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ENGINEERING GROUP

**Hydrology Calculations
Harvey's Market
9975 State Highway 99Wt
Proberta, California
BEG Project #18.379**

October 15, 2020

PROJECT SUMMARY

Hydrology calculations for the above referenced project site based on the NOAA Atlas 14, Volume 6, Version 2 Point Precipitation Frequency Estimates for the project site and Tehama County Phase II MS4 stormwater requirements.

DESIGN CRITERIA

California Building Code	2019 Edition
Site Elevation	253 ft
Project Site	73,180 sq. ft. / 1.68 ac
Developed Site	45,869 sq. ft. / 1.053 ac
Unimproved Area	27,311 sq. ft. / 0.627 ac
Buildings	7,320 sq. ft. / 0.168 ac
Site Paving/Concrete	27,994 sq. ft. / 0.643 ac
Landscaping.....	15,245 sq. ft. / 0.350 ac
Drainage Management Area (DMA)	3,047 sq. ft

Volume

Maximum Stormwater Storage Capacity.....	3,047 cu. ft
Stormwater Capacity Required per Rainfall Data Q100.....	989 cu. ft
Stormwater Capacity Required per MS4 DMA Vegetated Infiltration Basin	2,290 sq. ft.

CALCULATION INDEX

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HYDROLOGY CALCULATIONS.....	H1 – H
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CIVIL

STRUCTURAL

SURVEYING

Minor Hydraulic Structures
Rational Method

Q = CIA

C = Runoff Coefficient
Q = Peak Discharge
I = Rainfall Intensity
A = Drainage Area

C	=	0.20	Unimproved Areas
C	=	0.80	Industrial Areas
C	=	0.90	Paving/Driveways/Walkways
C	=	0.10	Landscape Areas

Total Project Site = 73,180 sf = 1.680 ac

Pre	Developed Site	=	9,468 sf	=	0.217 ac
	Unimproved Area	=	63,712 sf	=	1.463 ac
	Buildings	=	4,070 sf	=	0.093 ac
	Paving	=	4,805 sf	=	0.110 ac
	Landscape	=	593 sf	=	0.014 ac

			Pre	Proposed	Post	
Post	Developed Site	=	9,468	36,401	45,869	= 1.053 ac
	Unimproved Area	=			27,311	= 0.627 ac
	Buildings	=	4,070	3,250	7,320	= 0.168 ac
	Paving	=	4,805	23,189	27,994	= 0.643 ac
	Landscape	=	593	14,652	15,245	= 0.350 ac

Pre-Development ~ Weighted Average

C	=	0.20	1.463	=	0.293
	=	0.80	0.093	=	0.075
	=	0.90	0.110	=	0.099
	=	0.10	0.014	=	0.001
Sum	=		1.680		0.468
C	=	$\frac{0.47}{1.68}$		=	0.279

Post-Development ~ Weighted Average

C	=	0.20	0.627	=	0.125
	=	0.80	0.168	=	0.134
	=	0.90	0.643	=	0.578
	=	0.10	0.350	=	0.035
Sum	=		1.788		0.873
C	=	$\frac{0.87}{1.79}$		=	0.488

Design Criteria for Rainfall Intensity

Tc = 10 minutes

Elev = 253.43 feet

Per NOAA Atlas 14, Volume 6, Version 2, Point Precipitation Frequency Estimate

I2 = 2yr/24 Hour Event = 1.530 in/hr

I10	=	10yr/24 Hour Event	=	2.300 in/hr
I25	=	25yr/24 Hour Event	=	2.810 in/hr
I100	=	100yr/24 Hour Event	=	3.670 in/hr

Pre-Development Peak Discharge

Q2	=	0.28	1.530	1.680	=	0.716 cfs
Q10	=	0.28	2.300	1.680	=	1.076 cfs
Q25	=	0.28	2.810	1.680	=	1.315 cfs
Q100	=	0.28	3.670	1.680	=	1.717 cfs

Post-Development Peak Discharge

Q2	=	0.488	1.530	1.680	=	1.256 cfs
Q10	=	0.488	2.300	1.680	=	1.887 cfs
Q25	=	0.488	2.810	1.680	=	2.306 cfs
Q100	=	0.488	3.670	1.680	=	3.012 cfs

Reduce post development runoff to pre-development runoff levels

$$(Q_{in} - Q_{all})(3)(T_c)(0.5)(60s/min)(K)$$

$$K = 1.20$$

Q_{in} = Peak Basin Flow
 Q_{all} = Allowable Peak Flow
 T_c = Time of Concentration
 K = Factor

Q2 post versus Q2 pre	=	583 cf of storage
Q10 post versus Q10 pre	=	876 cf of storage
Q25 post versus Q25 pre	=	1,070 cf of storage
Q100 post versus Q100 pre	=	1,398 cf of storage

Calculated Stormwater Storage at various Q

	Elevation	Depth	Area	Volume	Cum Vol
	0.0	0.00	2,538.93		0.00
	0.1	0.10	2,723.56		263.12
Q2	0.2	0.20	2,909.59		544.78
Q10	0.3	0.30	3,097.00		845.11
Q25	0.4	0.40	3,285.81		1,164.25
Q100	0.5	0.50	3,476.01		1,502.34
	0.6	0.60	3,667.60		1,859.52
	0.7	0.70	3,860.59		2,235.93
	0.8	0.80	4,054.96		2,631.71
	0.9	0.90	4,250.73		3,046.99

	Req'd Storage	Weir Flow, cfs
Q2	583	0.21
Q10	876	0.39
Q25	1,070	0.61
Q100	1,398	0.85

Weir Equation: $Q = CLH^{3/2}$

C =	3.2	Discharge Coefficient
L =	0.75	width of weir



NOAA Atlas 14, Volume 6, Version 2
Location name: Proberta, California, USA*
Latitude: 40.0824°, Longitude: -122.1727°
Elevation: 253.43 ft**
 * source: ESRI Maps
 ** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

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PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	1.72 (1.49-2.00)	2.14 (1.84-2.50)	2.71 (2.33-3.18)	3.20 (2.74-3.80)	3.92 (3.20-4.84)	4.50 (3.59-5.70)	5.12 (3.97-6.68)	5.80 (4.34-7.82)	6.77 (4.82-9.59)	7.56 (5.17-11.2)
10-min	1.23 (1.06-1.43)	1.53 (1.32-1.79)	1.94 (1.67-2.28)	2.30 (1.96-2.72)	2.81 (2.30-3.47)	3.23 (2.57-4.09)	3.67 (2.84-4.79)	4.15 (3.11-5.60)	4.85 (3.46-6.87)	5.42 (3.71-8.00)
15-min	0.992 (0.856-1.16)	1.23 (1.06-1.44)	1.57 (1.35-1.84)	1.85 (1.58-2.20)	2.26 (1.85-2.80)	2.60 (2.08-3.30)	2.96 (2.29-3.86)	3.35 (2.51-4.52)	3.91 (2.78-5.54)	4.37 (2.99-6.45)
30-min	0.674 (0.582-0.788)	0.838 (0.724-0.980)	1.07 (0.918-1.25)	1.26 (1.07-1.49)	1.54 (1.26-1.90)	1.77 (1.41-2.24)	2.01 (1.56-2.63)	2.28 (1.71-3.07)	2.66 (1.89-3.77)	2.97 (2.03-4.39)
60-min	0.471 (0.407-0.550)	0.585 (0.505-0.685)	0.744 (0.641-0.873)	0.880 (0.750-1.04)	1.08 (0.881-1.33)	1.24 (0.986-1.57)	1.41 (1.09-1.84)	1.59 (1.19-2.15)	1.86 (1.32-2.63)	2.08 (1.42-3.07)
2-hr	0.327 (0.282-0.382)	0.395 (0.341-0.462)	0.488 (0.420-0.572)	0.566 (0.482-0.671)	0.677 (0.554-0.836)	0.766 (0.611-0.970)	0.860 (0.666-1.12)	0.960 (0.718-1.29)	1.10 (0.784-1.56)	1.22 (0.832-1.80)
3-hr	0.260 (0.225-0.304)	0.311 (0.269-0.364)	0.380 (0.327-0.446)	0.438 (0.373-0.519)	0.519 (0.425-0.641)	0.584 (0.466-0.740)	0.652 (0.505-0.850)	0.724 (0.542-0.976)	0.825 (0.588-1.17)	0.906 (0.620-1.34)
6-hr	0.178 (0.154-0.207)	0.210 (0.182-0.246)	0.254 (0.219-0.298)	0.291 (0.248-0.345)	0.341 (0.279-0.422)	0.381 (0.304-0.483)	0.423 (0.327-0.552)	0.466 (0.349-0.629)	0.527 (0.376-0.747)	0.575 (0.393-0.850)
12-hr	0.119 (0.103-0.139)	0.142 (0.123-0.166)	0.173 (0.149-0.203)	0.198 (0.169-0.235)	0.233 (0.191-0.288)	0.261 (0.208-0.331)	0.289 (0.224-0.378)	0.319 (0.239-0.431)	0.360 (0.257-0.511)	0.393 (0.269-0.580)
24-hr	0.082 (0.072-0.095)	0.100 (0.087-0.116)	0.123 (0.108-0.143)	0.142 (0.123-0.167)	0.168 (0.142-0.204)	0.189 (0.156-0.233)	0.210 (0.170-0.265)	0.232 (0.183-0.300)	0.263 (0.200-0.353)	0.287 (0.211-0.397)
2-day	0.053 (0.046-0.061)	0.064 (0.057-0.075)	0.080 (0.070-0.093)	0.093 (0.081-0.109)	0.111 (0.094-0.134)	0.125 (0.104-0.154)	0.139 (0.113-0.176)	0.154 (0.122-0.200)	0.175 (0.133-0.235)	0.191 (0.141-0.265)
3-day	0.040 (0.035-0.046)	0.049 (0.043-0.057)	0.062 (0.054-0.072)	0.072 (0.063-0.085)	0.086 (0.073-0.104)	0.097 (0.080-0.120)	0.108 (0.088-0.136)	0.120 (0.095-0.155)	0.136 (0.103-0.182)	0.148 (0.109-0.205)
4-day	0.033 (0.029-0.038)	0.041 (0.036-0.047)	0.051 (0.045-0.059)	0.059 (0.052-0.070)	0.071 (0.060-0.086)	0.080 (0.066-0.099)	0.089 (0.072-0.112)	0.098 (0.078-0.127)	0.111 (0.085-0.149)	0.121 (0.089-0.168)
7-day	0.023 (0.020-0.026)	0.028 (0.025-0.033)	0.036 (0.031-0.042)	0.042 (0.036-0.049)	0.050 (0.042-0.060)	0.056 (0.046-0.069)	0.062 (0.050-0.078)	0.068 (0.053-0.088)	0.076 (0.058-0.102)	0.082 (0.060-0.113)
10-day	0.018 (0.016-0.021)	0.023 (0.020-0.026)	0.029 (0.025-0.033)	0.033 (0.029-0.039)	0.040 (0.033-0.048)	0.044 (0.037-0.054)	0.049 (0.039-0.061)	0.053 (0.042-0.069)	0.059 (0.045-0.080)	0.064 (0.047-0.088)
20-day	0.012 (0.010-0.014)	0.015 (0.013-0.017)	0.019 (0.017-0.022)	0.022 (0.019-0.026)	0.026 (0.022-0.032)	0.029 (0.024-0.036)	0.032 (0.026-0.040)	0.035 (0.028-0.045)	0.039 (0.029-0.052)	0.041 (0.030-0.057)
30-day	0.010 (0.008-0.011)	0.012 (0.011-0.014)	0.015 (0.013-0.018)	0.018 (0.016-0.021)	0.021 (0.018-0.025)	0.023 (0.019-0.029)	0.026 (0.021-0.032)	0.028 (0.022-0.036)	0.031 (0.023-0.041)	0.033 (0.024-0.045)
45-day	0.008 (0.007-0.009)	0.010 (0.009-0.012)	0.013 (0.011-0.015)	0.015 (0.013-0.017)	0.017 (0.014-0.021)	0.019 (0.016-0.023)	0.021 (0.017-0.026)	0.023 (0.018-0.029)	0.025 (0.019-0.033)	0.026 (0.019-0.037)
60-day	0.007 (0.006-0.008)	0.009 (0.008-0.010)	0.011 (0.010-0.013)	0.013 (0.011-0.015)	0.015 (0.012-0.018)	0.016 (0.014-0.020)	0.018 (0.014-0.023)	0.019 (0.015-0.025)	0.021 (0.016-0.028)	0.023 (0.017-0.031)

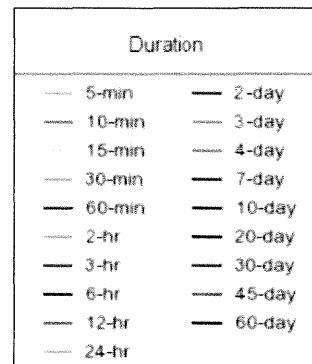
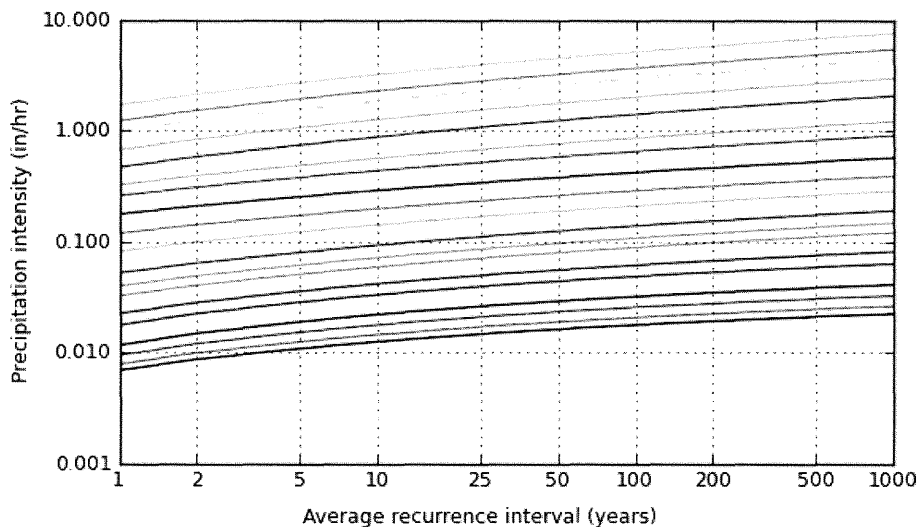
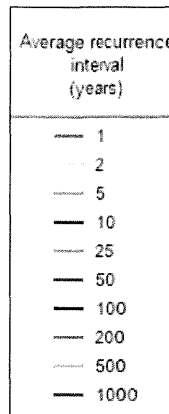
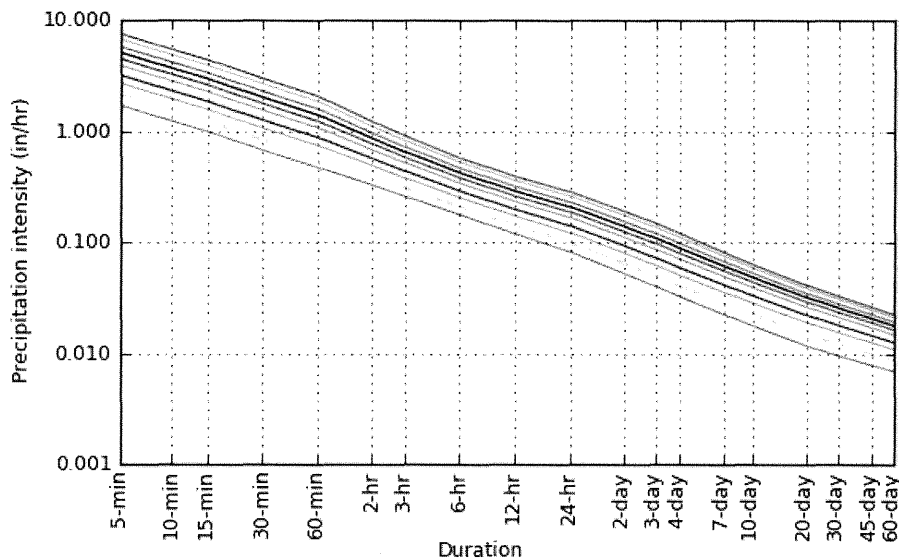
¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

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PF graphical

PDS-based intensity-duration-frequency (IDF) curves

Latitude: 40.0824°, Longitude: -122.1727°



Maps & aerials

Small scale terrain

Calculated Stage Storage Summary
Proposed Stormwater Detention Basins

Detention Basin Volumes	Elevation	Depth, ft.	Area, sf	Incremental Volume, cf	Cummulative Volume, cf	Outflow, cfs Q out
<u>Amended Drainage Swale ~ DMA</u>						
Bottom of Swale	0.00	0.00	2538.93	0.00	0.00	0.00
	0.10	0.10	2723.56	263.12	263.12	0.08
Q2 = 412 cf	0.20	0.20	2909.59	281.66	544.78	0.21
Q10 = 620 cf	0.30	0.30	3097.00	300.33	845.11	0.39
Q25 = 757 cf	0.40	0.40	3285.81	319.14	1164.25	0.61
Q100 = 989 cf	0.50	0.50	3476.01	338.09	1502.34	0.85
	0.60	0.60	3667.60	357.18	1859.52	1.12
	0.70	0.70	3860.59	376.41	2235.93	1.41
	0.80	0.80	4054.96	395.78	2631.71	1.72
	0.90	0.90	4250.73	415.28	3046.99	2.05

Swale Outflow Elevation = 0.50

18.379 DMA 1 POND 12

Project:

Basin Description: 12" DEEP POND

Contour Elevation	Contour Area (sq. ft)	Depth (ft)	Incremental Volume Avg. End (cu. ft)	Cumulative Volume Avg. End (cu. ft)	Incremental Volume Conic (cu. ft)	Cumulative Volume Conic (cu. ft)
0.40	2,538.93	N/A	N/A	0.00	N/A	0.00
0.50	2,723.56	0.10	263.12	263.12	263.07	263.07
0.60	2,909.59	0.10	281.66	544.78	281.61	544.68
0.70	3,097.00	0.10	300.33	845.11	300.28	844.96
0.80	3,285.81	0.10	319.14	1164.25	319.09	1164.05
0.90	3,476.01	0.10	338.09	1502.34	338.05	1502.10
1.00	3,667.60	0.10	357.18	1859.52	357.14	1859.24
1.10	3,860.59	0.10	376.41	2235.93	376.37	2235.61
1.20	4,054.96	0.10	395.78	2631.71	395.74	2631.34
1.30	4,250.73	0.10	415.28	3047.00	415.25	3046.59

California Phase II LID Sizing Tool - v1.2

Step 8 - Summary

Project name	18.379 DMA 1
Climate station	RED BLUFF MUNI AP
Saturated hydraulic conductivity	0.32 in/hr
Design Storm	0.68 inches

Method	LID BMP Types	Area Needed (square feet)	Area Available (square feet)	Percent Accomplished	Volume Evaporated (acre-ft/year)	Volume Infiltrated (acre-ft/year)	Volume of Passing Through the Underdrain (acre-ft/year)	Volume Untreated (acre-ft/year)
Design Storm	<u>Vegetated Infiltration Basin</u>	973	2290	235.35	-	-	-	-
Total LID BMP Area			2290	235.35	-	-	-	-
Total Impervious Area			24570	0.00	-	-	-	-
Totals			26860.00	235.35	-	-	-	-

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Instructions +

Background +

CA Phase II LID Sizing Tool Methods +

Special Notes Regarding the Tables +

California Phase II LID Sizing Tool - v1.2

California Phase II LID Sizing Tool - BMP Details

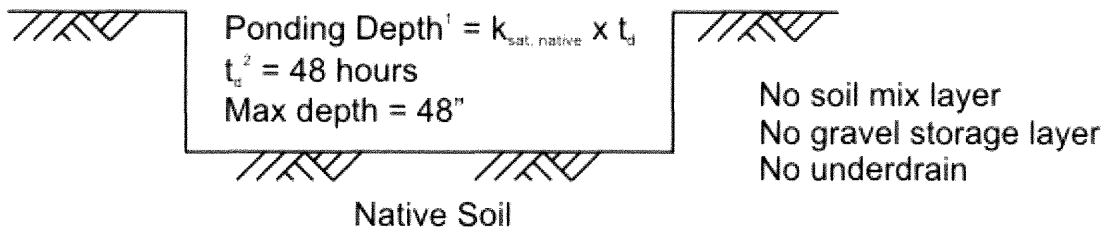
Summary

Project name	18.379 DMA 1
Climate station	RED BLUFF MUNI AP
Saturated hydraulic conductivity	0.32 in/hr
Impervious area	24570 square feet
LID area	2290 square feet
Total area	26860 square feet
Percent Accomplished	235.35%
LID BMP	Vegetated Infiltration Basin
Methodology	Design Storm User selected design storm is 0.68 inches 85th % design storm is 0.68 inches
Design storm volumetric runoff coefficient	0.892

Description

Vegetated infiltration basins are shallow, vegetated basins designed to provide storage and promote infiltration of runoff into the underlying native soils. The basins modeled by the CA Phase II LID Sizing Tool assume a surface storage depth dependent on the saturated conductivity of the underlying native soils.

LID BMP - Vegetated Infiltration Basin



Depths

LID Layer	Depth (inches)
Ponding	16

Notes

1. City of Sacramento et al. 2007, used for design of infiltration trench depth.
2. City of Sacramento et al. 2007, could use 72 hours but 48 hours provides a factor of safety for open-atmosphere ponding and vector issues.