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Christopher Henry, E.I.T.
David Nicolella, Planner
Leonard Filner, Planner

Chapel View Terrace Subdivision
Coconino County

DRAINAGE REPORT

for

APN: 404-01-018D

January 5, 2022

Prepared for:

Coconino County Community Development

2500 N Fort Valley Road, Bldg. 1
Flagstaff, AZ 86001

On Behalf of:
Chris Rife, Passion LLC
Submitted By;

Registered Professional Engineer (Civil)
CERTIFICATE NO.
37322
LUKE A.
SEFTON
Date Signed 01-05-2022
ARIZONA U.S.A.

Project #210305 Prepared By: Christopher Henry, EIT 13189
Reviewed By: Luke Sefton, PE 37322

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Table of Contents

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I. GENERAL LOCATION AND DESCRIPTION

LOCATION

Chapel View Terrace subdivision will be developed by Passion LLC. The current APN number is 401-34-033B. Surrounding roadway of this parcel include SR-179 to the east, W Chapel Rd to the north, and Sky Line Dr to the south.

Per the City of Sedona GIS, there are no drainageways or facilities located on site. Stormwater run off in the immediate area to the north and south are conveyed by roadside drainage paths until they meet the catch basins on the corners of Chapel Rd & SR-179 as well as Skyline Dr & SR-179.

All the surrounding developments are zoned as RS-18. The City of Sedona Land Development Code describes the RS-18 district is intended to accommodate and preserve lower-density to medium-density single-family residential uses with limited community and educational uses and incidental or accessory uses. This district can also serve as a transition between low- and medium-density residential to higher-density residential zoning districts.

Chapel View Terrace will consist of six lots that are on average 0.55 Acres. Access to the subdivision will be on the north side of the property off W Chapel Road. A roadway with an end cul-de-sac will be constructed to provide access to these properties along with a water line, sanitary sewer line, gas line, and electrical services.

DESCRIPTION OF PROPERTY

The entire property is 3.29 Acres. Ground cover is moderately dense and consists of medium to large sized trees and shrubbery. There are no major drainageways that exist through this property. Also, this property is not located in a FEMA floodplain nor a City of Sedona floodplain.

Along the south side of the parcel there is a drainage swale on Sky Line Dr. that drains into a catch basin on the corner of Sky Line Dr. and Hwy-179. On the north side of the parcel on W Chapel Rd there is also a drainage swale along side of the road. Driveways include culverts to allow continuation of flow.

Currently, there is no existing land use for this property. As mentioned before, it is proposed that this land be utilized to provide six lots as RS-18. An extension of the City of Sedona 8” wastewater line will provide residents of a means to dispose of wastewater.

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II. DRAINAGE BASINS AND SUB-BASINS

MAJOR BASIN DESCRIPTION

The City of Sedona has a storm water master plan to identify major drainages and focal points to help convey stormwater runoff safely. The subject parcel is located within the major drainage basin of Oak Creek. The Oak Creek drainage basin is one of four major basins within the City of Sedona. This basin has a total drainage area of 21.38 square miles. Due to the significant size of this drainage basin the area was split into four smaller areas (A, B, C, & D). This property is located within the sub-area watershed C.

There are no irrigation facilities within ½ mile of the property boundary, which will influence or be influenced by the local drainage. There are two catch basins in the right-of-way, one at each corner intersection. From the USDA Web Soil Survey, the soil is classified as Sedona soils. The typical profile of this soil type is as follows; extremely channery loam from 0-2 inches, extremely channery silty clay loam from 2-10 inches, extremely flaggy silt loam from 10-18 inches, and then bedrock from 18-60 inches. No detailed soils investigation has been performed.

SUB-BASIN DESCRIPTION

This parcel is situated on the west side of sub-basin K8B. See **Appendix A** for the City of Sedona Oak Creek Basin "C" Drainage Map. Historically this sub-basin flows to the south-west towards Oak Creek. In the immediate area runoff travels towards Hwy-179. A minimal amount of runoff from the single-family residence (SFR) directly to the west will have a small effect on site, but primarily off-site drainage will not impact this parcel as runoff is directed to travel along the roadside drainages nearby. Run off from the neighboring property has been considered for calculations.

The project location has been further broken down into three sub-basins and three concentration points. The design points have been delineated as both catch basins and the detention pond. A map delineating the property sub-basins has been provided in **Appendix B**.

Sub-basin A is approximately 0.68 Acres. This sub-basin includes a portion of West Chapel Rd, a small area of the neighboring property to the west, and a northern portion of the subject parcel to be developed. The land use pre-development contains approximately 0.63 Acres of natural hillslopes and 0.05 Acres of pavement. Post-development land use will contain approximately 0.60 Acres of natural hillslopes and 0.08 acres of pavement. Sub-basin A drains alongside West Chapel Rd and into the catch basin at the corner of SR-179.

Sub-basin B is approximately 3.03 Acres. This sub-basin includes the back yard of the SFR and majority of the subject parcel to be developed. The land use pre-development is classified as natural hillslopes. Post-development land use will contain approximately 2.74 Acres of natural hillslopes and 0.29 Acres of pavement. This sub-basin is conveyed

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as sheet flow towards SR-179. Drainage facilities to help direct water and a detention pond will be designed to reduce the peak flow post-development.

Sub-basin C is approximately 0.45 Acres. This sub-basin includes a small portion of the backyard of the SFR and a sliver of the southern part of the subject parcel. The land use pre-development is classified as natural hillslopes. Post-development land use does not contain any impervious area until the single-family residences are constructed. This sub-basin drains alongside Skyline Dr and into the catch basin at the corner of SR-179 and Skyline Dr.

Due to the increase in impervious area from the development stormwater management facilities will be needed. It is proposed to provide a retention pond along the east side of the lot to help mitigate the increase in run off. A retention pond will catch storm water runoff trying to make its way off the property and towards Hwy-179. This pond will retain the stormwater for no longer than 12 hours.

III. DRAINAGE DESIGN CRITERIA

REGULATIONS

The regulations described within the Coconino County Drainage Design Manual and the City of Sedona Land Development Code were followed while preparing this report. No deviations from the above referenced manuals were requested or anticipated at this time.

DEVELOPMENT CRITERIA AND CONSTRAINTS

The City of Sedona has developed an Area Drainage Study titled City of Sedona Storm Water Master Plan which was prepared by Dibble & Associates dated March 2005. The development falls within the study area of this drainage study. The hydrologic methods used within the previous study are not the same methods used for this study. The hydrologic calculations used within this report will be used for addressing the pre-development and post-development design conditions for this project only and not intended to override the previous study accepted by the City of Sedona.

It is required that there be no increase in runoff due to development.

The stormwater management area will only accommodate the additional runoff created from the roadway and not consider any impervious area from the development of any homes. Thus, it will be required on a case-by-case basis to provide stormwater retention on each lot once developed.

HYDROLOGIC CRITERIA AND RESULTS

The hydrologic calculations used within this report will be used for addressing the pre-development and post-development design conditions for this project only. The proposed roadway area was considered in the calculations. Individual lots will be

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required to provide stormwater drainage as the design in this report provides storm water management for only the added roadway and sidewalks.

Hydrologic calculations were performed using the Rational Method as outlined within Chapter 3 of the Coconino County Drainage Design Criteria Manual. The Rational Method is based on the equation Q = CIA where Q is the peak flow in cubic feet per second, C is the runoff coefficient, I is the average rainfall intensity in inches per hour and A is the contributing drainage area in Acres. Hydraflow Hydrographs 2007 modeling program based on the Rational Method was used to determine peak flows for the pre-development and post-development conditions. In the tables below the key data used for the rational method can be found.

Rainfall data was collected using NOAA Atlas 14 Point Precipitation Frequency Estimates. Data can be found in **Appendix C**. Below are tables showing the rainfall intensity at the project location as well as the land use characteristics.

Table 1: Rainfall Intensity

Rainfall Intensity, Inches/Hr				
Duration	***Frequency, in Years***			
	2	*10*	*25*	*100*
5-Minute	3.31	5.42	7.93	9.17
15-Minute	2.08	3.41	4.27	5.77
30-Minute	1.4	2.3	2.88	3.88
60-Minute	0.87	1.42	1.78	2.4

Table 2: Pre- vs Post- Land Use

Pre- vs Post- Land Use					
		Pre-Development		Post-Development	
Sub-basin	***Land Use***	***Area***	***Coefficient***	***Area***	***Coefficient***
A	*Hillslopes, Sonoran*	0.63	0.60	0.60	0.60
	Pavement & Rooftops	0.05	0.95	0.08	0.95
	Composite Coefficient		**0.63**		**0.64**
B	*Hillslopes, Sonoran*	3.03	0.60	2.74	0.60
	Pavement & Rooftops	-	-	0.29	0.95
	Composite Coefficient		**0.6**		**0.63**
C	*Hillslopes, Sonoran*	0.45	0.6	0.45	0.6
	Pavement & Rooftops	-	-	-	-
	Composite Coefficient		**0.6**		**0.6**

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Peak runoff rates have been calculated using the rational method as described above. Hydraflow Hydrograph has been used for the modeling. The above values in the tables have been used for the rational method as well as assuming a time of concentration of ten minutes.

The site in pre-development conditions drained entirely into the two catch basins on SR-179. For the purpose of designing the necessary stormwater management pond the 100-yr, 2-hr storm event will be used to size the pond in accordance with section 7.3.2.7 of the Yavapai County Drainage Design Manual.

IV. DRAINAGE FACILITY DESIGN

GENERAL CONCEPT

Existing drainage patterns of the undeveloped site sheet flow to the east towards Hwy-179.

A series of drainage swales and culverts will be used to help convey water down into the retention pond. These drainage swales will also provide homes with a means to place runoff collected from rooftops. Any stormwater that is part of sub-basin A or C will follow historical drainage patterns into the respected catch basin. The increase in run off into the catch basins from sub-basins A and C do not increase post-development more than 0.05 cfs. This increase in runoff is negligible.

As mentioned in the previous section, the retention pond is designed to accommodate the increase in runoff from the added roadway. This pond will be located on the east side of the property and span across the majority length of the property line.

Water quality concerns can arise when impervious area is added to previously undeveloped sites. Runoff from impervious areas often contains suspended solids and heavy metals along with other contaminants. Storm water quality will be addressed by implementing a first flush policy. First flush is defined by the county as, the delivery of a disproportionately large load of pollutants during short storms or the early part of storms due to the rapid runoff of accumulated pollutants. The county's policy is that subdivisions shall retain and/or treat the first 0.5" of runoff from developed areas. Below is the calculated volume of water that must be retained for first flush. The pond that has been designed will retain the first flush volume.

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V_{FF} = C (P_{FF} / 12)A	
C = Runoff Coefficent (Set = 1)	1
P_{FF} = 0.5 Inches of Direct Runoff	0.5
A = Area of Project Site (Impervious Area), in Acres	0.37
V_{FF} = First Flush Volume, in Ac-Ft	0.01542
V_{FF} = First Flush Volume, in Cubic Feet	**671.55**

SPECIFIC DETAILS

There are no drainage problems encountered that require any unique solutions. To accommodate the necessary storm the pond must retain the runoff from added impervious area. **To provide the necessary stormwater management the retention pond must be able to store a minimum of 4066 cubic feet.**

Retention Volume Calculations (Basin A)		
$V = C\left(\frac{P}{12}\right) A$		
C_{comp} =	0.95	
P =	2.66	Inches
A =	0.08	Acres
V =	0.017	Acre-feet
V =	**734**	**Cubic Feet**

Retention Volume Calculations (Basin B)		
$V = C\left(\frac{P}{12}\right) A$		
C_{comp} =	0.95	
P =	2.66	Inches
A =	0.29	Acres
V =	0.061	Acre-feet
V =	**2660**	**Cubic Feet**

Drainage swales along the interior property lines will be used to help convey stormwater to the pond. An additional swale on the west side of the subdivision road will be utilized to connect those swales and move water towards West Chapel Road. Refer to **Appendix B** for the exact locations. The swales have been sized to accommodate the peak discharge of 13.54 cfs for the 100-yr storm.

These swales shall be constructed with rip rap embankments. From the National Engineering Handbook, the U.S. Bureau of Reclamation method was used to size the riprap. The formula for the U.S. Geological Survey method $D_{50} = 0.01V^{2.44}$. Hydraflow

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Express was used to analyze whether the swale could handle the 100-yr storm event. The Hydraflow report can be found in **Appendix D**. Below is how the swales should be constructed:

- Bottom Width = 0 ft
- Side Slope = 2:1
- Total Depth = 2.50 ft
- Slope = 2.5% Min
- D_{50} Stone Size = 6 in

Upon construction, culverts will be needed underneath all driveways to continue positive drainage on site. Analysis has been completed using the peak discharge of 16.33 cfs that these structures will encounter. The results show that a 15-inch culvert will adequately handle the peak discharge. The City of Sedona prefers a 14-gauge corrugated metal pipe with a minimum length of 20 ft and maximum length of 30 ft. One foot of clear cover will be provided for the culverts. Results can be found in **Appendix E**.

- Culvert Span = 15.0 in
- Slope = 1.5% Minimum
- Culvert Type = Corrugated Metal Pipe
- Culvert Entrance = Mitered to Slope
- Length = 20 ft Minimum, 30 ft Maximum

DRAIN TIME

Per section 3.2 of the Sedona Design Review, Engineering, and Administration Manual all stormwater storage facilities shall be designed so that the stored runoff is emptied completely from the facility within 12 hours after the runoff event has ended. The soil in the area is a sandy loam from the USDA Web Soil Survey, and the lowest percolation rate has been estimated to be 4 inches/hour.

Using equations 15.3 and 15.4 in the Yavapai County Drainage Design Manual, the retention basin drain time can be calculated. A design factor of 2 was selected assuming that no groundwater or impermeable layer is encountered within 10-feet below the bottom of the basin. A minimum 6’ wide and 348’ long basin bottom has been specified for calculations. This results in a retention basin drain time of 12 hours as shown below. **It is required by the City of Sedona that any pond with a basin less than 10 Acres must drain in less than 12 hours, therefore it is essential that the pond meets the minimum requirements below.**

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$P_d = \frac{P}{D_r}$		
where:		
P_d =	Design percolation rate, in inches/hour, and	2
P =	Lowest measured percolation rate, in inches/hour, and	4
D_r =	Design factor from Table 15.3	2

$T_d = \frac{V}{A_p \frac{P_d}{12}}$		
T_d =	Retention basin drain time in hours,	12
A_p =	Percolation area (basin bottom), in acres,	0.047
P_d =	Design percolation rate, in inches/hour, and	2
V =	Retention basin design storage volume, in acre-feet	0.094

CONCLUSIONS

It is the engineer's opinion that the site can be constructed as described in the report and shown in the construction plans. The plan will satisfy the conditions for design while maintaining cost effective, low maintenance facilities. The facilities will retain the additional runoff from added impervious area. The project complies with the City of Sedona criteria and regulations as well as the Coconino County criteria and regulations.

V. REFERENCES:

Coconino County (August 2020), Coconino County Drainage Design Criteria Manual

*The City of Sedona (*January 26, 2021), Sedona Land Development Code

National Engineering Handbook (August 2007), Technical Supplement 14C, Stone Sizing Criteria

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APPENDIX A

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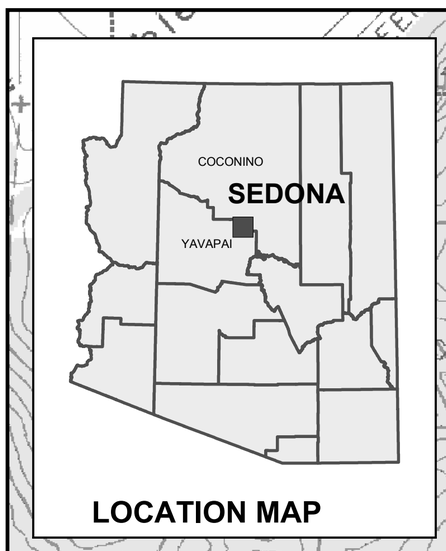
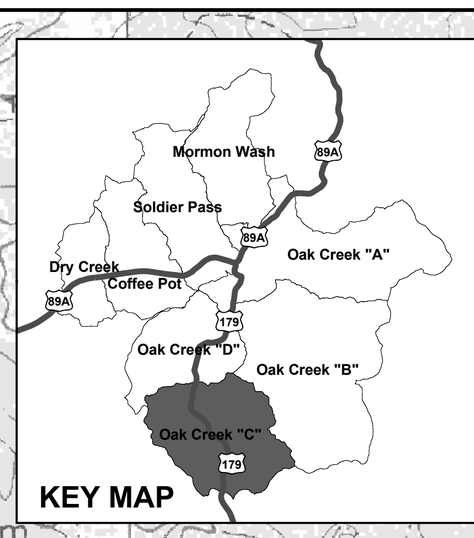


LOCATION MAP



KEY MAP

PROJECT SITE

K1B K1C K2B K2C K3B K4B K4C K5B K5C K6B K6C K7B K8B K8C K9B K9C K10B K10C K11B K11C K12B K12C K13B K13C K14B K15B K15C K17B K17C K18B K18C K19B K19C K20B K20C K21B K21C K22B K22C K23B K23C K24B K24C K25B K25C K26B K26C K27B

N
W E
S

1 inch equals 700 feet

LEGEND:

- Flow Concentration Points
- Flow Paths
- State Highways
- City Boundary
- Subbasins

PREPARED FOR:

CITY OF SEDONA

OAK CREEK BASIN "C" DRAINAGE MAP
EXHIBIT NO. 7

MAP SCALE: 0 0.050.1 0.2 0.3 0.4 0.5 Miles

CITY OF SEDONA STORM WATER MASTER PLAN

PREPARED BY:

DIBBLE & ASSOCIATES
CONSULTING ENGINEERS
Since 1962

DATE: SEPTEMBER 22, 2004

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APPENDIX B

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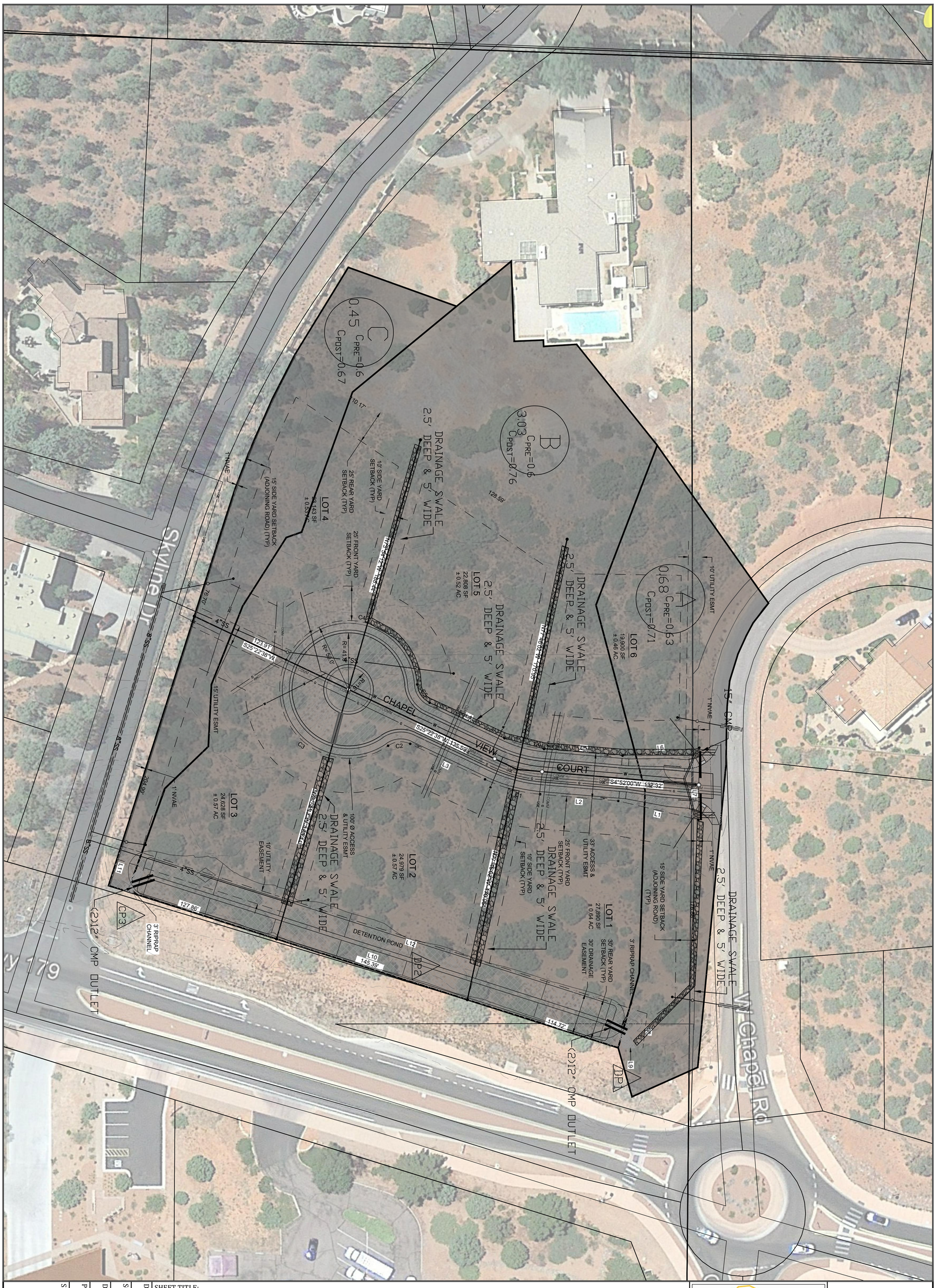

SHEET NO.
C-EX

PROJECT NO: 210305

DATE: 08-06-2021

SCALE: 1" = 30'

DRAWN BY: CDH

SHEET TITLE: DRAINAGE SUB-BASIN EXHIBIT

PROJECT TITLE:

CHAPEL VIEW TERRACE SUBDIVISION

APN: 404-01-018D

Sefton Engineering Consultants
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PRELIMINARY

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Hydraflow Rainfall Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 — Friday, 07 / 30 / 2021

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	-------
2	29.2252	8.8000	0.8306	-------
3	0.0000	0.0000	0.0000	-------
5	0.0000	0.0000	0.0000	-------
10	53.0189	9.5000	0.8535	-------
25	42.1143	4.0000	0.7607	-------
50	0.0000	0.0000	0.0000	-------
100	86.2044	9.2000	0.8452	-------

File name: Rainfall Intensity 2, 10, 25, 100 YR.IDF

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	3.30	2.56	2.10	1.79	1.57	1.40	1.27	1.16	1.07	0.99	0.93	0.87
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	5.41	4.20	3.46	2.95	2.58	2.30	2.08	1.90	1.75	1.62	1.51	1.42
25	7.92	5.66	4.48	3.75	3.25	2.88	2.59	2.37	2.18	2.03	1.89	1.78
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100	9.15	7.09	5.83	4.98	4.35	3.88	3.51	3.20	2.95	2.74	2.56	2.40

Tc = time in minutes. Values may exceed 60.

le name: Y:\210305 Rife - Skyline Dr. Subdivision\Documents\Hydrology\Precipitation Depth 2, 10, 25, 100 YR.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	0.00	2.04	0.00	3.30	2.94	3.50	6.80	4.39
SCS 6-Hr	0.00	1.28	0.00	0.00	1.86	2.26	0.00	2.92
Huff-1st	0.00	0.00	0.00	2.75	0.00	0.00	6.50	0.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	0.00	0.00	2.80	0.00	0.00	6.00	0.00

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Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Nov 16 2021

Drainage Swales

Triangular

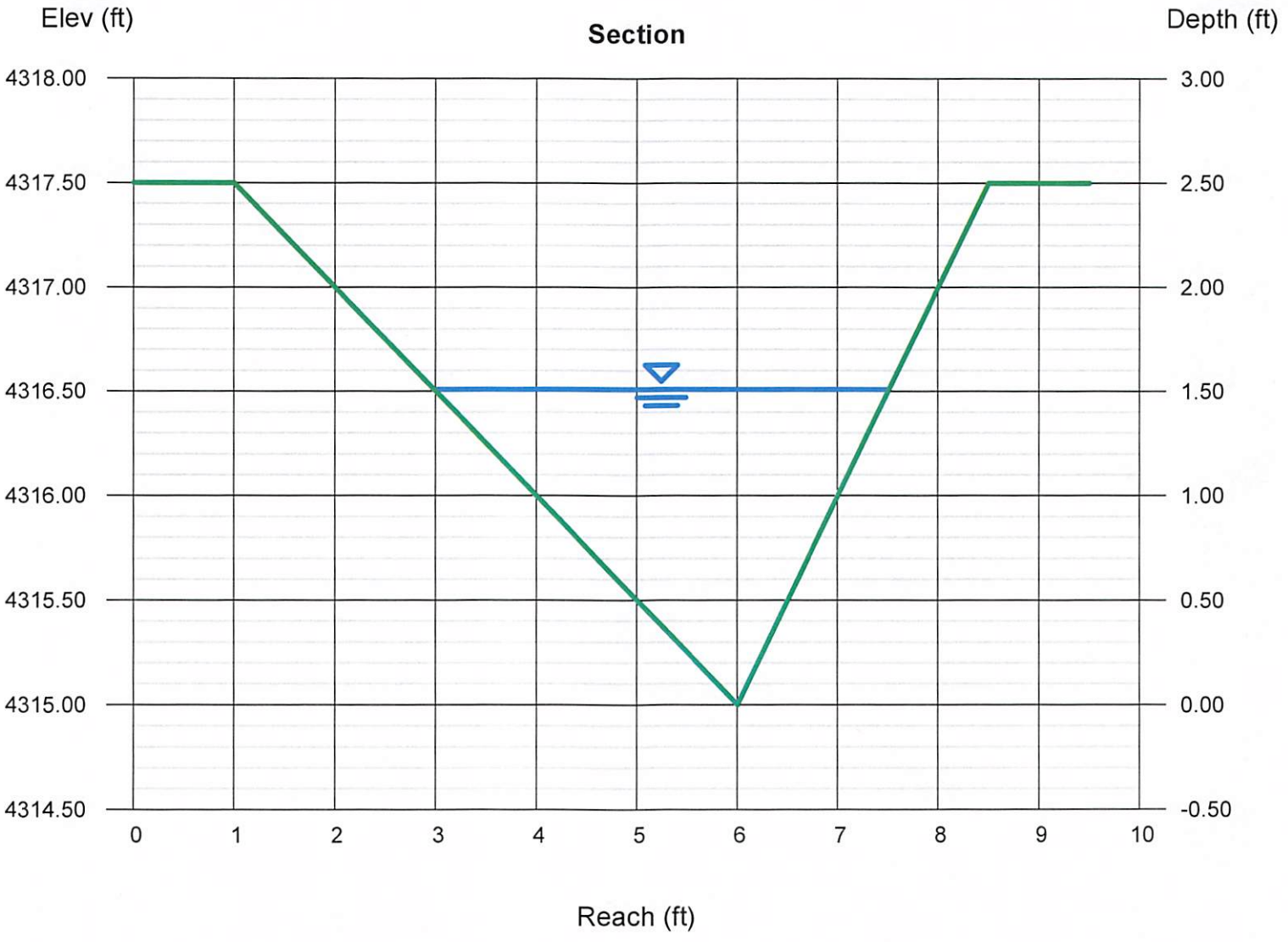
Side Slopes (z:1)	= 2.00, 1.00
Total Depth (ft)	= 2.50
Invert Elev (ft)	= 4315.00
Slope (%)	= 1.50
N-Value	= 0.033

Calculations

Compute by:	Known Q
Known Q (cfs)	= 13.54

Highlighted

Depth (ft)	= 1.51
Q (cfs)	= 13.54
Area (sqft)	= 3.42
Velocity (ft/s)	= 3.96
Wetted Perim (ft)	= 5.51
Crit Depth, Yc (ft)	= 1.39
Top Width (ft)	= 4.53
EGL (ft)	= 1.75



Luke Sefton, PE, CFM
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Christopher Henry, E.I.T.
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APPENDIX E

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In affiliation with:
Heritage Land Surveying & Mapping, Inc. with offices in Sedona, Camp Verde & Colorado

Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Nov 16 2021

Circular Culvert

Invert Elev Dn (ft)	= 0.01
Pipe Length (ft)	= 20.00
Slope (%)	= 1.50
Invert Elev Up (ft)	= 0.31
Rise (in)	= 15.0
Shape	= Circular
Span (in)	= 15.0
No. Barrels	= 1
n-Value	= 0.012
Culvert Type	= Circular Corrugate Metal Pipe
Culvert Entrance	= Mitered to slope (C)
Coeff. K,M,c,Y,k	= 0.021, 1.33, 0.0463, 0.75, 0.7

Embankment

Top Elevation (ft)	= 2.50
Top Width (ft)	= 15.00
Crest Width (ft)	= 15.00

Calculations

Qmin (cfs)	= 0.00
Qmax (cfs)	= 13.54
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 2.00
Qpipe (cfs)	= 2.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 2.10
Veloc Up (ft/s)	= 3.70
HGL Dn (ft)	= 0.92
HGL Up (ft)	= 0.88
Hw Elev (ft)	= 1.15
Hw/D (ft)	= 0.67
Flow Regime	= Inlet Control