predominant Watershed NRCS Soil Group	Choose One ○ A ◉ B ○ C / D
J) Excess Urban Runoff Volume (EURV) Design Volume For HSG A: $EURV_A = 1.68 * i^{1.28}$ For HSG B: $EURV_B = 1.36 * i^{1.08}$ For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$	EURV = 0.210 ac-f t
2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.)	L : W = 2.0 : 1
3. Basin Side Slopes A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Z = 4.00 ft / ft
4. Inlet A) Describe means of providing energy dissipation at concentrated inflow locations:	

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Marc A. Whorton, P.E.
Company: Classic Consulting
Date: April 28, 2020
Project: Redtail Ranch Filing No. 1 (Pond 1)
Location: Black Forest, CO

5. Forebay

A) Minimum Forebay Volume (V_{FMIN} = 2% of the WQCV) — V_{FMIN} = 0.002 ac-ft

B) Actual Forebay Volume — V_F = 0.002 ac-ft

C) Forebay Depth (D_F = 18 inch maximum) — D_F = 12.0 in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge — Q_{100} = 28.00 cfs

ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$) — Q_F = 0.56 cfs

E) Forebay Discharge Design

Choose One
- ○ Berm With Pipe
- ◉ Wall with Rect. Notch
- ○ Wall with V-Notch Weir

(flow too small for berm w/ pipe)

F) Discharge Pipe Size (minimum 8-inches) — Calculated D_P = ____ in

G) Rectangular Notch Width — Calculated W_N = 4.4 in

6. Trickle Channel

A) Type of Trickle Channel

Choose One
- ◉ Concrete
- ○ Soft Bottom

F) Slope of Trickle Channel — S = 0.0100 ft / ft

7. Micropool and Outlet Structure

A) Depth of Micropool (2.5-feet minimum) — D_M = 2.5 ft

B) Surface Area of Micropool (10 ft^2 minimum) — A_M = 40 sq ft

C) Outlet Type

Choose One
- ◉ Orifice Plate
- ○ Other (Describe):

D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention) — $D_{orifice}$ = 0.67 inches

E) Total Outlet Area — A_{ot} = 1.16 square inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Marc A. Whorton, P.E.
Company: Classic Consulting
Date: April 28, 2020
Project: Redtail Ranch Filing No. 1 (Pond 1)
Location: Black Forest, CO

8. Initial Surcharge Volume	
A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)	D_{IS} = 6 in
B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)	V_{IS} = cu ft
C) Initial Surcharge Provided Above Micropool	V_s= 20.0 cu ft
9. Trash Rack	
A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$	A_t = 42 square inches
B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.) Other (Y/N): N	*S.S. Well Screen with 60% Open Area*
C) Ratio of Total Open Area to Total Area (only for type 'Other')	User Ratio =
D) Total Water Quality Screen Area (based on screen type)	A_{total} = 70 sq. in.
E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)	H= 3 feet
F) Height of Water Quality Screen (H_{TR})	H_{TR}= 64 inches
G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended)	$W_{opening}$ = 12.0 inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Marc A. Whorton, P.E.
Company: Classic Consulting
Date: April 28, 2020
Project: Redtail Ranch Filing No. 1 (Pond 1)
Location: Black Forest, CO

10. Overflow Embankment A) Describe embankment protection for 100-year and greater overtopping: B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	
11. Vegetation	Choose One ○ Irrigated ◉ Not Irrigated
12. Access A) Describe Sediment Removal Procedures	

Notes:

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.06, November 2016)

Designer: Marc A. Whorton, P.E.
Company: Classic Consulting
Date: April 30, 2020
Project: Redtail Ranch Filing No. 1 (Pond 2)
Location: Black Forest, CO

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a	I_a = 9.5 %
B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	i = 0.095
C) Contributing Watershed Area	Area = 28.600 ac
D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = 0.42 in
E) Design Concept (Select EURV when also designing for flood control)	Choose One: ○ Water Quality Capture Volume (WQCV) ◉ Excess Urban Runoff Volume (EURV)
F) Design Volume (WQCV) Based on 40-hour Drain Time ($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area)$	V_{DESIGN}= 0.153 ac-ft
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume ($V_{WQCV\ OTHER} = (d_6*(V_{DESIGN}/0.43))$	$V_{DESIGN\ OTHER}$= 0.149 ac-ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{DESIGN\ USER}$= ac-ft
I) Predominant Watershed NRCS Soil Group	Choose One: ○ A ◉ B ○ C / D
J) Excess Urban Runoff Volume (EURV) Design Volume For HSG A: $EURV_A = 1.68 * i^{1.28}$ For HSG B: $EURV_B = 1.36 * i^{1.08}$ For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$	EURV = 0.255 ac-f t
2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.)	L : W = 2.0 : 1
3. Basin Side Slopes	
A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Z = 4.00 ft / ft
4. Inlet	
A) Describe means of providing energy dissipation at concentrated inflow locations:	Rip-Rap Dissipator into concrete forebay

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Marc A. Whorton, P.E.
Company: Classic Consulting
Date: April 30, 2020
Project: Redtail Ranch Filing No. 1 (Pond 2)
Location: Black Forest, CO

5. Forebay

A) Minimum Forebay Volume (V_{FMIN} = 2% of the WQCV) — V_{FMIN} = 0.003 ac-ft

B) Actual Forebay Volume — V_F = 0.003 ac-ft

C) Forebay Depth (D_F = 18 inch maximum) — D_F = 12.0 in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge — Q_{100} = 46.00 cfs

ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$) — Q_F = 0.92 cfs

E) Forebay Discharge Design

Choose One
- ○ Berm With Pipe
- ◉ Wall with Rect. Notch
- ○ Wall with V-Notch Weir

(flow too small for berm w/ pipe)

F) Discharge Pipe Size (minimum 8-inches) — Calculated D_P = ____ in

G) Rectangular Notch Width — Calculated W_N = 5.7 in

6. Trickle Channel

A) Type of Trickle Channel

Choose One
- ◉ Concrete
- ○ Soft Bottom

F) Slope of Trickle Channel — S = 0.0100 ft / ft

7. Micropool and Outlet Structure

A) Depth of Micropool (2.5-feet minimum) — D_M = 2.5 ft

B) Surface Area of Micropool (10 ft^2 minimum) — A_M = 60 sq ft

C) Outlet Type

Choose One
- ◉ Orifice Plate
- ○ Other (Describe):

D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention) — $D_{orifice}$ = 0.94 inches

E) Total Outlet Area — A_{ot} = 2.66 square inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Marc A. Whorton, P.E.
Company: Classic Consulting
Date: April 30, 2020
Project: Redtail Ranch Filing No. 1 (Pond 2)
Location: Black Forest, CO

8. Initial Surcharge Volume	
A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)	D_{IS} = 6 in
B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)	V_{IS} = cu ft
C) Initial Surcharge Provided Above Micropool	V_s= 30.0 cu ft
9. Trash Rack	
A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$	A_t = 94 square inches
B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.) Other (Y/N): N	*S.S. Well Screen with 60% Open Area*
C) Ratio of Total Open Area to Total Area (only for type 'Other')	User Ratio =
D) Total Water Quality Screen Area (based on screen type)	A_{total} = 156 sq. in.
E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)	H= 3 feet
F) Height of Water Quality Screen (H_{TR})	H_{TR}= 64 inches
G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended)	$W_{opening}$ = 12.0 inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Marc A. Whorton, P.E.
Company: Classic Consulting
Date: April 30, 2020
Project: Redtail Ranch Filing No. 1 (Pond 2)
Location: Black Forest, CO

10. Overflow Embankment A) Describe embankment protection for 100-year and greater overtopping: B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	
11. Vegetation	Choose One ○ Irrigated ◉ Not Irrigated
12. Access A) Describe Sediment Removal Procedures	

Notes:

Description

Photograph EDB-1: This EDB includes a concrete trickle channel and a micropool with a concrete bottom and grouted boulder sideslopes. The vegetation growing in the sediment of the micropool adds to the natural look of this facility and ties into the surrounding landscape.

An extended detention basin (EDB) is a sedimentation basin designed to detain stormwater for many hours after storm runoff ends. This BMP is similar to a detention basin used for flood control, however; the EDB uses a much smaller outlet that extends the emptying time of the more frequently occurring runoff events to facilitate pollutant removal. The EDB's 40-hour drain time for the water quality capture volume (WQCV) is recommended to remove a significant portion of total suspended solids (TSS). Soluble pollutant removal is enhanced by providing a small wetland marsh or "micropool" at the outlet to promote biological uptake. The basins are sometimes called "dry ponds" because they are designed not to have a significant permanent pool of water remaining between storm runoff events.

Site Selection

EDBs are well suited for watersheds with at least five impervious acres up to approximately one square mile of watershed. Smaller watersheds can result in an orifice size prone to clogging. Larger watersheds and watersheds with baseflows can complicate the design and reduce the level of treatment provided. EDBs are also well suited where flood detention is incorporated into the same basin. The depth of groundwater should be investigated. Groundwater depth should be 2 or more feet below the bottom of the basin in order to keep this area dry and maintainable.

Extended Detention Basin	
Functions	
LID/Volume Red.	Somewhat
WQCV Capture	Yes
WQCV+Flood Control	Yes
Fact Sheet Includes EURV Guidance	Yes
Typical Effectiveness for Targeted Pollutants[3]	
Sediment/Solids	Good
Nutrients	Moderate
Total Metals	Moderate
Bacteria	Poor
Other Considerations	
Life-cycle Costs[4]	Moderate

[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).

Designing for Maintenance

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

- Always provide a micropool (see step 7).
- Provide a design slope of at least 3% in the vegetated bottom of the basin (either toward the trickle channel or toward the micropool). This will help maintain the appearance of the turf grass in the bottom of the basin and reduce the possibility of saturated areas that may produce unwanted species of vegetation and mosquito breeding conditions. Verify slopes during construction, prior to vegetation.
- Follow trash rack sizing recommendations to determine the minimum area for the trash rack (see design step 9).
- Provide adequate initial surcharge volume for frequent inundation (see design step 3).
- Provide stabilized access to the forebay, outlet, spillway, and micropool for maintenance purposes.
- Provide access to the well screen. The well screen requires maintenance more often than any other EDB component. Ensure that the screen can be reached from a point outside of the micropool. When the well screen is located inside the outlet structure, provide an access port within the trash rack or use a sloped trash rack that consists of bearing bars (not horizontal) that create openings no more than five inches clear.
- Provide a hard-bottom forebay that allows for removal of sediment.
- Where baseflows are anticipated, consider providing a flow-measuring device (e.g. weir or flume with staff gage and rating curve) at the forebay to assist with future modifications of the water quality plate. Typically, the baseflow will increase as the watershed develops. It is important that the water quality plate continue to function, passing the baseflow while draining the WQCV over approximately 40 hours. Measuring the actual baseflow can be helpful in determining if and when the orifice place should be replaced.

Benefits

- The relatively simple design can make EDBs less expensive to construct than other BMPs, especially for larger basins.
- Maintenance requirements are straightforward.
- The facility can be designed for multiple uses.

Limitations

- Ponding time and depths may generate safety concerns.
- Best suited for tributary areas of 5 impervious acres or more. EDBs are not recommended for sites less than 2 impervious acres.
- Although ponds do not require more total area compared to other BMPs, they typically require a relatively large continuous area.

EDBs providing combined water quality and flood control functions can serve multiple uses such as playing fields or picnic areas. These uses are best located at higher elevation within the basin, above the WQCV pool level.

Design Procedure and Criteria

The following steps outline the design procedure and criteria for an EDB and Figure EDB-3 shows a typical configuration. UD-BMP, available at www.udfcd.org, is an Excel based workbook that can be used to perform some of the below calculations and ensure conformance to these criteria. UD-Detention, another workbook developed by UDFCD can be used to develop and route a storm hydrograph through an EDB and design the outlet structure.

1. **Basin Storage Volume**: Provide a design volume equal to the WQCV or the EURV. This volume begins at the lowest orifice in the outlet structure.

   - Determine the imperviousness of the watershed (or effective imperviousness where LID elements are used upstream).

   - Find the required storage volume. Determine the required WQCV or EURV (watershed inches of runoff) using Figure 3-2 located in Chapter 3 of this manual (for WQCV) or equations provided in the *Storage* chapter of Volume 2 (for EURV).

   - Calculate the design volume as follows:

   For WQCV:

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

   For EURV:

   $$V = \left[\frac{\text{EURV}}{12}\right] A \qquad \text{Equation EDB-2}$$

   Where:

   V = design volume (acre ft)

   A = watershed area tributary to the extended detention basin (acres)

2. **Basin Shape**: Always maximize the distance between the inlet and the outlet. It is best to have a basin length (measured along the flow path from inlet to outlet) to width ratio of at least 2:1. A longer flow path from inlet to outlet will minimize short circuiting and improve reduction of TSS. To achieve this ratio, it may be necessary to modify the inlet and outlet points through the use of pipes or swales.

3. **Basin Side Slopes**: Basin side slopes should be stable and gentle to facilitate maintenance and access. Slopes that are 4:1or flatter should be used to allow for conventional maintenance equipment and for improved safety, maintenance, and aesthetics. Side slopes should be no steeper than 3:1. The use of walls is highly discouraged due to maintenance constraints.

4. **Inlet**: Dissipate flow energy at concentrated points of inflow. This will limit erosion and promote particle sedimentation. Inlets should be designed in accordance with UDFCD drop structure criteria for inlets above the invert of the forebay, impact basin outlet details for at grade inlets, or other types of energy dissipating structures.

5. **Forebay Design**: The forebay provides an opportunity for larger particles to settle out in an area that can be easily maintained. The length of the flow path through the forebay should be maximized, and the slope minimized to encourage settling. The appropriate size of the forebay may be as much a function of the level of development in the tributary area as it is a percentage of the WQCV. When portions of the watershed may remain disturbed for an extended period of time, the forebay size will need to be increased due to the potentially high sediment load. Refer to Table EDB-4 for a design criteria summary. When using this table, the designer should consider increasing the size of the forebay if the watershed is not fully developed.

   The forebay outlet should be sized to release 2% of the undetained peak 100-year discharge. A soil riprap berm with 3:1 sideslopes (or flatter) and a pipe outlet or a concrete wall with a notch outlet should be constructed between the forebay and the main EDB. It is recommended that the berm/pipe configuration be reserved for watersheds in excess of 20 impervious acres to accommodate the minimum recommended pipe diameter of 8 inches. When using the berm/pipe configuration, round up to the nearest standard pipe size and use a minimum diameter of 8 inches. The floor of the forebay should be concrete or lined with grouted boulders to define sediment removal limits. With either configuration, soil riprap should also be provided on the downstream side of the forebay berm or wall if the downstream grade is lower than the top of the berm or wall. The forebay will overtop frequently so this protection is necessary for erosion control. All soil riprap in the area of the forebay should be seeded and erosion control fabric should be placed to retain the seed in this high flow area.

6. **Trickle Channel:** Convey low flows from the forebay to the micropool with a trickle channel. The trickle channel should have a minimum flow capacity equal to the maximum release from the forebay outlet.

   - **Concrete Trickle Channels:** A concrete trickle channel will help to establish the bottom of the basin long-term and may also facilitate regular sediment removal. It can be a "V" shaped concrete drain pan or a concrete channel with curbs. A flat-bottom channel facilitates maintenance. A slope between 0.4% - 1% is recommended to encourage settling while reducing the potential for low points within the pan.

   - **Soft-bottom Trickle Channels**: When designed and maintained properly, soft-bottom trickle channels can allow for an attractive alternative to concrete. They can also improve water quality. However, they are not appropriate for all sites. Be aware, maintenance of soft bottom trickle channels requires mechanical removal of sediment and vegetation. Additionally, this option provides mosquito habitat. For this reason, UDFCD recommends that they be considered on a case-by-case basis and with the approval of the local jurisdiction. It is recommended that soft bottom trickle channels be designed with a consistent longitudinal slope from forebay to micropool and that they not meander. This geometry will allow for reconstruction of the original design when sediment removal in the trickle channel is necessary. The trickle channel may also be located along the toe of the slope if a straight channel is not desired. The recommended minimum depth of a soft bottom trickle channel is 1.5 feet. This depth will help limit potential wetland growth to the trickle channel, preserving the bottom of the basin.

     Riprap and soil riprap lined trickle channels are not recommended due to past maintenance experiences, where the riprap was inadvertently removed along with the sediment during maintenance.

7. **Micropool and Outlet Structure**: Locate the outlet structure in the embankment of the EDB and provide a permanent micropool directly in front of the structure. Submerge the well screen to the bottom of the micropool. This will reduce clogging of the well screen because it allows water to flow though the well screen below the elevation of the lowest orifice even when the screen above the water surface is plugged. This will prevent shallow ponding in front of the structure, which provides a breeding ground for mosquitoes (large shallow puddles tend to produce more mosquitoes than a smaller, deeper permanent pond).

   Basins with micropools have fewer mosquitoes. Micropools reduce shallow wet areas where breeding is most favorable.

   Micropool side slopes may be vertical walls or stabilized slopes of 3:1 (horizontal:vertical). For watersheds with less than 5 impervious acres, the micropool can be located inside the outlet structure (refer to Figures OS-7 and OS-8 provided in Fact Sheet T-12). The micropool should be at least 2.5 feet in depth with a minimum surface area of 10 square feet. The bottom should be concrete unless a baseflow is present or anticipated or if groundwater is anticipated. Riprap is not recommended because it complicates maintenance operations.

   Where possible, place the outlet in an inconspicuous location as shown in Photo EDB-3. This urban EDB utilizes landscaped parking lot islands connected by a series of culverts (shown in Photo EDB-4) to provide the required water quality and flood control volumes.

   The outlet should be designed to release the WQCV over a 40-hour period. Draining a volume of water over a specified time can be done through an orifice plate as detailed in Fact Sheet T-12. Use reservoir routing calculations as discussed in the *Storage* Chapter of Volume 2 to assist in the design. Two workbooks tools have been developed by UDFCD for this purpose, UD-FSD and UD-Detention. Both are available at www.udfcd.org. UD-FSD is recommended for a typical EDB full spectrum detention design. UD-Detention uses the same methodology and can be used for a full spectrum detention basin or a WQCV only design. It also allows for a wider range of outlet controls should the user want to specify something beyond what is shown in Fact Sheet T-12.

   Refer to BMP Fact Sheet T-12 for schematics pertaining to structure geometry, grates, trash racks, orifice plate, and all other necessary components.

   The outlet may have flared or parallel wing walls as shown in Figures EDB-1 and EDB-2, respectively. Either configuration should be recessed into the embankment to minimize its profile. Additionally, the trash rack should be sloped with the basin side-slopes.

8. **Initial Surcharge Volume**: Providing a surcharge volume above the micropool for frequently occurring runoff minimizes standing water and sediment deposition in the remainder of the basin. This is critical to turf maintenance and mosquito abatement in the basin bottom. The initial surcharge volume is not provided in the micropool nor does it include the micropool volume. It is the available storage volume that begins at the water surface elevation of the micropool and extends upward to a grade break within the basin (typically the invert of the trickle channel).

Photograph EDB-2. The initial surcharge volume of this EDB is contained within the boulders that surround the micropool.

Photograph EDB-3. Although walls may complicate maintenance access, this outlet structure is relatively hidden from public view. This photo was taken shortly following a storm event.

Photograph EDB-4. A series of landscape islands connected by culverts provide water quality and flood control for this site.

The area of the initial surcharge volume, when full, is typically the same or slightly larger than that of the micropool. The initial surcharge volume should have a depth of at least 4 inches. For watersheds of at least 5 impervious acres, the initial surcharge volume should also be at least 0.3% of the WQCV. The initial surcharge volume is considered a part of the WQCV and does not need to be provided in addition to the WQCV. It is recommended that this area be shown on the grading plan or in a profile for the EDB. When baseflows are anticipated, it is recommended that the initial surcharge volume be increased. See the inset on page EDB-9 for additional guidelines for designing for baseflows.

9. **Trash Rack**: Provide a trash rack (or screen) of sufficient size at the outlet to provide hydraulic capacity while the rack is partially clogged. Openings should be small enough to limit clogging of the individual orifices. Size any overflow safety grate so it does not interfere with the hydraulic capacity of the outlet pipe. See BMP Fact Sheet T-12 for detailed trash rack and safety grate design guidance.

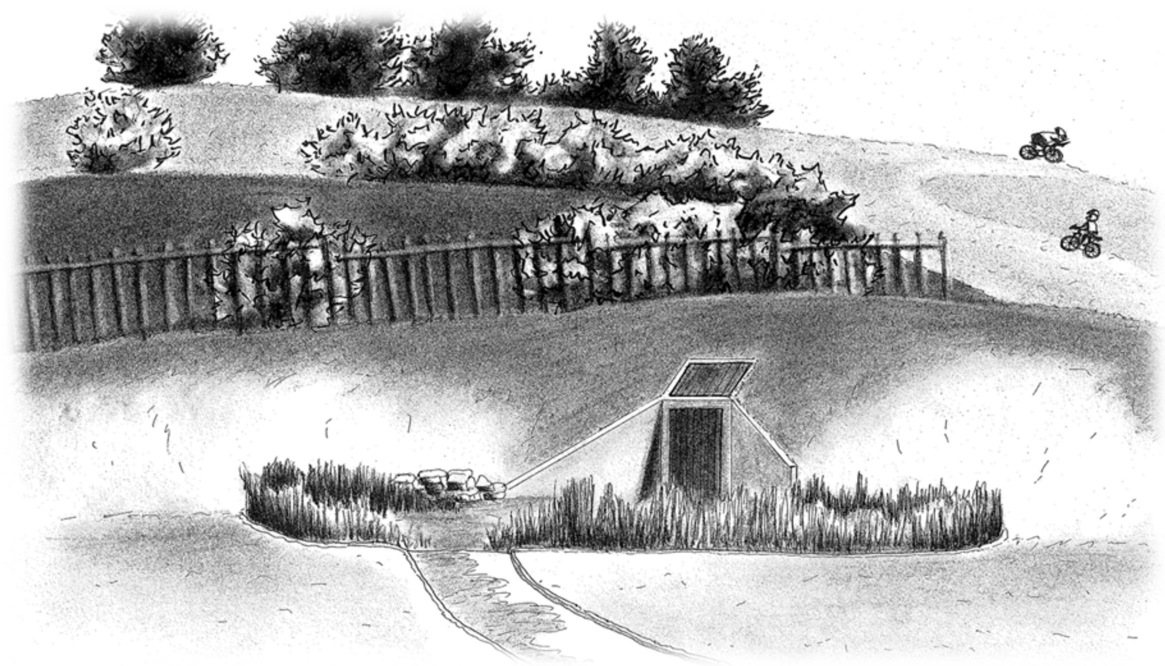


Figure EDB-1. Flared wall outlet structure configuration. Graphic by Adia Davis.

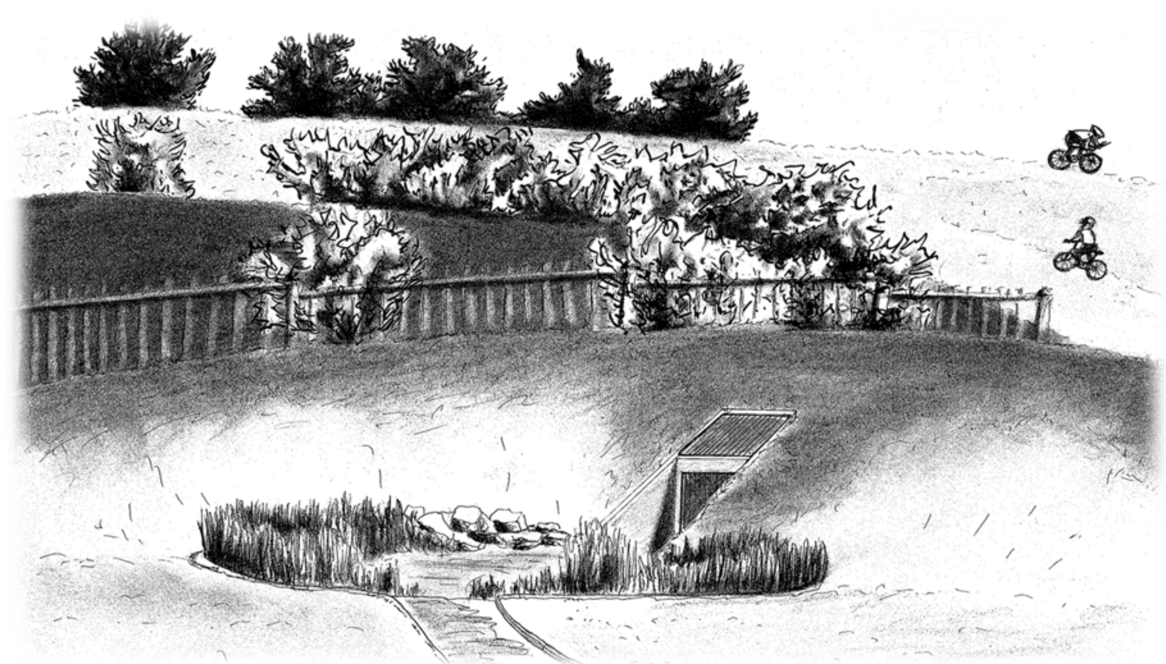


Figure EDB-2. Parallel wall outlet structure configuration. Graphic by Adia Davis.

10. **Overflow Embankment:** Design the embankment to withstand the 100-year storm at a minimum. If the embankment falls under the jurisdiction of the State Engineer's Office, it must be designed to meet the requirements of the State Engineer's Office. The overflow should be located at a point where waters can best be conveyed downstream. Slopes that are 4:1 or flatter should be used to allow for conventional maintenance equipment and for improved safety, maintenance, and aesthetics. Side slopes should be no steeper than 3:1 and should be planted with turf forming grasses. Poorly compacted native soils should be excavated and replaced. Embankment soils should be compacted to 95% of maximum dry density for ASTM D698 (Standard Proctor) or 90% for ASTM D1557 (Modified Proctor). Spillway structures and overflows should be designed in accordance with the *Storage* Chapter of Volume 2 as well as any local drainage criteria. Buried soil riprap or reinforced turf mats installed per manufacturer's recommendations can provide an attractive and less expensive alternative to concrete.

11. **Vegetation:** Vegetation provides erosion control and sediment entrapment. Basin bottom, berms, and side slopes should be planted with turf grass, which is a general term for any grasses that will form a turf or mat, as opposed to bunch grass which will grow in clumplike fashion. Xeric grasses with temporary irrigation are recommended to reduce maintenance requirements, including maintenance of the irrigation system as well as frequency of mowing. Where possible, place irrigation heads outside the basin bottom because irrigation heads in an EDB can become buried with sediment over time.

12. **Access:** Provide appropriate maintenance access to the forebay and outlet works. For larger basins, this means stabilized access for maintenance vehicles. If stabilized access is not provided, the maintenance plan should provide detail, including recommended equipment, on how sediment and trash will be removed from the outlet structure and micropool. Some communities may require

Designing for Baseflows

Baseflows should be anticipated for large tributary areas and can be accommodated in a variety of ways. Consider the following:

- If water rights are available, consider alternate BMPs such as a constructed wetland pond or retention pond.

- Anticipate future modifications to the outlet structure. Following construction, baseflows should be monitored periodically. Intermittent flows can become perennial and perennial flows can increase over time. It may be determined that outlet modifications are necessary long after construction of the BMP is complete.

- Design foundation drains and other groundwater drains to bypass the water quality plate directing these drains to a conveyance element downstream of the EDB. This will reduce baseflows and help preserve storage for the WQCV.

- When the basin is fully developed and an existing baseflow can be approximated prior to design, the water quality orifices should be increased to drain the WQCV in 40 hours while also draining the baseflow. This requires reservoir routing using an inflow hydrograph that includes the baseflow. The *UD-Detention* workbook available at www.udfcd.org may be used for this purpose.

- Increase the initial surcharge volume of the pond to provide some flexibility when baseflows are known or anticipated. Baseflows are difficult to approximate and will continue to increase as the watershed develops. Increasing the initial surcharge volume will accommodate a broader range of flows.

vehicle access to the bottom of the basin regardless of the size of the watershed. Grades should not exceed 10% for haul road surfaces and 20% for skid-loader and backhoe access. Stabilized access includes concrete, articulated concrete block, concrete grid pavement, or reinforced grass pavement. The recommended cross slope is 2%.

Aesthetic Design

Since all land owners and managers wish to use land in the most efficient manner possible, it is important that EDBs become part of a multi-use system. This encourages the design of EDBs as an aesthetic part of a naturalized environment or to include passive and/or active open space. Within each scenario, the EDB can begin to define itself as more than just a drainage facility. When this happens, the basin becomes a public amenity. This combination of public amenity and drainage facility is of much greater value to a landowner. Softened and varied slopes, interspersed irrigated fields, planting areas and wetlands can all be part of an EDB.

The design should be aesthetic whether it is considered to be an architectural or naturalized basin. Architectural basins incorporate design borrowed or reflective of the surrounding architecture or urban forms. An architectural basin is intended to appear as part of the built environment, rather than hiding the cues that identify it as a stormwater structure. A naturalized basin is designed to appear as though it is a natural part of the landscape. This section provides suggestions for designing a naturalized basin. The built environment, in contrast to the natural environment, does not typically contain the randomness of form inherent in nature. Constructed slopes typically remain consistent, as do slope transitions. Even dissipation structures are usually a hard form and have edges seldom seen in nature. If the EDB is to appear as though it is a natural part of the landscape, it is important to minimize shapes that provide visual cues indicating the presence of a drainage structure. For example, the side sides should be shaped more naturally and with varying slopes for a naturalized basin.

Suggested Methods for a Naturalized Basin

- Create a flowing form that looks like it was shaped by water.
- Extend one side of the basin higher than the other. This may require a berm.
- Shape the bottom of the basin differently than the top.
- Slope of one side of the basin more mildly than the opposing side.
- Vary slope transitions both at the top of the bank and at the toe.
- Use a soft-surface trickle channel if appropriate and approved.
- When using rock for energy dissipation, the rock should graduate away from the area of hard edge into the surrounding landscape. Other non-functional matching rock should occur in other areas of the basin to prevent the actual energy dissipation from appearing out of context.
- Design ground cover to reflect the type of water regime expected for their location within the basin.

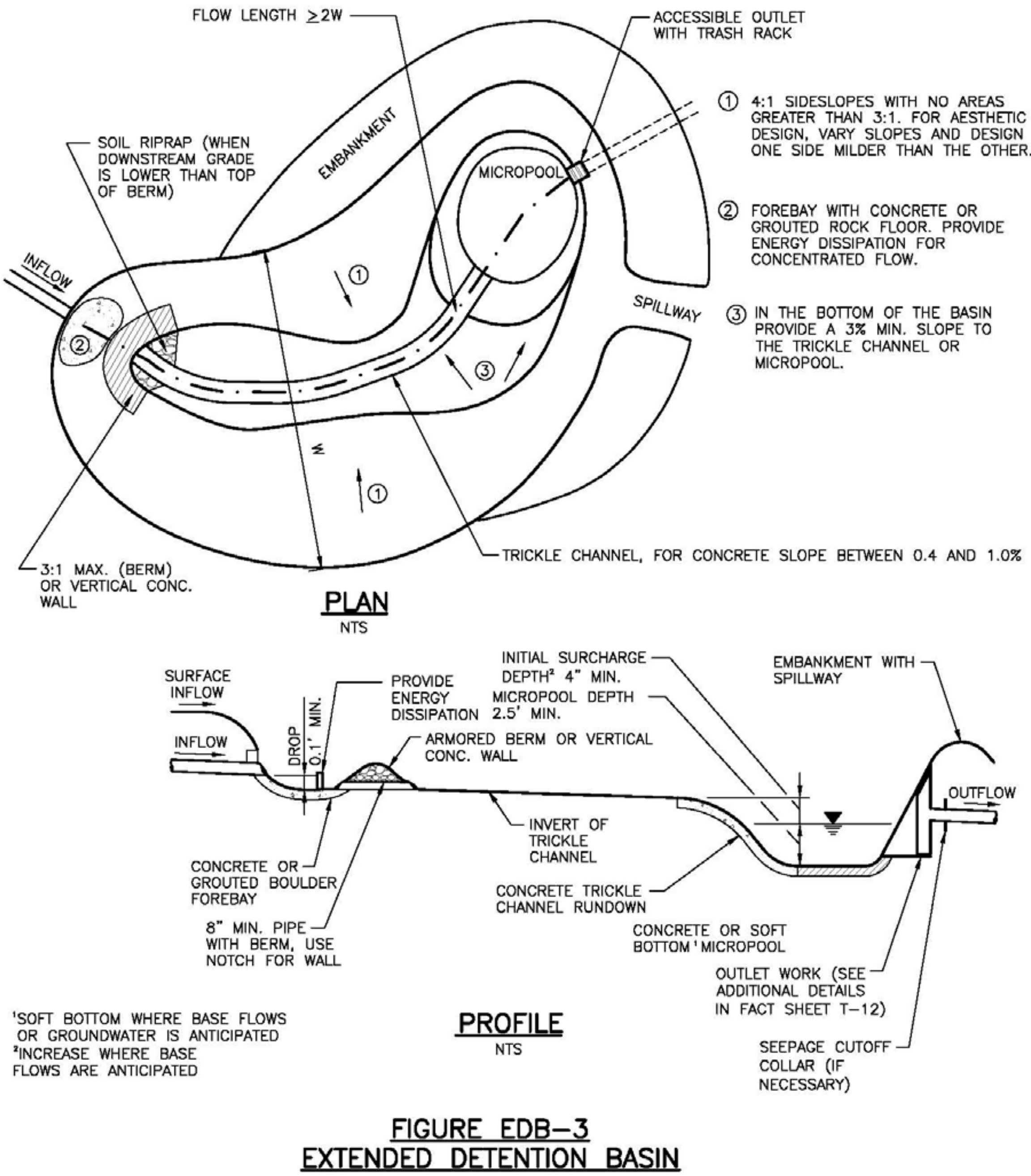


Figure EDB-3. Extended Detention Basin (EDB) Plan and Profile

Additional Details are provided in BMP Fact Sheet T-12. This includes outlet structure details including orifice plates and trash racks.

Table EDB-4. EDB component criteria

	On-Site EDBs for Watersheds up to 1 Impervious Acre[1]	EDBs with Watersheds between 1 and 2 Impervious Acres[1]	EDBs with Watersheds up to 5 Impervious Acres	EDBs with Watersheds over 5 Impervious Acres	EDBs with Watersheds over 20 Impervious Acres
Forebay Release and Configuration	EDBs should not be used for watersheds with less than 1 impervious acre.	Release 2% of the undetained 100-year peak discharge by way of a wall/notch configuration	Release 2% of the undetained 100-year peak discharge by way of a wall/notch configuration	Release 2% of the undetained 100-year peak discharge by way of a wall/notch configuration	Release 2% of the undetained 100-year peak discharge by way of a wall/notch or berm/pipe[2] configuration
Minimum Forebay Volume		1% of the WQCV	2% of the WQCV	3% of the WQCV	3% of the WQCV
Maximum Forebay Depth		12 inches	18 inches	18 inches	30 inches
Trickle Channel Capacity		≥ the maximum possible forebay outlet capacity	≥ the maximum possible forebay outlet capacity	≥ the maximum possible forebay outlet capacity	≥ the maximum possible forebay outlet capacity
Micropool		Area ≥ 10 ft^2	Area ≥ 10 ft^2	Area ≥ 10 ft^2	Area ≥ 10 ft^2
Initial Surcharge Volume		Depth ≥ 4 inches	Depth ≥ 4 inches	Depth ≥ 4 in. Volume ≥ 0.3% WQCV	Depth ≥ 4 in. Volume ≥ 0.3% WQCV

[1] EDBs are not recommended for sites with less than 2 impervious acres. Consider a sand filter or rain garden.

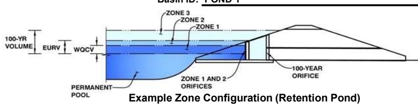
[2] Round up to the first standard pipe size (minimum 8 inches).

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 =	**EDB**			
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 =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			
Water Quality Capture Volume (WQCV) =	0.113	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) =	0.113	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.097	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) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	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)
Top of Micropool	--	0.00	--	--	--	40	0.001		
99	--	1.00	--	--	--	115	0.003	76	0.002
7600	--	2.00	--	--	--	6,421	0.147	3,281	0.075
1	--	3.00	--	--	--	7,821	0.180	10,466	0.240
2	--	4.00	--	--	--	9,335	0.214	19,044	0.437
3	--	5.00	--	--	--	11,027	0.253	29,225	0.671
4	--	6.00	--	--	--	14,490	0.333	41,984	0.964
4.5	--	6.50	--	--	--	16,129	0.370	49,639	1.140
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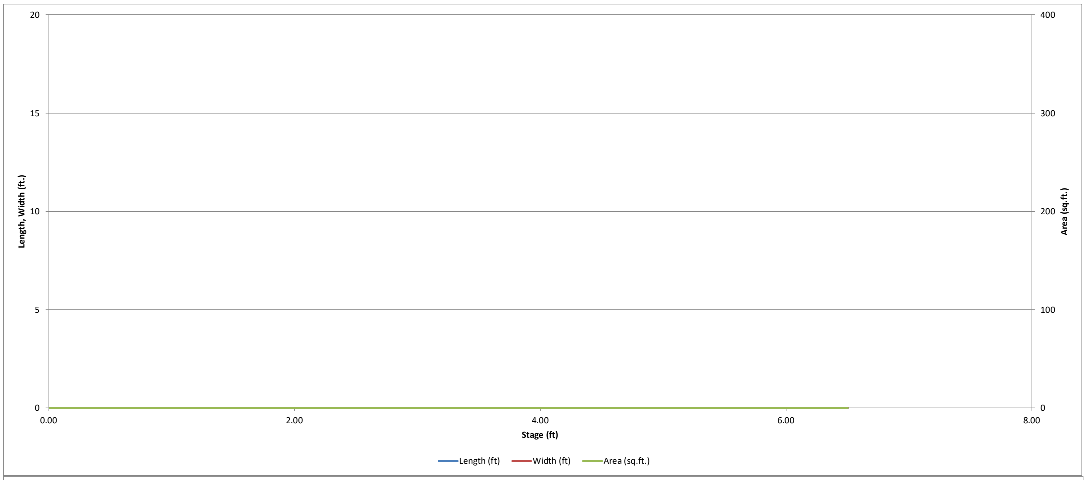
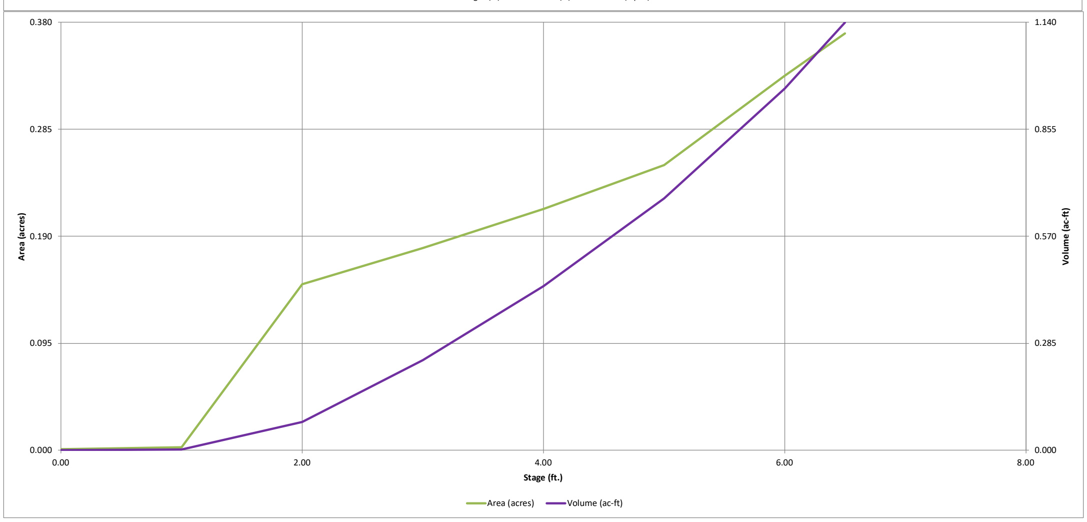
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)



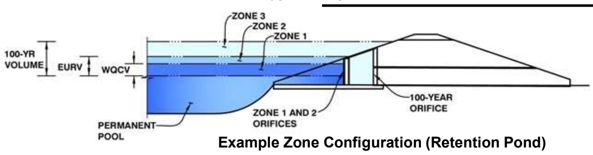


Detention Basin Outlet Structure Design

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)	2.24	0.113	Orifice Plate
Zone 2 (EURV)	2.83	0.097	Orifice Plate
Zone 3 (100-year)	4.95	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 =	N/A	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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 =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	3.00	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	12.00	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

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)	0.00	1.00	2.00					
Orifice Area (sq. inches)	0.46	0.35	0.35					

	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	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.00	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	3.00	N/A	feet
Overflow Weir Slope =	4.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	3.00	N/A	feet
Overflow Grate Open Area % =	75%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.75	N/A	feet
Over Flow Weir Slope Length =	3.09	N/A	feet
Grate Open Area / 100-yr Orifice Area =	5.56	N/A	should be $\geq$ 4
Overflow Grate Open Area w/o Debris =	6.96	N/A	ft^2
Overflow Grate Open Area w/ Debris =	3.48	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	12.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	1.25	N/A	ft^2
Outlet Orifice Centroid =	0.56	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.91	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.50	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	10.00	feet
Spillway End Slopes =	3.00	H:V
Freeboard above Max Water Surface =		feet

Calculated Parameters for Spillway

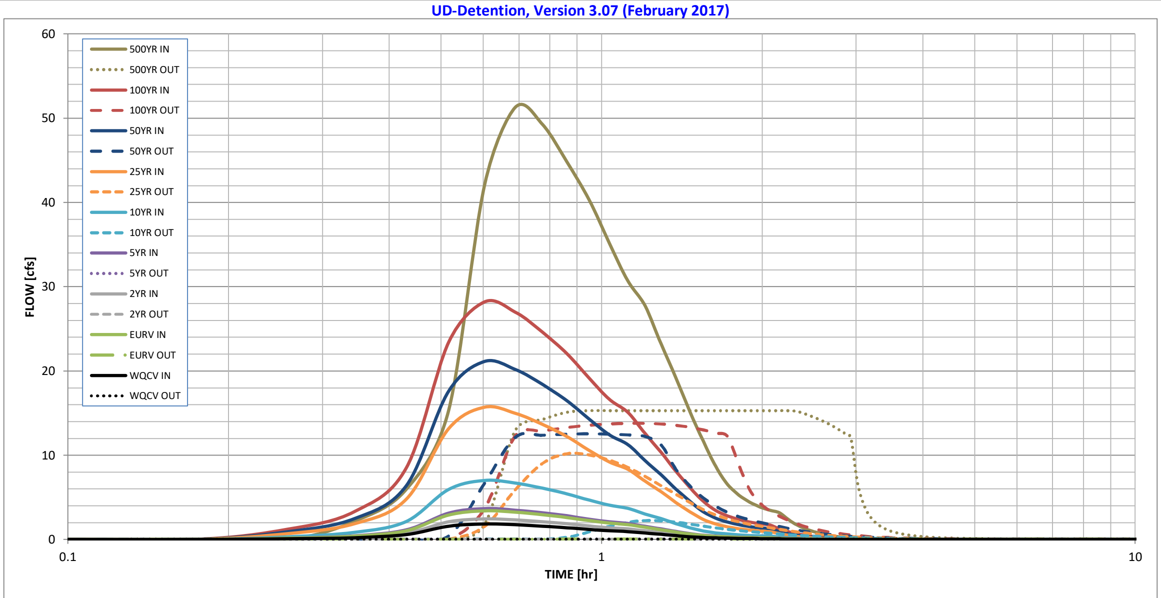
Spillway Design Flow Depth=	0.84	feet
Stage at Top of Freeboard =	6.34	feet
Basin Area at Top of Freeboard =	0.36	acres

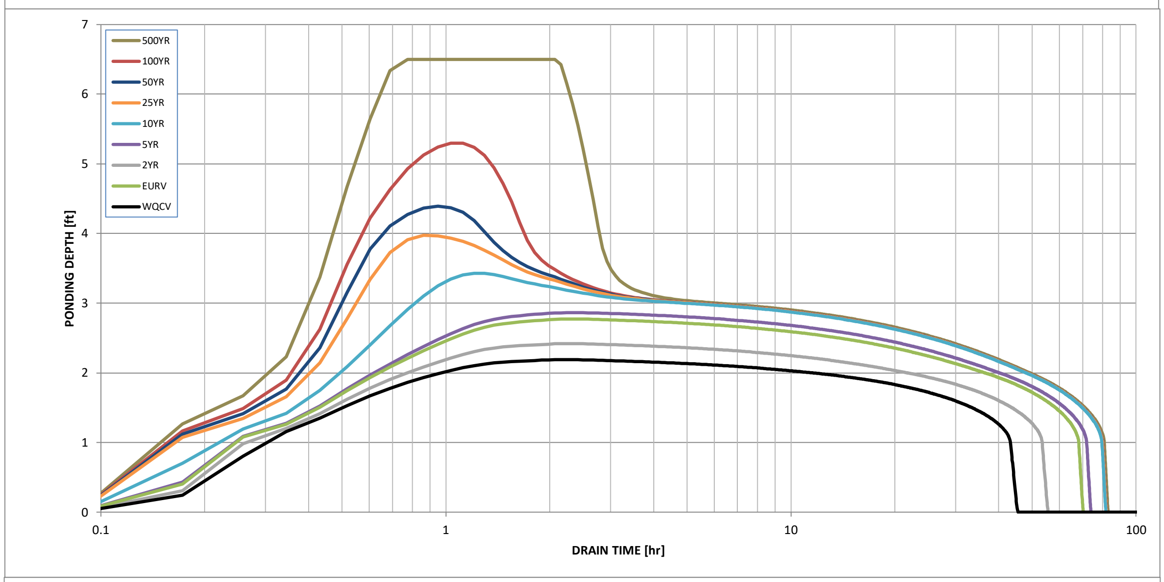
Routed Hydrograph Results

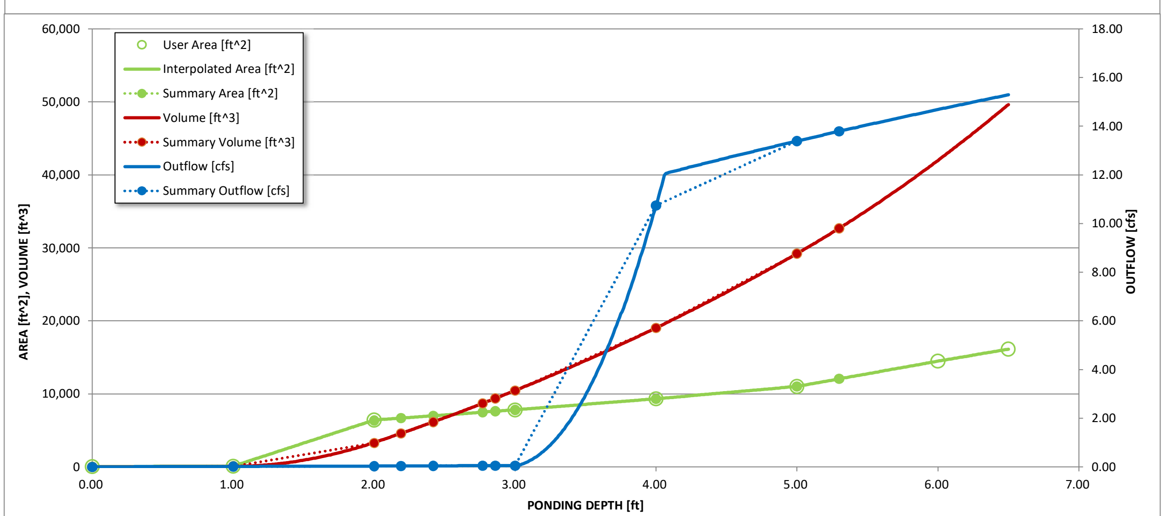
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.85
Calculated Runoff Volume (acre-ft) =	0.113	0.209	0.149	0.225	0.436	0.983	1.328	1.780	3.262
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.112	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) =	1.8	3.4	2.4	3.7	7.0	15.7	21.1	28.2	51.3
Peak Outflow Q (cfs) =	0.0	0.1	0.0	0.053	2.2	10.2	12.5	13.8	15.3
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.8	1.1	1.0	0.8	0.5
Structure Controlling Flow =	Plate	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	0.3	1.4	1.8	2.0	2.2
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) =	42	66	52	69	74	67	63	57	42
Time to Drain 99% of Inflow Volume (hours) =	**44**	68	54	72	78	76	74	72	66
Maximum Ponding Depth (ft) =	2.19	2.77	2.42	2.86	3.43	3.97	4.39	5.30	6.50
Area at Maximum Ponding Depth (acres) =	0.15	0.17	0.16	0.18	0.19	0.21	0.23	0.28	0.37
Maximum Volume Stored (acre-ft) =	0.104	0.200	0.140	0.215	0.319	0.431	0.524	0.748	1.140

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	
5.17 min	
Hydrograph Constant	0.966

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]
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
0:10:20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:15:31	0.08	0.15	0.11	0.17	0.31	0.69	0.92	1.22	2.16
0:20:41	0.22	0.41	0.30	0.44	0.84	1.86	2.50	3.32	5.97
0:25:51	0.57	1.06	0.76	1.14	2.16	4.78	6.41	8.52	15.32
0:31:01	1.58	2.91	2.09	3.13	5.94	13.14	17.60	23.39	42.02
0:36:11	1.84	3.40	2.44	3.66	7.01	15.69	21.11	28.20	51.29
0:41:22	1.74	3.24	2.31	3.49	6.68	14.99	20.19	27.00	49.22
0:46:32	1.58	2.94	2.10	3.17	6.08	13.65	18.38	24.57	44.79
0:51:42	1.40	2.61	1.86	2.82	5.42	12.21	16.47	22.05	40.32
0:56:52	1.19	2.24	1.59	2.41	4.67	10.57	14.29	19.15	35.20
1:02:02	1.05	1.96	1.39	2.11	4.07	9.20	12.42	16.64	30.69
1:07:13	0.94	1.77	1.26	1.91	3.69	8.34	11.26	15.09	27.75
1:12:23	0.76	1.44	1.02	1.56	3.03	6.91	9.36	12.57	23.21
1:17:33	0.61	1.17	0.82	1.26	2.47	5.66	7.69	10.36	19.20
1:22:43	0.46	0.88	0.62	0.95	1.89	4.39	5.99	8.11	15.16
1:27:53	0.33	0.64	0.45	0.70	1.40	3.29	4.53	6.16	11.66
1:33:04	0.24	0.47	0.33	0.51	1.02	2.38	3.30	4.52	8.67
1:38:14	0.19	0.37	0.26	0.40	0.79	1.84	2.53	3.44	6.53
1:43:24	0.16	0.31	0.21	0.33	0.65	1.51	2.07	2.80	5.27
1:48:34	0.14	0.26	0.18	0.28	0.55	1.28	1.75	2.37	4.44
1:53:44	0.12	0.23	0.16	0.25	0.49	1.12	1.53	2.07	3.87
1:58:55	0.11	0.21	0.15	0.22	0.44	1.01	1.37	1.86	3.46
2:04:05	0.10	0.19	0.14	0.21	0.41	0.93	1.26	1.71	3.17
2:09:15	0.07	0.14	0.10	0.15	0.30	0.68	0.93	1.26	2.36
2:14:25	0.05	0.10	0.07	0.11	0.22	0.50	0.68	0.92	1.71
2:19:35	0.04	0.08	0.05	0.08	0.16	0.37	0.50	0.67	1.26
2:24:46	0.03	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	0.01	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]
	0.00	40	0.001	0	0.000	0.00
	1.00	114	0.003	76	0.002	0.02
	2.00	6,358	0.146	3,281	0.075	0.03
WQCV	2.19	6,687	0.154	4,591	0.105	0.04
2 Yr	2.42	7,009	0.161	6,166	0.142	0.05
EURV	2.77	7,499	0.172	8,705	0.200	0.05
5 Yr	2.86	7,625	0.175	9,385	0.215	0.05
	3.00	7,821	0.180	10,466	0.240	0.05
	4.00	9,335	0.214	19,044	0.437	10.75
	5.00	11,027	0.253	29,225	0.671	13.39
100 Yr	5.30	12,066	0.277	32,689	0.750	13.79

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'.

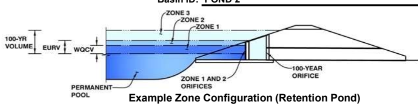
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

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 =	**EDB**			
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 =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			
Water Quality Capture Volume (WQCV) =	0.153	acre-feet	Optional User Override 1-hr Precipitation	
Excess Urban Runoff Volume (EURV) =	0.254	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	0.174	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.272	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.635	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	1.715	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	2.389	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	3.270	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.85 in.) =	6.102	acre-feet	3.85	inches
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		

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.153	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.101	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) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	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)
Top of Micropool	--	0.00	--	--	--	45	0.001		
	--	1.00	--	--	--	3,103	0.071	1,543	0.035
	--	2.00	--	--	--	7,895	0.181	6,994	0.161
	--	3.00	--	--	--	9,422	0.216	15,731	0.361
	--	4.00	--	--	--	10,942	0.251	25,913	0.595
	--	5.00	--	--	--	12,677	0.291	37,723	0.866
	--	6.00	--	--	--	14,446	0.332	51,284	1.177
	--	7.00	--	--	--	19,320	0.444	68,167	1.565
	--	8.00	--	--	--	25,278	0.580	90,466	2.077
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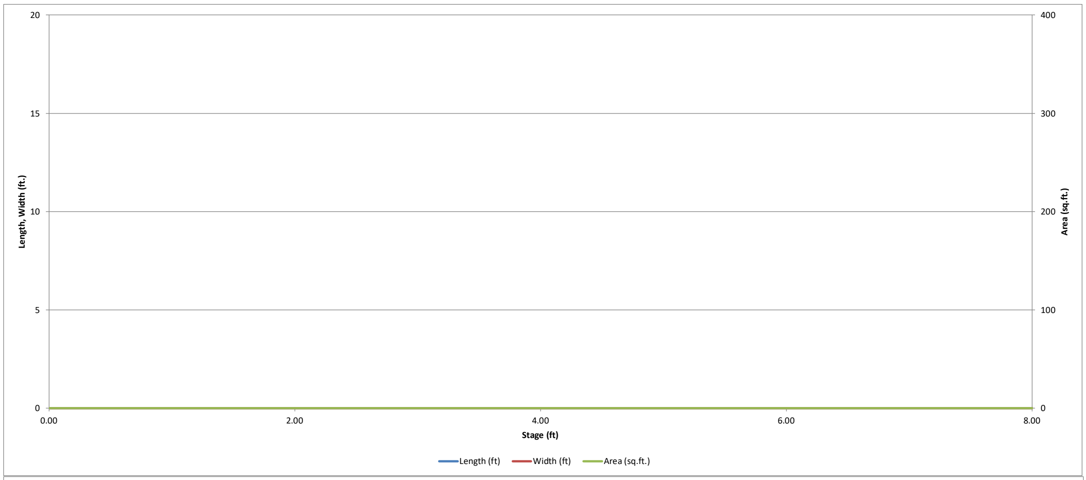
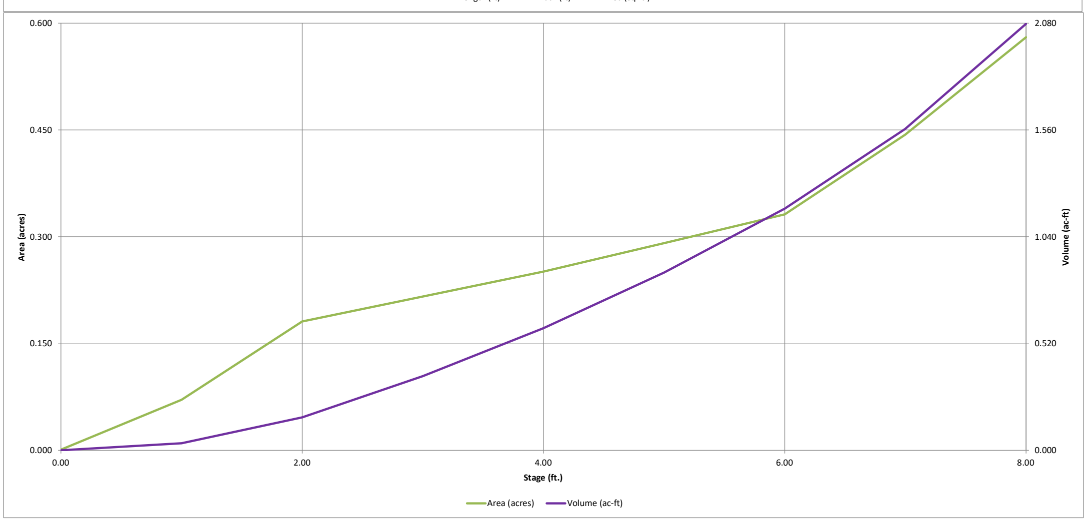
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)



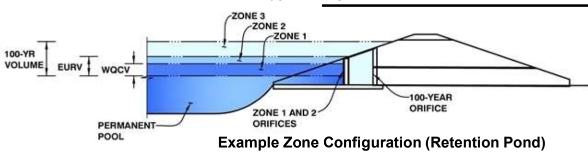


Detention Basin Outlet Structure Design

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)	1.95	0.153	Orifice Plate
Zone 2 (EURV)	2.49	0.101	Orifice Plate
Zone 3 (100-year)	5.55	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 =	N/A	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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 =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	3.00	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	12.00	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

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)	0.00	1.00	2.00					
Orifice Area (sq. inches)	0.70	0.98	0.98					

	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	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.00	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Slope =	4.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Open Area % =	75%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	4.00	N/A	feet
Over Flow Weir Slope Length =	4.12	N/A	feet
Grate Open Area / 100-yr Orifice Area =	8.39	N/A	should be $\geq$ 4
Overflow Grate Open Area w/o Debris =	12.37	N/A	ft^2
Overflow Grate Open Area w/ Debris =	6.18	N/A	ft^2

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

	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 Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	14.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	1.47	N/A	ft^2
Outlet Orifice Centroid =	0.64	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	2.16	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	7.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	18.00	feet
Spillway End Slopes =	3.00	H:V
Freeboard above Max Water Surface =		feet

Calculated Parameters for Spillway

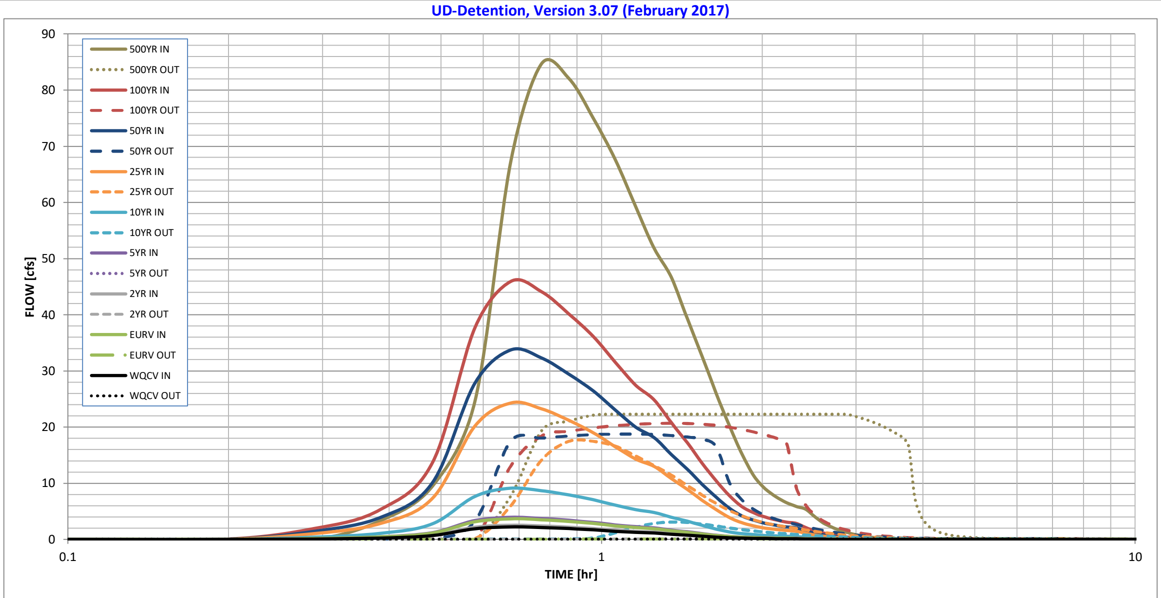
Spillway Design Flow Depth=	0.83	feet
Stage at Top of Freeboard =	7.83	feet
Basin Area at Top of Freeboard =	0.56	acres

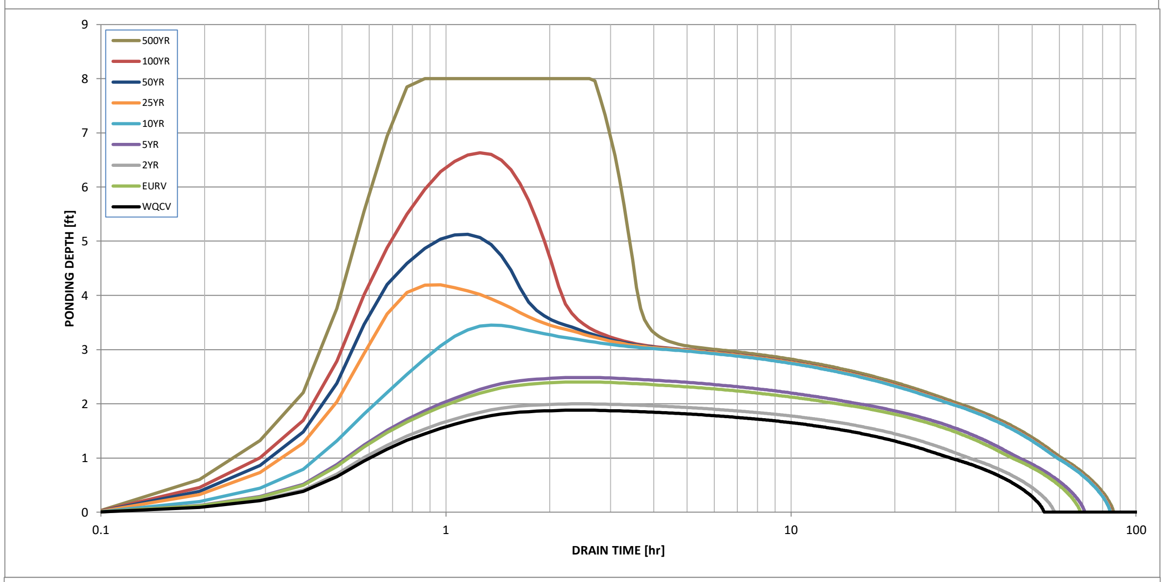
Routed Hydrograph Results

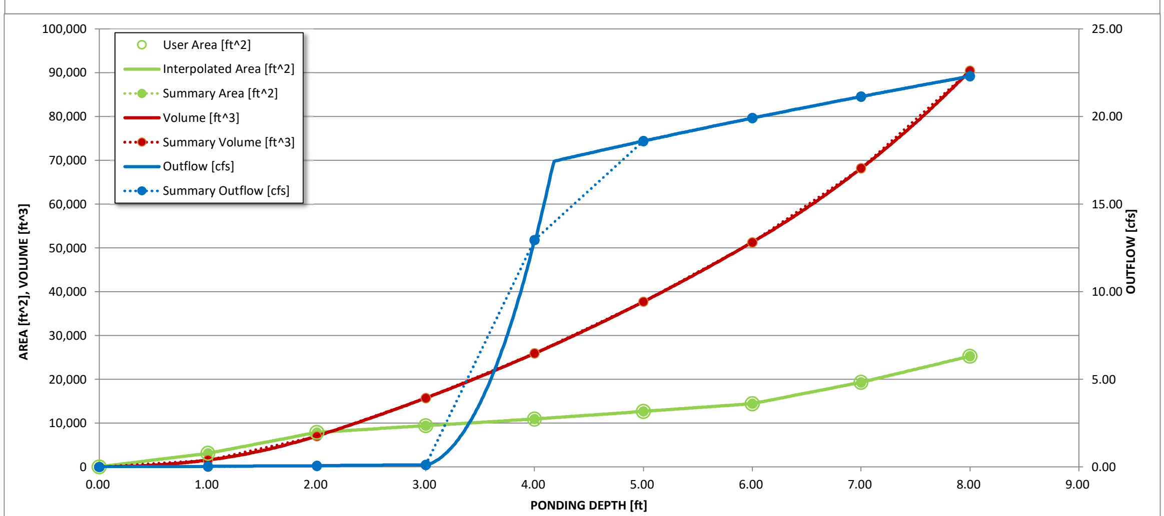
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.85
Calculated Runoff Volume (acre-ft) =	0.153	0.254	0.174	0.272	0.635	1.715	2.389	3.270	6.102
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.153	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) =	2.2	3.7	2.5	3.9	9.1	24.3	33.7	46.0	84.7
Peak Outflow Q (cfs) =	0.1	0.1	0.1	0.100	3.1	17.5	18.8	20.7	22.3
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.7	1.1	0.9	0.7	0.4
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	N/A
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.2	1.4	1.5	1.7	1.8
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) =	49	61	52	63	69	54	49	43	28
Time to Drain 99% of Inflow Volume (hours) =	**52**	65	55	67	77	70	66	62	53
Maximum Ponding Depth (ft) =	1.88	2.40	2.00	2.49	3.45	4.20	5.13	6.63	8.00
Area at Maximum Ponding Depth (acres) =	0.17	0.20	0.18	0.20	0.23	0.26	0.30	0.40	0.58
Maximum Volume Stored (acre-ft) =	0.141	0.238	0.162	0.253	0.462	0.643	0.901	1.408	2.077

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	Hydrograph Constant
5.79 min	0.864

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]
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
0:11:35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:17:22	0.10	0.17	0.12	0.18	0.40	1.05	1.44	1.94	3.37
0:23:10	0.27	0.44	0.31	0.47	1.09	2.86	3.95	5.35	9.56
0:28:57	0.70	1.14	0.79	1.22	2.79	7.35	10.14	13.72	24.55
0:34:44	1.92	3.14	2.17	3.35	7.67	20.18	27.83	37.65	67.23
0:40:32	2.23	3.69	2.54	3.94	9.10	24.31	33.73	45.95	84.68
0:46:19	2.12	3.51	2.41	3.75	8.69	23.27	32.32	44.10	82.07
0:52:07	1.93	3.19	2.19	3.41	7.91	21.18	29.42	40.13	74.99
0:57:54	1.71	2.84	1.94	3.03	7.06	19.00	26.44	36.12	67.60
1:03:41	1.46	2.43	1.66	2.60	6.10	16.50	23.02	31.54	59.30
1:09:29	1.28	2.13	1.45	2.27	5.31	14.34	20.03	27.50	51.86
1:15:16	1.15	1.92	1.31	2.05	4.81	13.00	18.14	24.86	46.67
1:21:04	0.94	1.57	1.07	1.68	3.97	10.83	15.14	20.79	39.30
1:26:51	0.76	1.27	0.86	1.36	3.24	8.92	12.50	17.21	32.63
1:32:38	0.57	0.96	0.65	1.03	2.50	6.98	9.83	13.59	26.01
1:38:26	0.41	0.71	0.47	0.76	1.86	5.30	7.52	10.45	20.19
1:44:13	0.30	0.52	0.35	0.55	1.35	3.89	5.55	7.77	15.19
1:50:01	0.24	0.40	0.27	0.43	1.04	2.96	4.20	5.85	11.32
1:55:48	0.20	0.33	0.23	0.36	0.86	2.41	3.41	4.72	9.04
2:01:35	0.17	0.28	0.19	0.30	0.73	2.04	2.87	3.98	7.60
2:07:23	0.15	0.25	0.17	0.27	0.64	1.78	2.51	3.47	6.59
2:13:10	0.13	0.23	0.15	0.24	0.58	1.60	2.25	3.10	5.89
2:18:58	0.13	0.21	0.14	0.22	0.53	1.47	2.06	2.84	5.38
2:24:45	0.09	0.15	0.10	0.16	0.39	1.08	1.53	2.11	4.06
2:30:32	0.07	0.11	0.08	0.12	0.29	0.79	1.11	1.53	2.93
2:36:20	0.05	0.08	0.06	0.09	0.21	0.58	0.82	1.13	2.17
2:42:07	0.04	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	0.02	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.

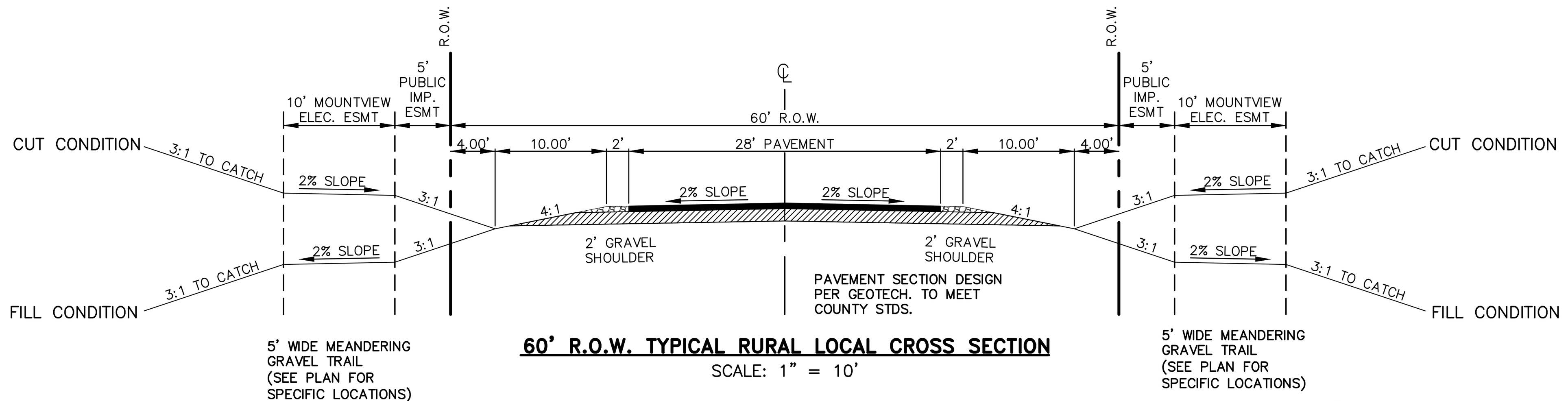
The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
	0.00	45	0.001	0	0.000	0.00
	1.00	3,072	0.071	1,543	0.035	0.02
	2.00	7,847	0.180	6,994	0.161	0.07
	3.00	9,422	0.216	15,731	0.361	0.12
	4.00	10,942	0.251	25,913	0.595	12.95
	5.00	12,677	0.291	37,723	0.866	18.60
	6.00	14,446	0.332	51,284	1.177	19.91
	7.00	19,320	0.444	68,167	1.565	21.14
	8.00	25,278	0.580	90,466	2.077	22.30

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).

DRAINAGE MAP



60' R.O.W. TYPICAL RURAL LOCAL CROSS SECTION
SCALE: 1" = 10'

FINAL DRAINAGE REPORT ~ BASIN RUNOFF SUMMARY																			
		WEIGHTED			OVERLAND				STREET / CHANNEL FLOW				Tc	INTENSITY			TOTAL FLOWS		
BASIN	TOTAL AREA (AC)	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	3.5	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	1.3	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	1.7	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	1.2	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
OS-5	40.6	1.22	3.65	14.62	0.09	300	12	20.0	1600	3.0%	1.2	22.0	42.0	1.59	1.98	3.32	2	7	48
A	5.0	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	8.9	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	5.1	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	1.4	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	5.1	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	5.8	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	13.3	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	9.1	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	1.6	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	0.7	0.12	0.16	0.33	0.12								5.0	4.12	5.17	8.68	0.5	0.8	3
K	2.1	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	5.4	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									
					Intensity		Flow		
Design Point(s)	Contributing Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	I(5)	I(100)	Q(5)	Q(100)	Outfall / Inlet Size
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 (TOTAL FLOWS INCL. OFF-SITE)	L (5.4 AC.) & OS-5 (40.6 AC.)	4.42	16.80	42.0	1.98	3.32	8	56	EXIST. 24" CULVERT
D8 (ON-SITE FLOWS ONLY)	L (5.4 AC.)	0.77	2.18	25.4	2.73	4.59	2	10	EXIST. 24" CULVERT
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		EXISTING FORESTED AREA OUTLINE	
BASIN BOUNDARY			
BASIN IDENTIFIER / AREA IN ACRES	H-1 / 10.0		
DESIGN POINT	D2		

NOTES

1. PURCHASERS OF LOTS WITHIN THIS SUBDIVISION ARE HEREBY ALERTED THAT THESE LOTS CONTAIN STORM WATER CONVEYANCE PATHS. SAID PURCHASERS ACKNOWLEDGE ACCEPTANCE OF THESE FLOWS ONTO, AND THROUGH, THESE LOTS. THE PURCHASER OF THESE LOTS SHALL BE RESPONSIBLE FOR MAINTAINING THESE PATHS AND FOR PROVIDING MEASURES TO ELIMINATE EROSION, IF SUCH SHOULD OCCUR.
2. ALL PROPERTY OWNERS ARE RESPONSIBLE FOR MAINTAINING PROPER STORMWATER DRAINAGE IN AND THROUGH THEIR PROPERTY. STRUCTURES, FENCES, MATERIALS OR LANDSCAPING THAT COULD IMPEDE THE FLOW OF RUNOFF SHALL NOT BE PLACED IN THE STORMWATER CONVEYANCE PATHS.
3. FUTURE PROPERTY OWNERS ARE ADVISED THAT EL PASO COUNTY'S APPROVAL OF THIS PLAT DOES NOT INCLUDE CERTIFICATION OF WATER RIGHTS OR THE STRUCTURAL STABILITY OF THE EXISTING STOCK PONDS LOCATED ON THE SUBJECT PROPERTY. THE STATE OF COLORADO HAS JURISDICTION REGARDING MODIFICATION OR ELIMINATION OF SUCH PONDS.

REDTAIL RANCH FILING NO. 1
PRELIMINARY/FINAL DRAINAGE REPORT
DEVELOPED DRAINAGE MAP

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(719)785-0799 (Fax)

DESIGNED BY	MAW	SCALE	DATE	4-15-20
DRAWN BY	MAW	(H) 1"= 100'	SHEET 1 OF 1	
CHECKED BY		(V) 1"= N/A	JOB NO.	2525.00