HYDROLOGY & HYDRAULICS STUDY

For

CITY OF BEAUMONT
2ND STREET IMPROVEMENT

LOCATED IN THE CITY OF BEAUMONT, CA

Prepared For:

BEAUMONT
California

NOVEMBER 2021

Cozad & Fox, Inc.

DECLARATION OF RESPONSIBLE CHARGE

I hereby declare that I am the Engineer of work for this Drainage Study for the City of Beaumont 2nd Street Improvement, that I have exercised responsible charge over the design of this project to date as defined in Section 6703 of the Business and Professions Code, and that the design is consistent with current standards.

I understand that the check of the project drawings and specifications by City of Beaumont is confined to a review only and does not relieve me, as the Engineer of work, of my responsibilities for the projects design.

Brian D. Fox	11/05/2021
Name	Date
Signature	57264
	RCE No.

PRELIMINARY

PRELIMINARY

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Purpose

This study was prepared as supporting calculations and analysis for the City of Beaumont 2nd Street Improvement. The hydrological and hydraulic analysis were prepared in conjunction with the street improvement plans for the project due to the addition of impervious material (asphalt concrete and AC dike) along approximately 2500 feet of previously undeveloped land.

Project Description

The City of Beaumont 2nd Street Improvement Project is approximately 3.40 acres. The project lies to the East of Pennsylvania Avenue, a highly transited street which connects to the Interstate 10 Freeway. The proposed project location is currently mostly dirt cover and asphalt pavemented road. Additionally, to the north of the self-storage facility lies an existing concrete sidewalk. To the north, lies a vacant undeveloped dirt land. To the east of the street, lies asphalt pavement road which will be widened. To the south of the project lies vacant and undeveloped land and to the south, lies vacant land bounded by E. 1st St. There are existing culverts due East of Pennsylvania Avenue. There is an existing storm drain system that lies to the north and south of 2nd street near the existing self-storage facility. The project is located approximately 2 miles south of Interstate 10 Freeway. Latitude and longitude for the site are 33° 55.24.0' N / 116° 43.8' W, respectively.

Existing Drainage Conditions

The site is composed of moderately sloping valley terrain that falls generally southwest. According to the Federal Emergency Management Agency (FEMA), the project area lies in a Zone X; this zone indicates that the project lies in a moderate to low-risk area and are non-special flood hazard areas. These areas lie outside the 1% annual chance floodplain, flood insurance is not required but can be obtained at a reduced cost for property owners and renters.

The elevations across the site vary from 2570 to 2585 feet above mean sea level (MSL) along the proposed road extension and from 2570 to 2600 feet above mean sea level (MSL) across the entire site. All surface runoff from the site drains as sheet flow to the existing storm drain structures. Since most of the existing project location is covered by dirt, this means that most of the storm water is most likely infiltrated through the soil.

Proposed Drainage Conditions

The proposed grading design for the site matches the flow regime of the existing drainage conditions. Four new RCP concrete culverts will be installed to handle the sites drainage requirements due to the increase of impervious materials and due to the existing seasonal creeks on-site.

METHODOLOGY

For off-site flows, only the peak flow rate was established. The Riverside County Rational Method, as described in the Riverside County Hydrology Manual was utilized to determine 100-year storm peak flows for both the pre-development and post-development conditions. CivilDesign hydrology software was used to generate peak flows based on the County's Rational Method requirement.

HYDROLOGY RESULTS

PRE-DEVELOPMENT CONDITION:

Please see provided appendices for all calculations and reference tables. The provided Q in the table below are based on the rational method and the provided V is based on the unit hydrograph method.

Pre-Development Condition		
Storm Year	Time of Concentration (min)	Peak Flow Q, (cfs)
100	17.03	63.009

POST-DEVELOPMENT CONDITION:

Post-Development Condition		
Storm Year	Time of Concentration (min)	Peak Flow Q, (cfs)
100	15.35	70.051

HYDROLOGICAL DATA

Based on the site's location, the following soil data is from the Riverside County Hydrology Manual:

- Soils Group – "B"

The following precipitation data is from the Riverside County Hydrology Manual Isohyetal Maps:

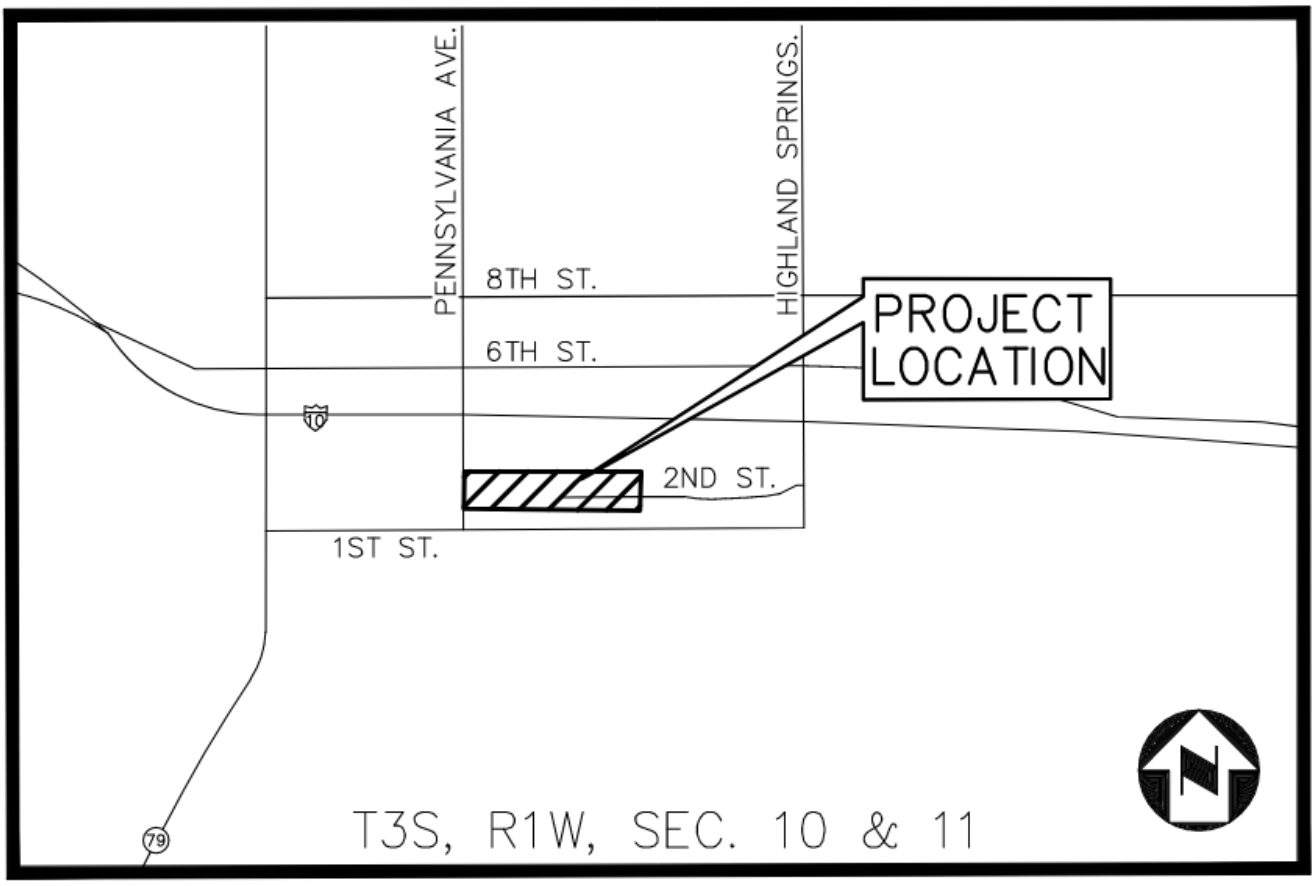
- 10 Year – 1 Hour Precipitation = 0.890 (in/hr)
- 100 Year – 1 Hour Precipitation = 1.320 (in/hr)
- 10 Year – 10 Minute Precipitation = 2.300 (in/hr)
- 100 Year – 10 Minute Precipitation = 3.410 (in/hr)

Please see provided appendices for all calculations and reference tables.

Conclusion

The project proposes the addition of four RCP culverts to mitigate the increased flow caused by the extension of 2nd Street to Pennsylvania Avenue. Based on the results of this report, it is concluded that the proposed infrastructure will adequately provide drainage and conveyance adequate and in accordance with the requirements of Riverside County Flood Control and the City of Beaumont.

APPENDIX 1 – VICINITY MAP



Appendix 2 – Rational Method

```
                Riverside County Rational Hydrology Program

      CIVILCADD/CIVILDESIGN Engineering Software,(c) 1989 - 2004 Version 7.0
           Rational Hydrology Study        Date: 11/17/21
File:2NDSTREETDRAINAGE.out
      ------------------------------------------------------------------------
      SECOND STREET INTIAL HYDROLOGY



      ------------------------------------------------------------------------
       *********   Hydrology Study Control Information **********

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

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


      Program License Serial Number 4067

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

      Storm event (year) =  100.00 Antecedent Moisture Condition = 2

      Standard intensity-duration curves data (Plate D-4.1)
      For the [ Beaumont ] area used.
      10 year storm 10 minute intensity =  2.300(In/Hr)
      10 year storm 60 minute intensity =  0.890(In/Hr)
      100 year storm 10 minute intensity =  3.410(In/Hr)
      100 year storm 60 minute intensity =  1.320(In/Hr)

      Storm event year = 100.0
      Calculated rainfall intensity data:
      1 hour intensity =  1.320(In/Hr)
      Slope of intensity duration curve = 0.5300




      ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
      Process from Point/Station        0.000(Ft.) to Point/Station
950.000(Ft.)
      **** INITIAL AREA EVALUATION ****
      ________________________________________________________________________
      Initial area flow distance =   950.000(Ft.)
      Top (of initial area) elevation =  2600.000(Ft.)
      Bottom (of initial area) elevation =  2575.000(Ft.)
      Difference in elevation =    25.000(Ft.)
      Slope =    0.02632  s(percent)=       2.63
      TC = k(0.530)*[(length^3)/(elevation change)]^0.2
```

```
      Initial area time of concentration =   17.034 min.
      Rainfall intensity =      2.573(In/Hr) for a   100.0 year storm
      UNDEVELOPED (poor cover) subarea
      Runoff Coefficient = 0.785
      Decimal fraction soil group A = 0.000
      Decimal fraction soil group B = 1.000
      Decimal fraction soil group C = 0.000
      Decimal fraction soil group D = 0.000
      RI index for soil(AMC 2)  =  78.00
      Pervious area fraction =  1.000; Impervious fraction =  0.000
      Initial subarea runoff =     20.000(CFS)
      Total initial stream area =        9.900(Ac.)
      Pervious area fraction = 1.000


      ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
      Process from Point/Station        0.000(Ft.) to Point/Station
1000.000(Ft.)
      **** SUBAREA FLOW ADDITION ****
      ------------------------------------------------------------------------
      UNDEVELOPED (poor cover) subarea
      Runoff Coefficient = 0.785
      Decimal fraction soil group A = 0.000
      Decimal fraction soil group B = 1.000
      Decimal fraction soil group C = 0.000
      Decimal fraction soil group D = 0.000
      RI index for soil(AMC 2)  =  78.00
      Pervious area fraction =  1.000; Impervious fraction =  0.000
      Time of concentration =    17.03 min.
      Rainfall intensity =      2.573(In/Hr) for a   100.0 year storm
      Subarea runoff =     43.009(CFS) for     21.290(Ac.)
      Total runoff =     63.009(CFS)      Total area =      31.190(Ac.)


      ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
      Process from Point/Station        0.000(Ft.) to Point/Station
950.000(Ft.)
      **** INITIAL AREA EVALUATION ****
      ------------------------------------------------------------------------
      Initial area flow distance =   950.000(Ft.)
      Top (of initial area) elevation =  2600.000(Ft.)
      Bottom (of initial area) elevation =  2575.000(Ft.)
      Difference in elevation =    25.000(Ft.)
      Slope =    0.02632  s(percent)=       2.63
      TC = k(0.530)*[(length^3)/(elevation change)]^0.2
      Initial area time of concentration =   17.034 min.
      Rainfall intensity =      2.573(In/Hr) for a   100.0 year storm
      UNDEVELOPED (poor cover) subarea
      Runoff Coefficient = 0.785
      Decimal fraction soil group A = 0.000
      Decimal fraction soil group B = 1.000
      Decimal fraction soil group C = 0.000
      Decimal fraction soil group D = 0.000
      RI index for soil(AMC 2)  =  78.00
      Pervious area fraction =  1.000; Impervious fraction =  0.000
```

```
      Initial subarea runoff =     20.202(CFS)
      Total initial stream area =       10.000(Ac.)
      Pervious area fraction = 1.000


      ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
      Process from Point/Station        0.000(Ft.) to Point/Station
950.000(Ft.)
      **** CONFLUENCE OF MAIN STREAMS ****
      ______________________________________________________________________
      The following data inside Main Stream is listed:
      In Main Stream number: 1
      Stream flow area =     10.000(Ac.)
      Runoff from this stream =     20.202(CFS)
      Time of concentration =   17.03 min.
      Rainfall intensity =     2.573(In/Hr)
      Summary of stream data:

      Stream   Flow rate      TC            Rainfall Intensity
       No.       (CFS)       (min)                 (In/Hr)


      1       20.202     17.03               2.573
      Largest stream flow has longer time of concentration
      Qp =     20.202 + sum of
      Qp =     20.202

      Total of 1 main streams to confluence:
      Flow rates before confluence point:
            20.202
      Area of streams before confluence:
             10.000


      Results of confluence:
      Total flow rate =     20.202(CFS)
      Time of concentration =    17.034 min.
      Effective stream area after confluence  =     10.000(Ac.)
      End of computations, total study area =           41.19 (Ac.)
      The following figures may
      be used for a unit hydrograph study of the same area.

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

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
      Process from Point/Station        0.000(Ft.) to Point/Station
1000.000(Ft.)
      **** SUBAREA FLOW ADDITION ****
      ______________________________________________________________________
      USER ENTRY subarea
      Runoff Coefficient = 0.785
      Decimal fraction soil group A = 0.000
      Decimal fraction soil group B = 1.000
      Decimal fraction soil group C = 0.000
```

```
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)   =  78.00
Pervious area fraction =  0.840; Impervious fraction =  0.160
Time of concentration =    15.35 min.
Rainfall intensity =      2.573(In/Hr) for a   100.0 year storm
Subarea runoff =     50.051(CFS) for     21.290(Ac.)
Total runoff =     70.051(CFS)      Total area =      31.190(Ac.)
```

CULVERT #1 SIZING

```
*************************************************************************
                  ****** PIPE FLOW CALCULATIONS ******
               Copyright (c) 1988, CivilDesign Software, Inc.
  *************************************************************************

 *************************************************************************
 For: For Licensed CivilDesign User
 *************************************************************************
          ***** NON-PRESSURE, OPEN CHANNEL CALCULATIONS ****

   CALCULATE PIPE SIZE GIVEN:
   Channel Slope =    -.013333 (Ft./Ft.) =    -1.3333 %
   Invert elevation at pipe INLET =     2570.000 (Ft.)
   Invert elevation at pipe OUTLET =     2568.000 (Ft.)
   Length of pipe =      150.000 (Ft.)



          *** PIPE OPEN CHANNEL FLOW ***


   Mannings "n" =  .020
   No. of pipes =   1   Velocity (Ft./Sec.) =     7.28
   Nearest 1 Inch Pipe Diameter (In.) =     31.00
   Individual pipe flow =    35.00     (CFS)
        "      "     "  =    .1571E+05 (GPM)
        "      "     "  =    22.62     (MGD)
   Total pipe area =       754.77 (In2)
   Total perimeter of pipe =        97.39 (In.)
   Normal flow depth in pipe =     26.75 (In.)
   Flow top width inside pipe =     21.32 (In.)
   Area of flow =     692.4686 (In2)
   Wetted Perimeter =    73.87 (In.)
   Critical Depth in Pipe =      23.98 (In.)
   Total flow of pipe(s) =    35.00     (CFS)
     "     "   "    "    =    .1571E+05 (GPM)
     "     "   "    "    =    22.62     (MGD)
```

THEREFORE TWO 36 INCH DIAMETER RCP PIPES EXCEEDS DRAINAGE REQUIREMENTS

CULVERT #2 SIZING

```
*************************************************************************
                  ****** PIPE FLOW CALCULATIONS ******
               Copyright (c) 1988, CivilDesign Software, Inc.
   *********************************************************************

 *************************************************************************
 For: For Licensed CivilDesign User
 *************************************************************************
          ***** NON-PRESSURE, OPEN CHANNEL CALCULATIONS ****

   CALCULATE PIPE SIZE GIVEN:
   Channel Slope =    -.006667 (Ft./Ft.) =     -.6667 %
   Invert elevation at pipe INLET =     2565.000 (Ft.)
   Invert elevation at pipe OUTLET =     2564.000 (Ft.)
   Length of pipe =      150.000 (Ft.)



          *** PIPE OPEN CHANNEL FLOW ***


   Mannings "n" =  .020
   No. of pipes =   1   Velocity (Ft./Sec.) =     5.53
   Nearest 1 Inch Pipe Diameter (In.) =     35.00
   Individual pipe flow =    35.03     (CFS)
        "      "     "  =    .1572E+05 (GPM)
        "      "     "  =    22.64     (MGD)
   Total pipe area =       962.11 (In2)
   Total perimeter of pipe =       109.96 (In.)
   Normal flow depth in pipe =     31.50 (In.)
   Flow top width inside pipe =     21.00 (In.)
   Area of flow =     912.0402 (In2)
   Wetted Perimeter =    87.43 (In.)
   Critical Depth in Pipe =      23.24 (In.)
   Total flow of pipe(s) =    35.03     (CFS)
     "     "   "    "    =    .1572E+05 (GPM)
     "     "   "    "    =    22.64     (MGD)
```

THEREFORE TWO 36 INCH DIAMETER RCP PIPES EXCEEDS DRAINAGE REQUIREMENTS


LEGEND
NOTES TO USERS
FIRM
FLOOD INSURANCE RATE MAP
RIVERSIDE COUNTY, CALIFORNIA AND INCORPORATED AREAS
PANEL 812 OF 3805
MAP NUMBER
06065C0812G
EFFECTIVE DATE
AUGUST 28, 2008
NATIONAL FLOOD INSURANCE PROGRAM

FEMA FLOOD ZONE DEFINITIONS

FEMA has created their Flood Insurance Rate Maps (FIRMs) to show the areas of high-risk, moderate-to-low risk, and areas where the risk is undetermined. These are the following.

HIGH-RISK AREAS: ALSO KNOWN AS THE SPECIAL FLOOD HAZARD AREA

High-risk areas have at least a 1% annual chance of flooding. This flood is also referred to as the Base Flood. Flood insurance is required for structures in these high-risk areas if they have a federally-backed mortgage. These areas are shown on the flood maps as follows.

ZONE A Area inundated by the Base Flood with no Base Flood Elevations determined.

ZONE AE Area inundated by the Base Flood with Base Flood Elevations determined.

ZONE AH Area inundated by the Base Flood with flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO Area inundated by the Base Flood with flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities are also determined.

ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

MODERATE-TO-LOW RISK AREAS: THESE ARE NON-SPECIAL FLOOD HAZARD AREAS

In moderate-to-low risk areas, the risk of being flooded is reduced, but not completely removed. These areas are outside the 1% annual chance floodplain, so flood insurance is not required. However, insurance can be obtained at a reduced cost for property owners and renters. These moderate-to-low risk areas are shown on the flood maps as follows.

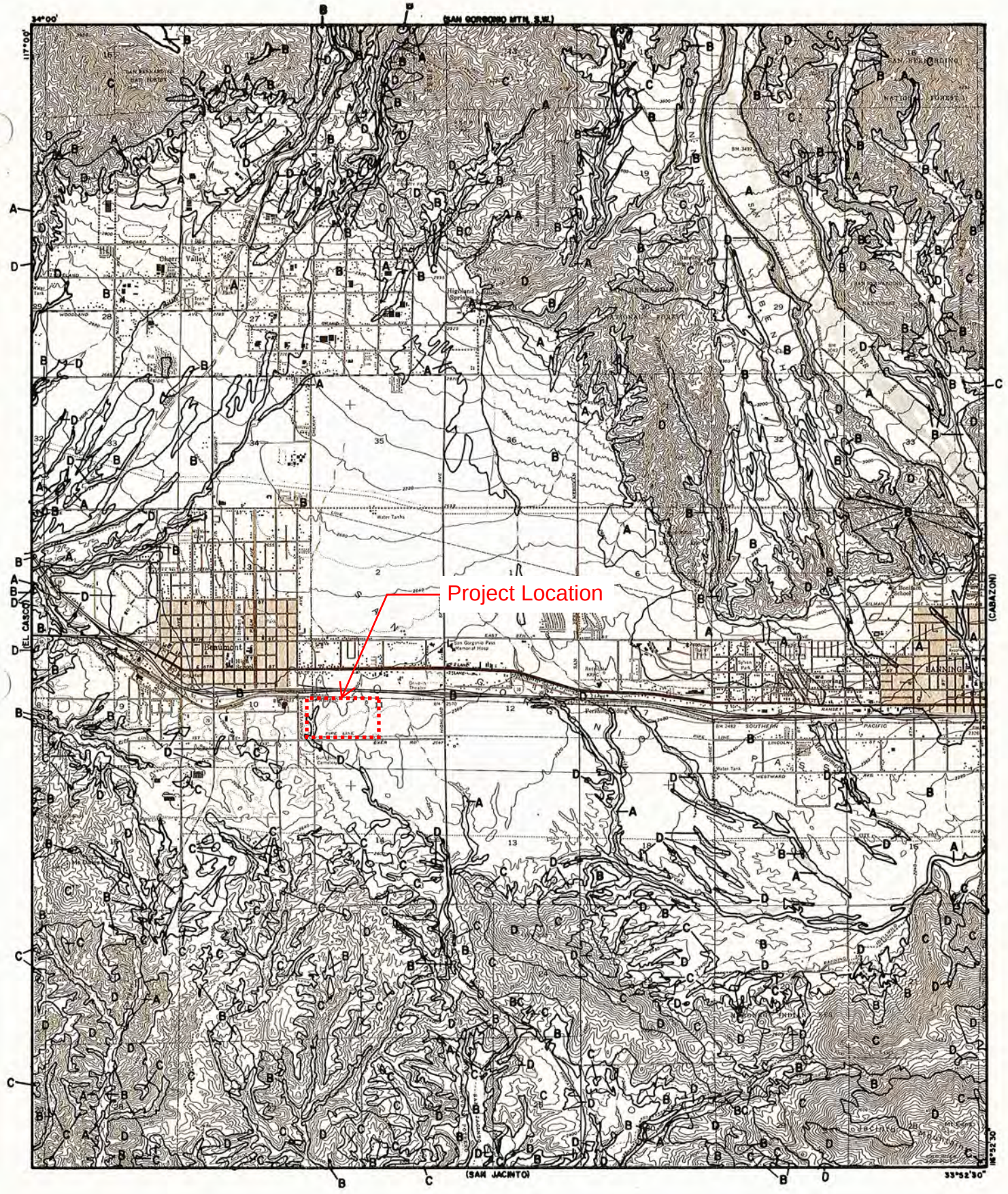
ZONE X (0.2%) This zone designation is for multiple risks including areas of the 0.2% annual chance flood; areas of the 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from the 1% annual chance flood.

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

UNDETERMINED-RISK AREAS

No flood-hazard analysis has been conducted in these areas, but a flood risk still exists. Flood insurance rates reflect the uncertainty of the flood risk. These areas are shown on the flood maps as follows.

ZONE D Areas in which flood hazards are undetermined, but possible.



LEGEND

—— SOILS GROUP BOUNDARY

A SOILS GROUP DESIGNATION

RCFC&WCD

HYDROLOGY MANUAL

N

0 FEET 5000

HYDROLOGIC SOILS GROUP MAP FOR BEAUMONT

PLATE C-1.19

PROJECT LOCATION

NOTES:
1. Isohyetals based on NOAA Atlas 2, Volume XI - California, 1973

RCFC & WCD
HYDROLOGY MANUAL

RIVERSIDE COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

2-YEAR — 1-HOUR PRECIPITATION

APPROVED CHIEF ENGINEER R.E. NO. 8822	DRAWN BY: R.A.S.	SHEET NO.
DATE	PLATE D-4.3	DR. NO.
REVISED:		

PROJECT LOCATION

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

DRAWN BY R.A.L. SHEET NO.
APPROVED CHIEF ENGINEER R.E. NO. 6822 PLATE D-4.4
REVISED DR. NO.