Preliminary Drainage Report

Villas at Aspen Trails
El Paso County, Colorado

PCD File No.: PUDSP208
SF-21-025

Add: SP234

Prepared for:
ROS Equity Holdings – Independence, LLC
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Colorado Springs, Colorado 80903

Prepared by:
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Project #: 096668022

Prepared: November 3, 2022

Kimley»Horn

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CERTIFICATION

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

SIGNATURE (Affix Seal): _____

Colorado P.E. No. 60470 Date

DEVELOPER'S STATEMENT

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

_____

Business Name

_____

By:

_____

Title:

_____

Address:

EL PASO COUNTY STATEMENT

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.

_____ _____

County Engineer/ECM Administrator Date

Conditions:

GENERAL LOCATION AND DESCRIPTION

Preliminary drainage report

PURPOSE AND SCOPE OF STUDY

The purpose of this Final Drainage Report (FDR) is to provide the hydrologic and hydraulic calculations and to document and finalize the drainage design methodology in support of the proposed Villas at Aspen Trails residential development (the "Project"). The Project is located within the jurisdictional limits of El Paso County (the "County"). Thus, the guidelines for the hydrologic and hydraulic design were based on the criteria outlined by the County's Engineering Criteria Manual.

LOCATION

The Project is located south of the Colorado Springs Airport and at the southeast corner of Bradley Road and Legacy Hill Drive. More specifically, the Project is within portions of Section 8 & 9, Township 15 South, Range 65 West of the 6th Principal Meridian, County of El Paso, State of Colorado (parcel number 5509200003). A vicinity map is provided below.

VICINITY MAP

LOCATION MAP
NTS

DESCRIPTION OF PROPERTY

The Project is located on approximately 4.25 acres of undeveloped land with limited vegetation and grass cover. The site is currently vacant and does not provide stormwater quality or detention and there are no known major drainage ways or irrigation facilities on the site. The proposed services in the development include the following: water, sewer, electric service,

natural gas service, telephone service, and fire protection. The site generally drains from the north to south with slopes ranging from 1.75% to 3.60%. The Project is no major drainageways and does not outfall directly to any major drainageways.

Indicate where flows do eventually release as well as any existing storm systems tie to.

NRCS soil data is available for the Site (See Appendix) and the onsite soils are USCS Hydrologic Soil Group B. Group B soils have a moderate infiltration rate when thoroughly wet and mainly consist of well drained soils that have moderately fine texture to moderately coarse texture. This site specifically is predominately comprised of fine sandy loams, with a mix of stoneham sandy loam. A Soil, Geology, and Geologic Hazard report was prepared for the site by Entech Engineering, Inc. dated February 21, 2018 and is provided in the Appendix of this report for reference.

Reference current report which was submitted.

Delete this portion of sentence as it is not located within appendix.

PROJECT CHARACTERISTICS

The Project is a proposed single family attached development that will include single-family lots attached with private road access. The site will be configured in seven attached (townhome) 3-plex units across 21 lots and five attached (townhome) 4-plex units across 20 lots. The project will include the construction of tracts for buffering, landscaping, open spaces, pedestrian corridors, private roads, and a full spectrum extended detention pond to serve the Project. Water quaility and detention is required for the site improvements and will be accomplished with the construction of a full spectrum extended detention pond located on the southwest corner of the site. As part of the utility infrastructure improvements, a proposed storm sewer system will be constructed to collect runoff. Stormwater will be conveyed via overland flow across the lots, within the curb and gutter of the proposed streets before being captured in proposed storm inlets. The storm sewer system will then convey runoff into the full spectrum extended detention pond before being discharged offsite.

DRAINAGE BASINS AND SUB-BASINS

MAJOR BASIN DESCRIPTIONS

The site is located within the Jimmy Camp Creek Basin. It is within the service area of the Widefield Water and Sanitation District (WWSD).

The Site is also located outside the 100-year floodplain and within Zone X (an area of minimal flood hazard) as noted on the FEMA FIRM Map No. 08041C0752G revised on December 7, 2018 (See Appendix).

There are no identified nearby irrigation facilities or other obstructions which could influence the local drainage.

SUB-BASIN DESCRIPTION

Historic Drainage Patterns

The existing drainage is divided into two sub-basins, Basin EX-1 and EX-2. Sub-Basin EX-1 is approximately 3.27 acres and consists of most of the on-site area within the property line. Runoff generated from this Sub-Basin drains overland from north to south. The weighted imperviousness for Sub-Basin EX-1 with existing conditions is 2% and the runoff for the 5-year and 100-year storm events are 1.33 cfs and 9.77 cfs respectively. Sub-Basin EX-2 is approximately 0.98 acres and consists of the northeast portion of this site. Runoff generated

Include descriptions of the facilities which accepts each of these flows, existing stub into project site, existing inlet within Frontside Drive, etc

from this Sub-Basin drains overland from west to east. The weighted imperviousness of Sub-Basin EX-2 is 2% and the runoff for the 5-year and 100-year storm events are 0.40 cfs and 2.97 cfs respectively.

Off-Site Drainage Flow Patterns

The site experiences offsite runoff from the north but is accounted for in proposed Sub-Basin A1. This offsite flow will be captured by the proposed storm sewer infrastructure and routed to the detention pond for water quality treatment and detention.

See comments on drainage maps regarding offsite flows

DRAINAGE DESIGN CRITERIA

DEVELOPMENT CRITERIA REFERENCE

The proposed storm facilities follow the El Paso County Drainage Criteria Manual (the "CRITERIA"), El Paso Engineering Criteria Manual (the "ECM"), and the Mile High Flood Control District Urban Storm Drainage Criteria Manual (the "MANUAL"). Site drainage is not significantly impacted by such constraints as utilities or existing development. Further detail regarding onsite drainage patterns is provided in the Proposed Drainage Conditions Section.

HYDROLOGIC CRITERIA

The 5-year and 100-year design storm events were used in determining rainfall and runoff for the proposed drainage system per chapter 6 of the CRITERIA. Table 6-2 of the CRITERIA is the source for rainfall data for the 5-year and 100-year design storm events. Design runoff was calculated using the Rational Method for developed conditions as established in the CRITERIA and MANUAL. Runoff coefficients for the proposed development were determined using Table 6-6 of the CRITERIA by calculating weighted impervious values for each specific site basin. The detention storage requirement was calculated using Full Spectrum Detention methods as specified in the CRITERIA and MANUAL. The Full Spectrum Extended Detention Basin's outlet structure will be designed to release the Water Quality Capture Volume (WQCV) in at least 40 hours and the EURV will be released with a 72 hour drain time. Outlet structure calculations will be provided in the Final Drainage Report. Based upon this approach, we feel that the drainage design provided for the Site is conservative and in keeping with the historic drainage patterns for the Site.

The proposed drainage facilities are designed in accordance with the CRITERIA and MANUAL. Floodplain identification was determined using FIRM panels by FEMA. Hydraulic calculations will be computed using StormCAD for the proposed storm sewer system and provided in the Final Drainage Report.

DRAINAGE FACILITY DESIGN

GENERAL CONCEPT

PROPOSED DRAINAGE PATTERNS

The developed runoff from the Project will generally be collected by means of a curb and gutter and storm sewer system with inlets located on the west street within each delineated sub-basin area. Additionally, there will be a proposed 6' wide concrete v-gutter that captures flows and

routes them to a 8' curb cut to discharge directly into the detention pond. A proposed 6' v-shaped vegetated swale will be located on the south portion of the project to direct the runoff to the detention pond. The runoff collected from each Sub-Basin A1 and A2 will be captured by storm inlets and conveyed through storm pipes to a Full Spectrum Extended Detention Basin located in the southwest corner of the site.

Please discuss how water quality and detention are provided (or excluded) for each sub-basin.

SPECIFIC DETAILS

The property has been divided into seven sub-basins, A1 through A5 and OS-1 - OS-2. Sub-basins A1 through A5 make up the Project on-site area and Sub-Basins OS-1 - OS-2 are the offsite basins consisting of the runoff that sheet flows offsite.

The weighted imperviousness of the Site area (Sub-basins A1 through A5) is 49.4%. The weighted imperviousness of the offsite area (Sub-basin OS1-OS2) with Sub-Basins A1 through A5 is 45.68%. Cumulative runoff for the 5-year and 100-year storm events are 8.02 cfs and 18.75 cfs, respectively.

This is a city type inlet. Please use a Type R inlets

Sub-Basin A1

Sub-basin A1 consists of approximately 0.84 acres and is the area along the north and central portions of the site, consisting of rooftops, landscaping, pavement, Road D and a portion of Road C. A Proposed 4' COS D-10-R storm inlet (Design point A1) on Road C captures this runoff and routes it to the detention pond. Developed runoff during the 5-year and 100-year events are 1.39 cfs and 3.32 cfs respectively.

Sub-Basin A2

Sub-basin A2 consists of approximately 0.45 acres and is made up of a portion of the west buildings along Road C, a portion of Road C, and a section of landscaping in the central portion of the site. A proposed 4' COS D-10-R storm inlet on Road C (Design Point A2) will capture the runoff from the roofs, landscaping, and pavement and route this runoff to the detention pond. Developed runoff during the 5-year and 100-year events are 0.69 cfs and 1.71 cfs respectively.

Sub-Basin A3

Sub-basin A3 consists of approximately 1.96 acres and is the south and eastern portions of the site, consisting of pavement, landscaping, roofing, Road A, Road B, and a portion of Road C. The runoff from this area is conveyed via curb and gutter before being collected by an 8-foot curb cut (Design point A3) that is discharged directly into the detention pond. Developed runoff during the 5-year and 100-year events are 5.17 cfs and 10.53 cfs respectively.

With FDR will need to address if flow in c&g exceeds gutter capacity.

Sub-Basin A4

Sub-basin A4 consists of approximately 0.40 acres and consists of runoff within the private detention basin. The runoff from this area is directly into the pond (Design Point A4). Developed runoff during the 5-year and 100-year events are 0.15 cfs and 1.10 cfs respectively.

Sub-Basin A5

Sub-basin A5 consists of approximately 0.15 acres and consists of landscaping and an associated drainage swale directed from east to west into the proposed detention pond. Developed runoff during the 5-year and 100-year events are 0.08 cfs and 0.40 cfs respectively.

Provide a design point that accounts for total flow into pond.

Sub-Basin OS-1

Sub-basin OS-1 consists of approximately 0.55 acres and consists of an eastern portion of the site which is vegetated hillside. Runoff will sheet flow to the portion of land that is east of the project (Design Point OS1), following historic drainage patterns. Developed runoff during the 5-year and 100-year events are 0.47 cfs and 1.58 cfs respectively.

Include where the flows go, intercepted, sheet flow, etc?

Please discuss how water quality and detention are provided (or excluded) for each sub-basin.

Sub-Basin OS-2

Sub-basin OS-2 consists of approximately 0.01 acres and consists of the western section of Road B that runs outside of the proposed property boundary. Runoff from this Sub-Basin is conveyed offsite to the intersection of Legacy Hill Drive and Road B (Design Point OS2). following historic drainage patterns. Developed runoff during the 5-year and 100-year events are 0.06 cfs and 0.11 cfs respectively.

Include where the flows go, intercepted, sheet flow, etc?

EMERGENCY OVERFLOW ROUTING

Emergency overflow routing consists of flows following historic drainage patterns from north to south and discharging into Frontside Drive.

DETENTION AND WATER QUALITY

The WQCV and 100-year detention is required for this Project. This is accomplished through the proposed private Full Spectrum Extended Detention Basin on the southwest corner of the Site. The Extended Detention Basin was sized to provide water quality and detention for the entire Site (Sub-Basins A1-A5 and OS-1 and OS-2) per UDFCD criteria. The water quality and detention calculations are provided in the Appendix of this report. The proposed Extended Detention Basin will be maintained by the homeowner's association.

The label in the calcs on pg 50 below is "South Pond" add this to the report text and dwgs/maps for consistency.

Four-Step Process

The four-step process per the MANUAL provides guidance and requirements for the selection of siting of structural Construction Control Measures (CCMs) for new development and significant redevelopment.

Step 1: Employ Runoff Reduction Practices
Currently the site is vacant undeveloped land. Development of the site will increase current runoff conditions due to increased imperviousness values. However, implementation of landscaping throughout the site, the proposed storm sewer infrastructure, and the proposed Extended Detention Basin will help slow runoff and encourage infiltration.

Step 2: Provide Water Quality Capture Volume (WQCV)
The water quality capture volume will be detained using a full spectrum extended detention basin on the southwest corner of the Site. The water quality outlet structure will control the release of stormwater to at or less than historic rates.

Step 3: Stabilize Drainageways
There are no current drainageways conveyed through this property. No improvements to stabilize drainageways are a part of this Project.

Step 4: Consider need for Industrial and Commercial BMPs
Erosion control features for the final stages of the Project will be designed to reduce contamination. Source control BMPs will include the use of, inlet protection, silt fences,

Discuss how the outlet structure will tie-into existing SW piping downstream of the pond (from what I can tell in the drainage map) and reference the previous report that that infrastructure was designed/approved/installed under and whether or not the flow from this proposed site was planned to outfall into that piping.

concrete washout areas, stockpile management, and stabilized staging areas. The Grading and Erosion Control Plans will be submitted as a separate construction document set.

Detention and Water Quality Design

The proposed private Full Spectrum Extended Detention Basin will be designed with an outlet structure that is fitted with an orifice plate and restrictor plate to release the WQCV in at least a 40-hour drain time period and the EURV in a 72 hour drain time period per the MANUAL.

Calculations included in the Appendix provide details regarding the private water quality and detention basins design. The calculations include determination of the storage volumes required for full spectrum detention for the WQCV and 100 year detention and allowable release rates. The Final Drainage Report will provide calculations for the proposed outlet structure.

Overall, 0.352 acre-feet of WQCV is required. The total area contributing to the Extended Detention Basin consists of 3.80 acres (49.4% imperviousness).

Outlet Requirements

The water quality standards established by the CRITERIA are met by the proposed Full Spectrum Extended Detention Basin. The water quality outlet structures will be designed per the specifications in the CRITERIA. The outlet structure for the extended detention basin will meet the micro-pool requirement that it be integrated into the design of the structure with an additional initial surcharge volume. The orifice plates of the structures will be designed based on the CRITERIA. The orifice plates will allow the WQCV to be drained from the structure in at least 40 hours and the EURV in 72 hours. The calculations for the design of the outlet structures will be provided in the Final Drainage Report. Provide comparison of existing to proposed flows.

Emergency Spillway Path

The emergency overflow from the Extended Detention Basin will be located on the south side of the pond and will discharge into Frontside Drive. The Final Drainage Report will provide calculations on the emergency overflow spillway for the pond which will be located on the south side of the detention pond. In FDR, also include what happens to existing inlet & storm system with spillway flows.

COST OF PROPOSED DRAINAGE FACILITIES

An Estimated Opinion of Probable Construction Cost (EOPCC) is provided in the Appendix of the report. There are no public drainage facilities. All improvements with this Project will be private.

DRAINAGE AND BRIDGE FEES

Calculations will need to be provided as to how impervious acres were determined.

The Site is located in the Jimmy Camp Creek Drainage Basin. The total imperviou the parcel (5509200003) is 2.08 acres. The total drainage and bridge fees due f $36,449.92.

Full review of drainage & bridge fees will be provided with FDR.

	2022 Fees ($ / Impervious acre)	Impervious Area (Acre)	Amount Due ($)
Drainage Fee	$9,185	2.08	$19,104.80
Pond Facility Fee	$8,339	2.08	$17,345.12
		Total amount due:	**$36,449.92**

does not ees for eek Basin

Per my comment on the FAE:

Include a cost estimate for each PBMP with line items for all components (ex: riprap, road base, forebay, trickle channel, outlet structure, outlet pipe, spillway, etc). Input the total value into the FAE form under “Permanent Pond/BMP (provide engineer’s estimate)” in Section 1. The total should not include grading, which is a separate line item in Section 1: “Earthwork.”

GRADING AND EROSION CONTROL

The GEC plans will be submitted to El Paso County Planning and Community Development Department for review and approval prior to construction.

MAINTENANCE AND OPERATIONS

Maintenance of the extended detention basin is provided by the homeowner's association.

OTHER GOVERNMENT AGENCY REQUIREMENTS

Approval from other agencies such as the FEMA, the Army Corps of Engineers, Colorado State Engineer, Colorado Water Conservation Board, and others are not needed with this Project.

SUMMARY

The Project will provide water quality and detention for the Site per a full spectrum detention pond located in the southwest corner of the Site. The proposed cumulative 5-year runoff is 8.02 cfs and the cumulative 100-year runoff is 18.75 cfs. The overall imperviousness tributary to the pond is 49.4%, with a total site imperviousness of 45.7%.

COMPLIANCE WITH STANDARDS

The drainage design presented within this report for Villas at Aspen Trails, conforms to the El Paso County Drainage Criteria Manual and the Mile High Flood District Urban Storm Drainage Criteria Manual. Additionally, the Site runoff and storm drain facilities will not adversely affect the downstream and surrounding developments. The proposed flows entering the extended detention basin will be released at or less than historic rates via an outlet structure which will be designed with the Final Drainage Report.

REFERENCES

1. City of Colorado Springs Drainage Criteria Manual, May 2014, Revised January 2021.

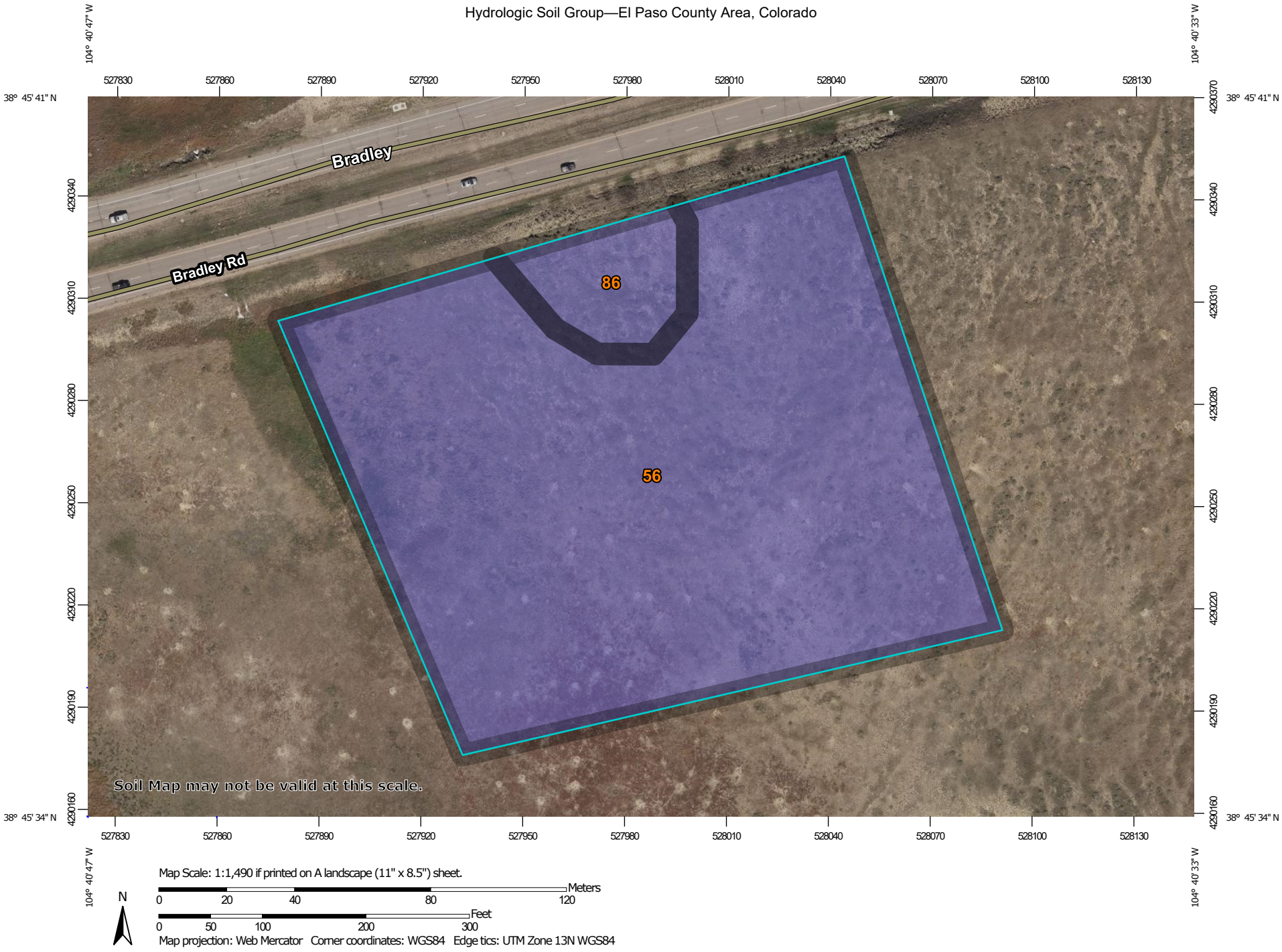
2. El Paso County Drainage Criteria Manual, Vol. 1 and 2, October 1994.

3. Mile High Flood District Drainage Criteria Manual (MHFDCM), Vol. 1, prepared by Wright-McLaughlin Engineers, June 2001, with latest revisions.

4. Flood Insurance Rate Map, El Paso County, Colorado and Incorporated Areas, Map Number 08041C0459G, Effective Date December 7, 2018, prepared by the Federal Emergency Management Agency (FEMA).

APPENDIX

APPENDIX A – FEMA FIRM MAP AND USGS SOILS MAP



Map Scale: 1:1,490 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 20 40 80 120

Feet
0 50 100 200 300

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

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 19, Aug 31, 2021

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

Date(s) aerial images were photographed: Aug 19, 2018—Sep 23, 2018

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
56	Nelson-Tassel fine sandy loams, 3 to 18 percent slopes	B	5.5	93.1%
86	Stoneham sandy loam, 3 to 8 percent slopes	B	0.4	6.9%
Totals for Area of Interest			**5.9**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

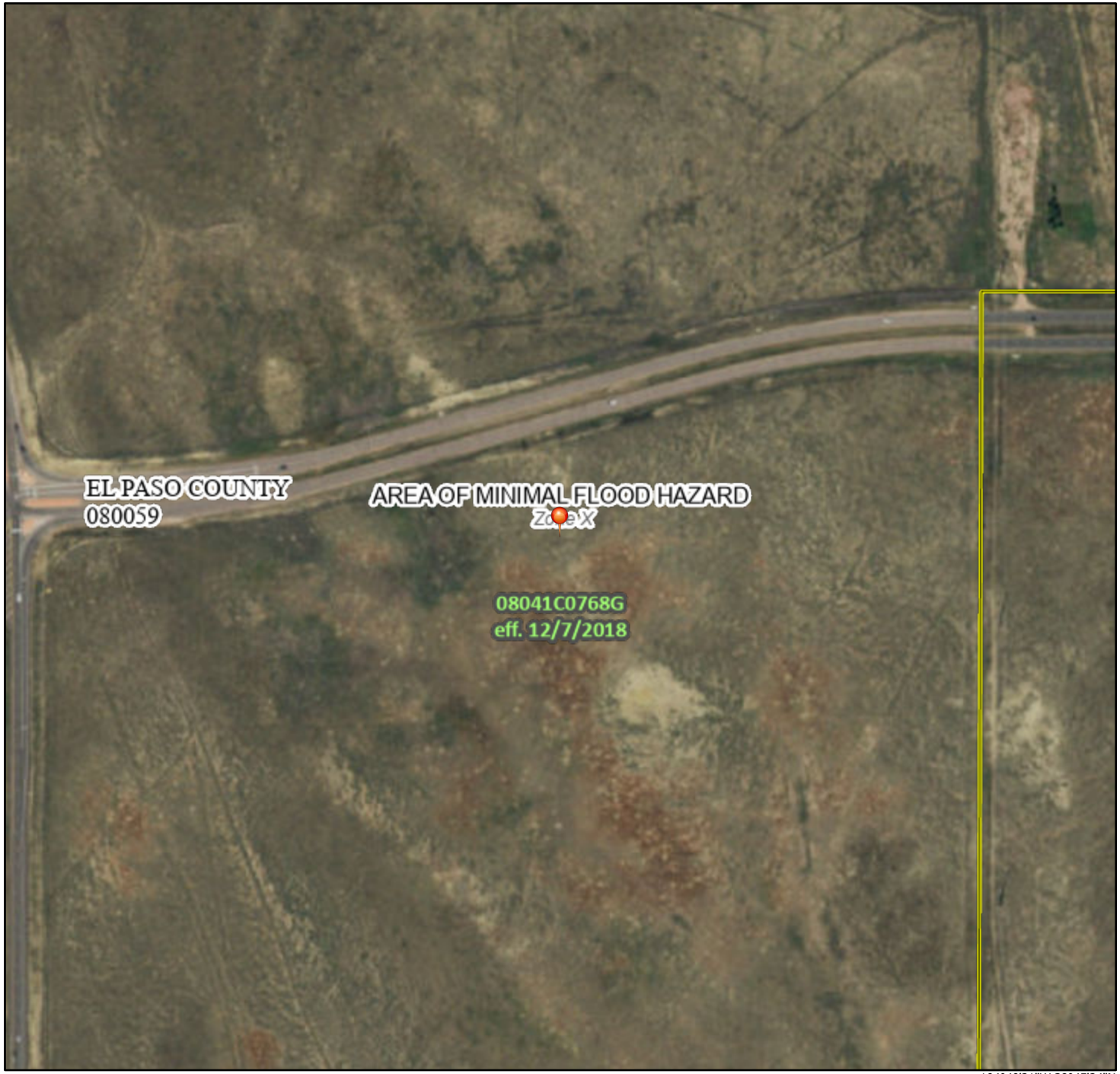
Component Percent Cutoff: None Specified

Tie-break Rule: Higher

National Flood Hazard Layer FIRMette

FEMA

104°40'58"W 38°45'52"N



104°40'21"W 38°45'24"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 2/21/2022 at 7:00 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.

APPENDIX B – SITE DRAINAGE CALCULATIONS (PROPOSED)

Move proposed calculations after existing calculations

IDF Equations:

I_{100} = -2.52ln(D) + 12.735
I_{50} = -2.25ln(D) + 11.375
I_{25} -2.00ln(D) + 10.111
I_{10} -1.75ln(D) + 8.847
I_{5} -1.50ln(D) + 7.583
I_{2} -1.19ln(D) + 6.035

Where:
I = Rainfall Intensity (in/hr)
D= Duration (minutes)

	2-yr	5-yr	10-yr	100-yr
P_1 =	1.19	1.5	1.75	2.52

Time Intensity Frequency Tabulation

Time	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR
5	4.12	5.17	6.03	6.89	7.75	8.68
10	3.29	4.13	4.82	5.51	6.19	6.93
15	2.81	3.52	4.11	4.69	5.28	5.91
30	1.99	2.48	2.89	3.31	3.72	4.16
60	1.16	1.44	1.68	1.92	2.16	2.42
120	0.34	0.40	0.47	0.54	0.60	0.67

*The Design Point Rainfall Values and Time Intensity Frequency Tabulation are found in Table 6-2 and Figure 6-5 respectively, of the Colorado Springs Drainage Criteria Manual, Volume 1

Weighted Imperviousness Calculations

SUB-BASIN	AREA (SF)	AREA (Acres)	ROOF AREA	ROOF IMPERVIOUSNESS	ROOF C2	ROOF C5	ROOF C10	ROOF C100	LANDSCAPE AREA	LANDSCAPE IMPERVIOUSNESS	LANDSCAPE C2	LANDSCAPE C5	LANDSCAPE C10	LANDSCAPE C100	PAVEMENT AREA	PAVEMENT IMPERVIOUSNESS	PAVEMENT C2	PAVEMENT C5	PAVEMENT C10	PAVEMENT C100	WEIGHTED IMPERVIOUSNESS	WEIGHTED COEFFICIENTS C2	WEIGHTED COEFFICIENTS C5	WEIGHTED COEFFICIENTS C10	WEIGHTED COEFFICIENTS C100
A1	36,687	0.84	8,090	90%	0.71	0.73	0.75	0.81	19,797	0%	0.02	0.08	0.15	0.35	8,800	100%	0.89	0.90	0.92	0.96	43.8%	0.38	0.42	0.47	0.60
A2	19,652	0.45	3,564	90%	0.71	0.73	0.75	0.81	11,350	0%	0.02	0.08	0.15	0.35	4,738	100%	0.89	0.90	0.92	0.96	40.4%	0.35	0.40	0.44	0.58
A3	85,176	1.96	24,866	90%	0.71	0.73	0.75	0.81	25,379	0%	0.02	0.08	0.15	0.35	34,931	100%	0.89	0.90	0.92	0.96	67.3%	0.58	0.61	0.64	0.73
A4	17,452	0.40	0	90%	0.71	0.73	0.75	0.81	17,452	0%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	0.0%	0.02	0.08	0.15	0.35
A5	6,520	0.15	0	90%	0.71	0.73	0.75	0.81	6,100	0%	0.02	0.08	0.15	0.35	420	100%	0.89	0.90	0.92	0.96	6.4%	0.08	0.13	0.20	0.39
OS1	24,090	0.55	0	90%	0.71	0.73	0.75	0.81	19,546	0%	0.02	0.08	0.15	0.35	4,544	100%	0.89	0.90	0.92	0.96	18.9%	0.18	0.23	0.30	0.47
OS2	602	0.01	0	90%	0.71	0.73	0.75	0.81	35	0%	0.02	0.08	0.15	0.35	567	100%	0.89	0.90	0.92	0.96	94.2%	0.84	0.85	0.88	0.92
(A1-A5)	165,487	3.80	36,520	90%	0.71	0.73	0.75	0.81	80,078	0%	0.02	0.08	0.15	0.35	48,889	100%	0.89	0.90	0.92	0.96	49.4%	0.43	0.47	0.51	0.63

Villas at Aspen Trails - Drainage Report
Proposed Runoff Calculations
Time of Concentration

Watercourse Coefficient

Forest & Meadow	2.50	Short Grass Pasture & Lawns	7.00	Grassed Waterway	15.00
Fallow or Cultivation	5.00	Nearly Bare Ground	10.00	Paved Area & Shallow Gutter	20.00

	SUB-BASIN DATA				INITIAL / OVERLAND TIME			TRAVEL TIME T(t)					T(c) CHECK (URBANIZED BASINS)			FINAL T(c)
DESIGN POINT	DRAIN BASIN	AREA sq. ft.	AREA ac.	C(5)	Length ft.	Slope %	T(i) min	Length ft.	Slope %	Coeff.	Velocity fps	T(t) min.	COMP. T(c)	TOTAL LENGTH	L/180+10	min.
A1	A1	36,687	0.84	0.42	100	0.4%	16.9	148	3.2%	20.00	3.6	0.7	17.6	248	11.4	11.4
A2	A2	19,652	0.45	0.40	20	1.3%	5.3	304	0.7%	7.00	0.6	8.7	14.0	324	11.8	11.8
A3	A3	85,176	1.96	0.61	70	2.4%	5.7	494	2.1%	20.00	2.9	2.8	8.5	564	13.1	8.5
A4	A4	17,452	0.40	0.08	67	13.8%	6.4	111	20.0%	7.00	3.1	0.6	7.0	178	11.0	7.0
A5	A5	6,520	0.15	0.13	18	6.0%	4.1	245	1.0%	7.00	0.7	5.8	9.9	263	11.5	9.9
OS1	OS1	24,090	0.55	0.23	100	2.5%	11.7	563	1.9%	7.00	1.0	9.7	21.4	663	13.7	13.7
OS2	OS2	602	0.01	0.85	33	3.6%	1.7	0	0.0%	20.00	0.0	0.0	5.0	33	10.2	5.0

Initial flow paths seem long for such a high density site. Please show flow paths on proposed map.

Villas at Aspen Trails - Drainage Report
Proposed Runoff Calculations ***Design Storm 5 Year***
(Rational Method Procedure)

BASIN INFORMATION				DIRECT RUNOFF				CUMULATIVE RUNOFF				NOTES
DESIGN POINT	DRAIN BASIN	AREA ac.	RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	C x A	I in/hr	Q cfs	
A1	A1	0.84	0.42	11.4	0.35	3.93	1.39					
A2	A2	0.45	0.40	11.8	0.18	3.88	0.69					
A3	A3	1.96	0.61	8.5	1.19	4.37	5.17					
A4	A4	0.40	0.08	7.0	0.03	4.67	0.15					
A5	A5	0.15	0.13	9.9	0.02	4.14	0.08					
OS1	OS1	0.55	0.23	13.7	0.13	3.66	0.47					
OS2	OS2	0.01	0.85	5.0	0.01	5.17	0.06					
							8.02					

Villas at Aspen Trails - Drainage Report
Proposed Runoff Calculations ***Design Storm 100 Year***
(Rational Method Procedure)

BASIN INFORMATION				DIRECT RUNOFF				CUMULATIVE RUNOFF				NOTES
DESIGN POINT	DRAIN BASIN	AREA ac.	RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	C x A	I in/hr	Q cfs	
A1	A1	0.84	0.60	11.4	0.50	6.60	3.32					
A2	A2	0.45	0.58	11.8	0.26	6.52	1.71					
A3	A3	1.96	0.73	8.5	1.44	7.33	10.53					
A4	A4	0.40	0.35	7.0	0.14	7.83	1.10					
A5	A5	0.15	0.39	9.9	0.06	6.95	0.40					
OS1	OS1	0.55	0.47	13.7	0.26	6.14	1.58					
OS2	OS2	0.01	0.92	5.0	0.01	8.68	0.11					
							18.75					

esign points need to
count for
mulation of flow
rough basins

SUMMARY - PROPOSED RUNOFF TABLE

DESIGN POINT	BASIN DESIGNATION	BASIN AREA (ACRES)	DIRECT 5-YR RUNOFF (CFS)	DIRECT 100-YR RUNOFF (CFS)	BASIN IMP. (%)	100-YR RUNOFF COEF.
A1	A1	0.84	1.39	3.32	43.8%	0.60
A2	A2	0.45	0.69	1.71	40.4%	0.58
A3	A3	1.96	5.17	10.53	67.3%	0.73
A4	A4	0.40	0.15	1.10	0.0%	0.35
A5	A5	0.15	0.08	0.40	6.4%	0.39
OS1	OS1	0.55	0.47	1.58	0.0%	0.47
OS2	OS2	0.01	0.06	0.11	94.2%	0.92
TOTAL		4.37	8.02	18.75		

APPENDIX C – SITE DRAINAGE CALCULATIONS (EXISTING)

IDF Equations:

I_{100} = -2.52ln(D) + 12.735
I_{50} = -2.25ln(D) + 11.375
I_{25} -2.00ln(D) + 10.111
I_{10} -1.75ln(D) + 8.847
I_{5} -1.50ln(D) + 7.583
I_{2} -1.19ln(D) + 6.035

Where:
I = Rainfall Intensity (in/hr)
D= Duration (minutes)

	2-yr	5-yr	10-yr	100-yr
P_1 =	1.19	1.5	1.75	2.52

Time Intensity Frequency Tabulation

Time	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR
5	4.12	5.17	6.03	6.89	7.75	8.68
10	3.29	4.13	4.82	5.51	6.19	6.93
15	2.81	3.52	4.11	4.69	5.28	5.91
30	1.99	2.48	2.89	3.31	3.72	4.16
60	1.16	1.44	1.68	1.92	2.16	2.42
120	0.34	0.40	0.47	0.54	0.60	0.67

*The Design Point Rainfall Values and Time Intensity Frequency Tabulation are found in Table 6-2 and Figure 6-5 respectively, of the Colorado Springs Drainage Criteria Manual, Volume 1

Weighted Imperviousness Calculations

SUB-BASIN	AREA (SF)	AREA (Acres)	ROOF AREA	ROOF IMPERVIOUSNESS	ROOF C2	ROOF C5	ROOF C10	ROOF C100	LANDSCAPE AREA	LANDSCAPE IMPERVIOUSNESS	LANDSCAPE C2	LANDSCAPE C5	LANDSCAPE C10	LANDSCAPE C100	PAVEMENT AREA	PAVEMENT IMPERVIOUSNESS	PAVEMENT C2	PAVEMENT C5	PAVEMENT C10	PAVEMENT C100	WEIGHTED IMPERVIOUSNESS	WEIGHTED COEFFICIENTS C2	WEIGHTED COEFFICIENTS C5	WEIGHTED COEFFICIENTS C10	WEIGHTED COEFFICIENTS C100
E1	142,523	3.27	0	90%	0.71	0.73	0.75	0.81	140,089	2%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	2.0%	0.02	0.08	0.15	0.34
E2	42,715	0.98	0	90%	0.71	0.73	0.75	0.81	42,634	2%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	2.0%	0.02	0.08	0.15	0.35

Existing

Ray O 5.2 Single Family Attached - Drainage Report
Proposed Runoff Calculations
Time of Concentration

Watercourse Coefficient

Forest & Meadow	2.50	Short Grass Pasture & Lawns	7.00
Fallow or Cultivation	5.00	Nearly Bare Ground	10.00
Grassed Waterway	15.00		
Paved Area & Shallow Gutter	20.00		

	SUB-BASIN DATA				INITIAL / OVERLAND TIME			TRAVEL TIME T(t)					T(c) CHECK (URBANIZED BASINS)			FINAL T(c)
DESIGN POINT	DRAIN BASIN	AREA sq. ft.	AREA ac.	C(5)	Length ft.	Slope %	T(i) min	Length ft.	Slope %	Coeff.	Velocity fps	T(t) min.	COMP. T(c)	TOTAL LENGTH	L/180+10	min.
1	E1	142,523	3.27	0.08	0	17.0%	0.0	431	2.5%	20.00	3.2	2.3	5.0	431	12.4	5.0
2	E2	42,715	0.98	0.08	0	12.0%	0.0	141	2.4%	20.00	3.1	0.8	5.0	141	10.8	5.0

Existing

Ray O 5.2 Single Family Attached - Drainage Report
Proposed Runoff Calculations ***Design Storm 5 Year***
(Rational Method Procedure)

BASIN INFORMATION				DIRECT RUNOFF				CUMULATIVE RUNOFF				NOTES
DESIGN POINT	DRAIN BASIN	AREA ac.	RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	C x A	I in/hr	Q cfs	
1	E1	3.27	0.08	5.0	0.26	5.17	1.33					
2	E2	0.98	0.08	5.0	0.08	5.17	0.40					
							1.73					

Existing

Ray O 5.2 Single Family Attached - Drainage Report
Proposed Runoff Calculations ***Design Storm*** ***100 Year***
(Rational Method Procedure)

BASIN INFORMATION				DIRECT RUNOFF				CUMULATIVE RUNOFF				NOTES
DESIGN POINT	DRAIN BASIN	AREA ac.	RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	C x A	I in/hr	Q cfs	
1	E1	3.27	0.34	5.0	1.13	8.68	9.77					
2	E2	0.98	0.35	5.0	0.34	8.68	2.97					
							12.74					

Existing

SUMMARY - PROPOSED RUNOFF TABLE

DESIGN POINT	BASIN DESIGNATION	BASIN AREA (ACRES)	DIRECT 5-YR RUNOFF (CFS)	DIRECT 100-YR RUNOFF (CFS)	BASIN IMP. (%)	100-YR RUNOFF COEF.
1	E1	3.27	1.33	9.77	0.02	0.34
2	E2	0.98	0.40	2.97	0.02	0.35
TOTAL		4.25	1.73	12.74		

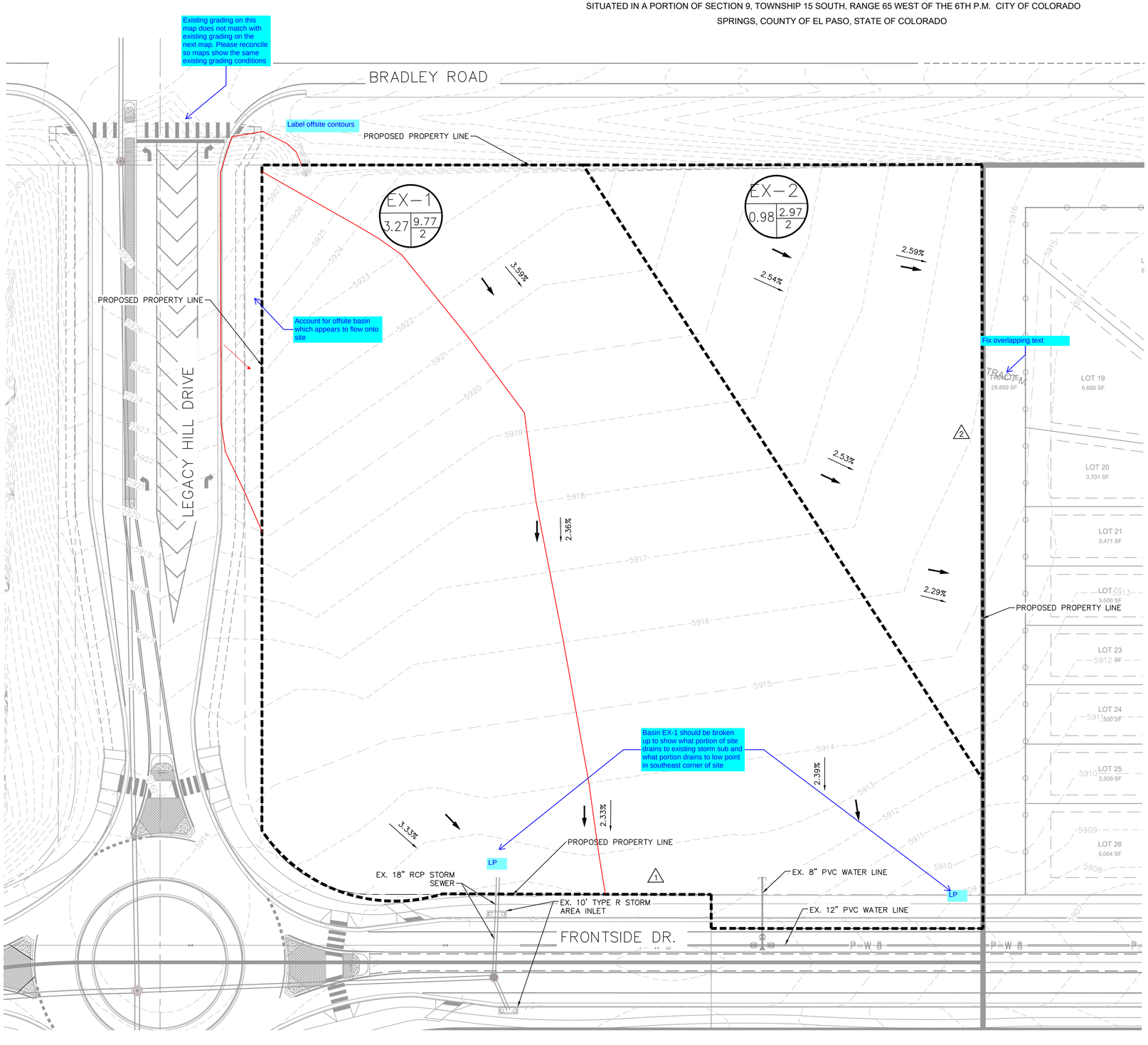
APPENDIX D – SITE DRAINAGE MAP (PROPOSED AND EXISTING)

Move maps to end of report

RAY O 5.2 SINGLE FAMILY ATTACHED

EXISTING DRAINAGE EXHIBIT

SITUATED IN A PORTION OF SECTION 9, TOWNSHIP 15 SOUTH, RANGE 65 WEST OF THE 6TH P.M. CITY OF COLORADO SPRINGS, COUNTY OF EL PASO, STATE OF COLORADO



LEGEND

A = BASIN DESIGNATION
B = AREA (ACRES)
C = 100-YR DESIGN STORM RUNOFF (CFS)
D = PERCENT IMPERVIOUSNESS

= DESIGN POINT

FLOW DIRECTION

DRAINAGE SUB-BASIN BOUNDARY

XXXX EXISTING MAJOR CONTOUR

XXXX EXISTING MINOR CONTOUR

PROPERTY LINE

SUMMARY - PROPOSED RUNOFF TABLE

DESIGN POINT	BASIN DESIGNATION	BASIN AREA (ACRES)	DIRECT 5-YR RUNOFF (CFS)	DIRECT 100-YR RUNOFF (CFS)	BASIN IMP. (%)	100-YR RUNOFF COEF.
1	E1	3.27	1.33	9.77	0.02	0.34
2	E2	0.98	0.40	2.97	0.02	0.35

Label adjacent property owners.

Show and label all existing easements

Label high and low points

GRAPHIC SCALE IN FEET
0 15 30 60

NORTH

Kimley»Horn

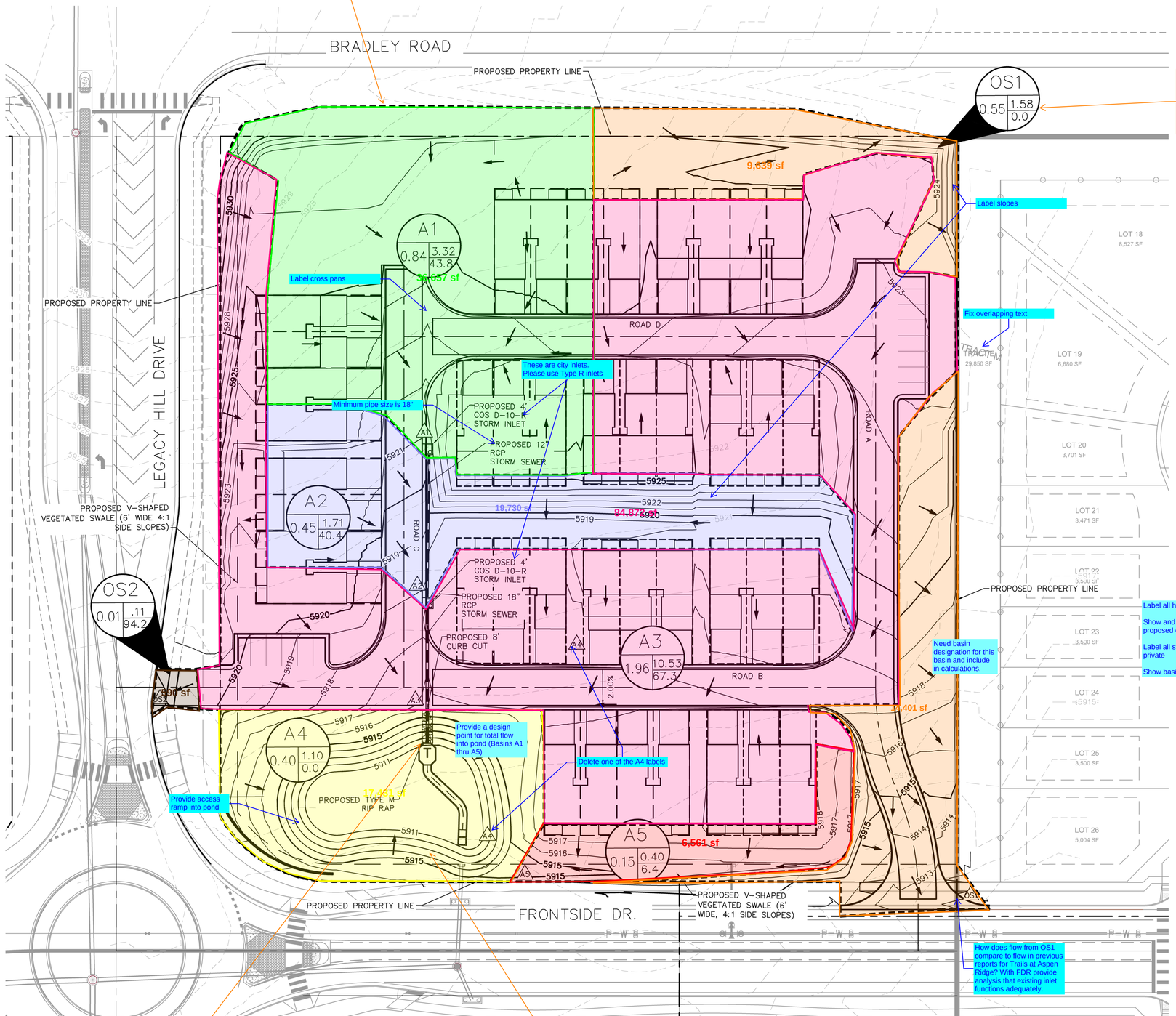
2 NORTH NEVADA AVENUE, SUITE 300
COLORADO SPRINGS, COLORADO 80903 (719) 453-0180

VILLAS AT ASPEN TRAILS

PROPOSED DRAINAGE EXHIBIT

SITUATED IN A PORTION OF SECTION 9, TOWNSHIP 15 SOUTH, RANGE 65 WEST OF THE 6TH P.M. CITY OF COLORADO SPRINGS, COUNTY OF EL PASO, STATE OF COLORADO

Note:
Colors and areas shown on this map are for review purposes only.



0.55ac includes both orange areas. But since these two areas are not connected and have different discharge point, split them into two different sub-basins

LEGEND

A = BASIN DESIGNATION
B = AREA (ACRES)
C = 100-YR DESIGN STORM RUNOFF (CFS)
D = PERCENT IMPERVIOUSNESS

= DESIGN POINT
FLOW DIRECTION
DRAINAGE SUB-BASIN BOUNDARY
XXXX PROPOSED MAJOR CONTOUR
XXXX PROPOSED MINOR CONTOUR
XXXX EXISTING MAJOR CONTOUR
XXXX EXISTING MINOR CONTOUR
PROPERTY LINE
PROPOSED STORM SEWER
PROPOSED STORM INLET

SUMMARY - PROPOSED RUNOFF TABLE

DESIGN POINT	BASIN DESIGNATION	BASIN AREA (ACRES)	DIRECT 5-YR RUNOFF (CFS)	DIRECT 100-YR RUNOFF (CFS)	BASIN IMP. (%)	100-YR RUNOFF COEF.
A1	A1	0.84	1.39	3.32	43.8%	0.60
A2	A2	0.45	0.69	1.71	40.4%	0.58
A3	A3	1.96	5.17	10.53	67.3%	0.73
A4	A4	0.40	0.15	1.10	0.0%	0.35
A5	A5	0.15	0.08	0.40	6.4%	0.39
OS1	OS1	0.55	0.47	1.58	0.0%	0.47
OS2	OS2	0.01	0.06	0.11	94.2%	0.92
TOTAL		4.37	8.02	18.75		

We need to know how much of the proposed disturbed (not impervious) area is treated vs untreated and if there are any exclusions that apply to the untreated areas. So please create a basic overview map (or modify an existing drainage map) with color shading/hatching that shows areas tributary to each PBMP (pond, runoff reduction, etc.) and those disturbed areas that are not treated by a PBMP, with the applicable exclusion labeled (ex: 20% up to 1ac of development can be excluded per ECM App I.7.1.C.1 and exclusions listed in ECM App I.7.1.B.#). An accompanying summary table on this map would also be very helpful (examples provided):

Basin ID	Total Area (ac)	Total Proposed Disturbed Area (ac)	Area Trib to Pond A (ac)	Disturbed Area Treated via Runoff Reduction (ac)	Disturbed Area Excluded from WQ per ECM App I.7.1.C.1 (ac)	Disturbed Area Excluded from WQ per ECM App I.7.1.B.# (ac)	Applicable WQ Exclusions (App I.7.1.B.#)
A	4.50	4.50	4.50	-	-	-	
B	1.25	1.25	-	1.25	-	-	
C	6.00	4.00	-	-	-	4.00	ECM App I.7.1.B.5
D	2.50	2.50	1.00	-	0.50	1.00	ECM App I.7.1.B.7
E	3.00	-	3.00	-	-	-	
F	8.25	-	-	-	-	-	
Total	25.50	12.25	8.50	1.25	0.50	5.00	
Comments		[For each row, the sum of the values in Columns 4-7 must be greater than or equal to the value in Column 3 above.]	[Values in this column can be more than Column 3 if over-treating non-disturbed areas of the same land-use.]	[See RR calc spreadsheet.]	[Total must be <20% of site and <1ac.]		
		Total Proposed Disturbed Area (ac)	Total Proposed Treated Area (ac)		Total Proposed Disturbed Area Excluded from WQ (ac)		Non-Excluded Area to be Treated (value must ≤ Total Proposed Treated Area) (ac)
		12.25	9.75		5.50		6.75

PBMP SUMMARY TABLE

BASINS	PBMP TRIBUTARY AREA (AC)	PBMP
A1.1	1.43	RG-A1.1
A3.1	1.87	RG-A3.1
B1,B2	8.60	EDB-B
OA2,A2	0.95	EXCLUDED*

* EXCLUDED BASED ON < 1-ACRE OF DEVELOPED ROADWAY AREA PER ECM APP. I.7.C.1.a

GRAPHIC SCALE IN FEET
0 15 30 60

NORTH

Note for Final Plat (SF) submittal: provide a detail of connection of riprap to the forebay. It should be designed such that the water does not pond behind the forebay wall and thus contribute to erosion around the sidewalls.

The label in the calcs on pg 50 below is "South Pond" add this to the report text and dwgs/maps for consistency.

Kimley»Horn

2 NORTH NEVADA AVENUE, SUITE 300
COLORADO SPRINGS, COLORADO 80903 (719) 453-0180

APPENDIX E – HYDRAULIC COMPUTATIONS

Hydraulic computations will be fully reviewed with final drainage report. Some initial comments have been provided.

Worksheet for Storm Line A1-2

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.020 ft/ft
Diameter	12.0 in
Discharge	2.10 cfs

Results	
Normal Depth	5.4 in
Flow Area	0.3 ft²
Wetted Perimeter	1.5 ft
Hydraulic Radius	2.8 in
Top Width	1.00 ft
Critical Depth	7.4 in
Percent Full	45.0 %
Critical Slope	0.007 ft/ft
Velocity	6.12 ft/s
Velocity Head	0.58 ft
Specific Energy	1.03 ft
Froude Number	1.837
Maximum Discharge	5.42 cfs
Discharge Full	5.04 cfs
Slope Full	0.003 ft/ft
Flow Type	Supercritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	45.0 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	5.4 in
Critical Depth	7.4 in
Channel Slope	0.020 ft/ft
Critical Slope	0.007 ft/ft

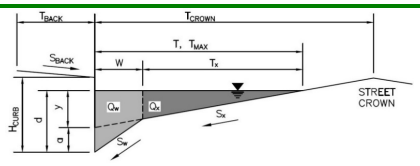
MHFD-Inlet, Version 5.01 (April 2021)

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

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

Project: **Villas at Aspen Trails**

Inlet ID: **Sub Basin A2**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	17.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.009	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} =	24.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.021	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 =	0.018	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} =	24.0	24.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

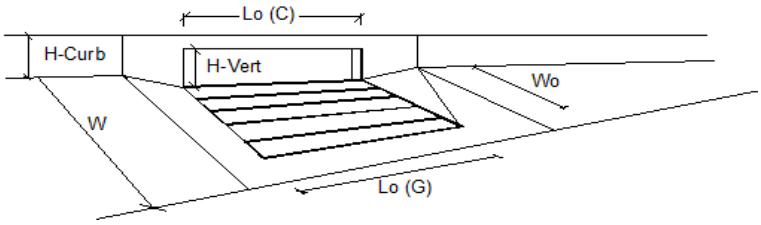
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**17.9**	**17.9**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)	Colorado Springs D-10-R		MINOR	MAJOR	
Type of Inlet		Type =	Colorado Springs D-10-R		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	4.0	4.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	4.00	4.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity'			MINOR	MAJOR	
Total Inlet Interception Capacity		**Q =**	**0.8**	**1.9**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)		**Q_b =**	**0.0**	**1.0**	**cfs**
Capture Percentage = Q_a/Q_o =		**C% =**	**100**	**65**	**%**

Worksheet for Design Point A3 Curb Cut

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.005 ft/ft
Bottom Width	8.00 ft
Discharge	15.53 cfs

How was this flow determined? Does not match flow on hydrology spreadsheets for Design Point A3

Results	
Normal Depth	5.3 in
Flow Area	3.5 ft²
Wetted Perimeter	8.9 ft
Hydraulic Radius	4.8 in
Top Width	8.00 ft
Critical Depth	5.9 in
Critical Slope	0.004 ft/ft
Velocity	4.38 ft/s
Velocity Head	0.30 ft
Specific Energy	0.74 ft
Froude Number	1.161
Flow Type	Supercritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	5.3 in
Critical Depth	5.9 in
Channel Slope	0.005 ft/ft
Critical Slope	0.004 ft/ft

Worksheet for Storm Line A1-2

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.020 ft/ft
Diameter	12.0 in
Discharge	2.10 cfs

Results	
Normal Depth	5.4 in
Flow Area	0.3 ft²
Wetted Perimeter	1.5 ft
Hydraulic Radius	2.8 in
Top Width	1.00 ft
Critical Depth	7.4 in
Percent Full	45.0 %
Critical Slope	0.007 ft/ft
Velocity	6.12 ft/s
Velocity Head	0.58 ft
Specific Energy	1.03 ft
Froude Number	1.837
Maximum Discharge	5.42 cfs
Discharge Full	5.04 cfs
Slope Full	0.003 ft/ft
Flow Type	Supercritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	45.0 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	5.4 in
Critical Depth	7.4 in
Channel Slope	0.020 ft/ft
Critical Slope	0.007 ft/ft

Worksheet for Storm Line A2-3

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.020 ft/ft
Diameter	18.0 in
Discharge	4.00 cfs

Results	
Normal Depth	6.4 in
Flow Area	0.6 ft²
Wetted Perimeter	1.9 ft
Hydraulic Radius	3.5 in
Top Width	1.44 ft
Critical Depth	9.2 in
Percent Full	35.4 %
Critical Slope	0.005 ft/ft
Velocity	7.13 ft/s
Velocity Head	0.79 ft
Specific Energy	1.32 ft
Froude Number	2.012
Maximum Discharge	15.98 cfs
Discharge Full	14.85 cfs
Slope Full	0.001 ft/ft
Flow Type	Supercritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	35.4 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	6.4 in
Critical Depth	9.2 in
Channel Slope	0.020 ft/ft
Critical Slope	0.005 ft/ft

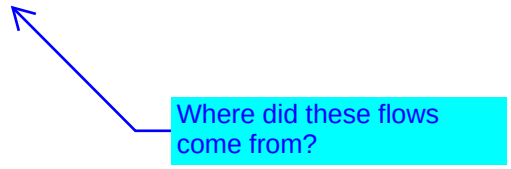
Worksheet for Swale A1

Show and label swale on proposed drainage map

Project Description	
Friction Method	Manning Formula
Solve For	Discharge

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.080 ft/ft
Normal Depth	6.0 in
Left Side Slope	50.000 H:V
Right Side Slope	3.000 H:V

Results	
Discharge	84.81 cfs
Flow Area	6.6 ft²
Wetted Perimeter	26.6 ft
Hydraulic Radius	3.0 in
Top Width	26.50 ft
Critical Depth	11.0 in
Critical Slope	0.003 ft/ft
Velocity	12.80 ft/s
Velocity Head	2.55 ft
Specific Energy	3.05 ft
Froude Number	4.514
Flow Type	Supercritical



GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	6.0 in
Critical Depth	11.0 in
Channel Slope	0.080 ft/ft
Critical Slope	0.003 ft/ft

Worksheet for Swale A2

Show and label swale on proposed drainage map

Project Description	
Friction Method	Manning Formula
Solve For	Discharge

Input Data		
Roughness Coefficient	0.030	
Channel Slope	0.020	ft/ft
Normal Depth	9.0	in
Left Side Slope	3.000	H:V
Right Side Slope	10.000	H:V

Results		
Discharge	13.18	cfs
Flow Area	3.7	ft²
Wetted Perimeter	9.9	ft
Hydraulic Radius	4.4	in
Top Width	9.75	ft
Critical Depth	9.1	in
Critical Slope	0.018	ft/ft
Velocity	3.60	ft/s
Velocity Head	0.20	ft
Specific Energy	0.95	ft
Froude Number	1.037	
Flow Type	Supercritical	

Flows do not match with hydrology spreadsheet for basin or design point A2

GVF Input Data		
Downstream Depth	0.0	in
Length	0.0	ft
Number Of Steps	0	

GVF Output Data		
Upstream Depth	0.0	in
Profile Description	N/A	
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	9.0	in
Critical Depth	9.1	in
Channel Slope	0.020	ft/ft
Critical Slope	0.018	ft/ft

Worksheet for Swale A3

Project Description	
Friction Method	Manning Formula
Solve For	Discharge

Input Data		
Roughness Coefficient	0.030	
Channel Slope	0.007	ft/ft
Normal Depth	7.0	in
Left Side Slope	5.000	H:V
Right Side Slope	50.000	H:V

Map calls out 4:1 sides

Results		
Discharge	17.03	cfs
Flow Area	9.4	ft²
Wetted Perimeter	32.1	ft
Hydraulic Radius	3.5	in
Top Width	32.08	ft
Critical Depth	5.7	in
Critical Slope	0.021	ft/ft
Velocity	1.82	ft/s
Velocity Head	0.05	ft
Specific Energy	0.63	ft
Froude Number	0.594	
Flow Type	Subcritical	

Flows do not match with hydrology spreadsheet for basin or design point A3

GVF Input Data		
Downstream Depth	0.0	in
Length	0.0	ft
Number Of Steps	0	

GVF Output Data		
Upstream Depth	0.0	in
Profile Description	N/A	
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	7.0	in
Critical Depth	5.7	in
Channel Slope	0.007	ft/ft
Critical Slope	0.021	ft/ft

Worksheet for Swale A5

Project Description	
Friction Method	Manning Formula
Solve For	Discharge

Input Data		
Roughness Coefficient	0.030	
Channel Slope	0.020	ft/ft
Normal Depth	12.0	in
Left Side Slope	8.000	H:V
Right Side Slope	3.000	H:V

Map calls out 4:1 sides

Results		
Discharge	23.94	cfs
Flow Area	5.5	ft²
Wetted Perimeter	11.2	ft
Hydraulic Radius	5.9	in
Top Width	11.00	ft
Critical Depth	12.4	in
Critical Slope	0.017	ft/ft
Velocity	4.35	ft/s
Velocity Head	0.29	ft
Specific Energy	1.29	ft
Froude Number	1.085	
Flow Type	Supercritical	

Flows do not match with hydrology spreadsheet for basin or design point A3

GVF Input Data		
Downstream Depth	0.0	in
Length	0.0	ft
Number Of Steps	0	

GVF Output Data		
Upstream Depth	0.0	in
Profile Description	N/A	
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	12.0	in
Critical Depth	12.4	in
Channel Slope	0.020	ft/ft
Critical Slope	0.017	ft/ft

Kimley»Horn

Extended Detention Basin (EDB) Calculations

Date	11/3/2022	Manual Input
Prepared By	JAR	Multipliers
Checked By	JAR	

Release Factor:	0.02

Forebay Release and Configuration: Release 2% of the undetained 100-year peak discharge by way of a wall/notch or berm/pipe configuration

Forebay	Incoming Pipe Diameter (in)	Release Rate (cfs)
A	18	0.31

Maximum Forebay Depth

Forebay	Impervious Area in Watershed (ac)	Maximum Forebay Depth (in)	Design Forebay Depth (in)	Design Forebay Depth (ft)
A	1.96	12	12	1

Note: a forebay depth of 30" requires handrails by most City Standards

County

Baffle Block Design

Forebay	Incoming Pipe Diameter (in)	1/4 of Diameter	Side length (in)	Height (in)
A	18	4.5	8.00	9

Minimum Forebay Volume Required: 3% WQCV

Volume Factor: 0.03

Forebay	WQCV (ac-ft)	Required Volume (ac-ft)	Required Volume (cf)	Total Length (ft)	Total Width (ft)	Corner Calculations			Design Volume (cf)
						Triangle Height (ft)	Triangle Base (ft)	Triangle Area (sf)	
A	0.065	0.002	85	12	9	2.5	2.5	3.125	95.5

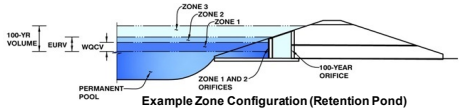
Please use the latest MHFD-Detention spreadsheet (v4.06)

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: Villas at Aspen Trails

Basin ID: South Pond



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	3.80	acres
Watershed Length =	500	ft
Watershed Length to Centroid =	250	ft
Watershed Slope =	0.035	ft/ft
Watershed Imperviousness =	49.40%	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) =	0.065	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	0.200	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.180	acre-feet	1.19 inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.257	acre-feet	1.50 inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.326	acre-feet	1.75 inches
25-yr Runoff Volume (P1 = 1.69 in.) =	0.327	acre-feet	inches
50-yr Runoff Volume (P1 = 1.99 in.) =	0.415	acre-feet	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.587	acre-feet	2.52 inches
500-yr Runoff Volume (P1 = 3.14 in.) =	0.780	acre-feet	inches
Approximate 2-yr Detention Volume =	0.151	acre-feet	
Approximate 5-yr Detention Volume =	0.207	acre-feet	
Approximate 10-yr Detention Volume =	0.275	acre-feet	
Approximate 25-yr Detention Volume =	0.255	acre-feet	
Approximate 50-yr Detention Volume =	0.279	acre-feet	
Approximate 100-yr Detention Volume =	0.352	acre-feet	

Define Zones and Basin Geometry

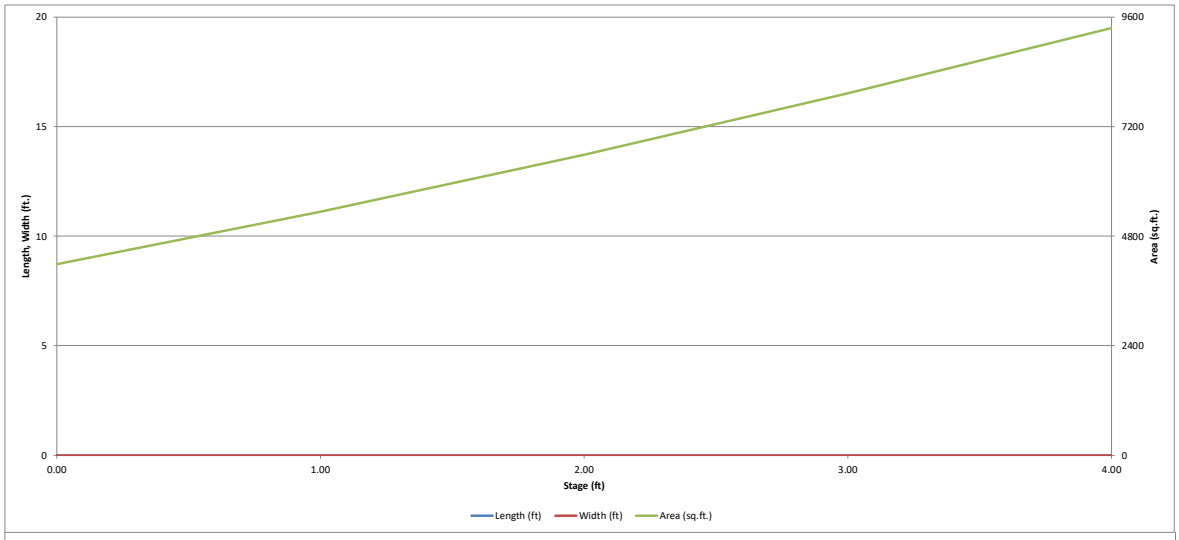
Zone 1 Volume (WQCV) =	0.065	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.136	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.152	acre-feet
Total Detention Basin Volume =	0.352	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (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

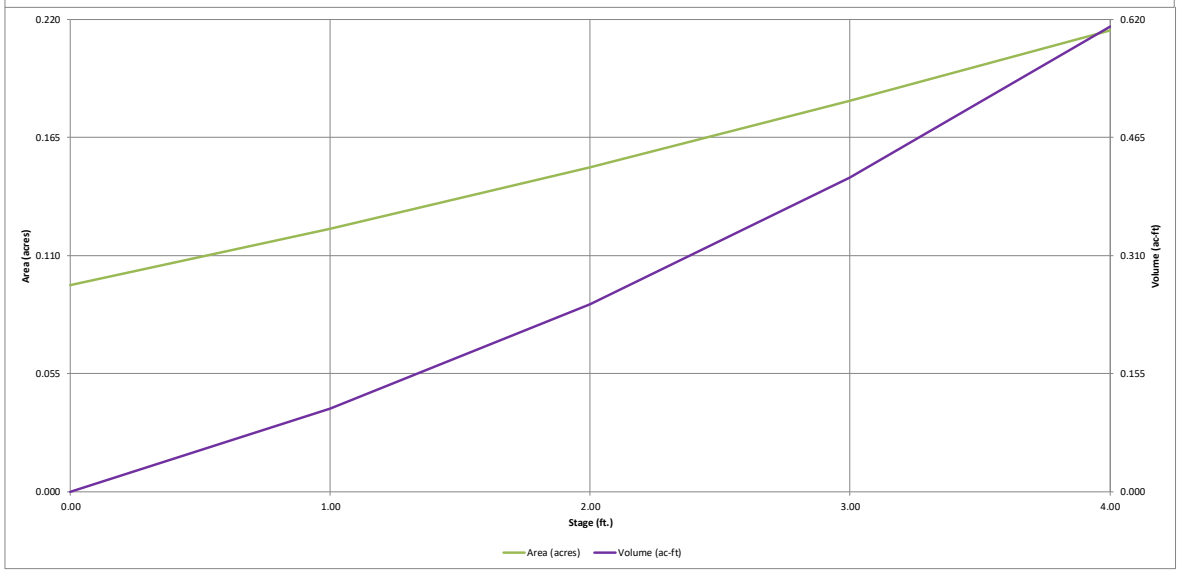
Depth Increment = ft

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	--	--	--	4,193	0.096		
	--	1.00	--	--	--	5,337	0.123	4,765	0.109
	--	2.00	--	--	--	6,581	0.151	10,724	0.246
	--	3.00	--	--	--	7,925	0.182	17,977	0.413
	--	4.00	--	--	--	9,371	0.215	26,625	0.611

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)



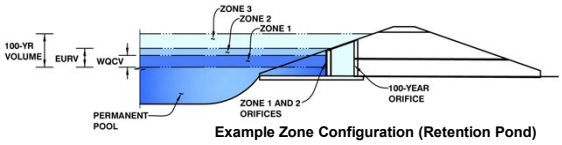


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: Villas at Aspen Trails

Basin ID: South Pond



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.63	0.065	Orifice Plate
Zone 2 (EURV)	1.69	0.136	Circular Orifice
Zone 3 (100-year)	2.66	0.152	Weir&Pipe (Restrict)
Total (all zones)		0.352	

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	ft^2
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)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	0.63	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	2.50	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	inches	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.21	0.42					
Orifice Area (sq. inches)	0.79	0.79	0.79					

	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)

	Zone 2 Circular	Not Selected			Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	0.63	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.00	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	1.69	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.02	N/A	feet
Vertical Orifice Diameter =	0.47	N/A	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 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.69	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	1.69	N/A	feet
Overflow Weir Front Edge Length =	4.00	N/A	feet	Overflow Weir Slope Length =	2.92	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	20.70	N/A	
Horiz. Length of Weir Sides =	2.92	N/A	feet	Overflow Grate Open Area w/o Debris =	8.13	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	4.06	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.00	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.39	N/A	ft^2
Outlet Pipe Diameter =	12.00	N/A	inches	Outlet Orifice Centroid =	0.29	N/A	feet
Restrictor Plate Height Above Pipe Invert =	6.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.57	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	2.80	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.71	feet
Spillway Crest Length =	4.00	feet	Stage at Top of Freeboard =	4.51	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.22	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	0.61	acre-ft

Calculated Parameters for Spillway

Per DCMv2 Section 4.3, outlet pipe should be 18" minimum.

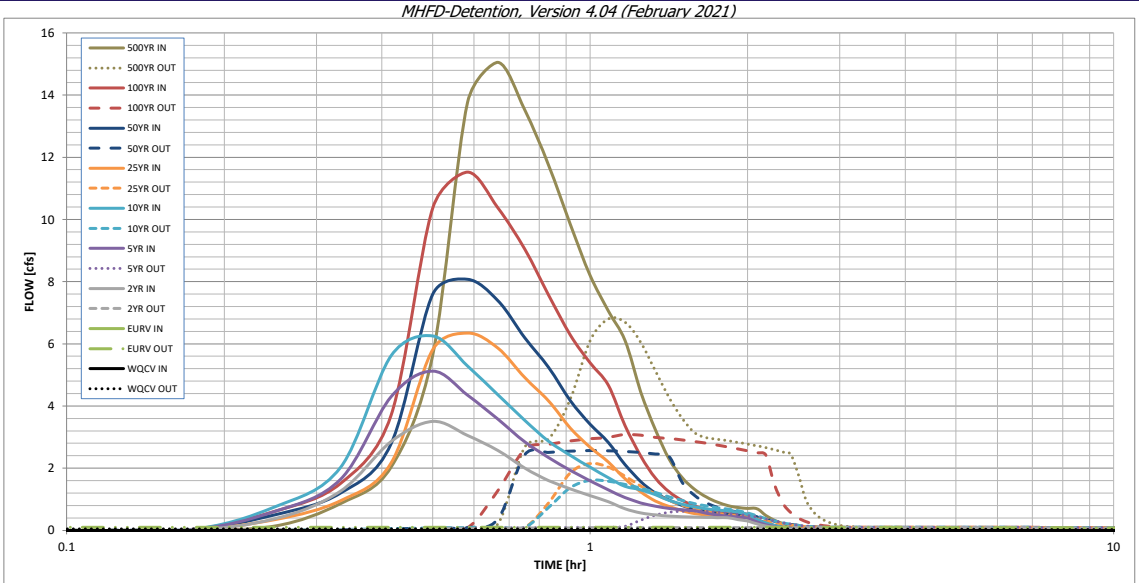
Routed Hydrograph Results

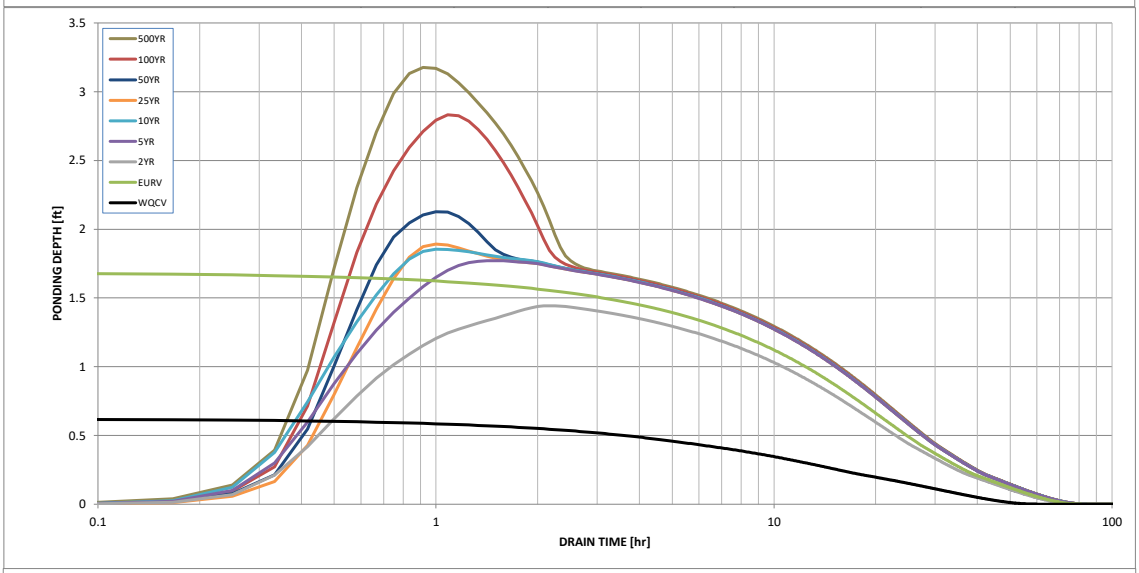
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

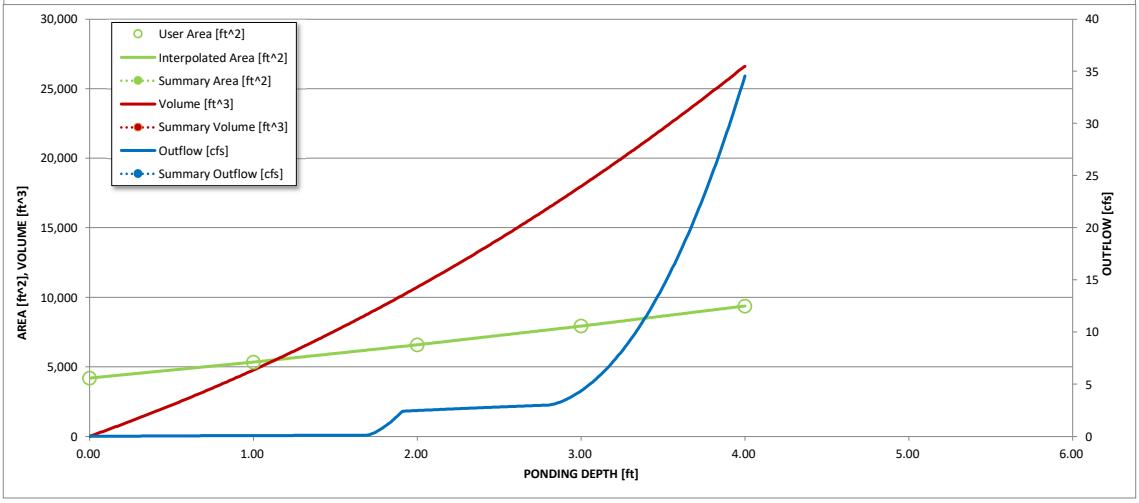
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	1.69	1.99	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.065	0.200	0.180	0.257	0.326	0.327	0.415	0.587	0.780
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.180	0.257	0.326	0.327	0.415	0.587	0.780
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.5	1.5	2.2	2.7	3.8	6.0	8.4
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.14	0.39	0.58	0.70	1.01	1.59	2.21
Peak Inflow Q (cfs) =	N/A	N/A	3.5	5.1	6.3	6.3	8.1	11.5	15.1
Peak Outflow Q (cfs) =	0.0	0.1	0.1	0.6	1.6	2.1	2.6	3.1	6.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.4	0.7	0.8	0.7	0.5	0.8
Structure Controlling Flow =	Plate	Overflow Weir 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.1	0.2	0.2	0.3	0.4	0.4
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) =	47	59	58	59	56	56	52	46	41
Time to Drain 99% of Inflow Volume (hours) =	**53**	68	67	69	68	68	66	62	59
Maximum Ponding Depth (ft) =	0.63	1.69	1.44	1.77	1.86	1.89	2.13	2.83	3.18
Area at Maximum Ponding Depth (acres) =	0.11	0.14	0.14	0.14	0.15	0.15	0.15	0.18	0.19
Maximum Volume Stored (acre-ft) =	0.066	0.201	0.166	0.212	0.224	0.230	0.265	0.382	0.444

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







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	0.00	0.00	0.14
	0:15:00	0.00	0.00	0.37	0.61	0.75	0.35	0.50	0.62	0.86
	0:20:00	0.00	0.00	1.26	1.64	2.03	0.96	1.20	1.51	2.03
	0:25:00	0.00	0.00	2.85	4.30	5.61	2.17	2.78	3.70	5.62
	0:30:00	0.00	0.00	3.50	5.12	6.26	5.81	7.59	10.36	13.76
	0:35:00	0.00	0.00	3.05	4.35	5.28	6.35	8.07	11.52	15.05
	0:40:00	0.00	0.00	2.57	3.57	4.36	5.86	7.39	10.37	13.52
	0:45:00	0.00	0.00	2.00	2.84	3.54	4.91	6.20	9.04	11.75
	0:50:00	0.00	0.00	1.60	2.34	2.86	4.16	5.24	7.57	9.84
	0:55:00	0.00	0.00	1.34	1.93	2.41	3.29	4.17	6.28	8.20
	1:00:00	0.00	0.00	1.12	1.59	2.03	2.67	3.42	5.39	7.05
	1:05:00	0.00	0.00	0.92	1.30	1.69	2.20	2.83	4.66	6.11
	1:10:00	0.00	0.00	0.70	1.06	1.42	1.66	2.12	3.37	4.45
	1:15:00	0.00	0.00	0.56	0.89	1.30	1.24	1.57	2.39	3.24
	1:20:00	0.00	0.00	0.49	0.77	1.15	0.95	1.20	1.68	2.29
	1:25:00	0.00	0.00	0.46	0.70	0.96	0.77	0.98	1.24	1.69
	1:30:00	0.00	0.00	0.44	0.66	0.84	0.63	0.79	0.96	1.32
	1:35:00	0.00	0.00	0.43	0.63	0.75	0.54	0.67	0.78	1.07
	1:40:00	0.00	0.00	0.42	0.55	0.70	0.49	0.60	0.66	0.91
	1:45:00	0.00	0.00	0.41	0.49	0.65	0.45	0.54	0.58	0.80
	1:50:00	0.00	0.00	0.41	0.46	0.62	0.43	0.51	0.54	0.73
	1:55:00	0.00	0.00	0.35	0.43	0.58	0.42	0.49	0.52	0.71
	2:00:00	0.00	0.00	0.30	0.40	0.51	0.41	0.48	0.52	0.70
	2:05:00	0.00	0.00	0.21	0.27	0.35	0.28	0.33	0.36	0.48
	2:10:00	0.00	0.00	0.14	0.18	0.24	0.19	0.22	0.24	0.33
	2:15:00	0.00	0.00	0.09	0.12	0.16	0.13	0.15	0.16	0.22
	2:20:00	0.00	0.00	0.06	0.08	0.10	0.08	0.10	0.11	0.14
	2:25:00	0.00	0.00	0.04	0.05	0.06	0.05	0.06	0.07	0.09
	2:30:00	0.00	0.00	0.02	0.03	0.04	0.03	0.04	0.04	0.05
	2:35:00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.02	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
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	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
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	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
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	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

APPENDIX F – OPINION OF PROBABLE CONSTRUCTION COST

Kimley»Horn

Kimley-Horn & Associates, Inc. **Opinion of Probable Construction Cost**

Client:	**ROS Equity Holdings - Independence, LLC**	**Date:**	**11/4/2022**
Project:	**Villas at Aspen Trails**	**Prepared By:**	**JAR**
KHA No.:	**096668022**	**Checked By:**	**JAR**

No:		**Sheet:**	**1 of 1**

Kimley-Horn & Associates, Inc. has not prepared fully engineered construction drawings for this site; therefore, the final quantities are subject to change. Additionally, the final land plan could change significantly through the development process. This OPC is not intended for basing financial decisions, or securing funding. Review all notes and assumptions. Since Kimley-Horn & Associates, Inc. has no control over the cost of labor, materials, equipment, or services furnished by others, or over methods of determining price, or over competitive bidding or market conditions, any and all opinions as to the cost herein, including but not limited to opinions as to the costs of construction materials, shall be made on the basis of experience and best available data. Kimley-Horn & Associates, Inc. cannot and does not guarantee that proposals, bids, or actual costs will not vary from the opinions on costs shown herein. The total costs and other numbers in this Opinion of Probable Cost have been rounded.

Item No.	Item Description	Quantity	Unit	Unit Price	Item Cost
	Storm Sewer Costs for Ray O 5.2 Multi-Family (Non-reimbursable)				
1	12" RCP Storm Sewer	83	LF	$20.00	$1,660
2	18" RCP Storm Sewer	78	LF	$25.00	$1,950
3	Type M Rip Rap	1	CY	$50.00	$50
4	4' COS D-10-R Storm Inlet	2	EA	$2,500.00	$5,000
			Subtotal:		$8,660
			Contingency (%,+/-)	10%	$866
			Project Total:		**$9,526**

Basis for Cost Projection:

- ☐ No Design Completed
- ☑ Preliminary Design
- ☐ Final Design

Per my comment on the FAE:

Include a cost estimate for each PBMP with line items for all components (ex: riprap, road base, forebay, trickle channel, outlet structure, outlet pipe, spillway, etc). Input the total value into the FAE form under “Permanent Pond/BMP (provide engineer’s estimate)” in Section 1. The total should not include grading, which is a separate line item in Section 1: “Earthwork.”

Design Engineer:

Jared A. Roberts
Registered Professional Engineer, State of Colorado No. 60470