PRELIMINARY HYDROLOGIC ANALYSIS

for ALBERHILL VILLAGES SPECIFIC PLAN

in the City of Lake Elsinore,
County of Riverside, California

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April 2015

JN 2006.1000.2.06
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1
INTRODUCTION

1.1 PURPOSE OF STUDY

The Alberhill Villages project is located within the City of Lake Elsinore, Riverside County, California. The purpose of this study is to hydrologically model the project site's onsite and offsite tributary watersheds and determine the existing and proposed peak storm runoffs. This report also approximates the peak storage required to mitigate any increased runoff due to development for the most critical storm and duration event. The flows are used to estimate the above and below ground drainage facilities to support the Alberhill Villages project as proposed by the Alberhill Villages Specific Plan.

1.2 PROJECT DESCRIPTION AND STUDY OVERVIEW

As proposed by the Alberhill Villages Specific Plan, the Alberhill Villages project site will be reclaimed for development as the existing onsite clay, sand, and aggregate mining operations are gradually phased out. The Alberhill Villages site is comprised of approximately 1,374 acres of undeveloped land that is currently being mined for its mineral resources. The site will also include an additional 9.1 acres and 16.8 acres for development which was originally part of the Alberhill Ranch Specific Plan. The site is bounded undeveloped to the south, the I-15 Freeway to the north, the existing Horsethief Canyon development to the west, and Lake Street to the east. **Figure 1** shows a vicinity map of the area. The Alberhill Villages project is planned for a multifaceted community consisting of a university campus, recreational lake and park areas, mixed-use commercial/office/retail, neighborhood commercial, public institutions/schools, and a large residential component ranging from very low density estate lots to very high density multifamily lots. Lake Street and Temescal Canyon Road/Lincoln Street are the main north-south thoroughfares into the community connecting the Downtown Lake Elsinore area and Interstate 15 Freeway. The development of the Alberhill Villages Project will enhance the north area of the City of Lake Elsinore producing a profound entry statement into the city off of Interstate 15 at Lake Street.

KWC Engineers has performed a hydrologic analysis for the Alberhill Villages project and its tributary watershed to Temescal Wash located along and south of the I-15 Freeway at Lake Street. The existing and proposed hydrology conditions were analyzed using the Synthetic Unit Hydrograph Method as outlined in the Riverside County Flood Control and Water Conservation District (RCFC&WCD) Hydrology Manual (1978). AutoCad 2012 and HEC-HMS v3.2 programs were used to delineate the watersheds and compute the required hydrographs and peak flows for the 2-year, 5-year, 10-year, and 100-year storm events. The increased runoff mitigation facilities (referred to as "detention ponds") were verified for the 2-year, 5-year, and 10-year return periods with the 1-hour, 3-hour, 6-hour, and 24-hour duration events, such that the

FIGURE 1

VICINITY MAP

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JN. 06.1000.2.10 R:\06\1000\REPORTS\Hydro\Draft Report\FIGURE 1 Vicinity Map.dwg 12/28/2011 16:06

proposed conditions peak outflow for the entire development is not greater than the existing conditions peak outflow. The design criteria follow the 1995 RCFC&WCD guidelines for the increased runoff mitigation facility design.

1.3 STUDY AREA

The study area is comprised of several drainage watersheds that drain to five discharge points along the project boundaries and ultimately to Temescal Wash. Proposed development drainage area includes approximately 1400 acres within the Alberhill Villages project and 400 acres within the future Alberhill Ridge project. Additional tributary development drainage areas have also been included from the adjacent Alberhill Ranch project and Horsethief Canyon project, approximately 300 acres and 50 acres, respectively. In addition, the study area also includes approximately 2000 acres of undeveloped drainage sheds from the southwest and 100 acres of undeveloped County of Riverside land [future Multi Species Habitat Conservation Plan (MSHCP) land] from the east. A series of proposed above and below ground drainage facilities have been strategically located within the project to pick up, contain as necessary, and convey the surface runoffs through the site to their respective discharge points.

The study area drains sheds within the Rice Canyon and Horsethief Canyon District where each drainage watershed is differentiated by a different color to the discharge point. **Figures 3 and 4** in Section 2 shows the approximate existing and proposed drainage watershed study area for the proposed Alberhill Villages project.

1.4 PROPOSED MASTER DRAINAGE FACILITIES

Figure 2 shows the approximate master drainage facilities for the proposed Alberhill Villages project. The estimated sizes of these facilities and their approximate locations are intended for conceptual purposes only and will be refined in the design review process.

1.5 RELATED STUDIES

Reference studies prepared for the adjacent Tract 28214 Alberhill Ranch project and Horsethief Canyon project have been reviewed and evaluated. The flows and/or tributary drainage areas have been included in the hydrologic models presented in this report.

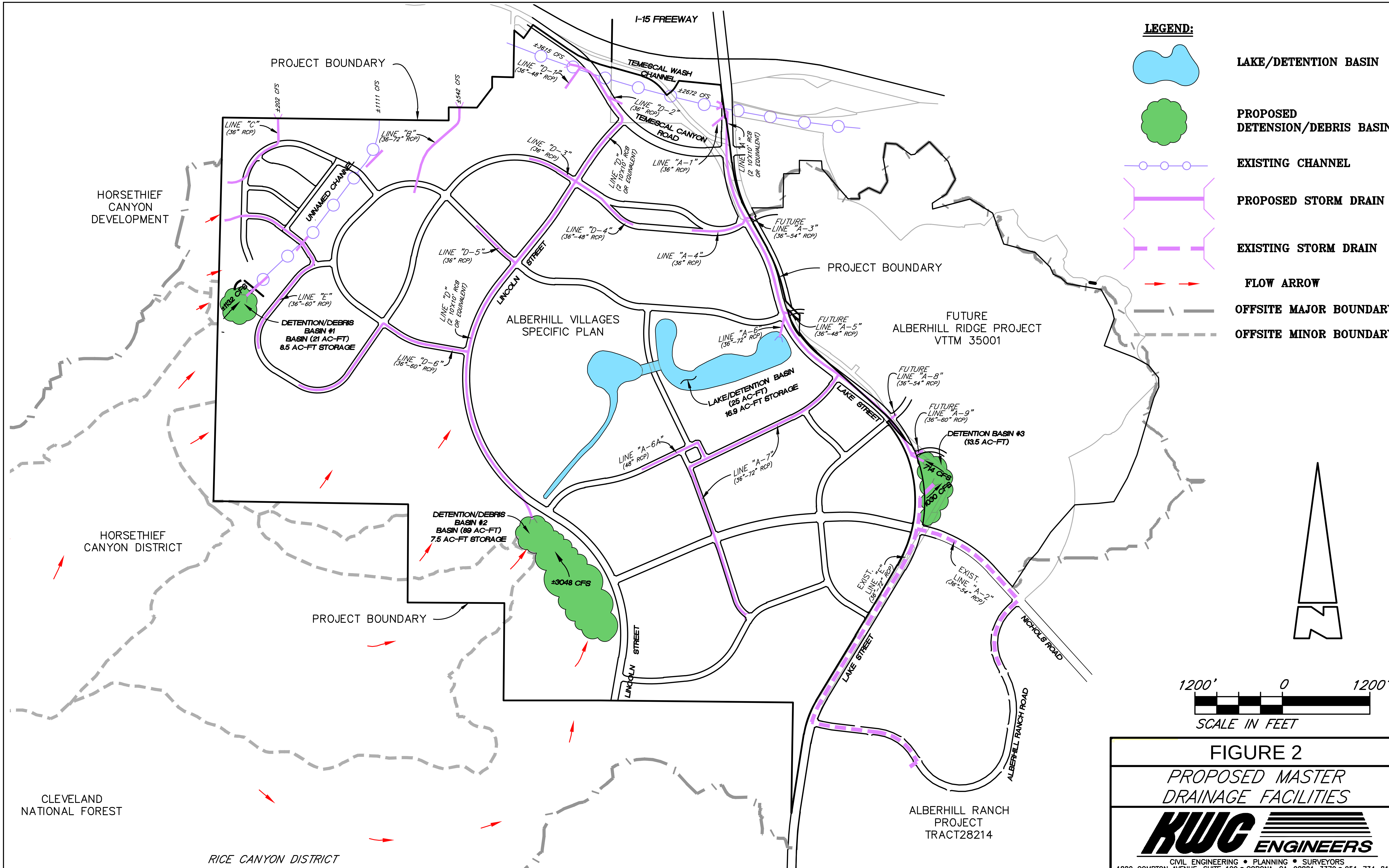

FIGURE 2
PROPOSED MASTER DRAINAGE FACILITIES

Section

2
HYDROLOGIC DATA AND MODEL DEVELOPMENT

2.1 EXISTING CONDITION MODEL

The Alberhill Villages site generally drains from the south to Temescal Wash, a major drainage channel along the northerly boundary of the project site. The site is divided into 5 drainage watersheds as identified by their discharge points in this report. Each watershed consists of smaller on-site and off-site shed areas. The 5 drainage watersheds are Outlet 1, Outlet 2, Outlet 3, Temescal 1, and Temescal 2. These existing watershed areas are consistent with the City of Lake Elsinore Master Drainage Plan. Tributary to Temescal 1 watershed are the developed flows generated from the Alberhill Ranch project discharging from the Lake Street Detention Basin located at the northeast corner of the Lake Street and Nichols Road intersection; Shed 1 and Shed 2 have also been considered developed as established by previously approved hydrology studies prepared for the Alberhill Ranch project (refer to reference Alberhill Ranch hydrology studies for more information). Sheds Horsethief 1, Horsethief 2, and Horsethief 3 are also developed flows tributary to Outlet 2 and Outlet 3.

Existing conditions drainage watersheds were delineated based on the May 2005 1-foot and 2-foot contour topographic data by Inland Aerial for the site. The outlet points where the peak flows were calculated are located along the northerly property boundary of the project as shown in **Figure 3**. These locations were identified as the most downstream point in the natural drain system where all the flow paths from the studied drainage area come together and exit the site. Additional topographic information was obtained from the 1995 RCFC&WCD Topo Maps. AutoCad was used to delineate the existing watersheds and flow path as shown in **Figure B-1** in **Appendix B**.

The soil and hydrologic soil group digital data (shapefiles) for Riverside County were downloaded from the Soil Data Mart of the National Resources Conservation Services (NRCS). **Figure B-2** in **Appendix B** shows the hydrologic soil group distribution over the proposed project site. The existing land use information was obtained from field surveys and aerial photographs. Land cover for the existing conditions was assumed to be mostly natural, chaparral narrow leaf in fair and poor conditions, open brush in fair and poor conditions, and some barren areas as indicated in **Figure B-3** in **Appendix B**.

Precipitation point values for the Alberhill Villages drainage sheds for the 2-year, 5-year, and 10-year return periods with the 1-hour, 3-hour, 6-hour, and 24-hour duration events were obtained from the Precipitation Frequency Data Server, NOAA Atlas 14 for the Semiarid Southwest, released online in 2006, which replaced the NOAA Atlas 2, Volume XI for California published in 1973 as shown in the RCFC&WCD Hydrology Manual (1978). Precipitation area adjustment

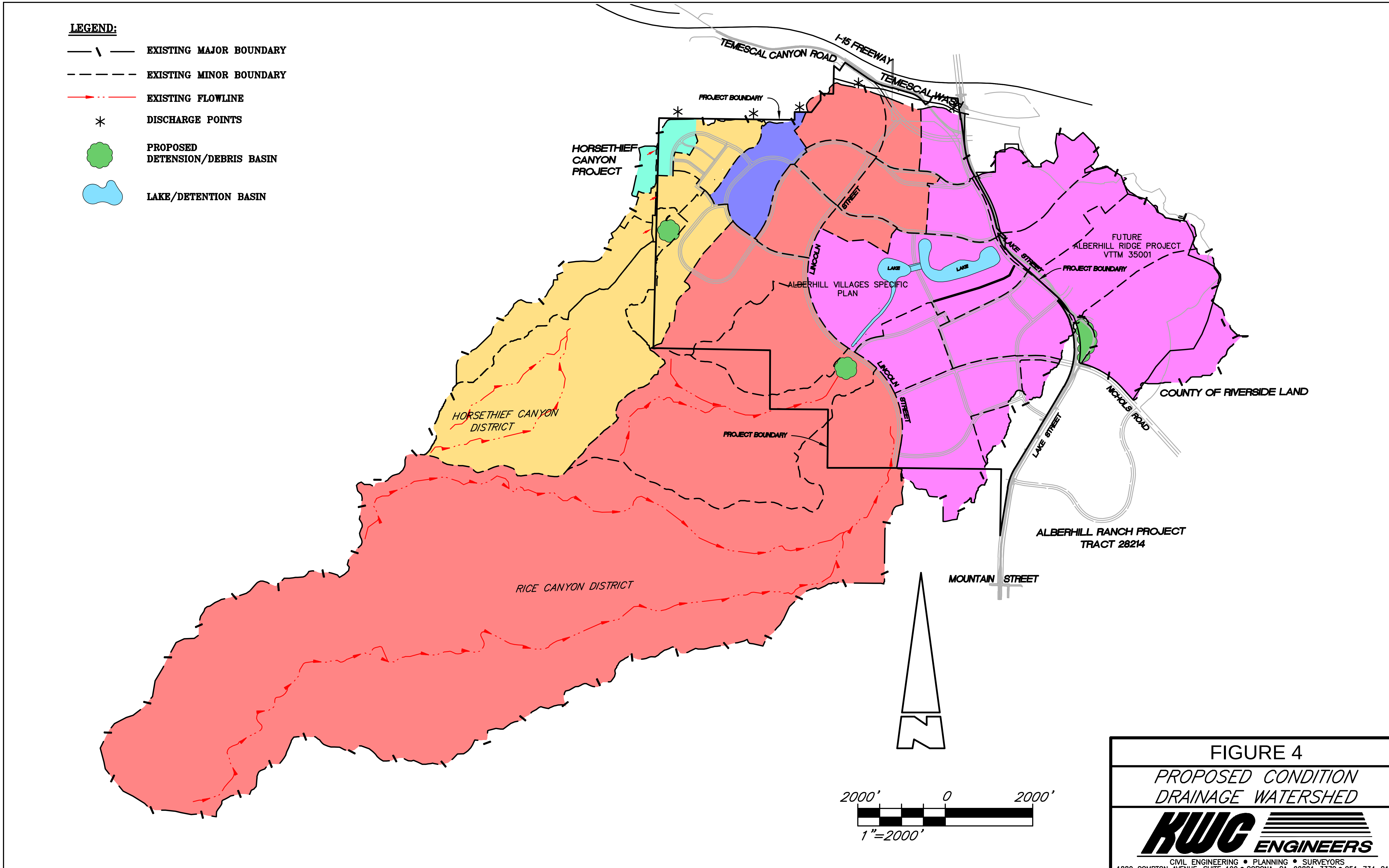

FIGURE 4

PROPOSED CONDITION DRAINAGE WATERSHED

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was necessary in some drainage sheds due to the size of the study area (more than one square mile). **Table 1** presents the unadjusted total point precipitation depths used in the study.

Table 1. Precipitation Depth in Inches (NOAA Atlas 14)

Duration\ Return Period	1-hr	3-hr	6-hr	24-hr
2 year	0.58	1.03	1.51	2.60
5 year	0.76	1.33	1.95	3.48
10 year	0.93	1.57	2.29	4.16
100 year	1.60	2.51	3.56	6.56

Table 2 presents adjusted total point precipitation depths for PacArea 1, PacArea 2 and Pac 1. (See Plate E-5.7 in **Appendix A** for the complete document).

Table 2. Adjusted Precipitation Depth in Inches (Plate E-5.7)

Duration\ Return Period	1-hr	3-hr	6-hr
2 year	0.57	1.02	1.49
5 year	0.75	1.32	1.93
10 year	0.92	1.55	2.27
100 year	1.58	2.48	3.52

Infiltration rates were estimated based on Plate E-6.2 in the RCFCWD Hydrology Manual (1978) using the runoff index (RI) determined for each soil and land use condition according to Plate E-6.1. Antecedent Soil Moisture Conditions (AMC) were assumed to be AMC II for the 10-year and 100-year return periods, while AMC I was used (Plate E-6.2) for the 2- and 5-year return periods. **Table 2** presents the calculated loss rates (Fp) for each soil group and land use for existing conditions based on the regression equations presented in **Appendix A**.

Table 3. Calculated Loss Rate for Existing Conditions (in/hr)

HYDROLOGIC SOIL GROUP	LAND USE	% IMPERVIOUS	CN	Fp PER AMC I	Fp PER AMC II	F (I)	F(II)
A	Chaparral Fair Conditions	0	55	0.71	0.52	0.71	0.52
B	Chaparral Fair Conditions	0	72	0.54	0.34	0.54	0.34
C	Chaparral Fair Conditions	0	81	0.43	0.24	0.43	0.24
D	Chaparral Fair Conditions	0	86	0.34	0.18	0.34	0.18
A	Chaparral Poor Conditions	0	71	0.55	0.35	0.55	0.35
B	Chaparral Poor Conditions	0	82	0.41	0.22	0.41	0.22
C	Chaparral Poor Conditions	0	88	0.30	0.15	0.30	0.15
D	Chaparral Poor Conditions	0	91	0.25	0.12	0.25	0.12
A	Open Brush Fair Conditions	0	46	0.79	0.61	0.79	0.61
B	Open Brush Fair Conditions	0	66	0.60	0.40	0.60	0.40
C	Open Brush Fair Conditions	0	77	0.48	0.28	0.48	0.28
D	Open Brush Fair Conditions	0	83	0.40	0.21	0.40	0.21
A	Open Brush Poor Conditions	0	62	0.65	0.45	0.65	0.45
B	Open Brush Poor Conditions	0	76	0.49	0.29	0.49	0.29
C	Open Brush Poor Conditions	0	84	0.37	0.20	0.37	0.20
D	Open Brush Poor Conditions	0	88	0.30	0.16	0.30	0.16
A	Barren	0	78	0.46	0.27	0.46	0.27
B	Barren	0	86	0.34	0.18	0.34	0.18
C	Barren	0	91	0.25	0.12	0.25	0.12
D	Barren	0	93	0.20	0.09	0.20	0.09
A	Single Family	50	32	0.88	0.74	0.48	0.41
B	Single Family	50	56	0.70	0.51	0.39	0.28
C	Single Family	50	69	0.57	0.37	0.31	0.20
D	Single Family	50	75	0.50	0.31	0.28	0.17

In the case of a 24-hour storm, losses were calculated for each storm and each infiltration rate value following the procedure outlined in the RCFC&WCD Hydrology Manual (1978). A variable loss rate (time dependent) was compared to the rainfall rate for the same time period. In the case when the loss rate was exceeding the precipitation rate, a minimum value of a loss rate (taken as 50 percent of the adjusted loss rate) was used instead. For each basin with a different infiltration rate (from 0.1 to 0.7), and excess precipitation function was assigned according to the frequency of the event (i.e., 2-year, 5-year, and 10-year). Each precipitation curve is presented in **Appendix B**, while the meteorological model description for the 24-hour event shows the correspondence between each shed and the assigned excess precipitation function. The rainfall-runoff transformation was determined using the S-graph approach as outlined in Section E of the RCFC&WCD Hydrology Manual (1978). The Foothills S-curve was found to be suitable for the study area. Lags were determined as described on Plate E-3 based on watershed parameters obtained for the existing conditions watersheds and are shown in **Table 3**. **Figure B-1** in **Appendix B** shows the location of watershed centroids, centroidal and longest flow paths for each shed for existing condition.

Table 4. Existing Conditions Watershed Hydrologic Parameters

WATERSHED	Area (Acres)	Longest Flow Path (miles)	Centr. Flow Path (miles)	Slope (ft/mile)	Manning's "n" value	Lag (hours)	CN	Infilt. rate for AMC I (in/hr)	Infilt. rate for AMC II (in/hr)
Ex Area 1	240	1.32	0.62	246	0.030	0.23	84	0.36	0.20
Ex Area 2	125	1.04	0.55	342	0.030	0.19	86	0.33	0.18
Ex Area 3	160	1.13	0.76	310	0.030	0.23	91	0.23	0.11
Ex Area 4	76	0.80	0.37	460	0.030	0.14	73	0.49	0.31
PacArea 1	1951	5.33	3.10	486	0.030	0.65	81	0.43	0.24
PacArea 2	833	2.70	1.14	456	0.030	0.35	84	0.36	0.20
PacArea 3	184	1.35	0.83	451	0.030	0.24	89	0.29	0.15
PacArea 4	330	1.77	1.03	795	0.030	0.25	82	0.41	0.23
PacArea 5	73	0.57	0.33	256	0.020	0.09	84	0.36	0.20
PacArea 6	29	0.41	0.17	541	0.020	0.05	83	0.38	0.21
Horsethief 1	82	1.39	0.73	672	0.024	0.17	72	0.34	0.22
Horsethief 2	8	0.25	0.15	321	0.015	0.03	56	0.39	0.28
Horsethief 3	10	0.26	0.13	230	0.015	0.04	56	0.39	0.28
Shed 1	90	0.85	0.29	439	0.015	0.07	75	0.31	0.20
Shed 2	87	0.85	0.49	403	0.015	0.08	70	0.28	0.17
MSHCP2	22	0.44	0.23	678	0.030	0.09	84	0.37	0.20
MSHCP2*	15	0.31	0.13	774	0.030	0.06	81	0.43	0.24

The Muskingum method was chosen to route the hydrographs through the entire watersheds. **Table 4** presents the parameters obtained from field surveys and topographic data for the existing condition.

Table 5. Existing Conditions Routing Hydrologic Parameters

Reach	Length (ft)	Upstream Elevation (ft)	Downstream Elevation (ft)	Slope (ft/ft)	Manning's n	Bottom Width (ft)	Side Slope (H:V)
Natural 1	2230	1394	1310	0.04	0.03	30	10
Natural 2	2760	1501	1310	0.07	0.03	30	10
Natural 3	3967	1301	1242	0.01	0.03	80	3
Natural 4	1110	1242	1222	0.02	0.03	80	3
Pac Natural 1	3660	1330	1210	0.03	0.03	80	10
Pac Natural 2	700	1430	1377	0.08	0.03	40	10
Pac Natural 3	2928	1377	1225	0.05	0.03	100	10
Pac Natural 4	2016	1427	1220	0.10	0.03	50	10
Pac Natural 5	1237	1370	1220	0.12	0.03	50	10

The hydrologic data were imported into the latest Hydrologic Engineering Center HEC-HMS Model, Version 3.2, and two existing conditions basin models (AMC I Conditions and AMC II Conditions) were created. The rainfall patterns were tabulated as presented on Plate E-5.9 in the RCFC&WCD Hydrology Manual (1978) and the total precipitation depths were adjusted based on **Table 1** and Plate E-5.7 (Appendix A), which are shown in **Table 2. Appendix D** shows the existing basin schematic in the HEC-HMS model.

2.2 PROPOSED CONDITION MODEL

Similar to the existing condition drainage watersheds, the proposed condition model also drains to the same 5 distinct watershed discharge points. For the Temescal 1 watershed, it is proposed that the developed flows be collected in a master plan storm drain system that runs within Lake Street from the Lake Street Detention Basin northerly to Temescal Wash. For the Temescal 2 watershed, it is proposed that the developed flows will be collected in a master plan storm drain system that runs within Temescal Canyon Road. For the Outlet 1 and Outlet 3 watersheds, it is proposed that the developed flow be collected in a storm drain system and discharged along the northerly boundary. For the Outlet 2 watershed, it is proposed that the existing off-site flows drain along the existing drainage channel while collecting developed flows generated from the project site.

Proposed condition drainage watershed was developed based on the land use plan proposed by the Alberhill Villages Specific Plan and is shown in **Figure 4**. Watersheds centroids, flow paths and elevations are presented in **Figure C-1** in **Appendix C**.

Land use information was obtained from the Alberhill Villages Specific Plan. Land cover for the proposed conditions includes residential (single family and multi-family), parks, commercial (i.e. mixed-use, institutional, etc.), chaparral narrow leaf in fair and poor conditions, and open brush in fair conditions (see **Figure C-3** in **Appendix C**).

Infiltration rates were determined as outlined in Section 2.1. However, for a developed area analysis, the effect of impervious surfaces on the average infiltration rate for each shed must be considered. Therefore, an adjusted loss rate based on the relationship presented on Page E-8 in the RCFC&WCD Hydrology Manual (1978) was used to account for the developed areas. The impervious area decimal percent for different conditions was chosen based on Plate E-6.3 in the RCFC&WCD Hydrology Manual (1978).

Table 6 presents the adjusted loss rate (F) for each soil group and land use for proposed conditions. The average infiltration rate value for each proposed shed was calculated based on the AMC conditions, soil, and land use information.

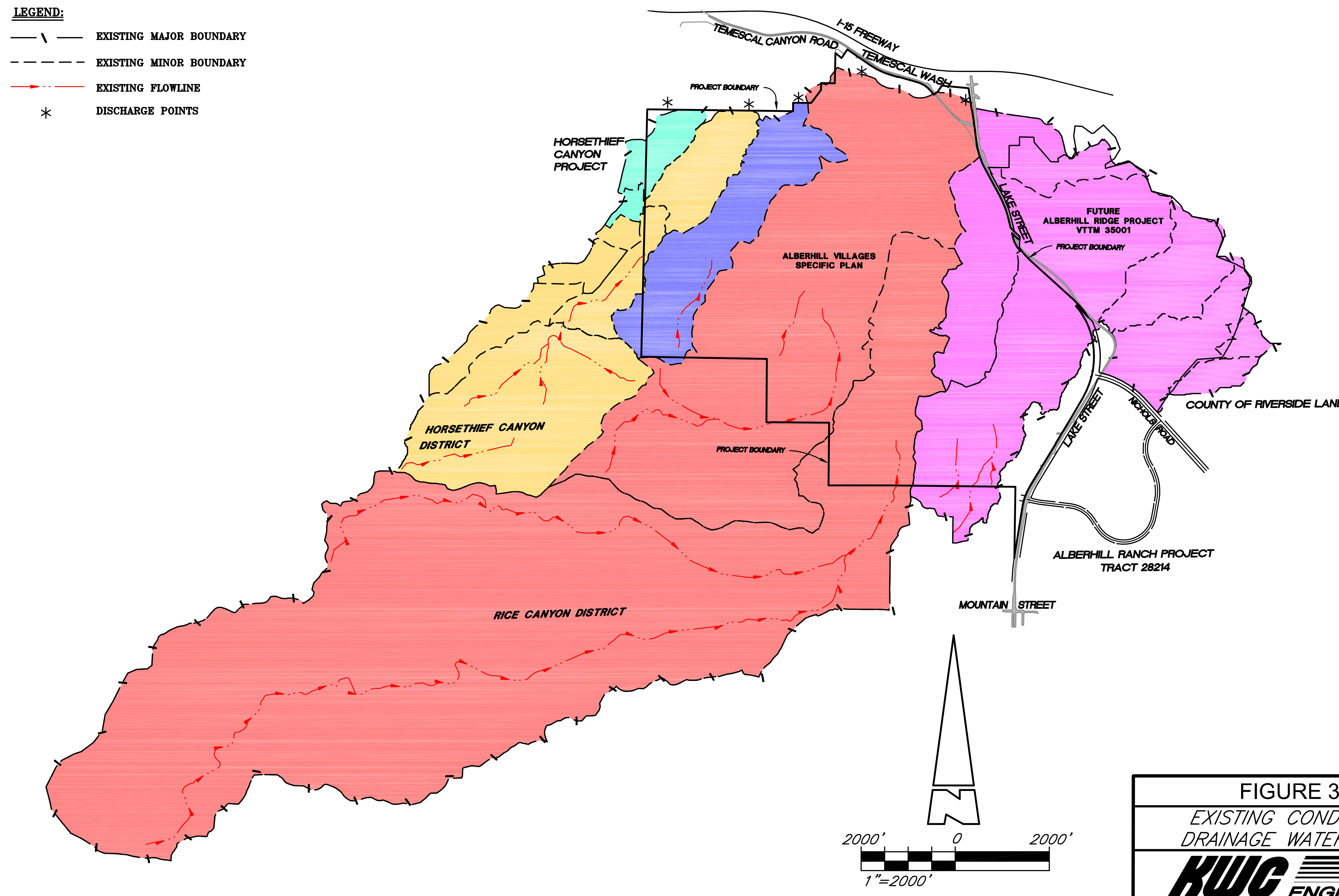

FIGURE 3

EXISTING CONDITION DRAINAGE WATERSHED

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Table 6. Adjusted Loss Rate for Proposed Conditions (in/hr)

HYDROLOGIC SOIL GROUP	LAND USE	% IMPERVIOUS	CN	Fp PER AMC I	Fp PER AMC II	F (I)	F(II)
A	Chaparral Fair Conditions	0	55	0.71	0.52	0.71	0.52
B	Chaparral Fair Conditions	0	72	0.54	0.34	0.54	0.34
C	Chaparral Fair Conditions	0	81	0.43	0.24	0.43	0.24
D	Chaparral Fair Conditions	0	86	0.34	0.18	0.34	0.18
A	Chaparral Poor Conditions	0	71	0.55	0.35	0.55	0.35
B	Chaparral Poor Conditions	0	82	0.41	0.22	0.41	0.22
C	Chaparral Poor Conditions	0	88	0.30	0.15	0.30	0.15
D	Chaparral Poor Conditions	0	91	0.25	0.12	0.25	0.12
A	Open Brush Fair Conditions	0	46	0.79	0.61	0.79	0.61
B	Open Brush Fair Conditions	0	66	0.60	0.40	0.60	0.40
C	Open Brush Fair Conditions	0	77	0.48	0.28	0.48	0.28
D	Open Brush Fair Conditions	0	83	0.40	0.21	0.40	0.21
A	Open Brush Poor Conditions	0	62	0.65	0.45	0.65	0.45
B	Open Brush Poor Conditions	0	76	0.49	0.29	0.49	0.29
C	Open Brush Poor Conditions	0	84	0.37	0.20	0.37	0.20
D	Open Brush Poor Conditions	0	88	0.30	0.16	0.30	0.16
A	Barren	0	78	0.46	0.27	0.46	0.27
B	Barren	0	86	0.34	0.18	0.34	0.18
C	Barren	0	91	0.25	0.12	0.25	0.12
D	Barren	0	93	0.20	0.09	0.20	0.09
A	Single Family	50	32	0.88	0.74	0.48	0.41
B	Single Family	50	56	0.70	0.51	0.39	0.28
C	Single Family	50	69	0.57	0.37	0.31	0.20
D	Single Family	50	75	0.50	0.31	0.28	0.17
A	Multi-family	65	32	0.88	0.74	0.37	0.31
B	Multi-family	65	56	0.70	0.51	0.29	0.21
C	Multi-family	65	69	0.57	0.37	0.24	0.15
D	Multi-family	65	75	0.50	0.31	0.21	0.13
A	Commercial	90	32	0.88	0.74	0.17	0.14
B	Commercial	90	56	0.70	0.51	0.13	0.10
C	Commercial	90	69	0.57	0.37	0.11	0.07
D	Commercial	90	75	0.50	0.31	0.10	0.06
A	Park Site	5	33	0.88	0.74	0.84	0.71
B	Park Site	5	58	0.68	0.49	0.65	0.47
C	Park Site	5	72	0.54	0.34	0.52	0.32
D	Park Site	5	79	0.45	0.26	0.43	0.25

Lags (to be included in the rainfall-runoff S-curve transformation) were determined based on the flow lengths and slopes obtained preliminary conceptual grading studies and are shown in **Table 7**.

Table 7. Proposed Conditions Watershed Hydrologic Parameters

WATERSHED	Area (Acres)	Longest Flow Path (miles)	Centr. Flow Path (miles)	Slope (ft/mile)	Manning's "n" value	Lag (hours)	CN	Infilt. rate for AMC I (in/hr)	Infilt. rate for AMC II (in/hr)
R-Area 1	178	0.79	0.38	555	0.021	0.09	77	0.32	0.19
R-Area 2	113	0.80	0.31	459	0.016	0.07	69	0.28	0.17
Area 3	322	1.42	0.73	216	0.017	0.15	64	0.32	0.22
Area 4	197	0.94	0.44	106	0.017	0.12	49	0.40	0.27
R-Area 5	65	0.79	0.28	527	0.018	0.07	41	0.34	0.20
Area 6	40	0.39	0.31	102	0.015	0.07	74	0.10	0.06
R-Area 7	79	0.59	0.28	297	0.016	0.06	63	0.30	0.19
Area 8	38	0.27	0.15	98	0.015	0.04	38	0.20	0.16
Pac 1	1827	4.63	2.52	519	0.03	0.54	80	0.43	0.24
Pac 2	311	1.33	0.67	766	0.027	0.17	80	0.41	0.23
Pac 3	230	0.91	0.39	597	0.019	0.09	76	0.29	0.17
Pac 4	52	0.59	0.24	169	0.017	0.07	41	0.31	0.18
Pac 5	37	0.36	0.17	143	0.015	0.05	75	0.21	0.13
Pac 6	75	0.93	0.40	75	0.015	0.11	63	0.17	0.12
Pac 7	30	0.40	0.27	72	0.015	0.07	42	0.19	0.15
Pac 8	53	0.39	0.18	97	0.015	0.05	73	0.11	0.07
Pac 9	65	0.68	0.34	218	0.015	0.07	74	0.28	0.17
Pac 10	332	1.71	0.97	817	0.03	0.24	81	0.41	0.23
Pac 11	68	0.79	0.36	632	0.016	0.07	71	0.34	0.22
Pac 12	17	0.28	0.14	316	0.015	0.03	62	0.35	0.24
Pac 13	40	0.45	0.27	295	0.020	0.07	68	0.39	0.25
Pac 14	23	0.35	0.16	583	0.015	0.04	71	0.30	0.19
Horsethief 1	82	1.39	0.73	672	0.024	0.17	72	0.34	0.22
Horsethief 2	8	0.25	0.15	321	0.015	0.03	56	0.39	0.28
Horsethief 3	10	0.26	0.13	230	0.015	0.04	56	0.39	0.28

Table 8 and **Table 9** shows the routing hydrologic parameters used for proposed conditions. All storm drain pipes (**Appendix C, Figure C-1**) were modeled using a simple lag method based on estimated travel time. Velocities were estimated based on Manning's equation.

Table 8. Proposed Conditions Routing Hydrologic Parameters (Open Channel)

Reach	Length (ft)	Upstream Elevation (ft)	Downstream Elevation (ft)	Slope (ft/ft)	Manning's n	Bottom Width (ft)	Side Slope (H:V)
Horsethief 1	503	1450	1382	0.14	0.03	40	3
K-L	1060	1382	1343	0.04	0.03	40	3
L-Outlet 2	2069	1343	1231	0.05	0.03	40	3
Pac Channel 1	2062	1450	1326	0.06	0.03	100	3
Pac Channel 2	921	1326	1310	0.02	0.03	100	3

Table 9. Proposed Conditions Routing Hydrologic Parameters (Storm Drain)

Pipe Name	Length (ft)	U/S Elevation (feet)	D/S Elevation (feet)	Slope (ft/ft)	Box Size/Diameter (feet)	Travel Time (minutes)
A-B	2554	1310	1298	0.005	2-10'X10'	0.99
B-C	1400	1298	1232	0.047	2-10'X10'	0.43
C-D	1397	1232	1209	0.016	2-10'X10'	0.72
D-E	1360	1209	1204	0.004	2-10'X10'	0.99
E-F	284	1204	1203	0.004	2-10'X10'	0.30
F-Temescal 2	143	1203	1202	0.007	2-10'X10'	0.04
H-I	458	1388	1310	0.170	2'	0.37
I-Outlet 3	912	1310	1218	0.101	3'	0.54
G-L	1453	1430	1343	0.060	3'	0.99
AA-BB	242	1304	1300	0.017	6.5'	0.20
BB-CC	513	1300	1280	0.039	7'	0.41
CC-DD	944	1280	1270	0.011	9'	0.86
DD-EE	1096	1270	1236	0.031	9'	0.62
EE-FF	90	1236	1235	0.011	10'X12'	0.06
FF-GG	1410	1235	1218	0.012	10'X12'	0.79
GG-HH	1478	1218	1213	0.003	2-10'X10'	0.99
HH-Temescal 1	143	1213	1212	0.007	2-10'X10'	0.06

Figure C-1 in **Appendix C** and **Table 10** represent a detailed overview of nodes and connections.

Table 10. Proposed Conditions Model Elements Connections (Storm Drain)

NODE	Drainage Areas	Upstream Connection	Downstream Connection	Elevation from Preliminary Grading Design
A	Pac 2	N/A	Pipe A-B	1310
B	Pac 3	Pipe A-B	Pipe B-C	1298
C	Pac 4	Pipe B-C	Pipe C-D	1232
D	Pac 5-6	Pipe C-D	Pipe D-E	1209
E	Pac 7	Pipe D-E	Pipe E-F	1204
F	Pac 8	Pipe E-F	Pipe F-Temescal 2	1203
I	Horsethief 1	Pipe H-I	Pipe-Outlet 3	1388
L	Horsethief 2	Pipe G-L	Channel L-Outlet 2	1430
AA	Alberhill Ranch	Detention Basin	Pipe AA-BB	1304
BB	R-Area 1	Pipe AA-BB	Pipe BB-CC	1300
CC	R-Area 2	Pipe BB-CC	Pipe CC-DD	1280
DD	R-Area 3, Area 5	Pipe CC-DD	Pipe DD-EE	1270
EE	R-Area 4	Pipe DD-EE	Pipe EE-FF	1236
FF	R-Area 5	Pipe EE-FF	Pipe FF-GG	1235
GG	Area 6, R-Area 7	Pipe FF-GG	Pipe GG-HH	1218
HH	Area 8	Pipe GG-HH	Pipe HH-Temescal 1	1213
Junction 1	Pac 1	N/A	Pac Channel 2	1326

The above hydrologic data were imported into the HEC-HMS model and corresponding proposed conditions basin models (AMC I Conditions and AMC II Conditions) were created. **Appendix D** shows the proposed basin schematic in the HEC-HMS model.

Section

3
DETENTION ANALYSIS

3.1 DESIGN CRITERIA

Onsite detention facilities were found to be effective in mitigating the impacts of frequent events (i.e., 2-year to 10-year storm events); however, they have little impacts on low frequency events (i.e., 100-year storm event). For this reason, RCFC&WCD released in 1995 the following guidelines for sizing increased runoff detention facilities:

1) Storms to be studied are 1-hour, 3-hour, 6-hour, and 24-hour duration events for the 2-year, 5-year, and 10-year return frequencies. Detention basin(s) and outlet sizing(s) will ensure that none of these storm events have higher peak discharge in the "after" condition than in the "before" condition.

2) Loss rates are to be determined for the 2- and 5-year events using an AMC I condition, while an AMC II should be used for the 10-year event. All durations should incorporate constant loss rates, except for the 24-hour where a variable loss rate is used.

3) A single plot showing the pre-development, post-development and routed hydrographs for each storm event considered shall be included with the submittal of the hydrology study.

4) The detention structure must be capable of passing the 100-year storm without damage to the facility.

3.2 PEAK FLOWS

Table 11 presents a comparison between the existing and proposed peak outflow at the outlet point without the proposed detention pond in place. As indicated in **Table 12**, the proposed conditions peak flow is lower than the existing conditions peak flow for the drainage watershed discharging at Outlet 1 and Outlet 3 for the 2-year, 5-year, 10-year, and 100-year storm events. However, the proposed conditions peak flow is higher than the existing conditions peak flow for the drainage watershed discharging at Outlet 2, Temescal 1, and Temescal 2. Results are presented in **Appendix F**.

Table 11. Existing and Proposed Conditions Peak Flows

Storm Event	Existing Conditions Peak Outflow (cfs)				Proposed Conditions Peak Outflow (cfs)			
	Ex-Outlet 1				Outlet 1			
	1-hour	3-hour	6-hour	24-hour	1-hour	3-hour	6-hour	24-hour
2-year	153.6	89.6	83.3	12.9	92.3	44.0	43.2	5.2
5year	217.6	130.8	123.3	35.8	126.7	62.2	61.1	13.7
10-year	303.7	190.1	180.2	83.0	166.4	84.0	82.2	25.0
100-year	542.1	320.6	295.6		294.4	141.0	134.0	
Storm Event	**Existing Conditions Peak Outflow (cfs)**				**Proposed Conditions Peak Outflow (cfs)**			
	Ex-Outlet 2				**Outlet 2**			
	1-hour	3-hour	6-hour	24-hour	1-hour	3-hour	6-hour	24-hour
2-year	288.7	163.2	150.1	24.8	276.5	194.7	185.9	26.2
5year	418.7	268.2	251.2	54.5	427.5	318.9	301.9	72.3
10-year	607.1	437.3	415.9	173.0	665.1	509.5	486.9	199.7
100-year	1111.2	767.5	715.0		1252.2	900.5	837.8	
Storm Event	**Existing Conditions Peak Outflow (cfs)**				**Proposed Conditions Peak Outflow (cfs)**			
	Ex-Outlet 3				**Outlet 3**			
	1-hour	3-hour	6-hour	24-hour	1-hour	3-hour	6-hour	24-hour
2-year	51.9	23.5	24.4	2.8	50.7	19.6	19.4	1.6
5year	76.5	39.2	37.5	5.6	69.5	28.2	28.0	5.3
10-year	107.9	57.1	54.8	16.4	90.5	38.3	37.8	10.4
100-year	201.7	99.1	92.6		160.5	65.2	62.4	
Storm Event	**Existing Conditions Peak Outflow (cfs)**				**Proposed Conditions Peak Outflow (cfs)**			
	Ex-Temescal 1				**Temescal 1**			
	1-hour	3-hour	6-hour	24-hour	1-hour	3-hour	6-hour	24-hour
2-year	613.9	406.5	392.1	71.3	1051.9	635.1	631.8	93.4
5year	923.3	622.9	589.8	166.1	1482.2	914.7	908.8	250.5
10-year	1331.3	917.8	881.6	366.4	2001.6	1260.4	1264.1	445.6
100-year	2672.4	1927.3	1813.6		3781.6	2505.9	2431.2	
Storm Event	**Existing Conditions Peak Outflow (cfs)**				**Proposed Conditions Peak Outflow (cfs)**			
	Ex-Temescal 2				**Temescal 2**			
	1-hour	3-hour	6-hour	24-hour	1-hour	3-hour	6-hour	24-hour
2-year	739.4	476.7	474.6	139.1	793.4	548.2	540.5	158.1
5year	1159.9	840.1	915.0	235.1	1205.9	931.7	974.7	282.0
10-year	1870.5	1661.1	1754.5	851.8	2022.4	1725.5	1781.7	849.9
100-year	3615.2	3054.4	3083.7		3859.6	3138.3	3111.2	

Table 12. Difference in Peak Flow between Existing and Proposed Conditions

Storm Event	Difference (Proposed - Existing) Peak Outflow (cfs)			
	Outlet 1/Ex-Outlet 1			
	1-hour	3-hour	6-hour	24-hour
2-year	-61.3	-45.6	-40.1	-7.7
5year	-90.9	-68.6	-62.2	-22.1
10-year	-137.3	-106.1	-98	-58
100-year	-247.7	-179.6	-161.6	
Storm Event	**Difference (Proposed - Existing) Peak Outflow (cfs)**			
	Outlet 2/Ex-Outlet 2			
	1-hour	3-hour	6-hour	24-hour
2-year	-12.2	31.5	35.8	1.4
5year	8.8	50.7	50.7	17.8
10-year	58	72.2	71	26.7
100-year	141	133	122.8	
Storm Event	**Difference (Proposed - Existing) Peak Outflow (cfs)**			
	Outlet 3/Ex-Outlet 3			
	1-hour	3-hour	6-hour	24-hour
2-year	-1.2	-3.9	-5	-1.2
5year	-7	-11	-9.5	-0.3
10-year	-17.4	-18.8	-17	-6
100-year	-41.2	-33.9	-30.2	
Storm Event	**Difference (Proposed - Existing) Peak Outflow (cfs)**			
	Temescal 1/Ex-Temescal 1			
	1-hour	3-hour	6-hour	24-hour
2-year	438	228.6	239.7	22.1
5year	558.9	291.8	319	84.4
10-year	670.3	342.6	382.5	79.2
100-year	1109.2	578.6	617.6	
Storm Event	**Difference (Proposed - Existing) Peak Outflow (cfs)**			
	Temescal 2/Ex-Temescal 2			
	1-hour	3-hour	6-hour	24-hour
2-year	54	71.5	65.9	19
5year	46	91.6	59.7	46.9
10-year	151.9	64.4	27.2	-1.9
100-year	244.4	83.9	27.5	

Appendix G presents the comparison between the existing and proposed conditions hydrographs at the outlet points.

3.2 PEAK RUNOFF VOLUME RESULTS

Table 13 presents a comparison between the existing and proposed peak storage at the outlet point without a proposed detention pond in place. As indicated in **Table 14**, the proposed conditions peak storage is lower than the existing conditions peak runoff volume for the drainage watershed discharging at Outlet 1 and Outlet 3 for the 2-year, 5-year, 10-year, and 100-year storm events. However, the proposed conditions peak runoff volume is higher than the existing conditions peak runoff volume for the drainage watershed discharging at Outlet 2, Temescal 1, and Temescal 2. Results are presented in **Appendix F**.

Table 13. Existing and Proposed Conditions Peak Runoff Volume (ac-ft)

Storm Event	Existing Conditions Peak Runoff Volume (ac-ft)				Proposed Conditions Peak Outflow (ac-ft)			
	Ex-Outlet 1				Outlet 1			
	1-hour	3-hour	6-hour	24-hour	1-hour	3-hour	6-hour	24-hour
2-year	4.5	4.6	5.2	7.2	1.6	1.7	2.0	2.5
5year	7.2	8.0	9.3	12.6	2.6	2.9	3.4	4.5
10-year	12.0	17.3	21.6	35.8	4.1	5.8	7.0	8.6
100-year	22.3	31.6	41.0		7.8	10.9	13.9	
Storm Event	**Existing Conditions Peak Runoff Volume (ac-ft)**				**Proposed Conditions Peak Runoff Volume (ac-ft)**			
	Ex-Outlet 2				**Outlet 2**			
	1-hour	3-hour	6-hour	24-hour	1-hour	3-hour	6-hour	24-hour
2-year	9.5	8.0	8.5	20.0	10.8	9.2	9.8	22.5
5year	15.4	14.9	16.9	26.5	17.6	17.2	19.5	31.4
10-year	28.6	36.9	42.0	63.8	32.3	41.1	46.6	72.3
100-year	55.7	74.6	90.6		63.3	84.1	101.6	
Storm Event	**Existing Conditions Peak Runoff Volume (ac-ft)**				**Proposed Conditions Peak Runoff Volume (ac-ft)**			
	Ex-Outlet 3				**Outlet 3**			
	1-hour	3-hour	6-hour	24-hour	1-hour	3-hour	6-hour	24-hour
2-year	0.9	0.8	0.8	2.0	0.7	0.6	0.7	1.2
5year	1.5	1.5	1.7	2.5	1.1	1.1	1.3	1.8
10-year	2.8	3.5	4.0	5.5	1.7	2.3	2.6	3.4
100-year	5.4	7.1	8.6		3.4	4.5	5.5	
Storm Event	**Existing Conditions Peak Runoff Volume (ac-ft)**				**Proposed Conditions Peak Runoff Volume (ac-ft)**			
	Ex-Temescal 1				**Temescal 1**			
	1-hour	3-hour	6-hour	24-hour	1-hour	3-hour	6-hour	24-hour
2-year	25.7	25.3	28.4	50.3	30.8	31.1	35.3	58.0
5year	40.9	44.3	51.0	77.3	49.4	54.1	63.1	94.2
10-year	68.4	93.3	112.2	155.0	80.0	106.5	125.3	170.5
100-year	129.8	178.4	223.0		153.0	208.2	256.9	
Storm Event	**Existing Conditions Peak Runoff Volume (ac-ft)**				**Proposed Conditions Peak Runoff Volume (ac-ft)**			
	Ex-Temescal 2				**Temescal 2**			
	1-hour	3-hour	6-hour	24-hour	1-hour	3-hour	6-hour	24-hour
2-year	50.4	42.0	42.7	115.6	50.7	45.9	48.0	112.8
5year	82.7	78.8	87.9	144.1	81.9	82.3	93.1	151.6
10-year	160.6	203.6	233.5	365.7	152.8	196.3	228.1	355.4
100-year	313.9	417.6	504.8		297.2	397.9	484.1	

Table 14. Difference in Peak Runoff Volume (ac-ft) between Existing and Proposed Conditions

Storm Event	Difference (Proposed - Existing) Peak Runoff Volume (ac-ft)			
	Outlet 1/Ex-Outlet 1			
	1-hour	3-hour	6-hour	24-hour
2-year	-2.9	-2.9	-3.2	-4.7
5year	-4.6	-5.1	-5.9	-8.1
10-year	-7.9	-11.5	-14.6	-27.2
100-year	-14.5	-20.7	-27.1	
Storm Event	**Difference (Proposed - Existing) Peak Runoff Volume (ac-ft)**			
	Outlet 2/Ex-Outlet 2			
	1-hour	3-hour	6-hour	24-hour
2-year	1.3	1.2	1.3	2.5
5year	2.2	2.3	2.6	4.9
10-year	3.7	4.2	4.6	8.5
100-year	7.6	9.5	11.0	0.0
Storm Event	**Difference (Proposed - Existing) Peak Runoff Volume (ac-ft)**			
	Outlet 3/Ex-Outlet 3			
	1-hour	3-hour	6-hour	24-hour
2-year	-0.2	-0.2	-0.1	-0.8
5year	-0.4	-0.4	-0.4	-0.7
10-year	-1.1	-1.2	-1.4	-2.1
100-year	-2.0	-2.6	-3.1	
Storm Event	**Difference (Proposed - Existing) Peak Runoff Volume (ac-ft)**			
	Temescal 1/Ex-Temescal 1			
	1-hour	3-hour	6-hour	24-hour
2-year	5.1	5.8	6.9	7.7
5year	8.5	9.8	12.1	16.9
10-year	11.6	13.2	13.1	15.5
100-year	23.2	29.8	33.9	
Storm Event	**Difference (Proposed - Existing) Peak Runoff Volume (ac-ft)**			
	Temescal 2/Ex-Temescal 2			
	1-hour	3-hour	6-hour	24-hour
2-year	0.3	3.9	5.3	-2.8
5year	-0.8	3.5	5.2	7.5
10-year	-7.8	-7.3	-5.4	-10.3
100-year	-16.7	-19.7	-20.7	

Appendix G presents the comparison between the existing and proposed conditions hydrographs at the outlet points.

Section

4
DEBRIS BASIN ANALYSIS

4.1 DESIGN CRITERIA

This Section determines the debris yield for the undeveloped tributary watershed areas upstream of the development. The corresponding calculated debris yield is then used to determine the size of the debris basin required upstream of the drainage watersheds Pac 1, Pac 2, and Pac 10 for the Rice Canyon District and Horsethief Canyon District. To predict debris yield Los Angeles District Method is used as shown below.

4.2 DEBRIS YIELD

LOS ANGELES DISTIRCT METHOD FOR PREDICTION OF DEBRIS YIELD
February 1992, updated February 2000

For Watershed areas from 0.1 square mile to 3.0 square miles, use equation 1 as shown on page 15

LOG DY = 0.65(LOG P) + 0.62(LOG RR) + 0.18(LOG A) + 0.12(FF)

Where:

Dy = Unit Debris Yield (yd^3/mi^2)
P = Maximum 1-Hour Precipitation (inches, taken to two decimal places after the decimal points, times 100)
RR = Relief Ratio (ft/mi)
A = Drainage Area (ac)
FF = Non-Dimentional Fire factor

UNDEVELOPED TRIBUTARY AREA (PAC 1 & PAC 2)

P = 160
RR = 519 ft/mi^2
A = 1827 + 311 = 2138 AC = 3.339 mi^2
FF = 6.5

LOG(P) = 2.204120
LOG(RR) = 2.715167
LOG(A) = 3.330008

LOG (DY) = 1.432678+1.683403+0.599401+0.78 = 4.495482

DY = 31,295.51 CY/mi^2

REDUCED ADJUSTED UNIT DEBRIS BY STUDY ACREAGE

THEREFORE DY = 104,495.71 CY

DEBRIS YIELD = 104,496 CY = 64.8 AC-FT

SAFETY FACTOR IS 1.25, THEREFORE THE TOTAL DEBRIS YIELD IS: 130,620 CY

USE DEBRIS YIELD = 130,620 CY = 80.9 AC-FT

UNDEVELOPED TRIBUTARY AREA (PAC 10)

P = 160
RR = 817 ft/mi^2
A = 332 AC = 0.519 mi^2
FF = 6.5

LOG(P) = 2.204120
LOG(RR) = 2.912222
LOG(A) = 2.521138

LOG (DY) = 1.432678+1.805578+0.453805+0.78 = 4.472060

DY = 29,652.45 CY/mi^2

REDUCED ADJUSTED UNIT DEBRIS BY STUDY ACREAGE

THEREFORE DY = 15,390 CY

DEBRIS YIELD = 15,390 CY = 9.5 AC-FT

SAFETY FACTOR IS 1.25, THEREFORE THE TOTAL DEBRIS YIELD IS: 19,238 CY

USE DEBRIS YIELD = 19,238 CY = 11.9 AC-FT

Section

5
TEMESCAL CREEK HYDRAULIC ANALYSIS

Temescal Creek runs in an east to west direction along the northerly property line of the Project just south of the I-15 freeway. FEMA has prepared a detailed Flood Insurance Study (FIS) for this reach of Temescal Creek, refer to FIRM Panel 06065C2007G in **Appendix H**. The FIRM map shows areas of Temescal Creek and the proposed development that are currently within the Floodway and Floodplain as well as water surface elevations per the detailed FIS. Development or structures within the floodplain limits would be required to obtain flood insurance. However, FEMA allows the floodplain/floodway limits to be revised or modified based on either a more detailed analysis of the existing drainage course using more accurate/current topography or a detailed analysis of a proposed channelizing of the floodway through filing of a Conditional Letter of Map Revision (CLOMR) and Letter of Map Revision (LOMR) process.

The Alberhill Villages project proposes to grade the existing Temescal Creek drainage course to create a more confined trapezoidal earthen channel to convey the drainage runoff across the site. Preliminary studies have been prepared to analyze the potential configuration and alignment of this proposed channel. The analysis estimates that a trapezoidal earthen channel with a bottom width of 150 feet and 3:1 side slopes will be sufficient to convey the drainage runoff across the project site and contain the runoff within the proposed earthen channel. Channel improvements proposed are based on a 100-year design storm of 10,400 cfs as determined by FEMA's FIS study for this reach of Temescal Creek.

Currently the City of Lake Elsinore is preparing initial plans and studies to reconstruct the existing two-lane Temescal Canyon Road Bridge over Temescal Creek. The City plans to construct a portion (phase 1) of the ultimate Temescal Creek Channel as they construct the new bridge located 1,200 feet downstream of the existing bridge. This new bridge is located at its ultimate location in conjunction with the future development of Alberhill Villages.

The HEC-RAS software program, version 4.1.0, was used to perform a preliminary hydraulic analyze of Temescal Creek along the project's northern boundary in the Pre-project, Phase 1 and Ultimate Conditions. In the Pre-project analysis, river cross-sections were sampled utilizing aerial topography flown in 2006. The Pre-project floodplain and floodway limit results are shown in **Figure 5.** In the Phase 1 analysis, the model analyzes the channel with the proposed Temescal Canyon Road Bridge in place and phase 1 of the channel improvements, approximately 1,250 feet total of channel improvements. The Post-project Phase 1 floodplain and floodway limit results are shown in **Figure 6.** In the Ultimate analysis, the model analyzes the channel improvements between Lake Street and the project's northwesterly limits. The Post-project Ultimate Condition floodplain and floodway limit results are shown in **Figure 7.** Hydraulic calculations for each condition are presented in **Appendix H**.

The proposed Temescal Canyon Road Bridge is 100 feet wide, 250 feet long, and 6 feet thick. The proposed channel improvements consist of an approximately 150 feet wide soft bottom earthen channel with approximately 30 feet wide side slopes, and approximately 210 feet wide channel top width. The channel bottom width reduces to 120 feet near the proposed bridge. The channel profile follows the existing grade of Temescal Creek approximately and outlets into the natural creek flowline with smooth transitions at the downstream end of the project boundary.

Detailed model result summary tables and corresponding Floodplain sections are included in **Appendix H** for the Pre-project, Post-Project Phase 1 and Post-Project Ultimate Condition Scenarios. The Post-Project Phase 1, and Post-Project Ultimate Condition Models water surface elevation and velocity match the Pre-Project water surface elevation 1207.40 and velocity 7.23 feet per second at the downstream station 107+400 of the Project improvements. Freeboard under the proposed Temescal Canyon Road Bridge (water surface elevation to bottom of bridge) is greater than 4 feet. Freeboard along the project frontage (proposed water surface elevation to the top of the channel) is greater than 2 feet. Velocities in the Post-Project Conditions range from 2.6 feet per second to 7.4 feet per second. The need for Energy Dissipating Rip-Rap within the channel to mitigate the velocity will be analyzed in Final Engineering. Channel side-slope protection will be necessary; the type of material will be analyzed in Final Engineering and coordinated with the landscape scheme for the channel improvements.

Section

6
REFERENCES

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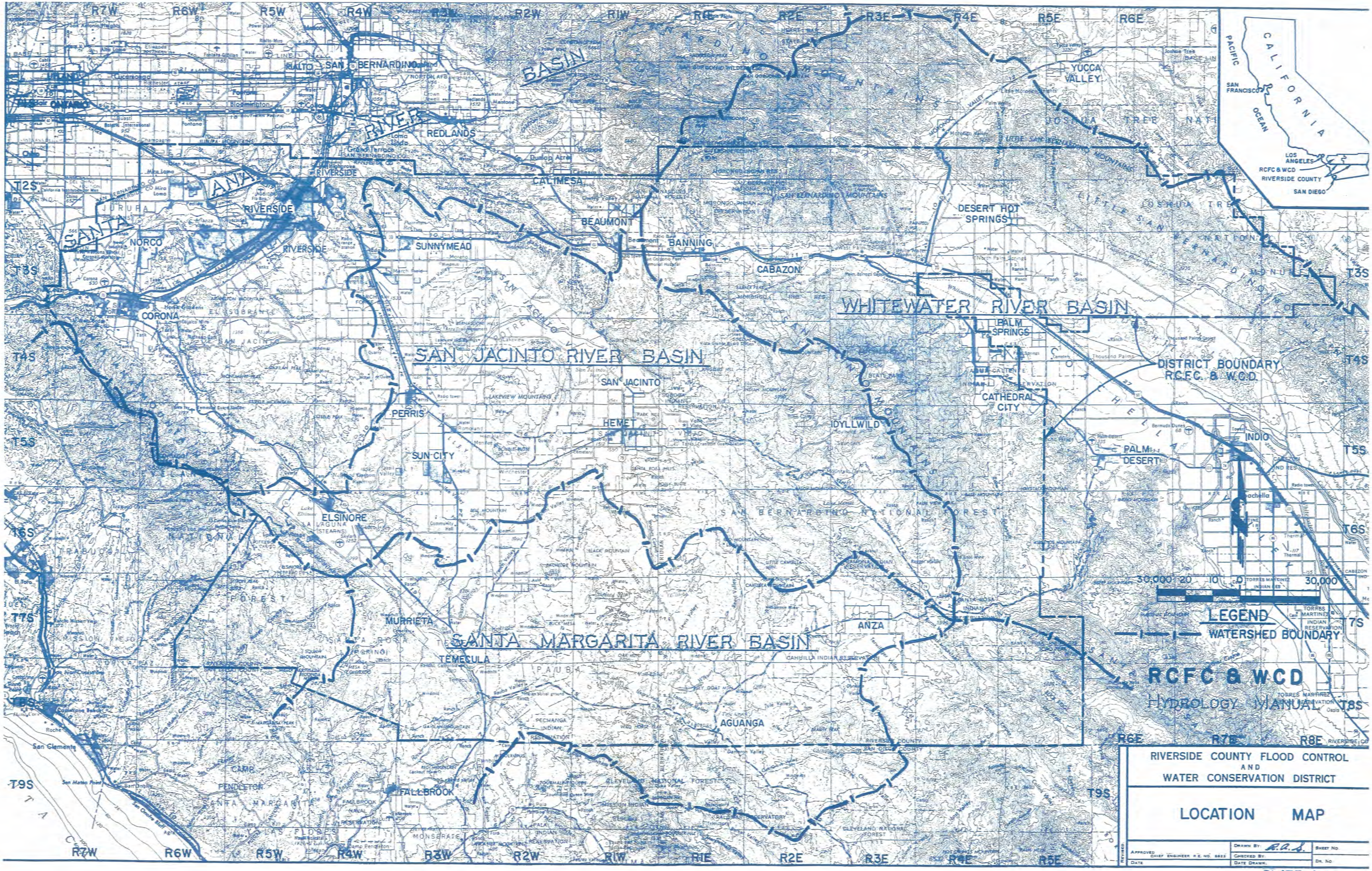
Appendix

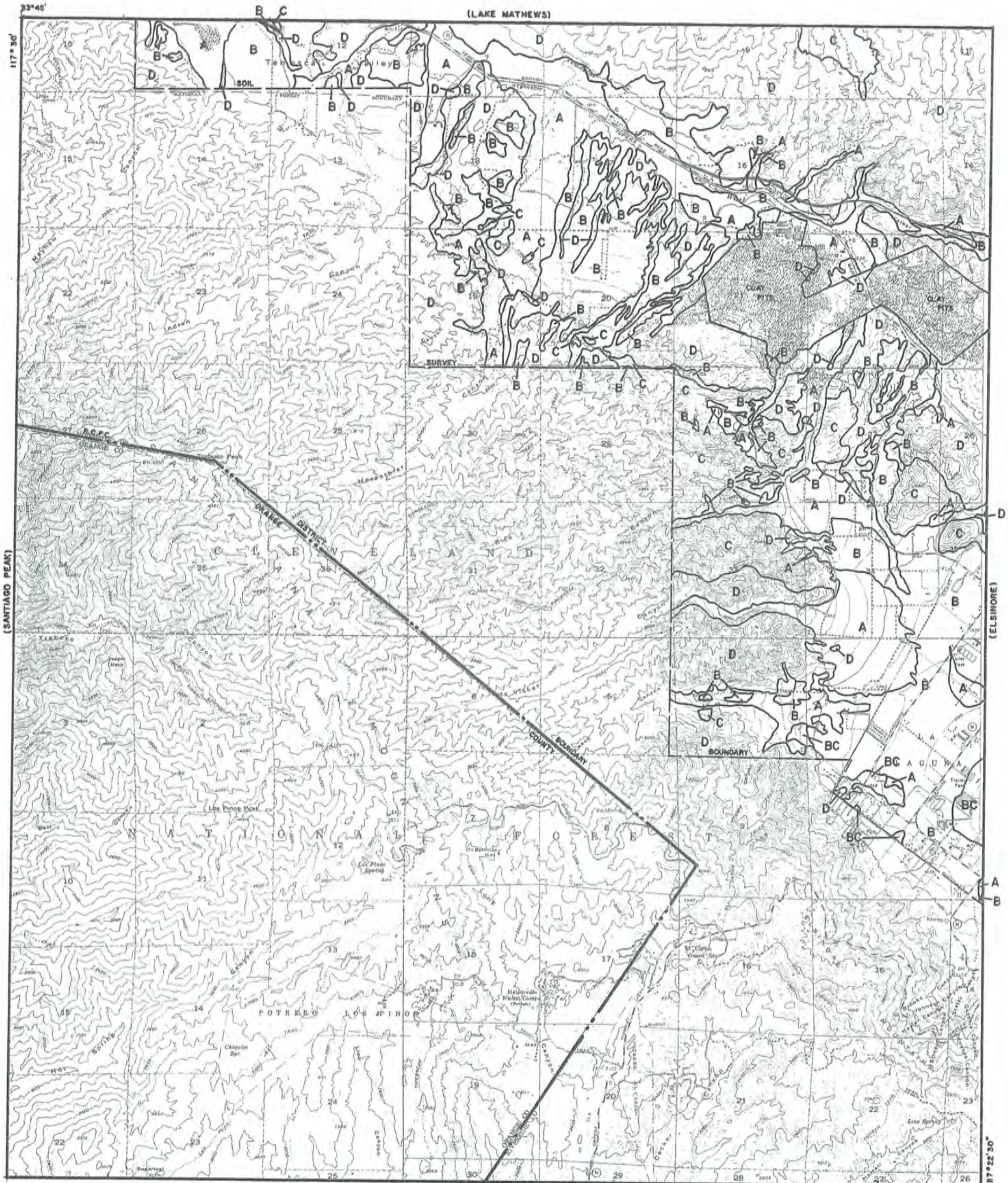
A
RCFC&WCD HYDROLOGIC DATA



RIVERSIDE COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

LOCATION MAP

PLATE A-1



LEGEND

—— SOILS GROUP BOUNDARY

A SOILS GROUP DESIGNATION

RCFC & WCD

HYDROLOGY MANUAL

0 FEET 5000

HYDROLOGIC SOILS GROUP MAP FOR ALBERHILL

PLATE C-1.40

LEGEND

—— SOILS GROUP BOUNDARY

A SOILS GROUP DESIGNATION

RCFC & WCD

HYDROLOGY MANUAL

0 FEET 5000

HYDROLOGIC SOILS GROUP MAP FOR ELSINORE

PLATE C-1.41


RIVERSIDE COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
2-YEAR — 3-HOUR PRECIPITATION
RCFC & WCD
HYDROLOGY MANUAL
NOTES:
1. Isohyetals based on NOAA Atlas 2, Volume XI - California, 1973.
R7W
R6W
R5W
R4W
R3W
R2W
R1W
R1E
R2E
R3E
R4E
R5E
R6E
R7E
R8E
T1S
T2S
T3S
T4S
T5S
T6S
T7S
T8S
T9S
SAN BERNARDINO
RIVERSIDE
ONTARIO
RIALTO
Beaumont
San Jacinto
LAKEVIEW MOUNTAINS
SAN BERNARDINO NATIONAL FOREST
JOSHUA TREE NATIONAL MONUMENT
CAHUILLA INDIAN RESERVATION
CLEVELAND NATIONAL FOREST
San Clemente
Fallbrook
Indio
Coachella
Palm Desert
Palm Springs
30,000
20
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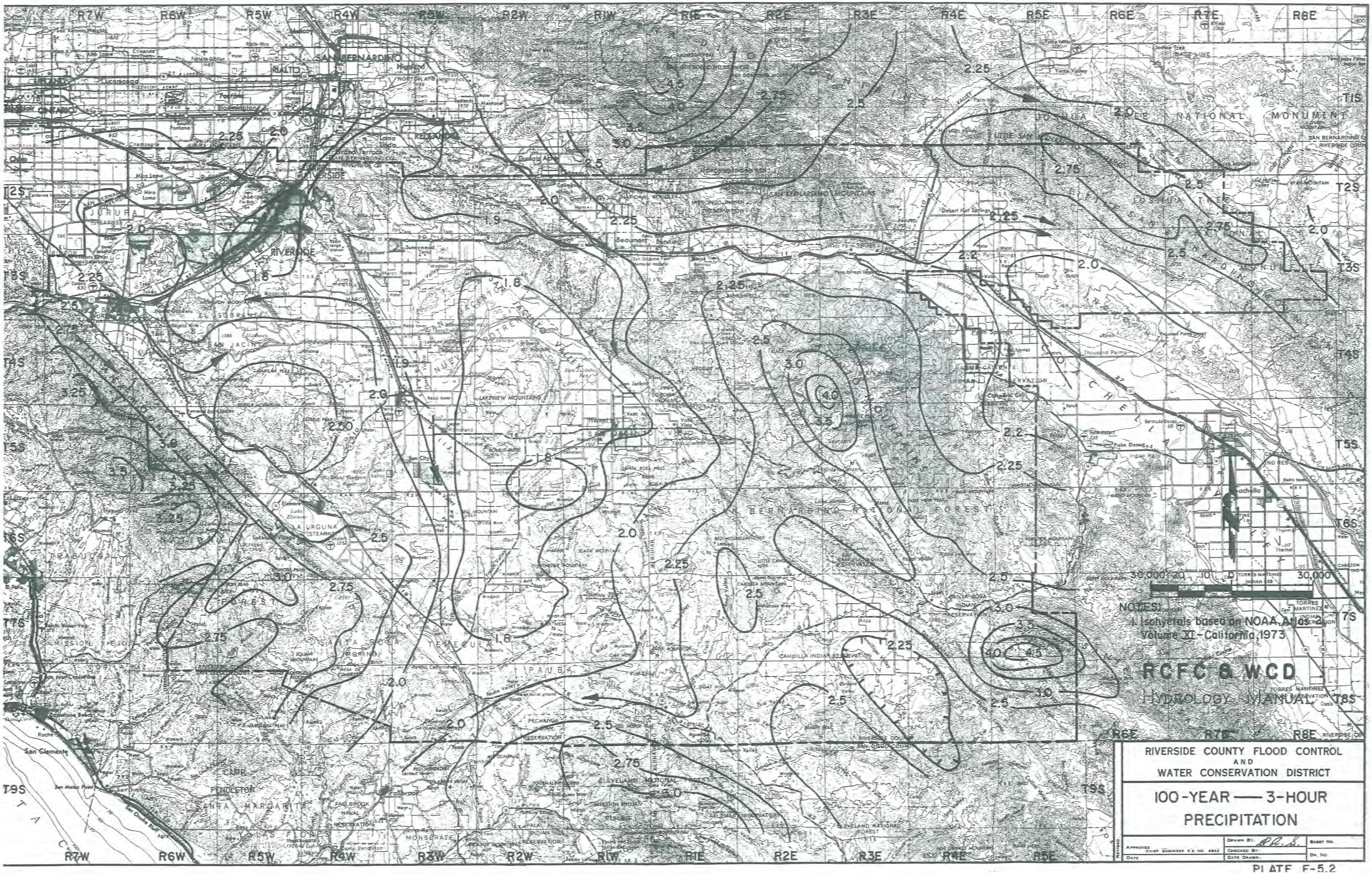
PLATE F-5.1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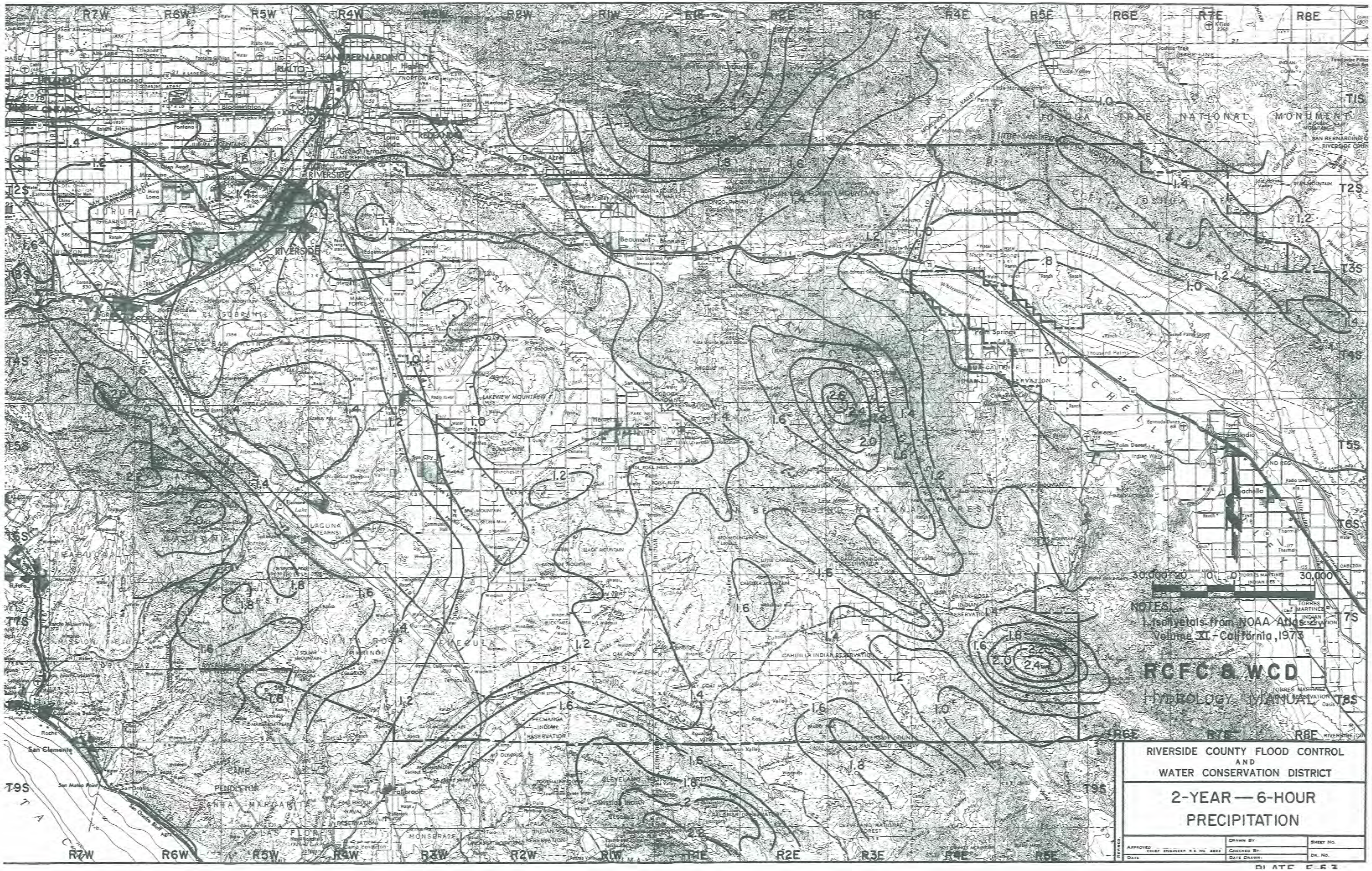
SAN BERNARDINO
RIVERSIDE
ONTARIO
JURUPA
BEAUMONT
PALM SPRINGS
SAN BERNARDINO MOUNTAINS
SAN BERNARDINO NATIONAL FOREST
JOSHUA TREE NATIONAL MONUMENT
CAHUILLA INDIAN RESERVATION
CLEVELAND NATIONAL FOREST
CAMP PENDLETON
SANTA MARGARITA
TEMECULA
PAUBA
PECHANGA
San Clemente
Fallbrook
30,000 20 10 0 30,000
NOTES:
1. Isohyetals based on NOAA Atlas 2, Volume XI - California, 1973
RCFC & WCD
HYDROLOGY MANUAL
RIVERSIDE COUNTY FLOOD CONTROL
AND
WATER CONSERVATION DISTRICT
100-YEAR —— 3-HOUR
PRECIPITATION
APPROVED
CHIEF ENGINEER R.E. NO.
DATE
DRAWN BY
CHECKED BY
DATE DRAWN
SHEET NO.
DR. NO.
REVISED
PLATE E-5.2


RIVERSIDE COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
2-YEAR — 6-HOUR PRECIPITATION
PLATE E-5.3
RCFC & WCD
HYDROLOGY MANUAL
NOTES:
1. Isohyetals from NOAA Atlas 2, Volume XI - California, 1973
30,000 20 10 0 30,000
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R3W
R2W
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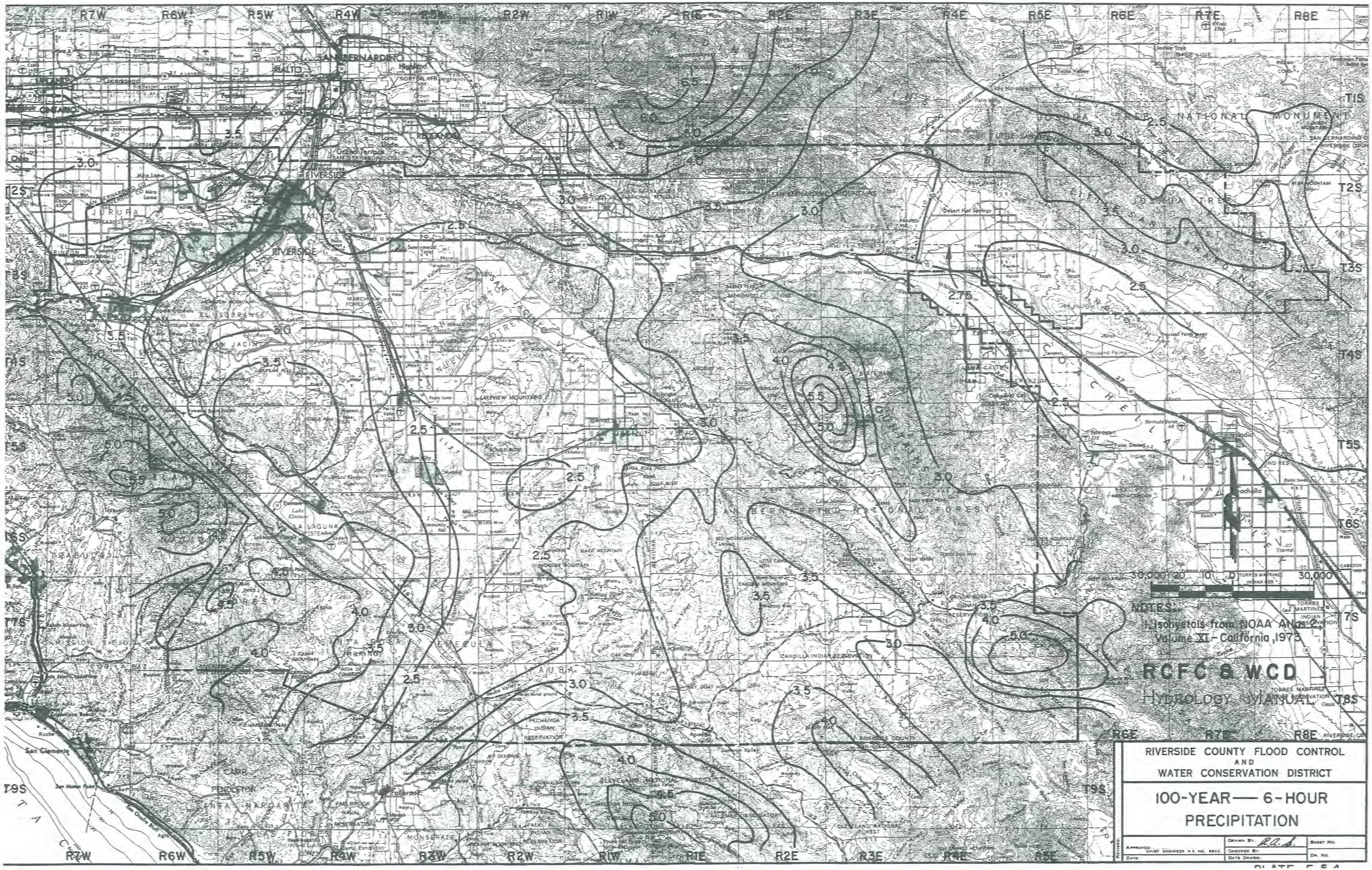
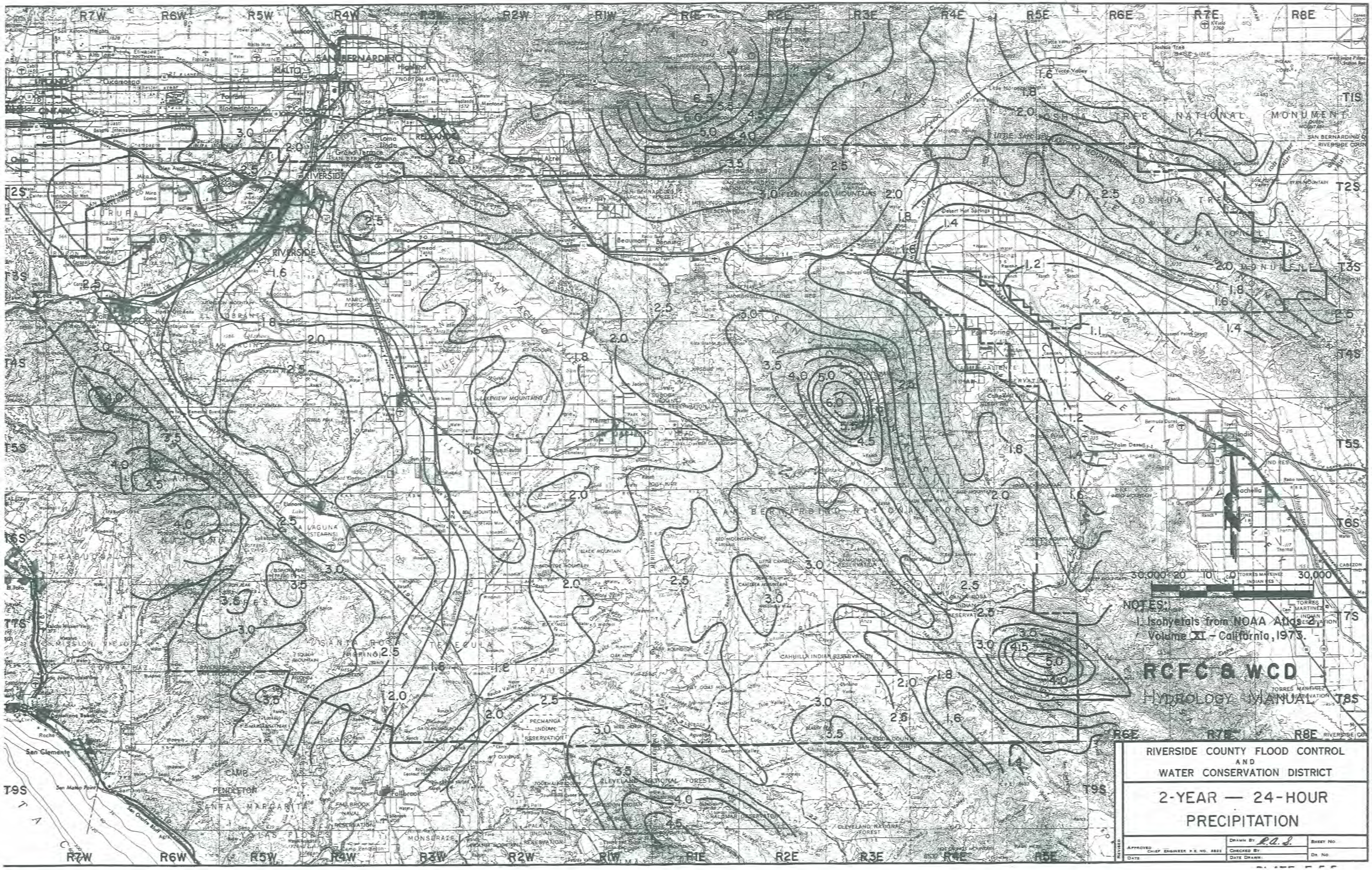
T2S
T3S
T4S
T5S
T6S
T7S
T8S
T9S
SAN BERNARDINO
RIVERSIDE
REDLANDS
RIALTO
ONTARIO
FONTANA
BEAUMONT
BANNING
PALM SPRINGS
INDIO
COACHELLA
SAN JACINTO
HEMET
SAN CLEMENTE
FALLBROOK
JOSHUA TREE NATIONAL MONUMENT
LAKEVIEW MOUNTAINS
SAN BERNARDINO NATIONAL FOREST
CAHUILLA INDIAN RESERVATION
PECHANGA INDIAN RESERVATION
CLEVELAND NATIONAL FOREST
LAGUNA
PENDLETON
SANTA MARGARITA
JURUPA
EL SOBRANTE
TORRES MARTINEZ INDIAN RESERVATION
APPROVED
CHIEF ENGINEER
DRAWN BY:
CHECKED BY:
DATE DRAWN:
DATE
SHEET NO.
DR. NO.



R7W R6W R5W R4W R3W R2W R1W R1E R2E R3E R4E R5E R6E R7E R8E
T1S T2S T3S T4S T5S T6S T7S T8S T9S
SAN BERNARDINO
RIALTO
RIVERSIDE
JURUPA
CORONA
ELSINORE
LAKEVIEW MOUNTAINS
HEMET
SAN JACINTO
BEAUMONT
BANNING
PALM SPRINGS
CATHEDRAL CITY
INDIO
COACHELLA
JOSHUA TREE NATIONAL MONUMENT
SAN BERNARDINO NATIONAL FOREST
SAN BERNARDINO MOUNTAINS
CAHUILLA INDIAN RESERVATION
PECHANGA INDIAN RESERVATION
TEMECULA
San Clemente
FALLBROOK
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 — 6-HOUR
PRECIPITATION
APPROVED
CHIEF ENGINEER R.E. NO.
DATE
DRAWN BY R.A.S.
CHECKED BY
DATE DRAWN
SHEET NO.
DR. NO.
REVISED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R4W
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R2W
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R1E
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T2S
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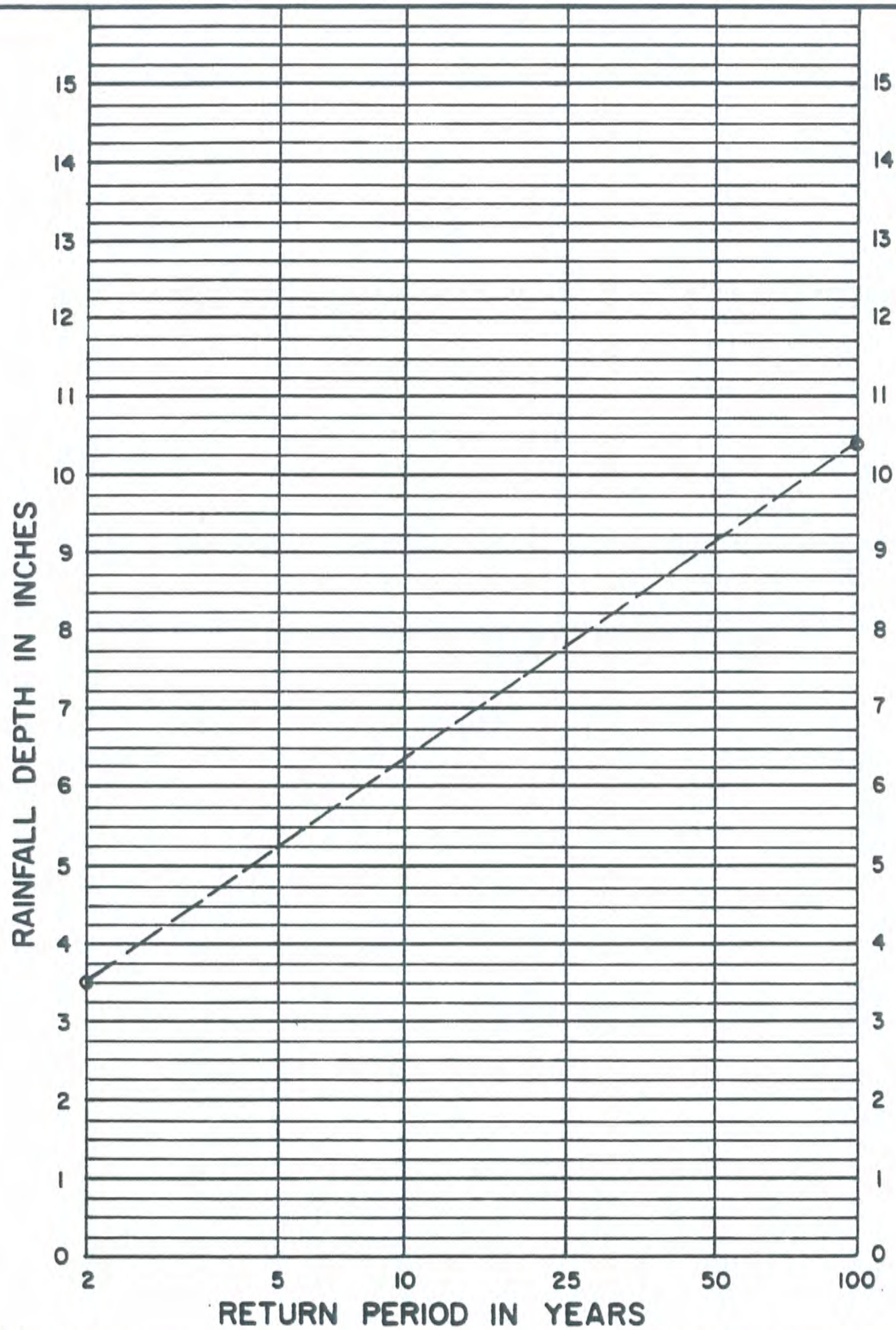
T4S
T5S
T6S
T7S
T8S
T9S
SAN BERNARDINO
RIVERSIDE
JOSHUA TREE NATIONAL MONUMENT
SAN BERNARDINO NATIONAL FOREST
CLEVELAND NATIONAL FOREST
CAMP PENDLETON
SANTA MARGARITA
Palm Springs
Desert Hot Springs
Beaumont
Banning
Indio
Coachella
San Clemente
Fallbrook
LA LAGUNA (STEARNS)
PECHANGA INDIAN RESERVATION
CAHUILLA INDIAN RESERVATION
TORRES MARTINEZ INDIAN RESERVATION
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
2-YEAR — 24-HOUR
PRECIPITATION
APPROVED
CHIEF ENGINEER R.E. NO. 8822
DATE
REVISED
DRAWN BY R.A.S.
CHECKED BY
DATE DRAWN
SHEET NO.
DR. NO.

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



NOTE:

1. For intermediate return periods plot 2-year and 100-year values from maps for a specific duration, then connect points and read value for desired return period. For example given 2-year 24-hour = 3.50" and 100-year 24-hour = 10.40", 25-year 24-hour = 7.80"

Reference: NOAA Atlas 2, Volume XI - California, 1973.

RCFC & WCD

HYDROLOGY MANUAL

RAINFALL DEPTH VERSUS RETURN PERIOD FOR PARTIAL DURATION SERIES

POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14

California 33.71 N 117.42 W 1578 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 1, Version 4
G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2006

Extracted: Fri Aug 1 2008

Confidence Limits | Seasonality | Location Maps | Other Info. | GIS data | Maps | Help | D

Precipitation Frequency Estimates (inches)

ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	(
1	0.14	0.22	0.27	0.37	0.46	0.66	0.82	1.19	1.59	2.00	2.20	2.59	3.02	3.35	4.03	4.75	5.41	6.
2	0.18	0.28	0.35	0.47	0.58	0.83	1.03	1.51	2.04	2.60	2.88	3.43	4.02	4.45	5.36	6.34	7.25	8.
5	0.24	0.37	0.46	0.62	0.76	1.07	1.33	1.95	2.67	3.48	3.96	4.81	5.71	6.29	7.59	9.03	10.48	1
10	0.29	0.45	0.56	0.75	0.93	1.28	1.57	2.29	3.14	4.16	4.80	5.87	7.02	7.72	9.32	11.06	13.02	1
25	0.37	0.56	0.70	0.94	1.16	1.58	1.93	2.77	3.80	5.08	5.98	7.32	8.86	9.72	11.74	13.88	16.61	1
50	0.43	0.66	0.82	1.10	1.37	1.82	2.21	3.16	4.31	5.80	6.92	8.48	10.33	11.31	13.67	16.09	19.53	2
100	0.51	0.77	0.96	1.29	1.60	2.09	2.51	3.56	4.84	6.56	7.92	9.70	11.90	13.01	15.72	18.42	22.68	2
200	0.59	0.89	1.11	1.49	1.84	2.38	2.83	3.97	5.38	7.34	8.97	10.98	13.54	14.79	17.88	20.85	26.04	2
500	0.70	1.07	1.33	1.79	2.21	2.79	3.29	4.54	6.11	8.41	10.45	12.75	15.86	17.29	20.92	24.21	30.85	3
1000	0.80	1.22	1.51	2.04	2.52	3.13	3.67	4.99	6.68	9.24	11.63	14.17	17.73	19.30	23.36	26.89	34.79	3

* These precipitation frequency estimates are based on a partial duration series. **ARI** is the Average Recurrence Interval.
Please refer to the documentation for more information. NOTE: Formatting forces estimates near zero to appear as zero.

* Upper bound of the 90% confidence interval Precipitation Frequency Estimates (inches)

ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	(
1	0.16	0.25	0.31	0.42	0.52	0.74	0.92	1.35	1.81	2.28	2.53	2.90	3.38	3.75	4.52	5.34	6.13	6.
2	0.21	0.32	0.39	0.53	0.66	0.93	1.16	1.71	2.31	2.95	3.30	3.83	4.51	4.98	6.02	7.13	8.23	9.
5	0.28	0.42	0.52	0.70	0.87	1.21	1.49	2.20	3.03	3.96	4.53	5.37	6.40	7.04	8.52	10.13	11.89	1
10	0.33	0.51	0.63	0.85	1.05	1.43	1.76	2.58	3.56	4.71	5.48	6.54	7.86	8.62	10.45	12.41	14.74	1
25	0.42	0.64	0.79	1.06	1.31	1.76	2.15	3.12	4.30	5.75	6.81	8.15	9.90	10.82	13.14	15.54	18.75	2
50	0.49	0.74	0.92	1.24	1.54	2.03	2.47	3.55	4.88	6.56	7.87	9.43	11.53	12.58	15.27	18.00	22.01	2
100	0.57	0.87	1.08	1.45	1.79	2.33	2.80	4.00	5.47	7.41	9.00	10.78	13.26	14.45	17.54	20.60	25.51	2
200	0.66	1.00	1.24	1.67	2.06	2.64	3.16	4.45	6.07	8.29	10.20	12.19	15.10	16.39	19.93	23.30	29.25	3
500	0.79	1.20	1.49	2.00	2.48	3.09	3.67	5.09	6.90	9.48	11.87	14.16	17.68	19.16	23.32	27.07	34.62	3
1000	0.90	1.36	1.69	2.27	2.82	3.46	4.08	5.58	7.53	10.42	13.22	15.75	19.77	21.42	26.07	30.08	39.03	4

* The **upper** bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are **greater** than.
** These precipitation frequency estimates are based on a partial duration series. **ARI** is the Average Recurrence Interval.

Please refer to the documentation for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

* Lower bound of the 90% confidence interval Precipitation Frequency Estimates (inches)

ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	(

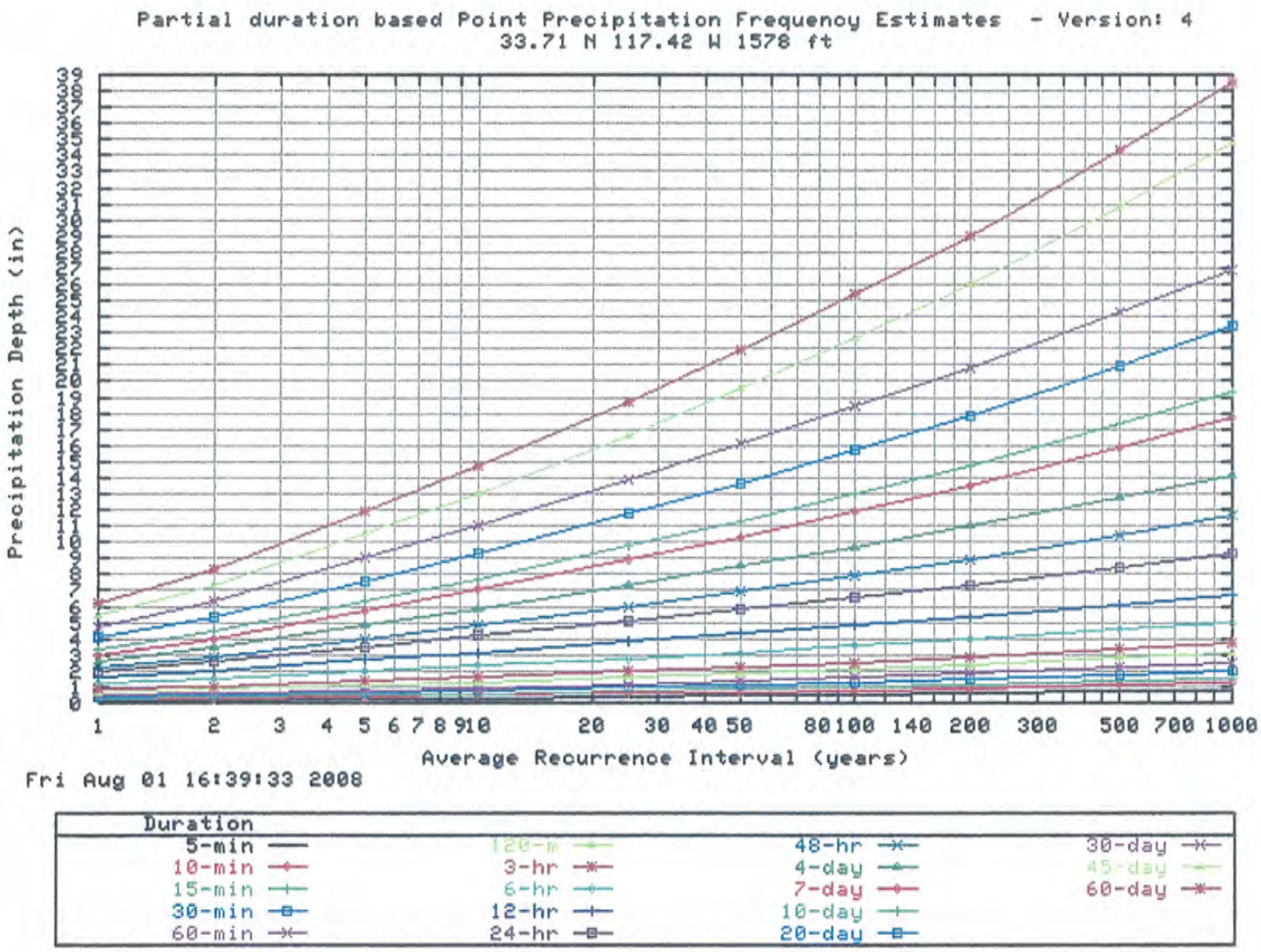
1	0.13	0.20	0.24	0.33	0.40	0.59	0.73	1.05	1.39	1.75	1.92	2.33	2.70	3.01	3.59	4.22	4.77	5.
2	0.16	0.25	0.31	0.41	0.51	0.74	0.92	1.33	1.78	2.27	2.50	3.09	3.60	4.00	4.77	5.63	6.40	7.
5	0.21	0.33	0.41	0.55	0.68	0.96	1.18	1.72	2.33	3.04	3.44	4.32	5.10	5.64	6.75	8.01	9.23	1(
10	0.26	0.40	0.49	0.66	0.82	1.14	1.40	2.01	2.74	3.62	4.15	5.26	6.26	6.90	8.27	9.79	11.43	1:
25	0.33	0.49	0.61	0.83	1.02	1.40	1.70	2.43	3.30	4.42	5.15	6.54	7.85	8.64	10.36	12.23	14.50	1(
50	0.38	0.58	0.71	0.96	1.19	1.61	1.95	2.75	3.74	5.03	5.94	7.54	9.11	10.01	12.01	14.13	16.97	1(
100	0.44	0.67	0.83	1.11	1.38	1.83	2.20	3.09	4.18	5.66	6.77	8.58	10.43	11.45	13.72	16.11	19.58	2:
200	0.50	0.76	0.95	1.27	1.58	2.07	2.47	3.43	4.62	6.30	7.63	9.66	11.81	12.93	15.50	18.13	22.31	2:
500	0.59	0.91	1.12	1.51	1.87	2.41	2.84	3.90	5.23	7.18	8.81	11.13	13.72	15.00	17.97	20.92	26.15	2(
1000	0.67	1.02	1.26	1.70	2.11	2.68	3.14	4.26	5.69	7.85	9.74	12.28	15.26	16.62	19.93	23.07	29.24	3:

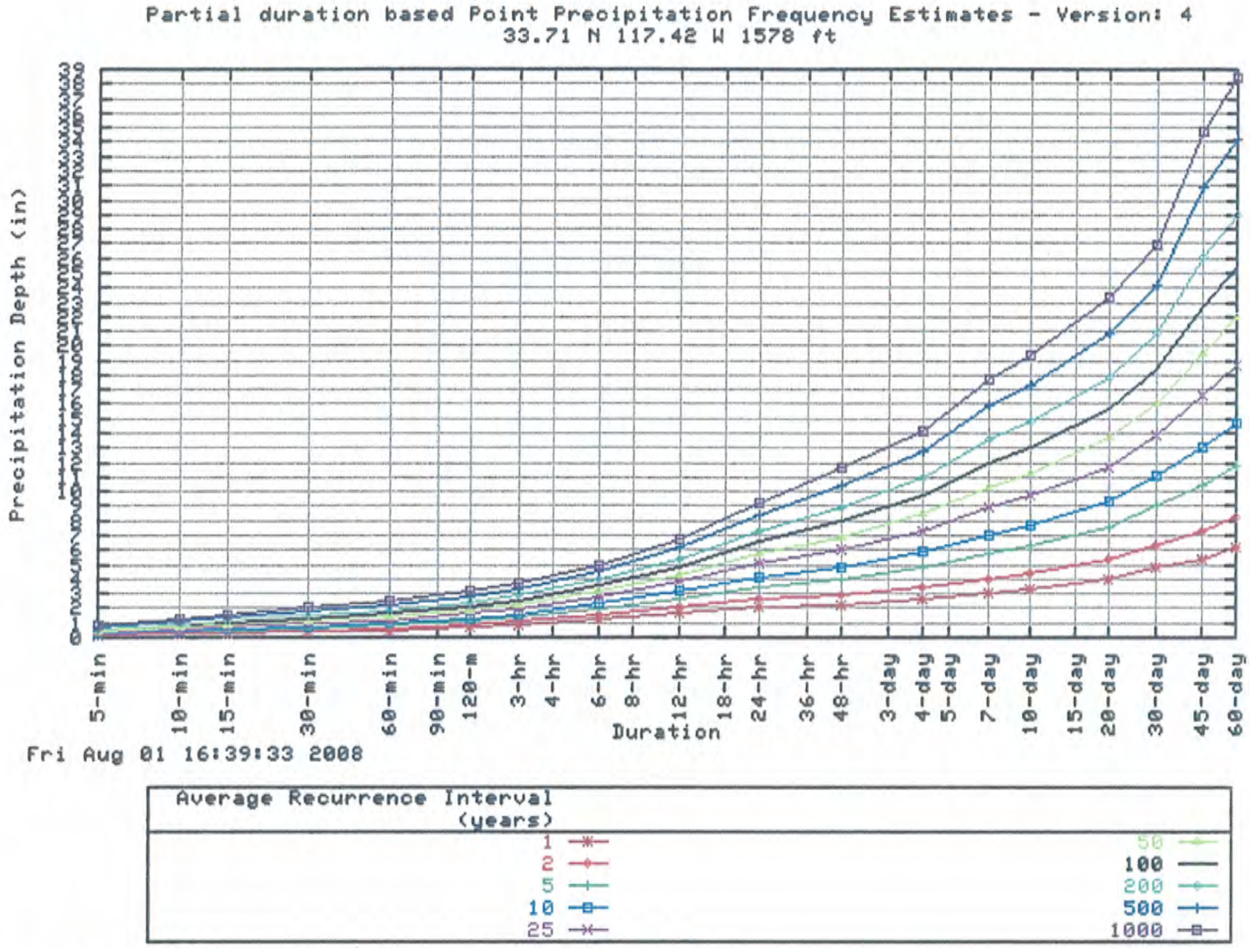
* The **lower** bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are **less** than.

** These precipitation frequency estimates are based on a partial duration maxima series. **ARI** is the Average Recurrence Interval.

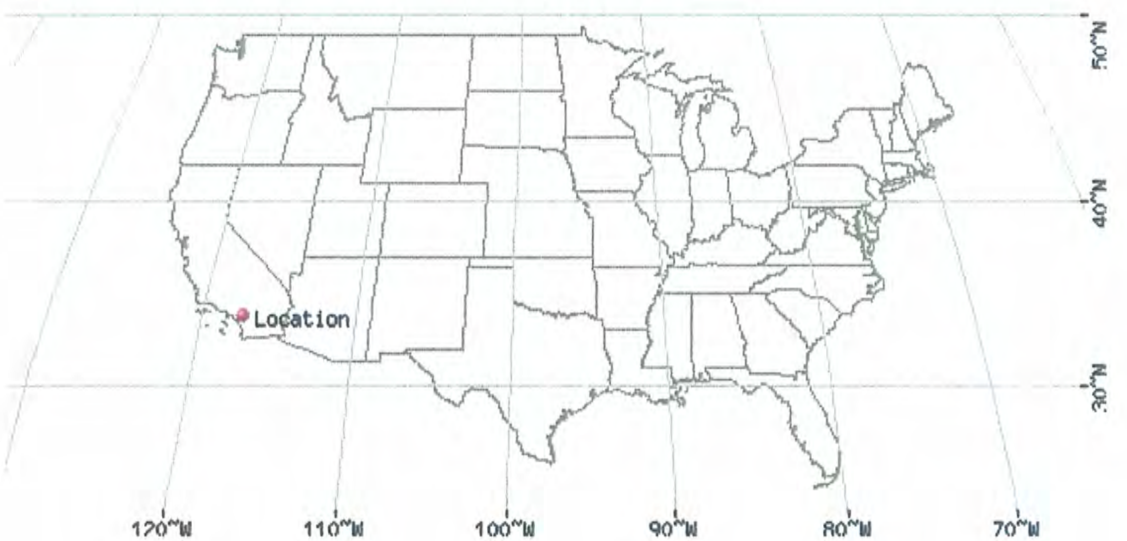
Please refer to the documentation for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

Text version of tables

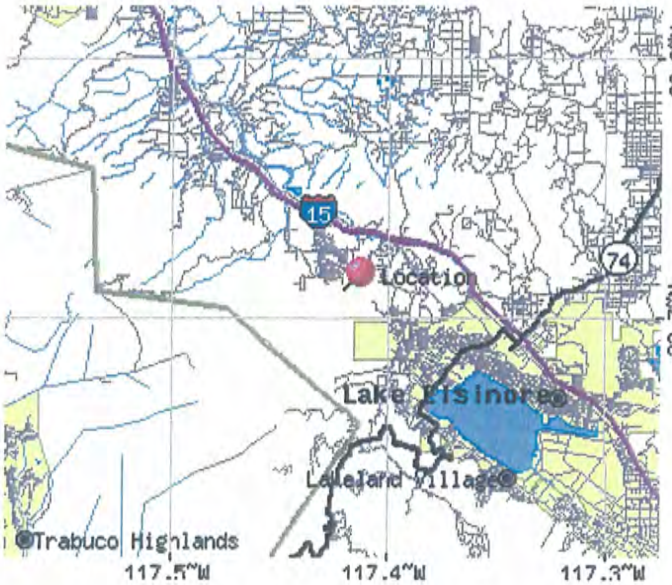




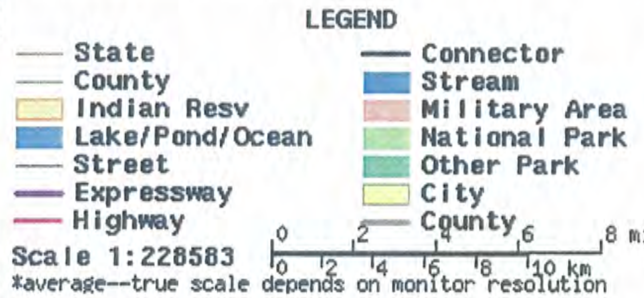
Maps -



These maps were produced using a direct map request from the
U.S. Census Bureau Mapping and Cartographic Resources
Tiger Map Server.



Please read disclaimer for more information.



Other Maps/Photographs -

View USGS digital orthophoto quadrangle (DOQ) covering this location from TerraServer; **USGS Aerial Photograph** may also be available
from this site. A DOQ is a computer-generated image of an aerial photograph in which image displacement caused by terrain relief and camera tilts has been removed. It combines the image characteristics of a photograph with the geometric qualities of a map. Visit the USGS for more information.

Watershed/Stream Flow Information -

Find the Watershed for this location using the U.S. Environmental Protection Agency's site.

Climate Data Sources -

Precipitation frequency results are based on data from a variety of sources, but largely NCDC. The following links provide general information
about observing sites in the area, regardless of if their data was used in this study. For detailed information about the stations used in this study,
please refer to our documentation.

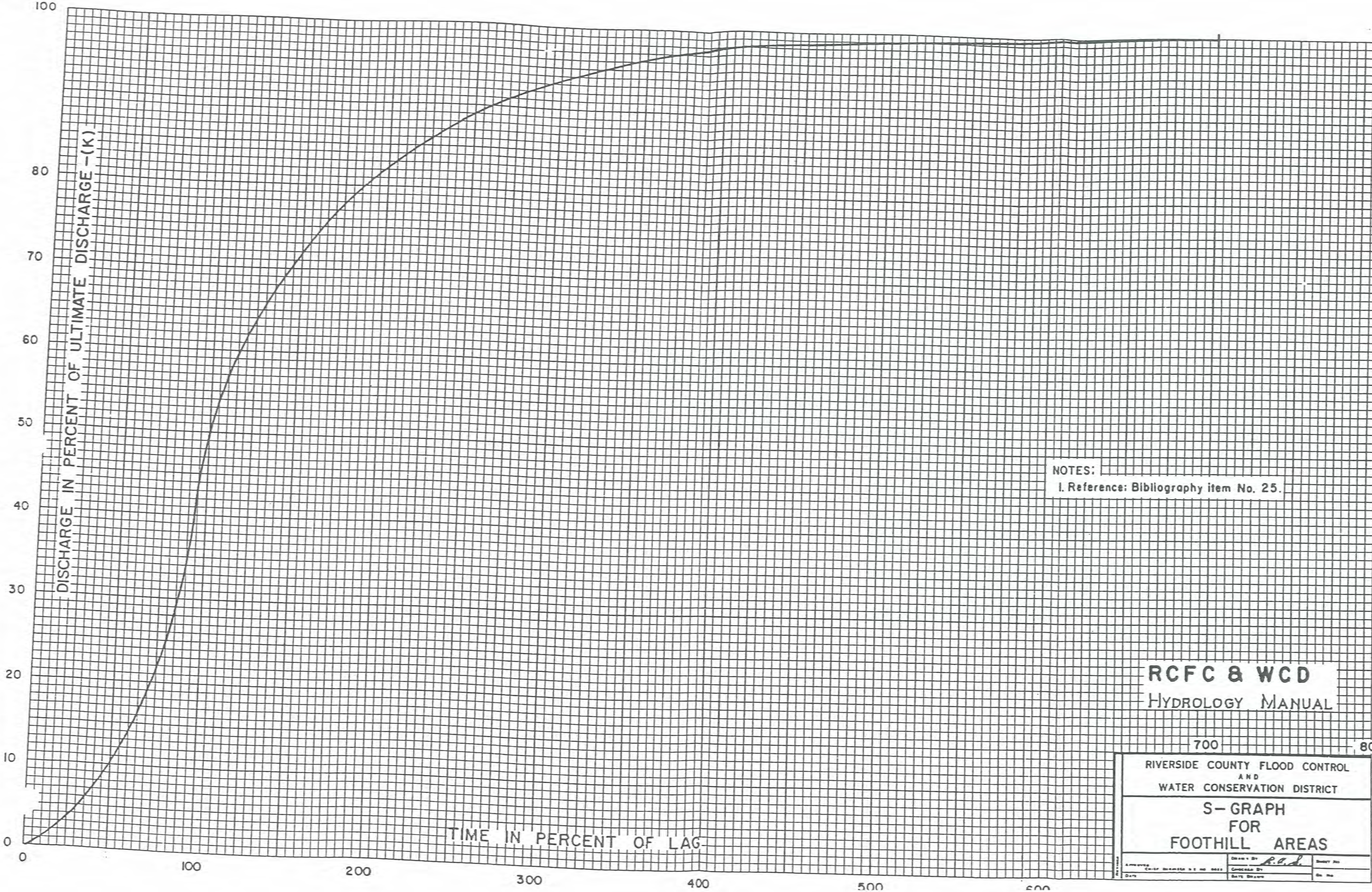
Using the **National Climatic Data Center's (NCDC)** station search engine, locate other climate stations within:

+/-30 minutes ...OR... +/-1 degree of this location (33.71/-117.42). Digital ASCII data can be obtained directly from **NCDC**.

Find Natural Resources Conservation Service (NRCS) SNOTEL (SNOwpack TELemetry) stations by visiting the **Western Regional Climate Center's state-specific SNOTEL station maps**.

Hydrometeorological Design Studies Center
DOC/NOAA/National Weather Service
1325 East-West Highway
Silver Spring, MD 20910
(301) 713-1669
Questions?: HDSC.Questions@noaa.gov

Disclaimer



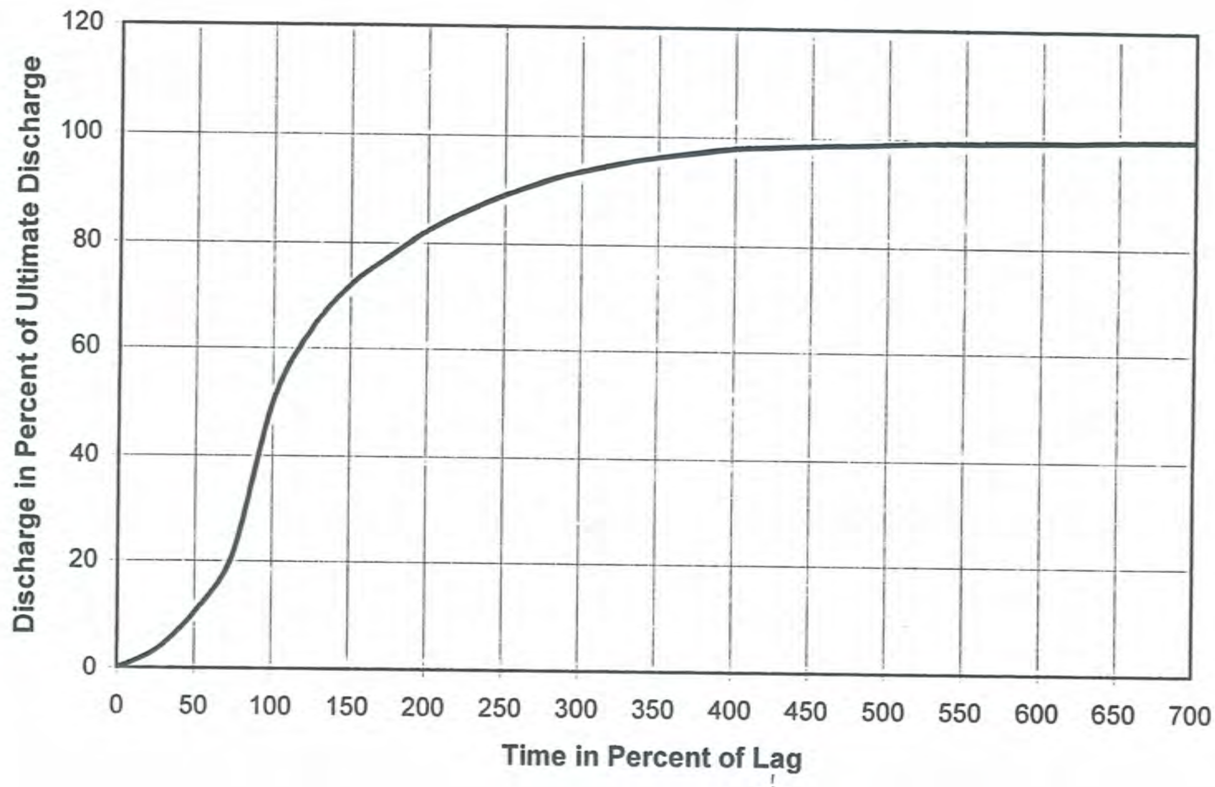
RCFC & WCD
HYDROLOGY MANUAL

RIVERSIDE COUNTY FLOOD CONTROL
AND
WATER CONSERVATION DISTRICT

S-GRAPH
FOR
FOOTHILL AREAS

Time in percent of Lag Time	*Discharge in Percent of Ultimate Discharge*
0	0
25	3.5
50	10.5
75	21.5
100	50
125	63.5
150	72
175	77.5
200	82.3
225	86
250	89
275	91.5
300	93.5
325	95
350	96.2
375	97.1
400	97.9
425	98.2
450	98.5
475	98.7
500	99
525	99.2
550	99.3
575	99.4
600	99.5
625	99.6
650	99.8
675	99.9
700	100

S - GRAPH FOR FOOTHILL AREAS



RUNOFF INDEX NUMBERS OF HYDROLOGIC SOIL-COVER COMPLEXES FOR PERVIOUS AREAS-AMC II

Cover Type (3)	Quality of Cover (2)	Soil Group A	B	C	D
NATURAL COVERS -					
Barren (Rockland, eroded and graded land)		78	86	91	93
Chaparrel, Broadleaf (Manzonita, ceanothus and scrub oak)	Poor	53	70	80	85
	Fair	40	63	75	81
	Good	31	57	71	78
Chaparrel, Narrowleaf (Chamise and redshank)	Poor	71	82	88	91
	Fair	55	72	81	86
Grass, Annual or Perennial	Poor	67	78	86	89
	Fair	50	69	79	84
	Good	38	61	74	80
Meadows or Cienegas (Areas with seasonally high water table, principal vegetation is sod forming grass)	Poor	63	77	85	88
	Fair	51	70	80	84
	Good	30	58	72	78
Open Brush (Soft wood shrubs - buckwheat, sage, etc.)	Poor	62	76	84	88
	Fair	46	66	77	83
	Good	41	63	75	81
Woodland (Coniferous or broadleaf trees predominate. Canopy density is at least 50 percent)	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	28	55	70	77
Woodland, Grass (Coniferous or broadleaf trees with canopy density from 20 to 50 percent)	Poor	57	73	82	86
	Fair	44	65	77	82
	Good	33	58	72	79
URBAN COVERS -					
Residential or Commercial Landscaping (Lawn, shrubs, etc.)	Good	32	56	69	75
Turf (Irrigated and mowed grass)	Poor	58	74	83	87
	Fair	44	65	77	82
	Good	33	58	72	79
AGRICULTURAL COVERS -					
Fallow (Land plowed but not tilled or seeded)		76	85	90	92

RUNOFF INDEX NUMBERS OF HYDROLOGIC SOIL-COVER COMPLEXES FOR PERVIOUS AREAS-AMC II

Cover Type (3)	Quality of Cover (2)	Soil Group A	B	C	D
AGRICULTURAL COVERS (cont.) -					
Legumes, Close Seeded	Poor	66	77	85	89
(Alfalfa, sweetclover, timothy, etc.)	Good	58	72	81	85
Orchards, Deciduous		See Note 4			
(Apples, apricots, pears, walnuts, etc.)					
Orchards, Evergreen	Poor	57	73	82	86
(Citrus, avocados, etc.)	Fair	44	65	77	82
	Good	33	58	72	79
Pasture, Dryland	Poor	67	78	86	89
(Annual grasses)	Fair	50	69	79	84
	Good	38	61	74	80
Pasture, Irrigated	Poor	58	74	83	87
(Legumes and perennial grass)	Fair	44	65	77	82
	Good	33	58	72	79
Row Crops	Poor	72	81	88	91
(Field crops - tomatoes, sugar beets, etc.)	Good	67	78	85	89
Small Grain	Poor	65	76	84	88
(Wheat, oats, barley, etc.)	Good	63	75	83	87
Vineyard		See Note 4			

Notes:

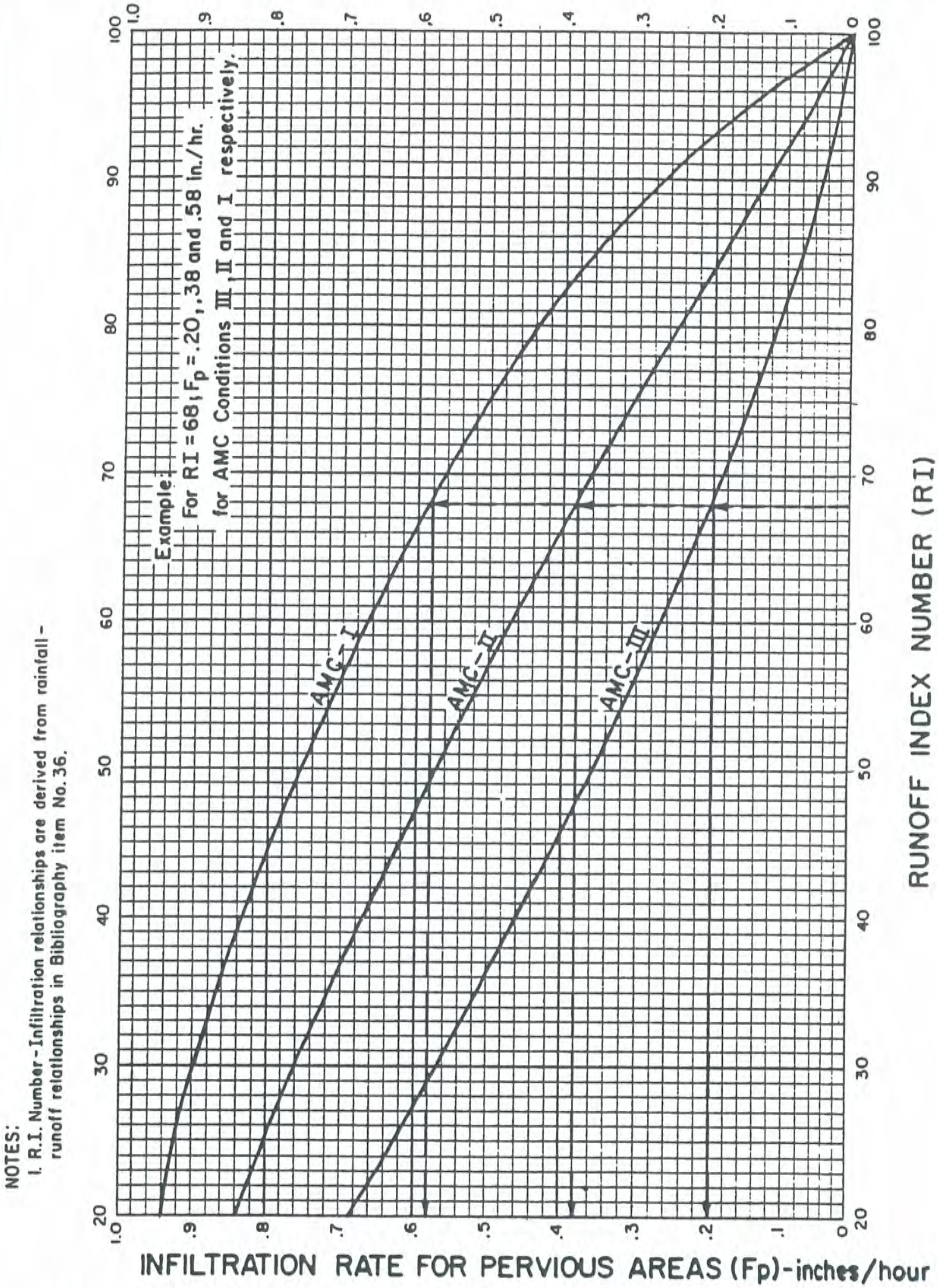
1. All runoff index (RI) numbers are for Antecedent Moisture Condition (AMC) II.

2. Quality of cover definitions:
   Poor-Heavily grazed or regularly burned areas. Less than 50 percent of the ground surface is protected by plant cover or brush and tree canopy.
   Fair-Moderate cover with 50 percent to 75 percent of the ground surface protected.
   Good-Heavy or dense cover with more than 75 percent of the ground surface protected.

3. See Plate C-2 for a detailed description of cover types.

4. Use runoff index numbers based on ground cover type. See discussion under "Cover Type Descriptions" on Plate C-2.

5. Reference Bibliography item 17.



RCFC & WCD

HYDROLOGY MANUAL

INFILTRATION RATE FOR PERVIOUS AREAS VERSUS RUNOFF INDEX NUMBERS

ACTUAL IMPERVIOUS COVER

Land Use (1)	Range-Percent	Recommended Value For Average Conditions-Percent(2)
Natural or Agriculture	0 - 10	0
Single Family Residential: (3)		
40,000 S. F. (1 Acre) Lots	10 - 25	20
20,000 S. F. (½ Acre) Lots	30 - 45	40
7,200 - 10,000 S. F. Lots	45 - 55	50
Multiple Family Residential:		
Condominiums	45 - 70	65
Apartments	65 - 90	80
Mobile Home Park	60 - 85	75
Commercial, Downtown Business or Industrial	80 -100	90

Notes:

1. Land use should be based on ultimate development of the watershed. Long range master plans for the County and incorporated cities should be reviewed to insure reasonable land use assumptions.
2. Recommended values are based on average conditions which may not apply to a particular study area. The percentage impervious may vary greatly even on comparable sized lots due to differences in dwelling size, improvements, etc. Landscape practices should also be considered as it is common in some areas to use ornamental gravels underlain by impervious plastic materials in place of lawns and shrubs. A field investigation of a study area should always be made, and a review of aerial photos, where available may assist in estimating the percentage of impervious cover in developed areas.
3. For typical horse ranch subdivisions increase impervious area 5 percent over the values recommended in the table above.

RCFC & WCD
HYDROLOGY MANUAL

IMPERVIOUS COVER FOR DEVELOPED AREAS

RAINFALL PATTERNS IN PERCENT

3-HOUR STORM

TIME PERIOD	5-MIN PERIOD	10-MIN PERIOD	15-MIN PERIOD	30-MIN PERIOD
1	1.3	2.6	3.7	8.5
2	1.3	2.6	4.8	10.0
3	1.1	3.3	5.1	13.9
4	1.5	3.3	4.9	17.4
5	1.5	3.3	6.6	29.9
6	1.8	3.4	7.3	20.3
7	1.5	4.4	8.4	
8	1.8	4.2	9.0	
9	1.8	5.3	12.3	
10	1.5	5.1	17.6	
11	1.6	6.4	16.1	
12	1.8	5.9	4.2	
13	2.2	7.3		
14	2.2	8.5		
15	2.2	14.1		
16	2.0	14.1		
17	2.6	3.8		
18	2.7	2.4		
19	2.4			
20	2.7			
21	3.3			
22	3.1			
23	2.9			
24	3.0			
25	3.1			
26	4.2			
27	5.0			
28	3.5			
29	6.8			
30	7.3			
31	8.2			
32	5.9			
33	2.0			
34	1.8			
35	1.8			
36	.6			

6-HOUR STORM

TIME PERIOD	5-MIN PERIOD	10-MIN PERIOD	15-MIN PERIOD	30-MIN PERIOD
1	.5	1.1	1.7	3.6
2	.6	1.2	1.9	4.3
3	.6	1.3	2.1	4.8
4	.6	1.4	2.2	4.9
5	.6	1.4	2.4	5.3
6	.7	1.5	2.4	5.8
7	.7	1.6	2.4	6.8
8	.7	1.6	2.5	9.0
9	.7	1.6	2.6	11.6
10	.7	1.6	2.7	14.4
11	.7	1.6	2.8	25.1
12	.8	1.7	3.0	4.4
13	.8	1.7	3.2	
14	.8	1.8	3.6	
15	.8	1.8	4.3	
16	.8	1.8	4.7	
17	.8	2.0	5.4	
18	.8	2.0	6.2	
19	.8	2.1	6.9	
20	.8	2.2	7.5	
21	.8	2.5	10.6	
22	.8	2.8	14.5	
23	.8	3.0	3.4	
24	.9	3.2	1.0	
25	.8	3.5		
26	.9	3.9		
27	.9	4.2		
28	.9	4.5		
29	.9	4.8		
30	.9	5.1		
31	.9	6.7		
32	.9	8.1		
33	1.0	10.3		
34	1.0	2.8		
35	1.0	1.1		
36	1.0	.5		
37	1.0			
38	1.1			
39	1.1			
40	1.1			
41	1.2			
42	1.3			
43	1.4			
44	1.4			
45	1.5			
46	1.5			
47	1.6			
48	1.6			

TIME PERIOD	5-MIN PERIOD
49	1.7
50	1.8
51	1.9
52	2.0
53	2.1
54	2.1
55	2.2
56	2.3
57	2.4
58	2.4
59	2.5
60	2.6
61	3.1
62	3.6
63	3.9
64	4.2
65	4.7
66	5.6
67	1.9
68	.9
69	.6
70	.5
71	.3
72	.2

24-HOUR STORM

TIME PERIOD	15-MIN PERIOD	30-MIN PERIOD	60-MIN PERIOD
1	.2	.5	1.2
2	.3	.7	1.3
3	.3	.6	1.8
4	.4	.7	2.1
5	.3	.8	2.8
6	.3	1.0	2.9
7	.3	1.0	3.8
8	.4	1.1	4.6
9	.4	1.3	6.3
10	.4	1.5	8.2
11	.5	1.3	7.0
12	.5	1.6	7.3
13	.5	1.8	10.8
14	.5	2.0	11.4
15	.5	2.1	10.4
16	.6	2.5	8.5
17	.6	3.0	1.4
18	.7	3.3	1.9
19	.7	3.9	1.3
20	.8	4.3	1.2
21	.6	3.0	1.1
22	.7	4.0	1.0
23	.8	3.8	.9
24	.8	3.5	.8
25	.9	5.1	
26	.9	5.7	
27	1.0	6.8	
28	1.0	4.6	
29	1.0	5.3	
30	1.1	5.1	
31	1.2	4.7	
32	1.3	3.8	
33	1.5	.8	
34	1.5	.6	
35	1.6	1.0	
36	1.7	.9	
37	1.9	.8	
38	2.0	.5	
39	2.1	.7	
40	2.2	.5	
41	1.5	.6	
42	1.5	.5	
43	2.0	.5	
44	2.0	.5	
45	1.9	.5	
46	1.9	.4	
47	1.7	.4	
48	1.8	.4	

TIME PERIOD	15-MIN PERIOD
49	2.5
50	2.6
51	2.8
52	2.9
53	3.4
54	3.4
55	2.3
56	2.3
57	2.7
58	2.6
59	2.6
60	2.5
61	2.4
62	2.3
63	1.9
64	1.9
65	.4
66	.4
67	.3
68	.3
69	.5
70	.5
71	.5
72	.4
73	.4
74	.4
75	.3
76	.2
77	.3
78	.4
79	.3
80	.2
81	.3
82	.3
83	.3
84	.2
85	.3
86	.2
87	.3
88	.2
89	.3
90	.2
91	.2
92	.2
93	.2
94	.2
95	.2
96	.2

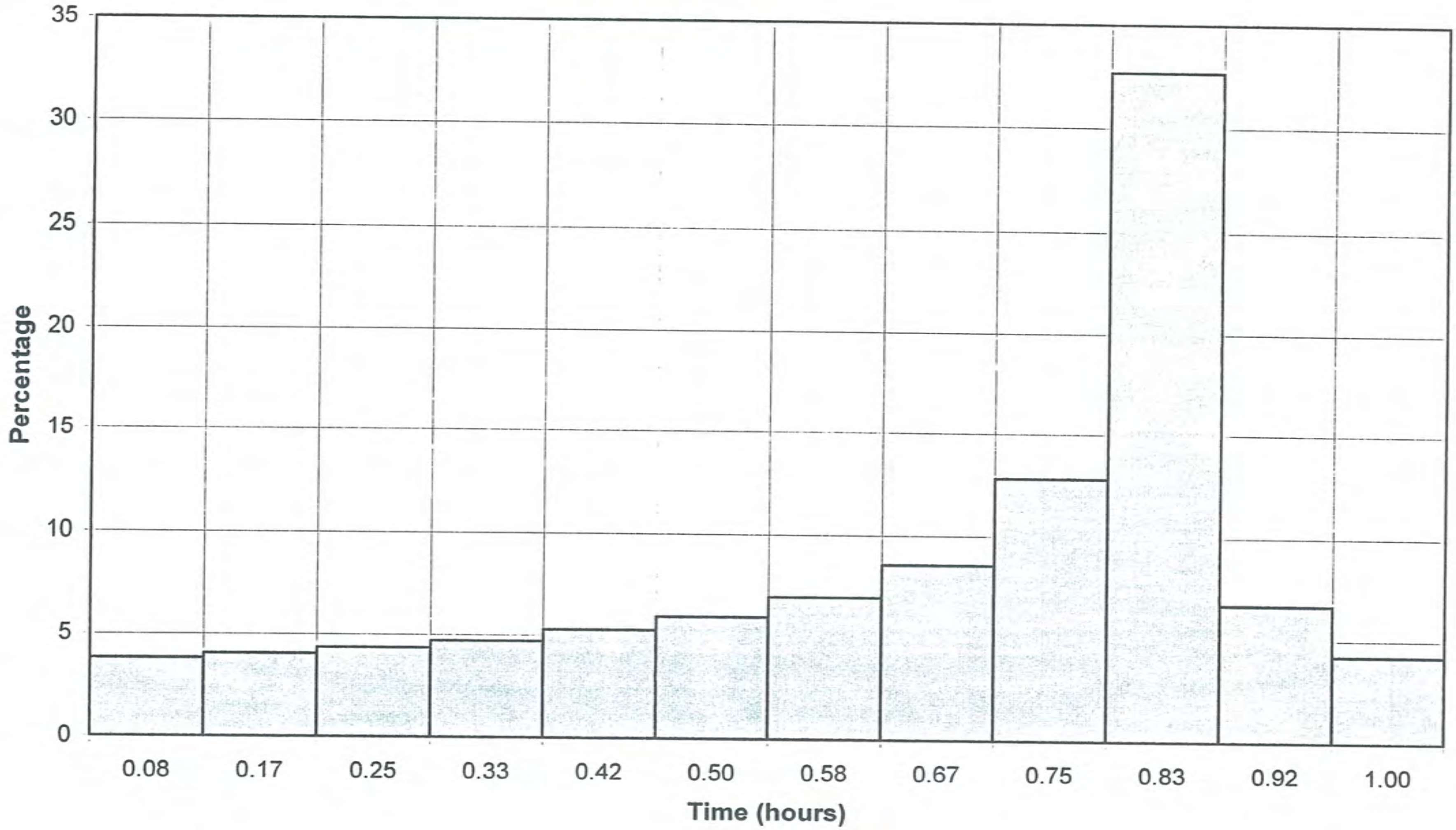
NOTES:

1. 3 and 6-hour patterns based on the Indio area thunderstorm of September 24,1939.
2. 24-hour patterns based on the general storm of March 2 & 3,1938.

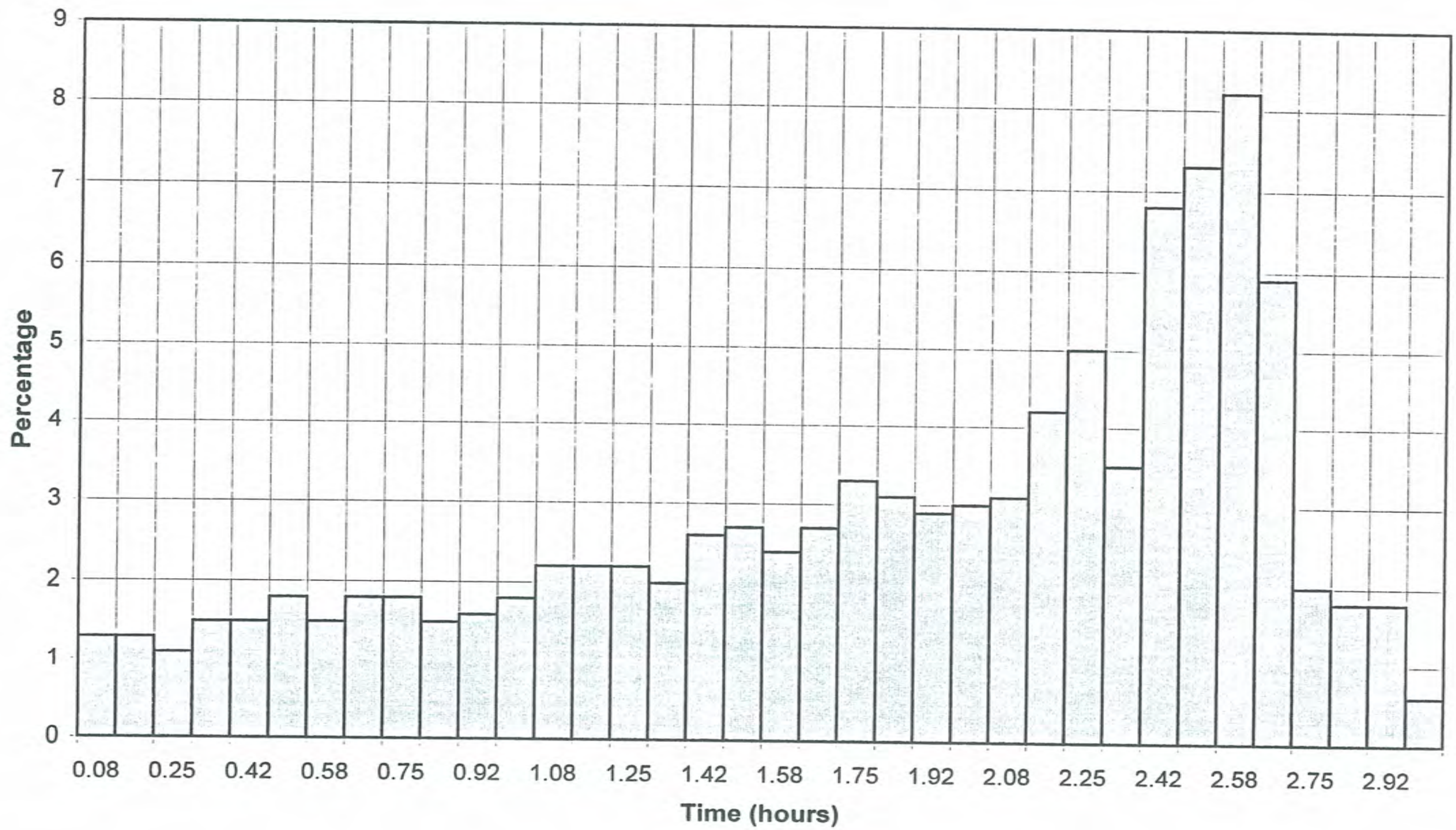
RCFC & WCD
HYDROLOGY MANUAL

RAINFALL PATTERNS
IN PERCENT

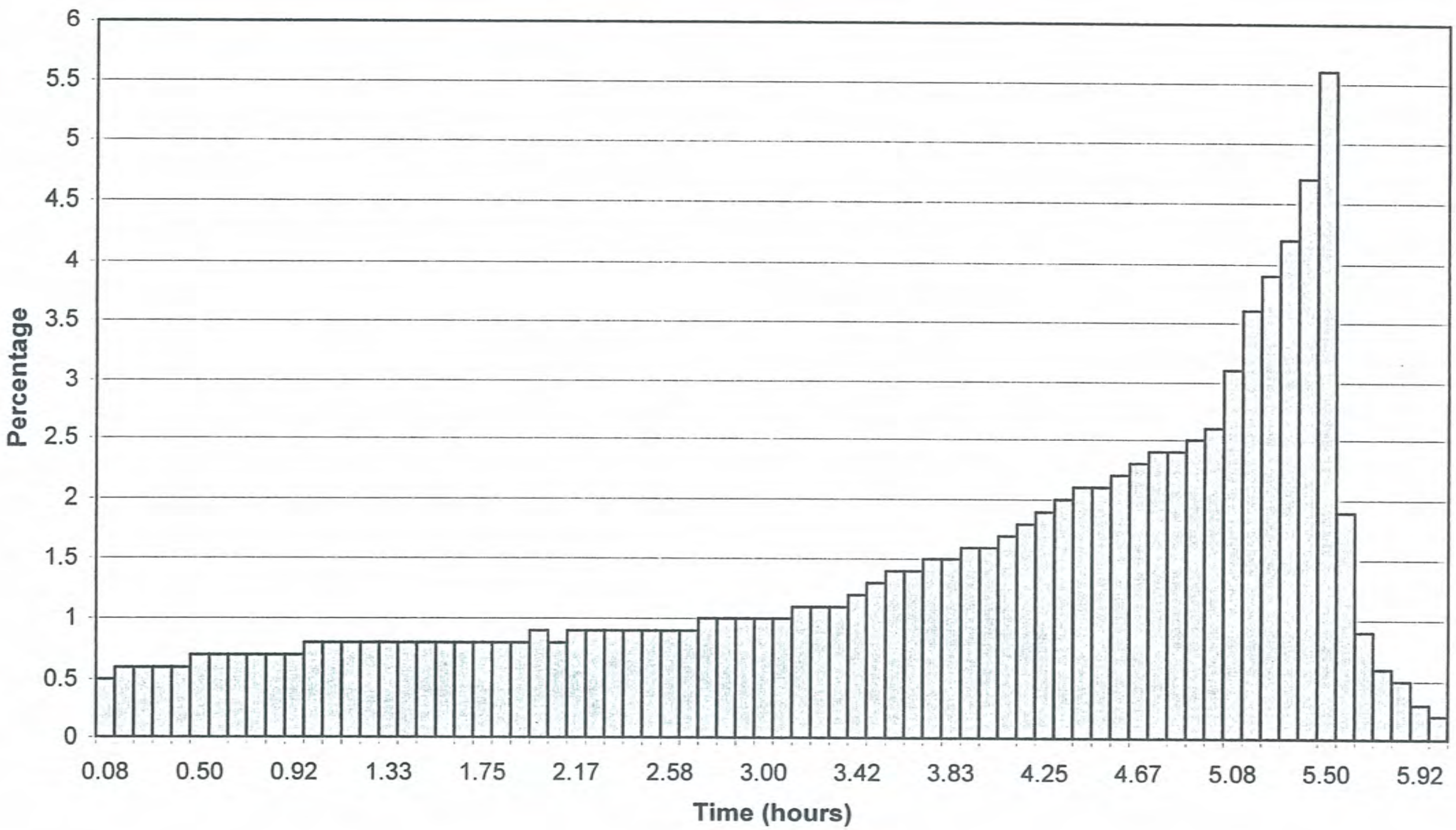
1-hour Rainfall Pattern
Riverside County Flood Control District



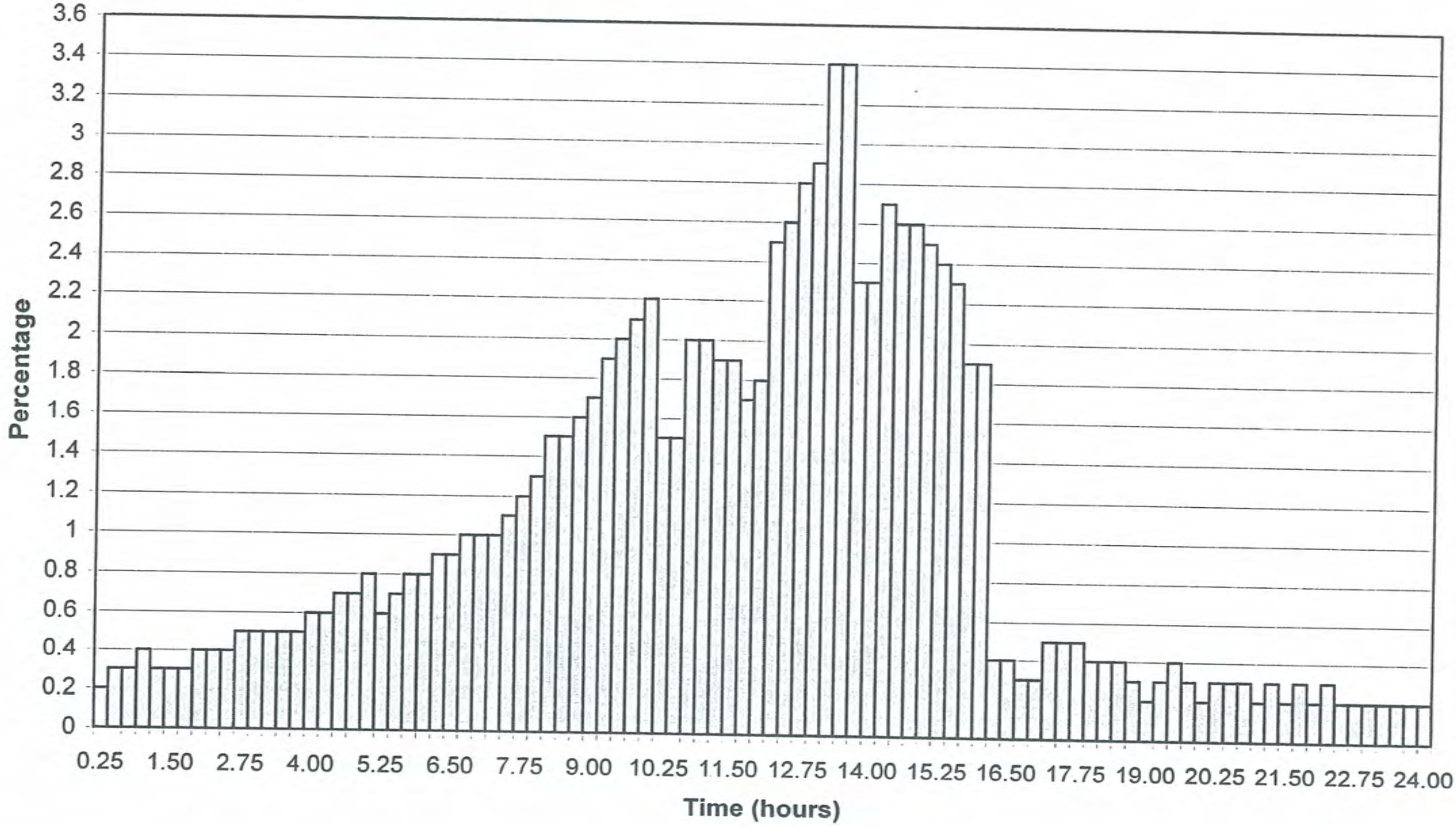
3-hour Rainfall Pattern
Riverside County Flood Control District



6-hour Rainfall Pattern
Riverside County Flood Control District



24-hour Rainfall Pattern
Riverside County Flood Control District



TERMINOLOGY

L = LENGTH OF LONGEST WATERCOURSE.

L_{ca} = LENGTH ALONG LONGEST WATERCOURSE, MEASURED UPSTREAM TO POINT OPPOSITE CENTER OF AREA.

S = OVER-ALL SLOPE OF LONGEST WATERCOURSE BETWEEN HEADWATER AND COLLECTION POINT.

LAG = ELAPSED TIME FROM BEGINNING OF UNIT PRECIPITATION TO INSTANT THAT SUMMATION HYDROGRAPH REACHES 50 % OF ULTIMATE DISCHARGE.

$\bar{n}$ = VISUALLY ESTIMATED MEAN OF THE n (MANNING'S FORMULA) VALUES OF ALL THE CHANNELS WITHIN AN AREA.

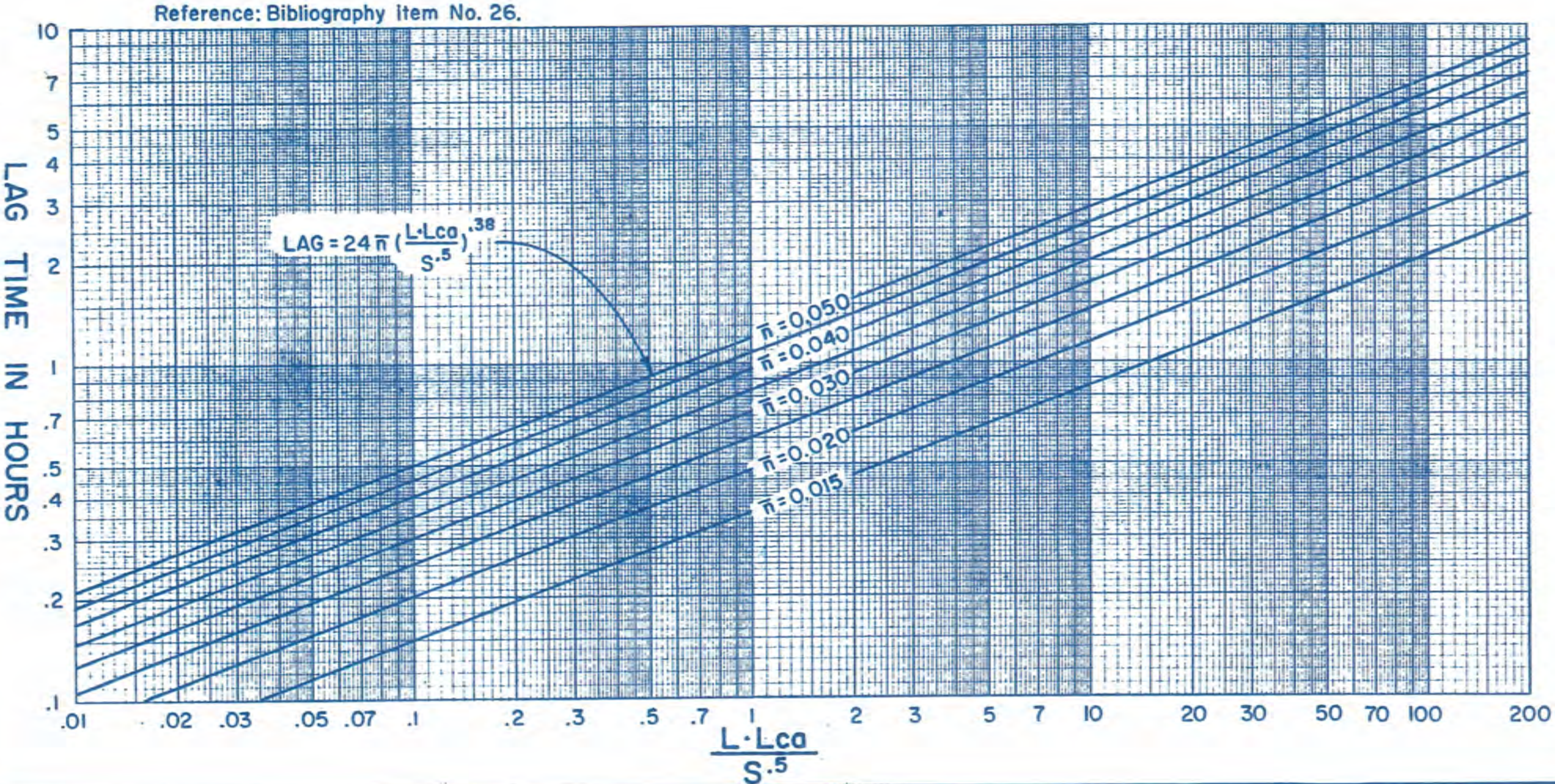
GUIDE FOR ESTIMATING BASIN FACTOR ($\bar{n}$)

$\bar{n}$=0.050: DRAINAGE AREA IS QUITE RUGGED, WITH SHARP RIDGES AND NARROW, STEEP CANYONS THROUGH WHICH WATERCOURSES MEANDER AROUND SHARP BENDS, OVER LARGE BOULDERS, AND CONSIDERABLE DEBRIS OBSTRUCTION. THE GROUND COVER, EXCLUDING SMALL AREAS OF ROCK OUTCROPS, INCLUDES MANY TREES AND CONSIDERABLE UNDERBRUSH. NO DRAINAGE IMPROVEMENTS EXIST IN THE AREA.

$\bar{n}$=0.030: DRAINAGE AREA IS GENERALLY ROLLING, WITH ROUNDED RIDGES AND MODERATE SIDE SLOPES. WATERCOURSES MEANDER IN FAIRLY STRAIGHT, UNIMPROVED CHANNELS WITH SOME BOULDERS AND LODGED DEBRIS. GROUND COVER INCLUDES SCATTERED BRUSH AND GRASSES. NO DRAINAGE IMPROVEMENTS EXIST IN THE AREA.

$\bar{n}$=0.015: DRAINAGE AREA HAS FAIRLY UNIFORM, GENTLE SLOPES WITH MOST WATERCOURSES EITHER IMPROVED OR ALONG PAVED STREETS. GROUND COVER CONSISTS OF SOME GRASSES WITH APPRECIABLE AREAS DEVELOPED TO THE EXTENT THAT A LARGE PERCENTAGE OF THE AREA IS IMPERVIOUS.

Reference: Bibliography item No. 26.



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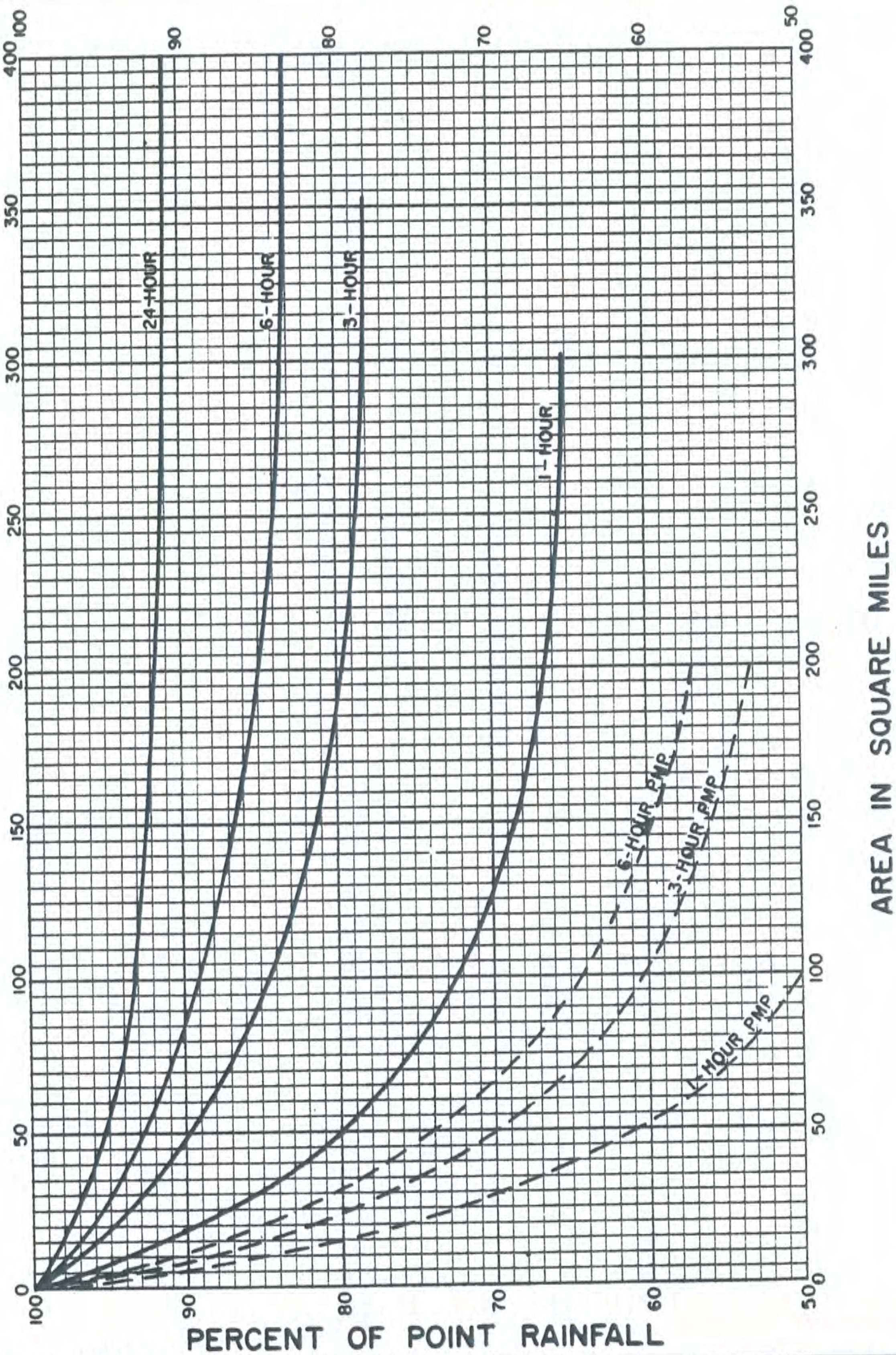
LAG RELATIONSHIPS FOR SOUTHERN CALIFORNIA



Reference: Bibliography items No. 27 & 29.

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DEPTH-AREA-DURATION RELATIONSHIPS