Drainage Study

Fallbrook Oaks

March 20, 2018

PREPARED FOR
Crossroads Investors I, LLC
10525 Vista Sorrento Parkway, Suite 310
San Diego, CA 92121

William Lundstrom, R.C.E.
Lundstrom Engineering & Surveying
5333 Mission Center Road, Suite 115
San Diego, California 92108
(619) 814-1220

Lundstrom
Engineering and Surveying, Inc.

Declaration of Responsible Charge

I hereby declare that I am the engineer of work for this project. That I have exercised responsible charge over the design of the project 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 project drawings and specifications by the County of San Diego is confined to a review only and does not relieve me, as engineer of work, of my responsibilities for project design.

William Lundstrom
Registered Civil Engineer 61630
Exp. Date: 06/30/19

Date

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Introduction

Purpose and Scope

To provide guidelines for preparation and review of preliminary hydrology/drainage study associated with discretionary projects under various County of San Diego Ordinances.

Development of permanent improved drainage facilities relies in part, on early identification of any adverse drainage conditions that are caused or worsened by new development projects. To avoid sub-standard drainage facilities, (difficult and costly to replace) sufficient information is needed early, when the project is being considered for approval. The County's application process requires a hydrology/ drainage study on all development projects at the time of application. This study provides the needed information to ensure that the proposed drainage facilities are located appropriately.

The study compares storm runoff under existing conditions versus proposed conditions (100 year event) and identifies existing drainage problems that may be caused, or aggravated, by project development. The study is further used to determine impacts that might be caused downstream (erosion) and to identify proposed mitigation measures.

Section 2. Project Information

2.1.Project Description

2.1.1 Project Location

The Fallbrook Oaks project is within the unincorporated San Diego County community of Fallbrook, California, approximately 6 miles northwest of Interstate 15 and Highway 76 intersection. It is bounded to the east by Ranger Road, to the west by West Valley Oaks Boulevard and to the south by Reche Road. **Exhibit A** provides a location map for the site.

2.1.2 Project Activities Description

The project will consist of grading of the site into 17 single family residential pads, a private road for access and necessary utility and street improvements.

2.2.Hydrologic Setting

This section summarizes the project's size and location in the context of the larger watershed perspective, topography, soil and vegetation conditions, percent impervious area, natural and infrastructure drainage features, and other relevant hydrologic and environmental factors to be protected specific to the project area's watershed.

2.2.1 Topography

The topography gently slopes in westerly, easterly, and southerly directions, and the natural site runoff discharges into and though natural drainage courses which runs towards the south of the project site. The majority of the runoff from the existing conditions comes from the upstream tributary area to the north. This area consist of naturally vegetated land, and several small orchards, and single family dwellings.

2.2.2 FEMA Flood Insurance Rate Map

The project site is located in Zone X of the Flood Insurance Rate Map (FIRM) Panel 06073C0481G, effective date May 16, 2012. Zone X is designated to be areas determined to be outside the 500-year floodplain. **Exhibit C** illustrates the project site within Flood Zone X.

2.2.3 Current and Adjacent Land Use

The existing site is vegetated with annual grass, ribbons of oaks trees along drainage courses, and abandoned orchard areas. Adjacent land use are single family residential and agriculture.

2.2.4 Soil and Vegetation Conditions

Geotechnical investigation, "Geotechnical Update" by GeoSoils Inc., dated July 14, 2016, indicates the site consists of silty fine sand (SM).

The project site is categorized as having Diegan Coastal Sage Scrub and non-native vegetation habitat.

2.2.5 Existing Drainage Patterns and Facilities (Narrative)

The topography gently slopes in westerly, easterly, and southerly directions, and the natural site runoff discharges into and though natural drainage courses which runs towards the south of the project site. The majority of the runoff from the existing conditions comes from the upstream tributary area to the north. This area consist of naturally vegetated land, and several small orchards, and single family dwellings.

The project area currently discharges into and through natural drainage courses which run toward the south and Reche Road. At Reche Road, stormwater flows through three culverts, two 72" CMP and one 54" CMP. The flow rates of these three tributary areas combine downstream south of Reche Road. At this downstream offsite confluence location, the natural flow have been rerouted by previous grading and development of the Valley Oaks Trailer Park.

2.2.6 Downstream Conditions

Runoff generated from the site is currently conveyed downstream towards the San Luis Rey River through a serious of natural drainage courses, existing golf course, and public storm drain.

2.3.Proposed Runoff Management Facilities

The proposed facilities managing runoff from the site include:

- Appropriate grading of pads to direct runoff away from future structures on the site.
- Storm drain and bioretention systems to collect, treat, detain and direct on-site runoff to appropriate outfalls.

Section 3. Design Criteria and Methodology

This section summarizes the design criteria and methodology applied during drainage analysis of the project site. The design criteria and methodology follow the County of San Diego County Hydrology Manual (June 2003), San Diego County Hydraulic Drainage Design Manual (September 2014), and Storm Water Standards as appropriate for the project site.

3.1.Hydrologic Design Methodology

3.1.1 Rational Method: Peak Flow

Runoff calculations for this study were accomplished using the Rational Method. The Rational Method is a physically-based numerical method where runoff is assumed to be directly proportional to rainfall and area, less losses for infiltration and depression storage. Flows were computed based on the Rational formula:

$$Q = C\,i\,A$$

where ... Q = Peak discharge (cfs);
C = runoff coefficient, based on land use and soil type;
i = rainfall intensity (in/hr);
A = watershed area (acre)

The runoff coefficient represents the ratio of rainfall that runs off the watershed versus the portion that infiltrates to the soil or is held in depression storage. The runoff coefficient is dependent on the land use coverage and soil type.

For a typical drainage study, rainfall intensity varies with the watershed time of concentration. The watershed time of concentration at any given point is defined as the time it would theoretically take runoff to travel from the most upstream point in the watershed to a concentration point, as calculated by equations in the San Diego County Hydrology Manual.

Table 3-1 Rational Method Runoff Coefficients.

		RUNOFF COEFFICIENT			
	(%)	Hydrologic Soil Type			
LAND USE (County Elements)	**Imperv.**	**A**	**B**	**C**	**D**
Permanent Open Space		0.20	0.25	0.30	0.35
Residential, 1.0 DU/A or less	10	0.27	0.32	0.36	0.41
Residential, 2.0 DU/A or less	20	0.34	0.38	0.42	0.46
Residential, 2.9 DU/A or less	25	0.38	0.41	0.45	0.49
Residential, 4.3 DU/A or less	30	0.41	0.45	0.48	0.52
Residential, 7.3 DU/A or less	40	0.48	0.51	0.54	0.57
Residential, 10.9 DU/A or less	45	0.52	0.54	0.57	0.60
Residential, 14.5 DU/A or less	50	0.55	0.58	0.60	0.63
Residential, 24.0 DU/A or less	65	0.66	0.67	0.69	0.71
Residential, 43.0 DU/A or less	80	0.76	0.77	0.78	0.79
Neighborhood Commercial	80	0.76	0.77	0.78	0.79
General Commercial	85	0.80	0.80	0.81	0.82
Office Professional/Commercial	90	0.83	0.84	0.84	0.85
Limited Industrial	90	0.83	0.84	0.84	0.85
General Industrial	95	0.87	0.87	0.87	0.87

Rational Method calculations were accomplished using the Advanced Engineering Software Rational Method Analysis (Southern California County Methods) (AES-RATSCx) computer software packages. Peak discharges were computed for 100-year and 50-year storm return frequencies. The final use for this project site is unknown at this time. Therefore, for conservative purposes, a runoff "C" coefficient of 0.90 (paved surface) was used.

3.1.2 Time of Concentration

The Time of Concentration (T_c) is the time required for runoff to flow from the most remote part of the drainage area to the point of interest. The T_c is composed of two components: initial time of concentration (T_i) and the travel time (T_t). The T_i is the time required for runoff to travel across the surface of the most remote subarea in the study, or "initial subarea". Guidelines for designation the initial subarea are provided within the discussion of computation of T_i. The T_i is the time required for the runoff to flow in a watercourse (e.g., swale, channel, gutter, pipe) or series of watercourses from the initial subarea to the point of interest. For the Rational Method, the T_c at any point within the drainage area is given by:

$$T_c = T_i + T_t$$

Methods of calculation differ for natural watersheds (nonurbanized) and for urban drainage systems. When analyzing storm drain systems, the designer must consider the possibility that an existing natural watershed may become urbanized during the useful life

of the storm drain system. Future land uses must be used for T_c and runoff calculations, and can be determined from the local Community General Plan.

3.1.3 Initial Time of Concentration

The initial time of concentration is typically based on sheet flow at the upstream end of a drainage basin. The Overland Time of Flow is approximated by an equation developed by the Federal Aviation Agency (FAA) for analyzing flow on runways (FAA, 1970). The usual runway configuration consists of a crown, like most freeways, with sloping pavement that directs flow to either side of the runway. This type of flow is uniform in the direction perpendicular to the velocity and is very shallow. Since these depths are ¼ of an inch in magnitude, the relative roughness is high. Some higher relative roughness values for overland flow are presented in the *HEC-1 Flood Hydrograph Package User's Manual* (USACE, 1990).

The sheet flow that is predicted by the FAA equation is limited to conditions that are similar to runway topography. Some considerations that limit the extent to which the FAA equation applies are identified below:

- Urban Areas – This "runway type" runoff includes:
  - Flat roofs, sloping at 1% +/-
  - Parking lots at the extreme upstream drainage basin boundary (at the "ridge" of a catchment area.) Even a parking lot is limited in the amounts of sheet flow. Parked or moving vehicles would "break-up" the sheet flow, concentrating runoff into streams that are not characteristic of sheet flow.
  - Driveways are constructed at the upstream end of catchment areas in some developments. However, if flow from a roof is directed to a driveway through a downspout or other conveyance mechanism, flow would be concentrated.
  - Flat slopes are prone to meandering flow that tends to be disrupted by minor irregularities and obstructions. Maximum Overland Flow lengths are shorter for the flatter slopes.
- Rural or Natural Areas –The FAA equation is applicable to these conditions since (0.5% to 10%) slopes that are uniform in width of flow have slow velocities consistent with the equation. Irregularities in terrain limit the length of application.
  - Most hills and ridge lines have a relatively flat area near the drainage divide. However, with flat slopes of 0.5% +/-, minor irregularities would cause flow to concentrate into streams.

- Parks, lawns and other vegetated areas would have slow velocities that are consistent with the FAA Equation.

The Initial Time of Concentration is reflective of the general land-use at the upstream end of a drainage basin.

3.1.4 Travel Time

The T_t is the time required for the runoff to flow in a watercourse or series of watercourses from the initial subarea to the point of interest. The T_t is computed by dividing the length of the flow path by the computed flow velocity. Since the velocity normally changes as a result of each change in flow rate or slope, such as at an inlet or grade break, the total T_t must be computed as the sum of the T_t's for each section of the flow path.

3.1.5 Rational Method: Runoff Volume

For designs that are dependent on the total storm volume, a hydrograph must be generated to account for the entire volume of runoff from the 6-hour storm event. The hydrograph for the entire 6-hour storm event is generated by creating a rainfall distribution consisting of blocks of rain, creating an incremental hydrograph for each block of rain, and adding the hydrographs from each block of rain. This process creates a hydrograph that contains runoff from all the blocks of rain and accounts for the entire volume of runoff from the 6-hour storm event. The total volume under the resulting hydrograph is equal to the following equation:

$$VOL = CP_6A$$

Where:
VOL = volume of runoff (acres-inches)
P_6 = 6-hour rainfall (inches)
C = runoff coefficient
A = area of the watershed (acres)

Section 4. Characterization of Project Runoff

4.1.Hydrologic Effects of Project

The proposed project will not significantly alter drainage patterns on the site. **Exhibit E** illustrates the proposed condition hydrology map. Table 3-1 summarizes the hydrologic effects of the project.

Table 3-1 Summary of Hydrology Analysis.

EXISTING

NODE	TC (MIN.)	AREA (ACRES)	VELOCITY (FPS)	Q100 RUN-OFF (CFS)
100	15.8	140.0	15.2	191.00
200	12.0	282.2	14.0	554.0
300	8.2	9.5	8.9	22.9

PROPOSED

NODE	TC (MIN.)	AREA (ACRES)	VELOCITY (FPS)	Q100 RUN-OFF (CFS)
100	15.8	140.0	15.2	191.00
200	16.6	278.12	19.6	554.1
300	13.8	13.4	9.1	23.8

The existing and proposed condition analyses illustrate that there is an increase in the amount of unmitigated runoff generated from the proposed condition. Proposed bioretention basins shall mitigate peak runoff rates from the project site to match exiting runoff rates downstream.

Post construction storm water BMPs for the project are listed below (please see "Storm Water Quality Management Plan for Fallbrook Oaks" for sizing calculations and product performance/manufacturer's specifications):

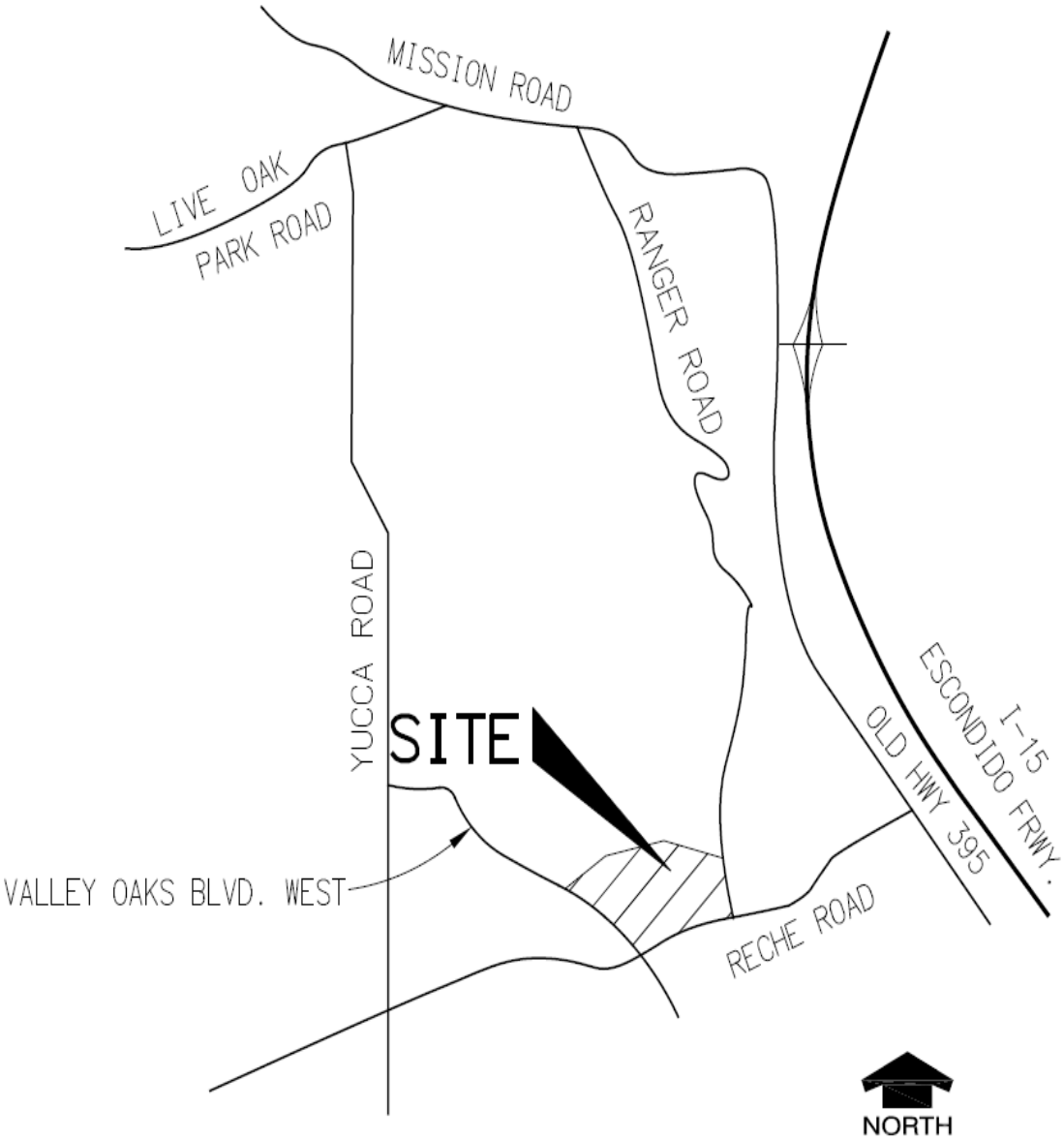
- Bioretention Basins with HMP Flow Control

Section 5. Summary and Conclusions

This hydrology and hydraulic study has evaluated the potential effects of runoff on the proposed project. In addition, the report has addressed the methodology used to analyze the pre- and post-construction condition, which was based on the San Diego County Hydrology and Design Manual. This section provides a summary discussion that evaluates the potential effects of the proposed project.

- The proposed project will not substantially alter the existing drainage patterns on the site or area, including through the alteration of the existing drainage course, in which would not result in substantial erosion or siltation on- or off-site and not exceed the capacity of downstream storm drain.
- The proposed project does not place housing or structures within 100-year flood area.
- The proposed project does not expose people or structures to significant risk of loss, injury, or death involving flooding as a result of the failure of a levee or dam.
- The project will add new impervious area to the site, increasing unmitigated storm water runoff rates and volume from the existing condition. Proposed bioretention basins shall mitigate peak runoff rates from the project site to match exiting runoff rates down stream.

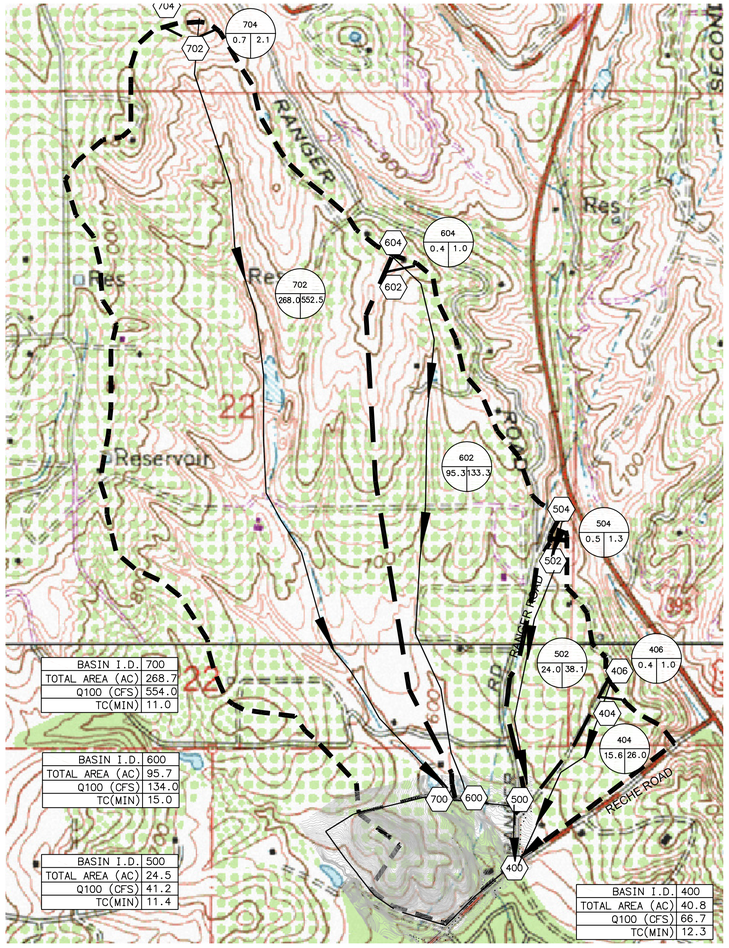
EXHIBITS



VICINITY MAP
N.T.S.

Exhibit A

FALLBROOK OAKS
EXISTING CONDITION HYDROLOGY MAP



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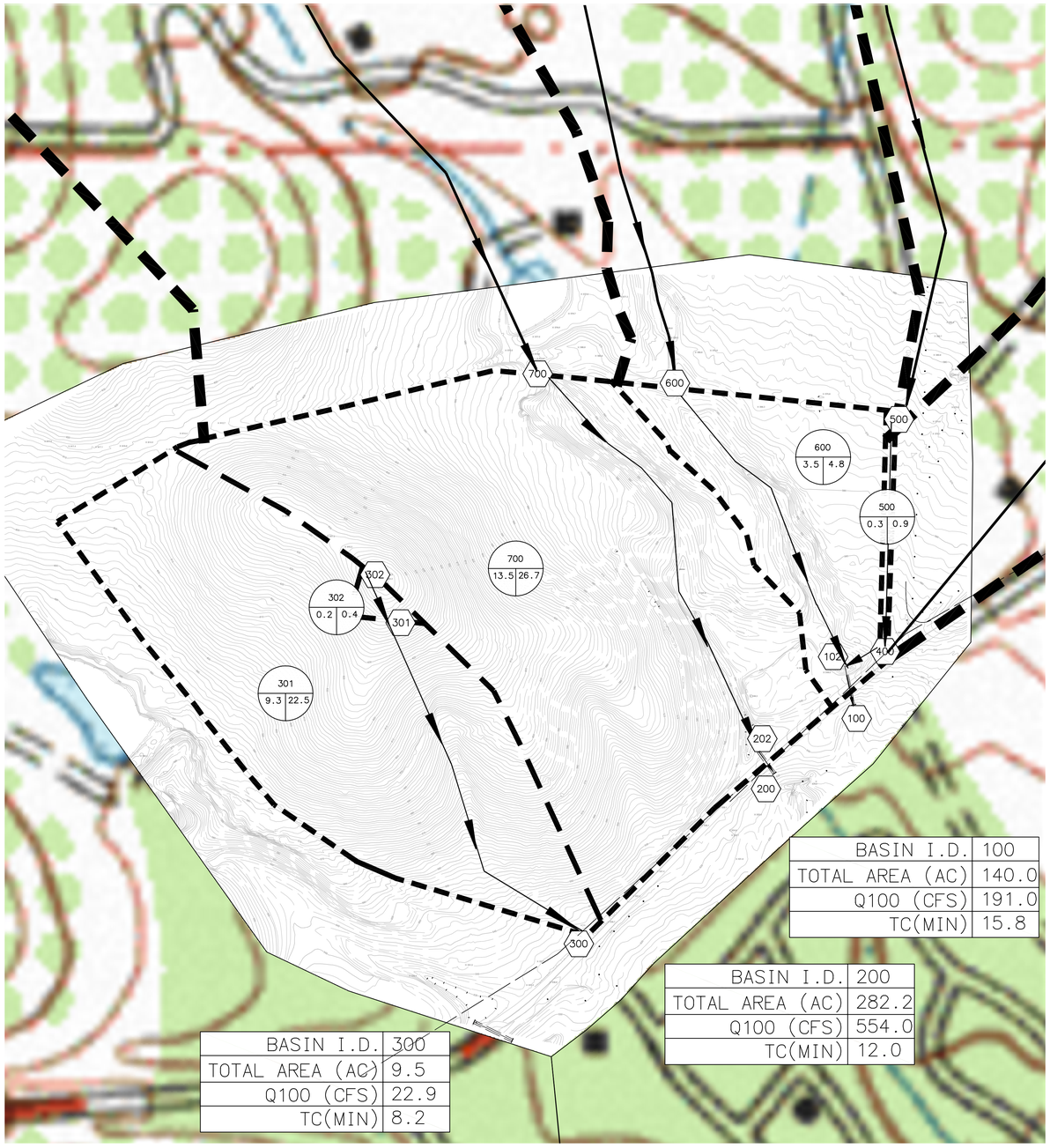
GRAPHIC SCALE



LEGEND

SUB-BASIN NUMBER — A-1
BASIN AREA (AC) — 5.1
SUB-BASIN Q100 (cfs) — 14.6

NODE NUMBER — 204

BASIN LIMITS

FLOW PATH

GRAPHIC SCALE

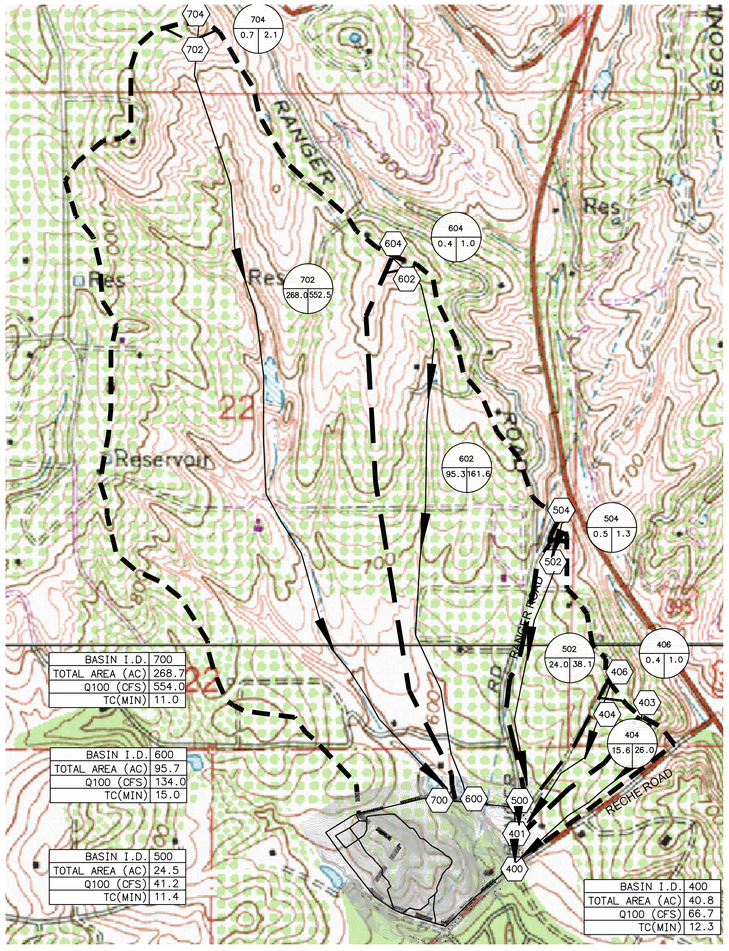
120 0 60 120 240 480
(IN FEET)
1 inch = 120 ft.

EXHIBIT D

FALLBROOK OAKS
EXISTING CONDITION
HYDROLOGY MAP

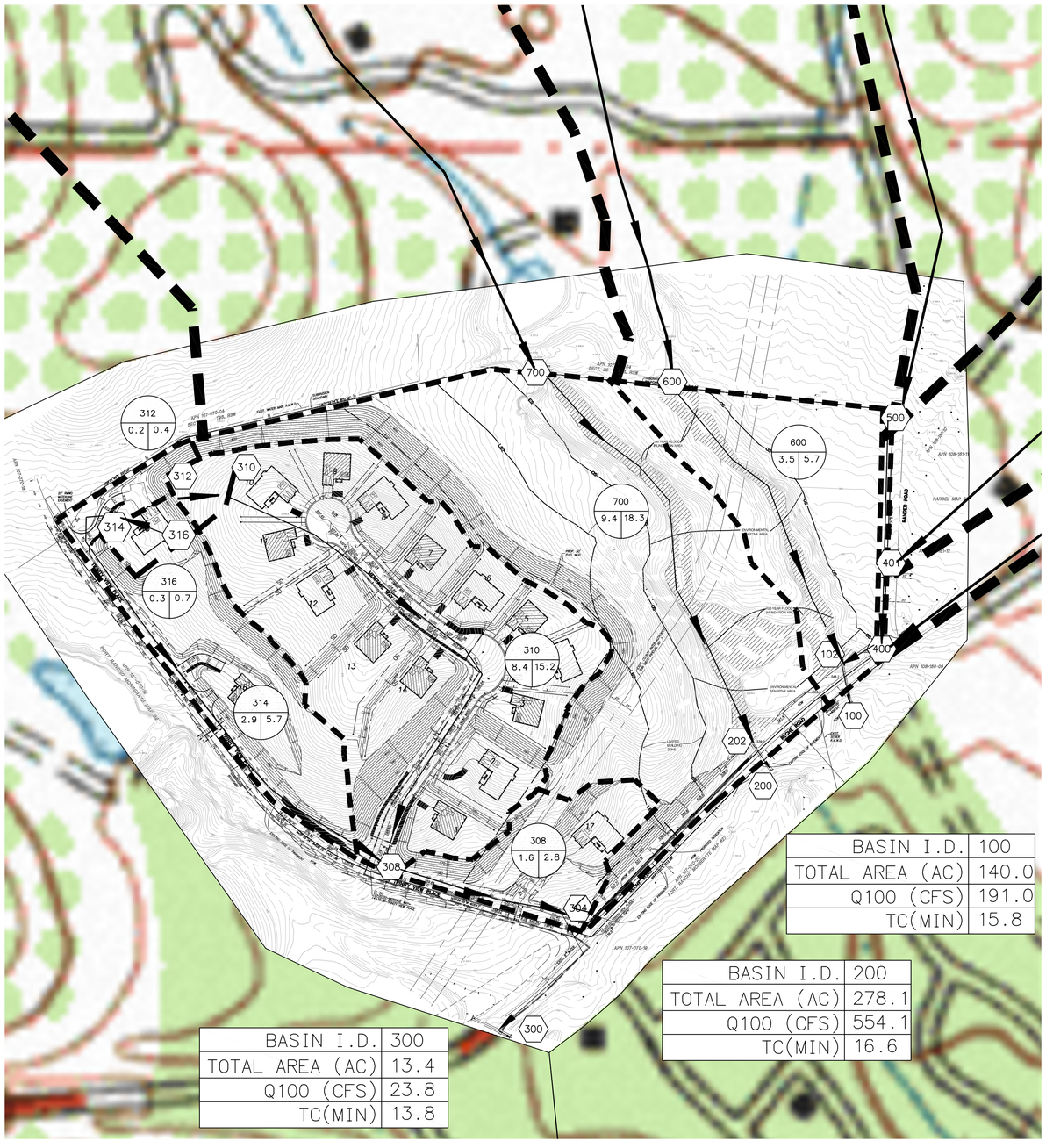
J.N. (196-01)
X: \proj\196-01\dwg\Water Resources\196EX04.dwg

FALLBROOK OAKS
PROPOSED CONDITION HYDROLOGY MAP



600 0 600 1200 1800

GRAPHIC SCALE



LEGEND

SUB-BASIN NUMBER — A-1
BASIN AREA (AC) — 5.1
SUB-BASIN Q100 (cfs) — 14.6

NODE NUMBER — 204

BASIN LIMITS

FLOW PATH

N

GRAPHIC SCALE

120 0 60 120 240 480

(IN FEET)
1 inch = 120 ft.

EXHIBIT E
FALLBROOK OAKS
PROPOSED CONDITION
HYDROLOGY MAP

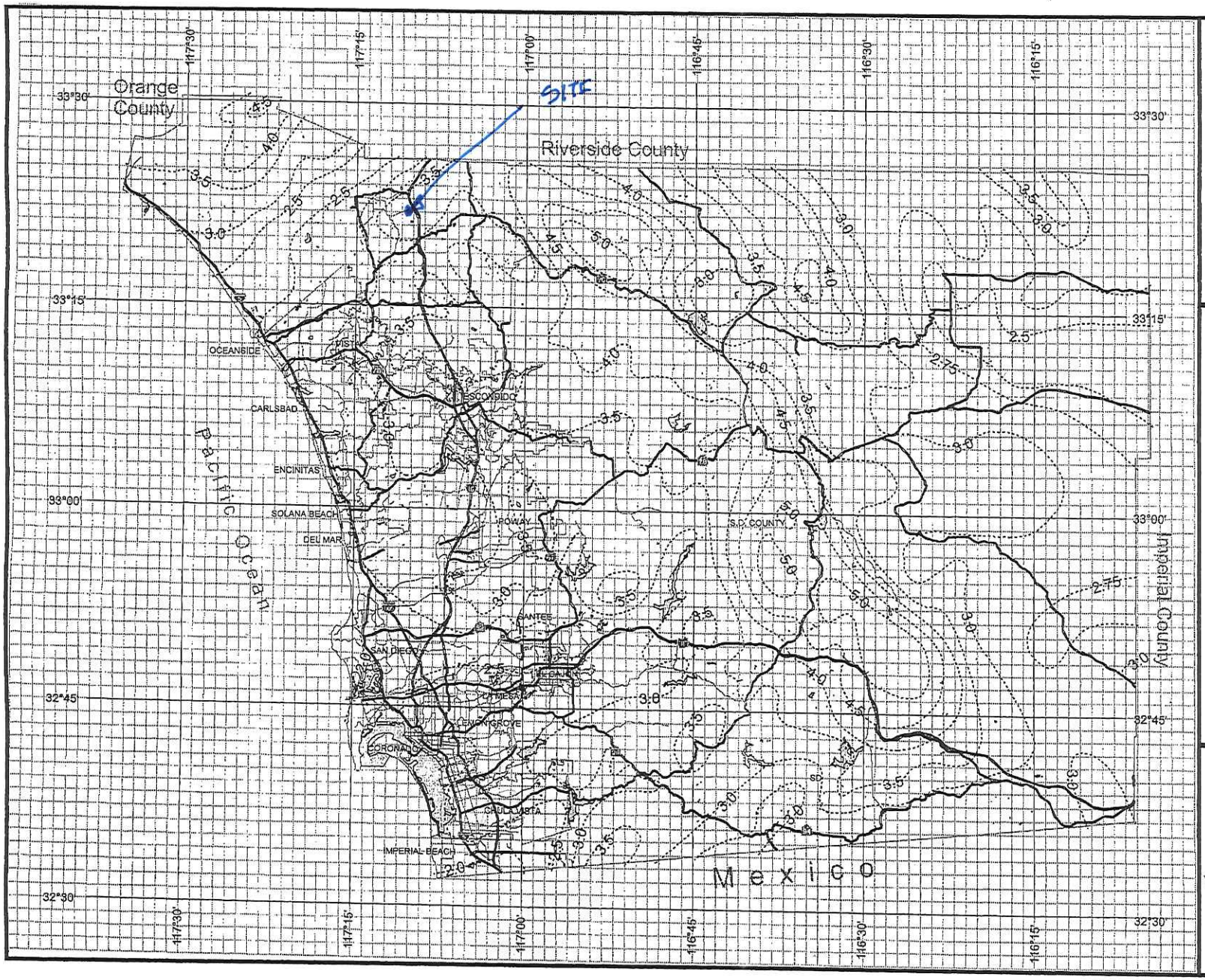
J.N. (196-01)
X: \proj\196-01\dwg\Water Resources\196pr05.dwg

APPENDIX A
Hydrologic Information

This Section Contains:

- Precipitation Analysis

Precipitation Analysis



County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 6 Hours

Isopluvial (inches)

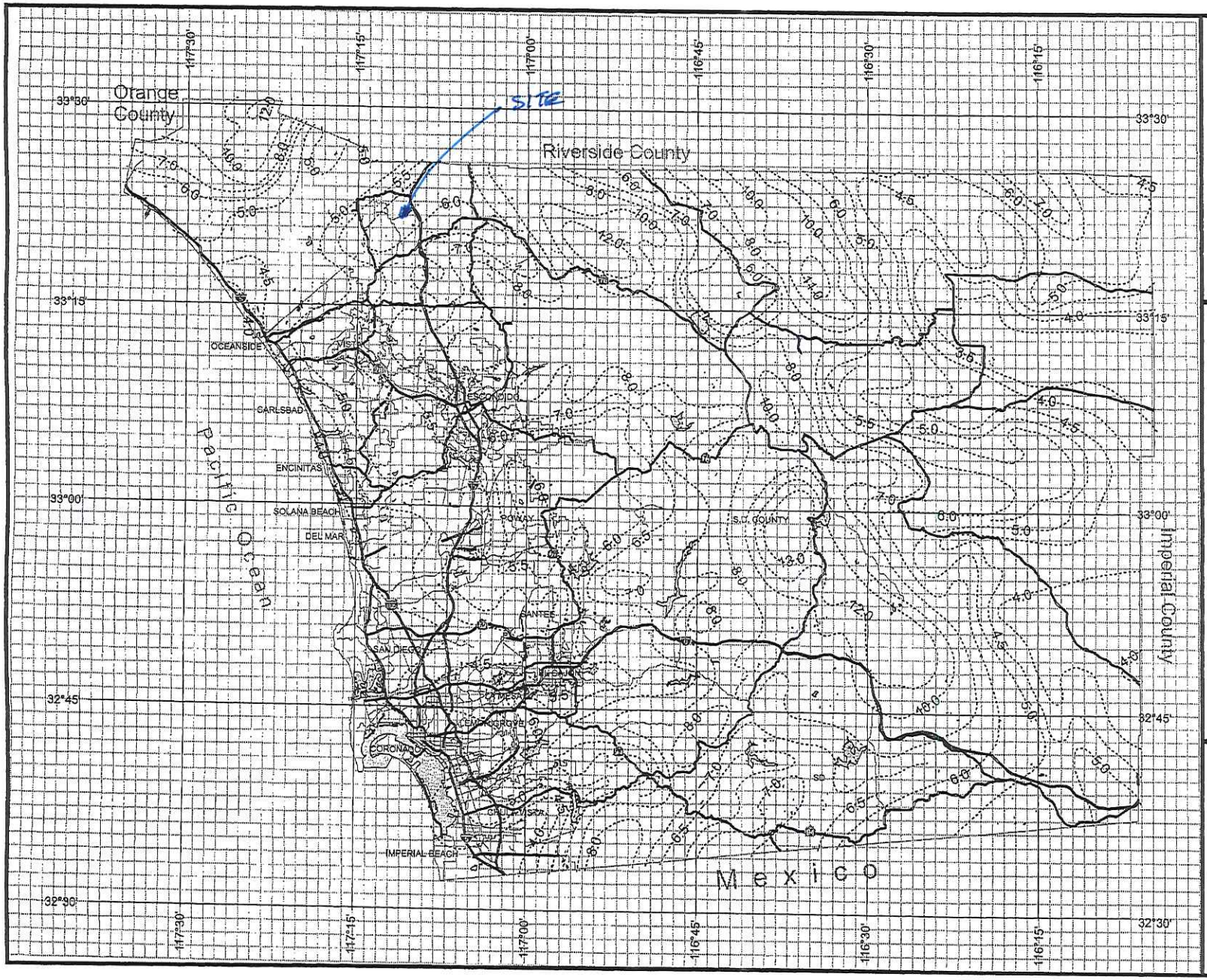
$P_{6\,100yr} = 3.6$ inches

DPW GIS
Department of Public Works Geographic Information System

SanGIS
We Have San Diego Covered!

N
W E
S

3 0 3 Miles



County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 24 Hours

Isopluvial (inches)

$P_{24\ 100yr} = 6.1$ inches

DPW GIS
Department of Public Works
Geographic Information Services

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N
W E
S

3 0 3 Miles

APPENDIX B
Hydrologic Calculations

This Section Contains:

- Existing Condition Analysis
- Proposed Condition Analysis

Existing Condition Analysis

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            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
            Reference: SAN DIEGO COUNTY FLOOD CONTROL DISTRICT
                         2003,1985,1981 HYDROLOGY MANUAL
          (c) Copyright 1982-2006 Advanced Engineering Software (aes)
              Ver. 2.0 Release Date: 06/01/2005  License ID 1553

                              Analysis prepared by:



                                    LUNDSTROM




  ************************** DESCRIPTION OF STUDY
**************************
 * EXSTING CONDITION
*
 * 100 YEAR STORM EVENT
*
 *
*

*************************************************************************
*

   FILE NAME: C:\196EX100.DAT
   TIME/DATE OF STUDY: 10:03 04/12/2018
 ------------------------------------------------------------------------
----
   USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
 ------------------------------------------------------------------------
----
   2003 SAN DIEGO MANUAL CRITERIA

   USER SPECIFIED STORM EVENT(YEAR) = 100.00
   6-HOUR DURATION PRECIPITATION (INCHES) =   3.600
   SPECIFIED MINIMUM PIPE SIZE(INCH) =  18.00
   SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE =
0.95
   SAN DIEGO HYDROLOGY MANUAL "C"-VALUES USED FOR RATIONAL METHOD
   NOTE: USE MODIFIED RATIONAL METHOD PROCEDURES FOR CONFLUENCE ANALYSIS
```

```
   *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW
MODEL*
      HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:
MANNING
      WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE
FACTOR
 NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)
(n)
 ===  =====  =========  =================  ======  ===== ====== =====
=======
   1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0313 0.167
0.0150

   GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
     1. Relative Flow-Depth =  0.00 FEET
        as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
     2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
   *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
    OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*


****************************************************************************
***
   FLOW PROCESS FROM NODE    704.00 TO NODE    702.00 IS CODE =  21
 ----------------------------------------------------------------------------
----
   >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<

============================================================================
===
   USER-SPECIFIED RUNOFF COEFFICIENT = .3600
   S.C.S. CURVE NUMBER (AMC II) =  76
   INITIAL SUBAREA FLOW-LENGTH(FEET) =   150.00
   UPSTREAM ELEVATION(FEET) =   1120.00
   DOWNSTREAM ELEVATION(FEET) =   1080.00
   ELEVATION DIFFERENCE(FEET) =     40.00
   SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.183
   WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
            THE MAXIMUM OVERLAND FLOW LENGTH =   100.00
            (Reference: Table 3-1B of Hydrology Manual)
            THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  8.271
   SUBAREA RUNOFF(CFS) =      2.08
   TOTAL AREA(ACRES) =      0.70   TOTAL RUNOFF(CFS) =      2.08


****************************************************************************
***
   FLOW PROCESS FROM NODE    702.00 TO NODE    700.00 IS CODE =  51
 ----------------------------------------------------------------------------
----
   >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
   >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
```

```
================================================================================
   ELEVATION DATA: UPSTREAM(FEET) =   1080.00  DOWNSTREAM(FEET) =
570.00
   CHANNEL LENGTH THRU SUBAREA(FEET) =  4800.00   CHANNEL SLOPE =  0.1063
   CHANNEL BASE(FEET) =   10.00   "Z" FACTOR =   2.000
   MANNING'S FACTOR = 0.030   MAXIMUM DEPTH(FEET) =   4.00
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.727
   USER-SPECIFIED RUNOFF COEFFICIENT = .3600
   S.C.S. CURVE NUMBER (AMC II) =  76
   TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =     286.28
   TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =  16.85
   AVERAGE FLOW DEPTH(FEET) =   1.34   TRAVEL TIME(MIN.) =   4.75
   Tc(MIN.) =  10.93
   SUBAREA AREA(ACRES) =   268.00       SUBAREA RUNOFF(CFS) =  552.56
   AREA-AVERAGE RUNOFF COEFFICIENT =  0.360
   TOTAL AREA(ACRES) =      268.7         PEAK FLOW RATE(CFS) =
554.01

   END OF SUBAREA CHANNEL FLOW HYDRAULICS:
   DEPTH(FEET) =  1.94   FLOW VELOCITY(FEET/SEC.) =  20.56
   LONGEST FLOWPATH FROM NODE    704.00 TO NODE    700.00 =    4950.00
FEET.


****************************************************************************
***
   FLOW PROCESS FROM NODE    700.00 TO NODE    202.00 IS CODE =  51
 ----------------------------------------------------------------------------
----
   >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
   >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<

================================================================================
   ELEVATION DATA: UPSTREAM(FEET) =    570.00  DOWNSTREAM(FEET) =
540.00
   CHANNEL LENGTH THRU SUBAREA(FEET) =   860.00   CHANNEL SLOPE =  0.0349
   CHANNEL BASE(FEET) =    6.00   "Z" FACTOR =   1.000
   MANNING'S FACTOR = 0.035   MAXIMUM DEPTH(FEET) =  10.00
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.405
   USER-SPECIFIED RUNOFF COEFFICIENT = .3600
   S.C.S. CURVE NUMBER (AMC II) =  76
   TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =     567.14
   TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =  13.94
   AVERAGE FLOW DEPTH(FEET) =   4.05   TRAVEL TIME(MIN.) =   1.03
   Tc(MIN.) =  11.96
   SUBAREA AREA(ACRES) =    13.50       SUBAREA RUNOFF(CFS) =   26.27
   AREA-AVERAGE RUNOFF COEFFICIENT =  0.360
   TOTAL AREA(ACRES) =      282.2         PEAK FLOW RATE(CFS) =
554.01

   END OF SUBAREA CHANNEL FLOW HYDRAULICS:
```

```
   DEPTH(FEET) =  4.00   FLOW VELOCITY(FEET/SEC.) =  13.85
   LONGEST FLOWPATH FROM NODE    704.00 TO NODE    202.00 =    5810.00
FEET.


****************************************************************************
***
   FLOW PROCESS FROM NODE    202.00 TO NODE    200.00 IS CODE =  41
 --------------------------------------------------------------------------
----
   >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
   >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<

============================================================================
===
   ELEVATION DATA: UPSTREAM(FEET) =   540.00  DOWNSTREAM(FEET) =   539.00
   FLOW LENGTH(FEET) =   100.00   MANNING'S N =  0.013
   ASSUME FULL-FLOWING PIPELINE
   PIPE-FLOW VELOCITY(FEET/SEC.) =  19.59
   PIPE FLOW VELOCITY = (TOTAL FLOW)/(PIPE CROSS SECTION AREA)
   GIVEN PIPE DIAMETER(INCH) =  72.00    NUMBER OF PIPES =   1
   PIPE-FLOW(CFS) =     554.01
   PIPE TRAVEL TIME(MIN.) =   0.09    Tc(MIN.) =  12.04
   LONGEST FLOWPATH FROM NODE    704.00 TO NODE    200.00 =    5910.00
FEET.


****************************************************************************
***
   FLOW PROCESS FROM NODE    200.00 TO NODE    200.00 IS CODE =  13
 --------------------------------------------------------------------------
----
   >>>>>CLEAR THE MAIN-STREAM MEMORY<<<<<

============================================================================
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****************************************************************************
***
   FLOW PROCESS FROM NODE    604.00 TO NODE    602.00 IS CODE =  21
 --------------------------------------------------------------------------
----
   >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<

============================================================================
===
   USER-SPECIFIED RUNOFF COEFFICIENT = .3000
   S.C.S. CURVE NUMBER (AMC II) =  78
   INITIAL SUBAREA FLOW-LENGTH(FEET) =   170.00
   UPSTREAM ELEVATION(FEET) =    940.00
   DOWNSTREAM ELEVATION(FEET) =    920.00
   ELEVATION DIFFERENCE(FEET) =     20.00
   SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.684
```

```
   WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
            THE MAXIMUM OVERLAND FLOW LENGTH =   100.00
            (Reference: Table 3-1B of Hydrology Manual)
            THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.865
   SUBAREA RUNOFF(CFS) =      0.94
   TOTAL AREA(ACRES) =      0.40   TOTAL RUNOFF(CFS) =      0.94


****************************************************************************
***
   FLOW PROCESS FROM NODE    602.00 TO NODE    600.00 IS CODE =  51
 ----------------------------------------------------------------------------
----
   >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
   >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<

============================================================================
===
   ELEVATION DATA: UPSTREAM(FEET) =    920.00  DOWNSTREAM(FEET) =
570.00
   CHANNEL LENGTH THRU SUBAREA(FEET) =  4800.00   CHANNEL SLOPE =  0.0729
   CHANNEL BASE(FEET) =    5.00   "Z" FACTOR =   2.000
   MANNING'S FACTOR = 0.035   MAXIMUM DEPTH(FEET) =  10.00
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.663
   USER-SPECIFIED RUNOFF COEFFICIENT = .3000
   S.C.S. CURVE NUMBER (AMC II) =  78
   TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      70.78
   TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   9.58
   AVERAGE FLOW DEPTH(FEET) =   1.04   TRAVEL TIME(MIN.) =   8.35
   Tc(MIN.) =  15.03
   SUBAREA AREA(ACRES) =    95.30       SUBAREA RUNOFF(CFS) =  133.33
   AREA-AVERAGE RUNOFF COEFFICIENT =  0.300
   TOTAL AREA(ACRES) =       95.7         PEAK FLOW RATE(CFS) =
133.89

   END OF SUBAREA CHANNEL FLOW HYDRAULICS:
   DEPTH(FEET) =  1.47   FLOW VELOCITY(FEET/SEC.) =  11.50
   LONGEST FLOWPATH FROM NODE    604.00 TO NODE    600.00 =    4970.00
FEET.


****************************************************************************
***
   FLOW PROCESS FROM NODE    600.00 TO NODE    102.00 IS CODE =  51
 ----------------------------------------------------------------------------
----
   >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
   >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<

============================================================================
===
   ELEVATION DATA: UPSTREAM(FEET) =    570.00  DOWNSTREAM(FEET) =
540.00
```

```
   CHANNEL LENGTH THRU SUBAREA(FEET) =   500.00   CHANNEL SLOPE =  0.0600
   CHANNEL BASE(FEET) =    6.00   "Z" FACTOR =   1.000
   MANNING'S FACTOR = 0.035   MAXIMUM DEPTH(FEET) =  10.00
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.522
   USER-SPECIFIED RUNOFF COEFFICIENT = .3000
   S.C.S. CURVE NUMBER (AMC II) =  78
   TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =     136.26
   TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =  11.36
   AVERAGE FLOW DEPTH(FEET) =   1.58   TRAVEL TIME(MIN.) =   0.73
   Tc(MIN.) =  15.77
   SUBAREA AREA(ACRES) =     3.50       SUBAREA RUNOFF(CFS) =    4.75
   AREA-AVERAGE RUNOFF COEFFICIENT =  0.300
   TOTAL AREA(ACRES) =       99.2         PEAK FLOW RATE(CFS) =
134.58

   END OF SUBAREA CHANNEL FLOW HYDRAULICS:
   DEPTH(FEET) =  1.57   FLOW VELOCITY(FEET/SEC.) =  11.33
   LONGEST FLOWPATH FROM NODE    604.00 TO NODE    102.00 =    5470.00
FEET.


****************************************************************************
***
   FLOW PROCESS FROM NODE    102.00 TO NODE    102.00 IS CODE =  10
 --------------------------------------------------------------------------
----
   >>>>>MAIN-STREAM MEMORY COPIED ONTO MEMORY BANK # 1 <<<<<

============================================================================
===


****************************************************************************
***
   FLOW PROCESS FROM NODE    102.00 TO NODE    102.00 IS CODE =  13
 --------------------------------------------------------------------------
----
   >>>>>CLEAR THE MAIN-STREAM MEMORY<<<<<

============================================================================
===


****************************************************************************
***
   FLOW PROCESS FROM NODE    504.00 TO NODE    502.00 IS CODE =  21
 --------------------------------------------------------------------------
----
   >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<

============================================================================
===
   USER-SPECIFIED RUNOFF COEFFICIENT = .3500
   S.C.S. CURVE NUMBER (AMC II) =  83
```

```
   INITIAL SUBAREA FLOW-LENGTH(FEET) =   150.00
   UPSTREAM ELEVATION(FEET) =    700.00
   DOWNSTREAM ELEVATION(FEET) =    690.00
   ELEVATION DIFFERENCE(FEET) =     10.00
   SUBAREA OVERLAND TIME OF FLOW(MIN.) =    7.173
   WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
            THE MAXIMUM OVERLAND FLOW LENGTH =   100.00
            (Reference: Table 3-1B of Hydrology Manual)
            THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.515
   SUBAREA RUNOFF(CFS) =      1.32
   TOTAL AREA(ACRES) =      0.50   TOTAL RUNOFF(CFS) =      1.32


****************************************************************************
***
   FLOW PROCESS FROM NODE    502.00 TO NODE    500.00 IS CODE =  51
 ----------------------------------------------------------------------------
----
   >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
   >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<

============================================================================
===
   ELEVATION DATA: UPSTREAM(FEET) =    680.00  DOWNSTREAM(FEET) =
570.00
   CHANNEL LENGTH THRU SUBAREA(FEET) =  1900.00   CHANNEL SLOPE =  0.0579
   CHANNEL BASE(FEET) =    5.00   "Z" FACTOR =   2.000
   MANNING'S FACTOR = 0.035   MAXIMUM DEPTH(FEET) =  10.00
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.294
   USER-SPECIFIED RUNOFF COEFFICIENT = .3000
   S.C.S. CURVE NUMBER (AMC II) =  78
   TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      21.05
   TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   6.12
   AVERAGE FLOW DEPTH(FEET) =   0.56   TRAVEL TIME(MIN.) =   5.17
   Tc(MIN.) =  12.35
   SUBAREA AREA(ACRES) =    24.00       SUBAREA RUNOFF(CFS) =   38.12
   AREA-AVERAGE RUNOFF COEFFICIENT =  0.301
   TOTAL AREA(ACRES) =       24.5         PEAK FLOW RATE(CFS) =
39.05

   END OF SUBAREA CHANNEL FLOW HYDRAULICS:
   DEPTH(FEET) =  0.80   FLOW VELOCITY(FEET/SEC.) =   7.42
   LONGEST FLOWPATH FROM NODE    504.00 TO NODE    500.00 =    2050.00
FEET.


****************************************************************************
***
   FLOW PROCESS FROM NODE    500.00 TO NODE    400.00 IS CODE =  51
 ----------------------------------------------------------------------------
----
   >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
   >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
```

```
================================================================================
   ELEVATION DATA: UPSTREAM(FEET) =    570.00  DOWNSTREAM(FEET) =
550.00
   CHANNEL LENGTH THRU SUBAREA(FEET) =   430.00   CHANNEL SLOPE =  0.0465
   CHANNEL BASE(FEET) =    2.00   "Z" FACTOR =   1.000
   MANNING'S FACTOR = 0.035   MAXIMUM DEPTH(FEET) =   3.00
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.060
   USER-SPECIFIED RUNOFF COEFFICIENT = .6000
   S.C.S. CURVE NUMBER (AMC II) =  86
   TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      39.50
   TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   7.98
   AVERAGE FLOW DEPTH(FEET) =   1.44   TRAVEL TIME(MIN.) =   0.90
   Tc(MIN.) =  13.25
   SUBAREA AREA(ACRES) =     0.30       SUBAREA RUNOFF(CFS) =    0.91
   AREA-AVERAGE RUNOFF COEFFICIENT =  0.305
   TOTAL AREA(ACRES) =       24.8         PEAK FLOW RATE(CFS) =
39.05

   END OF SUBAREA CHANNEL FLOW HYDRAULICS:
   DEPTH(FEET) =  1.43   FLOW VELOCITY(FEET/SEC.) =   7.96
   LONGEST FLOWPATH FROM NODE    504.00 TO NODE    400.00 =    2480.00
FEET.


****************************************************************************
***
   FLOW PROCESS FROM NODE    400.00 TO NODE    400.00 IS CODE =   1
 --------------------------------------------------------------------------
----
   >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<

================================================================================
===
   TOTAL NUMBER OF STREAMS =  2
   CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
   TIME OF CONCENTRATION(MIN.) =  13.25
   RAINFALL INTENSITY(INCH/HR) =   5.06
   TOTAL STREAM AREA(ACRES) =    24.80
   PEAK FLOW RATE(CFS) AT CONFLUENCE =     39.05


****************************************************************************
***
   FLOW PROCESS FROM NODE    406.00 TO NODE    404.00 IS CODE =  21
 --------------------------------------------------------------------------
----
   >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<

================================================================================
===
   USER-SPECIFIED RUNOFF COEFFICIENT = .3000
   S.C.S. CURVE NUMBER (AMC II) =  78
```

```
   INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
   UPSTREAM ELEVATION(FEET) =    740.00
   DOWNSTREAM ELEVATION(FEET) =    720.00
   ELEVATION DIFFERENCE(FEET) =     20.00
   SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.684
   WARNING: THE MAXIMUM OVERLAND FLOW SLOPE, 10.%, IS USED IN Tc
CALCULATION!
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.865
   SUBAREA RUNOFF(CFS) =      0.94
   TOTAL AREA(ACRES) =      0.40   TOTAL RUNOFF(CFS) =      0.94


****************************************************************************
***
   FLOW PROCESS FROM NODE    404.00 TO NODE    400.00 IS CODE =  51
 ----------------------------------------------------------------------------
----
   >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
   >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<

============================================================================
===
   ELEVATION DATA: UPSTREAM(FEET) =    700.00  DOWNSTREAM(FEET) =
550.00
   CHANNEL LENGTH THRU SUBAREA(FEET) =  1800.00   CHANNEL SLOPE =  0.0833
   CHANNEL BASE(FEET) =    4.00   "Z" FACTOR =   2.000
   MANNING'S FACTOR = 0.035   MAXIMUM DEPTH(FEET) =   5.00
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.562
   USER-SPECIFIED RUNOFF COEFFICIENT = .3000
   S.C.S. CURVE NUMBER (AMC II) =  78
   TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      14.31
   TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   6.31
   AVERAGE FLOW DEPTH(FEET) =   0.46   TRAVEL TIME(MIN.) =   4.75
   Tc(MIN.) =  11.44
   SUBAREA AREA(ACRES) =    15.60       SUBAREA RUNOFF(CFS) =   26.03
   AREA-AVERAGE RUNOFF COEFFICIENT =  0.300
   TOTAL AREA(ACRES) =       16.0         PEAK FLOW RATE(CFS) =
26.70

   END OF SUBAREA CHANNEL FLOW HYDRAULICS:
   DEPTH(FEET) =  0.65   FLOW VELOCITY(FEET/SEC.) =   7.73
   LONGEST FLOWPATH FROM NODE    406.00 TO NODE    400.00 =    1900.00
FEET.


****************************************************************************
***
   FLOW PROCESS FROM NODE    400.00 TO NODE    400.00 IS CODE =   1
 ----------------------------------------------------------------------------
----
   >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
   >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
```

```
================================================================================
===
   TOTAL NUMBER OF STREAMS =  2
   CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
   TIME OF CONCENTRATION(MIN.) =  11.44
   RAINFALL INTENSITY(INCH/HR) =   5.56
   TOTAL STREAM AREA(ACRES) =    16.00
   PEAK FLOW RATE(CFS) AT CONFLUENCE =     26.70

   ** CONFLUENCE DATA **
   STREAM     RUNOFF      Tc      INTENSITY      AREA
   NUMBER      (CFS)    (MIN.)   (INCH/HOUR)    (ACRE)
       1       39.05    13.25        5.060         24.80
       2       26.70    11.44        5.562         16.00

   RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
   CONFLUENCE FORMULA USED FOR  2 STREAMS.

   ** PEAK FLOW RATE TABLE **
   STREAM     RUNOFF      Tc      INTENSITY
   NUMBER      (CFS)    (MIN.)   (INCH/HOUR)
       1       60.42    11.44       5.562
       2       63.33    13.25       5.060

   COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
   PEAK FLOW RATE(CFS) =      63.33   Tc(MIN.) =   13.25
   TOTAL AREA(ACRES) =       40.8
   LONGEST FLOWPATH FROM NODE    504.00 TO NODE    400.00 =    2480.00
FEET.


****************************************************************************
***
   FLOW PROCESS FROM NODE    400.00 TO NODE    102.00 IS CODE =  41
 ----------------------------------------------------------------------------
----
   >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
   >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<

================================================================================
===
   ELEVATION DATA: UPSTREAM(FEET) =   550.00  DOWNSTREAM(FEET) =   540.00
   FLOW LENGTH(FEET) =    80.00   MANNING'S N =  0.015
   DEPTH OF FLOW IN  36.0 INCH PIPE IS  14.0 INCHES
   PIPE-FLOW VELOCITY(FEET/SEC.) =  25.03
   GIVEN PIPE DIAMETER(INCH) =  36.00    NUMBER OF PIPES =   1
   PIPE-FLOW(CFS) =      63.33
   PIPE TRAVEL TIME(MIN.) =   0.05    Tc(MIN.) =  13.30
   LONGEST FLOWPATH FROM NODE    504.00 TO NODE    102.00 =    2560.00
FEET.
```

```
****************************************************************************
***
   FLOW PROCESS FROM NODE    102.00 TO NODE    102.00 IS CODE =  11
 ----------------------------------------------------------------------------
----
   >>>>>CONFLUENCE MEMORY BANK # 1 WITH THE MAIN-STREAM MEMORY<<<<<

============================================================================
===

   ** MAIN STREAM CONFLUENCE DATA **
   STREAM     RUNOFF      Tc       INTENSITY     AREA
   NUMBER       (CFS)    (MIN.)    (INCH/HOUR)    (ACRE)
       1       63.33    13.30        5.047        40.80
   LONGEST FLOWPATH FROM NODE    504.00 TO NODE    102.00 =    2560.00
FEET.

   ** MEMORY BANK #  1 CONFLUENCE DATA **
   STREAM     RUNOFF      Tc       INTENSITY     AREA
   NUMBER       (CFS)    (MIN.)    (INCH/HOUR)    (ACRE)
       1      134.58    15.77        4.522        99.20
   LONGEST FLOWPATH FROM NODE    604.00 TO NODE    102.00 =    5470.00
FEET.

   ** PEAK FLOW RATE TABLE **
   STREAM    RUNOFF       Tc       INTENSITY
   NUMBER     (CFS)      (MIN.)    (INCH/HOUR)
       1     176.86      13.30         5.047
       2     191.33      15.77         4.522

   COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
   PEAK FLOW RATE(CFS) =     191.33   Tc(MIN.) =   15.77
   TOTAL AREA(ACRES) =      140.0


****************************************************************************
***
   FLOW PROCESS FROM NODE    100.00 TO NODE    100.00 IS CODE =  41
 ----------------------------------------------------------------------------
----
   >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
   >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<

============================================================================
===
   ELEVATION DATA: UPSTREAM(FEET) =   540.00  DOWNSTREAM(FEET) =   539.00
   FLOW LENGTH(FEET) =   100.00   MANNING'S N =  0.013
   ASSUME FULL-FLOWING PIPELINE
   PIPE-FLOW VELOCITY(FEET/SEC.) =  15.23
   PIPE FLOW VELOCITY = (TOTAL FLOW)/(PIPE CROSS SECTION AREA)
   GIVEN PIPE DIAMETER(INCH) =  48.00    NUMBER OF PIPES =   1
   PIPE-FLOW(CFS) =     191.33
   PIPE TRAVEL TIME(MIN.) =   0.11    Tc(MIN.) =  15.87
```

```
   LONGEST FLOWPATH FROM NODE    604.00 TO NODE    100.00 =    5570.00
FEET.

============================================================================
===
   END OF STUDY SUMMARY:
   TOTAL AREA(ACRES)     =      140.0  TC(MIN.) =     15.87
   PEAK FLOW RATE(CFS)   =     191.33

============================================================================
===

============================================================================
===
   END OF RATIONAL METHOD ANALYSIS
```

Proposed Condition Analysis

```
_____
___

**************************************************************************
***

            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
            Reference: SAN DIEGO COUNTY FLOOD CONTROL DISTRICT
                         2003,1985,1981 HYDROLOGY MANUAL
          (c) Copyright 1982-2006 Advanced Engineering Software (aes)
              Ver. 2.0 Release Date: 06/01/2005  License ID 1553

                              Analysis prepared by:



                                     LUNDSTROM




  ************************** DESCRIPTION OF STUDY
**************************
 * PROPOSED CONDITION
*
 * 100 YEAR STROM EVENT
*
 *
*

**************************************************************************
*

   FILE NAME: C:\196PR100.DAT
   TIME/DATE OF STUDY: 11:49 04/12/2018
 ------------------------------------------------------------------------
----
   USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
 ------------------------------------------------------------------------
----
   2003 SAN DIEGO MANUAL CRITERIA

   USER SPECIFIED STORM EVENT(YEAR) = 100.00
   6-HOUR DURATION PRECIPITATION (INCHES) =   3.600
   SPECIFIED MINIMUM PIPE SIZE(INCH) =  18.00
   SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE =
0.95
   SAN DIEGO HYDROLOGY MANUAL "C"-VALUES USED FOR RATIONAL METHOD
   NOTE: USE MODIFIED RATIONAL METHOD PROCEDURES FOR CONFLUENCE ANALYSIS
```

```
   *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW
MODEL*
      HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:
MANNING
      WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE
FACTOR
 NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)
(n)
 ===  =====  =========  =================  ======  ===== ====== =====
=======
   1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0313 0.167
0.0150

   GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
     1. Relative Flow-Depth =  0.00 FEET
        as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
     2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
   *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
    OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*


****************************************************************************
***
   FLOW PROCESS FROM NODE    704.00 TO NODE    702.00 IS CODE =  21
 ----------------------------------------------------------------------------
----
   >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<

============================================================================
===
   USER-SPECIFIED RUNOFF COEFFICIENT = .3600
   S.C.S. CURVE NUMBER (AMC II) =  76
   INITIAL SUBAREA FLOW-LENGTH(FEET) =   150.00
   UPSTREAM ELEVATION(FEET) =   1120.00
   DOWNSTREAM ELEVATION(FEET) =   1080.00
   ELEVATION DIFFERENCE(FEET) =     40.00
   SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.183
   WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
            THE MAXIMUM OVERLAND FLOW LENGTH =   100.00
            (Reference: Table 3-1B of Hydrology Manual)
            THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  8.271
   SUBAREA RUNOFF(CFS) =      2.08
   TOTAL AREA(ACRES) =      0.70   TOTAL RUNOFF(CFS) =      2.08


****************************************************************************
***
   FLOW PROCESS FROM NODE    702.00 TO NODE    700.00 IS CODE =  51
 ----------------------------------------------------------------------------
----
   >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
   >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
```

```
================================================================================
   ELEVATION DATA: UPSTREAM(FEET) =   1080.00  DOWNSTREAM(FEET) =
570.00
   CHANNEL LENGTH THRU SUBAREA(FEET) =  4800.00   CHANNEL SLOPE =  0.1063
   CHANNEL BASE(FEET) =   10.00   "Z" FACTOR =   2.000
   MANNING'S FACTOR = 0.030   MAXIMUM DEPTH(FEET) =   4.00
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.727
   USER-SPECIFIED RUNOFF COEFFICIENT = .3600
   S.C.S. CURVE NUMBER (AMC II) =  76
   TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =     286.28
   TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =  16.85
   AVERAGE FLOW DEPTH(FEET) =   1.34   TRAVEL TIME(MIN.) =   4.75
   Tc(MIN.) =  10.93
   SUBAREA AREA(ACRES) =   268.00       SUBAREA RUNOFF(CFS) =  552.56
   AREA-AVERAGE RUNOFF COEFFICIENT =  0.360
   TOTAL AREA(ACRES) =      268.7         PEAK FLOW RATE(CFS) =
554.01

   END OF SUBAREA CHANNEL FLOW HYDRAULICS:
   DEPTH(FEET) =  1.94   FLOW VELOCITY(FEET/SEC.) =  20.56
   LONGEST FLOWPATH FROM NODE    704.00 TO NODE    700.00 =    4950.00
FEET.


****************************************************************************
***
   FLOW PROCESS FROM NODE    700.00 TO NODE    202.00 IS CODE =  51
 ----------------------------------------------------------------------------
----
   >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
   >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<

================================================================================
   ELEVATION DATA: UPSTREAM(FEET) =    570.00  DOWNSTREAM(FEET) =
540.00
   CHANNEL LENGTH THRU SUBAREA(FEET) =   860.00   CHANNEL SLOPE =  0.0349
   CHANNEL BASE(FEET) =    6.00   "Z" FACTOR =   1.000
   MANNING'S FACTOR = 0.035   MAXIMUM DEPTH(FEET) =  10.00
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.404
   USER-SPECIFIED RUNOFF COEFFICIENT = .3600
   S.C.S. CURVE NUMBER (AMC II) =  76
   TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =     563.15
   TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =  13.92
   AVERAGE FLOW DEPTH(FEET) =   4.03   TRAVEL TIME(MIN.) =   1.03
   Tc(MIN.) =  11.96
   SUBAREA AREA(ACRES) =     9.40       SUBAREA RUNOFF(CFS) =   18.29
   AREA-AVERAGE RUNOFF COEFFICIENT =  0.360
   TOTAL AREA(ACRES) =      278.1         PEAK FLOW RATE(CFS) =
554.01

   END OF SUBAREA CHANNEL FLOW HYDRAULICS:
```

```
   DEPTH(FEET) =  4.00   FLOW VELOCITY(FEET/SEC.) =  13.85
   LONGEST FLOWPATH FROM NODE    704.00 TO NODE    202.00 =    5810.00
FEET.


****************************************************************************
***
   FLOW PROCESS FROM NODE    202.00 TO NODE    200.00 IS CODE =  41
 ----------------------------------------------------------------------------
----
   >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
   >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<

============================================================================
===
   ELEVATION DATA: UPSTREAM(FEET) =   540.00  DOWNSTREAM(FEET) =   539.00
   FLOW LENGTH(FEET) =   100.00   MANNING'S N =  0.013
   ASSUME FULL-FLOWING PIPELINE
   PIPE-FLOW VELOCITY(FEET/SEC.) =  19.59
   PIPE FLOW VELOCITY = (TOTAL FLOW)/(PIPE CROSS SECTION AREA)
   GIVEN PIPE DIAMETER(INCH) =  72.00    NUMBER OF PIPES =   1
   PIPE-FLOW(CFS) =     554.01
   PIPE TRAVEL TIME(MIN.) =   0.09    Tc(MIN.) =  12.05
   LONGEST FLOWPATH FROM NODE    704.00 TO NODE    200.00 =    5910.00
FEET.


****************************************************************************
***
   FLOW PROCESS FROM NODE    200.00 TO NODE    200.00 IS CODE =  13
 ----------------------------------------------------------------------------
----
   >>>>>CLEAR THE MAIN-STREAM MEMORY<<<<<

============================================================================
===


****************************************************************************
***
   FLOW PROCESS FROM NODE    604.00 TO NODE    602.00 IS CODE =  21
 ----------------------------------------------------------------------------
----
   >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<

============================================================================
===
   USER-SPECIFIED RUNOFF COEFFICIENT = .3000
   S.C.S. CURVE NUMBER (AMC II) =  76
   INITIAL SUBAREA FLOW-LENGTH(FEET) =   170.00
   UPSTREAM ELEVATION(FEET) =    940.00
   DOWNSTREAM ELEVATION(FEET) =    920.00
   ELEVATION DIFFERENCE(FEET) =     20.00
   SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.684
```

```
   WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
            THE MAXIMUM OVERLAND FLOW LENGTH =   100.00
            (Reference: Table 3-1B of Hydrology Manual)
            THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.865
   SUBAREA RUNOFF(CFS) =      0.94
   TOTAL AREA(ACRES) =      0.40   TOTAL RUNOFF(CFS) =      0.94


****************************************************************************
***
   FLOW PROCESS FROM NODE    602.00 TO NODE    600.00 IS CODE =  51
 ----------------------------------------------------------------------------
----
   >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
   >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<

============================================================================
===
   ELEVATION DATA: UPSTREAM(FEET) =    920.00  DOWNSTREAM(FEET) =
570.00
   CHANNEL LENGTH THRU SUBAREA(FEET) =  4800.00   CHANNEL SLOPE =  0.0729
   CHANNEL BASE(FEET) =    5.00   "Z" FACTOR =   2.000
   MANNING'S FACTOR = 0.035   MAXIMUM DEPTH(FEET) =  10.00
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.663
   USER-SPECIFIED RUNOFF COEFFICIENT = .3000
   S.C.S. CURVE NUMBER (AMC II) =  78
   TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      70.78
   TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   9.58
   AVERAGE FLOW DEPTH(FEET) =   1.04   TRAVEL TIME(MIN.) =   8.35
   Tc(MIN.) =  15.03
   SUBAREA AREA(ACRES) =    95.30       SUBAREA RUNOFF(CFS) =  133.33
   AREA-AVERAGE RUNOFF COEFFICIENT =  0.300
   TOTAL AREA(ACRES) =       95.7         PEAK FLOW RATE(CFS) =
133.89

   END OF SUBAREA CHANNEL FLOW HYDRAULICS:
   DEPTH(FEET) =  1.47   FLOW VELOCITY(FEET/SEC.) =  11.50
   LONGEST FLOWPATH FROM NODE    604.00 TO NODE    600.00 =    4970.00
FEET.


****************************************************************************
***
   FLOW PROCESS FROM NODE    600.00 TO NODE    102.00 IS CODE =  51
 ----------------------------------------------------------------------------
----
   >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
   >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<

============================================================================
===
   ELEVATION DATA: UPSTREAM(FEET) =    570.00  DOWNSTREAM(FEET) =
540.00
```

```
   CHANNEL LENGTH THRU SUBAREA(FEET) =   500.00   CHANNEL SLOPE =  0.0600
   CHANNEL BASE(FEET) =    6.00   "Z" FACTOR =   1.000
   MANNING'S FACTOR = 0.035   MAXIMUM DEPTH(FEET) =  10.00
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.523
   USER-SPECIFIED RUNOFF COEFFICIENT = .3600
   S.C.S. CURVE NUMBER (AMC II) =  76
   TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =     136.74
   TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =  11.38
   AVERAGE FLOW DEPTH(FEET) =   1.58   TRAVEL TIME(MIN.) =   0.73
   Tc(MIN.) =  15.76
   SUBAREA AREA(ACRES) =     3.50       SUBAREA RUNOFF(CFS) =    5.70
   AREA-AVERAGE RUNOFF COEFFICIENT =  0.302
   TOTAL AREA(ACRES) =       99.2         PEAK FLOW RATE(CFS) =
135.54

   END OF SUBAREA CHANNEL FLOW HYDRAULICS:
   DEPTH(FEET) =  1.57   FLOW VELOCITY(FEET/SEC.) =  11.37
   LONGEST FLOWPATH FROM NODE    604.00 TO NODE    102.00 =    5470.00
FEET.


****************************************************************************
***
   FLOW PROCESS FROM NODE    102.00 TO NODE    102.00 IS CODE =  10
 --------------------------------------------------------------------------
----
   >>>>>MAIN-STREAM MEMORY COPIED ONTO MEMORY BANK # 1 <<<<<

============================================================================
===


****************************************************************************
***
   FLOW PROCESS FROM NODE    102.00 TO NODE    102.00 IS CODE =  13
 --------------------------------------------------------------------------
----
   >>>>>CLEAR THE MAIN-STREAM MEMORY<<<<<

============================================================================
===


****************************************************************************
***
   FLOW PROCESS FROM NODE    504.00 TO NODE    502.00 IS CODE =  21
 --------------------------------------------------------------------------
----
   >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<

============================================================================
===
   USER-SPECIFIED RUNOFF COEFFICIENT = .4100
   S.C.S. CURVE NUMBER (AMC II) =  82
```

```
   INITIAL SUBAREA FLOW-LENGTH(FEET) =   150.00
   UPSTREAM ELEVATION(FEET) =    700.00
   DOWNSTREAM ELEVATION(FEET) =    690.00
   ELEVATION DIFFERENCE(FEET) =     10.00
   SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.600
   WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
            THE MAXIMUM OVERLAND FLOW LENGTH =   100.00
            (Reference: Table 3-1B of Hydrology Manual)
            THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.930
   SUBAREA RUNOFF(CFS) =      1.63
   TOTAL AREA(ACRES) =      0.50   TOTAL RUNOFF(CFS) =      1.63


****************************************************************************
***
   FLOW PROCESS FROM NODE    502.00 TO NODE    500.00 IS CODE =  51
 ----------------------------------------------------------------------------
----
   >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
   >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<

============================================================================
===
   ELEVATION DATA: UPSTREAM(FEET) =    680.00  DOWNSTREAM(FEET) =
570.00
   CHANNEL LENGTH THRU SUBAREA(FEET) =  1900.00   CHANNEL SLOPE =  0.0579
   CHANNEL BASE(FEET) =    5.00   "Z" FACTOR =   2.000
   MANNING'S FACTOR = 0.035   MAXIMUM DEPTH(FEET) =  10.00
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.545
   USER-SPECIFIED RUNOFF COEFFICIENT = .3500
   S.C.S. CURVE NUMBER (AMC II) =  83
   TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      25.81
   TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   6.47
   AVERAGE FLOW DEPTH(FEET) =   0.64   TRAVEL TIME(MIN.) =   4.89
   Tc(MIN.) =  11.49
   SUBAREA AREA(ACRES) =    24.00       SUBAREA RUNOFF(CFS) =   46.58
   AREA-AVERAGE RUNOFF COEFFICIENT =  0.351
   TOTAL AREA(ACRES) =       24.5         PEAK FLOW RATE(CFS) =
47.71

   END OF SUBAREA CHANNEL FLOW HYDRAULICS:
   DEPTH(FEET) =  0.90   FLOW VELOCITY(FEET/SEC.) =   7.85
   LONGEST FLOWPATH FROM NODE    504.00 TO NODE    500.00 =    2050.00
FEET.


****************************************************************************
***
   FLOW PROCESS FROM NODE    500.00 TO NODE    400.00 IS CODE =  51
 ----------------------------------------------------------------------------
----
   >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
   >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
```

```
================================================================================
   ELEVATION DATA: UPSTREAM(FEET) =    570.00  DOWNSTREAM(FEET) =
550.00
   CHANNEL LENGTH THRU SUBAREA(FEET) =   430.00   CHANNEL SLOPE =  0.0465
   CHANNEL BASE(FEET) =    2.00   "Z" FACTOR =   1.000
   MANNING'S FACTOR = 0.035   MAXIMUM DEPTH(FEET) =   3.00
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.294
   USER-SPECIFIED RUNOFF COEFFICIENT = .3500
   S.C.S. CURVE NUMBER (AMC II) =  83
   TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      47.99
   TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   8.39
   AVERAGE FLOW DEPTH(FEET) =   1.59   TRAVEL TIME(MIN.) =   0.85
   Tc(MIN.) =  12.35
   SUBAREA AREA(ACRES) =     0.30       SUBAREA RUNOFF(CFS) =    0.56
   AREA-AVERAGE RUNOFF COEFFICIENT =  0.351
   TOTAL AREA(ACRES) =       24.8         PEAK FLOW RATE(CFS) =
47.71

   END OF SUBAREA CHANNEL FLOW HYDRAULICS:
   DEPTH(FEET) =  1.58   FLOW VELOCITY(FEET/SEC.) =   8.40
   LONGEST FLOWPATH FROM NODE    504.00 TO NODE    400.00 =    2480.00
FEET.


****************************************************************************
***
   FLOW PROCESS FROM NODE    400.00 TO NODE    400.00 IS CODE =   1
 --------------------------------------------------------------------------
----
   >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<

================================================================================
===
   TOTAL NUMBER OF STREAMS =  2
   CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
   TIME OF CONCENTRATION(MIN.) =  12.35
   RAINFALL INTENSITY(INCH/HR) =   5.29
   TOTAL STREAM AREA(ACRES) =    24.80
   PEAK FLOW RATE(CFS) AT CONFLUENCE =     47.71


****************************************************************************
***
   FLOW PROCESS FROM NODE    406.00 TO NODE    404.00 IS CODE =  21
 --------------------------------------------------------------------------
----
   >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<

================================================================================
===
   USER-SPECIFIED RUNOFF COEFFICIENT = .3000
   S.C.S. CURVE NUMBER (AMC II) =  78
```

```
   INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
   UPSTREAM ELEVATION(FEET) =    740.00
   DOWNSTREAM ELEVATION(FEET) =    720.00
   ELEVATION DIFFERENCE(FEET) =     20.00
   SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.684
   WARNING: THE MAXIMUM OVERLAND FLOW SLOPE, 10.%, IS USED IN Tc
CALCULATION!
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.865
   SUBAREA RUNOFF(CFS) =      0.94
   TOTAL AREA(ACRES) =      0.40   TOTAL RUNOFF(CFS) =      0.94


****************************************************************************
***
   FLOW PROCESS FROM NODE    404.00 TO NODE    400.00 IS CODE =  51
 ----------------------------------------------------------------------------
----
   >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
   >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<

============================================================================
===
   ELEVATION DATA: UPSTREAM(FEET) =    700.00  DOWNSTREAM(FEET) =
550.00
   CHANNEL LENGTH THRU SUBAREA(FEET) =  1800.00   CHANNEL SLOPE =  0.0833
   CHANNEL BASE(FEET) =    4.00   "Z" FACTOR =   2.000
   MANNING'S FACTOR = 0.035   MAXIMUM DEPTH(FEET) =   5.00
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.562
   USER-SPECIFIED RUNOFF COEFFICIENT = .3000
   S.C.S. CURVE NUMBER (AMC II) =  78
   TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      14.31
   TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   6.31
   AVERAGE FLOW DEPTH(FEET) =   0.46   TRAVEL TIME(MIN.) =   4.75
   Tc(MIN.) =  11.44
   SUBAREA AREA(ACRES) =    15.60       SUBAREA RUNOFF(CFS) =   26.03
   AREA-AVERAGE RUNOFF COEFFICIENT =  0.300
   TOTAL AREA(ACRES) =       16.0         PEAK FLOW RATE(CFS) =
26.70

   END OF SUBAREA CHANNEL FLOW HYDRAULICS:
   DEPTH(FEET) =  0.65   FLOW VELOCITY(FEET/SEC.) =   7.73
   LONGEST FLOWPATH FROM NODE    406.00 TO NODE    400.00 =    1900.00
FEET.


****************************************************************************
***
   FLOW PROCESS FROM NODE    400.00 TO NODE    400.00 IS CODE =   1
 ----------------------------------------------------------------------------
----
   >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
   >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
```

```
================================================================================
===
   TOTAL NUMBER OF STREAMS =  2
   CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
   TIME OF CONCENTRATION(MIN.) =  11.44
   RAINFALL INTENSITY(INCH/HR) =   5.56
   TOTAL STREAM AREA(ACRES) =    16.00
   PEAK FLOW RATE(CFS) AT CONFLUENCE =     26.70

   ** CONFLUENCE DATA **
   STREAM     RUNOFF      Tc      INTENSITY      AREA
   NUMBER      (CFS)    (MIN.)   (INCH/HOUR)    (ACRE)
       1       47.71    12.35        5.294        24.80
       2       26.70    11.44        5.562        16.00

   RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
   CONFLUENCE FORMULA USED FOR  2 STREAMS.

   ** PEAK FLOW RATE TABLE **
   STREAM     RUNOFF      Tc      INTENSITY
   NUMBER      (CFS)    (MIN.)   (INCH/HOUR)
       1       70.90    11.44       5.562
       2       73.12    12.35       5.294

   COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
   PEAK FLOW RATE(CFS) =      73.12   Tc(MIN.) =   12.35
   TOTAL AREA(ACRES) =       40.8
   LONGEST FLOWPATH FROM NODE    504.00 TO NODE    400.00 =    2480.00
FEET.


****************************************************************************
***
   FLOW PROCESS FROM NODE    400.00 TO NODE    102.00 IS CODE =  41
 ----------------------------------------------------------------------------
----
   >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
   >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<

================================================================================
===
   ELEVATION DATA: UPSTREAM(FEET) =   550.00  DOWNSTREAM(FEET) =   540.00
   FLOW LENGTH(FEET) =    80.00   MANNING'S N =  0.013
   DEPTH OF FLOW IN  36.0 INCH PIPE IS  14.0 INCHES
   PIPE-FLOW VELOCITY(FEET/SEC.) =  28.88
   GIVEN PIPE DIAMETER(INCH) =  36.00    NUMBER OF PIPES =   1
   PIPE-FLOW(CFS) =      73.12
   PIPE TRAVEL TIME(MIN.) =   0.05    Tc(MIN.) =  12.39
   LONGEST FLOWPATH FROM NODE    504.00 TO NODE    102.00 =    2560.00
FEET.
```

```
****************************************************************************
***
   FLOW PROCESS FROM NODE    102.00 TO NODE    102.00 IS CODE =  11
 ----------------------------------------------------------------------------
----
   >>>>>CONFLUENCE MEMORY BANK # 1 WITH THE MAIN-STREAM MEMORY<<<<<

============================================================================
===

   ** MAIN STREAM CONFLUENCE DATA **
   STREAM     RUNOFF      Tc       INTENSITY     AREA
   NUMBER       (CFS)    (MIN.)    (INCH/HOUR)   (ACRE)
       1       73.12    12.39        5.282        40.80
   LONGEST FLOWPATH FROM NODE    504.00 TO NODE    102.00 =    2560.00
FEET.

   ** MEMORY BANK #  1 CONFLUENCE DATA **
   STREAM     RUNOFF      Tc       INTENSITY     AREA
   NUMBER       (CFS)    (MIN.)    (INCH/HOUR)   (ACRE)
       1      135.54    15.76        4.523        99.20
   LONGEST FLOWPATH FROM NODE    604.00 TO NODE    102.00 =    5470.00
FEET.

   ** PEAK FLOW RATE TABLE **
   STREAM    RUNOFF       Tc       INTENSITY
   NUMBER     (CFS)      (MIN.)    (INCH/HOUR)
       1     179.69      12.39         5.282
       2     198.16      15.76         4.523

   COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
   PEAK FLOW RATE(CFS) =     198.16   Tc(MIN.) =   15.76
   TOTAL AREA(ACRES) =      140.0


****************************************************************************
***
   FLOW PROCESS FROM NODE    316.00 TO NODE    314.00 IS CODE =  21
 ----------------------------------------------------------------------------
----
   >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<

============================================================================
===
   USER-SPECIFIED RUNOFF COEFFICIENT = .3600
   S.C.S. CURVE NUMBER (AMC II) =  76
   INITIAL SUBAREA FLOW-LENGTH(FEET) =    50.00
   UPSTREAM ELEVATION(FEET) =    614.00
   DOWNSTREAM ELEVATION(FEET) =    613.50
   ELEVATION DIFFERENCE(FEET) =      0.50
   SUBAREA OVERLAND TIME OF FLOW(MIN.) =    9.419
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  6.305
   SUBAREA RUNOFF(CFS) =      0.68
```

```
   TOTAL AREA(ACRES) =      0.30   TOTAL RUNOFF(CFS) =      0.68


****************************************************************************
***
   FLOW PROCESS FROM NODE    314.00 TO NODE    308.00 IS CODE =  51
 ----------------------------------------------------------------------------
----
   >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
   >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<

============================================================================
===
   ELEVATION DATA: UPSTREAM(FEET) =    600.00  DOWNSTREAM(FEET) =
570.00
   CHANNEL LENGTH THRU SUBAREA(FEET) =  1000.00   CHANNEL SLOPE =  0.0300
   CHANNEL BASE(FEET) =    1.00   "Z" FACTOR =   1.000
   MANNING'S FACTOR = 0.015   MAXIMUM DEPTH(FEET) =   1.00
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.431
   USER-SPECIFIED RUNOFF COEFFICIENT = .3600
   S.C.S. CURVE NUMBER (AMC II) =  76
   TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       3.53
   TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   6.81
   AVERAGE FLOW DEPTH(FEET) =   0.38   TRAVEL TIME(MIN.) =   2.45
   Tc(MIN.) =  11.87
   SUBAREA AREA(ACRES) =     2.90       SUBAREA RUNOFF(CFS) =    5.67
   AREA-AVERAGE RUNOFF COEFFICIENT =  0.360
   TOTAL AREA(ACRES) =        3.2         PEAK FLOW RATE(CFS) =
6.26

   END OF SUBAREA CHANNEL FLOW HYDRAULICS:
   DEPTH(FEET) =  0.52   FLOW VELOCITY(FEET/SEC.) =   8.00
   LONGEST FLOWPATH FROM NODE    316.00 TO NODE    308.00 =    1050.00
FEET.


****************************************************************************
***
   FLOW PROCESS FROM NODE    308.00 TO NODE    308.00 IS CODE =   1
 ----------------------------------------------------------------------------
----
   >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<

============================================================================
===
   TOTAL NUMBER OF STREAMS =  2
   CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
   TIME OF CONCENTRATION(MIN.) =  11.87
   RAINFALL INTENSITY(INCH/HR) =   5.43
   TOTAL STREAM AREA(ACRES) =     3.20
   PEAK FLOW RATE(CFS) AT CONFLUENCE =      6.26
```

```
****************************************************************************
***
   FLOW PROCESS FROM NODE    312.00 TO NODE    310.00 IS CODE =  21
 ----------------------------------------------------------------------------
----
   >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<

============================================================================
===
   USER-SPECIFIED RUNOFF COEFFICIENT = .3600
   S.C.S. CURVE NUMBER (AMC II) =  76
   INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
   UPSTREAM ELEVATION(FEET) =    630.00
   DOWNSTREAM ELEVATION(FEET) =    629.00
   ELEVATION DIFFERENCE(FEET) =      1.00
   SUBAREA OVERLAND TIME OF FLOW(MIN.) =   11.144
   WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
            THE MAXIMUM OVERLAND FLOW LENGTH =    70.00
            (Reference: Table 3-1B of Hydrology Manual)
            THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.656
   SUBAREA RUNOFF(CFS) =      0.41
   TOTAL AREA(ACRES) =      0.20   TOTAL RUNOFF(CFS) =      0.41


****************************************************************************
***
   FLOW PROCESS FROM NODE    310.00 TO NODE    308.00 IS CODE =  41
 ----------------------------------------------------------------------------
----
   >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
   >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<

============================================================================
===
   ELEVATION DATA: UPSTREAM(FEET) =   625.00  DOWNSTREAM(FEET) =   560.00
   FLOW LENGTH(FEET) =   800.00   MANNING'S N =  0.013
   DEPTH OF FLOW IN  18.0 INCH PIPE IS   1.5 INCHES
   PIPE-FLOW VELOCITY(FEET/SEC.) =   5.84
   GIVEN PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
   PIPE-FLOW(CFS) =       0.41
   PIPE TRAVEL TIME(MIN.) =   2.28    Tc(MIN.) =  13.43
   LONGEST FLOWPATH FROM NODE    312.00 TO NODE    308.00 =     900.00
FEET.


****************************************************************************
***
   FLOW PROCESS FROM NODE    308.00 TO NODE    308.00 IS CODE =  81
 ----------------------------------------------------------------------------
----
   >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
```

```
================================================================================
===
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.016
   USER-SPECIFIED RUNOFF COEFFICIENT = .3600
   S.C.S. CURVE NUMBER (AMC II) =  76
   AREA-AVERAGE RUNOFF COEFFICIENT = 0.3600
   SUBAREA AREA(ACRES) =    8.40   SUBAREA RUNOFF(CFS) =   15.17
   TOTAL AREA(ACRES) =        8.6   TOTAL RUNOFF(CFS) =      15.53
   TC(MIN.) =  13.43


****************************************************************************
***
   FLOW PROCESS FROM NODE    308.00 TO NODE    308.00 IS CODE =   1
 ----------------------------------------------------------------------------
----
   >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
   >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<

================================================================================
===
   TOTAL NUMBER OF STREAMS =  2
   CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
   TIME OF CONCENTRATION(MIN.) =  13.43
   RAINFALL INTENSITY(INCH/HR) =   5.02
   TOTAL STREAM AREA(ACRES) =     8.60
   PEAK FLOW RATE(CFS) AT CONFLUENCE =     15.53

   ** CONFLUENCE DATA **
   STREAM     RUNOFF      Tc      INTENSITY      AREA
   NUMBER      (CFS)    (MIN.)   (INCH/HOUR)    (ACRE)
       1        6.26    11.87        5.431          3.20
       2       15.53    13.43        5.016          8.60

   RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
   CONFLUENCE FORMULA USED FOR  2 STREAMS.

   ** PEAK FLOW RATE TABLE **
   STREAM     RUNOFF      Tc      INTENSITY
   NUMBER      (CFS)    (MIN.)   (INCH/HOUR)
       1       19.98    11.87       5.431
       2       21.31    13.43       5.016

   COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
   PEAK FLOW RATE(CFS) =      21.31   Tc(MIN.) =   13.43
   TOTAL AREA(ACRES) =       11.8
   LONGEST FLOWPATH FROM NODE    316.00 TO NODE    308.00 =    1050.00
FEET.


****************************************************************************
***
   FLOW PROCESS FROM NODE    308.00 TO NODE    304.00 IS CODE =  41
```

```
 ----------------------------------------------------------------------
----
   >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
   >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<

======================================================================
===
   ELEVATION DATA: UPSTREAM(FEET) =   560.00  DOWNSTREAM(FEET) =   530.00
   FLOW LENGTH(FEET) =   400.00   MANNING'S N =  0.013
   DEPTH OF FLOW IN  36.0 INCH PIPE IS   8.4 INCHES
   PIPE-FLOW VELOCITY(FEET/SEC.) =  16.97
   GIVEN PIPE DIAMETER(INCH) =  36.00    NUMBER OF PIPES =   1
   PIPE-FLOW(CFS) =      21.31
   PIPE TRAVEL TIME(MIN.) =   0.39    Tc(MIN.) =  13.82
   LONGEST FLOWPATH FROM NODE    316.00 TO NODE    304.00 =    1450.00
FEET.


****************************************************************************
***
   FLOW PROCESS FROM NODE    304.00 TO NODE    304.00 IS CODE =  81
 ----------------------------------------------------------------------
----
   >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<

======================================================================
===
    100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.924
   USER-SPECIFIED RUNOFF COEFFICIENT = .3600
   S.C.S. CURVE NUMBER (AMC II) =  76
   AREA-AVERAGE RUNOFF COEFFICIENT = 0.3600
   SUBAREA AREA(ACRES) =    1.60   SUBAREA RUNOFF(CFS) =    2.84
   TOTAL AREA(ACRES) =       13.4   TOTAL RUNOFF(CFS) =      23.75
   TC(MIN.) =  13.82


****************************************************************************
***
   FLOW PROCESS FROM NODE    304.00 TO NODE    300.00 IS CODE =  41
 ----------------------------------------------------------------------
----
   >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
   >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<

======================================================================
===
   ELEVATION DATA: UPSTREAM(FEET) =   530.00  DOWNSTREAM(FEET) =   527.00
   FLOW LENGTH(FEET) =   250.00   MANNING'S N =  0.013
   DEPTH OF FLOW IN  36.0 INCH PIPE IS  14.3 INCHES
   PIPE-FLOW VELOCITY(FEET/SEC.) =   9.06
   GIVEN PIPE DIAMETER(INCH) =  36.00    NUMBER OF PIPES =   1
   PIPE-FLOW(CFS) =      23.75
   PIPE TRAVEL TIME(MIN.) =   0.46    Tc(MIN.) =  14.28
```

```
   LONGEST FLOWPATH FROM NODE    316.00 TO NODE    300.00 =    1700.00
FEET.

============================================================================
===
   END OF STUDY SUMMARY:
   TOTAL AREA(ACRES)     =       13.4  TC(MIN.) =     14.28
   PEAK FLOW RATE(CFS)   =      23.75

============================================================================
===

============================================================================
===
   END OF RATIONAL METHOD ANALYSIS
```