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Project:	**JHA**
Address:	**W SAN MARTIN AVENUE, SAN MARTIN**
APN:	**779-47-007**
County File No.:	
Calculated By:	**PT**
Date:	**5/3/2022**

HYDROLOGY AND HYDRAULIC CALCULATIONS FOR LANDS OF JHA

REFERENCES:

1. County of Santa Clara Drainage Manual (SCDM) 2007, Adopted August 14, 2007
2. County Santa Clara requirements:
   - 2.1. Provide the pre-developed time of concentration, intensity, and peak runoff rate.
   - 2.2. Provide the post-developed time of concentration, intensity, and peak runoff rate. (the 100-year storm return to post-developed flow)
   - 2.3. ASCE for calculation the volume required for detention.
   - 2.4. Size detention pond that allows the release of the a 10 year storm and 100 year overflow.

CALCULATIONS DETENTION

1. From Figure A-2 : Mean Annual Precipitation Map Santa Clara County

Mean Annual Precipitation (M.A.P) = 23 in/hr

2. Existing conditons

A	= Drainage Basin area	=	1.77 ac	
A1	= Developed area	=	0.00 ac	
A2	= Undeveloped area (landscape)	=	1.77 ac	
$C1 = C_{developed}$	= Coefficient of developed	=	0.85	**Paved / Impervious Surface**
$C2 = C_{undeveloped}$	= Coefficicient undeveloped	=	0.35	**Urban Open Space**

$$C_{existing} = C_{average} = \frac{[(A1xC1) + (A2xC2)]}{(A1+A2)} = 0.35$$

3. Future conditons

A	= Drainage Basin Area	=	1.77 ac	
A1	= Developed area	=	0.81 ac	
A2	= Undeveloped area (landscape)	=	0.96 ac	
$C1 = C_{developed}$	= Coefficient of developed	=	0.85	**Paved / Impervious Surface**
$C2 = C_{undeveloped}$	= Coefficicient undeveloped	=	0.35	**Urban Open Space**

$$C_{future} = C_{average} = \frac{[(A1xC1) + (A2xC2)]}{(A1+A2)} = 0.58$$

A. EXISTING CONDITIONS

Time of concentration:

$$T_c = 0.0078 \left(\frac{L^2}{S}\right)^{0.385} + 10 \quad \text{(minutes)}$$

Where:

L	= Maximum length of travel, in feet.		=	358.00 ft
H	= Difference in elevation along the effective slope line, in feet.		=	103.00 ft
		High elevation	=	101.50 ft
		Low elevation	=	-1.50 ft
S	= Slope in feet per feet.	S = H / L	=	0.288 ft/ft
Tc	= Time of concentration, in minutes.			

$$T_c = 0.0078 \left(\frac{358^2}{0.29}\right)^{0.385} + 10 = 11.17 \text{ minutes} = \mathbf{0.19\ hr}$$

Find rainfall depth X_{TD} (and intensity) for the 10-year storm **at 23 M.A.P**

From Table B-1 for the 10-year return period.

T_c = **11.17 minutes** ==> A_{TD} = 0.267135

B_{TD} = 0.003836

Depth $X_{TD} = A_{TD} + (B_{TD}) \times (M.A.P)$

$= 0.267135 + 0.003836 \times 23.0 =$ **0.3554 in**

Rainfall intensity:

$$I = \frac{X_{TD}}{Tc} = \frac{0.3554 \text{ in}}{0.19 \text{ hr}} = 1.87 \text{ in/hr}$$

Peak rate of runoff:

$Q_{\text{Existing Peak}}$ = C x I x A = **1.16 cfs**

Where: C = Coefficicient existing = 0.35
I = the rainfall intensity = 1.87 in/hr
A = Drainage basin area = 1.77 ac

B. FUTURE CONDITIONS

Time of concentration: 5 minutes

Find rainfall depth X_{TD} (and intensity) for the 100-year storm **at 23 M.A.P**

From Table B-2 for the 100-year return period.

T_c = 5 minutes ==> A_{TD} = 0.269993
(0.0833 hr) B_{TD} = 0.003580

Depth X_{TD} = A_{TD} + (B_{TD}) x (M.A.P)
= 0.269993 + 0.003580 x 23.0 = **0.352333 in**

Rainfall intensity:

$$I = \frac{X_{TD}}{Tc} = \frac{0.3523 \text{ in}}{0.083 \text{ hr}} = 4.23 \text{ in/hr}$$

Peak rate of runoff:

$Q_{\text{future peak}}$ = C x I x A = **4.35 cfs**

Where: C = Coefficicient future = 0.58
I = the rainfall intensity = 4.23 in/hr
A = Drainage basin area = 1.77 ac

C. MAXIMUN DRAINAGE STORAGE REQUIRED.

ASCE Method (Constant Outflow)

Depth X_{TD} = A_{TD} + (B_{TD}) x (M.A.P)

Volume In = A (ac) x (C+0.15) x (Depth/12) x 43,560 (ft^2/ac) (add 0.15 to C develop)

for 10-year storm

T	10-Yr Depth (in)	Volume In (cf)	Volume Out (cf)	Storage (cf)	MAX STORAGE (cf)
5-min	0.2493	1,172	348	824	
10-min	0.3408	1,602	696	906	**906**
15-min	0.4031	1,895	1,044	851	
30-min	0.5491	2,581	2,088	493	
1-hr	0.7682	3,612	4,176	-564	
2-hr	1.1541	5,426	8,352	-2,926	
3-hr	1.4874	6,993	12,528	-5,535	
6-hr	2.2515	10,585	25,056	-14,471	
12-hr	3.2098	15,090	50,112	-35,022	

for 100-year storm

T	100-Yr Depth (in)	Volume In (cf)	Volume Out (cf)	Storage (cf)	MAX STORAGE (cf)
5-min	0.3523	1,656	348	1,308	
10-min	0.4834	2,273	696	1,577	
15-min	0.5814	2,733	1,044	1,689	**1,689**
30-min	0.7806	3,670	2,088	1,582	
1-hr	1.0682	5,022	4,176	846	
2-hr	1.5654	7,359	8,352	-993	
3-hr	2.0120	9,459	12,528	-3,069	
6-hr	3.1009	14,578	25,056	-10,478	
12-hr	4.5521	21,401	50,112	-28,711	

$V_{\text{max stogare required}}$ = **1,689 cf**

D. PEAK FLOW COMPARISON

Pre-development	**Q** $_{Existing\ peak}$	=	**1.16 cfs**
Post-develpoment	**Q** $_{future\ peak}$	=	**4.35 cfs**

E. RETENTION VOLUME

BIORETENTION 1

1.1. Storage in Biorentention area

Shape	=	Rectangular			
With	=	8	ft		
Depth	=	0.5	ft		
Length	=	77	ft		
V $_{1.1.}$	**=**	**308**	**cf**		

1.2. Storage in gravel with 40% void space

Shape	=	Rectangular			
With	=	8	ft		
Depth	=	1.5	ft		
Length	=	77	ft		
V $_{1.2.}$		**369.6**	**cf**		

1.3. Storage in 4" perforated pipe

Shape	=	Circular			
Pipe radius	=	6	=	0.5	ft
Pipe length	=	75	ft		
V $_{1.3.}$	**=**	**58.9**	**cf**		

BIORETENTION 2

2.1. Storage in Biorentention area

Shape	=	Rectangular			
With	=	6	ft		
Depth	=	0.5	ft		
Length	=	38	ft		
V $_{1.1.}$	**=**	**114**	**cf**		

2.2. Storage in gravel with 40% void space

Shape	=	Rectangular			
With	=	6	ft		
Depth	=	1.5	ft		
Length	=	38	ft		
V $_{1.2.}$		**136.8**	**cf**		

2.3. Storage in 4" perforated pipe

Shape	=	Circular			
Pipe radius	=	6	=	0.5	ft
Pipe length	=	36	ft		
V $_{1.3.}$	**=**	**28.3**	**cf**		

BIORETENTION 3

3.1. Storage in Biorentention area

Shape	=	Rectangular			
With	=	8	ft		
Depth	=	0.5	ft		
Length	=	74	ft		
V $_{3.1.}$	**=**	**296**	**cf**		

3.2. Storage in gravel with 40% void space

Shape	=	Rectangular			
With	=	8	ft		
Depth	=	1.5	ft		
Length	=	74	ft		
V $_{3.2.}$		**355.2**	**cf**		

3.3. Storage in 4" perforated pipe

Shape	=	Circular			
Pipe radius	=	6	=	0.5	ft
Pipe length	=	72	ft		
V $_{3.3.}$	**=**	**56.5**	**cf**		

Total volume storage = ΣV_i = 1,723.3 cf **> 1,689 cf = V** $_{max\ stogare\ required}$

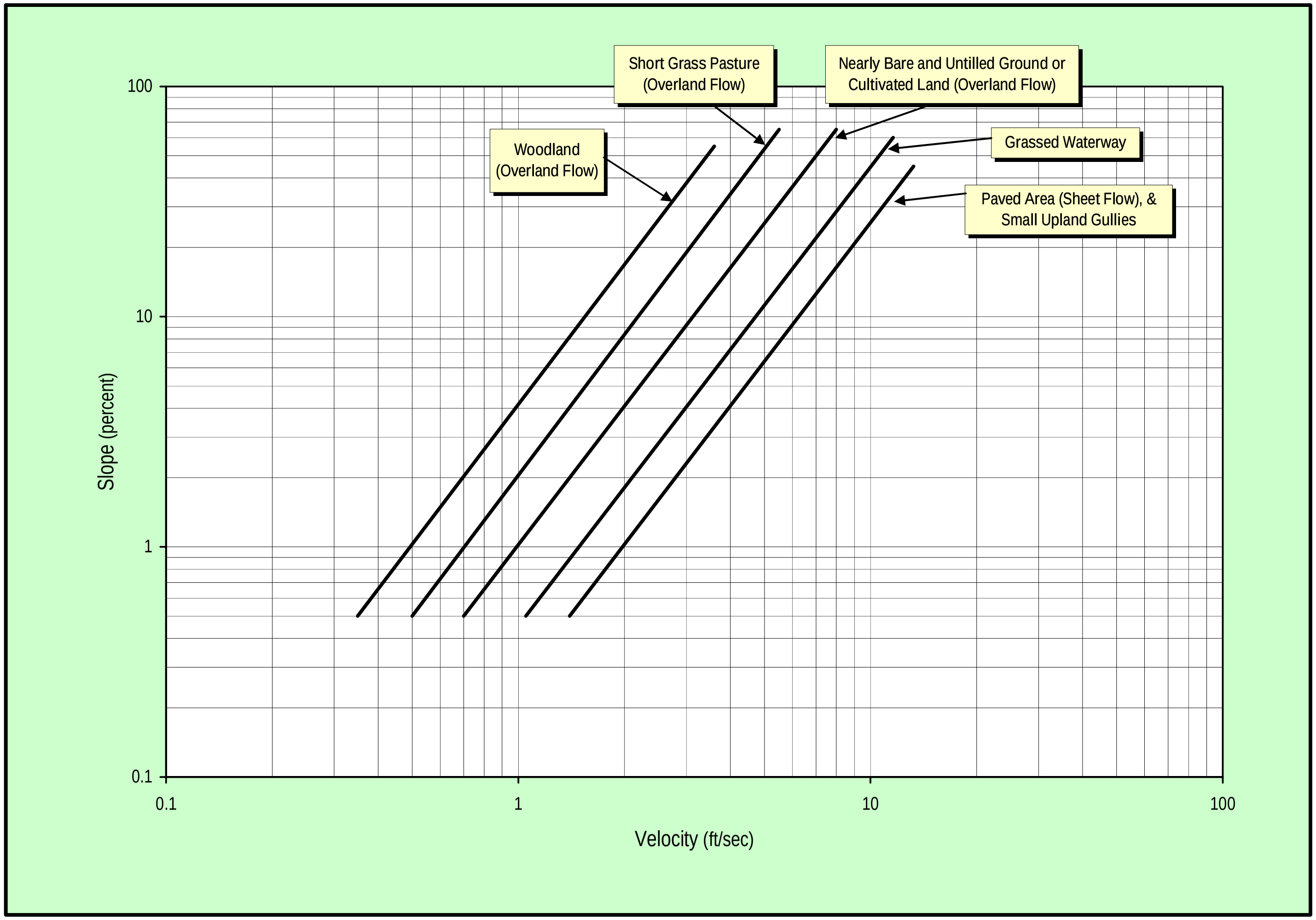

Figure A-1: Overland Flow Velocity

Table B-1: Parameters $A_{T,D}$ and $B_{T,D}$ for TDS Equation

2-YR RETURN PERIOD		
5-min	0.120194	0.001385
10-min	0.166507	0.001956
15-min	0.176618	0.003181
30-min	0.212497	0.005950
1-hr	0.253885	0.010792
2-hr	0.330848	0.019418
3-hr	0.374053	0.027327
6-hr	0.425178	0.045735
12-hr	0.409397	0.069267
24-hr	0.314185	0.096343
48-hr	0.444080	0.134537
72-hr	0.447104	0.159461
5-YR RETURN PERIOD		
5-min	0.170347	0.001857
10-min	0.228482	0.002758
15-min	0.250029	0.004036
30-min	0.307588	0.007082
1-hr	0.357109	0.013400
2-hr	0.451840	0.024242
3-hr	0.512583	0.034359
6-hr	0.554937	0.060859
12-hr	0.562227	0.094871
24-hr	0.474528	0.136056
48-hr	0.692427	0.187173
72-hr	0.673277	0.224003
10-YR RETURN PERIOD		
5-min	0.201876	0.002063
10-min	0.258682	0.003569
15-min	0.294808	0.004710
30-min	0.367861	0.007879
1-hr	0.427723	0.014802
2-hr	0.522608	0.027457
3-hr	0.591660	0.038944
6-hr	0.625054	0.070715
12-hr	0.641638	0.111660
24-hr	0.567017	0.162550
48-hr	0.832445	0.221820
72-hr	0.810509	0.265469

Table B-2: Parameters $A_{T,D}$ and $B_{T,D}$ for TDS Equation

Return Period/Duration	$A_{T,D}$	$B_{T,D}$
25-YR RETURN PERIOD		
5-min	0.230641	0.002691
10-min	0.287566	0.004930
15-min	0.348021	0.005594
30-min	0.443761	0.008719
1-hr	0.508791	0.016680
2-hr	0.612629	0.031025
3-hr	0.689252	0.044264
6-hr	0.693566	0.083195
12-hr	0.725892	0.132326
24-hr	0.675008	0.195496
48-hr	0.989588	0.264703
72-hr	0.967854	0.316424
50-YR RETURN PERIOD		
5-min	0.249324	0.003241
10-min	0.300971	0.006161
15-min	0.384016	0.006315
30-min	0.496301	0.009417
1-hr	0.568345	0.017953
2-hr	0.672662	0.033694
3-hr	0.754661	0.048157
6-hr	0.740666	0.092105
12-hr	0.779967	0.147303
24-hr	0.747121	0.219673
48-hr	1.108358	0.295510
72-hr	1.075643	0.353143
100-YR RETURN PERIOD		
5-min	0.269993	0.003580
10-min	0.315263	0.007312
15-min	0.421360	0.006957
30-min	0.553934	0.009857
1-hr	0.626608	0.019201
2-hr	0.732944	0.036193
3-hr	0.816471	0.051981
6-hr	0.776677	0.101053
12-hr	0.821859	0.162184
24-hr	0.814046	0.243391
48-hr	1.210895	0.325943
72-hr	1.175000	0.389038

In Table 3-1 Soil Types B, C and D are based on the SCS classification of HSG. This designation is a standard designation used by the SCS and has been defined for Santa Clara County in existing SCS publications. D-type soils are less permeable than are C-type soils, which are, in turn, less permeable than B-type soils.

Table 3-1: Runoff Coefficients for Rational Formula

Land Use	C for Soil Type		
	B	C	D
Low Density Residential	0.30	0.40	0.45
Medium Density Residential	0.50	0.55	0.60
High Density Residential	0.70	0.70	0.75
Commercial	0.80	0.80	0.80
Industrial	0.70	0.75	0.75
Parks	0.20	0.30	0.35
Agricultural	0.15	0.35	0.40
Urban Open Space	0.10	0.35	0.45
Shrub Land	0.10	0.20	0.30
Paved / Impervious Surface	0.85	0.85	0.85

The Rational Method implies that this ratio is fixed for a given drainage basin. Studies have shown, however, that the coefficient may vary with respect to prior wetting and seasonal conditions (antecedent moisture). It has also been observed that as rainfall intensity increases, soil permeability decreases. One may sense that runoff coefficients should increase with rainfall intensity.

Applying such non-linearities over relatively small urbanized drainage basins does not necessarily improve hydrologic precision enough to offset the more difficult computations, so using a constant runoff coefficient is standard in Santa Clara County. For watersheds with significant variation in antecedent moisture conditions, soil types, or other complexities, however; the hydrograph method described in Chapter 4 should be employed regardless of basin size.