# APPENDIX H:
# HYDROLOGY REPORTS

# Preliminary Hydrology Report

*for*

# Riverside Community Hospital Garage (Phase 1 Ultimate Buildout)

# Riverside, CA

APN(s): 217-060-009, 217-060-020, 217-060-028, 217-060-027, 217-060-026, 217-060-024

*Southwest corner of Brockton Avenue and 14th Street*

*Riverside, CA 92501*

**JANUARY 2025**

**PREPARED FOR:**

HCA / Riverside Community Hospital
4445 Magnolia Avenue
Riverside, CA 92501
(951) 788-3151

**PREPARED BY:**

Kimley»Horn

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KHA Project # 194077057

## Certification by Engineer


______________________________ ___1/21/2025_______

Nikki Kerry, PE Date

## Table of Contents



## Appendices

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## References

Hydrology Manual. Riverside County Flood Control and Water Conservation District, April 1978.

Hydraulic Design Manual. Riverside County Flood Control and Water Conservation District, March 2024.

# INTRODUCTION

Kimley-Horn and Associates has been retained to prepare a Preliminary Hydrology Report for the proposed improvements for Riverside Community Hospital in the City of Riverside, California. The purpose of this report is to demonstrate final analysis of the hydrologic and hydraulic conditions associated with the development of the project site. To do so, the following is the scope of this report:

- Discuss the pre-development discharge patterns and points
- Discuss the post-development discharge patterns and points
- Determine the offsite flow rates for the 2-year, 5-year, 10-year and 100-year events
- Determine the pre-development onsite flow rates for the 2-year, 5-year, 10-year and 100-year events
- Determine the post-development un-mitigated flow rates for the 2-year, 5-year, 10-year and 100-year events
- Determine required post-development onsite mitigation for the 2-year, 5-year, 10-year and 100-year events

Even though this report discusses stormwater, this report is not a Stormwater Pollution Prevention Plan (SWPPP), a Groundwater Study, a Geotechnical Report, nor a Water Quality Management Plan (WQMP). Each of these separate reports discusses separate aspects of stormwater. Portions of the Geotechnical Report are utilized and referenced for the purpose of this report. Similarly, the requirements of the WQMP are considered for the stormwater mitigation and sizing of outlet structures for this project.

# PROJECT DESCRIPTION

This report encompasses only garage improvements in Phase 1 and uses ultimate proposed imperviousness values from Phase 2 that will replace a portion of phase 1. The remainder of Phase 2 will be addressed in a future drainage report.

The project is part of a larger development which is bounded by 14th Street to the north, Magnolia Avenue to the east, Brockton Avenue to the west, and Tequesquite Avenue to the south. The project is part of a larger development and will consist of two (2) phases. Phase 1 includes the addition of a multi-level Parking Garage, a gravel lot, proposed concrete pad, and proposed infiltration system. Phase 1 is located at the northwest corner of the Existing Development, near the intersection of Brockton Avenue and 14th Street. Northeast of the parking garage is a proposed ramp and stairs connecting to an existing walkway to 14th Street. East of the parking garage is also a sidewalk that connects to the existing hospital campus path-of-travel. Catch basins and drain inlets are scattered throughout the site to capture flows and redirect them toward the proposed basins for treatment. Within Phase 2, additional improvements to the parking garage include the addition of a parking lot and proposed driveway on the southern end of the parking garage as well as the redevelopment of a roundabout area to the east of the parking garage. While these improvements occur during Phase 2, they were considered within Phase 1's drainage analysis due to the higher imperviousness, thus more conservative sizing. Refer to the *Riverside Community Hospital Patient Tower (Phase 2) Hydrology Report* for the Phase 2 drainage analysis.

# LOCATION

The site is located at the northwest corner of the Existing Riverside Community Hospital Development, near the southeast intersection of Brockton Avenue and 14th Street. For reference see Appendix A for the Location Map.

# METHODOLOGY

The hydrologic and hydraulic analyses were completed following the methods outlined in the RCFC & WCD Hydrology Manual and the Hydraulic Design Manual. The rational method was used to estimate time of concentrations and peak flow rates generated from the proposed 10-year and 100-year storm events. The synthetic unit hydrograph method was used to determine the onsite proposed hydrographs for the 1-hour, 3-hour, 6-hour, and 24-hour duration of the 2-year, 5-year, and 10-year while the 1-hour and 24-hour durations were analyzed for the 100-year storm event. AES for Riverside County was used to perform the rational method calculations. The CivilDesign Engineering Software – 2018 Version 9.0 was used to complete the synthetic unit hydrograph analyses. The results of the rational method analyses are included in Appendix G and the results of the synthetic unit hydrograph analyses are included in Appendix H. CivilDesign (CivilD) was also used to complete the basin routing using the Modified Pul's Method. The results of the analyses are included in Appendix I.

The rainfall data used for the analyses impacts the flow and runoff results. For the synthetic unit hydrograph analysis, the 10-year and 100-year (1-hr, 3-hr, 6-hr and 24-hr) rainfall isohyetal maps from Plates D and E of the RCFCD Hydrology Manual for Riverside, CA were used. For the rational method analysis, the 10-year and 100-year (10 minutes and 60 minutes) rainfall intensities from NOAA Atlas 14 were used. See Appendix D for rainfall data.

The type of soil and soil conditions are major factors affecting infiltration/detention and resultant storm water runoff. The Natural Resources Conservation Service (NRCS) has classified soil into one general hydrologic soil group for comparing infiltration and runoff rates. The group is based on properties that influence runoff, such as water infiltration rate, texture, natural discharge, and moisture condition. The runoff potential is based on the amount of runoff at the end of a long duration storm that occurs after wetting and swelling of the soil not protected by vegetation. Using the United States Department of Agriculture's Natural Resources Conservation Service Web Soil Survey online tool, it was determined that the hydrologic soil group classification onsite is B. Soil type B is defined as soils having moderate infiltration rates (low runoff potential) when thoroughly wet.

Per the Geotechnical Investigation prepared by Group Delta Consultants, Inc. dated May 10, 2024 and Report of Field Infiltration Testing dated April 5$^{th}$, 2024, The measured infiltration rates for I-2A and I-2B (south basin) ranged from 2.63 to 2.92 in/hr, respectively without a factor of safety. A factor of safety of 2 was applied to the measured infiltration rate, giving an averaged factor rate of 1.39 in/hr. The test results presented in detail per the Riverside County LID BMP Design Handbook Infiltration Testing guidelines. See Appendix E for the soil information.

In addition, antecedent moisture condition (AMC) I was used to calculate the 2-year, and 5-year peak flows, AMC II was used to calculate the 10-year peak flows, and AMC III was used to calculate the 100-year peak flows based on the hydrology manual. The land use for the proposed drainage subareas were selected based on the percent impervious that characterizes each subarea in the proposed conditions. See Appendix C Plate D-5.6 for the impervious percentages that correspond to each land use. The combination of the soil and coverage type was used as the basis for selecting the appropriate curve numbers used to calculate the soil loss rates.

# DRAINAGE CHARACTERISTICS

## FEMA MAPPING

The site is located in Zone X per the Federal Emergency Management Administration (FEMA) Map 06065C0710G effective 8/28/2008. Flood Zone X is defined by FEMA as areas with minimal flood hazard. For reference, see Appendix B, FIRM Map.

## GROUNDWATER

Groundwater was encountered in one boring, Boring B-2, at a depth of 36 feet below grade (current groundwater surface elevation of about 762 feet MSL) during the Geotechnical field investigation prepared by Group Delta Consultants, Inc. The groundwater depths will typically vary from about 30 to 45 feet below grade in the lower portions of the site. It should be noted that the groundwater levels fluctuate over time due changes in season, rainfall, or site drainage may result in seepage or locally perched groundwater. Additional information can be found in the Geotechnical Investigation prepared by Group Delta Consultants, Inc. dated May 10, 2024 in Appendix E.

## PRE-DEVELOPMENT CONDITION

The existing site is fully developed with medical office buildings, surface parking, and parking structures. The predevelopment condition is broken down into two drainage subareas, labeled A and B. Drainage area A is located on the northern and eastern portions of the site, consisting of an existing surface parking lot, existing driveway, and an existing roundabout area. Drainage area A sheet flows southwesterly into an existing catch basin that discharge directly into the existing onsite storm drain line. The existing storm drain line discharges directly into an existing infiltration system labeled as EX-BMP-A. EX-BMP-A overflows via an existing 24" storm drain lateral along Tequesquite Ave. Note that drainage area A is the only area that drains to the existing BMPs. The unit hydrograph peak flow rates for area A were used to determine the allowable peak flow rate discharge for the proposed project's BMPs and thus only those hydrographs were included in this analysis. Drainage area B consists of an existing medical office building located on the western portion of the site which sheet flows west onto Brockton Ave where discharge is eventually collected in an existing catch basin along Brockton Ave. See Appendix F for the Pre-development Drainage Map and Appendix G for the rational method calculations. Table 1 below summarizes the existing peak flow results.

**Table 1: Pre-Development Flows***

| Drainage Area | Area (ac) | Rational Method (cfs) | |
|---|---|---|---|
| | | 10-Year | 100-Year |
| A | 2.27 | 3.09 | 5.09 |
| B | 1.01 | 1.38 | 3.00 |
| **Total** | **3.28** | **4.47** | **8.09** |

| Drainage Area | Area (ac) | 2-Year Peak Flows (cfs) | | | |
|---|---|---|---|---|---|
| | | **1-hr** | **3-hr** | **6-hr** | **24-hr** |
| **DMA A** | 2.27 | 2.30 | 1.19 | 0.97 | 0.37 |
| | | **5-Year Peak Flows (cfs)** | | | |
| | | **1-hr** | **3-hr** | **6-hr** | **24-hr** |
| | | 3.03 | 1.62 | 1.35 | 0.50 |
| | | **10-Year Peak Flows (cfs)** | | | |
| | | **1-hr** | **3-hr** | **6-hr** | **24-hr** |
| | | 3.69 | 2.07 | 1.79 | 0.60 |
| | | **100-Year Peak Flows (cfs)** | | | |
| | | **1-hr** | | **24-hr** | |
| | | 5.69 | | 1.08 | |

*Note that the post-development peak flows are compared to only A as this is the only DA that is originally tributary to EX-BMP-A. Therefore, only Existing hydrograph values for A are provided.

## POST-DEVELOPMENT CONDITION (PHASE 1)

In Phase 1, there are nine (9) drainage subareas labeled as A1.1-A1.7, A2, and B. Drainage areas (DA) A1.1-A1.4 and A1.6-A1.7 consist of the proposed parking garage and its associated landscape and sidewalk areas. Area A1.5 consists of the addition of a gravel lot with a proposed concrete pad to the south of the garage addition. A1.5 will be further redeveloped during Phase 2. Drainage area A2 consists of existing offsite area that will bypass the proposed PR-BMP-1 and sheet flow to the catch basin located at Node 91. DA B consists of 0.02 acres of proposed driveway entrance area along Brockton Ave that cannot be feasibly captured on-site. Flows from DA B matches existing conditions, and sheet flows offsite onto Brockton Ave. Flows from all areas, A1.1-A1.7, will be tributary to PR-BMP-1, and the combination of overflows from PR-BMP-1 and DA A2 are tributary to EX-BMP-A matching existing conditions. Drainage areas under Phase 1 have an overall imperviousness of about 73% while drainage areas in Phase 2 will have an overall imperviousness of about 77%. Higher impervious values during Phase 2 suggest higher peak flows, therefore PR-BMP-1 will be sized for the ultimate buildout Phase 2 condition. See Appendix F for the Post-Development Condition (Phase 1) Exhibit and Appendix G for the rational method calculations. See the Post-Development Condition Phase 2 section below for the drainage analysis using the higher impervious percentage.

## POST-DEVELOPMENT CONDITION (PHASE 1 WITH PHASE 2 ULTIMATE BUILDOUT)

The Phase 2 post-development condition for the project site consists of nine (9) drainage areas. Drainage Areas A1.1-A1.4, A1.6, A1.7, and B will have no major changes and will still consist of the Parking Garage and its associated landscape and sidewalk areas. DA A1.5 will be redeveloped into proposed surface parking, driveway, and landscape areas. DA A2 will consist of existing area as well as proposed improvements to the roundabout area north of the existing medical office building at 4500 Brockton. Drainage areas A1.1-A1.7 will sheet flow into their respective inlets located at low points throughout the site and will discharge directly into the proposed underground infiltration system (PR-BMP-1). Overflows from the PR-BMP-1 will tie into the catch basin located at Node 91, which is capturing flows from DA A2. Peak flows from A1.1-A1.7 and A2 are ultimately tributary to the EX-BMP-A, matching existing conditions. Table 2 shows a summary of the post-development flows prior to detention. See Appendix F for the Post-

Development Condition (Phase 1 Ultimate Buildout) Exhibit and Appendix G for the rational method calculations.

**Table 2: Post-Development Flows Phase 2 (Un-mitigated)**

| Drainage Area | Area (ac) | Rational Method (cfs) | |
|---|---|---|---|
| | | 10-Year | 100-Year |
| A1.1-A1.7 | 1.92 | 3.5 | 5.62 |
| A2 | 1.34 | 2.05 | 3.31 |
| B | 0.02 | 0.04 | 0.06 |
| **Total** | **3.28** | **5.59** | **8.99** |

| Drainage Area | Area (ac) | 2-Year Unit Hydrograph (cfs) | | | |
|---|---|---|---|---|---|
| | | 1-hr | 3-hr | 6-hr | 24-hr |
| A1 | 1.92 | 2.06 | 0.94 | 0.75 | 0.28 |
| A2 | 1.34 | 1.43 | 0.69 | 0.54 | 0.20 |

| Drainage Area | Area (ac) | 5-Year Unit Hydrograph (cfs) | | | |
|---|---|---|---|---|---|
| | | 1-hr | 3-hr | 6-hr | 24-hr |
| A1 | 1.92 | 2.74 | 1.31 | 1.06 | 0.38 |
| A2 | 1.34 | 1.89 | 0.96 | 0.79 | 0.27 |

| Drainage Area | Area (ac) | 10-Year Unit Hydrograph (cfs) | | | |
|---|---|---|---|---|---|
| | | 1-hr | 3-hr | 6-hr | 24-hr |
| A1 | 1.92 | 3.37 | 1.72 | 1.45 | 0.46 |
| A2 | 1.34 | 2.31 | 1.24 | 1.06 | 0.32 |

| Drainage Area | Area (ac) | 100-Year Unit Hydrograph (cfs) | |
|---|---|---|---|
| | | 1-hr | 24-hr |
| A1 | 1.92 | 5.25 | 0.87 |
| A2 | 1.34 | 3.57 | 0.64 |

## STORMWATER MITIGATION

PR-BMP-1 is designed to retain the water quality volume for the entirety of DA A1 and also mitigated flows to that of the existing drainage area EX-A. Under Existing conditions EX-B was discharging to Brockton Ave however, now that EX-B will be redeveloped, it will be routed towards the proposed underground infiltration system (PR-BMP-1) for water quality treatment and peak flow mitigation. At Node 91 of the Post-Development Phase 1 Exhibit, the existing peak flow is that of area EX-A. Therefore, the peak flows from DA A1 and DA A2 will need to be reduced to that of EX-A. The infiltration system (PR-BMP-1) is designed with proposed orifices and weir to mitigate peak flows. See proposed CivilD output in Appendix I for a summary of provided weir and orifices rating table. Refer to the CivilD mitigated outflow calculations in Appendix I. The orifice is set at a height of 2.66 ft from the bottom of the stone to allow for retention of the water quality volume from DA-A1. Overflows from the proposed infiltration system will discharge to the existing onsite storm drain system at Node 91. Flows are ultimately tributary to EX-BMP-A which overflows to the existing storm drain along Tequesquite Ave. Table 3 shows a summary of the proposed mitigated flows.

**Table 3: Post-Development Flows (mitigated)**

| Drainage Area | Area (ac) | 2-Year Unit Hydrograph (cfs) | | | |
|---|---|---|---|---|---|
| | | 1-hr | 3-hr | 6-hr | 24-hr |
| A1 | 1.92 | 0.01 | 0.11 | 0.15 | 0.16 |
| A2 | 1.34 | 1.43 | 0.69 | 0.54 | 0.20 |
| **Total** | **3.26** | **1.44** | **0.80** | **0.69** | **0.36** |

| Drainage Area | Area (ac) | 5-Year Unit Hydrograph (cfs) | | | |
|---|---|---|---|---|---|
| | | 1-hr | 3-hr | 6-hr | 24-hr |
| A1 | 1.92 | 0.08 | 0.17 | 0.21 | 0.21 |
| A2 | 1.34 | 1.89 | 0.96 | 0.79 | 0.27 |
| **Total** | **3.26** | **1.97** | **1.14** | **1.00** | **0.48** |

| Drainage Area | Area (ac) | 10-Year Unit Hydrograph (cfs) | | | |
|---|---|---|---|---|---|
| | | 1-hr | 3-hr | 6-hr | 24-hr |
| A1 | 1.92 | 0.14 | 0.22 | 0.26 | 0.25 |
| A2 | 1.34 | 2.31 | 1.24 | 1.06 | 0.32 |
| **Total** | **3.26** | **2.45** | **1.46** | **1.32** | **0.57** |

| Drainage Area | Area (ac) | 100-Year Unit Hydrograph (cfs) | |
|---|---|---|---|
| | | 1-hr | 24-hr |
| A1 | 1.92 | 0.25 | 0.45 |
| A2 | 1.34 | 3.57 | 0.63 |
| **Total** | **3.26** | **3.82** | **1.08** |

# HYDRAULIC ANALYSIS

The calculated peak flows from the analyses discussed above will be used to size the onsite drainage infrastructure using Bentley's Flowmaster during final design. Catch Basin calculations were sized assuming a 50% clogging factor. Pipes sizing will be provided during final analysis. See Appendix J for Catch Basin and Street Capacity Calculations.

# CONCLUSION

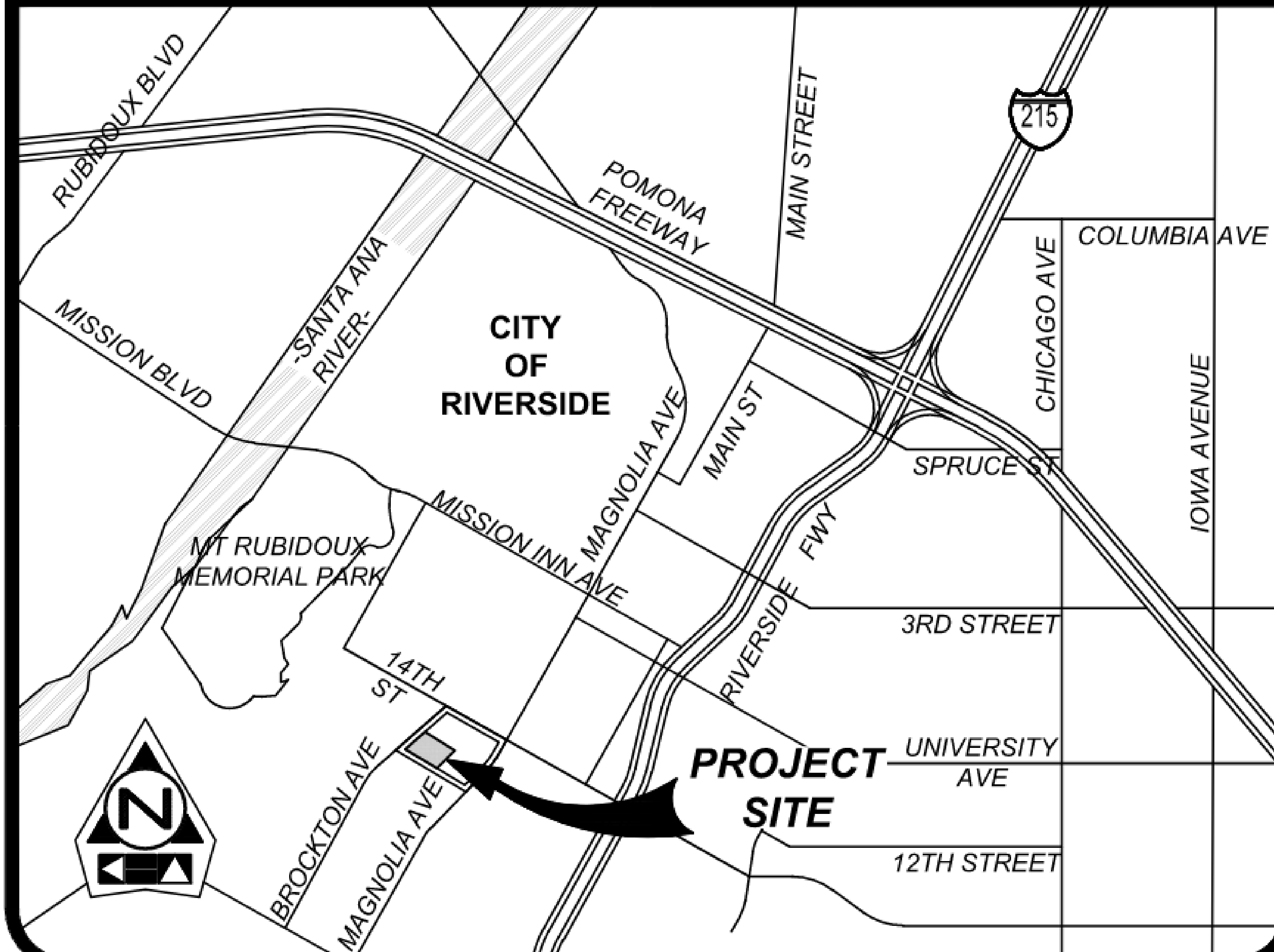
In conclusion, the following was covered in this report:

- The pre-development discharge patterns and points were discussed
- The post-development discharge patterns and points were discussed
- The pre-development flow rates for the 2-year, 5-year, 10-year for the 1-hr, 3-hr, 6-hr, 24-hr and 100-year 1-hr and 24-hr events were determined
- The post-development un-mitigated flow rates for 2-year, 5-year, 10-year for the 1-hr, 3-hr, 6-hr, 24-hr and 100-year 1-hr and 24-hr events were determined
- The post-development stormwater mitigation for the 2-year, 5-year, 10-year for the 1-hr, 3-hr, 6-hr, 24-hr and 100-year 1-hr and 24-hr events were determined
- The post-development mitigated flow rates were proven to be less than the existing flow rates for the 2-year, 5-year, 10-year for the 1-hr, 3-hr, 6-hr, 24-hr and 100-year 1-hr and 24-hr events at Node 91

As discussed in the contents of this report, the development of the existing developed site into the proposed development is not expected to cause a significant impact to downstream systems for storms up to the 100-year condition. The mitigated development discharges smaller stormwater flows than the existing capacity at Node 91.

# Appendix A - Location Map

# VICINITY MAP



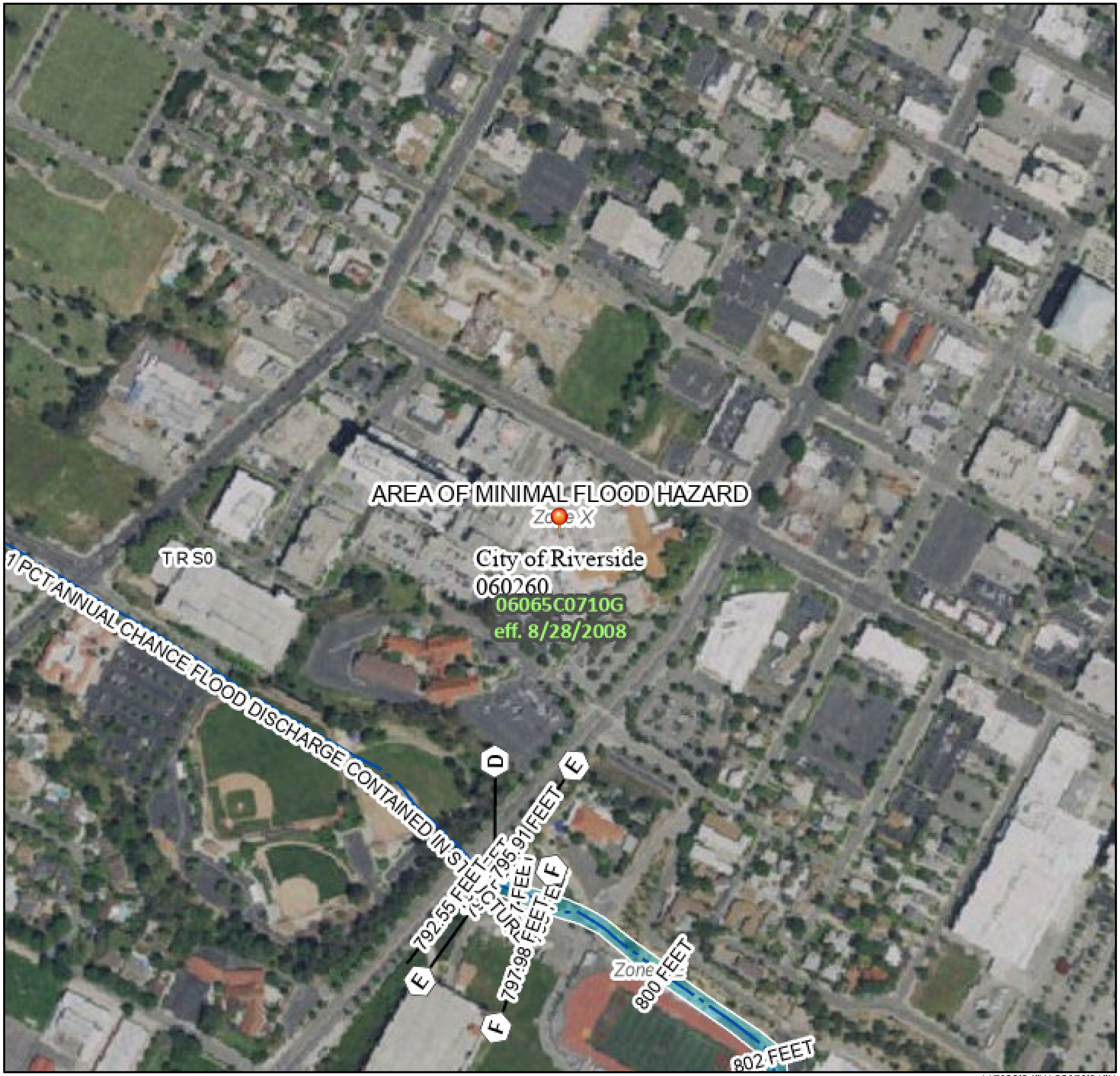

THOMAS GUIDE - SAN BERNARDINO
PAGE #603 GRID C-6
SECTION 24, TOWNSHIP 1 SOUTH, RANGE 7 WEST
(NOT TO SCALE)

# Appendix B - FIRM MAP

# National Flood Hazard Layer FIRMette

FEMA

117°23'11"W 33°58'51"N




117°22'34"W 33°58'21"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

*Basemap Imagery Source: USGS National Map 2023*

## Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

| | | |
|---|---|---|
| SPECIAL FLOOD HAZARD AREAS | | Without Base Flood Elevation (BFE) *Zone A, V, A99* |
| | | With BFE or Depth *Zone AE, AO, AH, VE, AR* |
| | | Regulatory Floodway |
| OTHER AREAS OF FLOOD HAZARD | | 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X* |
| | | Future Conditions 1% Annual Chance Flood Hazard *Zone X* |
| | | Area with Reduced Flood Risk due to Levee. See Notes. *Zone X* |
| | | Area with Flood Risk due to Levee *Zone D* |
| OTHER AREAS | NO SCREEN | Area of Minimal Flood Hazard *Zone X* |
| | | Effective LOMRs |
| | | Area of Undetermined Flood Hazard *Zone D* |
| GENERAL STRUCTURES | | Channel, Culvert, or Storm Sewer |
| | | Levee, Dike, or Floodwall |
| OTHER FEATURES | B 20.2 / 17.5 | Cross Sections with 1% Annual Chance Water Surface Elevation |
| | 8 | Coastal Transect |
| | 513 | Base Flood Elevation Line (BFE) |
| | | Limit of Study |
| | | Jurisdiction Boundary |
| | | Coastal Transect Baseline |
| | | Profile Baseline |
| | | Hydrographic Feature |
| MAP PANELS | | Digital Data Available |
| | | No Digital Data Available |
| | | Unmapped |

N

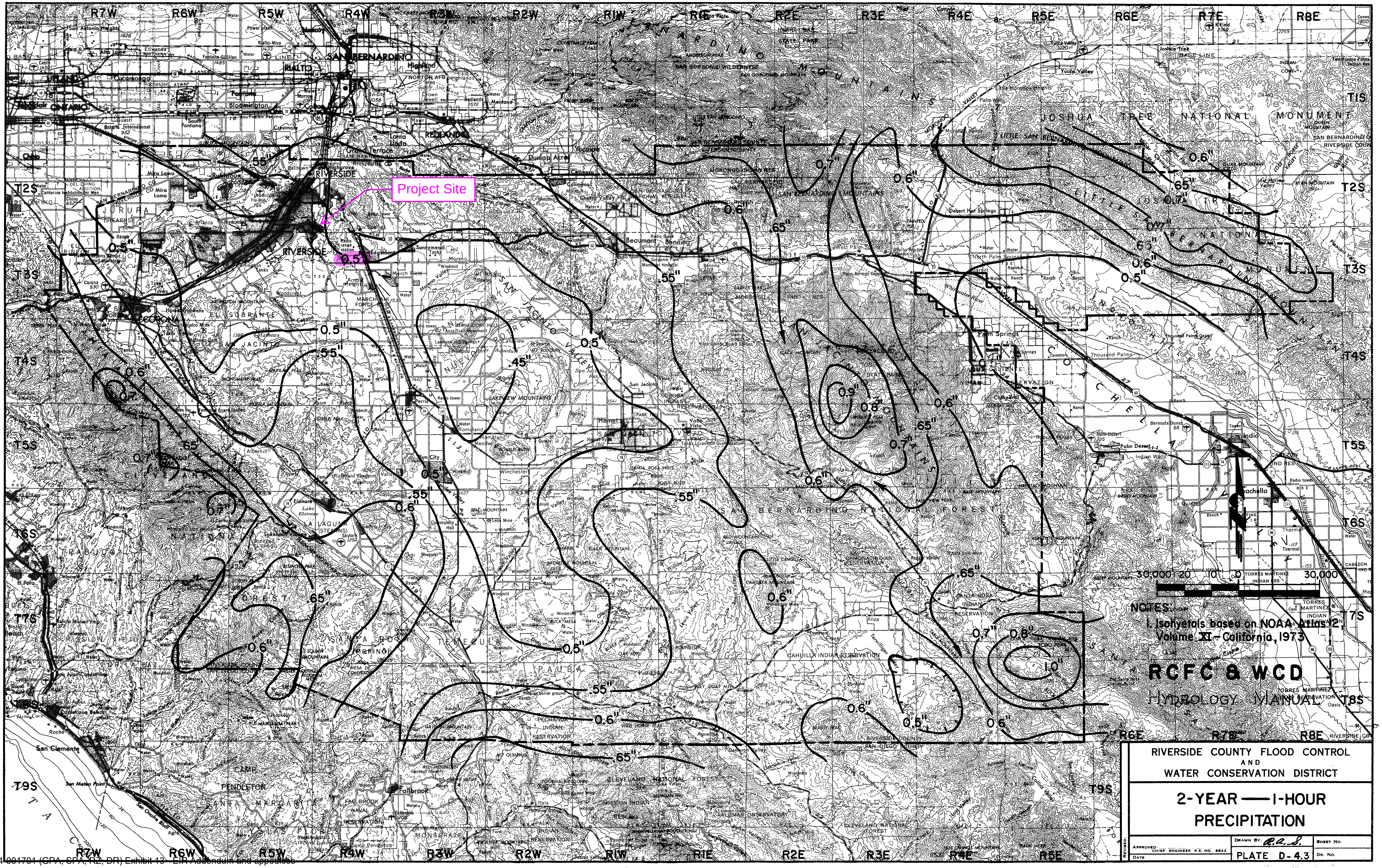
The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 7/17/2024 at 2:28 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

# Appendix C - Hydrology References



Project Site
RIVERSIDE COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
2-YEAR — 1-HOUR PRECIPITATION
PLATE D-4.3
NOTES:
1. Isohyetals based on NOAA Atlas 2, Volume XI - California, 1973
RCFC & WCD
HYDROLOGY MANUAL
APPROVED: CHIEF ENGINEER
DRAWN BY:
SHEET NO.
DATE
DR. NO.
REVISED
30,000 20 10 0 30,000
R7W
R6W
R5W
R4W
R3W
R2W
R1W
R1E
R2E
R3E
R4E
R5E
R6E
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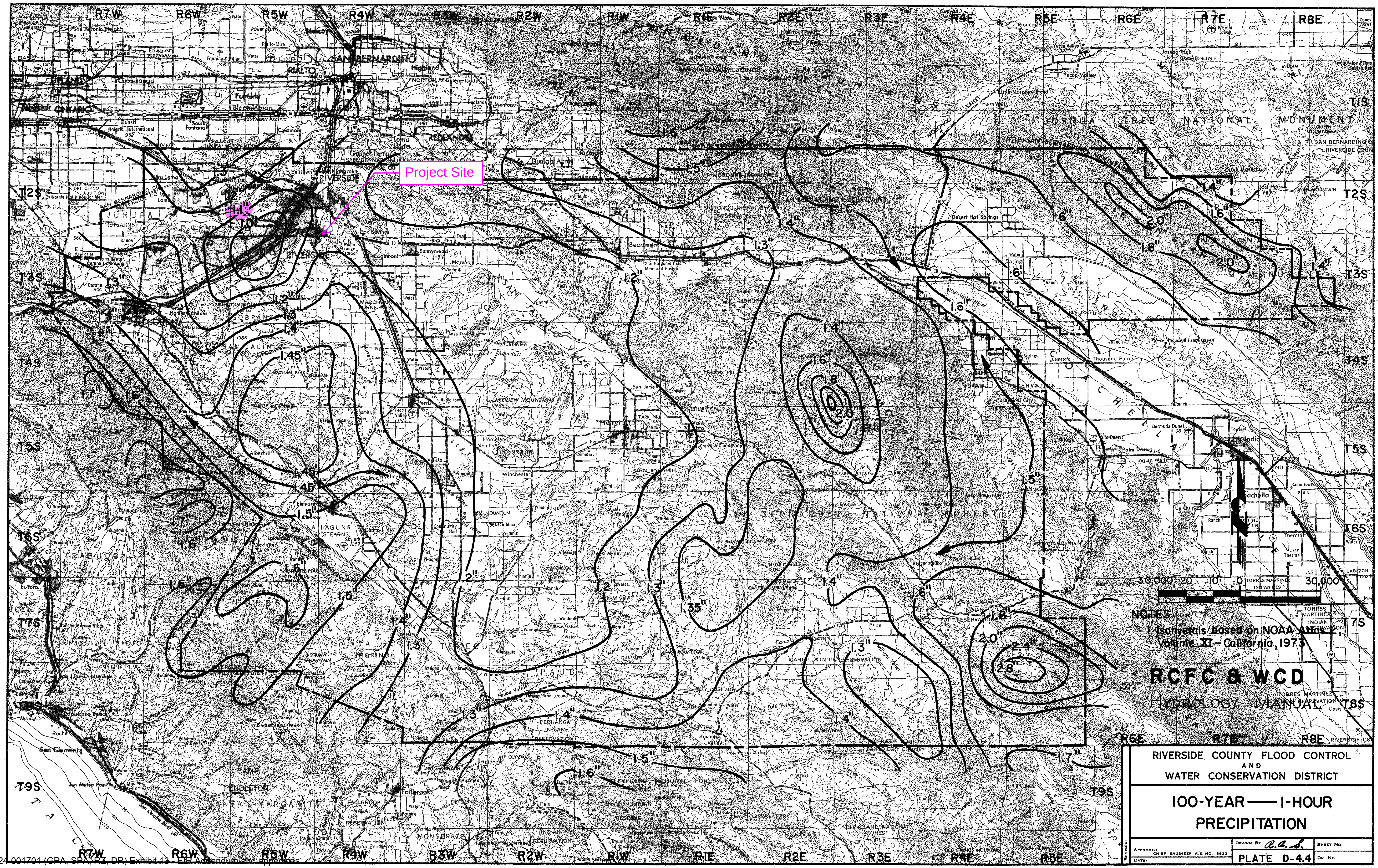
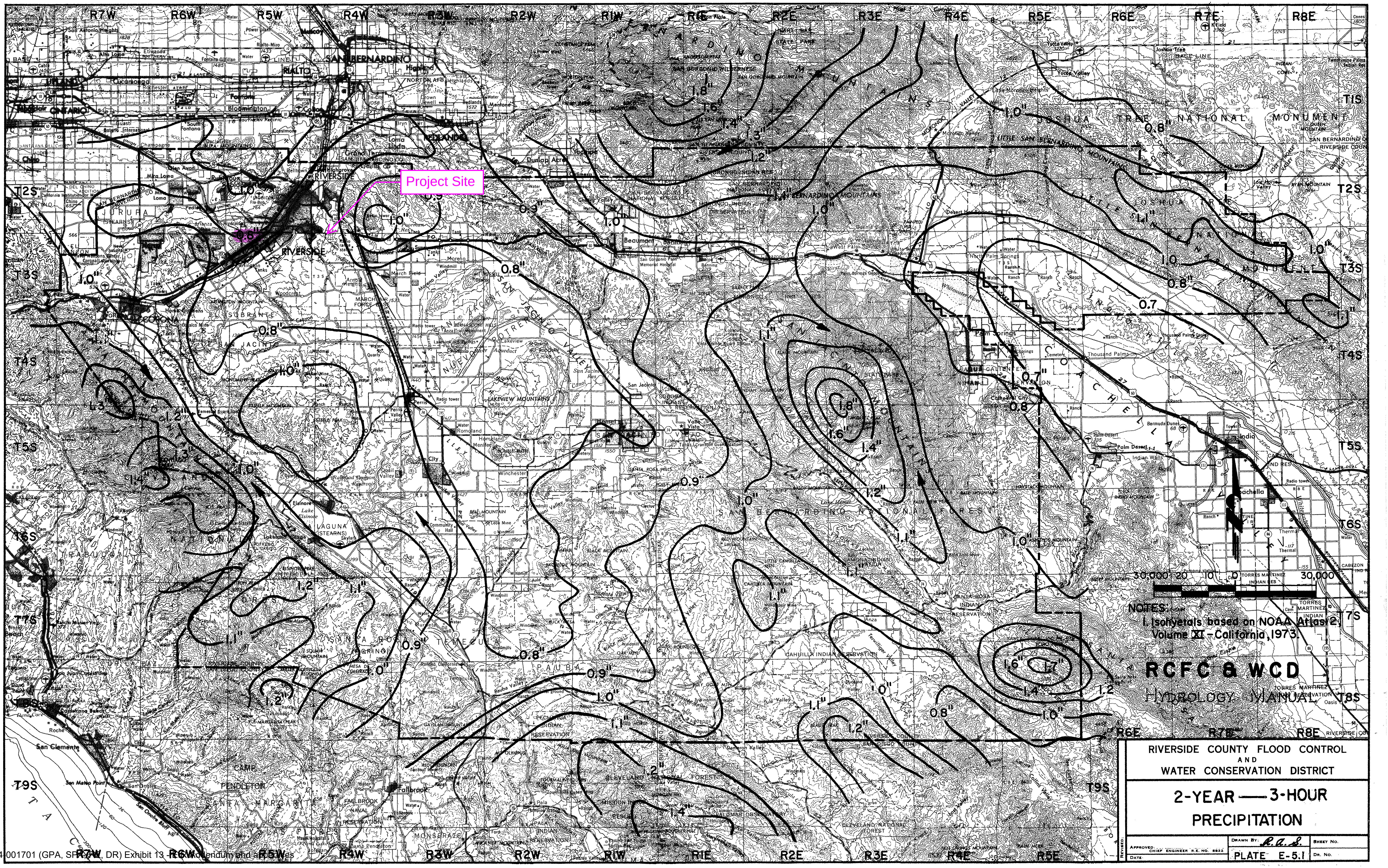
R8E
T1S
T2S
T3S
T4S
T5S
T6S
T7S
T8S
T9S
SAN BERNARDINO
RIVERSIDE
CORONA
JOSHUA TREE NATIONAL MONUMENT
SAN BERNARDINO NATIONAL FOREST
CLEVELAND NATIONAL FOREST
SAN BERNARDINO MOUNTAINS
LITTLE SAN BERNARDINO MOUNTAINS
COACHELLA VALLEY
CAMP PENDLETON
San Clemente
Palm Springs
Indio
Hemet
Perris
Temecula
Beaumont
Banning
Fallbrook


Project Site
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 —— 1-HOUR
PRECIPITATION
APPROVED:
CHIEF ENGINEER R.E. NO. 8822
DATE:
REVISED:
DRAWN BY: R.A.S.
PLATE D-4.4
SHEET NO.
DR. NO.



Project Site
RIVERSIDE COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
2-YEAR — 3-HOUR PRECIPITATION
PLATE E-5.1
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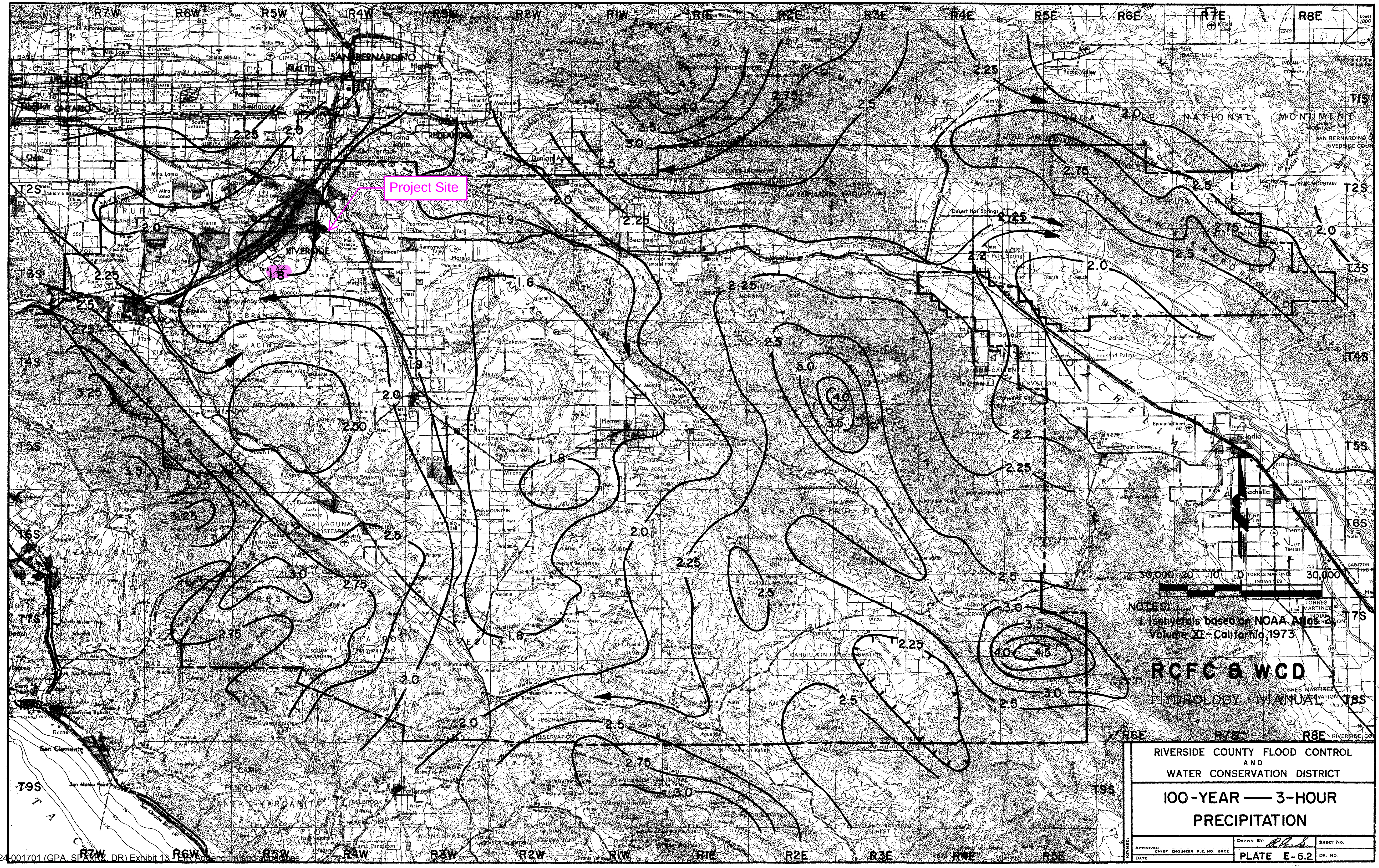
RCFC & WCD
HYDROLOGY MANUAL



Project Site
RIVERSIDE
SAN BERNARDINO
1.8
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. 8822
DATE
REVISED:
DRAWN BY:
SHEET NO.
PLATE E-5.2
DR. NO.