

**HYDROLOGY AND HYDRAULICS STUDY**

**FOR**

**HIGHGROVE COMMERCIAL DEVELOPMENT  
N-E CORNER MT. VERNON AND CENTER  
COUTY OF RIVERSIDE  
CALIFORNIA**

**OWNER:**

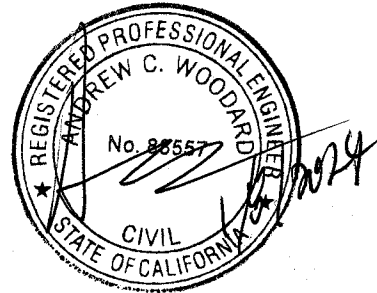
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**January 2024**



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## INTRODUCTION

This project is a proposed on a 10 Acre commercial site with a planned to 72 residential lots, recreational building, open spaces, bioretention, associated streets and parking. The site is located on the northwest corner of the intersection of Mt Vernon Avenue and Center Street in the County of Riverside.

## METHODOLOGY

The hydrology calculations were performed using the Riverside County Hydrology Manual Rational Method procedures. The hydraulic calculations for the grate inlet and storm drain pipe were performed using the Hydraflow Express Extension for Autodesk AutoCAD Civil 3D program. Included in this report are the existing and proposed condition 2-year, hydrology calculations showing the peak flows to the storm drain system and the hydraulic calculations for grate inlet, storm drain pipe capacity.

## EXISTING CONDITIONS

The existing site is currently undeveloped. Under existing condition, flow that originates onsite flow across the project area northwest from Center Street towards Mt Vernon Ave. There is no storm drain onsite and no storm drain on Mt Vernon Ave, so the water sheet flows out to the street. No offsite water enters the site.

## CONCLUSION

### *Hydrology Results*

Exist. Q2(cfs) Rational	Exist. Q2(cfs) TR55-24hr	Exist. Vol2(CF) TR55-24hr	Proposed Q2(cfs) Rational	Proposed Q2 (cfs) TR55-24hr	Proposed Vol2(CF) TR55-24hr	Flood Vol (req) (CF)	Water Quality Vol (CF)	Proposed Q2 (CF) TR55-24hr - <b>Mitigated</b>
4.78	6.09	24,731	5.41	6.24	26,349	8,617	9,046	1,618

### **Synthetic Unit Hydrograph results indicate: 2 year-24hr**

Pre-development condition=24,731 CF

Post-development condition=26,349 CF

Pre/Post Difference=1,618 CF

### **Bioretention Capacity**

V=9,046(Total Proposed Flood Volume)

**9,046 CF is greater than 8,617 CF required.**

**II. EXISTING HYDROLOGY CALCULATIONS**

- 2-Year Storm Hydrology Calculations

**PROPOSED HYDROLOGY CALCULATIONS**

- 2-Year Storm Hydrology Calculations

Riverside County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c) 1989 - 2018 Version 9.0  
Rational Hydrology Study Date: 01/08/24 File:PREHG2.out

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\*\*\*\*\* Hydrology Study Control Information \*\*\*\*\*

English (in-lb) Units used in input data file  
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Program License Serial Number 6539  
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Rational Method Hydrology Program based on  
Riverside County Flood Control & Water Conservation District  
1978 hydrology manual

Storm event (year) = 2.00 Antecedent Moisture Condition = 2

2 year, 1 hour precipitation = 0.454(In.)  
100 year, 1 hour precipitation = 1.080(In.)

Storm event year = 2.0  
Calculated rainfall intensity data:  
1 hour intensity = 0.454(In/Hr)  
Slope of intensity duration curve = 0.5000

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Process from Point/Station 11.000 to Point/Station 10.000  
\*\*\*\* INITIAL AREA EVALUATION \*\*\*\*

-----  
Initial area flow distance = 711.760(Ft.)  
Top (of initial area) elevation = 1126.400(Ft.)  
Bottom (of initial area) elevation = 1109.500(Ft.)  
Difference in elevation = 16.900(Ft.)  
Slope = 0.02374 s(percent)= 2.37  
TC = k(0.530)\*[(length^3)/(elevation change)]^0.2  
Initial area time of concentration = 15.492 min.  
Rainfall intensity = 0.893(In/Hr) for a 2.0 year storm  
UNDEVELOPED (poor cover) subarea  
Runoff Coefficient = 0.633  
Decimal fraction soil group A = 0.000  
Decimal fraction soil group B = 1.000

Decimal fraction soil group C = 0.000  
Decimal fraction soil group D = 0.000  
RI index for soil(AMC 2) = 78.00  
Pervious area fraction = 1.000; Impervious fraction = 0.000  
Initial subarea runoff = 4.788(CFS)  
Total initial stream area = 8.460(Ac.)  
Pervious area fraction = 1.000  
End of computations, total study area = 8.46 (Ac.)  
The following figures may  
be used for a unit hydrograph study of the same area.

Area averaged pervious area fraction( $A_p$ ) = 1.000  
Area averaged RI index number = 78.0

Unit Hydrograph Analysis

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Study date 01/08/24 File: PREHG2242.out

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Riverside County Synthetic Unit Hydrology Method  
RCFC & WCD Manual date - April 1978

Program License Serial Number 6539

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English (in-lb) Input Units Used  
English Rainfall Data (Inches) Input Values Used  
  
English Units used in output format

-----  
Drainage Area = 8.46(Ac.) = 0.013 Sq. Mi.  
Drainage Area for Depth-Area Areal Adjustment = 8.46(Ac.) =  
0.013 Sq. Mi.  
Length along longest watercourse = 711.76(Ft.)  
Length along longest watercourse measured to centroid = 355.88(Ft.)  
Length along longest watercourse = 0.135 Mi.  
Length along longest watercourse measured to centroid = 0.067 Mi.  
Difference in elevation = 16.90(Ft.)  
Slope along watercourse = 125.3681 Ft./Mi.  
Average Manning's 'N' = 0.040  
Lag time = 0.064 Hr.  
Lag time = 3.85 Min.  
25% of lag time = 0.96 Min.  
40% of lag time = 1.54 Min.  
Unit time = 60.00 Min.  
Duration of storm = 24 Hour(s)  
User Entered Base Flow = 4.79(CFS)

2 YEAR Area rainfall data:

Area(Ac.)[1]	Rainfall(In)[2]	Weighting[1*2]
8.46	1.94	16.41

100 YEAR Area rainfall data:

Area(Ac.)[1]	Rainfall(In)[2]	Weighting[1*2]
8.46	4.54	38.41

STORM EVENT (YEAR) = 2.00  
 Area Averaged 2-Year Rainfall = 1.940(In)  
 Area Averaged 100-Year Rainfall = 4.540(In)

Point rain (area averaged) = 1.940(In)  
 Areal adjustment factor = 100.00 %  
 Adjusted average point rain = 1.940(In)

Sub-Area Data:

Area(Ac.)	Runoff Index	Impervious %
8.460	86.00	0.600
Total Area Entered = 8.46(Ac.)		

RI	RI	Infil. Rate	Impervious	Adj. Infil. Rate	Area%	F
AMC2	AMC-2	(In/Hr)	(Dec.%)	(In/Hr)	(Dec.)	(In/Hr)
86.0	86.0	0.176	0.600	0.081	1.000	0.081
Sum (F) =						0.081

Area averaged mean soil loss (F) (In/Hr) = 0.081  
 Minimum soil loss rate ((In/Hr)) = 0.040  
 (for 24 hour storm duration)  
 Soil low loss rate (decimal) = 0.900

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 U n i t H y d r o g r a p h  
 MOUNTAIN S-Curve  
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Unit Hydrograph Data  
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Unit time period	Time % of lag	Distribution	Unit Hydrograph
(hrs)		Graph %	(CFS)
1	1.000	1556.697	100.000
Sum = 100.000			Sum= 8.526

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The following loss rate calculations reflect use of the minimum calculated loss rate subtracted from the Storm Rain to produce the maximum Effective Rain value

Unit Time	Pattern	Storm Rain	Loss rate(In./Hr)	Effective
(Hr.)	Percent	(In/Hr)	Max   Low	(In/Hr)
1	1.00	1.20	( 0.140)	0.021
2	2.00	1.30	( 0.134)	0.023



3	3.00	1.80	0.035	( 0.127)	0.031	0.003
4	4.00	2.10	0.041	( 0.121)	0.037	0.004
5	5.00	2.80	0.054	( 0.115)	0.049	0.005
6	6.00	2.90	0.056	( 0.109)	0.051	0.006
7	7.00	3.80	0.074	( 0.104)	0.066	0.007
8	8.00	4.60	0.089	( 0.098)	0.080	0.009
9	9.00	6.30	0.122	0.093 ( 0.110)		0.029
10	10.00	8.20	0.159	0.088 ( 0.143)		0.071
11	11.00	7.00	0.136	0.083 ( 0.122)		0.053
12	12.00	7.30	0.142	0.078 ( 0.127)		0.064
13	13.00	10.80	0.210	0.073 ( 0.189)		0.136
14	14.00	11.40	0.221	0.069 ( 0.199)		0.152
15	15.00	10.40	0.202	0.065 ( 0.182)		0.137
16	16.00	8.50	0.165	0.061 ( 0.148)		0.104
17	17.00	1.40	0.027	( 0.057)	0.024	0.003
18	18.00	1.90	0.037	( 0.054)	0.033	0.004
19	19.00	1.30	0.025	( 0.051)	0.023	0.003
20	20.00	1.20	0.023	( 0.048)	0.021	0.002
21	21.00	1.10	0.021	( 0.046)	0.019	0.002
22	22.00	1.00	0.019	( 0.043)	0.017	0.002
23	23.00	0.90	0.017	( 0.042)	0.016	0.002
24	24.00	0.80	0.016	( 0.041)	0.014	0.002

(Loss Rate Not Used)

Sum = 100.0

Sum = 0.8

Flood volume = Effective rainfall 0.81(In)  
times area 8.5(Ac.)/[((In)/(Ft.))] = 0.6(Ac.Ft)  
Total soil loss = 1.13(In)  
Total soil loss = 0.800(Ac.Ft)  
Total rainfall = 1.94(In)  
Flood volume = 24730.7 Cubic Feet  
Total soil loss = 34845.3 Cubic Feet

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Peak flow rate of this hydrograph = 6.086(CFS)  
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24 - H O U R S T O R M  
R u n o f f H y d r o g r a p h

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Hydrograph in 60 Minute intervals ((CFS))  
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Time(h+m)	Volume Ac.Ft	Q(CFS)	0	2.5	5.0	7.5	10.0
1+ 0	0.3973	4.81	V		Q		
2+ 0	0.7948	4.81	V		Q		
3+ 0	1.1930	4.82	V		Q		
4+ 0	1.5916	4.82	V		Q		
5+ 0	1.9911	4.83	V		Q		
6+ 0	2.3908	4.84	V	V	Q		
7+ 0	2.7917	4.85	V	V	Q		

8+ 0	3.1937	4.86		V	Q		
9+ 0	3.6101	5.04		V	Q		
10+ 0	4.0562	5.40		V	Q		
11+ 0	4.4894	5.24		V	Q		
12+ 0	4.9301	5.33		V	Q		
13+ 0	5.4218	5.95		V	Q		
14+ 0	5.9247	6.09		V	Q		
15+ 0	6.4169	5.96		V	Q		
16+ 0	6.8858	5.67		V	Q		
17+ 0	7.2835	4.81		V	Q		
18+ 0	7.6818	4.82		V	Q		
19+ 0	8.0792	4.81		V	Q		
20+ 0	8.4766	4.81		V	Q		
21+ 0	8.8738	4.81		V	Q		
22+ 0	9.2709	4.80		V	Q		
23+ 0	9.6678	4.80		V	Q		
24+ 0	10.0646	4.80		V	Q		

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Riverside County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c) 1989 - 2018 Version 9.0  
Rational Hydrology Study Date: 01/08/24 File:POSTHG2.out

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\*\*\*\*\* Hydrology Study Control Information \*\*\*\*\*

English (in-lb) Units used in input data file

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Program License Serial Number 6539

-----  
Rational Method Hydrology Program based on  
Riverside County Flood Control & Water Conservation District  
1978 hydrology manual

Storm event (year) = 2.00 Antecedent Moisture Condition = 2

2 year, 1 hour precipitation = 0.454(In.)  
100 year, 1 hour precipitation = 1.080(In.)

Storm event year = 2.0  
Calculated rainfall intensity data:  
1 hour intensity = 0.454(In/Hr)  
Slope of intensity duration curve = 0.5000

++++  
Process from Point/Station 11.000 to Point/Station 10.000  
\*\*\*\* INITIAL AREA EVALUATION \*\*\*\*

-----  
Initial area flow distance = 993.000(Ft.)  
Top (of initial area) elevation = 1115.500(Ft.)  
Bottom (of initial area) elevation = 1095.000(Ft.)  
Difference in elevation = 20.500(Ft.)  
Slope = 0.02064 s(percent)= 2.06  
TC =  $k(0.390)*[(length^3)/(elevation\ change)]^{0.2}$   
Initial area time of concentration = 13.393 min.  
Rainfall intensity = 0.961(In/Hr) for a 2.0 year storm  
SINGLE FAMILY (1/4 Acre Lot)  
Runoff Coefficient = 0.665  
Decimal fraction soil group A = 0.000  
Decimal fraction soil group B = 1.000

Decimal fraction soil group C = 0.000  
Decimal fraction soil group D = 0.000  
RI index for soil(AMC 2) = 56.00  
Pervious area fraction = 0.500; Impervious fraction = 0.500  
Initial subarea runoff = 5.408(CFS)  
Total initial stream area = 8.460(Ac.)  
Pervious area fraction = 0.500  
End of computations, total study area = 8.46 (Ac.)  
The following figures may  
be used for a unit hydrograph study of the same area.

Area averaged pervious area fraction( $A_p$ ) = 0.500  
Area averaged RI index number = 56.0

Unit Hydrograph Analysis

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Study date 01/08/24 File: POSTHGUH2.out

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Riverside County Synthetic Unit Hydrology Method  
RCFC & WCD Manual date - April 1978

Program License Serial Number 6539

-----  
English (in-lb) Input Units Used  
English Rainfall Data (Inches) Input Values Used  
  
English Units used in output format

-----  
Drainage Area = 8.46(Ac.) = 0.013 Sq. Mi.  
Drainage Area for Depth-Area Areal Adjustment = 8.46(Ac.) =  
0.013 Sq. Mi.  
Length along longest watercourse = 993.00(Ft.)  
Length along longest watercourse measured to centroid = 496.50(Ft.)  
Length along longest watercourse = 0.188 Mi.  
Length along longest watercourse measured to centroid = 0.094 Mi.  
Difference in elevation = 20.50(Ft.)  
Slope along watercourse = 109.0030 Ft./Mi.  
Average Manning's 'N' = 0.020  
Lag time = 0.042 Hr.  
Lag time = 2.55 Min.  
25% of lag time = 0.64 Min.  
40% of lag time = 1.02 Min.  
Unit time = 60.00 Min.  
Duration of storm = 24 Hour(s)  
User Entered Base Flow = 5.41(CFS)

2 YEAR Area rainfall data:

Area(Ac.)[1]	Rainfall(In)[2]	Weighting[1*2]
8.46	1.94	16.41

100 YEAR Area rainfall data:

Area(Ac.)[1]	Rainfall(In)[2]	Weighting[1*2]
8.46	4.54	38.41

STORM EVENT (YEAR) = 1.00  
 Area Averaged 2-Year Rainfall = 1.940(In)  
 Area Averaged 100-Year Rainfall = 4.540(In)

Point rain (area averaged) = 1.479(In)  
 Areal adjustment factor = 100.00 %  
 Adjusted average point rain = 1.479(In)

Sub-Area Data:

Area(Ac.)	Runoff Index	Impervious %
8.460	56.00	0.600
Total Area Entered = 8.46(Ac.)		

RI	RI	Infil. Rate	Impervious	Adj. Infil. Rate	Area%	F
AMC2	AMC-2	(In/Hr)	(Dec.%)	(In/Hr)	(Dec.)	(In/Hr)
56.0	56.0	0.511	0.600	0.235	1.000	0.235
Sum (F) =						0.235

Area averaged mean soil loss (F) (In/Hr) = 0.235  
 Minimum soil loss rate ((In/Hr)) = 0.117  
 (for 24 hour storm duration)  
 Soil low loss rate (decimal) = 0.420

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 U n i t H y d r o g r a p h  
 MOUNTAIN S-Curve  
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Unit Hydrograph Data  
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Unit time period	Time % of lag	Distribution	Unit Hydrograph
(hrs)		Graph %	(CFS)
1 1.000	2353.877	100.000	8.526
		Sum = 100.000	Sum= 8.526

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The following loss rate calculations reflect use of the minimum calculated loss rate subtracted from the Storm Rain to produce the maximum Effective Rain value

Unit Time	Pattern	Storm Rain	Loss rate(In./Hr)	Effective
(Hr.)	Percent	(In/Hr)	Max   Low	(In/Hr)
1 1.00	1.20	0.018	( 0.408)	0.007 0.010
2 2.00	1.30	0.019	( 0.389)	0.008 0.011



8+ 0	3.6995	5.74			V	Q		
9+ 0	4.1846	5.87			V	Q		
10+ 0	4.6811	6.01			V	Q		
11+ 0	5.1704	5.92			V	Q		
12+ 0	5.6615	5.94			V	Q		
13+ 0	6.1738	6.20			V	Q		
14+ 0	6.6897	6.24			V	VQ		
15+ 0	7.1995	6.17			V	QV		
16+ 0	7.6979	6.03			V	Q		
17+ 0	8.1533	5.51			V	Q		
18+ 0	8.6117	5.55			V	Q		
19+ 0	9.0665	5.50			V	Q		
20+ 0	9.5207	5.50			V	Q		
21+ 0	9.9743	5.49			V	Q		
22+ 0	10.4273	5.48			V	Q		
23+ 0	10.8797	5.47			V	Q		
24+ 0	11.3315	5.47			V	Q		