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Technical Memorandum

To: San Jacinto Reach III Technical Advisory Committee

From: Joseph C. Caldwell, PE | CPSWQ | CPESC - Director- Stormwater Engineering

Date: May 18, 2016

Re: San Jacinto River Stage III Hydrology Update

Introduction

The following Technical Memorandum documents the rainfall update for the San Jacinto River Stage III Project. The most up to date (currently approved) hydrology model of the San Jacinto River utilizes NOAA 2 rainfall data. In 1975, RCFC&WCD published a report titled "Report of the San Jacinto River Hydrology" (Ref. 1) and updated the analysis in 1994 (Ref. 2). The best available rainfall data at the time was the National Oceanic and Atmospheric Administration (NOAA) II rainfall records and statistics published in 1975 (Ref. 3) and is the rainfall data used in the initial study and for all sequential studies performed for the San Jacinto River Watershed. Figure 1 shows the San Jacinto River Sub-area boundaries overlaid on the RCFC&WCD 100-Year 24-Hour Precipitation (NOAA 2) Isohyet Map.

The most recent hydrology model was prepared as part of the application for a Letter of Map Revision (LOMR) for a portion of the San Jacinto River, January 2011 (Ref. 4). 100-year 24-hour hydrographs were developed and were used as input into the unsteady HEC-RAS model of the San Jacinto River Floodplain. The HEC-RAS model was used as the basis for determining the 100-year Base Flood Elevations (BFEs) and Special Flood Hazard Areas (SFHAs) used in the FEMA Physical Map Revision of the San Jacinto River, Effective Date August 2014.

The data and conclusions provided in this technical memorandum will be used as part of current planning efforts for the San Jacinto River Stage III Project.

NOAA 14 Data

NOAA Atlas 14 was published in 2004 and was revised in 2006. The updated NOAA 14 (Ref. 5) publication includes data from several rain gages which were not available at the time of the prior publication of NOAA Atlas 2, as well as 25 years of additional data at several of the gages used in NOAA Atlas 2. Consequently, thousands of additional station years of data are included in the updated NOAA Atlas 14. Review of the small scale (county-wide) NOAA 2 and NOAA 14 maps generally indicate that the most notable changes affect the arid desert regions and mountainous areas.

NOAA 14 point rainfall values for the 100-year frequency 24-hour duration were retrieved from NOAA Precipitation Frequency Data Server (PFDS) at http://hdsc.nws.noaa.gov/hdsc/pfds/. ASCII grid files containing various rainfall frequency-duration depths (5-minute to 60-day duration for the 1-year to 1,000-year frequency) are available for download. The 100-year 24-hour data was downloaded from the PFDS site and imported into ArcGIS (Geographic Information System, GIS). The hydrologic subareas were overlaid onto the grids to compute the area-weighted (average point value) precipitation-duration frequency data (see Figure 2). Area-average and centroid values were determined for each subarea. These values were compared with the point rainfall values used in the 2011 San Jacinto River LOMR study report. Table 1 summarizes the rainfall data from the two sources.

Rainfall Comparison NOAA 14 vs. NOAA 2

As indicated in the Table 1, there is large spread of the percent difference, ranging from -15.2 % for Pigeon Pass Subarea to +28.1% for Nuevo Subarea. Review of the two data sources indicated that the NOAA 14 had lower rainfall values for the San Jacinto Mountains, explaining the lower average point values for the San Jacinto Subarea. The other lower point rainfall values were located along the southern slopes of the western Badlands range, and the Railroad Canyon Subarea. When considering the entire San Jacinto River Watershed, the overall change resulted in a 6.1 % increase.

Table 1: 100-Year Precipitation Value Comparisons for Sub-Areas of the San Jacinto River

Sub Area ID	Sub Area Name	Sub-Area (sqmi)	NOAA 14 Centroid Point Value (in)	NOAA 14 Average Point Value (in)	2011 Study[1] Average Point Value (in)	Percent Difference NOAA 14 vs. 2011 Study
2	San Jacinto Mt. at Bautista Creek	178.50	8.81	8.49	8.99	-5.72%
3	Bautista Creek	51.38	7.33	7.26	7.02	3.36%
4	Poppet Creek	15.76	7.67	7.41	6.90	7.13%
5	Soboba– Gilman	12.07	5.97	5.94	5.66	4.83%
6	Massacre Canyon	35.42	6.80	6.97	6.49	7.13%
7	Lamb Canyon	5.64	6.02	5.97	5.18	14.17%
8	Laborde Canyon	9.73	6.04	5.95	5.04	16.56%
9	San Jacinto Valley	43.98	5.26	5.34	4.73	12.12%
10	Jack Rabbit	17.90	5.44	5.54	4.73	15.77%
11	Badlands	18.10	5.38	5.45	4.75	13.73%
12	Lakeview	12.26	5.36	5.39	4.32	22.04%
13	Nuevo	25.74	5.55	5.52	4.16	28.10%
14	Pigeon Pass	9.031	4.87	4.88	5.68	-15.19%
1A	Indian Festival	1.172	4.90	4.90	5.29	-7.61%
LA	Lasselle Basin	0.689	5.28	5.29	5.30	-0.16%
NA	Nason Basin	4.329	5.51	5.51	5.52	-0.22%
SA	Sinclair Basin	4.34	5.50	5.46	5.50	-0.75%
CP4A	Perris Valley	62.87	5.03	4.98	4.83	3.07%
SEATA	Seaton Basin	3.01	5.22	5.16	5.19	-0.62%
15A	Romoland A-System	28.11	5.32	5.42	4.52	18.11%
15B	Romoland B-System	4.27	5.48	5.49	4.52	19.38%
16	Railroad Canyon	26.04	5.62	5.67	5.75	-1.40%
17	Salt Creek	123.91	5.68	5.69	4.94	14.11%

(1) 2011 Study Rainfall Values were from NOAA Atlas 2

Consideration of the HYDRO-40 Area Reduction Factors for the San Jacinto River Watershed

A Review of the NOAA Technical Memorandum NWS HYDRO-40 (Ref.6) "Depth-Area Ratios in the Semi-Arid Southwest United States" for the purpose of converting NOAA 14 point rainfall data for areal-effect (depth area reduction) according to the drainage area size was performed and the following conclusions were determined.

HYDRO-40 states that based on the analysis conducted using 20 years of dense network recording rain gage data from the Agricultural Research Service experimental watershed at Walnut Gulch in southeast Arizona, depth-area ratios (area reduction factors) decrease more rapidly with increasing area than those published in NOAA 2. The objective of the HYDRO-40 is to derive depth-area ratios in a form suitable for engineering use for a substantial portion of Arizona and New Mexico.

The general consensus is that the depth area reduction curves from HYDRO-40 better represents the desert areas of California than the NOAA 2 curves, therefore the HYDRO-40 curves are recommended for the southern desert regions (Colorado Desert, Sonoran Desert, Antelope Valley and the Mojave Desert). The San Jacinto River Basin is located within the South Coast Hydrologic Region and is a major tributary to the Santa Ana River. Annual precipitation amounts are from 10 inches in the valleys and coastal areas to 45 inches in the mountains. For the South Coast Region (including the San Jacinto River Basin), the curves from NOAA Atlas 2 are the most recommended depth area reduction curves, and are those used for this analysis.

Hydrology Results

In order to quantify the impacts of the NOAA 14 rainfall data, a comparison of the hydrographs are made with the values used in the 2011 San Jacinto River LOMR report. Table 2 summarizes the results of the updated HEC-1 model utilizing the NOAA 14 data and compares it with the 2011 LOMR Study HEC-1 (utilizing NOAA 2 data) model results.

Table 2: HEC-1 100-Year Hydrograph Summary Comparison

Name	2016 Study Update		2011 LOMR Study		Comparison	
	Peak Flow (cfs)	Volume (ac-ft)	Peak flow (cfs)	Volume (ac-ft)	Percent Difference Peak Flow: 2016 Study vs. 2011 Study	Percent Difference Volume: 2016 Study vs. 2011 Study
Bridge Street	61,254	55,198	62,068	56,160	-1.3%	-1.7%
Jack Rabbit	2,964	1,717	2,196	1,231	29.8%	33.0%
Badlands	2,698	1,501	2,063	1,110	26.7%	30.0%
Lakeview	2,217	1,166	1,299	601	52.2%	64.0%
Nuevo	4,115	2,356	2,306	1,262	56.3%	60.5%
CP4	12,519	7,242	14,411	7,525	-14.1%	-3.8%
Romoland (B System)	896	436	652	300	31.5%	37.0%
Romoland (A System)	5,417	2,788	3,988	1,978	30.4%	34.0%

As indicated in the Table 2, the two largest hydrographs showed reduced peak flow rates and volumes as a result of the NOAA 14 update. All other hydrographs showed an increase in peak flow rates and volumes. Adding the individual peak flows together for the 2016 study and comparing it to summation of the peak flows for the 2011 study, indicates an overall increase of 3.4%. For unsteady hydraulic modeling, volume consideration is also an important input parameter. By adding the individual volumes together for each study, and comparing the two, indicates an overall volume increase of 3.1%.

Multi-Day Storm Analysis

In addition to the 24-hour duration storm analysis, a multiple day storm analysis was performed. Multiple day storm hydrographs are typically used in the design and analysis for a watershed flood control system which includes one or several detention basins in order to determine that the basins have an adequate storage capacity remaining when the peak 24-hour storm event occurs.

A three day duration storm was developed as part of this technical memorandum in order to verify that the 24-hour duration storm is the actual critical duration. The extended (3-day) storm is based on a series of individual 24-hour storm patterns, where the third day of the 3 day storm contains the 24 hour rainfall amount ($P_{Day3} = P_{24}$). The first day storm rainfall equals the difference between 72-hour rainfall and the 48-hour rainfall ($P_{Day1} = P_{72} - P_{48}$), and the second day storm equal the difference between 48-hour rainfall and the 24-hour rainfall ($P_{Day2} = P_{48} - P_{24}$). The 48- hour rainfall (P_{48}) and 72-hour rainfall (P_{72}) area average amounts were obtained from the NOAA PFDS following the same procedures as the 24-hour rainfall. Table 3 summarizes the 24-hour, 48-hour, and 72-hour area average rainfalls used in the multiple day storm hydrology.

Table 3: NOAA 14 100-Year 24-hour, 48-hour and 72-hour Precipitation

Sub Area ID	Sub Area Name	Sub-Area (sqmi)	24-Hour Average Point Value (in)	48-Hour Average Point Value (in)	72-Hour Average Point Value (in)
2	San Jacinto Mt. at Bautista Creek	178.50	8.81	11.35	12.64
3	Bautista Creek	51.38	7.33	9.36	10.44
4	Poppet Creek	15.76	7.67	9.92	11.30
5	Soboba– Gilman	12.07	5.97	7.82	8.89
6	Massacre Canyon	35.42	6.80	9.40	10.86
7	Lamb Canyon	5.64	6.02	7.91	9.13
8	Laborde Canyon	9.73	6.04	8.00	9.25
9	San Jacinto Valley	43.98	5.26	6.86	7.75
10	Jack Rabbit	17.90	5.44	7.14	8.07
11	Badlands	18.10	5.38	6.81	7.55
12	Lakeview	12.26	5.36	6.76	7.50
13	Nuevo	25.74	5.55	6.92	7.71
14	Pigeon Pass	9.031	4.87	6.18	6.94
1A	Indian Festival	1.172	4.90	6.21	6.93
LA	Lasselle Basin	0.689	5.28	6.69	7.53
NA	Nason Basin	4.329	5.51	7.02	7.95
SA	Sinclair Basin	4.34	5.50	6.90	7.64
CP4A	Perris Valley	62.87	5.03	6.13	6.80
SEATA	Seaton Basin	3.01	5.22	6.48	7.20
15A	Romoland A-System	28.11	5.32	6.83	7.64
15B	Romoland B-System	4.27	5.48	6.87	7.67
16	Railroad Canyon	26.04	5.62	7.17	8.09
17	Salt Creek	123.91	5.68	7.27	8.09

Results of the extended (3-day) storm hydrology are shown in Table 4. As indicated in the table, there are three separate peak flows corresponding to the day 1, day 2, and day 3 time periods. The results of these models will be used as part of the multi-day analysis of Mystic Lake and the San Jacinto River Flood Plain.

Table 4: HEC-1 100-Year Extended (3-Day) Storm Summary

Name	Day 1		Day 2		Day 3	
	Peak Flow (cfs)	Volume (ac-ft)	Peak flow (cfs)	Volume (ac-ft)	Peak Flow (cfs)	Volume (ac-ft)
Bridge Street	1,730	2075	4,194	4636	61254	55198
Jack Rabbit	91	80	158	139	2964	1717
Badlands	75	66	137	119	2698	1501
Lakeview	58	43	108	81	2217	1166
Nuevo	111	115	195	174	4115	2356
CP4	346	290	597	502	12519	7242
Romoland (B System)	21	17	37	29	896	434
Romoland (A System)	136	111	236	192	5417	2788

Conclusion

Changing the rainfall input to NOAA 14 resulted in the following conclusions:

On a subarea to subarea comparison, there appears to be a fairly large spread (-15.2% to 22.0%) of the computed percent difference of average point rainfall values. However, when considering the entire San Jacinto River Watershed, the overall change is a 6.1% increase. The summation of the individual hydrograph peak flows and volumes also indicated small increases (3.4% peak flows and 3.1% volume). While individual subares are affected by this change, the entire San Jacinto River System does not experience a significant change.

Since there are only minor increases of the peak flow rates and volumes, an update of the hydrologic and hydraulic model of the San Jacinto River FEMA floodplain is not recommended. However, it is recommended that the point rainfall values and hydrology from this study should be used for the forthcoming San Jacinto River Stage III master planning efforts since it is based on the best data currently available.

References

1. Riverside County Flood Control and Water Conservation District, “Report on San Jacinto River Hydrology”, March 1975.

2. Riverside County Flood Control and Water Conservation District, “Draft Report on San Jacinto River Hydrology”, January 1994.

3. U.S. Department of Commerce - National Oceanic and Atmospheric Administration - National Weather Service, “NOAA Atlas 2 Precipitation-Frequency Atlas of the Western United States Volume XI-California”, 1973.

4. WEBB Associates, “Application for a Letter of Map revision (LOMR) for a Portion of the San Jacinto River FEMA Case No. 11-09-0820P”, January 2011

5. U.S. Department of Commerce – National Oceanic and Atmospheric Administration – National Weather Service, “NOAA Atlas 14 Precipitation-Frequency Atlas of the United states, Volume 6 Version 2”, 2006

6. U.S. Department of Commerce - National Oceanic and Atmospheric Administration - National Weather Service, “NOAA Technical Memorandum NWS HYDRO-40, Depth-Area Ratios in the Semi-Arid Southwest United States”, August 1984.

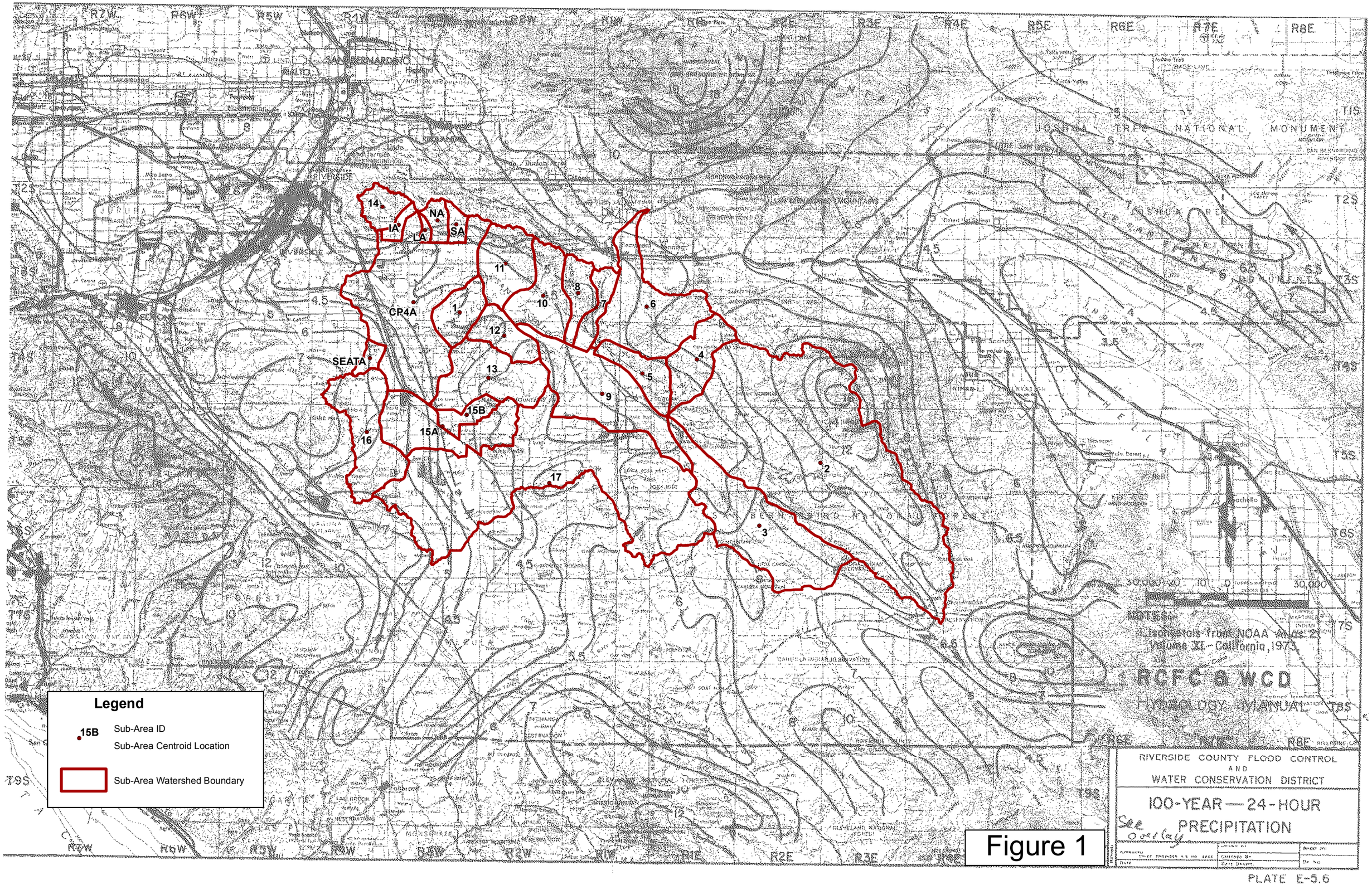
Legend
15B Sub-Area ID
Sub-Area Centroid Location
Sub-Area Watershed Boundary
14
NA
IA
LA
SA
11
8
10
7
6
CP4A
1
12
4
SEATA
13
5
9
15B
15A
16
17
2
3
RIVERSIDE COUNTY FLOOD CONTROL
AND
WATER CONSERVATION DISTRICT
100-YEAR — 24-HOUR
PRECIPITATION
See Overlay
PLATE E-5.6

Figure 1

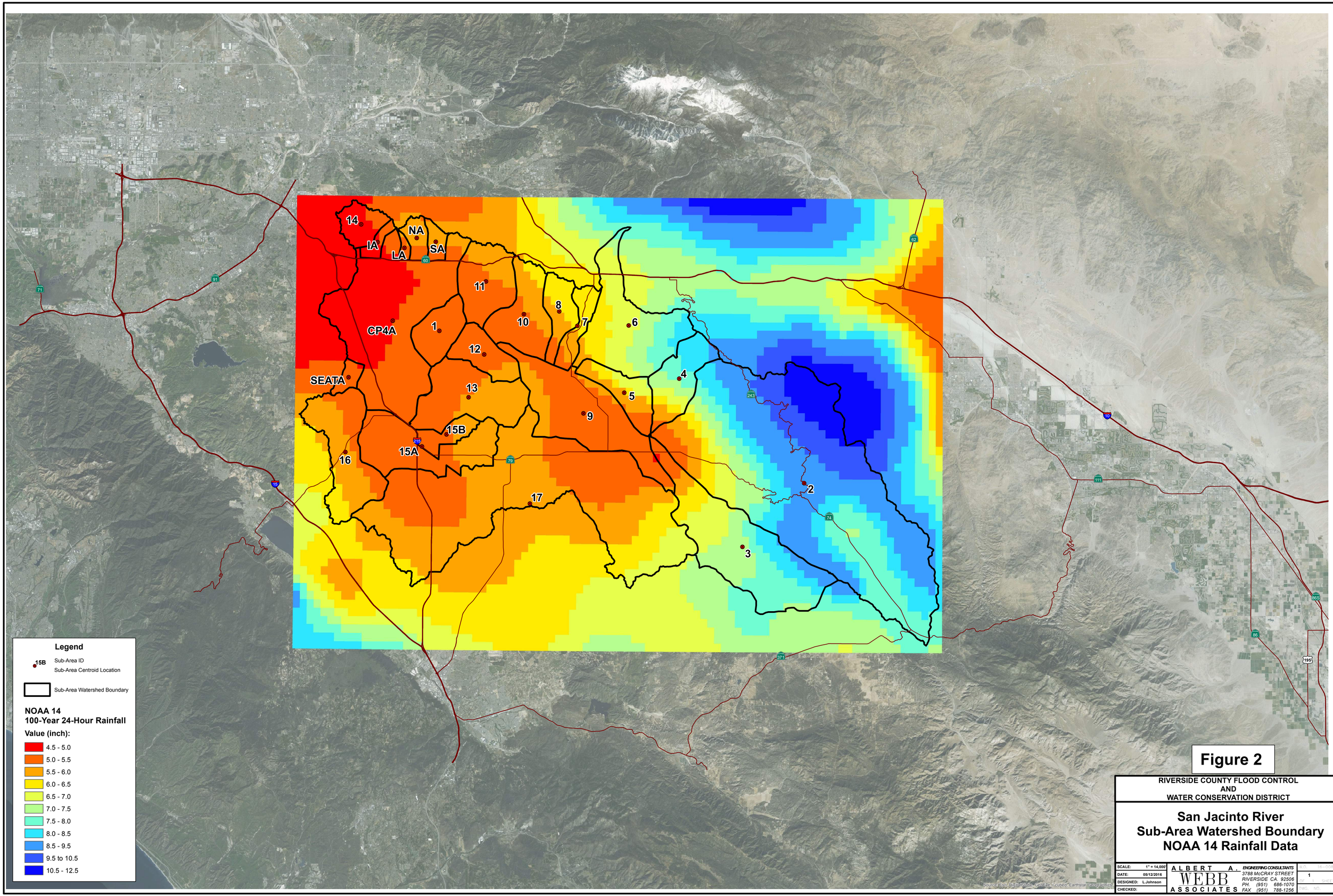

Figure 2

RIVERSIDE COUNTY FLOOD CONTROL
AND
WATER CONSERVATION DISTRICT

San Jacinto River
Sub-Area Watershed Boundary
NOAA 14 Rainfall Data

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