TENTATIVE MAP DRAINAGE STUDY
for
LONE OAK RANCH

APN: 184-080-01 and 181-162.06

Prepared for:
Marker Development Company
427 South Cedros Avenue
Suite 201
Solana Beach, CA 92075

W.O. 2414-0034

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Hunsaker & Associates
San Diego, Inc.

Alisa Vialpando, RCE# 47945

REGISTERED PROFESSIONAL ENGINEER
ALISA S. VIALPANDO
No. 47945
Exp. 12/31/15
CIVIL
STATE OF CALIFORNIA

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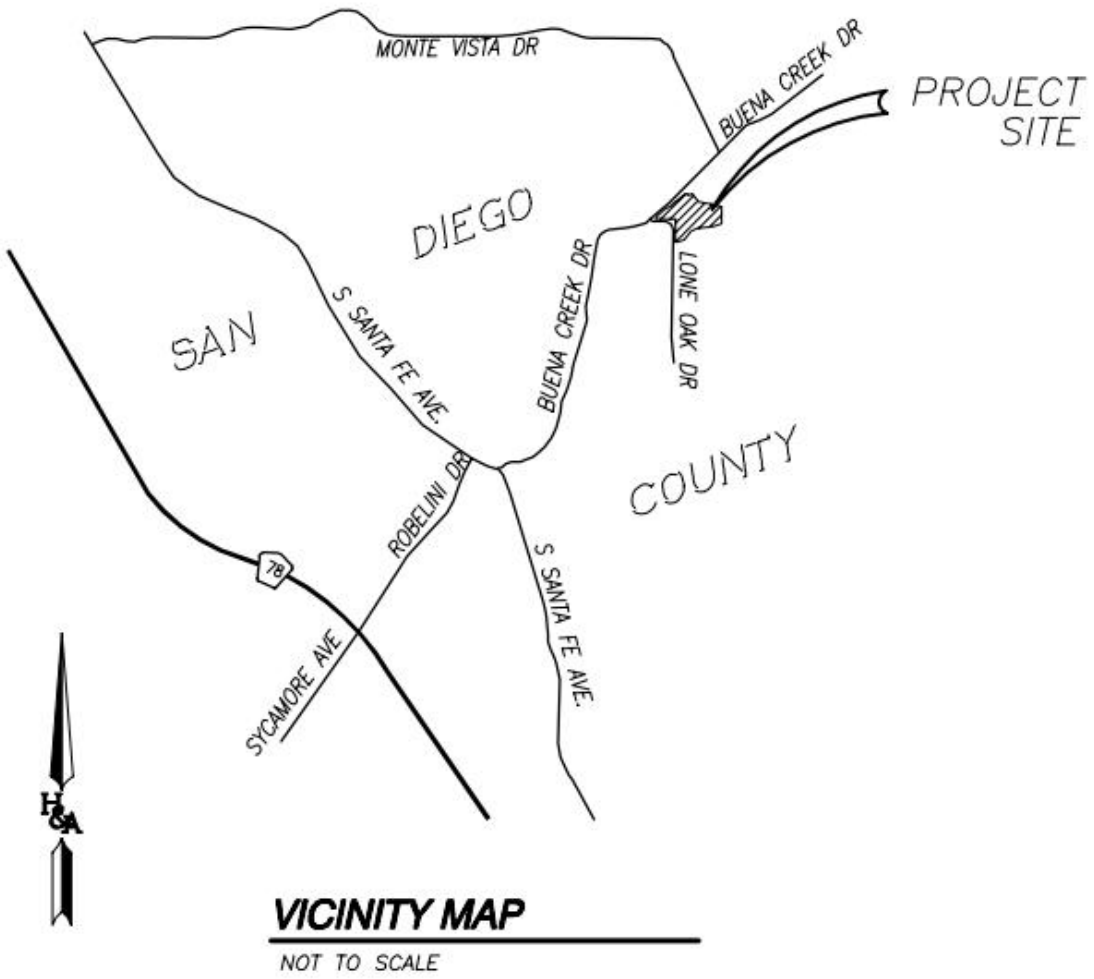
CHAPTER 1

EXECUTIVE SUMMARY

CHAPTER 1 - EXECUTIVE SUMMARY

1.1 - Introduction

The proposed Lone Oak Ranch development site is located immediately east of Buena Creek Road, northeast of Lone Oak Drive, and south of Cleveland Trail within the County of San Diego, California (see the Vicinity Map below). This study will analyze the existing and developed conditions for the 50-year peak flowrates from the proposed project as well as the 50-year offsite runoff conveyed around the site from areas to the east of the project site. Smaller frequency storm events such as the 10-year and 2-year are not included in this study but are addressed in the hydromodification section of the water quality technical report titled *Major Stormwater Management Plan (SWMP) for Lone Oak Ranch* prepared by Hunsaker & Associates San Diego, Inc. (October 2014). To detain any increases in peak flow runoff due to the proposed development, the preliminary design of detention basins and outfall structures are included in this study. Managing the offsite runoff which currently drains onto the project site from the east will also be addressed.



The WQTR for Lone Oak Ranch prepared for this site addresses water quality and hydromodification requirements for the development.

Since the project site is located outside any FEMA floodplain zones, there is no requirement for a Letter of Map Revision. It is located at 33.1833^0 N latitude and W 117.1982^0 W longitude. It is within the Buena Hydrologic Sub-Area (904.32) within the Carlsbad Watershed. The Beneficial Uses of this hydrologic area per Table 2-2 (Beneficial Uses of Inland Surface Waters) of the San Diego RWQCB Basin Plan include MUN, AGR, IND, REC1, REC2, WARM, and WILD. In addition to above, beneficial uses for Agua Hedionda Lagoon include COMM, BIOL, EST, RARE, MAR, AQUA, MIGR, SPWN, and SHELL.

Per County of San Diego drainage criteria, the Modified Rational Method should be used to determine peak design flowrates when the contributing drainage area is less than 1.0 square mile. Since the total watershed area discharging from the site is less than 1.0 square mile, the AES-2010 computer software was used to model the runoff response per the Modified Rational Method. Methodology used for the computation of design rainfall events, runoff coefficients, and rainfall intensity values are consistent with criteria set forth in the "County of San Diego 2003 Hydrology Manual." A more detailed explanation of methodology used for this analysis is listed in Chapter 2 of this report

1.2 – Summary of Existing Conditions

The project site currently consists of two (2) individual legal parcels. The northerly parcel (APN 181-162-06) is currently vacant. This parcel abuts Buena Creek Road and is bordered by an RPO Wetland and Oak Woodland which extends from Lone Oak Road to the Cleveland Trail. The southerly parcel (APN 184-080-01) forms the southerly half of the project site and currently has two structures on it. One structure is a single family residence and the other structure is a large storage building. Both structures will be removed as part of this project. The property is located within the Village Residential plan designation with a density of 2 dwelling units per acre. The northerly parcel is currently zoned A70 (Limited Agriculture) and the southerly parcel is zoned RR (Rural Residential).

The existing northern portion of the site slopes to the west towards Buena Creek with an average grade of approximately 5.2%. After entering Buena Creek, runoff is directed towards the southwest along the east side of Buena Creek Road. An existing 72" storm drain concrete culvert conveys the channel flows underneath Lone Oak Road before continuing downstream.

The southern half of the site drains towards the west to existing Lone Oak Road where it continues in a southwesterly direction then confluences with flows from a tributary of Buena Creek. Runoff from the southern half reaches Buena Creek approximately 0.23 miles west of Lone Oak Road. An existing natural drainage

channel conveys offsite runoff along the sites southern boundary. The offsite upstream area includes approximately 40 acres of undeveloped hilly land and a few residential homes.

Per the NRCS Web Soil Survey website, the site consists of Huerhuero loam with a soil Type D classification. Type D soils are classified as having very slow infiltration rates when thoroughly wet and slow rate of water transmission..

Per the "*2003 San Diego County Hydrology Manual*", a weighted runoff coefficient of 0.35-0.41 was selected to represent the current conditions found throughout most of the associated drainage areas of the project site. This runoff factor was based on Table 3-1 and type 'D' soil. The rational method analysis was used for the 50-year existing conditions analysis. The existing condition hydrologic model can be found in Chapter 3 of this study.

1.3 – Summary of Proposed Development

This project proposes a Vesting Tentative Map and Major Use Permit (PRD Site Plan) with the development of a total 26 residential lots (approx. average lot size of 10,500 sf). The project is further divided into one private drive lot, one Cleveland Trail lot, two water quality/detention basin lots, one HOA open space lot and one HOA open space wetland/woodland lot. The open space wetland/woodland lot includes an undisturbed 50' Oak Root buffer which will include a non-intrusive walking trail for the residents of the project. Residential structures will be required to be setback an additional 50' from this Oak Root buffer. All grading for the project will occur outside the existing 100 year floodway.

The primary project access is off of Lone Oak Road through a proposed gated entrance. Secondary emergency access is provided through connection to the existing Cleveland Trail drive which connects to Buena Creek Road. Additional AC pavement will be added to the existing pavement to provide a 24' wide emergency access drive. The existing creek crossing will remain unchanged.

Onsite runoff will drain along the street gutter towards the proposed inlets located at the proposed entrance to the site. This runoff will then be directed towards the proposed basins. This basin will serve three purposes: water quality, hydromodification, and peak flow attenuation. Please refer to the *Tentative Map WQTR for Lone Oak Ranch* (October 2014) for water quality and hydromodification discussion and calculations. The onsite runoff will tie in to the existing 72" culvert at the intersection of Lone Oak Road and Buena Creek Road. This onsite analysis of the site will require that flows towards the 72" culvert address HMP requirements.

Approximately 38 acres of upstream offsite runoff will be directed around the site along the southern boundary and into the existing natural drainage channel that eventually crosses Lone Oak Road. This offsite area will not increase the amount of imperviousness and will not increase the unmitigated peak flow compared to the existing condition at the downstream project boundary and therefore is exempt from addressing hydromodification per the City's SUSMP HMP requirements. The offsite runoff will be channeled around the eastern portion of the site via proposed brow ditches. Existing and Proposed Condition hydrologic results are included in Chapter 3 for the 50-year hydrologic event. The associated hydrologic maps are included in Chapter 6.

Street capacity and inlet sizing calculations are provided in Chapter 4. Peak flow attenuation (detention basin) calculations are included in Chapter 5 of this study. The storm drain outlet pipe from the basin will tie in to the existing 72" culvert crossing Lone Oak Road. Detention basin calculations will verify a reduction of peak flow runoff towards the 72" culvert due to the project's inclusion of a detention basin.

See Table 1 in Section 1.4 for a summary of drainage watersheds and associated runoff amounts in the developed condition. See Map 2 of 2 in Chapter 6 for Proposed Condition drainage areas and patterns.

1.4 – Results and Recommendations

Table 1 below summarizes the existing and proposed peak flows from the site. The developed peak flows consider the flow attenuation from the proposed detention basin. Per the San Diego County rainfall isolpluvial maps, the design rainfall depth for the 50-year flow event at the project site area is 3.05-inches.

Table 1 - Summary of 50-Year Peak Flows

	Node	Drainage Area (ac)	50-Year Peak Flow w/o detention (cfs)	50-Year Peak Flow w/ detention (cfs)
Existing Conditions	104	44.69	55.23	55.23
	202	6.34	8.91	N/A
	Subtotal	51.03	64.14	
Developed Conditions	104	41.18	50.69	50.69
	308	10.10	21.04	7.92
	Subtotal	51.28	71.73	58.61
Difference		**+0.25**	**+7.59**	**- 5.53**

*=Attenuated Flows through Detention Basin

The table above shows the results from the hydrologic analysis routing flows through the extended detention basin. These results show that the proposed development of this project will not increase peak flows.

For the Hydraflow Hydrographs for flows through the basin, refer to the calculations in Chapter 5. Basin drawdown calculations are also included at the end of Chapter 5.

The outlet structure for the basin was designed to correlate with the water quality and hydromodification design. The outlet structure and basin design criteria from the Hydraflow Hydrographs modeling results are listed in Table 5 below.

Table 2 - Extended Detention Basin Design Criteria

			Spillway		Orifice 1		Orifice 2	
	Effective Basin Bottom/ Top Elev (ft)	**Max Water Surface Elev (ft)**	**Length (in)**	**Rim Elevation (ft)**	**Diameter (in)**	**Elevation (ft)**	**Diameter (in)**	**Elevation (ft)**
Lone Oak Basin	523.8 – 528.8	527.39	30” dia.	526.55	2 – 1”	523.88	2 – 1.5”	526.3

Table 3 below summarizes the North & South detention basin output data for the 100-year event peak flow.

Table 3 – North & South Detention Basin Summary

Output Data	100-Year Event
Lone Oak Detention Basin (Drainage Area = 7.86 Ac)	
Q_{IN} (cfs)	20.09
Q_{OUT} (cfs)	5.65
Peak Elevation (ft)	527.39
Volume @ Peak Elev. (Ac-ft)	0.785
Total Basin Vol. (Ac-ft)	1.22

Peak flow rates listed above were generated based on the criteria set forth in the "*2003 San Diego County Hydrology Manual*" (methodology presented in Chapter 2 of this report). The Modified Rational Method output is located in Chapter 3.

The final storm drain, inlet and rip rap design details will be provided at the final engineering stage of the development.

1.5 - References

"San Diego County Hydrology Manual"; Department of Public Works – Flood Control Division; County of San Diego, California; Revised June 2003.

"Major Stormwater Management Plan (SWMP) for Lone Oak Ranch", Hunsaker & Associates San Diego, Inc., October 2014.

CHAPTER 2

METHODOLOGY & MODEL DEVELOPMENT

2.1 – County of San Diego Drainage Design Criteria

2.3 Selection of Hydrologic Method and Design Criteria

Design Frequency – The flood frequency for determining the design storm discharge is 50 years for drainage that is upstream of any major roadway and 100 years frequency for all design storms at a major roadway, crossing the major roadway and thereafter. The 50-year storm flows shall be contained within the pipe and not encroach into the travel lane. For the 100-year storm this includes allowing one lane of a four-lane road (four or more lanes) to be used for conveyance without encroaching onto private property outside the dedicated street right-of-way. Natural channels that remain natural within private property are excluded from the right-of-way guideline.

Design Method – The choice of method to determine flows (discharge) shall be based on the size of the watershed area. For an area 0 to approximately 1 square mile the Rational Method or the Modified Rational Method shall be used. For watershed areas larger than 1 square mile the NRCS hydrologic method shall be used. Please check with the governing agency for any variations to these guidelines.

SECTION 3
RATIONAL METHOD AND MODIFIED RATIONAL METHOD

3.1 THE RATIONAL METHOD

The Rational Method (RM) is a mathematical formula used to determine the maximum runoff rate from a given rainfall. It has particular application in urban storm drainage, where it is used to estimate peak runoff rates from small urban and rural watersheds for the design of storm drains and small drainage structures. The RM is recommended for analyzing the runoff response from drainage areas up to approximately 1 square mile in size. It should not be used in instances where there is a junction of independent drainage systems or for drainage areas greater than approximately 1 square mile in size. In these instances, the Modified Rational Method (MRM) should be used for junctions of independent drainage systems in watersheds up to approximately 1 square mile in size (see Section 3.4); or the NRCS Hydrologic Method should be used for watersheds greater than approximately 1 square mile in size (see Section 4).

The RM can be applied using any design storm frequency (e.g., 100-year, 50-year, 10-year, etc.). The local agency determines the design storm frequency that must be used based on the type of project and specific local requirements. A discussion of design storm frequency is provided in Section 2.3 of this manual. A procedure has been developed that converts the 6-hour and 24-hour precipitation isopluvial map data to an Intensity-Duration curve that can be used for the rainfall intensity in the RM formula as shown in Figure 3-1. The RM is applicable to a 6-hour storm duration because the procedure uses Intensity-Duration Design Charts that are based on a 6-hour storm duration.

3.1.1 Rational Method Formula

The RM formula estimates the peak rate of runoff at any location in a watershed as a function of the drainage area (A), runoff coefficient (C), and rainfall intensity (I) for a duration equal to the time of concentration (T_c), which is the time required for water to

flow from the most remote point of the basin to the location being analyzed. The RM formula is expressed as follows:

$$Q = C\,I\,A$$

Where: Q = peak discharge, in cubic feet per second (cfs)

C = runoff coefficient, proportion of the rainfall that runs off the surface (no units)

I = average rainfall intensity for a duration equal to the T_c for the area, in inches per hour (Note: If the computed T_c is less than 5 minutes, use 5 minutes for computing the peak discharge, Q)

A = drainage area contributing to the design location, in acres

Combining the units for the expression CIA yields:

$$\left(\frac{1\,\text{acre}\times\text{inch}}{\text{hour}}\right)\left(\frac{43{,}560\ \text{ft}^2}{\text{acre}}\right)\left(\frac{1\,\text{foot}}{12\,\text{inches}}\right)\left(\frac{1\,\text{hour}}{3{,}600\,\text{seconds}}\right) \Rightarrow 1.008\ \text{cfs}$$

For practical purposes the unit conversion coefficient difference of 0.8% can be ignored.

The RM formula is based on the assumption that for constant rainfall intensity, the peak discharge rate at a point will occur when the raindrop that falls at the most upstream point in the tributary drainage basin arrives at the point of interest.

Unlike the MRM (discussed in Section 3.4) or the NRCS hydrologic method (discussed in Section 4), the RM does not create hydrographs and therefore does not add separate subarea hydrographs at collection points. Instead, the RM develops peak discharges in the main line by increasing the T_c as flow travels downstream.

Characteristics of, or assumptions inherent to, the RM are listed below:

- The discharge flow rate resulting from any I is maximum when the I lasts as long as or longer than the T_c.

- The storm frequency of peak discharges is the same as that of I for the given T_c.

- The fraction of rainfall that becomes runoff (or the runoff coefficient, C) is independent of I or precipitation zone number (PZN) condition (PZN Condition is discussed in Section 4.1.2.4).

- The peak rate of runoff is the only information produced by using the RM.

3.1.2 Runoff Coefficient

Table 3-1 lists the estimated runoff coefficients for urban areas. The concepts related to the runoff coefficient were evaluated in a report entitled *Evaluation, Rational Method "C" Values* (Hill, 2002) that was reviewed by the Hydrology Manual Committee. The Report is available at San Diego County Department of Public Works, Flood Control Section and on the San Diego County Department of Public Works web page.

The runoff coefficients are based on land use and soil type. Soil type can be determined from the soil type map provided in Appendix A. An appropriate runoff coefficient (C) for each type of land use in the subarea should be selected from this table and multiplied by the percentage of the total area (A) included in that class. The sum of the products for all land uses is the weighted runoff coefficient ($\Sigma[CA]$). Good engineering judgment should be used when applying the values presented in Table 3-1, as adjustments to these values may be appropriate based on site-specific characteristics. In any event, the impervious percentage (% Impervious) as given in the table, for any area, shall govern the selected value for C. The runoff coefficient can also be calculated for an area based on soil type and impervious percentage using the following formula:

$$C = 0.90 \times (\% \text{ Impervious}) + C_p \times (1 - \% \text{ Impervious})$$

Where: C_p = Pervious Coefficient Runoff Value for the soil type (shown in Table 3-1 as Undisturbed Natural Terrain/Permanent Open Space, 0% Impervious). Soil type can be determined from the soil type map provided in Appendix A.

The values in Table 3-1 are typical for most urban areas. However, if the basin contains rural or agricultural land use, parks, golf courses, or other types of nonurban land use that are expected to be permanent, the appropriate value should be selected based upon the soil and cover and approved by the local agency.

3.1.3 Rainfall Intensity

The rainfall intensity (I) is the rainfall in inches per hour (in/hr) for a duration equal to the T_c for a selected storm frequency. Once a particular storm frequency has been selected for design and a T_c calculated for the drainage area, the rainfall intensity can be determined from the Intensity-Duration Design Chart (Figure 3-1). The 6-hour storm rainfall amount (P_6) and the 24-hour storm rainfall amount (P_{24}) for the selected storm frequency are also needed for calculation of I. P_6 and P_{24} can be read from the isopluvial maps provided in Appendix B. An Intensity-Duration Design Chart applicable to all areas within San Diego County is provided as Figure 3-1. Figure 3-2 provides an example of use of the Intensity-Duration Design Chart. Intensity can also be calculated using the following equation:

$$I = 7.44\, P_6\, D^{-0.645}$$

Where: P_6 = adjusted 6-hour storm rainfall amount (see discussion below)
D = duration in minutes (use T_c)

Note: This equation applies only to the 6-hour storm rainfall amount (i.e., P_6 cannot be changed to P_{24} to calculate a 24-hour intensity using this equation).

The Intensity-Duration Design Chart and the equation are for the 6-hour storm rainfall amount. In general, P_6 for the selected frequency should be between 45% and 65% of P_{24} for the selected frequency. If P_6 is not within 45% to 65% of P_{24}, P_6 should be increased or decreased as necessary to meet this criteria. The isopluvial lines are based on precipitation gauge data. At the time that the isopluvial lines were created, the majority of precipitation gauges in San Diego County were read daily, and these readings yielded 24-hour precipitation data. Some 6-hour data were available from the few recording gauges distributed throughout the County at that time; however, some 6-hour data were extrapolated. Therefore, the 24-hour precipitation data for San Diego County are considered to be more reliable.

3.1.4 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 travel time (T_t). Methods of computation for T_i and T_t are discussed below. 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 designating the initial subarea are provided within the discussion of computation of T_i. The T_t 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 RM, 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.

3.1.4.1 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 (Figure 3-3) is approximated by an equation developed by the Federal Aviation Agency (FAA) for analyzing flow on runaways (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 (more or less) in magnitude, the relative roughness is high. Some higher relative roughness values for overland flow are presented in Table 3.5 of 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:
  1) Flat roofs, sloping at 1% ±
  2) 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.
  3) 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.
  4) 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 (see Table 3-2).

- Rural or Natural Areas - The FAA equation is applicable to these conditions since (.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.
  1) Most hills and ridge lines have a relatively flat area near the drainage divide. However, with flat slopes of .5% ±, minor irregularities would cause flow to concentrate into streams.
  2) Parks, lawns and other vegetated areas would have slow velocities that are consistent with the FAA Equation.

The concepts related to the initial time of concentration were evaluated in a report entitled *Initial Time of Concentration, Analysis of Parameters* (Hill, 2002) that was reviewed by the Hydrology Manual Committee. The Report is available at San Diego County Department of Public Works, Flood Control Section and on the San Diego County Department of Public Works web page.

Note that the Initial Time of Concentration should be reflective of the general land-use at the upstream end of a drainage basin. A single lot with an area of two or less acres does not have a significant effect where the drainage basin area is 20 to 600 acres.

Table 3-2 provides limits of the length (Maximum Length (L_M)) of sheet flow to be used in hydrology studies. Initial T_i values based on average C values for the Land Use Element are also included. These values can be used in planning and design applications as described below. Exceptions may be approved by the "Regulating Agency" when submitted with a detailed study.

Table 3-2

MAXIMUM OVERLAND FLOW LENGTH (L_M) & INITIAL TIME OF CONCENTRATION (T_i)

Element*	DU/	.5%		1%		2%		3%		5%		10%	
	Acre	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i
Natural		50	13.2	70	12.5	85	10.9	100	10.3	100	8.7	100	6.9
LDR	1	50	12.2	70	11.5	85	10.0	100	9.5	100	8.0	100	6.4
LDR	2	50	11.3	70	10.5	85	9.2	100	8.8	100	7.4	100	5.8
LDR	2.9	50	10.7	70	10.0	85	8.8	95	8.1	100	7.0	100	5.6
MDR	4.3	50	10.2	70	9.6	80	8.1	95	7.8	100	6.7	100	5.3
MDR	7.3	50	9.2	65	8.4	80	7.4	95	7.0	100	6.0	100	4.8
MDR	10.9	50	8.7	65	7.9	80	6.9	90	6.4	100	5.7	100	4.5
MDR	14.5	50	8.2	65	7.4	80	6.5	90	6.0	100	5.4	100	4.3
HDR	24	50	6.7	65	6.1	75	5.1	90	4.9	95	4.3	100	3.5
HDR	43	50	5.3	65	4.7	75	4.0	85	3.8	95	3.4	100	2.7
N. Com		50	5.3	60	4.5	75	4.0	85	3.8	95	3.4	100	2.7
G. Com		50	4.7	60	4.1	75	3.6	85	3.4	90	2.9	100	2.4
O.P./Com		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
Limited I.		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
General I.		50	3.7	60	3.2	70	2.7	80	2.6	90	2.3	100	1.9

*See Table 3-1 for more detailed description

3.1.4.1A Planning Considerations

The purpose of most hydrology studies is to develop flood flow values for areas that are not at the upstream end of the basin. Another example is the Master Plan, which is usually completed before the actual detailed design of lots, streets, etc. are accomplished. In these situations it is necessary that the initial time of concentration be determined without detailed information about flow patterns.

To provide guidance for the initial time of concentration design parameters, Table 3-2 includes the Land Use Elements and other variables related to the Time of Concentration. The table development included a review of the typical "layout" of the different Land Use Elements and related flow patterns and consideration of the extent of the sheet flow regimen, the effect of ponding, the significance to the drainage basin, downstream effects, etc.

3.1.4.1B Computation Criteria

(a) Developed Drainage Areas With Overland Flow - T_i may be obtained directly from the chart, "Rational Formula – Overland Time of Flow Nomograph," shown in Figure 3-3 or from Table 3-2. This chart is based on the Federal Aviation Agency (FAA) equation (FAA, 1970). For the short rain durations (<15 minutes) involved, intensities are high but the depth of flooding is limited and much of the runoff is stored temporarily in the overland flow and in shallow ponded areas. In developed areas, overland flow is limited to lengths given in Table 3-2. Beyond these distances, flow tends to become concentrated into streets, gutters, swales, ditches, etc.

(b) Natural Or Rural Watersheds – These areas usually have an initial subarea at the upstream end with sheet flow. The sheet flow length is limited to 50 to 100 feet as specified in Table 3-2. The Overland Time of Flow Nomograph, Figure 3-3, can be used to obtain T_i. The initial time of concentration can excessively affect the magnitude of flow further downstream in the drainage basin. For instance, variations in the initial time of concentration for an initial subarea of one acre can change the flow further downstream where the area is 400 acres by 100%. Therefore, the initial time of concentration is limited (see Table 3-2).

The Rational Method procedure included in the original Hydrology Manual (1971) and Design and Procedure Manual (1968) included a 10 minute value to be added to the initial time of concentration developed through the Kirpich Formula (see Figure 3-4) for a natural watershed. That procedure is superceded by the procedure above to use Table 3-2 or Figure 3-3 to determine T_i for the appropriate sheet flow length of the initial subarea. The values for natural watersheds given in Table 3-2 vary from 13 to 7 minutes, depending on slope. If the total length of the initial subarea is greater than the maximum length allowable based on Table 3-2, add the travel time based on the Kirpich formula for the remaining length of the initial subarea.

3.1.4.2 Travel Time

The T_t 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. 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. Use Figure 3-6 to estimate time of travel for street gutter flow. Velocity in a channel can be estimated by using the nomograph shown in Figure 3-7 (Manning's Equation Nomograph).

(a) Natural Watersheds – This includes rural, ranch, and agricultural areas with natural channels. Obtain T_t directly from the Kirpich nomograph in Figure 3-4 or from the equation. This nomograph requires values for length and change in elevation along the effective slope line for the subarea. See Figure 3-5 for a representation of the effective slope line.

This nomograph is based on the Kirpich formula, which was developed with data from agricultural watersheds ranging from 1.25 to 112 acres in area, 350 to 4,000 feet in length, and 2.7 to 8.8% slope (Kirpich, 1940). A maximum length of 4,000 feet should be used for the subarea length. Typically, as the flow length increases, the depth of flow will increase, and therefore it is considered a concentration of flow at points beyond lengths listed in Figure 3-2. However, because the Kirpich formula has been shown to be applicable for watersheds up to 4,000 feet in length (Kirpich, 1940), a subarea may be designated with a length up to 4,000 feet provided the topography and slope of the natural channel are generally uniform.

Justification needs to be included with this calculation showing that the watershed will remain natural forever. Examples include areas located in the Multiple Species Conservation Plan (MSCP), areas designated as open space or rural in a community's General Plan, and Cleveland National Forest.

(b) Urban Watersheds - Flow through a closed conduit where no additional flow can enter the system during the travel, length, velocity and T_t are determined using the peak flow in the conduit. In cases where the conduit is not closed and additional flow from a contributing subarea is added to the total flow during travel (e.g., street flow in a gutter), calculation of velocity and T_t is performed using an assumed average flow based on the total area (including upstream subareas) contributing to the point of interest. The Manning equation is usually used to determine velocity. Discharges for small watersheds typically range from 2 to 3 cfs per acre, depending on land use, drainage area, and slope and rainfall intensity.

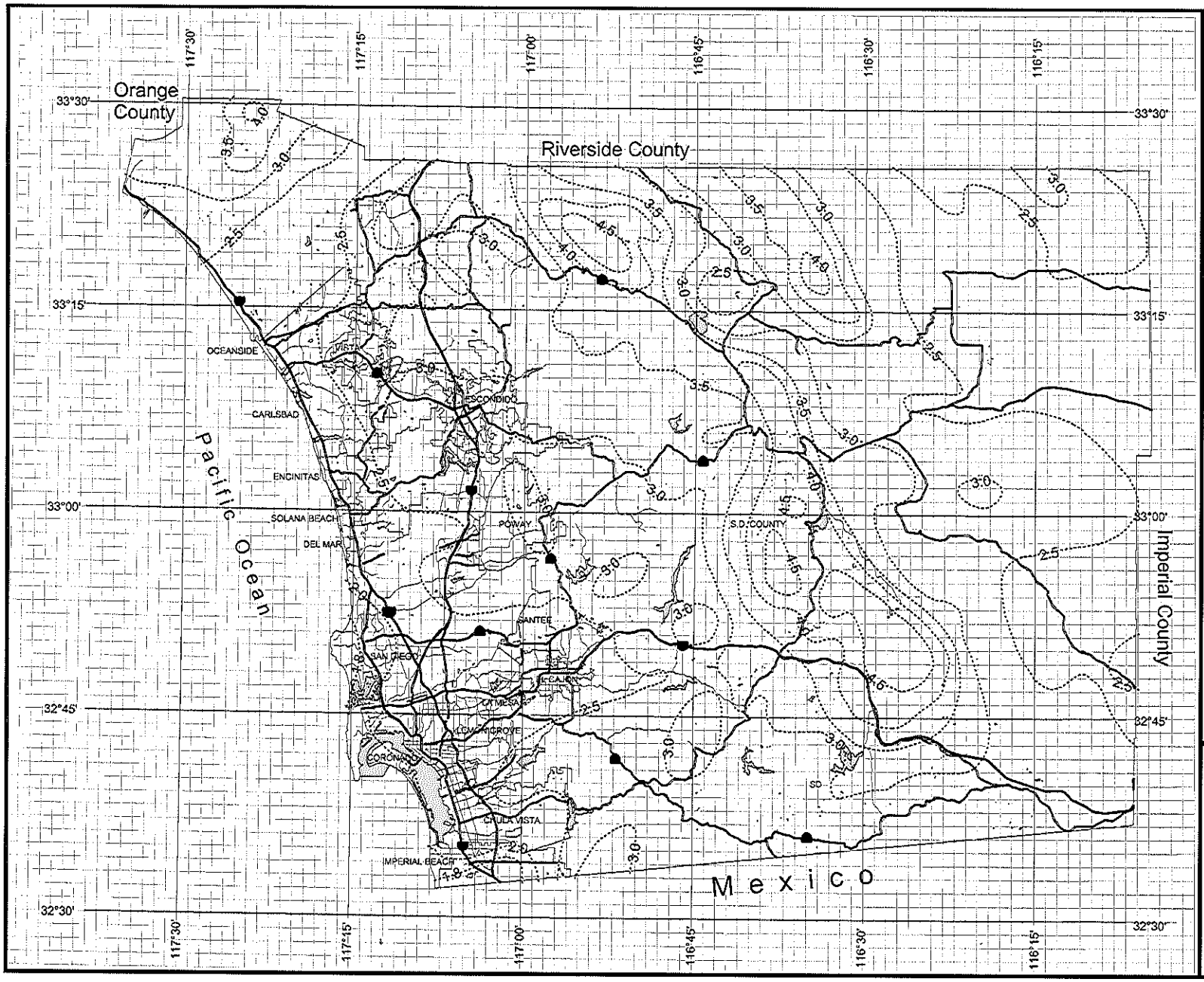
Note: The MRM should be used to calculate the peak discharge when there is a junction from independent subareas into the drainage system.

CHAPTER 2

METHODOLOGY & MODEL DEVELOPMENT

2.2 – Design Rainfall Determination

50-Year, 6-Hour Rainfall Isopluvial Map
50-Year, 24-Hour Rainfall Isopluvial Map
100-Year, 6-Hour Rainfall Isopluvial Map
100-Year, 24-Hour Rainfall Isopluvial Map



County of San Diego Hydrology Manual

Rainfall Isopluvials

50 Year Rainfall Event - 6 Hours

Isopluvial (inches)

$P_6 = 3.05$

DPW GIS

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3 0 3 Miles

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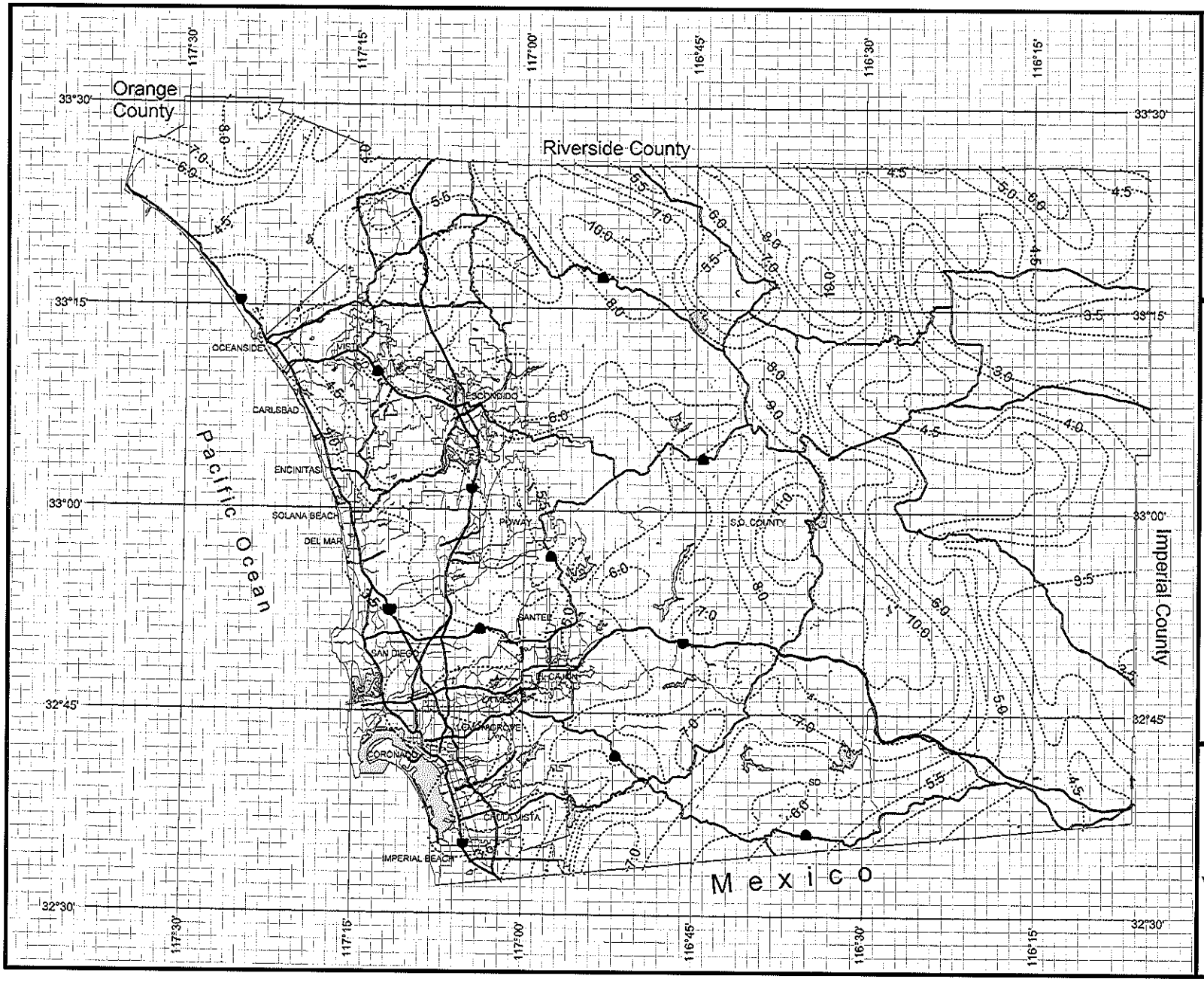

County of San Diego Hydrology Manual

Rainfall Isopluvials

50 Year Rainfall Event - 24 Hours

Isopluvial (Inches)

P24 = 5.5

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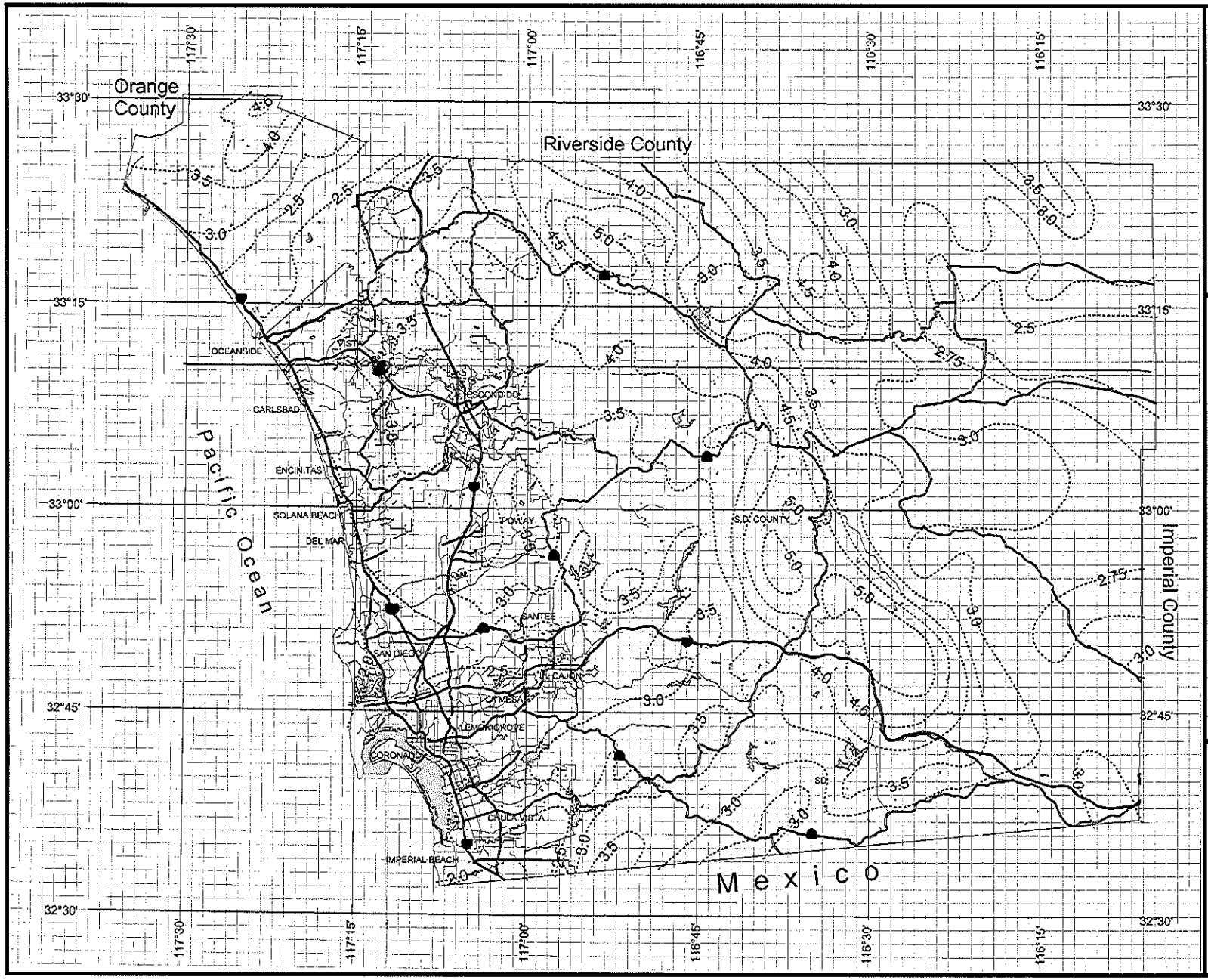

County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 6 Hours

Isopluvial (inches)

$P_6 = 3.25$

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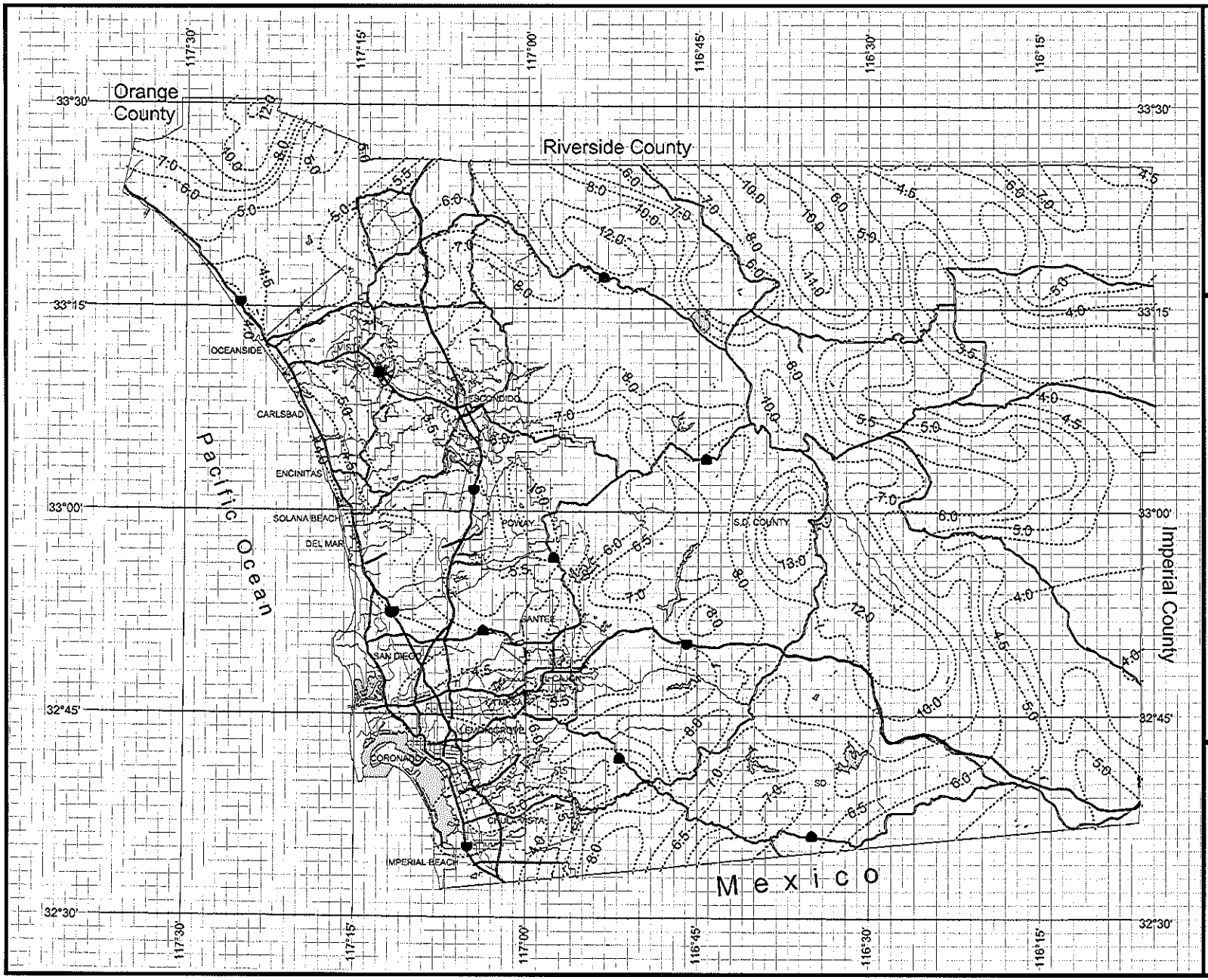

County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 24 Hours

Isopluvial (inches)

$P_{24} = 5.75$

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N W E S

3 0 3 Miles

CHAPTER 2

METHODOLOGY & MODEL DEVELOPMENT

2.3 – Rainfall Coefficient Determination

Table 3-1
RUNOFF COEFFICIENTS FOR URBAN AREAS

Land Use		Runoff Coefficient "C"				
			Soil Type			
NRCS Elements	County Elements	% IMPER.	A	B	C	D
Undisturbed Natural Terrain (Natural)	Permanent Open Space	0*	0.20	0.25	0.30	0.35
Low Density Residential (LDR)	Residential, 1.0 DU/A or less	10	0.27	0.32	0.36	0.41
Low Density Residential (LDR)	Residential, 2.0 DU/A or less	20	0.34	0.38	0.42	0.46
Low Density Residential (LDR)	Residential, 2.9 DU/A or less	25	0.38	0.41	0.45	0.49
Medium Density Residential (MDR)	Residential, 4.3 DU/A or less	30	0.41	0.45	0.48	0.52
Medium Density Residential (MDR)	Residential, 7.3 DU/A or less	40	0.48	0.51	0.54	0.57
Medium Density Residential (MDR)	Residential, 10.9 DU/A or less	45	0.52	0.54	0.57	0.60
Medium Density Residential (MDR)	Residential, 14.5 DU/A or less	50	0.55	0.58	0.60	0.63
High Density Residential (HDR)	Residential, 24.0 DU/A or less	65	0.66	0.67	0.69	0.71
High Density Residential (HDR)	Residential, 43.0 DU/A or less	80	0.76	0.77	0.78	0.79
Commercial/Industrial (N. Com)	Neighborhood Commercial	80	0.76	0.77	0.78	0.79
Commercial/Industrial (G. Com)	General Commercial	85	0.80	0.80	0.81	0.82
Commercial/Industrial (O.P. Com)	Office Professional/Commercial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (Limited I.)	Limited Industrial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (General I.)	General Industrial	95	0.87	0.87	0.87	0.87

*The values associated with 0% impervious may be used for direct calculation of the runoff coefficient as described in Section 3.1.2 (representing the pervious runoff coefficient, Cp, for the soil type), or for areas that will remain undisturbed in perpetuity. Justification must be given that the area will remain natural forever (e.g., the area is located in Cleveland National Forest).
DU/A = dwelling units per acre
NRCS = National Resources Conservation Service

CHAPTER 2

METHODOLOGY & MODEL DEVELOPMENT

2.4 – Rainfall Intensity Determination

Maximum Overland Flow Length & Initial Time of Concentration Table

Note that the Initial Time of Concentration should be reflective of the general land-use at the upstream end of a drainage basin. A single lot with an area of two or less acres does not have a significant effect where the drainage basin area is 20 to 600 acres.

Table 3-2 provides limits of the length (Maximum Length (L_M)) of sheet flow to be used in hydrology studies. Initial T_i values based on average C values for the Land Use Element are also included. These values can be used in planning and design applications as described below. Exceptions may be approved by the "Regulating Agency" when submitted with a detailed study.

Table 3-2

MAXIMUM OVERLAND FLOW LENGTH (L_M) & INITIAL TIME OF CONCENTRATION (T_i)

Element*	DU/	.5%		1%		2%		3%		5%		10%	
	Acre	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i
Natural		50	13.2	70	12.5	85	10.9	100	10.3	100	8.7	100	6.9
LDR	1	50	12.2	70	11.5	85	10.0	100	9.5	100	8.0	100	6.4
LDR	2	50	11.3	70	10.5	85	9.2	100	8.8	100	7.4	100	5.8
LDR	2.9	50	10.7	70	10.0	85	8.8	95	8.1	100	7.0	100	5.6
MDR	4.3	50	10.2	70	9.6	80	8.1	95	7.8	100	6.7	100	5.3
MDR	7.3	50	9.2	65	8.4	80	7.4	95	7.0	100	6.0	100	4.8
MDR	10.9	50	8.7	65	7.9	80	6.9	90	6.4	100	5.7	100	4.5
MDR	14.5	50	8.2	65	7.4	80	6.5	90	6.0	100	5.4	100	4.3
HDR	24	50	6.7	65	6.1	75	5.1	90	4.9	95	4.3	100	3.5
HDR	43	50	5.3	65	4.7	75	4.0	85	3.8	95	3.4	100	2.7
N. Com		50	5.3	60	4.5	75	4.0	85	3.8	95	3.4	100	2.7
G. Com		50	4.7	60	4.1	75	3.6	85	3.4	90	2.9	100	2.4
O.P./Com		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
Limited I.		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
General I.		50	3.7	60	3.2	70	2.7	80	2.6	90	2.3	100	1.9

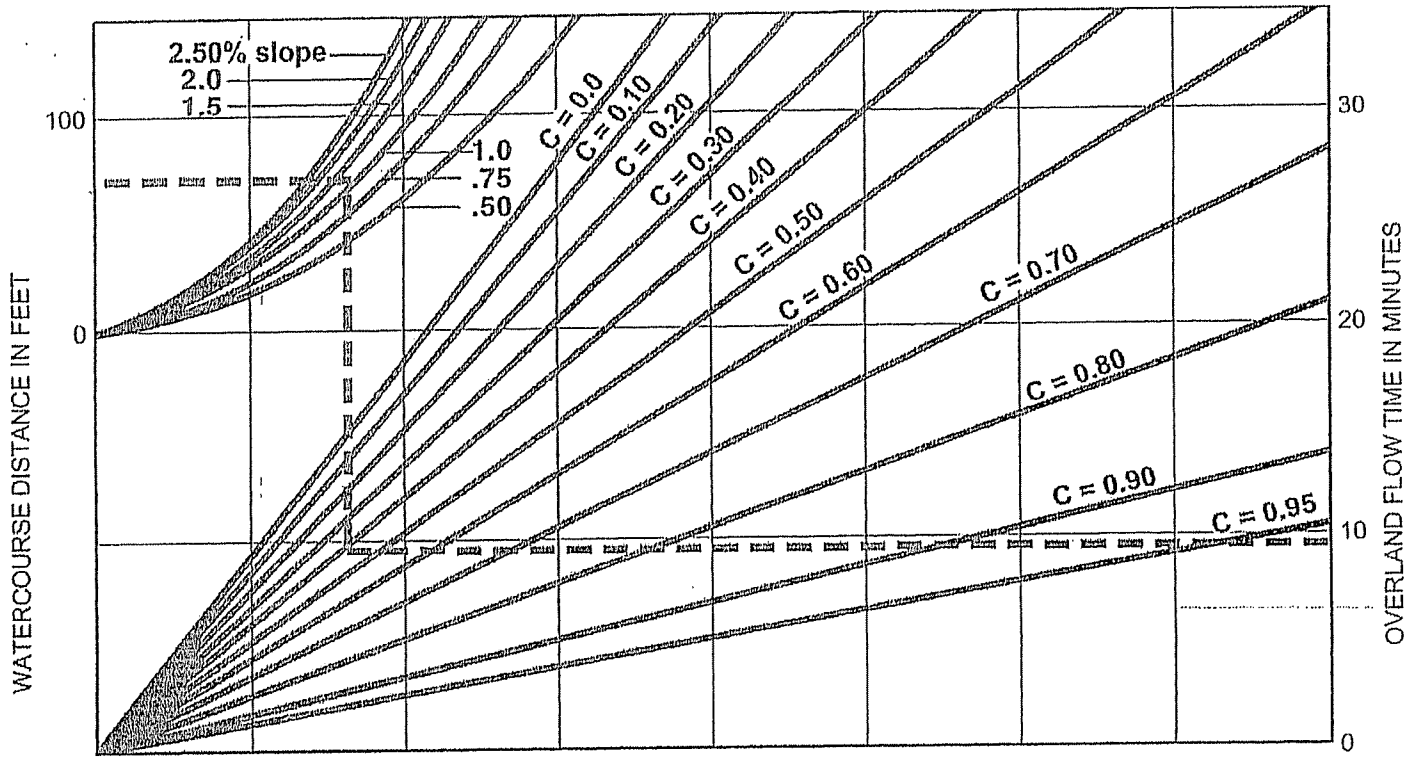
*See Table 3-1 for more detailed description

CHAPTER 2

METHODOLOGY & MODEL DEVELOPMENT

2.4 – Rainfall Intensity Determination

Urban Watershed Overland Time of Flow Nomograph



EXAMPLE:

Given: Watercourse Distance (D) = 70 Feet
Slope (s) = 1.3%
Runoff Coefficient (C) = 0.41
Overland Flow Time (T) = 9.5 Minutes

$$T = \frac{1.8\,(1.1-C)\sqrt{D}}{\sqrt[3]{s}}$$

SOURCE: Airport Drainage, Federal Aviation Administration, 1965

FIGURE 3-3

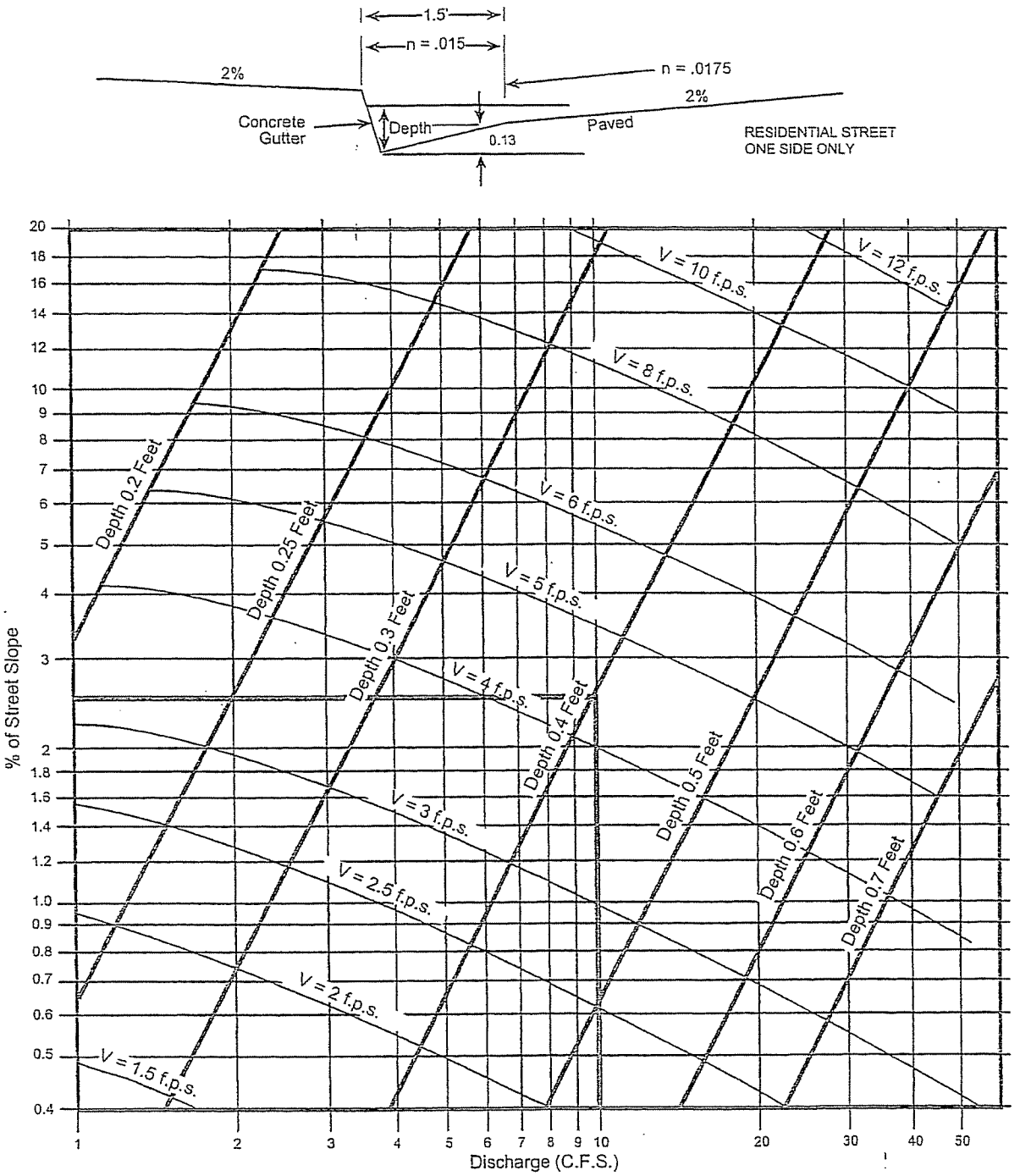
Rational Formula - Overland Time of Flow Nomograph

CHAPTER 2

METHODOLOGY & MODEL DEVELOPMENT

2.4 – Rainfall Intensity Determination

Gutter & Roadway Discharge-Velocity Chart



EXAMPLE:
Given: Q = 10 S = 2.5%
Chart gives: Depth = 0.4, Velocity = 4.4 f.p.s.

SOURCE: San Diego County Department of Special District Services Design Manual

FIGURE

Gutter and Roadway Discharge - Velocity Chart

3-6

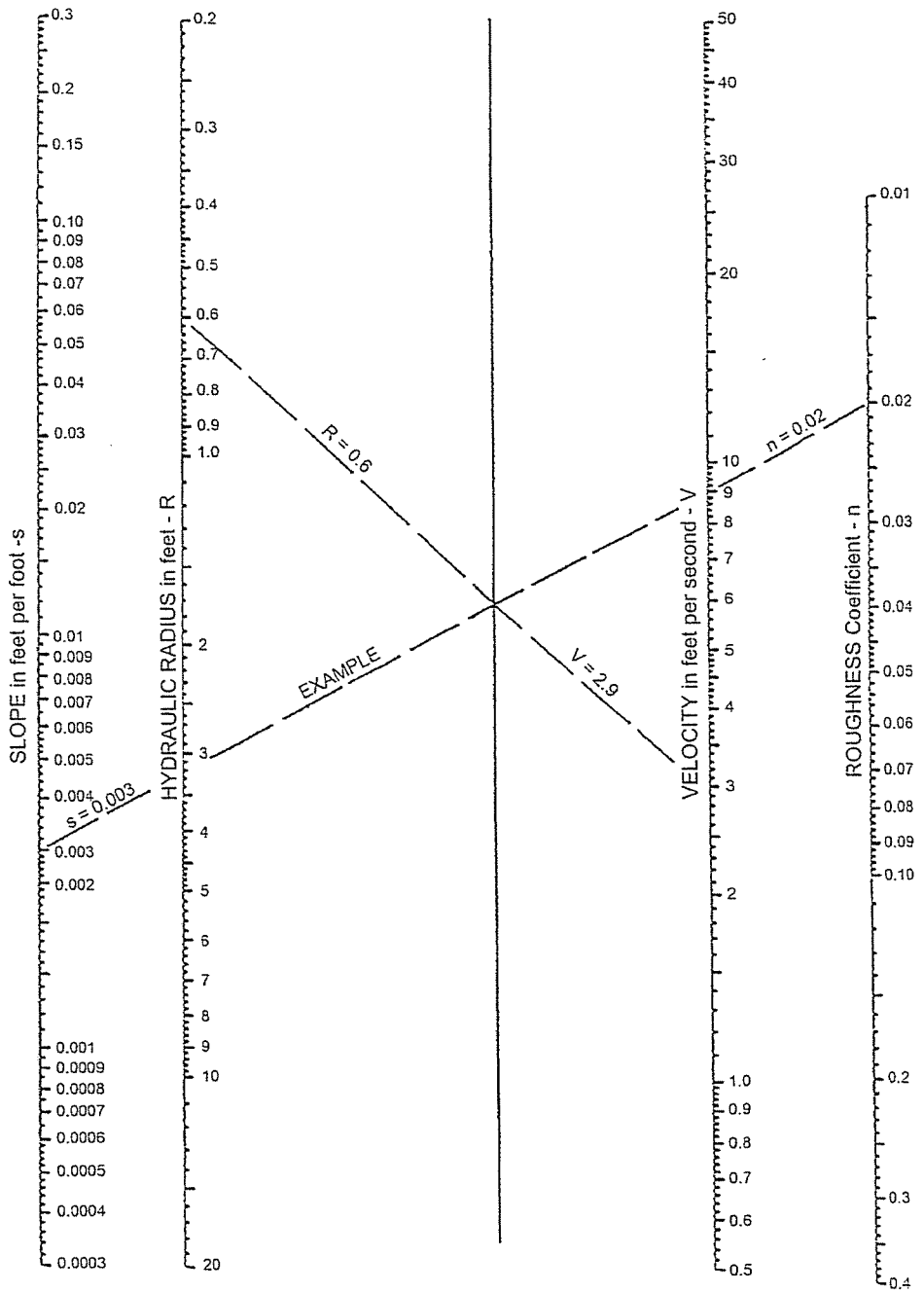
CHAPTER 2

METHODOLOGY & MODEL DEVELOPMENT

2.4 – Rainfall Intensity Determination

Manning's Equation Nomograph

EQUATION: $V = \frac{1.49}{n} R^{2/3} s^{1/2}$



GENERAL SOLUTION

SOURCE: USDOT, FHWA, HDS-3 (1961)

FIGURE 3-7

Manning's Equation Nomograph

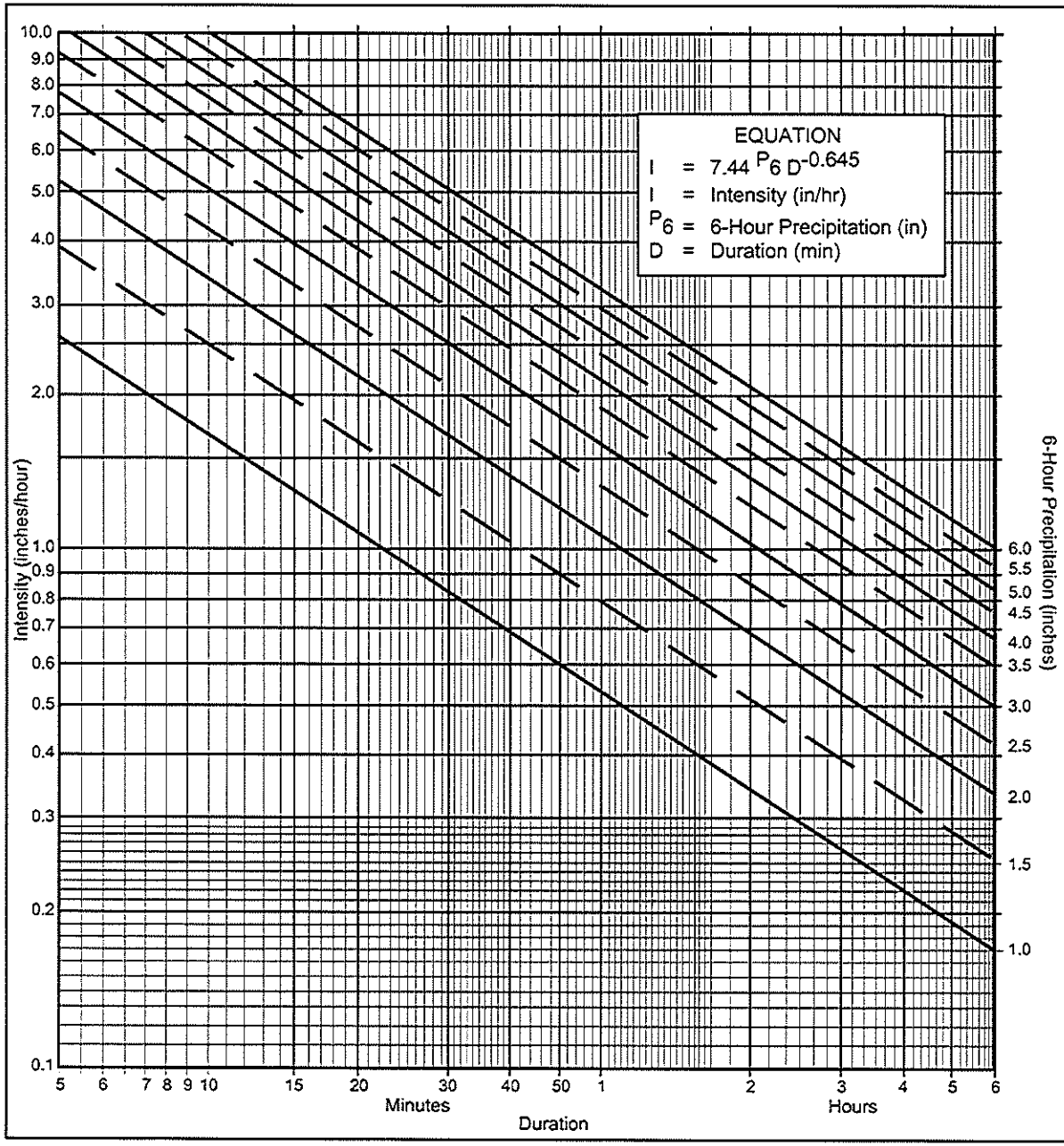
CHAPTER 2

METHODOLOGY & MODEL DEVELOPMENT

2.4 – Rainfall Intensity Determination

Intensity-Duration Design Chart

LONE OAK



Directions for Application:

(1) From precipitation maps determine 6 hr and 24 hr amounts for the selected frequency. These maps are included in the County Hydrology Manual (10, 50, and 100 yr maps included in the Design and Procedure Manual).

(2) Adjust 6 hr precipitation (if necessary) so that it is within the range of 45% to 65% of the 24 hr precipitation (not applicaple to Desert).

(3) Plot 6 hr precipitation on the right side of the chart.

(4) Draw a line through the point parallel to the plotted lines.

(5) This line is the intensity-duration curve for the location being analyzed.

Application Form:

(a) Selected frequency 100 year

(b) P_6 = 3.25 in., P_{24} = 5.75, $\frac{P_6}{P_{24}}$ = 56.5 %(2)

(c) Adjusted $P_6^{(2)}$ = 3.25 in.

(d) t_x = _____ min.

(e) I = _____ in./hr.

Note: This chart replaces the Intensity-Duration-Frequency curves used since 1965.

P6 / Duration	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
5	2.63	3.95	5.27	6.59	7.90	9.22	10.54	11.86	13.17	14.49	15.81
7	2.12	3.18	4.24	5.30	6.36	7.42	8.48	9.54	10.60	11.66	12.72
10	1.68	2.53	3.37	4.21	5.05	5.90	6.74	7.58	8.42	9.27	10.11
15	1.30	1.95	2.59	3.24	3.89	4.54	5.19	5.84	6.49	7.13	7.78
20	1.08	1.62	2.15	2.69	3.23	3.77	4.31	4.85	5.39	5.93	6.46
25	0.93	1.40	1.87	2.33	2.80	3.27	3.73	4.20	4.67	5.13	5.60
30	0.83	1.24	1.66	2.07	2.49	2.90	3.32	3.73	4.15	4.56	4.98
40	0.69	1.03	1.38	1.72	2.07	2.41	2.76	3.10	3.45	3.79	4.13
50	0.60	0.90	1.19	1.49	1.79	2.09	2.39	2.69	2.98	3.28	3.58
60	0.53	0.80	1.06	1.33	1.59	1.86	2.12	2.39	2.65	2.92	3.18
90	0.41	0.61	0.82	1.02	1.23	1.43	1.63	1.84	2.04	2.25	2.45
120	0.34	0.51	0.68	0.85	1.02	1.19	1.36	1.53	1.70	1.87	2.04
150	0.29	0.44	0.59	0.73	0.88	1.03	1.18	1.32	1.47	1.62	1.76
180	0.26	0.39	0.52	0.65	0.78	0.91	1.04	1.18	1.31	1.44	1.57
240	0.22	0.33	0.43	0.54	0.65	0.76	0.87	0.98	1.08	1.19	1.30
300	0.19	0.28	0.38	0.47	0.56	0.66	0.75	0.85	0.94	1.03	1.13
360	0.17	0.25	0.33	0.42	0.50	0.58	0.67	0.75	0.84	0.92	1.00

Intensity-Duration Design Chart - Template

FIGURE

3-1

CHAPTER 2

METHODOLOGY & MODEL DEVELOPMENT

2.5 - Rational Method Model Development Summary

Rational Method Hydrologic Analysis

Computer Software Package – AES-2010

Design Storm - 50-Year Return Interval

Land Use – Single Family Residential in Developed Areas

Soil Type - Hydrologic soil group D was assumed for all areas. Group D soils have very slow infiltration rates when thoroughly wetted. Consisting chiefly of clay soils with a high swelling potential, soils with a high permanent water table, soils with clay pan or clay layer at or near the surface, and shallow soils over nearly impervious materials, Group D soils have a very slow rate of water transmission.

Runoff Coefficient – In accordance with the County of San Diego standards, Single Family Residential areas with over 2.9 DU/ac and under 4.3 DU/ac were designated a runoff coefficient of 0.52 while natural areas were designated a runoff coefficient between 0.35 and 0.45 depending on the surface imperviousness.

Method of Analysis – The Rational Method is the most widely used hydrologic model for estimating peak runoff rates. Applied to small urban and semi-urban areas with drainage areas less than 1.0 square mile, the Rational Method relates storm rainfall intensity, a runoff coefficient, and drainage area to peak runoff rate. This relationship is expressed by the equation: 3

Q = CIA, where:

Q = The peak runoff rate in cubic feet per second at the point of analysis.

C = A runoff coefficient representing the area - averaged ratio of runoff to rainfall intensity.

I = The time-averaged rainfall intensity in inches per hour corresponding to the time of concentration.

A = The drainage basin area in acres.

To perform a node-link study, the total watershed area is divided into subareas which discharge at designated nodes.

The procedure for the subarea summation model is as follows:

(1) Subdivide the watershed into an initial subarea (generally 1 lot) and subsequent subareas, which are generally less than 10 acres in size. Assign upstream and downstream node numbers to each subarea.

(2) Estimate an initial T_c by using the appropriate nomograph or overland flow velocity estimation.

(3) Using the initial T_c, determine the corresponding values of I. Then Q = C I A.

(4) Using Q, estimate the travel time between this node and the next by Manning's equation as applied to the particular channel or conduit linking the

two nodes. Then, repeat the calculation for Q based on the revised intensity (which is a function of the revised time of concentration).

The nodes are joined together by links, which may be street gutter flows, drainage swales, drainage ditches, pipe flow, or various channel flows. The AES-2010 computer subarea menu is as follows:

SUBAREA HYDROLOGIC PROCESS

1. Confluence analysis at node.
2. Initial subarea analysis (including time of concentration calculation).
3. Pipeflow travel time (computer estimated).
4. Pipeflow travel time (user specified).
5. Trapezoidal channel travel time.
6. Street flow analysis through subarea.
7. User - specified information at node.
8. Addition of subarea runoff to main line.
9. V-gutter flow through area.
10. Copy main stream data to memory bank
11. Confluence main stream data with a memory bank
12. Clear a memory bank

At the confluence point of two or more basins, the following procedure is used to combine peak flow rates to account for differences in the basin's times of concentration. This adjustment is based on the assumption that each basin's hydrographs are triangular in shape.

(1). If the collection streams have the same times of concentration, then the Q values are directly summed,

$Q_p = Q_a + Q_b$; $T_p = T_a = T_b$

(2). If the collection streams have different times of concentration, the smaller of the tributary Q values may be adjusted as follows:

(i). The most frequent case is where the collection stream with the longer time of concentration has the larger Q. The smaller Q value is adjusted by the ratio of rainfall intensities.

$Q_p = Q_a + Q_b \ (I_a/I_b)$; $T_p = T_a$

(ii). In some cases, the collection stream with the shorter time of concentration has the larger Q. Then the smaller Q is adjusted by a ratio of the T values.

$Q_p = Q_b + Q_a \ (T_b/T_a)$; $T_p = T_b$

CHAPTER 3

EXISTING AND PROPOSED CONDITION RATIONAL METHOD HYDROLOGIC ANALYSIS

Q50 and Q100 (with detention routing)

50-YEAR RETURN

```
____________________________________________________________________________
****************************************************************************

            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
            Reference: SAN DIEGO COUNTY FLOOD CONTROL DISTRICT
                          2003,1985,1981 HYDROLOGY MANUAL
         (c) Copyright 1982-2010 Advanced Engineering Software (aes)
             Ver. 17.0 Release Date: 07/01/2010  License ID 1239

                           Analysis prepared by:

                    Hunsaker & Associates San Diego, Inc.
                              9707 Waples Street
                           San Diego,  CA  92121


 ************************** DESCRIPTION OF STUDY **************************
* Lone Oak Ranch TM Hydrologic Analysis                                    *
* 50-year return interval                                                  *
* w.o. 2414-035, dln 1191                                                  *
 ****************************************************************************

  FILE NAME: R:\1191\HYD\CALCS\AES\50.DAT
  TIME/DATE OF STUDY: 15:57 03/26/2014
----------------------------------------------------------------------------
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
----------------------------------------------------------------------------
  2003 SAN DIEGO MANUAL CRITERIA

  USER SPECIFIED STORM EVENT(YEAR) =  50.00
  6-HOUR DURATION PRECIPITATION (INCHES) =   3.050
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  18.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.90
  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    100.00 TO NODE    101.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  ANNUAL GRASS (DRYLAND) FAIR COVER RUNOFF COEFFICIENT = .3500
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    895.00
  DOWNSTREAM ELEVATION(FEET) =    865.00
  ELEVATION DIFFERENCE(FEET) =     30.00
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.267
  WARNING: THE MAXIMUM OVERLAND FLOW SLOPE, 10.%, IS USED IN Tc CALCULATION!
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  6.947
  SUBAREA RUNOFF(CFS) =      0.68
  TOTAL AREA(ACRES) =      0.28   TOTAL RUNOFF(CFS) =      0.68

****************************************************************************
  FLOW PROCESS FROM NODE    101.00 TO NODE    102.00 IS CODE =  53
----------------------------------------------------------------------------
  >>>>>COMPUTE NATURAL MOUNTAIN CHANNEL FLOW<<<<<
```

```
  >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    865.00  DOWNSTREAM(FEET) =    650.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =  1130.00   CHANNEL SLOPE =  0.1903
  NOTE: CHANNEL FLOW OF 1. CFS WAS ASSUMED IN VELOCITY ESTIMATION
  CHANNEL FLOW THRU SUBAREA(CFS) =       0.68
  FLOW VELOCITY(FEET/SEC) =   2.44 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
  TRAVEL TIME(MIN.) =   7.71   Tc(MIN.) =   13.98
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    102.00 =    1230.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    101.00 TO NODE    102.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.141
  *USER SPECIFIED(SUBAREA):
  ANNUAL GRASS (DRYLAND) FAIR COVER RUNOFF COEFFICIENT = .3500
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.3500
  SUBAREA AREA(ACRES) =   15.03   SUBAREA RUNOFF(CFS) =   21.78
  TOTAL AREA(ACRES) =       15.3   TOTAL RUNOFF(CFS) =      22.19
  TC(MIN.) =   13.98

****************************************************************************
  FLOW PROCESS FROM NODE    102.00 TO NODE    103.00 IS CODE =  53
----------------------------------------------------------------------------
  >>>>>COMPUTE NATURAL MOUNTAIN CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    650.00  DOWNSTREAM(FEET) =    562.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =  1236.00   CHANNEL SLOPE =  0.0712
  CHANNEL FLOW THRU SUBAREA(CFS) =      22.19
  FLOW VELOCITY(FEET/SEC) =   4.19 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
  TRAVEL TIME(MIN.) =   4.91   Tc(MIN.) =   18.89
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    103.00 =    2466.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    102.00 TO NODE    103.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.410
  *USER SPECIFIED(SUBAREA):
  BARREN COVER RUNOFF COEFFICIENT = .4100
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.3857
  SUBAREA AREA(ACRES) =   22.48   SUBAREA RUNOFF(CFS) =   31.43
  TOTAL AREA(ACRES) =       37.8   TOTAL RUNOFF(CFS) =      49.70
  TC(MIN.) =   18.89

****************************************************************************
  FLOW PROCESS FROM NODE    103.00 TO NODE    104.00 IS CODE =  52
----------------------------------------------------------------------------
  >>>>>COMPUTE NATURAL VALLEY CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    562.00  DOWNSTREAM(FEET) =    525.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =   995.00   CHANNEL SLOPE =  0.0372
  CHANNEL FLOW THRU SUBAREA(CFS) =      49.70
  FLOW VELOCITY(FEET/SEC) =   7.45 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
  TRAVEL TIME(MIN.) =   2.23   Tc(MIN.) =   21.11
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    104.00 =    3461.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    103.00 TO NODE    104.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.173
  *USER SPECIFIED(SUBAREA):
```

```
  BARREN COVER RUNOFF COEFFICIENT = .4100
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.3894
  SUBAREA AREA(ACRES) =    6.90   SUBAREA RUNOFF(CFS) =    8.98
  TOTAL AREA(ACRES) =       44.7   TOTAL RUNOFF(CFS) =      55.23
  TC(MIN.) =   21.11

****************************************************************************
  FLOW PROCESS FROM NODE    200.00 TO NODE    201.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  BARREN COVER RUNOFF COEFFICIENT = .4100
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    92.00
  UPSTREAM ELEVATION(FEET) =    569.00
  DOWNSTREAM ELEVATION(FEET) =    566.00
  ELEVATION DIFFERENCE(FEET) =      3.00
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    8.034
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.918
  SUBAREA RUNOFF(CFS) =      0.27
  TOTAL AREA(ACRES) =      0.11   TOTAL RUNOFF(CFS) =      0.27

****************************************************************************
  FLOW PROCESS FROM NODE    201.00 TO NODE    202.00 IS CODE =  53
----------------------------------------------------------------------------
  >>>>>COMPUTE NATURAL MOUNTAIN CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    566.00  DOWNSTREAM(FEET) =    524.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =   816.00   CHANNEL SLOPE =  0.0515
  NOTE: CHANNEL FLOW OF 1. CFS WAS ASSUMED IN VELOCITY ESTIMATION
  CHANNEL FLOW THRU SUBAREA(CFS) =       0.27
  FLOW VELOCITY(FEET/SEC) =   1.27 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
  TRAVEL TIME(MIN.) =  10.70   Tc(MIN.) =   18.74
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    202.00 =     908.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    201.00 TO NODE    202.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.427
  *USER SPECIFIED(SUBAREA):
  BARREN COVER RUNOFF COEFFICIENT = .4100
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.4100
  SUBAREA AREA(ACRES) =    6.23   SUBAREA RUNOFF(CFS) =    8.75
  TOTAL AREA(ACRES) =        6.3   TOTAL RUNOFF(CFS) =       8.91
  TC(MIN.) =   18.74

****************************************************************************
  FLOW PROCESS FROM NODE    100.00 TO NODE    101.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  ANNUAL GRASS (DRYLAND) FAIR COVER RUNOFF COEFFICIENT = .3500
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    895.00
  DOWNSTREAM ELEVATION(FEET) =    865.00
  ELEVATION DIFFERENCE(FEET) =     30.00
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.267
  WARNING: THE MAXIMUM OVERLAND FLOW SLOPE, 10.%, IS USED IN Tc CALCULATION!
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  6.947
  SUBAREA RUNOFF(CFS) =      0.68
  TOTAL AREA(ACRES) =      0.28   TOTAL RUNOFF(CFS) =      0.68

****************************************************************************
```

```
  FLOW PROCESS FROM NODE    101.00 TO NODE    102.00 IS CODE =  53
----------------------------------------------------------------------------
  >>>>>COMPUTE NATURAL MOUNTAIN CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    865.00  DOWNSTREAM(FEET) =    650.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =  1130.00   CHANNEL SLOPE =  0.1903
  NOTE: CHANNEL FLOW OF 1. CFS WAS ASSUMED IN VELOCITY ESTIMATION
  CHANNEL FLOW THRU SUBAREA(CFS) =       0.68
  FLOW VELOCITY(FEET/SEC) =   2.44 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
  TRAVEL TIME(MIN.) =   7.71   Tc(MIN.) =   13.98
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    102.00 =    1230.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    101.00 TO NODE    102.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.141
  *USER SPECIFIED(SUBAREA):
  ANNUAL GRASS (DRYLAND) FAIR COVER RUNOFF COEFFICIENT = .3500
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.3500
  SUBAREA AREA(ACRES) =   15.03   SUBAREA RUNOFF(CFS) =   21.78
  TOTAL AREA(ACRES) =       15.3   TOTAL RUNOFF(CFS) =      22.19
  TC(MIN.) =   13.98

****************************************************************************
  FLOW PROCESS FROM NODE    102.00 TO NODE    103.00 IS CODE =  53
----------------------------------------------------------------------------
  >>>>>COMPUTE NATURAL MOUNTAIN CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    650.00  DOWNSTREAM(FEET) =    562.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =  1236.00   CHANNEL SLOPE =  0.0712
  CHANNEL FLOW THRU SUBAREA(CFS) =      22.19
  FLOW VELOCITY(FEET/SEC) =   4.19 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
  TRAVEL TIME(MIN.) =   4.91   Tc(MIN.) =   18.89
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    103.00 =    2466.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    102.00 TO NODE    103.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.410
  *USER SPECIFIED(SUBAREA):
  BARREN COVER RUNOFF COEFFICIENT = .4100
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.3857
  SUBAREA AREA(ACRES) =   22.48   SUBAREA RUNOFF(CFS) =   31.43
  TOTAL AREA(ACRES) =       37.8   TOTAL RUNOFF(CFS) =      49.70
  TC(MIN.) =   18.89

****************************************************************************
  FLOW PROCESS FROM NODE    103.10 TO NODE    103.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.410
  *USER SPECIFIED(SUBAREA):
  BARREN COVER RUNOFF COEFFICIENT = .4100
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.3861
  SUBAREA AREA(ACRES) =    0.63   SUBAREA RUNOFF(CFS) =    0.88
  TOTAL AREA(ACRES) =       38.4   TOTAL RUNOFF(CFS) =      50.58
  TC(MIN.) =   18.89

****************************************************************************
  FLOW PROCESS FROM NODE    103.00 TO NODE    104.00 IS CODE =  52
----------------------------------------------------------------------------
```

```
  >>>>>COMPUTE NATURAL VALLEY CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA<<<<<
================================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    562.00  DOWNSTREAM(FEET) =    525.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =   994.00   CHANNEL SLOPE =  0.0372
  CHANNEL FLOW THRU SUBAREA(CFS) =      50.58
  FLOW VELOCITY(FEET/SEC) =   7.49 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
  TRAVEL TIME(MIN.) =   2.21   Tc(MIN.) =   21.10
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    104.00 =    3460.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    103.00 TO NODE    104.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
================================================================================
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.175
  *USER SPECIFIED(SUBAREA):
  BARREN COVER RUNOFF COEFFICIENT = .4100
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.3877
  SUBAREA AREA(ACRES) =    2.76   SUBAREA RUNOFF(CFS) =    3.59
  TOTAL AREA(ACRES) =       41.2   TOTAL RUNOFF(CFS) =      50.69
  TC(MIN.) =   21.10

****************************************************************************
  FLOW PROCESS FROM NODE    300.00 TO NODE    301.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
================================================================================
  *USER SPECIFIED(SUBAREA):
  RESIDENTIAL (4.3 DU/AC OR LESS) RUNOFF COEFFICIENT = .5200
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    562.40
  DOWNSTREAM ELEVATION(FEET) =    560.00
  ELEVATION DIFFERENCE(FEET) =      2.40
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    7.231
  WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
           THE MAXIMUM OVERLAND FLOW LENGTH =    86.00
           (Reference: Table 3-1B of Hydrology Manual)
           THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  6.334
  SUBAREA RUNOFF(CFS) =      0.72
  TOTAL AREA(ACRES) =      0.22   TOTAL RUNOFF(CFS) =      0.72

****************************************************************************
  FLOW PROCESS FROM NODE    301.00 TO NODE    302.00 IS CODE =  61
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STANDARD CURB SECTION USED)<<<<<
================================================================================
  UPSTREAM ELEVATION(FEET) =  559.50  DOWNSTREAM ELEVATION(FEET) =  530.00
  STREET LENGTH(FEET) =  1023.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 13.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   7.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       7.22
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.31
    HALFSTREET FLOOD WIDTH(FEET) =    9.31
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    3.67
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.15
  STREET FLOW TRAVEL TIME(MIN.) =   4.65   Tc(MIN.) =   11.88
```

```
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.598
  *USER SPECIFIED(SUBAREA):
  RESIDENTIAL (4.3 DU/AC OR LESS) RUNOFF COEFFICIENT = .5200
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.520
  SUBAREA AREA(ACRES) =    5.34      SUBAREA RUNOFF(CFS) =   12.77
  TOTAL AREA(ACRES) =        5.6        PEAK FLOW RATE(CFS) =      13.29

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.37   HALFSTREET FLOOD WIDTH(FEET) =  12.04
  FLOW VELOCITY(FEET/SEC.) =  4.24   DEPTH*VELOCITY(FT*FT/SEC.) =   1.56
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    302.00 =    1123.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    302.00 TO NODE    307.00 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.) =   11.88
  RAINFALL INTENSITY(INCH/HR) =   4.60
  TOTAL STREAM AREA(ACRES) =     5.56
  PEAK FLOW RATE(CFS) AT CONFLUENCE =     13.29

****************************************************************************
  FLOW PROCESS FROM NODE    305.00 TO NODE    306.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  RESIDENTIAL (4.3 DU/AC OR LESS) RUNOFF COEFFICIENT = .5200
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    70.00
  UPSTREAM ELEVATION(FEET) =    548.35
  DOWNSTREAM ELEVATION(FEET) =    547.65
  ELEVATION DIFFERENCE(FEET) =      0.70
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    8.735
  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!
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.607
  SUBAREA RUNOFF(CFS) =      1.02
  TOTAL AREA(ACRES) =      0.35   TOTAL RUNOFF(CFS) =      1.02

****************************************************************************
  FLOW PROCESS FROM NODE    306.00 TO NODE    307.00 IS CODE =  61
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STANDARD CURB SECTION USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  547.15  DOWNSTREAM ELEVATION(FEET) =  530.00
  STREET LENGTH(FEET) =   615.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 13.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   7.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       3.40
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.31
    HALFSTREET FLOOD WIDTH(FEET) =    9.14
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    3.56
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.10
```

```
  STREET FLOW TRAVEL TIME(MIN.) =   2.88   Tc(MIN.) =   11.61
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.667
  *USER SPECIFIED(SUBAREA):
  RESIDENTIAL (4.3 DU/AC OR LESS) RUNOFF COEFFICIENT = .5200
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.520
  SUBAREA AREA(ACRES) =    1.95      SUBAREA RUNOFF(CFS) =    4.73
  TOTAL AREA(ACRES) =        2.3        PEAK FLOW RATE(CFS) =       5.58

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.35   HALFSTREET FLOOD WIDTH(FEET) =  11.28
  FLOW VELOCITY(FEET/SEC.) =  4.02   DEPTH*VELOCITY(FT*FT/SEC.) =   1.41
  LONGEST FLOWPATH FROM NODE    305.00 TO NODE    307.00 =     685.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    307.00 TO NODE    307.00 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.) =   11.61
  RAINFALL INTENSITY(INCH/HR) =   4.67
  TOTAL STREAM AREA(ACRES) =     2.30
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      5.58

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1       13.29    11.88        4.598          5.56
      2        5.58    11.61        4.667          2.30

  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       18.57    11.61       4.667
      2       18.79    11.88       4.598

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      18.79   Tc(MIN.) =   11.88
  TOTAL AREA(ACRES) =        7.9
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    307.00 =    1123.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    307.00 TO NODE    307.00 IS CODE =   7
----------------------------------------------------------------------------
  >>>>>USER SPECIFIED HYDROLOGY INFORMATION AT NODE<<<<<
============================================================================
  USER-SPECIFIED VALUES ARE AS FOLLOWS:
  TC(MIN) =  11.82   RAIN INTENSITY(INCH/HOUR) =  4.61
  TOTAL AREA(ACRES) =     7.86   TOTAL RUNOFF(CFS) =      5.65

****************************************************************************
  FLOW PROCESS FROM NODE    307.00 TO NODE    308.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   525.00  DOWNSTREAM(FEET) =   519.00
  FLOW LENGTH(FEET) =   365.00   MANNING'S N =  0.013
  ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 18.000
  DEPTH OF FLOW IN  18.0 INCH PIPE IS   8.4 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   7.01
  ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       5.65
  PIPE TRAVEL TIME(MIN.) =   0.87    Tc(MIN.) =   12.69
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    308.00 =    1488.00 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.) =   12.69
  RAINFALL INTENSITY(INCH/HR) =   4.41
  TOTAL STREAM AREA(ACRES) =     7.86
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      5.65

****************************************************************************
  FLOW PROCESS FROM NODE    310.00 TO NODE    311.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  URBAN NEWLY GRADED AREAS RUNOFF COEFFICIENT = .3500
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    560.00
  DOWNSTREAM ELEVATION(FEET) =    550.00
  ELEVATION DIFFERENCE(FEET) =     10.00
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.267
  WARNING: THE MAXIMUM OVERLAND FLOW SLOPE, 10.%, IS USED IN Tc CALCULATION!
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  6.947
  SUBAREA RUNOFF(CFS) =      0.15
  TOTAL AREA(ACRES) =      0.06   TOTAL RUNOFF(CFS) =      0.15

****************************************************************************
  FLOW PROCESS FROM NODE    311.00 TO NODE    312.00 IS CODE =  53
----------------------------------------------------------------------------
  >>>>>COMPUTE NATURAL MOUNTAIN CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    550.00  DOWNSTREAM(FEET) =    524.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =   670.00   CHANNEL SLOPE =  0.0388
  NOTE: CHANNEL FLOW OF 1. CFS WAS ASSUMED IN VELOCITY ESTIMATION
  CHANNEL FLOW THRU SUBAREA(CFS) =       0.15
  FLOW VELOCITY(FEET/SEC) =   1.10 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
  TRAVEL TIME(MIN.) =  10.12   Tc(MIN.) =   16.39
  LONGEST FLOWPATH FROM NODE    310.00 TO NODE    312.00 =     770.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    311.00 TO NODE    312.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.737
  *USER SPECIFIED(SUBAREA):
  URBAN NEWLY GRADED AREAS RUNOFF COEFFICIENT = .3500
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.3500
  SUBAREA AREA(ACRES) =    2.18   SUBAREA RUNOFF(CFS) =    2.85
  TOTAL AREA(ACRES) =        2.2   TOTAL RUNOFF(CFS) =       2.93
  TC(MIN.) =   16.39

****************************************************************************
  FLOW PROCESS FROM NODE    312.00 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.) =   16.39
  RAINFALL INTENSITY(INCH/HR) =   3.74
  TOTAL STREAM AREA(ACRES) =     2.24
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      2.93
```

```
  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1        5.65    12.69        4.408          7.86
      2        2.93    16.39        3.737          2.24

  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        7.92    12.69       4.408
      2        7.72    16.39       3.737

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =       7.92   Tc(MIN.) =   12.69
  TOTAL AREA(ACRES) =       10.1
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    308.00 =    1488.00 FEET.
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =       10.1  TC(MIN.) =     12.69
  PEAK FLOW RATE(CFS)   =       7.92
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS
```

100-YEAR RETURN

```
____________________________________________________________________________
****************************************************************************

            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
            Reference: SAN DIEGO COUNTY FLOOD CONTROL DISTRICT
                          2003,1985,1981 HYDROLOGY MANUAL
         (c) Copyright 1982-2010 Advanced Engineering Software (aes)
             Ver. 17.0 Release Date: 07/01/2010  License ID 1239

                           Analysis prepared by:

                    Hunsaker & Associates San Diego, Inc.
                              9707 Waples Street
                           San Diego,  CA  92121


 ************************** DESCRIPTION OF STUDY **************************
* Lone Oak Ranch TM Hydrologic Analysis                                   *
* 100-Year Return Interval                                                *
* w.o. 2414-035  DLN 1191                                                 *
 ***************************************************************************

  FILE NAME: R:\1191\HYD\CALCS\AES\100.DAT
  TIME/DATE OF STUDY: 15:52 03/26/2014
----------------------------------------------------------------------------
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
----------------------------------------------------------------------------
  2003 SAN DIEGO MANUAL CRITERIA

  USER SPECIFIED STORM EVENT(YEAR) = 100.00
  6-HOUR DURATION PRECIPITATION (INCHES) =   3.250
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  18.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.90
  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.*

+---------------------------------------------------------------------------+
| Begin Existing Condition Hydrologic Model.                                |
|                                                                           |
|                                                                           |
+---------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE    100.00 TO NODE    101.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  ANNUAL GRASS (DRYLAND) FAIR COVER RUNOFF COEFFICIENT = .3500
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    895.00
  DOWNSTREAM ELEVATION(FEET) =    865.00
  ELEVATION DIFFERENCE(FEET) =     30.00
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.267
  WARNING: THE MAXIMUM OVERLAND FLOW SLOPE, 10.%, IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.402
  SUBAREA RUNOFF(CFS) =      0.73
```

```
  TOTAL AREA(ACRES) =      0.28   TOTAL RUNOFF(CFS) =      0.73

****************************************************************************
  FLOW PROCESS FROM NODE    101.00 TO NODE    102.00 IS CODE =  53
----------------------------------------------------------------------------
  >>>>>COMPUTE NATURAL MOUNTAIN CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    865.00  DOWNSTREAM(FEET) =    650.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =  1130.00   CHANNEL SLOPE =  0.1903
  NOTE: CHANNEL FLOW OF 1. CFS WAS ASSUMED IN VELOCITY ESTIMATION
  CHANNEL FLOW THRU SUBAREA(CFS) =       0.73
  FLOW VELOCITY(FEET/SEC) =   2.44 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
  TRAVEL TIME(MIN.) =   7.71   Tc(MIN.) =   13.98
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    102.00 =    1230.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    101.00 TO NODE    102.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.412
  *USER SPECIFIED(SUBAREA):
  ANNUAL GRASS (DRYLAND) FAIR COVER RUNOFF COEFFICIENT = .3500
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.3500
  SUBAREA AREA(ACRES) =   15.03   SUBAREA RUNOFF(CFS) =   23.21
  TOTAL AREA(ACRES) =       15.3   TOTAL RUNOFF(CFS) =      23.64
  TC(MIN.) =   13.98

****************************************************************************
  FLOW PROCESS FROM NODE    102.00 TO NODE    103.00 IS CODE =  53
----------------------------------------------------------------------------
  >>>>>COMPUTE NATURAL MOUNTAIN CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    650.00  DOWNSTREAM(FEET) =    562.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =  1236.00   CHANNEL SLOPE =  0.0712
  CHANNEL FLOW THRU SUBAREA(CFS) =      23.64
  FLOW VELOCITY(FEET/SEC) =   4.28 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
  TRAVEL TIME(MIN.) =   4.81   Tc(MIN.) =   18.79
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    103.00 =    2466.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    102.00 TO NODE    103.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.646
  *USER SPECIFIED(SUBAREA):
  BARREN COVER RUNOFF COEFFICIENT = .4100
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.3857
  SUBAREA AREA(ACRES) =   22.48   SUBAREA RUNOFF(CFS) =   33.61
  TOTAL AREA(ACRES) =       37.8   TOTAL RUNOFF(CFS) =      53.15
  TC(MIN.) =   18.79

****************************************************************************
  FLOW PROCESS FROM NODE    103.00 TO NODE    104.00 IS CODE =  52
----------------------------------------------------------------------------
  >>>>>COMPUTE NATURAL VALLEY CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    562.00  DOWNSTREAM(FEET) =    525.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =   995.00   CHANNEL SLOPE =  0.0372
  CHANNEL FLOW THRU SUBAREA(CFS) =      53.15
  FLOW VELOCITY(FEET/SEC) =   7.60 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
  TRAVEL TIME(MIN.) =   2.18   Tc(MIN.) =   20.97
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    104.00 =    3461.00 FEET.

****************************************************************************
```

```
  FLOW PROCESS FROM NODE    103.00 TO NODE    104.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.397
  *USER SPECIFIED(SUBAREA):
  BARREN COVER RUNOFF COEFFICIENT = .4100
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.3894
  SUBAREA AREA(ACRES) =    6.90   SUBAREA RUNOFF(CFS) =    9.61
  TOTAL AREA(ACRES) =       44.7   TOTAL RUNOFF(CFS) =      59.12
  TC(MIN.) =   20.97

+--------------------------------------------------------------------------+
|                                                                          |
|                                                                          |
|                                                                          |
+--------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE    200.00 TO NODE    201.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  BARREN COVER RUNOFF COEFFICIENT = .4100
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    92.00
  UPSTREAM ELEVATION(FEET) =    569.00
  DOWNSTREAM ELEVATION(FEET) =    566.00
  ELEVATION DIFFERENCE(FEET) =      3.00
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    8.034
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  6.306
  SUBAREA RUNOFF(CFS) =      0.28
  TOTAL AREA(ACRES) =      0.11   TOTAL RUNOFF(CFS) =      0.28

****************************************************************************
  FLOW PROCESS FROM NODE    201.00 TO NODE    202.00 IS CODE =  53
----------------------------------------------------------------------------
  >>>>>COMPUTE NATURAL MOUNTAIN CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    566.00  DOWNSTREAM(FEET) =    524.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =   816.00   CHANNEL SLOPE =  0.0515
  NOTE: CHANNEL FLOW OF 1. CFS WAS ASSUMED IN VELOCITY ESTIMATION
  CHANNEL FLOW THRU SUBAREA(CFS) =       0.28
  FLOW VELOCITY(FEET/SEC) =   1.27 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
  TRAVEL TIME(MIN.) =  10.70   Tc(MIN.) =   18.74
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    202.00 =     908.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    201.00 TO NODE    202.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.652
  *USER SPECIFIED(SUBAREA):
  BARREN COVER RUNOFF COEFFICIENT = .4100
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.4100
  SUBAREA AREA(ACRES) =    6.23   SUBAREA RUNOFF(CFS) =    9.33
  TOTAL AREA(ACRES) =        6.3   TOTAL RUNOFF(CFS) =       9.49
  TC(MIN.) =   18.74

+--------------------------------------------------------------------------+
| End Existing Condition Hydrologic Model.                                 |
|                                                                          |
| Begin Proposed Condition Hydrologic Model.                               |
+--------------------------------------------------------------------------+

+--------------------------------------------------------------------------+
```

```
|                                                                        |
|                                                                        |
|                                                                        |
+------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE    100.00 TO NODE    101.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  ANNUAL GRASS (DRYLAND) FAIR COVER RUNOFF COEFFICIENT = .3500
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    895.00
  DOWNSTREAM ELEVATION(FEET) =    865.00
  ELEVATION DIFFERENCE(FEET) =     30.00
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.267
  WARNING: THE MAXIMUM OVERLAND FLOW SLOPE, 10.%, IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.402
  SUBAREA RUNOFF(CFS) =      0.73
  TOTAL AREA(ACRES) =      0.28   TOTAL RUNOFF(CFS) =      0.73

****************************************************************************
  FLOW PROCESS FROM NODE    101.00 TO NODE    102.00 IS CODE =  53
----------------------------------------------------------------------------
  >>>>>COMPUTE NATURAL MOUNTAIN CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    865.00  DOWNSTREAM(FEET) =    650.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =  1130.00   CHANNEL SLOPE =  0.1903
  NOTE: CHANNEL FLOW OF 1. CFS WAS ASSUMED IN VELOCITY ESTIMATION
  CHANNEL FLOW THRU SUBAREA(CFS) =       0.73
  FLOW VELOCITY(FEET/SEC) =   2.44 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
  TRAVEL TIME(MIN.) =   7.71   Tc(MIN.) =   13.98
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    102.00 =    1230.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    101.00 TO NODE    102.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.412
  *USER SPECIFIED(SUBAREA):
  ANNUAL GRASS (DRYLAND) FAIR COVER RUNOFF COEFFICIENT = .3500
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.3500
  SUBAREA AREA(ACRES) =   15.03   SUBAREA RUNOFF(CFS) =   23.21
  TOTAL AREA(ACRES) =       15.3   TOTAL RUNOFF(CFS) =      23.64
  TC(MIN.) =   13.98

****************************************************************************
  FLOW PROCESS FROM NODE    102.00 TO NODE    103.00 IS CODE =  53
----------------------------------------------------------------------------
  >>>>>COMPUTE NATURAL MOUNTAIN CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    650.00  DOWNSTREAM(FEET) =    562.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =  1236.00   CHANNEL SLOPE =  0.0712
  CHANNEL FLOW THRU SUBAREA(CFS) =      23.64
  FLOW VELOCITY(FEET/SEC) =   4.28 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
  TRAVEL TIME(MIN.) =   4.81   Tc(MIN.) =   18.79
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    103.00 =    2466.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    102.00 TO NODE    103.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.646
  *USER SPECIFIED(SUBAREA):
```

```
  BARREN COVER RUNOFF COEFFICIENT = .4100
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.3857
  SUBAREA AREA(ACRES) =   22.48   SUBAREA RUNOFF(CFS) =   33.61
  TOTAL AREA(ACRES) =       37.8   TOTAL RUNOFF(CFS) =      53.15
  TC(MIN.) =   18.79

****************************************************************************
  FLOW PROCESS FROM NODE    103.10 TO NODE    103.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.646
  *USER SPECIFIED(SUBAREA):
  BARREN COVER RUNOFF COEFFICIENT = .4100
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.3861
  SUBAREA AREA(ACRES) =    0.63   SUBAREA RUNOFF(CFS) =    0.94
  TOTAL AREA(ACRES) =       38.4   TOTAL RUNOFF(CFS) =      54.09
  TC(MIN.) =   18.79

****************************************************************************
  FLOW PROCESS FROM NODE    103.00 TO NODE    104.00 IS CODE =  52
----------------------------------------------------------------------------
  >>>>>COMPUTE NATURAL VALLEY CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    562.00  DOWNSTREAM(FEET) =    525.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =   994.00   CHANNEL SLOPE =  0.0372
  CHANNEL FLOW THRU SUBAREA(CFS) =      54.09
  FLOW VELOCITY(FEET/SEC) =   7.64 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
  TRAVEL TIME(MIN.) =   2.17   Tc(MIN.) =   20.95
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    104.00 =    3460.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    103.00 TO NODE    104.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.398
  *USER SPECIFIED(SUBAREA):
  BARREN COVER RUNOFF COEFFICIENT = .4100
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.3877
  SUBAREA AREA(ACRES) =    2.76   SUBAREA RUNOFF(CFS) =    3.85
  TOTAL AREA(ACRES) =       41.2   TOTAL RUNOFF(CFS) =      54.25
  TC(MIN.) =   20.95

+--------------------------------------------------------------------------+
|                                                                          |
|                                                                          |
|                                                                          |
+--------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE    300.00 TO NODE    301.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  RESIDENTIAL (4.3 DU/AC OR LESS) RUNOFF COEFFICIENT = .5200
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    562.40
  DOWNSTREAM ELEVATION(FEET) =    560.00
  ELEVATION DIFFERENCE(FEET) =      2.40
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    7.231
  WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
           THE MAXIMUM OVERLAND FLOW LENGTH =    86.00
           (Reference: Table 3-1B of Hydrology Manual)
           THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
```

```
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  6.749
  SUBAREA RUNOFF(CFS) =      0.77
  TOTAL AREA(ACRES) =      0.22   TOTAL RUNOFF(CFS) =      0.77

****************************************************************************
  FLOW PROCESS FROM NODE    301.00 TO NODE    302.00 IS CODE =  61
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STANDARD CURB SECTION USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  559.50  DOWNSTREAM ELEVATION(FEET) =  530.00
  STREET LENGTH(FEET) =  1023.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 13.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   7.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       7.70
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.32
    HALFSTREET FLOOD WIDTH(FEET) =    9.58
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    3.72
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.18
  STREET FLOW TRAVEL TIME(MIN.) =   4.59   Tc(MIN.) =   11.82
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.917
  *USER SPECIFIED(SUBAREA):
  RESIDENTIAL (4.3 DU/AC OR LESS) RUNOFF COEFFICIENT = .5200
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.520
  SUBAREA AREA(ACRES) =    5.34      SUBAREA RUNOFF(CFS) =   13.65
  TOTAL AREA(ACRES) =        5.6        PEAK FLOW RATE(CFS) =      14.21

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.37   HALFSTREET FLOOD WIDTH(FEET) =  12.37
  FLOW VELOCITY(FEET/SEC.) =  4.31   DEPTH*VELOCITY(FT*FT/SEC.) =   1.61
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    302.00 =    1123.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    302.00 TO NODE    307.00 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.) =   11.82
  RAINFALL INTENSITY(INCH/HR) =   4.92
  TOTAL STREAM AREA(ACRES) =     5.56
  PEAK FLOW RATE(CFS) AT CONFLUENCE =     14.21

****************************************************************************
  FLOW PROCESS FROM NODE    305.00 TO NODE    306.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  RESIDENTIAL (4.3 DU/AC OR LESS) RUNOFF COEFFICIENT = .5200
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    70.00
  UPSTREAM ELEVATION(FEET) =    548.35
  DOWNSTREAM ELEVATION(FEET) =    547.65
  ELEVATION DIFFERENCE(FEET) =      0.70
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    8.735
  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) =  5.975
  SUBAREA RUNOFF(CFS) =      1.09
  TOTAL AREA(ACRES) =      0.35   TOTAL RUNOFF(CFS) =      1.09

****************************************************************************
  FLOW PROCESS FROM NODE    306.00 TO NODE    307.00 IS CODE =  61
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STANDARD CURB SECTION USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  547.15  DOWNSTREAM ELEVATION(FEET) =  530.00
  STREET LENGTH(FEET) =   615.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 13.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   7.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       3.63
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.31
    HALFSTREET FLOOD WIDTH(FEET) =    9.42
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    3.61
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.14
  STREET FLOW TRAVEL TIME(MIN.) =   2.84   Tc(MIN.) =   11.57
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.983
  *USER SPECIFIED(SUBAREA):
  RESIDENTIAL (4.3 DU/AC OR LESS) RUNOFF COEFFICIENT = .5200
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.520
  SUBAREA AREA(ACRES) =    1.95      SUBAREA RUNOFF(CFS) =    5.05
  TOTAL AREA(ACRES) =        2.3        PEAK FLOW RATE(CFS) =       5.96

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.36   HALFSTREET FLOOD WIDTH(FEET) =  11.61
  FLOW VELOCITY(FEET/SEC.) =  4.07   DEPTH*VELOCITY(FT*FT/SEC.) =   1.46
  LONGEST FLOWPATH FROM NODE    305.00 TO NODE    307.00 =     685.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    307.00 TO NODE    307.00 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.) =   11.57
  RAINFALL INTENSITY(INCH/HR) =   4.98
  TOTAL STREAM AREA(ACRES) =     2.30
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      5.96

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1       14.21    11.82        4.917          5.56
      2        5.96    11.57        4.983          2.30

  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       19.88    11.57       4.983
      2       20.09    11.82       4.917
```

```
  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      20.09   Tc(MIN.) =   11.82
  TOTAL AREA(ACRES) =        7.9
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    307.00 =    1123.00 FEET.

+-----------------------------------------------------------------------+
| Per Detention Analysis:                                               |
| Qout = 5.65 cfs                                                       |
|                                                                       |
+-----------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE    307.00 TO NODE    307.00 IS CODE =   7
----------------------------------------------------------------------------
  >>>>>USER SPECIFIED HYDROLOGY INFORMATION AT NODE<<<<<
============================================================================
  USER-SPECIFIED VALUES ARE AS FOLLOWS:
  TC(MIN) =  11.82   RAIN INTENSITY(INCH/HOUR) =  4.92
  TOTAL AREA(ACRES) =     7.86   TOTAL RUNOFF(CFS) =      5.65

****************************************************************************
  FLOW PROCESS FROM NODE    307.00 TO NODE    308.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   525.00  DOWNSTREAM(FEET) =   519.00
  FLOW LENGTH(FEET) =   365.00   MANNING'S N =  0.013
  ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 18.000
  DEPTH OF FLOW IN  18.0 INCH PIPE IS   8.4 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   7.01
  ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       5.65
  PIPE TRAVEL TIME(MIN.) =   0.87    Tc(MIN.) =   12.69
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    308.00 =    1488.00 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.) =   12.69
  RAINFALL INTENSITY(INCH/HR) =   4.70
  TOTAL STREAM AREA(ACRES) =     7.86
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      5.65

****************************************************************************
  FLOW PROCESS FROM NODE    310.00 TO NODE    311.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  URBAN NEWLY GRADED AREAS RUNOFF COEFFICIENT = .3500
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    560.00
  DOWNSTREAM ELEVATION(FEET) =    550.00
  ELEVATION DIFFERENCE(FEET) =     10.00
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.267
  WARNING: THE MAXIMUM OVERLAND FLOW SLOPE, 10.%, IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.402
  SUBAREA RUNOFF(CFS) =      0.16
  TOTAL AREA(ACRES) =      0.06   TOTAL RUNOFF(CFS) =      0.16

****************************************************************************
  FLOW PROCESS FROM NODE    311.00 TO NODE    312.00 IS CODE =  53
----------------------------------------------------------------------------
  >>>>>COMPUTE NATURAL MOUNTAIN CHANNEL FLOW<<<<<
```

```
  >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    550.00  DOWNSTREAM(FEET) =    524.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =   670.00   CHANNEL SLOPE =  0.0388
  NOTE: CHANNEL FLOW OF 1. CFS WAS ASSUMED IN VELOCITY ESTIMATION
  CHANNEL FLOW THRU SUBAREA(CFS) =       0.16
  FLOW VELOCITY(FEET/SEC) =   1.10 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
  TRAVEL TIME(MIN.) =  10.12   Tc(MIN.) =   16.39
  LONGEST FLOWPATH FROM NODE    310.00 TO NODE    312.00 =     770.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    311.00 TO NODE    312.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.982
  *USER SPECIFIED(SUBAREA):
  URBAN NEWLY GRADED AREAS RUNOFF COEFFICIENT = .3500
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.3500
  SUBAREA AREA(ACRES) =    2.18   SUBAREA RUNOFF(CFS) =    3.04
  TOTAL AREA(ACRES) =        2.2   TOTAL RUNOFF(CFS) =       3.12
  TC(MIN.) =   16.39

****************************************************************************
  FLOW PROCESS FROM NODE    312.00 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.) =   16.39
  RAINFALL INTENSITY(INCH/HR) =   3.98
  TOTAL STREAM AREA(ACRES) =     2.24
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      3.12

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1        5.65    12.69        4.697          7.86
      2        3.12    16.39        3.982          2.24

  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        8.07    12.69       4.697
      2        7.91    16.39       3.982

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =       8.07   Tc(MIN.) =   12.69
  TOTAL AREA(ACRES) =       10.1
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    308.00 =    1488.00 FEET.
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =       10.1  TC(MIN.) =     12.69
  PEAK FLOW RATE(CFS)   =       8.07
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS
```

CHAPTER 4

INLET CALCULATIONS

User Name: MOrdillas Date: 03-26-14
Project: Lone Oak Raod Propoerty (Buena Creek) Time: 16:27:04
Page: 1

INLET @ NODE 307

Hec22 Calculation Report:

==========

Results:

Flow Intercepted:	5.58	cfs
Flow Bypassed:	0.00	cfs
Inlet Length:	16.986	ft
Splash-over Velocity:	0.00	ft/s
Ponding Width:	10.661	ft
Depth at Curb:	0.303	ft

USE 18' inlet

Efficiency:

Curb	100.00	%
Grate	*	%
Slotted	*	%
Total:	100.00	%

Flow Data Input:

Input Method:	Known Flow	
Known Flow:	5.58	cfs

Inlet Parameters:

Computation Type:	Grade	
Inlet Type:	Curb	
Longitudinal Slope:	0.03	ft/ft
Manning's n:	0.016	
Pavement Cross Slope:	0.02	ft/ft
Gutter Cross Slope:	0.08	ft/ft
Local Depression:	4.000	in
Gutter Width:	1.500	ft
Curb Opening Length:	16.986	ft
Curb Throat Type:	Horizontal	
Inclined Throat Angle:	0.0000	deg
Inlet Opening Height:	0.500	in
Curb Weir Coefficient:	2.300	
Curb Orifice Coefficient:	0.670	

User Name: MOrdillas Date: 03-26-14
Project: Lone Oak Raod Propoerty (Buena Creek) Time: 16:26:38
Page: 1

INLET NODE 302 (1 of 2)

Hec22 Calculation Report:

==========

Results:

Flow Intercepted:	11.64	cfs
Flow Bypassed:	1.65	cfs
Inlet Length:	20.000	ft
Splash-over Velocity:	0.00	ft/s
Ponding Width:	15.119	ft
Depth at Curb:	0.392	ft

% Intercepted = 87.6 %

% Bypassed = 12.4 %

BYPASSED TO NODE 302 (2 of 2)

Efficiency:

Curb	87.60	%
Grate	*	%
Slotted	*	%
Total:	87.60	%

Flow Data Input:

Input Method:	Known Flow	
Known Flow:	13.29	cfs

Inlet Parameters:

Computation Type:	Grade	
Inlet Type:	Curb	
Longitudinal Slope:	0.03	ft/ft
Manning's n:	0.016	
Pavement Cross Slope:	0.02	ft/ft
Gutter Cross Slope:	0.08	ft/ft
Local Depression:	4.000	in
Gutter Width:	1.500	ft
Curb Opening Length:	20.000	ft
Curb Throat Type:	Horizontal	
Inclined Throat Angle:	0.0000	deg
Inlet Opening Height:	0.500	in
Curb Weir Coefficient:	2.300	
Curb Orifice Coefficient:	0.670	

User Name: MOrdillas Date: 03-26-14
Project: Lone Oak Raod Propoerty (Buena Creek) Time: 16:31:04
Page: 1

INLET NODE 302 (2 of 2)

Hec22 Calculation Report:

==========

Results:

Flow Intercepted:	1.65	cfs
Flow Bypassed:	0.00	cfs
Inlet Length:	7.931	ft
Splash-over Velocity:	0.00	ft/s
Ponding Width:	6.205	ft
Depth at Curb:	0.214	ft

← BYPASSED FLOW FROM UPSTREAM 20' INLET.

Efficiency:

Curb	100.00	%
Grate	*	%
Slotted	*	%
Total:	100.00	%

Flow Data Input:

Input Method:	Known Flow	
Known Flow:	1.65	cfs

Inlet Parameters:

Computation Type:	Grade	
Inlet Type:	Curb	
Longitudinal Slope:	0.03	ft/ft
Manning's n:	0.016	
Pavement Cross Slope:	0.02	ft/ft
Gutter Cross Slope:	0.08	ft/ft
Local Depression:	4.000	in
Gutter Width:	1.500	ft
Curb Opening Length:	7.931	ft
Curb Throat Type:	Horizontal	
Inclined Throat Angle:	0.0000	deg
Inlet Opening Height:	0.500	in
Curb Weir Coefficient:	2.300	
Curb Orifice Coefficient:	0.670	

CHAPTER 5

DETENTION BASIN AND

BASIN CALCULATIONS

LONE OAK RANCH: STAGE STORAGE

Basin Bottom: 523.8

Stage	Elev	North Basin Area	South Basin Area	Areas Combined
0	523.8	5138	2453	7591
0.5	524.3	5430	2739	8169
1	524.8	5729	3031	8760
1.5	525.3	6033	3330	9363
2	525.8	6344	3635	9979
2.5	526.3	6661	3947	10608
3	526.8	6985	4264	11249
3.5	527.3	7315	4588	11903
4	527.8	7651	4918	12569
4.5	528.3	7993	5255	13248
5	528.8	8342	5597	13939

Basin #1 Discharge

Discharge vs Elevation Table

Low orifice:	1 "	Top orifice:	2 "
Number:	2	Number:	0
Cg-low:	0.61	Cg-low:	0.61
invert elev:	0.08 ft	invert elev:	1.50 ft
Middle orifice:	1.5 "	Emergency inlet:	
number of orif:	2	Invert:	2.75 ft
Cg-middle:	0.61	Area (SF=2)	4.91 sq ft
invert elev:	2.50 ft		

Total Discharge per stage = Qtot + 0.146 to account for underdrain discharge

h (ft)	H/D-low -	H/D-mid -	H/D-top -	Qlow-orif (cfs)	Qlow-weir (cfs)	Qtot-low (cfs)	Qmid-orif (cfs)	Qmid-weir (cfs)	Qtot-med (cfs)	Qtop-orif (cfs)	Qtop-weir (cfs)	Qtot-top (cfs)	Qemerg (cfs)	Qtot (cfs)
0.0	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.1	0.30	0.00	0.00	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
0.2	1.50	0.00	0.00	0.015	0.019	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.015
0.3	2.70	0.00	0.00	0.023	0.028	0.023	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.023
0.4	3.90	0.00	0.00	0.028	0.042	0.028	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.028
0.5	5.10	0.00	0.00	0.033	0.220	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.033
0.6	6.30	0.00	0.00	0.037	0.958	0.037	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.037
0.7	7.50	0.00	0.00	0.041	2.994	0.041	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041
0.8	8.70	0.00	0.00	0.044	7.495	0.044	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.044
0.9	9.90	0.00	0.00	0.047	16.157	0.047	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.047
1.0	11.10	0.00	0.00	0.050	31.300	0.050	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.050
1.1	12.30	0.00	0.00	0.053	55.965	0.053	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.053
1.2	13.50	0.00	0.00	0.056	94.008	0.056	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.056
1.3	14.70	0.00	0.00	0.058	150.198	0.058	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.058
1.4	15.90	0.00	0.00	0.060	230.310	0.060	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.060
1.5	17.10	0.00	0.00	0.063	341.223	0.063	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.063
1.6	18.30	0.00	0.60	0.065	491.015	0.065	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.065
1.7	19.50	0.00	1.20	0.067	689.061	0.067	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.067
1.8	20.70	0.00	1.80	0.069	946.125	0.069	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.069
1.9	21.90	0.00	2.40	0.071	1274.459	0.071	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.071
2.0	23.10	0.00	3.00	0.073	1687.897	0.073	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.073
2.1	24.30	0.00	3.60	0.075	2201.951	0.075	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.075
2.2	25.50	0.00	4.20	0.077	2833.911	0.077	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.077
2.3	26.70	0.00	4.80	0.079	3602.932	0.079	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.079
2.4	27.90	0.00	5.40	0.081	4530.140	0.081	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.081
2.5	29.10	0.00	6.00	0.082	5638.720	0.082	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.082
2.6	30.30	0.80	6.60	0.084	6954.016	0.084	0.023	0.020	0.020	0.000	0.000	0.000	0.000	0.104
2.7	31.50	1.60	7.20	0.086	8503.625	0.086	0.045	0.056	0.045	0.000	0.000	0.000	0.000	0.130
2.8	32.70	2.40	7.80	0.087	########	0.087	0.059	0.076	0.059	0.000	0.000	0.000	0.087	0.233
2.9	33.90	3.20	8.40	0.089	########	0.089	0.070	0.079	0.070	0.000	0.000	0.000	0.450	0.609
3.0	35.10	4.00	9.00	0.091	########	0.091	0.079	0.130	0.079	0.000	0.000	0.000	0.969	1.139
3.1	36.30	4.80	9.60	0.092	########	0.092	0.088	0.395	0.088	0.000	0.000	0.000	1.605	1.785
3.2	37.50	5.60	10.20	0.094	########	0.094	0.096	1.173	0.096	0.000	0.000	0.000	2.340	2.529
3.3	38.70	6.40	10.80	0.095	########	0.095	0.103	2.936	0.103	0.000	0.000	0.000	3.162	3.360
3.4	39.90	7.20	11.40	0.097	########	0.097	0.110	6.361	0.110	0.000	0.000	0.000	4.062	4.269
3.5	41.10	8.00	12.00	0.098	########	0.098	0.116	12.361	0.116	0.000	0.000	0.000	5.034	5.249
3.6	42.30	8.80	12.60	0.100	########	0.100	0.122	22.129	0.122	0.000	0.000	0.000	6.074	6.296
3.7	43.50	9.60	13.20	0.101	########	0.101	0.128	37.163	0.128	0.000	0.000	0.000	7.177	7.406
3.8	44.70	10.40	13.80	0.102	########	0.102	0.134	59.307	0.134	0.000	0.000	0.000	8.340	8.576
3.9	45.90	11.20	14.40	0.104	########	0.104	0.139	90.784	0.139	0.000	0.000	0.000	9.559	9.802
4.0	47.10	12.00	15.00	0.105	########	0.105	0.144	134.229	0.144	0.000	0.000	0.000	10.832	11.082
4.1	48.30	12.80	15.60	0.107	########	0.107	0.149	192.729	0.149	0.000	0.000	0.000	12.158	12.413
4.2	49.50	13.60	16.20	0.108	########	0.108	0.154	269.850	0.154	0.000	0.000	0.000	13.533	13.795
4.3	50.70	14.40	16.80	0.109	########	0.109	0.158	369.679	0.158	0.000	0.000	0.000	14.957	15.225
4.4	51.90	15.20	17.40	0.111	########	0.111	0.163	496.854	0.163	0.000	0.000	0.000	16.428	16.701
4.5	53.10	16.00	18.00	0.112	########	0.112	0.167	656.603	0.167	0.000	0.000	0.000	17.944	18.223
4.6	54.30	16.80	18.60	0.113	########	0.113	0.171	854.773	0.171	0.000	0.000	0.000	19.504	19.788
4.7	55.50	17.60	19.20	0.114	########	0.114	0.176	1097.872	0.176	0.000	0.000	0.000	21.106	21.396
4.8	56.70	18.40	19.80	0.116	########	0.116	0.180	1393.096	0.180	0.000	0.000	0.000	22.750	23.046
4.9	57.90	19.20	20.40	0.117	########	0.117	0.184	1748.371	0.184	0.000	0.000	0.000	24.435	24.736
5.0	59.10	20.00	21.00	0.118	########	0.118	0.188	2172.383	0.188	0.000	0.000	0.000	26.160	26.465

RATIONAL METHOD HYDROGRAPH PROGRAM
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RUN DATE 3/25/2014
HYDROGRAPH FILE NAME Text1
TIME OF CONCENTRATION 12 MIN.
6 HOUR RAINFALL 3.25 INCHES
BASIN AREA 7.86 ACRES
RUNOFF COEFFICIENT 0.52
PEAK DISCHARGE 20.09 CFS

TIME (MIN) = 0	DISCHARGE (CFS) = 0
TIME (MIN) = 12	DISCHARGE (CFS) = 0.8
TIME (MIN) = 24	DISCHARGE (CFS) = 0.8
TIME (MIN) = 36	DISCHARGE (CFS) = 0.9
TIME (MIN) = 48	DISCHARGE (CFS) = 0.9
TIME (MIN) = 60	DISCHARGE (CFS) = 0.9
TIME (MIN) = 72	DISCHARGE (CFS) = 0.9
TIME (MIN) = 84	DISCHARGE (CFS) = 1
TIME (MIN) = 96	DISCHARGE (CFS) = 1
TIME (MIN) = 108	DISCHARGE (CFS) = 1.1
TIME (MIN) = 120	DISCHARGE (CFS) = 1.2
TIME (MIN) = 132	DISCHARGE (CFS) = 1.3
TIME (MIN) = 144	DISCHARGE (CFS) = 1.3
TIME (MIN) = 156	DISCHARGE (CFS) = 1.5
TIME (MIN) = 168	DISCHARGE (CFS) = 1.6
TIME (MIN) = 180	DISCHARGE (CFS) = 1.8
TIME (MIN) = 192	DISCHARGE (CFS) = 1.9
TIME (MIN) = 204	DISCHARGE (CFS) = 2.4
TIME (MIN) = 216	DISCHARGE (CFS) = 2.7
TIME (MIN) = 228	DISCHARGE (CFS) = 3.9
TIME (MIN) = 240	DISCHARGE (CFS) = 5.4
TIME (MIN) = 252	DISCHARGE (CFS) = 20.09
TIME (MIN) = 264	DISCHARGE (CFS) = 3.2
TIME (MIN) = 276	DISCHARGE (CFS) = 2.1
TIME (MIN) = 288	DISCHARGE (CFS) = 1.7
TIME (MIN) = 300	DISCHARGE (CFS) = 1.4
TIME (MIN) = 312	DISCHARGE (CFS) = 1.2
TIME (MIN) = 324	DISCHARGE (CFS) = 1.1
TIME (MIN) = 336	DISCHARGE (CFS) = 1
TIME (MIN) = 348	DISCHARGE (CFS) = 0.9
TIME (MIN) = 360	DISCHARGE (CFS) = 0.8
TIME (MIN) = 372	DISCHARGE (CFS) = 0

Hydraflow Table of Contents

Lone Oak Detention Basin.gpw

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Tuesday, 04 / 1 / 2014

Watershed Model Schematic **1**

100 - Year

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Hydrograph No. 2, Reservoir, Lone Oak Detention 4

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Legend

Hyd.	Origin	Description
1	Manual	Lone Oak Runoff
2	Reservoir	Lone Oak Detention

Project: Lone Oak Detention Basin.gpw

Tuesday, 04 / 1 / 2014

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Manual	20.09	12	252	48,089	------	------	------	Lone Oak Runoff
2	Reservoir	5.650	12	264	48,067	1	527.39	34,196	Lone Oak Detention

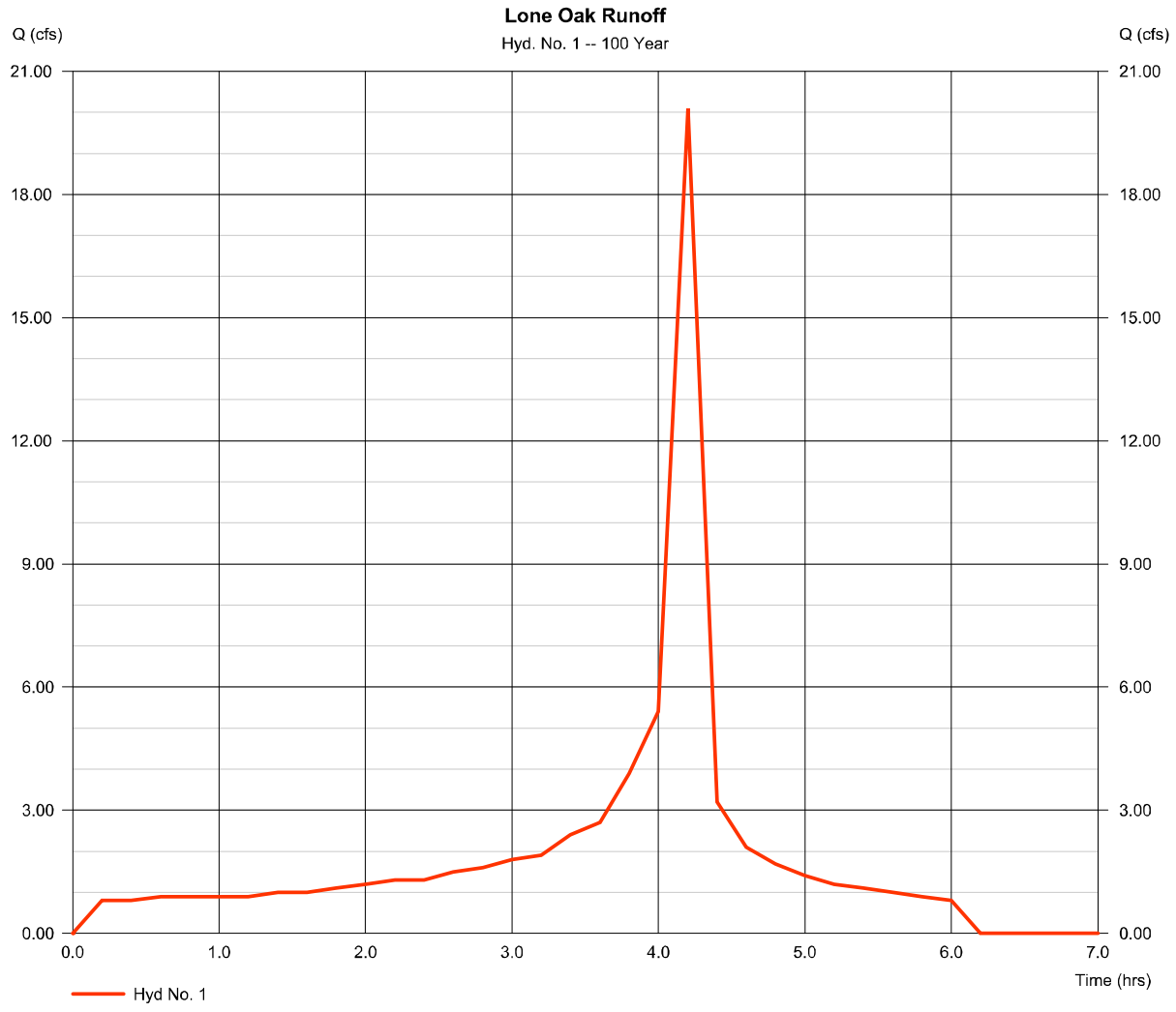
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Tuesday, 04 / 1 / 2014

Hyd. No. 1

Lone Oak Runoff

Hydrograph type	= Manual	Peak discharge	= 20.09 cfs
Storm frequency	= 100 yrs	Time to peak	= 4.20 hrs
Time interval	= 12 min	Hyd. volume	= 48,089 cuft



Hydrograph Report

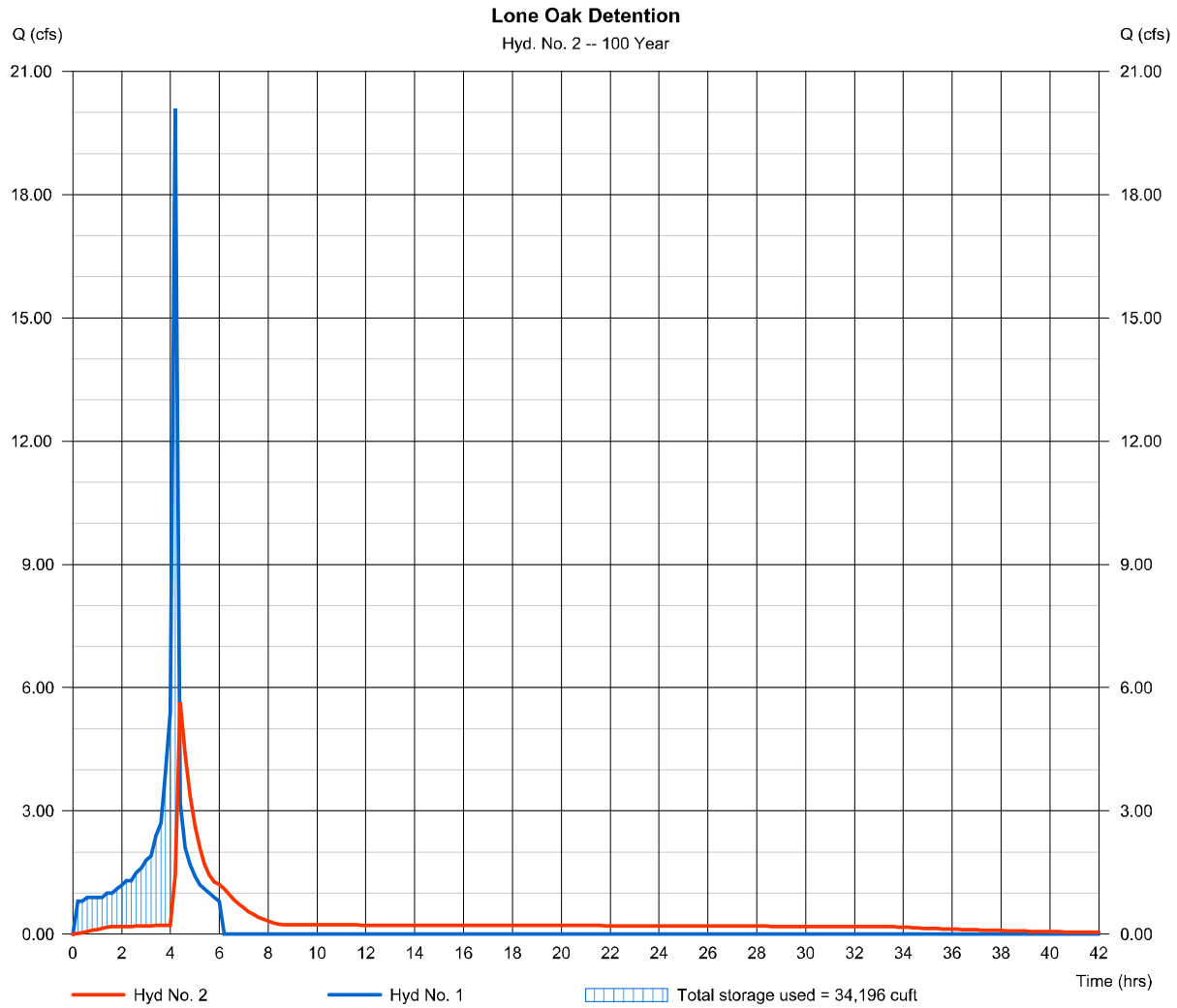
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Tuesday, 04 / 1 / 2014

Hyd. No. 2

Lone Oak Detention

Hydrograph type	= Reservoir	Peak discharge	= 5.650 cfs
Storm frequency	= 100 yrs	Time to peak	= 4.40 hrs
Time interval	= 12 min	Hyd. volume	= 48,067 cuft
Inflow hyd. No.	= 1 - Lone Oak Runoff	Max. Elevation	= 527.39 ft
Reservoir name	= Lone Oak Detention Basin	Max. Storage	= 34,196 cuft

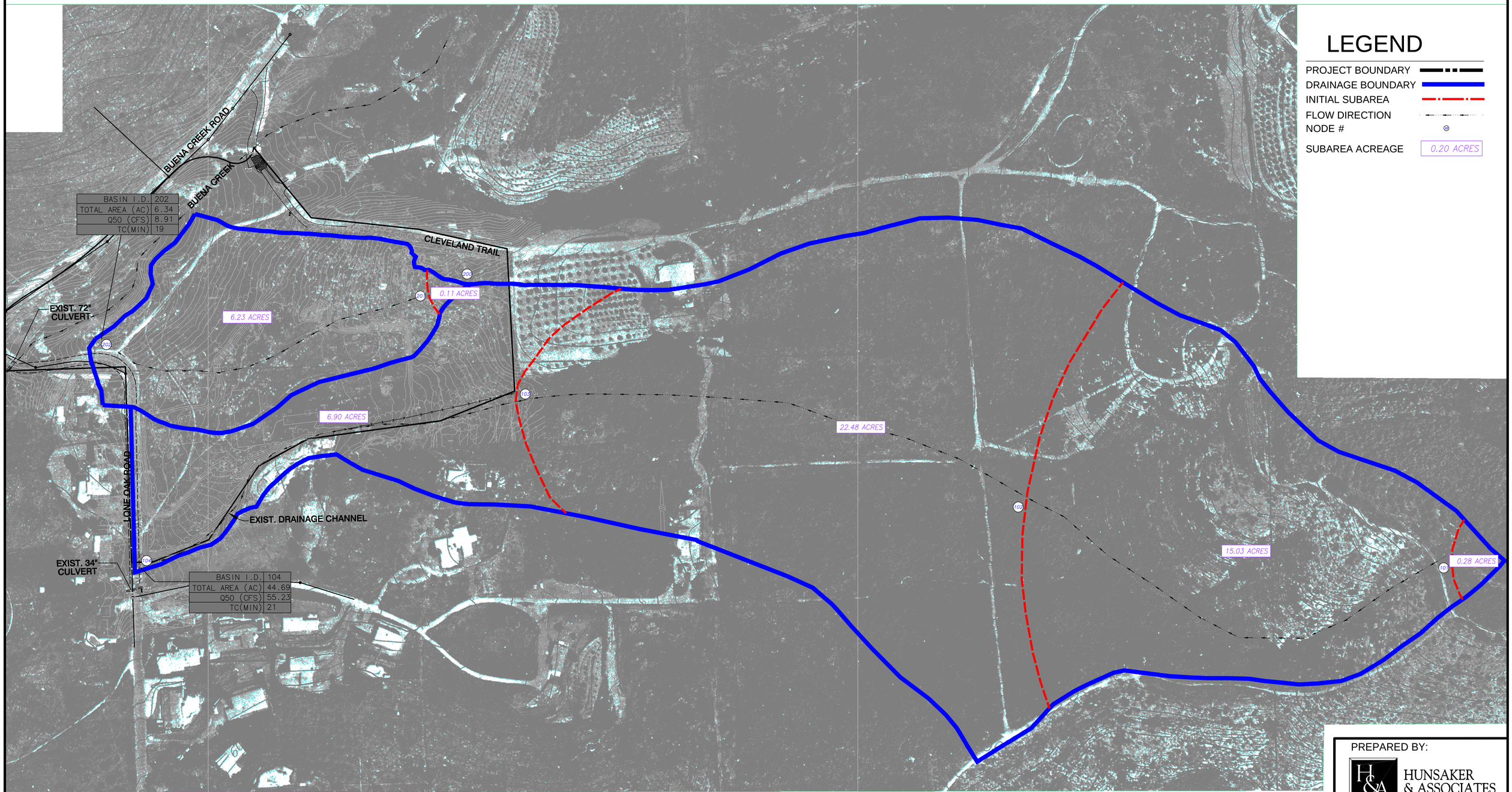
Storage Indication method used.



CHAPTER 6

Exhibit 6.1

EXISTING CONDITION HYDROLOGY MAP



PREPARED BY:

HUNSAKER & ASSOCIATES
SAN DIEGO, INC

PLANNING 9707 Waples Street
ENGINEERING San Diego, Ca 92121
SURVEYING PH(858)558-4500 · FX(858)558-1414

H&A

100 0 100 200 300
SCALE 1"=100'

EXISTING CONDITION HYDROLOGY EXHIBIT FOR:

LONE OAK RANCH

COUNTY OF SAN DIEGO, CALIFORNIA

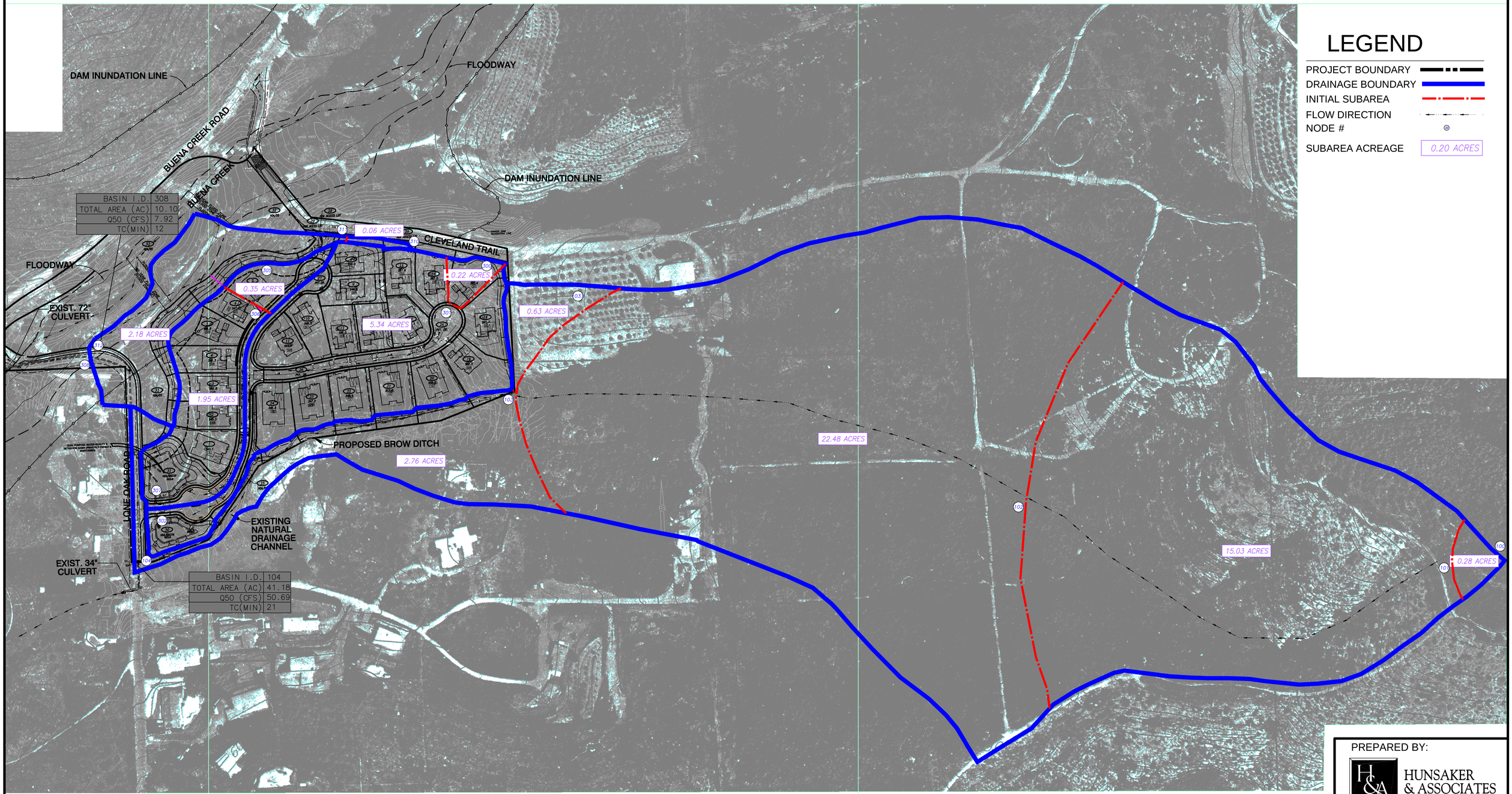
SHEET 1 OF 2

W.O.# 2411-341

CHAPTER 6

Exhibit 6.2

DEVELOPED CONDITION HYDROLOGY MAP



LEGEND

PROJECT BOUNDARY	
DRAINAGE BOUNDARY	
INITIAL SUBAREA	
FLOW DIRECTION	
NODE #	
SUBAREA ACREAGE	0.20 ACRES

PREPARED BY:

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PLANNING
ENGINEERING
SURVEYING

9707 Waples Street
San Diego, Ca 92121
PH(858)558-4500· FX(858)558-1414

100 0 100 200 300
SCALE 1"=100'

PROPOSED CONDITION HYDROLOGY EXHIBIT FOR:

LONE OAK RANCH

COUNTY OF SAN DIEGO, CALIFORNIA

SHEET 2 OF 2

W.O.# 2414-34