DRAINAGE STUDY

FOR

State and Cottonwood

San Jacinto, California

Engineer:

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Prepared by: _____ Date: _____

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Original: 9/23/18
Revision 1: 10/10/18
12/17/18
3/11/19

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Exhibit A – Pre-Development Hydrology Map

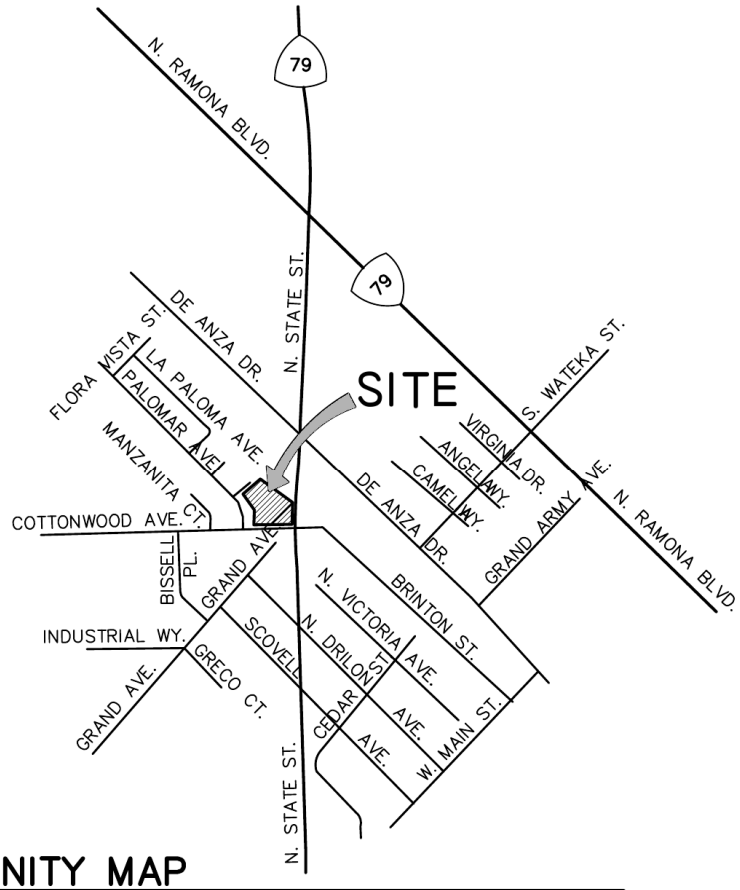
Exhibit B – Post-Development Hydrology Map

1.0 PROJECT DESCRIPTION

The proposed project is a retail center at the northwest corner of State Street and Cottonwood Avenue in San Jacinto, CA. The project will consist of three retail buildings. The building uses will be a 7-11 with a gas station, a drive-thru fast food restaurant and an automotive repair shop.

The property is currently undeveloped and drains from the NE corner to the SW corner of the site. There is currently no storm drain located within State or Cottonwood adjacent to the project site.

In the developed condition the drainage patterns will remain the same. Storm water will ultimately discharge to Cottonwood. The site will have five (5) biofiltration areas that will help retain storm water runoff from the site. The site also benefits from a relatively high infiltration rate of 5 in/hr which will help offset the increased runoff.



VICINITY MAP

THOMAS GUIDE ED. 2006: 811–A1 NO SCALE

2.0 PURPOSE

The purpose of this study is to determine the peak runoff rates and velocities for the pre-development and post-development conditions. Comparisons will be made at the same discharge points for each drainage basin affecting the site and adjacent properties. The adequacy of existing and proposed conveyance facilities affected by the project will be determined.

3.0 METHODOLOGY

The Rational Method as outlined in the Riverside County Flood Control and Water Conservation District Hydrology Manual, dated April 1978, was used to determine the runoff flow rate for the onsite runoff. The 2, 10, and 100-year frequency storm event were analyzed to determine peak runoff rates discharging the site for the post-development condition. The CivilDesign Rational Method program for Riverside County by Joseph E. Bonadiman & Associates was used for the hydrology calculations.

Soil type was determined to be a type A determined by the USDA NRCS Web Soil Survey (see Appendix A).

Runoff coefficients, “C” are summarized below:

- Pre-Development – undeveloped, poor cover
- Post-Development - Commercial

4.0 HYDROLOGY

4.1 Pre-Development Conditions

Currently a portion of the site sheet drains from South to North down the existing slope. This sheet flow is picked up by an existing concrete channel, West of the project boundary. The remaining portion of the site drains towards the South beginning with sheet flow, then along the existing gutter to the existing storm drain system.

A pre-development hydrology map delineating basin areas, flow paths, and concentration points has been prepared and is attached to this report as Exhibit “A”. Pre-development hydrology calculations can be found in Appendix “B”.

4.2 Post-Development Conditions

The post-development condition will direct run off North down the existing slope; the remainder of the runoff from the site will be directed to the South. The project will construct an onsite storm drain system to convey the water. All runoff from impermeable areas will be directed to biofiltration basins for pretreatment and to be infiltrated into the ground through the associated orifices. In a 100-year storm event the water will bypass the storm water treatment and be detained and released at predevelopment flows. There is no negative impact to any adjacent properties.

A post-development hydrology map delineating basin areas, flow paths, and concentration points has been prepared and is attached to this report as Exhibit “B”. Post-development hydrology calculations can be found in Appendix “C”.

5.0 CONCLUSION

Development of the project site will increase the runoff from the pre-developed condition due to the change from an undeveloped condition to a commercial development. The increase in the runoff flow rate will be addressed by the combination of the detention volumes within the biofiltration basins and the infiltration into the surrounding soil from these detention areas.

See the Detention Analysis in Appendix D.

Table 1 – Pre-Development Areas and Flows

	Area (ac)	Q_{100} (cfs)	
Basin / Node	**Pre-Dev**	**Pre-Dev**	**Impervious %**
100	2.2	4.91	0

Table 2 – Post-Development Areas and Flows

	Area (ac)	Q_{100} (cfs)	
Basin / Node	**Post-Dev**	**Post-Dev**	**Impervious %**
100	2.2	5.77	90

Table 3 – Pre vs. Post-Development

	$\sum Q_{100}$ (cfs)	Runoff Detained (cfs)	Runoff Released (cfs)
Pre	4.91	0	4.91
Post	5.77	0.86	4.91

REFERENCES

CivilDesign Corporation. *Riverside County Rational Method*. (Software Version 7.1)

Riverside County Flood Control and Water Conservation District. *Hydrology Manual.* (1978)

APPENDIX A

Reference Charts

Table 3-1
RUNOFF COEFFICIENTS FOR URBAN AREAS

Land Use		Runoff Coefficient "C"				
			Soil Type			
NRCS Elements	County Elements	% IMPER.	A	B	C	D
Undisturbed Natural Terrain (Natural)	Permanent Open Space	0*	0.20	0.25	0.30	0.35
Low Density Residential (LDR)	Residential, 1.0 DU/A or less	10	0.27	0.32	0.36	0.41
Low Density Residential (LDR)	Residential, 2.0 DU/A or less	20	0.34	0.38	0.42	0.46
Low Density Residential (LDR)	Residential, 2.9 DU/A or less	25	0.38	0.41	0.45	0.49
Medium Density Residential (MDR)	Residential, 4.3 DU/A or less	30	0.41	0.45	0.48	0.52
Medium Density Residential (MDR)	Residential, 7.3 DU/A or less	40	0.48	0.51	0.54	0.57
Medium Density Residential (MDR)	Residential, 10.9 DU/A or less	45	0.52	0.54	0.57	0.60
Medium Density Residential (MDR)	Residential, 14.5 DU/A or less	50	0.55	0.58	0.60	0.63
High Density Residential (HDR)	Residential, 24.0 DU/A or less	65	0.66	0.67	0.69	0.71
High Density Residential (HDR)	Residential, 43.0 DU/A or less	80	0.76	0.77	0.78	0.79
Commercial/Industrial (N. Com)	Neighborhood Commercial	80	0.76	0.77	0.78	0.79
Commercial/Industrial (G. Com)	General Commercial	85	0.80	0.80	0.81	0.82
Commercial/Industrial (O.P. Com)	Office Professional/Commercial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (Limited I.)	Limited Industrial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (General I.)	General Industrial	95	0.87	0.87	0.87	0.87

*The values associated with 0% impervious may be used for direct calculation of the runoff coefficient as described in Section 3.1.2 (representing the pervious runoff coefficient, Cp, for the soil type), or for areas that will remain undisturbed in perpetuity. Justification must be given that the area will remain natural forever (e.g., the area is located in Cleveland National Forest).
DU/A = dwelling units per acre
NRCS = National Resources Conservation Service

RAINFALL INTENSITY—INCHES PER HOUR

RIVERSIDE			RIVERSIDE (FOOTHILL AREAS)			RUBIDOUX			SAN JACINTO			SUN CITY		
DURATION MINUTES	FREQUENCY 10 YEAR	FREQUENCY 100 YEAR	DURATION MINUTES	FREQUENCY 10 YEAR	FREQUENCY 100 YEAR	DURATION MINUTES	FREQUENCY 10 YEAR	FREQUENCY 100 YEAR	DURATION MINUTES	FREQUENCY 10 YEAR	FREQUENCY 100 YEAR	DURATION MINUTES	FREQUENCY 10 YEAR	FREQUENCY 100 YEAR
5	2.75	3.92	5	3.14	4.71	5	3.18	4.71	5	2.81	4.16	5	3.25	4.85
6	2.48	3.55	6	2.84	4.26	6	2.87	4.26	6	2.56	3.79	6	2.95	4.40
7	2.28	3.26	7	2.61	3.91	7	2.64	3.91	7	2.37	3.51	7	2.72	4.06
8	2.12	3.03	8	2.42	3.63	8	2.45	3.63	8	2.22	3.29	8	2.53	3.78
9	1.99	2.84	9	2.27	3.41	9	2.30	3.41	9	2.09	3.10	9	2.38	3.55
10	1.88	2.68	10	2.14	3.21	10	2.17	3.21	10	1.98	2.94	10	2.25	3.36
11	1.78	2.54	11	2.03	3.05	11	2.06	3.05	11	1.89	2.80	11	2.14	3.19
12	1.70	2.42	12	1.94	2.91	12	1.96	2.91	12	1.81	2.68	12	2.04	3.05
13	1.62	2.32	13	1.86	2.78	13	1.88	2.78	13	1.74	2.58	13	1.96	2.92
14	1.56	2.23	14	1.78	2.67	14	1.80	2.67	14	1.68	2.48	14	1.88	2.81
15	1.50	2.14	15	1.71	2.57	15	1.74	2.57	15	1.62	2.40	15	1.81	2.71
16	1.45	2.07	16	1.66	2.48	16	1.68	2.48	16	1.57	2.32	16	1.75	2.62
17	1.40	2.00	17	1.60	2.40	17	1.62	2.40	17	1.52	2.25	17	1.70	2.54
18	1.36	1.94	18	1.55	2.33	18	1.57	2.33	18	1.48	2.19	18	1.65	2.46
19	1.32	1.88	19	1.51	2.26	19	1.52	2.26	19	1.44	2.13	19	1.60	2.39
20	1.28	1.83	20	1.46	2.20	20	1.48	2.20	20	1.40	2.08	20	1.56	2.33
22	1.22	1.74	22	1.39	2.08	22	1.41	2.08	22	1.34	1.98	22	1.48	2.21
24	1.16	1.66	24	1.32	1.99	24	1.34	1.99	24	1.28	1.90	24	1.41	2.11
26	1.11	1.58	26	1.27	1.90	26	1.28	1.90	26	1.23	1.82	26	1.36	2.03
28	1.06	1.52	28	1.22	1.82	28	1.23	1.82	28	1.19	1.76	28	1.30	1.95
30	1.02	1.46	30	1.17	1.76	30	1.19	1.76	30	1.15	1.70	30	1.26	1.88
32	.99	1.41	32	1.13	1.70	32	1.14	1.70	32	1.11	1.64	32	1.21	1.81
34	.96	1.37	34	1.09	1.64	34	1.11	1.64	34	1.08	1.59	34	1.18	1.76
36	.93	1.32	36	1.06	1.59	36	1.07	1.59	36	1.05	1.55	36	1.14	1.70
38	.90	1.29	38	1.03	1.54	38	1.04	1.54	38	1.02	1.51	38	1.11	1.66
40	.87	1.25	40	1.00	1.50	40	1.01	1.50	40	.99	1.47	40	1.08	1.61
45	.82	1.17	45	.94	1.41	45	.95	1.41	45	.94	1.39	45	1.01	1.51
50	.77	1.11	50	.88	1.33	50	.90	1.33	50	.89	1.31	50	.96	1.43
55	.73	1.05	55	.84	1.26	55	.85	1.26	55	.85	1.25	55	.91	1.36
60	.70	1.00	60	.80	1.20	60	.81	1.20	60	.81	1.20	60	.87	1.30
65	.67	.96	65	.77	1.15	65	.78	1.15	65	.78	1.15	65	.83	1.25
70	.64	.92	70	.73	1.10	70	.74	1.10	70	.75	1.11	70	.80	1.20
75	.62	.88	75	.71	1.06	75	.72	1.06	75	.72	1.07	75	.77	1.15
80	.60	.85	80	.68	1.02	80	.69	1.02	80	.70	1.04	80	.75	1.12
85	.58	.83	85	.66	.99	85	.67	.99	85	.68	1.01	85	.72	1.08
SLOPE = .550			SLOPE = .550			SLOPE = .550			SLOPE = .500			SLOPE = .530		

RCFC & WCD

HYDROLOGY MANUAL

STANDARD INTENSITY-DURATION CURVES DATA

Map Scale: 1:1,480 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 11N 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 1:15,800.

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: Western Riverside Area, California
Survey Area Data: Version 11, Sep 12, 2018

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

Date(s) aerial images were photographed: Jan 5, 2015—Feb 4, 2015

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
SeA	San Emigdio fine sandy loam, 0 to 2 percent slopes, occassional frost	A	1.5	14.4%
SfA	San Emigdio fine sandy loam, deep, 0 to 2 percent slopes	A	8.9	85.6%
Totals for Area of Interest			**10.4**	**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.

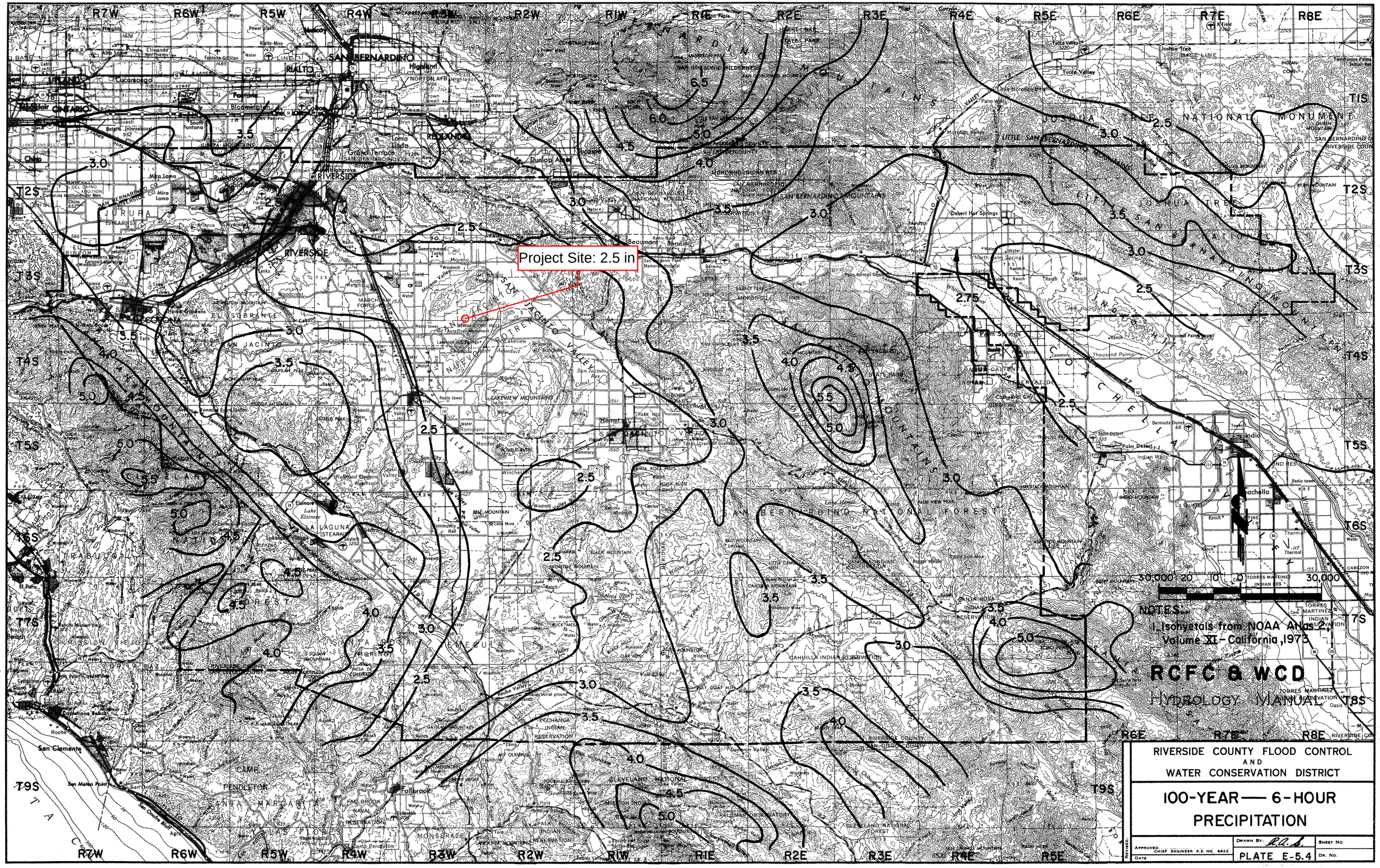
If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

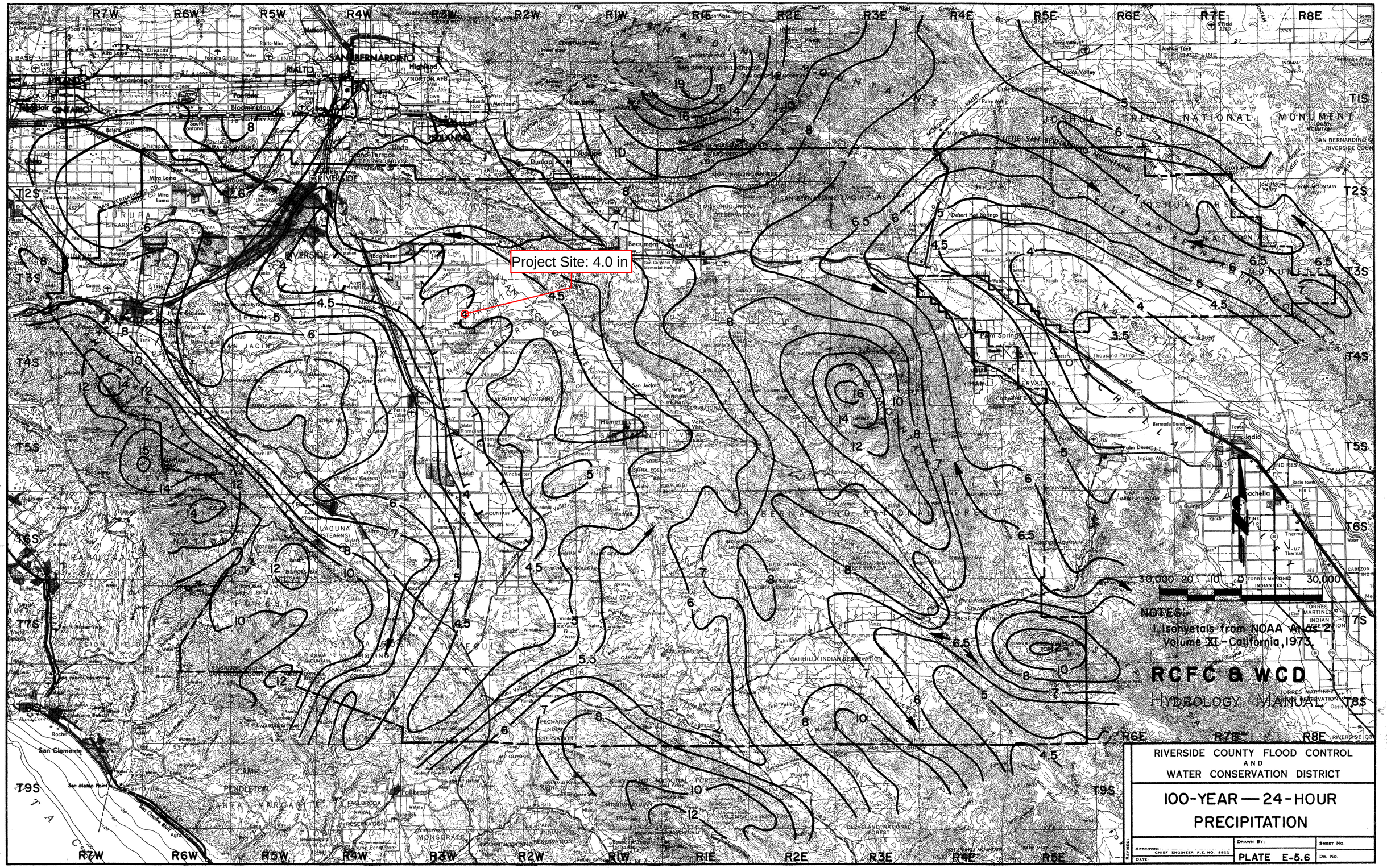
Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher


Project Site: 2.5 in
NOTES:
1. Isohyetals from NOAA Atlas 2, Volume XI - California, 1973
RCFC & WCD
HYDROLOGY MANUAL
30,000 20 10 0 30,000
RIVERSIDE COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
100-YEAR — 6-HOUR PRECIPITATION
DRAWN BY: R.O.S.
SHEET NO.
PLATE E-5.4
DR. NO.
APPROVED
CHIEF ENGINEER R.E. NO. 8822
DATE
REVISED


Project Site: 4.0 in
30,000 20 10 0 30,000
NOTES:
1. Isohyetals from NOAA Atlas 2, Volume XI - California, 1973.
RCFC & WCD
HYDROLOGY MANUAL
RIVERSIDE COUNTY FLOOD CONTROL
AND
WATER CONSERVATION DISTRICT
100-YEAR — 24-HOUR
PRECIPITATION
APPROVED: CHIEF ENGINEER R.E. NO. 8822
DATE
DRAWN BY:
PLATE E-5.6
SHEET NO.
DR. NO.
REVISED:

APPENDIX B

Pre-Development Hydrology Calculations

```
                    Riverside County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c) 1989 - 2005 Version 7.1
        Rational Hydrology Study        Date: 10/08/18
File:100sanjacinto100pre.out
---------------------------------------------------------------------------
SAN JACINTO
BASIN 100
PRE-DEVELOPMENT CONDITION 100-YEAR STORM
PN 17-043
---------------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

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

---------------------------------------------------------------------------


Program License Serial Number 6144

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

Storm event (year) =  100.00 Antecedent Moisture Condition = 3

Standard intensity-duration curves data (Plate D-4.1)
For the [ San Jacinto ] area used.
10 year storm 10 minute intensity =  1.980(In/Hr)
10 year storm 60 minute intensity =  0.810(In/Hr)
100 year storm 10 minute intensity =  2.940(In/Hr)
100 year storm 60 minute intensity =  1.200(In/Hr)

Storm event year = 100.0
Calculated rainfall intensity data:
1 hour intensity =  1.200(In/Hr)
Slope of intensity duration curve = 0.5000




++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      101.000 to Point/Station      102.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Initial area flow distance =    62.000(Ft.)
Top (of initial area) elevation =  1533.100(Ft.)
Bottom (of initial area) elevation =  1529.800(Ft.)
Difference in elevation =     3.300(Ft.)
Slope =    0.05323  s(percent)=       5.32
TC = k(0.530)*[(length^3)/(elevation change)]^0.2
Warning: TC computed to be less than 5 min.; program is assuming the
time of concentration is 5 minutes.
Initial area time of concentration =    5.000 min.
Rainfall intensity =      4.157(In/Hr) for a   100.0 year storm
UNDEVELOPED (poor cover) subarea
Runoff Coefficient = 0.845
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
```

```
Decimal fraction soil group D = 0.000
RI index for soil(AMC 3)  =  83.20
Pervious area fraction =  1.000; Impervious fraction =  0.000
Initial subarea runoff =      0.246(CFS)
Total initial stream area =        0.070(Ac.)
Pervious area fraction = 1.000


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      102.000 to Point/Station      100.000
**** NATURAL CHANNEL TIME + SUBAREA FLOW ADDITION ****
______________________________________________________________________
Top of natural channel elevation =   1529.800(Ft.)
End of natural channel elevation =   1529.000(Ft.)
Length of natural channel  =   386.000(Ft.)
Estimated mean flow rate at midpoint of channel =      3.988(CFS)

Natural valley channel type used
L.A. County flood control district formula for channel velocity:
 Velocity(ft/s) = (7 + 8(q(English Units)^.352)(slope^0.5)
Velocity using mean channel flow =   0.91(Ft/s)

Correction to map slope used on extremely rugged channels with
drops and waterfalls (Plate D-6.2)
        Normal channel slope =  0.0021
Corrected/adjusted channel slope =  0.0021
Travel time =    7.06 min.     TC =   12.06  min.


 Adding area flow to channel
UNDEVELOPED (poor cover) subarea
Runoff Coefficient = 0.818
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 3)  =  83.20
Pervious area fraction =  1.000; Impervious fraction =  0.000
Rainfall intensity =      2.677(In/Hr) for a   100.0 year storm
Subarea runoff =      4.662(CFS) for      2.130(Ac.)
Total runoff =      4.908(CFS)  Total area =       2.200(Ac.)
End of computations, total study area =            2.20 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.

Area averaged pervious area fraction(Ap) = 1.000
Area averaged RI index number =  67.0
```

APPENDIX C

Post-Development Hydrology Calculations

```
                    Riverside County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c) 1989 - 2005 Version 7.1
        Rational Hydrology Study        Date: 10/08/18
File:100sanjacinto100post.out
---------------------------------------------------------------------------
SAN JACINTO
BASIN 100
POST-DEVELOPMENT CONDITION 100-YEAR STORM
PN 17-043
---------------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

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

---------------------------------------------------------------------------


Program License Serial Number 6144

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

Storm event (year) =  100.00 Antecedent Moisture Condition = 3

Standard intensity-duration curves data (Plate D-4.1)
For the [ San Jacinto ] area used.
10 year storm 10 minute intensity =  1.980(In/Hr)
10 year storm 60 minute intensity =  0.810(In/Hr)
100 year storm 10 minute intensity =  2.940(In/Hr)
100 year storm 60 minute intensity =  1.200(In/Hr)

Storm event year = 100.0
Calculated rainfall intensity data:
1 hour intensity =  1.200(In/Hr)
Slope of intensity duration curve = 0.5000




++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      101.000 to Point/Station      102.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Initial area flow distance =    62.000(Ft.)
Top (of initial area) elevation =  1533.100(Ft.)
Bottom (of initial area) elevation =  1532.940(Ft.)
Difference in elevation =     0.160(Ft.)
Slope =    0.00258  s(percent)=       0.26
TC = k(0.300)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    5.149 min.
Rainfall intensity =      4.096(In/Hr) for a   100.0 year storm
COMMERCIAL subarea type
Runoff Coefficient = 0.879
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 3)  =  52.00
```

```
Pervious area fraction =  0.100; Impervious fraction =  0.900
Initial subarea runoff =      0.252(CFS)
Total initial stream area =        0.070(Ac.)
Pervious area fraction = 0.100


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      102.000 to Point/Station      100.000
**** STREET FLOW TRAVEL TIME + SUBAREA FLOW ADDITION ****
______________________________________________________________________
Top of street segment elevation =  1532.940(Ft.)
End of street segment elevation =  1530.250(Ft.)
Length of street segment  =   430.000(Ft.)
Height of curb above gutter flowline  =    6.0(In.)
Width of half street (curb to crown)  =  20.000(Ft.)
Distance from crown to crossfall grade break  =  10.000(Ft.)
Slope from gutter to grade break (v/hz) =   0.015
Slope from grade break to crown (v/hz)  =   0.015
Street flow is on [2] side(s) of the street
Distance from curb to property line  =   0.000(Ft.)
Slope from curb to property line (v/hz) =   0.015
Gutter width =   1.500(Ft.)
Gutter hike from flowline =  1.440(In.)
 Manning's N in gutter =  0.0150
 Manning's N from gutter to grade break =  0.0150
 Manning's N from grade break to crown =  0.0150
Estimated mean flow rate at midpoint of street =      2.956(CFS)
Depth of flow =   0.261(Ft.), Average velocity =   1.531(Ft/s)
Streetflow hydraulics at midpoint of street travel:
Halfstreet flow width =  10.907(Ft.)
Flow velocity =   1.53(Ft/s)
Travel time =    4.68 min.     TC =    9.83  min.
 Adding area flow to street
COMMERCIAL subarea type
Runoff Coefficient = 0.874
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 3)  =  52.00
Pervious area fraction =  0.100; Impervious fraction =  0.900
Rainfall intensity =      2.965(In/Hr) for a   100.0 year storm
Subarea runoff =      5.517(CFS) for      2.130(Ac.)
Total runoff =      5.769(CFS)  Total area =       2.200(Ac.)
Street flow at end of street =      5.769(CFS)
Half street flow at end of street =      2.884(CFS)
Depth of flow =   0.312(Ft.), Average velocity =   1.797(Ft/s)
Flow width (from curb towards crown)=  14.291(Ft.)
End of computations, total study area =            2.20 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.

Area averaged pervious area fraction(Ap) = 0.100
Area averaged RI index number =  32.0
```

APPENDIX D

Detention Analysis

ESTIMATED DETENTION STORAGE

METHODOLOGY

The estimate storage volume required for detention can be obtained using the Triangular Hydrograph Method. The methodology is outlined below in an excerpt from the Connecticut DOT Drainage Manual.

10.6.4 Triangular Hydrograph Method

A preliminary estimate of the storage volume required for peak flow attenuation may be obtained from a simplified design procedure that replaces the actual inflow and outflow hydrographs with standard triangular shapes. This method should not be applied if the hydrographs can not be approximated by a triangular shape. This would introduce additional errors of the preliminary estimate of the required storage. The procedure is illustrated by Figure 10-2. The required storage volume may be estimated from the area above the outflow hydrograph and inside the inflow hydrograph as defined by equation 10.1.

$$V_s = 0.5\, t_i\, (Q_i - Q_o) \qquad \textbf{(10.1)}$$

where: V_s = storage volume estimate, m^3 (ft^3)
Q_i = peak inflow rate into the basin, m^3/s (ft^3/s)
Q_o = peak outflow rate out of the basin, m^3/s (ft^3/s)
t_i = duration of basin inflow, s
t_p = time to peak of the inflow hydrograph, s

The duration of basin inflow should be derived from the estimated inflow hydrograph. The triangular hydrograph procedure, originally described by Boyd, was found to compare favorably with more complete design procedures involving reservoir routing.

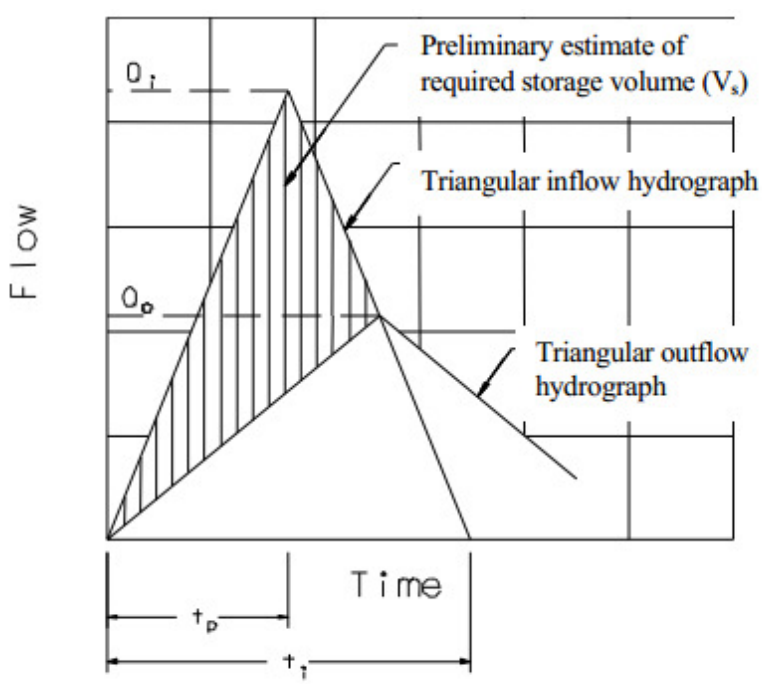


Figure 10-2 Triangular hydrograph method

CALCULATIONS

Input Values

Q_i = 5.77 cfs

Q_o = 4.91 cfs

t_p = 9.8 min.

t_i = 12.1 min.

Calculation

V_s = 0.5 (12.1*60) (5.77-4.91)

V_s = 313 cubic feet

UNDERGROUND STORAGE SIZING

Using the above hydrograph calculation, the required storage volume is 313 cubic feet. Detaining 313 cubic feet will reduce site runoff discharge to pre-development conditions.

The underground storage will be used for both the 100-year storage and for the water quality hydromodification events. The hydromodification event is significantly higher than the calculated 100-year event, the 100-year event will be handled within the underground storage pipes. This runoff will then infiltrate into the underlying soil.

EXHIBIT A

Pre-Development Map

LEGEND

100	NODE
100 / Q_{100} = X.X cfs / T_c = X.X min / A = X.XX ac	BASIN NUMBER / 100–YEAR FREQUENCY DISCHARGE / TIME OF CONCENTRATION / AREA
	MAJOR BASIN BOUNDARY
	SUBBASIN BOUNDARY
	FLOW PATH
X.XX	BASIN AREA (ACRES)
	PERVIOUS (2.20 ACRES)

SWS
N

20 10 0 20 40 60
SCALE IN FEET
GRAPHIC SCALE

STATE AND COTTON
PRE-DEVELOPMENT

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DATE: Oct 17, 18 5:08pm by:carol.stein
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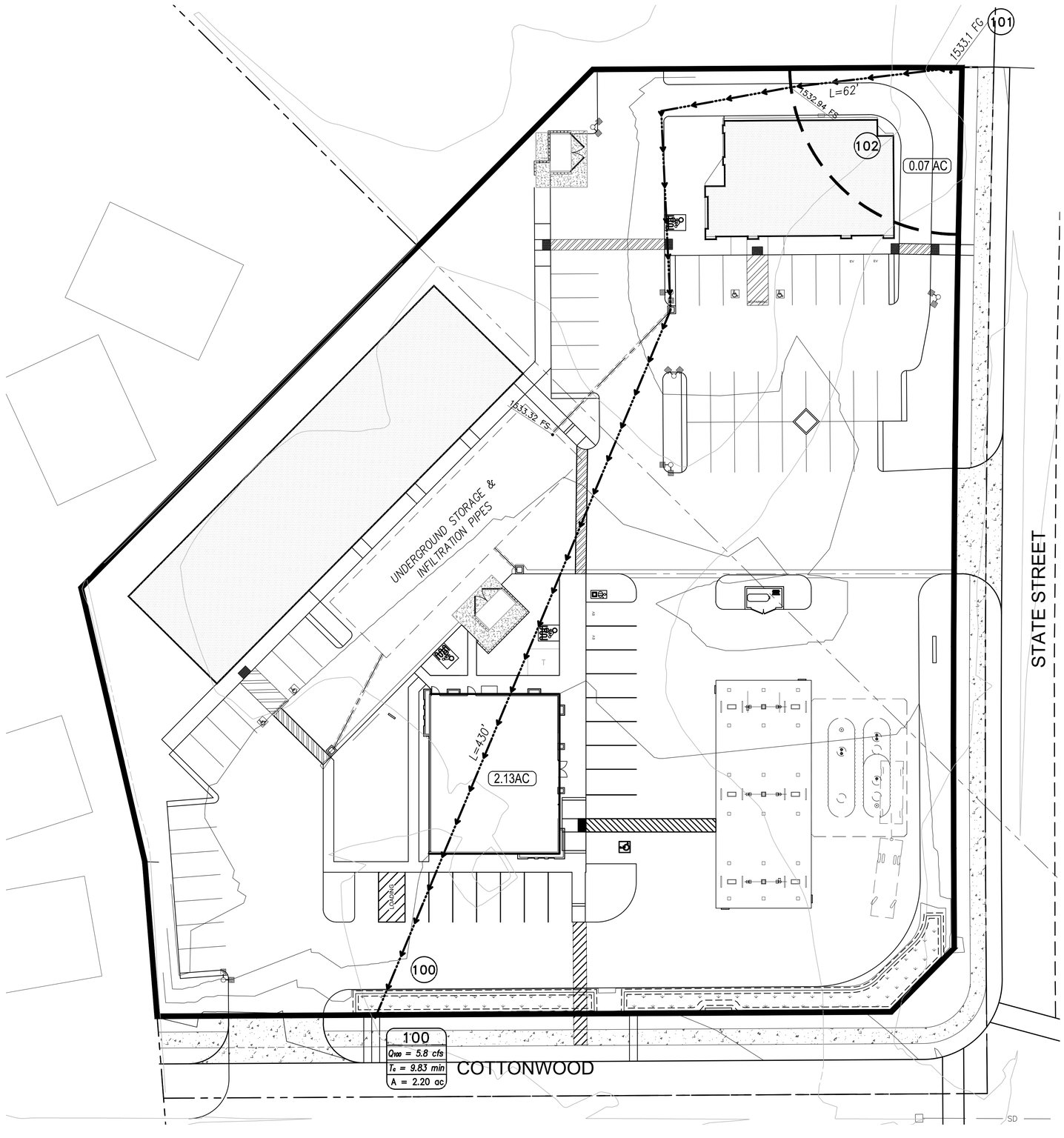
EXHIBIT B

Post-Development Map



LEGEND

100	NODE
100 / Q_{100} = X.X cfs / T_c = X.X min / A = X.XX ac	BASIN NUMBER / 100-YEAR FREQUENCY DISCHARGE / TIME OF CONCENTRATION / AREA
	MAJOR BASIN BOUNDARY
	SUBBASIN BOUNDARY
	FLOW PATH
X.XX	BASIN AREA (ACRES)
	PERVIOUS (0.28 ACRES)
	IMPERVIOUS (1.92 ACRES)

SWS
N

20 10 0 20 40 60
SCALE IN FEET
GRAPHIC SCALE

STATE AND COTTON POST-DEVELOPMENT

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