DRAINAGE LETTER REPORT

for

STRUTHERS RANCH POLARIS
847 STRUTHERS RANCH ROAD
LOTS 1-2, STRUTHERS RANCH SUBDIVISION FILING NO. 4

Prepared for:

Hammers Construction, Inc.
1411 Woolsey Heights
Colorado Springs, CO 80915

August 10, 2022

Prepared by:

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JPS Project No. 032203

Add text:

PCD Filing No.:
PPR2248

STRUTHERS RANCH POLARIS
DRAINAGE LETTER REPORT
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APPENDICES

DRAINAGE STATEMENT

Engineer's Statement:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for liability caused by negligent acts, errors or omissions on my part in preparing this report.

_____

John P. Schwab, P.E. #29891

Developer's Statement:

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

By:

_____

Date

Hammers Construction, Inc.
1411 Woolsey Heights, Colorado Springs, CO 80915

El Paso County's Statement

Filed in accordance with the requirements of the El Paso County Land Development Code, Drainage Criteria Manual, Volumes 1 and 2, and Engineering Criteria Manual as amended.

_____

Joshua Palmer, P.E. Date
County Engineer / ECM Administrator

Conditions:

I. INTRODUCTION

A. Property Location and Description

Hammers Construction is planning to construct a new Polaris dealership on the vacant 2.94-acre property at the southeast corner of Struthers Road and Struthers Ranch Road in northern El Paso County, Colorado. The property is described as Lots 1 and 2, Struthers Ranch Subdivision Filing No. 4 (El Paso County Assessor's Parcel Numbers 71363-03-010 and 71363-03-011).

The project consists of a new 12,000 square-foot, single-story Polaris dealership building with associated parking and site improvements. The property is bounded by Struthers Road on the southwest side and Struthers Ranch Road on the northwest side. Struthers Road is a fully improved, asphalt-paved arterial public street, and Struthers Ranch Road is a fully improved local public street. Existing platted residential lots are located along the northeast boundary of the parcel (Struthers Ranch Filing No. 2). The south boundary of the site adjoins vacant commercial properties (Lots 3 and 4, Struthers Ranch Subdivision Filing No. 4).

The property is zoned Planned Unit Development (PUD), and the proposed site development is fully consistent with the existing zoning of the site. Access to the site will be provided by the existing private driveway connection to Struthers Ranch Road along the north boundary of Lot 1.

The site is located in the Black Forest Creek Drainage Basin, and surface drainage from this site sheet flows southwesterly to an existing public storm sewer system along the west boundary of the property, flowing to the existing Struthers Ranch stormwater detention pond on the west side of Struthers Road.

This report is intended to meet the requirements of a site-specific "Letter Type" drainage report in accordance with El Paso County subdivision drainage criteria.

B. Drainage Analysis Methods and Criteria

ITEM	DESCRIPTION	REFERENCE
Design Storm (initial/major)	5-year/100-year	CS/EPC DCM
Storm Runoff	Rational Method (Area<100acres)	CS/EPC DCM
Major Drainage Basin	Black Forest Creek	
Floodplain Impacts	Parcel is located outside any delineated FEMA floodplains	FIRM
Existing Downstream Facilities	Existing storm sewer system on east side of Struthers Road; Existing detention pond on west side of Struthers Road	

CS/EPC DCM = City of Colorado Springs & El Paso County Drainage Criteria Manual

C. References

JPS Engineering, Inc., "Final Drainage Report for Struthers Ranch Filing No. 2," October 14, 2004 (approved by El Paso County 10/20/04).

JPS Engineering, Inc., "Drainage Letter Report for Struthers Ranch Subdivision Filing No. 4," February 22, 2006.

II. EXISTING / PROPOSED DRAINAGE CONDITIONS

Subdivision Drainage Report

As shown on the enclosed Struthers Ranch Subdivision Drainage Plan (Figure D1, Appendix D), the proposed Polaris development site lies entirely within Basin D6A as delineated in the approved "Final Drainage Report for Struthers Ranch Filing No. 2." The site slopes downward to the southwest, with average grades of 1-4 percent. On-site soils are classified by SCS as type 71, "Pring" series coarse sandy loam soils. These soils have moderately rapid permeability and slow to medium surface runoff characteristics. The soils are classified as hydrologic soils group B.

Developed drainage from this commercial site will sheet flow southwesterly to the existing storm sewer system along the east side of Struthers Road. Flows combine at the existing grated inlet on the east side of Struthers Road, where double 48-inch culverts convey developed flows across Struthers Road and into the existing detention pond. The previously approved drainage report for Struthers Ranch Filing No. 2 assumed full commercial development for this basin, which is consistent with the proposed site development. The existing detention pond was sized to account for fully developed flows from this commercial area.

According to the Rational Method calculations in the original subdivision drainage report, developed peak flows from Basin D6A were calculated as $Q_5 = 14.0$ cfs and $Q_{100} = 24.3$ cfs. The impervious area for the proposed Struthers Ranch Polaris development amounts to approximately 65 percent of the site, which is well below the impervious area of 95 percent assumed for full commercial development in the previously approved subdivision drainage report.

Based on the previous construction of drainage improvements for the Struthers Ranch Subdivision, no significant impact on downstream drainage facilities is anticipated from this site development and replat. Proper erosion control measures will be required for development of the site, including silt fence along property boundaries to minimize off-site transport of construction sediment.

Clarify existing or proposed. The use of "EDB" is confusing given the existing EDB mentioned on the previous page

Please revise the name of the pond to not include "detention" to avoid confusion since the majority of to site's detention occurs offsite at the existing pond. For clarify, just call the proposed pond "Water Quality Pond A" or similar (do this global name change on all applicable docs).

Developed Site Drainage Plan

As shown on the enclosed Drainage Plan (Figure D1.1, Appendix D), the site has been delineated as two on-site drainage basins. Developed flows have been calculated based on the impervious areas associated with the proposed building and parking improvements.

Surface drainage swales and a private storm sewer system will convey developed flows to the extended detention basin (EDB) along the west boundary of the site. Site grades will slope to storm inlets and curb openings at selected locations, collecting surface drainage and conveying stormwater to the detention basin. The proposed building pad will be graded with protective slopes to provide positive drainage away from the building, and the curb, gutter, drainage swales, and private storm sewer system will convey developed flows southwesterly into Detention Basin A.

Label on drainage map D1.1 below.

The proposed Polaris site development on Lots 1-2 has been delineated as Basin A, which drains by sheet flow and curb and gutter to the proposed Stormwater Quality Detention Basin along the west boundary of the site. Private Storm Inlet A (Type 16) will intercept surface drainage from the north side of the Polaris site, and Private Storm Sewer A1 (12") will convey this flow into the on-site Stormwater Quality Detention Basin A. The balance of the Polaris site will flow by drainage swales and curb and gutter into the south side of the Detention Basin A.

Per ECM Chap3.3.1.C - Min pipe size is 18" diameter

Developed peak flows at Design Point A are calculated as $Q_5 = 8.1$ cfs and $Q_{100} = 16.6$ cfs. Basin A generally correlates with "Basin D6A" in the Final Drainage Report for Struthers Ranch Filing No. 2 ($Q_5 = 14.0$ cfs and $Q_{100} = 24.3$ cfs).

via a proposed 18" pipe

The future commercial site development areas to the south in Lots 3-4 have been delineated as Basin B, which will generally drain northwesterly by sheet flow and curb and gutter to a future private storm sewer conveying developed flows into Stormwater Quality Detention Basin A. Developed peak flows at Design Point B are calculated as $Q_5 = 4.3$ cfs and $Q_{100} = 8.2$ cfs. Basin B generally correlates with "Basin D9A" in the Final Drainage Report for Struthers Ranch Filing No. 2 ($Q_5 = 14.9$ cfs and $Q_{100} = 25.8$ cfs).

Developed flows from Basins A and B combine at Design Point #1, with peak flows calculated as $Q_5 = 11.9$ cfs and $Q_{100} = 23.9$ cfs.

Add a discuss of how water is conveyed from the proposed pond's outlet structure to existing Detention Basin 11, as it is unclear from the drainage map.

Hydrologic and hydraulic calculations for the site are detailed in the appendices (Appendix A and B), and peak flows are identified on Figure D1.1 (Appendix D).

III. DRAINAGE PLANNING FOUR STEP PROCESS

El Paso County Drainage Criteria require drainage planning to include a Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long-term source controls.

As stated in ECM Appendix I.7., the Four Step Process is applicable to all new and re-development projects with construction activities that disturb 1 acre or greater or that disturb less than 1 acre but are part of a larger common plan of development. The Four Step Process has been implemented as follows in the planning of this project:

Step 1: Employ Runoff Reduction Practices

- Extended Detention Basin: The majority of developed flows will be routed through the on-site detention basin, which will be grass-lined to encourage stormwater infiltration.

Step 2: Stabilize Drainageways

- There are no drainageways directly adjacent to this project site. Implementation of the on-site drainage improvements and detention basin will minimize downstream drainage impacts from this site.
- Drainage basin fees were previously paid during recording of the subdivision plat, and these fees provided the applicable cost contribution towards regional drainage improvements.

Step 3: Provide Water Quality Capture Volume (WQCV)

- EDB: The majority of the developed site will drain through an on-site Private Extended Detention Basin (EDB) along the west boundary of the property. The extended detention basin which will capture and slowly release the WQCV over an extended release period.

Step 4: Consider Need for Industrial and Commercial BMPs

- No industrial uses are proposed for this site.
- The commercial property owner will implement a Stormwater Management Plan including proper housekeeping practices and spill containment procedures.
- On-site drainage will be routed through the Extended Detention Basin (EDB) to minimize introduction of contaminants to the County's public drainage system.

IV. FLOODPLAIN IMPACTS

According to the FEMA floodplain map for this area, El Paso County FIRM Panel No. 08041C0287G, dated December 7, 2018, the site is located beyond the limits of any delineated floodplains.

V. STORMWATER DETENTION AND WATER QUALITY

Engineer must confirm in the Drainage Report that the existing pond is functioning as intended.

Stormwater detention for this site is provided in the existing stormwater detention pond constructed during initial development of the Struthers Ranch Subdivision.

An on-site private Extended Detention Basin (EDB) will be constructed to meet stormwater quality improvements in accordance with current El Paso County drainage criteria.

As detailed in the detention pond calculations in Appendix C, the required Water Quality Capture Volume (WQCV) has been calculated as 0.10 acre-feet. The proposed on-site Extended Detention Basin (EDB) provides a storage volume of 0.23 acre-feet, which meets the required WQCV volume.

The proposed detention pond will include a forebay, trickle channel, and outlet structure with a water quality orifice plate to maintain discharges below the allowable release rates. The pond outlet structure has been designed using the Mile High Flood District's "MH-Detention" calculation spreadsheets, providing for a 40-hour release of the WQCV, and outlet structure sizing to maintain maximum allowable release rates from the pond. The EDB will have a grass-lined bottom to encourage infiltration of stormwater prior to discharging into the downstream public drainage system.

The new on-site Stormwater Quality Detention Basin will be privately owned and maintained by the property owner, and maintenance access will be provided from the southwest parking lot.

VI. PUBLIC IMPROVEMENTS / DRAINAGE BASIN FEES

No public drainage improvements are required or proposed for this project. The site lies completely within the Black Forest Creek Drainage Basin. Applicable drainage basin fees were paid at the time of original platting of Struthers Ranch Filing No. 2, so no drainage basin fees or bridge fees are applicable at this time.

VII. SUMMARY

The developed drainage patterns for the proposed site development on Lots 1-2, Struthers Ranch Filing No. 4 will remain consistent with the established drainage plan for this subdivision. The grading and drainage plan for the proposed Polaris site development fully conforms to the approved drainage plan for Struthers Ranch Filings No. 2 and 4.

Developed flows from the site will drain through a Private Stormwater Quality Detention Pond at the southwest corner of the property prior to discharging to the existing downstream public drainage system. Stormwater detention is provided by the existing Struthers Ranch Detention Pond, and the new on-site Extended Detention Basin will be provided to meet current stormwater quality requirements. Construction and proper maintenance of the on-site drainage facilities and Extended Detention Basin, in conjunction with proper erosion control practices, will ensure that this developed site has no significant adverse drainage impact on downstream or surrounding areas.

Confirm the existing offsite detention pond provides the required detention for flows generated by the site. State numerical increase in flows of undeveloped conditions compared to developed conditions.

Provide a cost estimate of the proposed water quality pond.

APPENDIX A

HYDROLOGIC CALCULATIONS

Table 6-6. Runoff Coefficients for Rational Method
(Source: UDFCD 2001)

Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.60	0.65	0.62	0.68
Residential													
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.57	0.62	0.59	0.65
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.43	0.52	0.47	0.57
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.41	0.51	0.46	0.56
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.40	0.50	0.44	0.55
Industrial													
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Heavy Areas	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
Undeveloped Areas													
Historic Flow Analysis--Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59
Streets													
Paved	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Drive and Walks	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Roofs	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration (t_c) consists of an initial time or overland flow time (t_i) plus the travel time (t_t) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time (t_i) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion (t_t) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

$$t_c = t_i + t_t \quad \text{(Eq. 6-7)}$$

Where:

t_c = time of concentration (min)

t_i = overland (initial) flow time (min)

t_t = travel time in the ditch, channel, gutter, storm sewer, etc. (min)

3.2.1 Overland (Initial) Flow Time

The overland flow time, t_i, may be calculated using Equation 6-8.

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \quad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \quad \text{(Eq. 6-9)}$$

Where:

V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

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.

The travel time is calculated by dividing the flow distance (in feet) by the velocity calculated using Equation 6-9 and converting units to minutes.

The time of concentration (t_c) is then the sum of the overland flow time (t_i) and the travel time (t_t) per Equation 6-7.

3.2.3 First Design Point Time of Concentration in Urban Catchments

Using this procedure, the time of concentration at the first design point (typically the first inlet in the system) in an urbanized catchment should not exceed the time of concentration calculated using Equation 6-10. The first design point is defined as the point where runoff first enters the storm sewer system.

$$t_c = \frac{L}{180} + 10 \qquad \text{(Eq. 6-10)}$$

Where:

t_c = maximum time of concentration at the first design point in an urban watershed (min)

L = waterway length (ft)

Equation 6-10 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional "calibration" of the Rational Method. Normally, Equation 6-10 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed. For subsequent design points, the time of concentration is calculated by accumulating the travel times in downstream drainageway reaches.

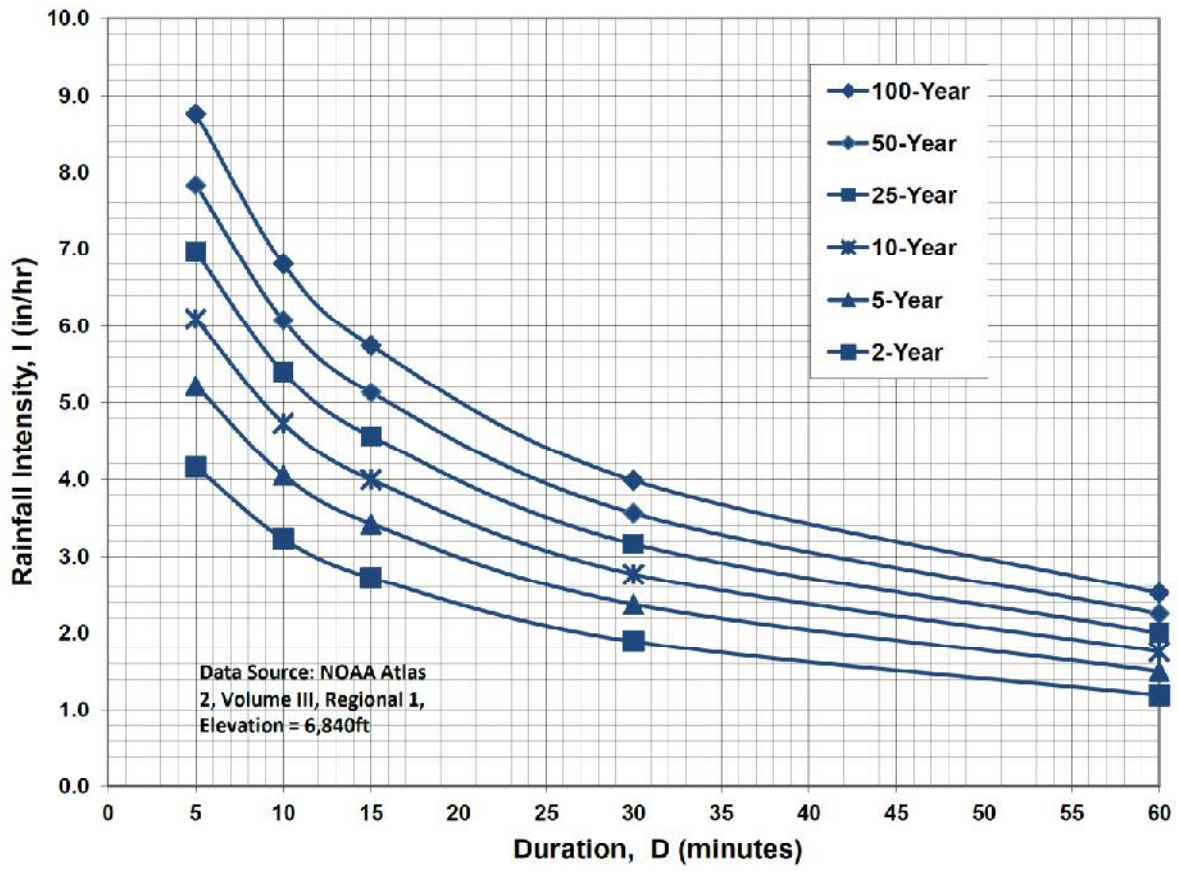
3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

3.2.5 Post-Development Time of Concentration

As Equation 6-8 indicates, the time of concentration is a function of the 5-year runoff coefficient for a drainage basin. Typically, higher levels of imperviousness (higher 5-year runoff coefficients) correspond to shorter times of concentration, and lower levels of imperviousness correspond to longer times of

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

$I_{100} = -2.52 \ln(D) + 12.735$

$I_{50} = -2.25 \ln(D) + 11.375$

$I_{25} = -2.00 \ln(D) + 10.111$

$I_{10} = -1.75 \ln(D) + 8.847$

$I_{5} = -1.50 \ln(D) + 7.583$

$I_{2} = -1.19 \ln(D) + 6.035$

Note: Values calculated by equations may not precisely duplicate values read from figure.

STRUTHERS RANCH POLARIS
COMPOSITE RUNOFF COEFFICIENTS

DEVELOPED CONDITIONS

5-YEAR C VALUES

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
A	2.94	1.90	PAVED/IMPERVIOUS	0.9	1.04	LANDSCAPED	0.08				0.610
B	1.22	0.98	PAVED/IMPERVIOUS	0.9	0.24	LANDSCAPED	0.08				0.736
A,B	4.16										0.647

100-YEAR C VALUES

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
A	2.94	1.90	PAVED/IMPERVIOUS	0.96	1.04	LANDSCAPED	0.35				0.744
B	1.22	0.98	PAVED/IMPERVIOUS	0.96	0.24	LANDSCAPED	0.35				0.838
A,B	4.16										0.772

IMPERVIOUS AREAS

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	WEIGHTED % IMP
A	2.94	1.90	PAVED/IMPERVIOUS	100	1.04	LANDSCAPED	0.00				64.626
B	1.22	0.98	PAVED/IMPERVIOUS	100	0.24	LANDSCAPED	0.00				80.000
A,B	4.16										69.135

Based on the imperviousness calculation Lots 3 & 4 would be limited to 80% imperviousness when they develop which is no longer in conformance with the original report. Since basin B drains into the WQ facility, the pond should be sized to maintain the 95% imperviousness for Lots 3 & 4 per the original report's assumption or include a section in the narrative identify the 80% design limit of the proposed pond and identifying the expected design consideration should proposed development within Lots 3 & 4 exceed 80% percent imperviousness.

STRUTHERS RANCH POLARIS
RATIONAL METHOD

DEVELOPED CONDITIONS

					Overland Flow			Channel flow										
BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR	C 100-YEAR	LENGTH (FT)	SLOPE (FT/FT)	Tco [1] (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS [2] VELOCITY (FT/S)	Tt [3] (MIN)	TOTAL Tc [4] (MIN)	TOTAL Tc [4] (MIN)	INTENSITY [5] 5-YR (IN/HR)	INTENSITY [5] 100-YR (IN/HR)	PEAK FLOW Q5 [6] (CFS)	PEAK FLOW Q100 [6] (CFS)
A	A	2.94	0.610	0.744	60	0.017	5.8	440	20	0.039	3.95	1.9	7.7	7.7	4.53	7.60	8.12	16.62
B	B	1.22	0.736	0.838	100	0.030	4.6	235	20	0.01	2.00	2.0	6.6	6.6	4.76	7.99	4.27	8.17
Tt DP-B to DP-1								190	20	0.01	2.00	1.6						
A,B	1	4.16	0.647	0.772									8.2	8.2	4.43	7.44	11.93	23.91

1) OVERLAND FLOW Tco = (0.395*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH^(0.5)/(SLOPE^(0.333))
2) SCS VELOCITY = C * ((SLOPE(FT/FT)^0.5)
C = 2.5 FOR HEAVY MEADOW
C = 5 FOR TILLAGE/FIELD
C = 7 FOR SHORT PASTURE AND LAWNS
C = 10 FOR NEARLY BARE GROUND
C = 15 FOR GRASSED WATERWAY
C = 20 FOR PAVED AREAS AND SHALLOW PAVED SWALES

3) MANNING'S CHANNEL TRAVEL TIME = L/V (WHEN CHANNEL VELOCITY IS KNOWN)
4) Tc = Tco + Tt
*** IF TOTAL TIME OF CONCENTRATION IS LESS THAN 5 MINUTES, THEN 5 MINUTES IS USED
5) INTENSITY BASED ON I-D-F EQUATIONS IN CITY OF COLORADO SPRINGS DRAINAGE CRITERIA MANUAL
I_5 = -1.5 * ln(Tc) + 7.583
I_{100} = -2.52 * ln(Tc) + 12.735
6) Q = CiA

APPENDIX B

HYDRAULIC CALCULATIONS

STRUTHERS RANCH POLARIS
STORM INLET SIZING SUMMARY

	BASIN FLOW			INLET FLOW					
INLET	DP	Q5 FLOW (CFS)	Q100 FLOW (CFS)	INLET FLOW % OF BASIN	Q5 FLOW (CFS)	Q100 FLOW (CFS)	INLET CONDITION / TYPE	INLET SIZE (FT)	INLET CAPACITY (CFS)
A1	A	8.1	16.6	40	3.2	6.6	SUMP TYPE 16	SGL	6.8

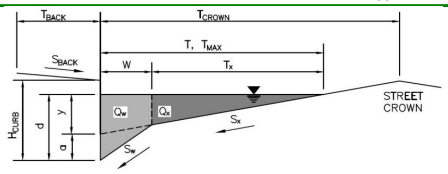
Version 4.05 Released March 2017

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

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Struthers Ranch Polaris - Inlet A1

Inlet ID: Inlet A1



Gutter Geometry (Enter data in the blue cells)

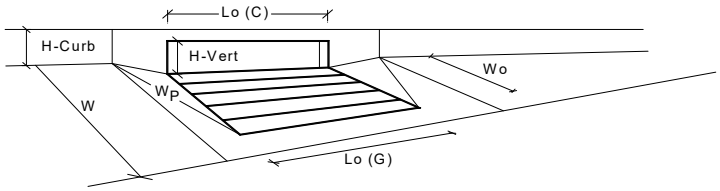
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	4.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	50.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.010	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	50.0	50.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)	Denver No. 16 Combination			
Type of Inlet	Type =	MINOR: Denver No. 16 Combination	MAJOR	
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	9.0	inches
Grate Information		MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate	L_o (G) =	3.00	3.00	feet
Width of a Unit Grate	W_o =	1.73	1.73	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.60	3.60	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.50	6.50	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	0.00	0.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.523	0.773	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.58	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.94	1.00	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.94	1.00	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**3.9**	**6.8**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	3.2	6.6	cfs

STRUTHERS RANCH POLARIS
STORM SEWER SIZING SUMMARY

	PIPE FLOW				PIPE CAPACITY		
PIPE	DESIGN POINT	Q5 FLOW (CFS)	Q100 FLOW (CFS)		PIPE SIZE	MIN. PIPE SLOPE	PIPE CAPACITY (CFS)
A1	A1	3.2	6.6		12	3.5%	6.7

ASSUMPTIONS:
1. STORM DRAIN PIPE ASSUMED TO BE RCP OR HDPE

Hydraulic Analysis Report

Project Data

Project Title: Struthers Ranch Polaris

Designer: JPS

Project Date: Monday, June 13, 2022

Project Units: U.S. Customary Units

Notes:

Channel Analysis: SD-A1

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 1.0000 ft

Longitudinal Slope: 0.0350 ft/ft

Manning's n: 0.0130

Depth: 1.0000 ft

Result Parameters

Flow: 6.6654 cfs

Area of Flow: 0.7854 ft^2

Wetted Perimeter: 3.1416 ft

Hydraulic Radius: 0.2500 ft

Average Velocity: 8.4866 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 0.9700 ft

Critical Velocity: 8.5616 ft/s

Critical Slope: 0.0308 ft/ft

Critical Top Width: 0.34 ft

Calculated Max Shear Stress: 2.1840 lb/ft^2

Calculated Avg Shear Stress: 0.5460 lb/ft^2

APPENDIX C

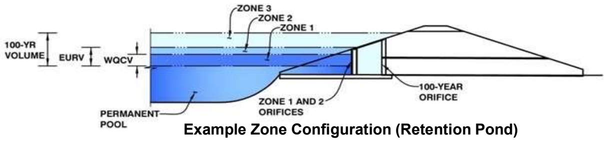
WATER QUALITY POND CALCULATIONS

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)

Project: **Struthers Ranch Polaris**

Basin ID: **A**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	4.16	acres
Watershed Length =	525	ft
Watershed Length to Centroid =	250	ft
Watershed Slope =	0.014	ft/ft
Watershed Imperviousness =	69.10%	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
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.094	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.315	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.273	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.368	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.449	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.545	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.630	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.731	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	0.946	acre-feet	3.14	inches
Approximate 2-yr Detention Volume =	0.246	acre-feet		
Approximate 5-yr Detention Volume =	0.328	acre-feet		
Approximate 10-yr Detention Volume =	0.415	acre-feet		
Approximate 25-yr Detention Volume =	0.446	acre-feet		
Approximate 50-yr Detention Volume =	0.464	acre-feet		
Approximate 100-yr Detention Volume =	0.498	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.094	acre-feet
Zone 2 Volume (User Defined - Zone 1) =	0.100	acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.194	acre-feet

Total detention volume is less than 100-year volume.

Remove or update the narrative to describe the purpose for adding the user defined 0.1 ac-ft of storage.

Depth Increment = 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	--	--	--	10	0.000		
Bot EL=6752.0	--	1.50	--	--	--	1,437	0.033	1,085	0.025
	--	3.50	--	--	--	2,201	0.051	4,723	0.108
EL=6756.0	--	5.50	--	--	--	3,180	0.073	10,104	0.232
Top EL=6758.0	--	7.50	--	--	--	4,160	0.096	17,444	0.400
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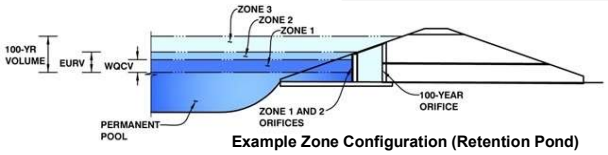
DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Project: **Struthers Ranch Polaris**

Basin ID: **A**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.21	0.094	Orifice Plate
Zone 2 (User)	4.96	0.100	Weir&Pipe (Restrict)
Zone 3			
Total (all zones)		0.194	

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 Area =	N/A	ft²
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	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)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft²
Depth at top of Zone using Orifice Plate =	3.21	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	11.50	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	sq. inches	Elliptical Slot Area =	N/A	ft²

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)	0.00	1.07	2.14					
Orifice Area (sq. inches)	0.38	0.38	0.38					

	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 =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =			ft²
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =			feet
Vertical Orifice Diameter =			inches				

Calculated Parameters for Vertical Orifice

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Zone 2 Weir	Not Selected			Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.21		ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	3.21		feet
Overflow Weir Front Edge Length =	4.00		feet	Overflow Weir Slope Length =	2.50		feet
Overflow Weir Grate Slope =	0.00		H:V	Grate Open Area / 100-yr Orifice Area =	45.33		
Horiz. Length of Weir Sides =	2.50		feet	Overflow Grate Open Area w/o Debris =	6.96		ft²
Overflow Grate Type =	Type C Grate			Overflow Grate Open Area w/ Debris =	3.48		ft²
Debris Clogging % =	50%		%				

Calculated Parameters for Overflow Weir

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

	Zone 2 Restrictor	Not Selected			Zone 2 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.50		ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.15		ft²
Outlet Pipe Diameter =	12.00		inches	Outlet Orifice Centroid =	0.15		feet
Restrictor Plate Height Above Pipe Invert =	3.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.05	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

Per ECM Chap3.3.1.C - Min pipe size is 18" diameter

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	6.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.48	feet
Spillway Crest Length =	12.00	feet	Stage at Top of Freeboard =	7.48	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.10	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	0.40	acre-ft

Calculated Parameters for Spillway

Internal note: verify on GEC Plan once spillway detail provided.

Routed Hydrograph Results

The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

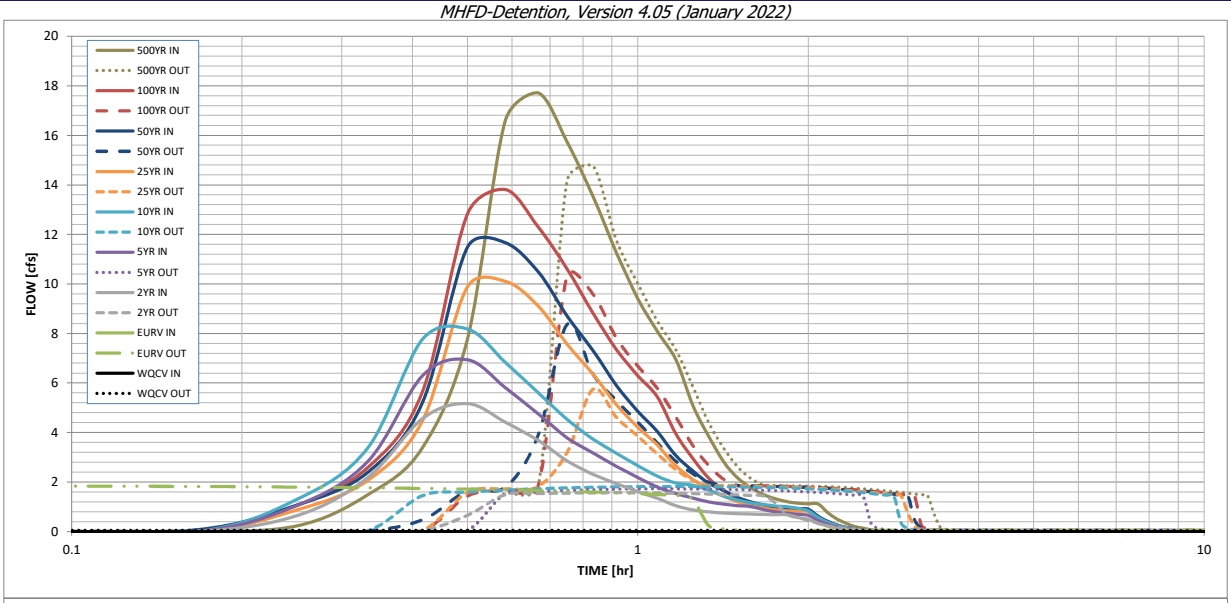
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.094	0.315	0.273	0.368	0.449	0.545	0.630	0.731	0.946
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.273	0.368	0.449	0.545	0.630	0.731	0.946
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.5	1.4	2.1	3.7	4.6	5.8	8.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.12	0.33	0.50	0.88	1.11	1.38	1.93
Peak Inflow Q (cfs) =	N/A	N/A	5.2	6.9	8.2	10.1	11.7	13.8	17.7
Peak Outflow Q (cfs) =	0.1	7.0	1.6	1.7	1.8	5.7	8.4	10.3	14.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.3	0.9	1.6	1.8	1.8	1.8
Structure Controlling Flow =	Overflow Weir 1	Spillway	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.27	0.22	0.2	0.2	0.3	0.3	0.3	0.3
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) =	40	35	37	34	32	31	29	27	24
Time to Drain 99% of Inflow Volume (hours) =	**43**	42	43	42	42	41	40	39	36
Maximum Ponding Depth (ft) =	3.21	6.56	4.15	5.09	5.70	6.22	6.30	6.36	6.47
Area at Maximum Ponding Depth (acres) =	0.05	0.08	0.06	0.07	0.08	0.08	0.08	0.08	0.08
Maximum Volume Stored (acre-ft) =	0.094	0.316	0.144	0.202	0.247	0.287	0.294	0.298	0.307

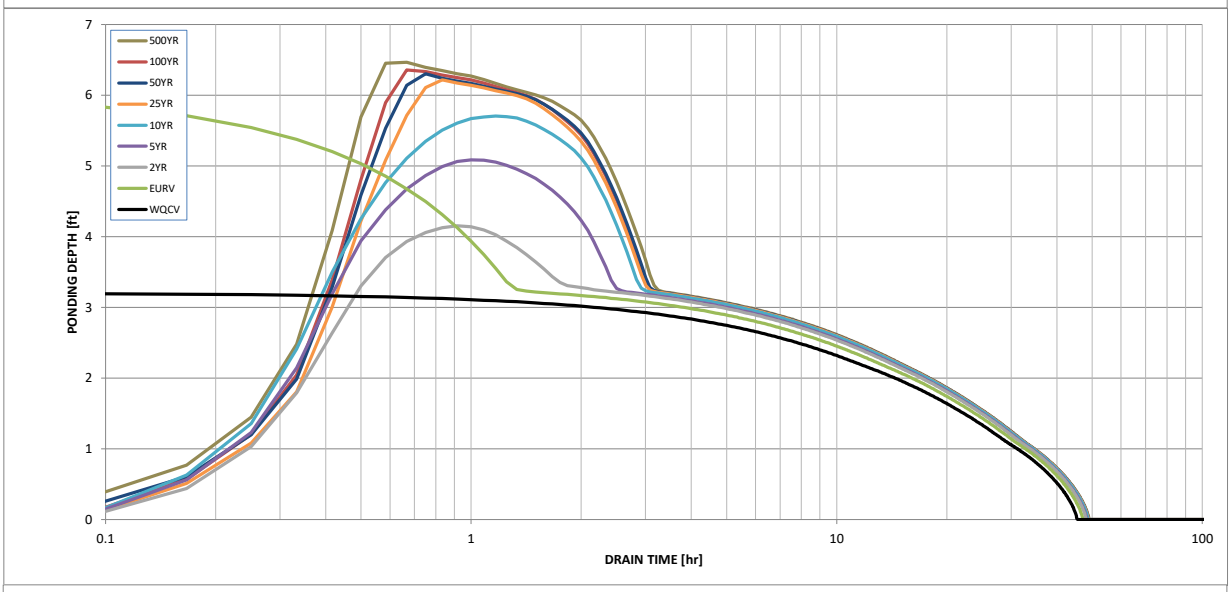
WQCV should be controlled by the Outlet Plate

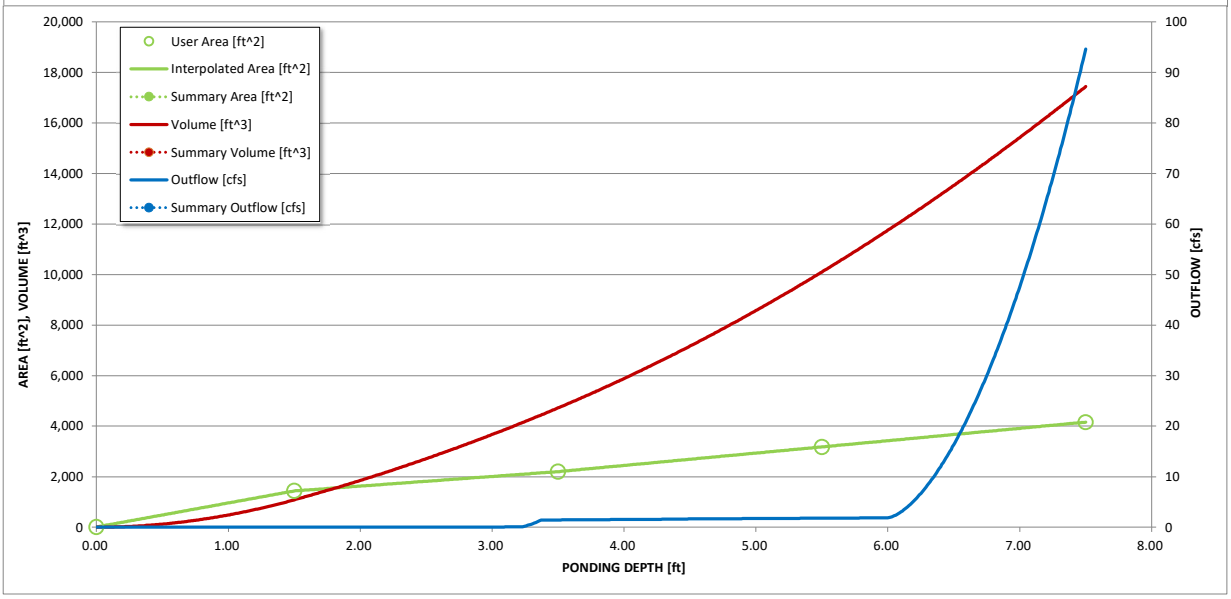
Check why these all aren't overflow weir or spillway

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)







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:

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
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]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.01	0.23
	0:15:00	0.00	0.00	0.65	1.05	1.30	0.87	1.08	1.06	1.48
	0:20:00	0.00	0.00	2.18	2.82	3.37	2.07	2.39	2.58	3.38
	0:25:00	0.00	0.00	4.56	6.29	7.76	4.47	5.20	5.64	7.78
	0:30:00	0.00	0.00	5.16	6.94	8.18	9.88	11.49	12.83	16.59
	0:35:00	0.00	0.00	4.41	5.81	6.84	10.11	11.67	13.82	17.71
	0:40:00	0.00	0.00	3.68	4.75	5.60	9.11	10.49	12.30	15.74
	0:45:00	0.00	0.00	2.86	3.79	4.54	7.57	8.71	10.61	13.54
	0:50:00	0.00	0.00	2.31	3.18	3.74	6.36	7.31	8.82	11.27
	0:55:00	0.00	0.00	1.94	2.64	3.16	5.12	5.90	7.35	9.41
	1:00:00	0.00	0.00	1.61	2.18	2.66	4.21	4.86	6.30	8.07
	1:05:00	0.00	0.00	1.34	1.80	2.24	3.49	4.03	5.42	6.95
	1:10:00	0.00	0.00	1.04	1.54	1.97	2.65	3.07	3.95	5.10
	1:15:00	0.00	0.00	0.88	1.35	1.87	2.11	2.45	2.96	3.86
	1:20:00	0.00	0.00	0.80	1.20	1.68	1.69	1.96	2.16	2.83
	1:25:00	0.00	0.00	0.75	1.11	1.44	1.43	1.66	1.66	2.17
	1:30:00	0.00	0.00	0.72	1.05	1.27	1.20	1.38	1.36	1.77
	1:35:00	0.00	0.00	0.70	1.01	1.16	1.04	1.19	1.15	1.50
	1:40:00	0.00	0.00	0.69	0.89	1.09	0.95	1.08	1.02	1.32
	1:45:00	0.00	0.00	0.68	0.80	1.04	0.88	1.00	0.93	1.21
	1:50:00	0.00	0.00	0.68	0.74	1.00	0.84	0.95	0.88	1.15
	1:55:00	0.00	0.00	0.57	0.70	0.94	0.82	0.92	0.87	1.12
	2:00:00	0.00	0.00	0.49	0.65	0.84	0.80	0.91	0.86	1.11
	2:05:00	0.00	0.00	0.33	0.44	0.57	0.54	0.61	0.58	0.76
	2:10:00	0.00	0.00	0.22	0.29	0.38	0.36	0.41	0.39	0.51
	2:15:00	0.00	0.00	0.14	0.19	0.25	0.24	0.27	0.26	0.33
	2:20:00	0.00	0.00	0.09	0.12	0.15	0.15	0.17	0.16	0.21
	2:25:00	0.00	0.00	0.05	0.07	0.10	0.10	0.11	0.10	0.13
	2:30:00	0.00	0.00	0.03	0.04	0.05	0.06	0.06	0.06	0.08
	2:35:00	0.00	0.00	0.01	0.02	0.02	0.03	0.03	0.03	0.03
	2:40:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Designer: JPS
Company: JPS
Date: August 10, 2022
Project: Struthers Ranch Polaris
Location: Detention Basin A

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 69.1 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 0.691

C) Contributing Watershed Area — Area = 4.160 ac

D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm — d_6 = 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} = 0.094 ac-ft

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume ($V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN}/0.43))$) — $V_{DESIGN\ OTHER}$ = 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

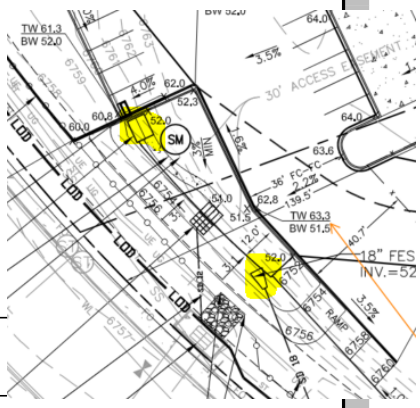
I) NRCS Hydrologic Soil Groups of Tributary Watershed
- i) Percentage of Watershed consisting of Type A Soils — HSG $_A$ = 0 %
- ii) Percentage of Watershed consisting of Type B Soils — HSG $_B$ = 100 %
- iii) Percentage of Watershed consisting of Type C/D Soils — HSG $_{C/D}$ = 0 %

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: $EURV_{C/D} = 1.20 * i^{1.08}$
— $EURV_{DESIGN}$ = 0.316 ac-f t

K) User Input of Excess Urban Runoff Volume (EURV) Design Volume (Only if a different EURV Design Volume is desired) — $EURV_{DESIGN\ USER}$ = ac-f t

In sizing the forebay revise the area and impervious specific to what's tributary to the northern forebay.

A second worksheet would need to be submitted for sizing the southern forebay.



2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.) — L : W = 3.0 : 1

3. Basin Side Slopes

A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred) — Z = 3.00 ft / ft
DIFFICULT TO MAINTAIN, INCREASE WHERE POSSIBLE

4. Inlet

A) Describe means of providing energy dissipation at concentrated inflow locations: Concrete Forebay

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} = 6.60 cfs

ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$) — Q_F = 0.13 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 = 2.9 in

Design Procedure Form: Extended Detention Basin (EDB)

Designer: JPS
Company: JPS
Date: August 10, 2022
Project: Struthers Ranch Polaris
Location: Detention Basin A

6. Trickle Channel	
A) Type of Trickle Channel	Choose One: (●) Concrete ( ) Soft Bottom
F) Slope of Trickle Channel	S = 0.0050 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 = sq ft
C) Outlet Type	Choose One: (●) Orifice Plate ( ) Other (Describe):
D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention)	$D_{orifice}$ = 0.69 inches
E) Total Outlet Area	A_{ot} = 1.14 square inches
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= cu ft
9. Trash Rack	
A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$	A_t = 41 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.)	*S.S. Well Screen with 60% Open Area*
Other (Y/N): N	
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} = 69 sq. in.
E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)	H= 3.21 feet
F) Height of Water Quality Screen (H_{TR})	H_{TR}= 66.52 inches
G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended)	$W_{opening}$ = 12.0 inches **VALUE LESS THAN RECOMMENDED MIN. WIDTH. WIDTH HAS BEEN SET TO 12 INCHES.**

Design Procedure Form: Extended Detention Basin (EDB)

Designer: JPS
Company: JPS
Date: August 10, 2022
Project: Struthers Ranch Polaris
Location: Detention Basin A

10. Overflow Embankment

A) Describe embankment protection for 100-year and greater overtopping:

Riprap Spillway

B) Slope of Overflow Embankment
(Horizontal distance per unit vertical, 4:1 or flatter preferred)

Ze = 4.00 ft / ft

11. Vegetation

Choose One
- ○ Irrigated
- ◉ Not Irrigated

12. Access

A) Describe Sediment Removal Procedures

Periodic inspection and removal as needed; Access ramp provided to pond bottom

Notes:

APPENDIX D

FIGURES

National Flood Hazard Layer FIRMette

FEMA

104°50'49"W 39°2'50"N

104°50'12"W 39°2'22"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

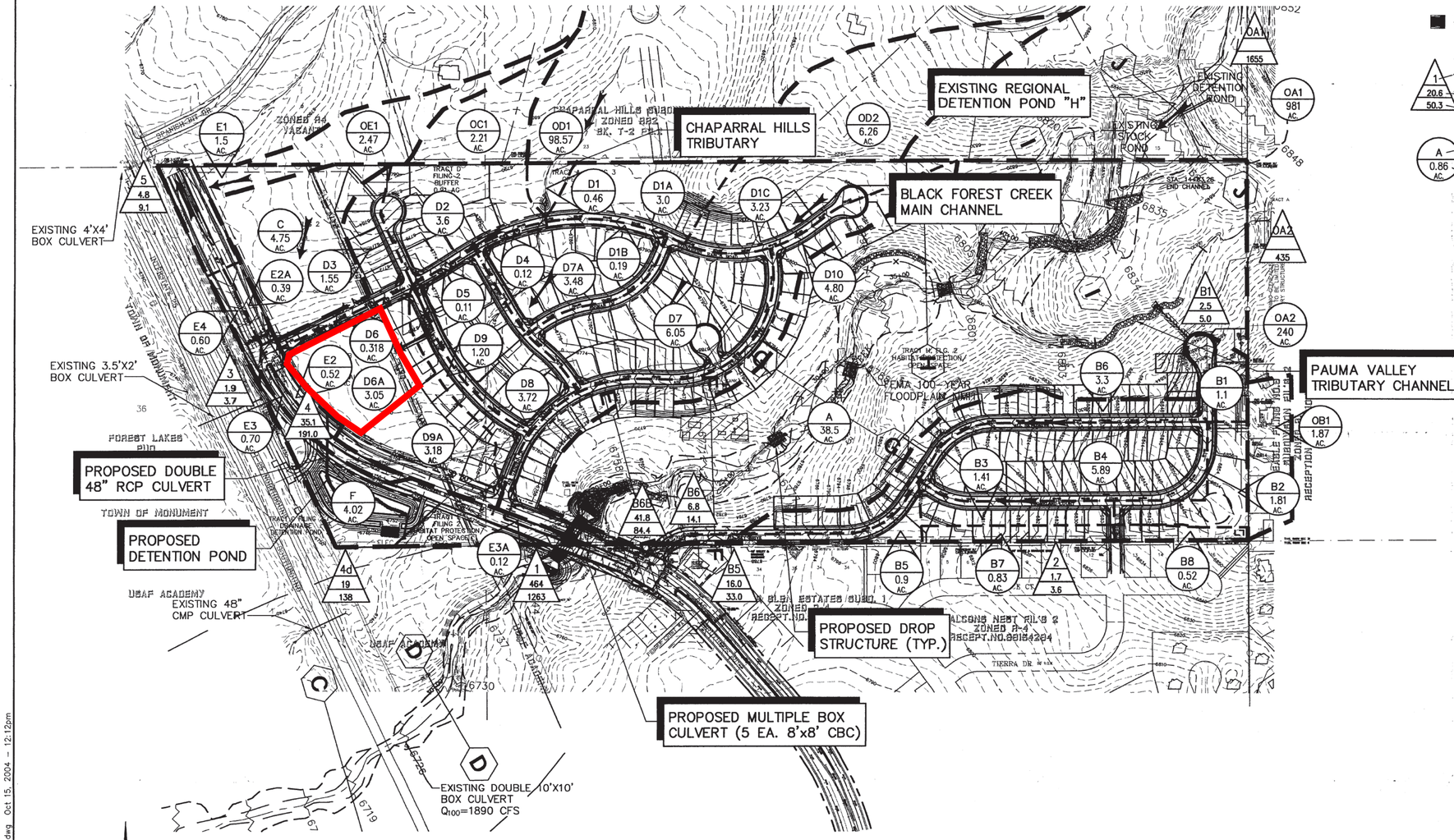
N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 8/10/2022 at 5:04 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.



LEGEND

- FILING LIMITS
- MAJOR BASIN BOUNDARY
- MINOR BASIN BOUNDARY
- 6520 EXISTING CONTOUR
- FLOWLINE
- PROPOSED FLOW DIRECTION ARROW
- PROPOSED DROP STRUCTURE
- DESIGN POINT (1 / 20.6 / 50.3) — Q_5 (cfs), Q_{100} (cfs)
- BASIN DESIGNATION (A / 0.86 AC.) — BASIN AREA (ACRES)

NOTES:

1. DEVELOPMENT SHALL FOLLOW ALL REQUIREMENTS OF THE APPROVED HABITAT CONSERVATION PLAN (HCP) AND ASSOCIATED ENVIRONMENTAL PERMITS.
2. PERIMETER DRAINS SHALL BE REQUIRED FOR ALL HOMES WITH BASEMENTS.

STRUTHERS RANCH SUBDIVISION

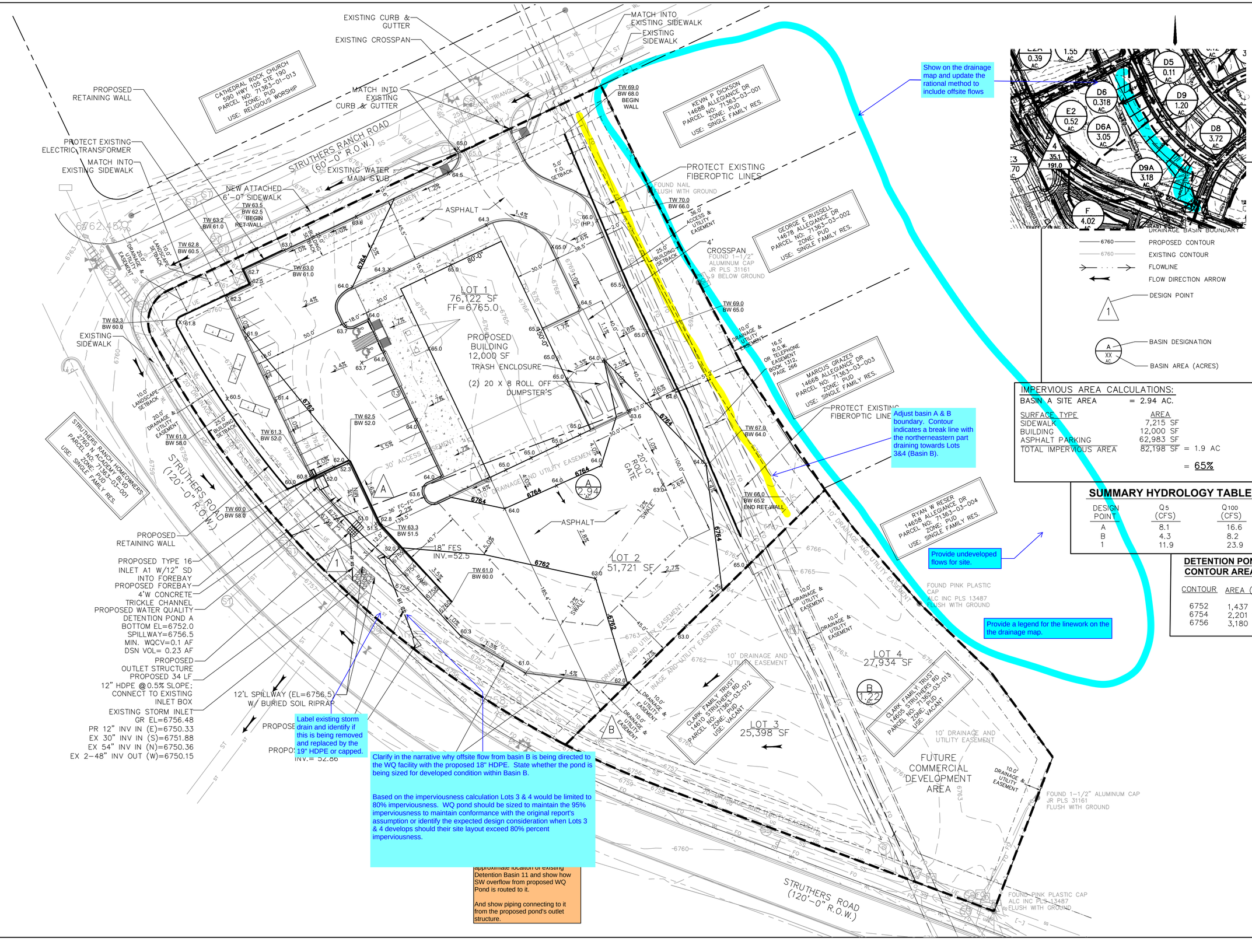
DEVELOPED DRAINAGE PLAN

JPS ENGINEERING
19 E. Willamette Ave.
Colorado Springs, CO 80903
PH: 719-477-9429
FAX: 719-471-0766

No.	REVISION	BY	DATE
1	EPC COMMENTS	JPS	4/8/04
2	EPC COMMENTS	JPS	5/7/04
3	EPC COMMENTS	JPS	5/25/04
4	EPC COMMENTS	JPS	9/2/04
5	EPC COMMENTS	JPS	9/30/04
6	RE-SUBMITTAL TO EPC	JPS	

HORZ. SCALE: 1"=200'	DRAWN: MJP
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: PINNACLE	CHECKED: JPS
CREATED: 9/11/00	LAST MODIFIED: 10/15/04
PROJECT NO: 080006	MODIFIED BY: MJP
SHEET: D1	

J:\jpprojects\080006.struthers\dwg\civil\D1.dwg Oct 15, 2004 - 12:12pm



IMPERVIOUS AREA CALCULATIONS:

BASIN A SITE AREA = 2.94 AC.

SURFACE TYPE	AREA
SIDEWALK	7,215 SF
BUILDING	12,000 SF
ASPHALT PARKING	62,983 SF
TOTAL IMPERVIOUS AREA	82,198 SF = 1.9 AC

= 65%

SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q5 (CFS)	Q100 (CFS)
A	8.1	16.6
B	4.3	8.2
1	11.9	23.9

DETENTION POND CONTOUR AREAS

CONTOUR	AREA (SF)
6752	1,437 SF
6754	2,201 SF
6756	3,180 SF

JPS ENGINEERING
19 E. Willamette Ave.
Colorado Springs, CO
80903
PH: 719-477-9429
FAX: 719-471-0766
www.jpsengr.com

CALL UTILITY NOTIFICATION CENTER OF COLORADO
1-800-922-1987
CALL 2 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

No.	REVISION	BY	DATE

STRUTHERS RANCH POLARIS
LOTS 1-2, STRUTHERS RANCH SUBDIVISION FILING NO. 4

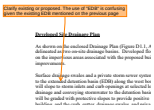
DEVELOPED DRAINAGE PLAN

HORZ. SCALE: 1"=30'	DRAWN: PV
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: COMPASS	CHECKED: JPS
CREATED: 05/27/20	LAST MODIFIED: 08/10/22
PROJECT NO: 032203	MODIFIED BY: PV
SHEET: D1.1	

C:\Users\Owner\Dropbox\jpsprojects\032203\nommers-struthers\dwg\incoming\D1.1.dwg Aug 10, 2022 - 4:31pm

Drainage Report Final_V1.pdf Markup Summary

9/12/2022 1:17:45 PM (1)



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Page Label: 6
Author: Glenn Reese - EPC Stormwater
Date: 9/12/2022 1:17:45 PM
Status:
Color:
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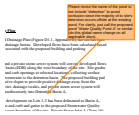
Clarify existing or proposed. The use of "EDB" is confusing given the existing EDB mentioned on the previous page

9/12/2022 1:20:21 PM (1)



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Page Label: 6
Author: Glenn Reese - EPC Stormwater
Date: 9/12/2022 1:20:21 PM
Status:
Color:
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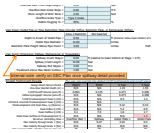
Space:

Please revise the name of the pond to not include "detention" to avoid confusion since the majority of to site's detention occurs offsite at the existing pond. For clarify, just call the proposed pond "Water Quality Pond A" or similar (do this global name change on all applicable docs).

9/12/2022 1:31:59 PM (1)



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Page Label: 16
Author: Glenn Reese - EPC Stormwater
Date: 9/12/2022 1:31:59 PM
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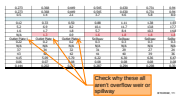
Color:
Layer:
Space:

Internal note: verify on GEC Plan once spillway detail provided.

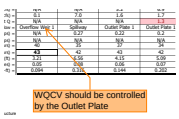
9/12/2022 1:33:25 PM (1)



Subject: SW - Textbox with Arrow
Page Label: 16
Author: Glenn Reese - EPC Stormwater
Date: 9/12/2022 1:33:25 PM
Status:
Color:
Layer:
Space:

Check why these all aren't overflow weir or spillway

9/12/2022 1:33:29 PM (1)



Subject: SW - Textbox with Arrow
Page Label: 16
Author: Glenn Reese - EPC Stormwater
Date: 9/12/2022 1:33:29 PM
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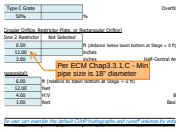
WQCV should be controlled by the Outlet Plate

9/12/2022 1:33:40 PM (1)



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Page Label: 16
Author: Glenn Reese - EPC Stormwater
Date: 9/12/2022 1:33:40 PM
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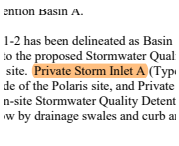
Per ECM Chap3.3.1.C - Min pipe size is 18" diameter

9/12/2022 1:41:36 PM (1)



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Page Label: 6
Author: Glenn Reese - EPC Stormwater
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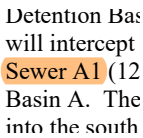
Private Storm Inlet A

9/12/2022 1:42:13 PM (1)



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Sewer A1

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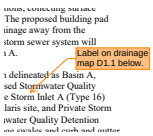

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Author: Glenn Reese - EPC Stormwater
Date: 9/12/2022 1:42:54 PM
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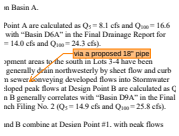
Label on drainage map D1.1 below.

9/12/2022 1:43:49 PM (1)



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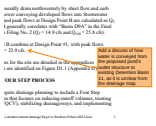
via a proposed 18" pipe

9/12/2022 1:55:15 PM (1)



Subject: SW - Textbox with Arrow
Page Label: 6
Author: Glenn Reese - EPC Stormwater
Date: 9/12/2022 1:55:15 PM
Status:
Color:
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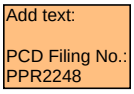
Space:

Add a discuss of how water is conveyed from the proposed pond's outlet structure to existing Detention Basin 11, as it is unclear from the drainage map.

9/12/2022 12:35:25 PM (1)



Subject: SW - Textbox
Page Label: 1
Author: Glenn Reese - EPC Stormwater
Date: 9/12/2022 12:35:25 PM
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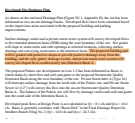
Add text:

PCD Filing No.:
PPR2248

9/12/2022 12:40:40 PM (1)



Subject: SW - Highlight
Page Label: 6
Author: Glenn Reese - EPC Stormwater
Date: 9/12/2022 12:40:40 PM
Status:
Color:
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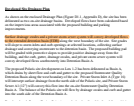
Space:

The proposed building pad will be graded with protective slopes to provide positive drainage away from the building, and the curb, gutter, drainage swales, and private storm sewer system will convey developed flows southwesterly into Detention Basin A.

9/12/2022 12:40:43 PM (1)



Subject: SW - Highlight
Page Label: 6
Author: Glenn Reese - EPC Stormwater
Date: 9/12/2022 12:40:43 PM
Status:
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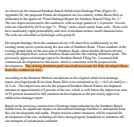
Surface drainage swales and a private storm sewer system will convey developed flows to the extended detention basin (EDB)

9/12/2022 12:40:56 PM (1)



Subject: SW - Highlight
Page Label: 5
Author: Glenn Reese - EPC Stormwater
Date: 9/12/2022 12:40:56 PM
Status:
Color:
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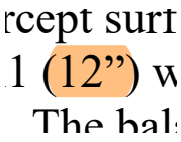
The existing detention pond was sized to account for fully developed flows from this commercial area.

9/12/2022 12:43:44 PM (1)



Subject: SW - Highlight
Page Label: 6
Author: Glenn Reese - EPC Stormwater
Date: 9/12/2022 12:43:44 PM
Status:
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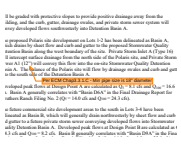
12”

9/12/2022 12:44:10 PM (1)



Subject: SW - Textbox with Arrow
Page Label: 6
Author: Glenn Reese - EPC Stormwater
Date: 9/12/2022 12:44:10 PM
Status:
Color:
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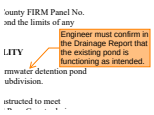
Space:

Per ECM Chap3.3.1.C - Min pipe size is 18" diameter

9/12/2022 12:50:58 PM (1)



Subject: SW - Textbox with Arrow
Page Label: 7
Author: Glenn Reese - EPC Stormwater
Date: 9/12/2022 12:50:58 PM
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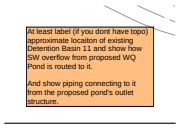
Engineer must confirm in the Drainage Report that the existing pond is functioning as intended.

9/12/2022 4:00:38 PM (1)



Subject: SW - Textbox
Page Label: [1] D1
Author: Glenn Reese - EPC Stormwater
Date: 9/12/2022 4:00:38 PM
Status:
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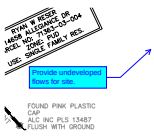
At least label (if you dont have topo) approximate locaiton of existing Detention Basin 11 and show how SW overflow from proposed WQ Pond is routed to it.

And show piping connecting to it from the proposed pond's outlet structure.

9/14/2022 12:11:57 PM (1)



Subject: Callout
Page Label: [1] D1
Author: lpackman
Date: 9/14/2022 12:11:57 PM
Status:
Color:
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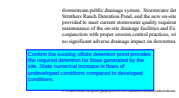
Provide undeveloped flows for site.

9/14/2022 12:26:39 PM (1)



Subject: Text Box
Page Label: 8
Author: lpackman
Date: 9/14/2022 12:26:39 PM
Status:
Color:
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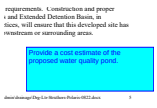
Confirm the existing offsite detention pond provides the required detention for flows generated by the site. State numerical increase in flows of undeveloped conditions compared to developed conditions.

9/14/2022 12:26:53 PM (1)



Subject: Text Box
Page Label: 8
Author: lpackman
Date: 9/14/2022 12:26:53 PM
Status:
Color:
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Provide a cost estimate of the proposed water quality pond.

9/14/2022 4:15:09 PM (1)

Subject: Callout
Page Label: [1] D1
Author: dsdlaforce
Date: 9/14/2022 4:15:09 PM
Status:
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Label existing storm drain and identify if this is being removed and replaced by the 19" HDPE or capped.

9/14/2022 4:28:10 PM (1)

Subject: Callout
Page Label: [1] D1
Author: dsdlaforce
Date: 9/14/2022 4:28:10 PM
Status:
Color:
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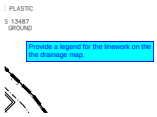
Clarify in the narrative why offsite flow from basin B is being directed to the WQ facility with the proposed 18" HDPE. State whether the pond is being sized for developed condition within Basin B.

Based on the imperviousness calculation Lots 3 & 4 would be limited to 80% imperviousness. WQ pond should be sized to maintain the 95% imperviousness to maintain conformance with the original report's assumption or identify the expected design consideration when Lots 3 & 4 develops should their site layout exceed 80% percent imperviousness.

9/14/2022 9:22:23 AM (1)



Subject: Text Box
Page Label: [1] D1
Author: lpackman
Date: 9/14/2022 9:22:23 AM
Status:
Color:
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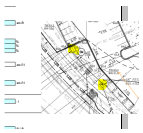
Provide a legend for the linework on the the drainage map.

9/15/2022 10:15:28 AM (1)



Subject: Image
Page Label: 19
Author: dsdlaforce
Date: 9/15/2022 10:15:28 AM
Status:
Color:
Layer:
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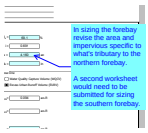
9/15/2022 10:15:42 AM (1)

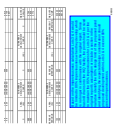


Subject: Callout
Page Label: 19
Author: dsdlaforce
Date: 9/15/2022 10:15:42 AM
Status:
Color:
Layer:
Space:

In sizing the forebay revise the area and impervious specific to what's tributary to the northern forebay.

A second worksheet would need to be submitted for sizing the southern forebay.

9/15/2022 6:26:03 AM (1)



Subject: Text Box
Page Label: 6
Author: dsdlaforce
Date: 9/15/2022 6:26:03 AM
Status:
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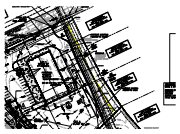
Space:

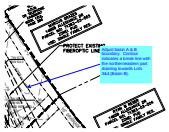
Based on the imperviousness calculation Lots 3 & 4 would be limited to 80% imperviousness when they develop which is no longer in conformance with the original report. Since basin B drains into the WQ facility, the pond should be sized to maintain the 95% imperviousness for Lots 3 & 4 per the original report's assumption or include a section in the narrative identify the 80% design limit of the proposed pond and identifying the expected design consideration should proposed development within Lots 3 & 4 exceed 80% percent imperviousness.

9/15/2022 7:00:24 AM (1)



Subject: Highlight
Page Label: [1] D1
Author: dsdlaforce
Date: 9/15/2022 7:00:24 AM
Status:
Color:
Layer:
Space:

9/15/2022 7:01:49 AM (1)



Subject: Callout
Page Label: [1] D1
Author: dsdlaforce
Date: 9/15/2022 7:01:49 AM
Status:
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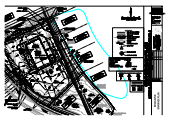
Adjust basin A & B boundary. Contour indicates a break line with the northerneastern part draining towards Lots 3&4 (Basin B).

9/15/2022 7:10:16 AM (1)



Subject: Highlight
Page Label: [1] D1
Author: dsdlaforce
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Status:
Color:
Layer:
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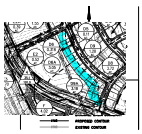
9/15/2022 7:10:37 AM (1)



Subject: Group
Page Label: [1] D1
Author: dsdlaforce
Date: 9/15/2022 7:10:37 AM
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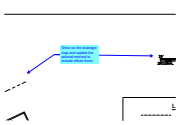
9/15/2022 7:12:10 AM (1)



Subject: Callout
Page Label: [1] D1
Author: dsdlaforce
Date: 9/15/2022 7:12:10 AM
Status:
Color:
Layer:
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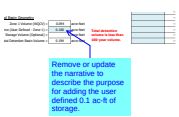
Show on the drainage map and update the rational method to include offsite flows

9/15/2022 7:37:15 AM (1)



Subject: Callout
Page Label: 15
Author: dsdlaforce
Date: 9/15/2022 7:37:15 AM
Status:
Color:
Layer:
Space:

Remove or update the narrative to describe the purpose for adding the user defined 0.1 ac-ft of storage.