ESTRELLA FREEWAY
HYDROLOGIC INVESTIGATION REPORT
PREPARED FOR:
ARIZONA DEPARTMENT OF TRANSPORTATION
PREPARED BY:
CELLA BARR ASSOCIATES

CBA CELLA BARR ASSOCIATES

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ESTRELLA FREEWAY
HYDROLOGIC INVESTIGATION REPORT
PREPARED FOR:
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PREPARED BY:
CELLA BARR ASSOCIATES

Cella Barr Associates
5062 North 19th Avenue
Phoenix, Arizona 85015
July, 14, 1987

CBA File No. 40955-02-30
JHN-21

Registered Professional Engineer
Certificate No. 20321
JAMES H. NELSON
Date Signed 7.14.87
ARIZONA, U.S.A.

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ESTRELLA FREEWAY

HYDROLOGIC INVESTIGATION REPORT

INTRODUCTION

This is a hydrologic investigation for the Estrella Freeway Route Location study, and has been prepared to establish peak discharge values that will be used as a basis for preliminary design assessments. The Estrella Freeway, formerly the Cotton Lane/Northwest Loop Freeway, will proceed north along (or parallel to) Cotton Lane from State Route 85 to Grand Avenue and then bend northeasterly extending through mountain and foothill slopes to eventually intersect with I-17 near the Central Arizona Project Canal. In the construction schedule of all the valley freeways, the Estrella Freeway has the lowest priority and is not projected to be completed until the year 2005.

In October 1986, the Arizona Department of Transportation contracted with Cella Barr Associates, in association with Kimley-Horn and Associates, Inc., to complete the route location study and preliminary design for the Estrella Freeway. The purpose of the route location study is to be established and preserve the right-of-way required for future freeway construction. The right-of-way requirements will be based, in part, on the location and preliminary sizing of drainage channels, detention/ retention basins, flood control structures, and additional areas needed for backwater ponding behind culvert and bridge crossings. Drainage costs will be assessed for channels, culverts, bridges, detention/ retention facilities and other drainage control structures to aid in the selection process for a preferred alignment.

The level of detail providing the basis for this hydrologic report is not overly intensive in consideration of the fact that present hydrologic conditions and accepted methodologies will change prior to implementation of final design in the future. This hydrologic investigation has utilized reasonable assumptions and levels of conservatism in the establishment of watershed boundaries and discharges to provide projections for right-of-way needs that have a strong likelihood of being adequate for future freeway construction.

PROCEDURES

Hydrologic Setting:

The Estrella Freeway Corridor traverses through roughly 39 miles of arid desert and agricultural land to the west and north of Phoenix. The climate is temperate with summer highs reaching as much as 120 degrees and winter lows dipping below freezing. Rainfall in the area averages 7.11 inches per year (verbal reference, National Weather Service).

The Corridor is impacted by a wide variety of drainage features, ranging from small local watersheds to large regional watersheds, such as the Agua Fria River (Figure 1). Drainage conditions for the Cotton Lane section also differ dramatically from those conditions present in the Agua Fria and Northwest Loop area, which extends between Grand Avenue and I-17.

The Cotton Lane section is comprised mainly of agricultural land and small farmsteads. The slope of the land is relatively flat which produces lower peak discharges and longer times of concentration. The Agua Fria and Northwest Loop area consists of natural desert and mountainous areas with few scattered areas of development. Characteristically, steeper slopes create higher peak discharges and shorter times of concentration than those of the flatter Cotton Lane section.

Watersheds:

Watershed conditions differ appreciably between the Cotton Lane section of the corridor, and the Agua Fria and Northwest Loop area. The Cotton Lane section is characterized by watersheds extending upstream to the west consisting of natural alluvial fan areas and graded farm fields on the east face of the White Tank Mountains (Figure 2). Due to the complexity of drainage across agricultural lands, watershed boundaries were determined by detailed field inspection of the area. Arterial roadways form the most common east-west watershed boundaries with Cotton Lane and various parallel roadways forming some north-south boundaries. The Beardsley Canal is significantly elevated throughout the study area and serves as a boundary until it's height decreases in the southernmost portion near I-10 and allows flow to cross it. The Trilby Wash and SCS White Tanks detention basins are assumed to be effective flood control structures which define limitations on upstream watershed boundaries. Internal watershed boundaries are valid for low flow, however, there is a strong possibility that during extreme storm events, spillover from one watershed to another may occur. The low flow, internal boundaries were utilized as a reasonable assumption with respect to anticipated future conditions.

The watersheds in the Agua Fria and Northwest Loop area are less complex and are generally comprised of more defined, naturally-shaped basins extending upstream to the north (Figure 3 and 3A). These boundaries were determined from recent aerial photographs taken of the region, U.S.G.S. quad sheets and limited field investigation, as appropriate.

Concentration points are located along each of the proposed alignments extending throughout the entire corridor based on the watershed boundary information as shown on Figures 4 & 5. In the Cotton Lane area, these concentration points typically fall in the southeastern corner of each watershed, where the majority of the flow is believed to concentrate before spilling over into adjoining watersheds. In the Agua Fria and Northwest Loop area, concentration points are located in topographical low spots of each basin.

Known Discharges:

There are four significant points of concentration where discharges are known (or previously established) within the Corridor, all of which are in the Agua Fria and Northwest Loop area.

1. The Agua Fria River has an established 100-year discharge of about 121,000 cfs based upon information obtained from the Flood Control District of Maricopa County (Concentration Point 183).

121,990

2. Construction of the New River Dam by the U.S. Army Corps of Engineers has reduced the 100-year flow for New River to 2,350 cfs immediately downstream of the dam (Concentration Point 221), (Reference 5).

3. A flood control channel was built by the U.S. Army Corps of Engineers on Skunk Creek at I-17 with the capacity to contain in excess of the 100-year discharge (Concentration Point 280), (Reference 5). Two overchutes on the Central Arizona Project Canal have a combined capacity of 16,600 cfs (Reference 5). The adopted 100-year discharge is 39,000 cfs along Skunk Creek above Adobe Dam, according to the Flood Control District of Maricopa County.

4. The outlet structure of the McMicken Dam has a capacity of 4,400 cfs (Concentration Point 284), (Reference 3 and 5).

5. The 100-year discharge collected along the McMicken Dam Outlet Channel has been estimated to be approximately 16,300 cfs at it's point of release into a natural channel (Concentration Point 151). This value represents the sum of the discharge from the dam and the flow entering the Outlet Channel via 3 overchutes along the Beardsley Canal to the north. Computations for the 3 northern watersheds are shown in Appendix B. These watershed boundaries are shown on Figure 3A.

The above 100-year discharges will be implemented in determining drainage structure sizes as appropriate along freeway alignment segments due to considerations of Federal regulations, interfacing of flood control improvements, damage potential and magnitude of discharge. All other drainage structures are proposed to be designed on a 50-year storm event.

Discharge Computations:

The remainder of the concentration points within the Corridor, for which established discharges to not exist, were evaluated using a general procedure discussed in a meeting with Mr. Ray Jordan and Mr. Art May from the Arizona Department of Transportation (ADOT) held on May 28, 1987. The procedures outlined in the U.S. Department of Agriculture, Soil Conservation Service Technical Release No. 55, entitled, Urban Hydrology for Small Watersheds (TR-55) were implemented to determine the 50-year peak discharges for a sample set of watersheds (Reference 7). Rainfall data used in the TR-55 computations were obtained from the Arizona Highway Department publication entitled, Hydrologic Design for Highway Drainage in Arizona (Reference 1). Eight sample watersheds were evaluated, four of which were located within the Cotton Lane area and four within the Agua Fria and Northwest Loop area.

In the Cotton Lane section, the watersheds ranged in size from 320 acres to 2,880 acres, and produced 50-year discharges ranging from 259 cfs to 779 cfs. In the Agua Fria and Northwest Loop area, the watersheds ranged in size from 13 acres to 2,099 acres, and produced 50-year discharges of 28 cfs to 2,461 cfs. The Agua Fria and Northwest Loop area has a tendency to produce higher discharge rates per acre than the Cotton Lane section. Representative TR-55 work sheets are contained in Appendix A.

The resultant discharges derived from the TR-55 computations were plotted on log-log paper (2 x 2 cycles for the Cotton Lane section and 3 x 3 cycles for the Northwest Loop area), and a curve of best fit was drawn for each group of four values. A second curve was then drawn at 20% above the actual computed values to apply a reasonable factor of safety (Figure 6). The 20% conservative upper curve for the 2 characteristic areas was then used to compute discharges at all of the respective concentration points (excluding those having adopted discharge values), based on the area of their contributing watersheds (Appendix C). This generalized method of obtaining discharges was deemed acceptable by ADOT based on the fact that present hydrologic conditions and accepted methodologies will change prior to the implementation of final design in the future.

A more detailed study will be conducted in the future during the final design phase of the Estrella Freeway.

Drainage Structures:

Drainage structure sizes are not presented in this report and will be represented to the level of detail required in later versions of the Location Design Report for the Estrella Freeway. Drainage structures, such as channels, culverts, bridges and detention/retention facilities are to be sized to accommodate the discharges computed for each concentration point. Culverts will be sized using procedures outlined in the U.S. Department of Transportation, Hydraulic Charts for the Selection of Highway Culverts (HEC-5) publication (Reference 8), and channels are to be sized using the Manning's Equation. Bridge lengths are to be calculated by means of the U.S. Army Corps of Engineers HEC-2 Water Surface Profiles generalized computer program. Most detention/retention facilities are to be sized according to methods outlined in the TR-55 manual (Reference 4). However, when the desired ratio of peak outflow to peak inflow is greater than 0.8, the method from the draft version of Pima County's Department of Transportation report entitled, Drainage and Channel Design Standards for Local Drainage, Section VI will be used (Reference 2). The times to peak for this method will be obtained from Hydrologic Design for Highway Drainage, (Reference 1).

CONCLUSIONS

1. This hydrologic investigation has been prepared to establish discharges to be incorporated into the concept and preliminary design of drainage improvements associated with the Estrella Freeway Route Location Study.

2. Established discharges have been adopted for major washes and watercourses when available, as appropriate.

3. For watersheds where hydrologic information is presently unavailable, discharges have been computed based on the development of simplified drainage area/discharge curves as contained in this report. One curve (each) was developed for watersheds impacting the Cotton Lane section, and the Agua Fria and Northwest Loop area, based on a sample set of watershed computations using TR-55 methodologies. A 20% "safety factor" increase was applied to all discharges computed via this simplified procedure.

4. The 50-year discharge will be used for the sizing of drainage structures, with the exception of the Agua Fria River, New River and the natural channel outletting the McMicken Dam Outlet Channel. In these instances, the 100-year discharge will be used, based on considerations of Federal regulations, interfacing of flood control improvements, damage potential and magnitude of discharge.

REFERENCES

1) Arizona Highway Department, "Hydrologic Design for Highway Drainage in Arizona," December 1968, (Revised June 1975).

2) Pima County Department of Transportation and Flood Control District, "Drainage and Channel Design Standards for Local Drainage," (draft version), Section VI, June 1984.

3) Sergent, Hauskins and Beckwith, "McMicken Dam Restoration Study", 1983.

4) U.S. Army Corps of Engineers, Hydrologic Engineering Center, "HEC-2 Water Surface Profiles, November 1976.

5) U.S. Army Corps of Engineers, "New River Dam, Including New River to Skunk Creek," November 1982.

6) U.S. Bureau of Reclamation, Central Arizona Project, "Location Map, Granite Reef Agueduct Reach 10", June 1980.

7) U.S. Department of Agriculture, Soil Conservation Service, Technical Release No. 55, "Urban Hydrology for Small Watersheds," June 1986.

8) U.S. Department of Transportation, Hydraulic Engineering Circular No. 5, "Hydraulic Charts for the Selection of Highway Culverts," December 1965.

9) U.S. Geological Survey, Avondale SW, Baldy Mountain, Biscuit Flat, Calderwood Butte, Daisy Mountain, Hedgepeth Hills, Hieroglyphic Mountains SW, McMicken Dam, New River, New River SE, Perryville, Union Hills, and Waddell 7.5 Minute Quadrangle Maps.

FIGURES

5062 North 19th Avenue
Phoenix, Arizona 85015
(602) 242-2999

CELLA BARR ASSOCIATES

OHN

November 4, 1987

Mr. Ray Jordan, P.E.
Arizona Department of Transportation (ADOT)
205 South 17th Avenue, Room 216E
Phoenix, Arizona 85007

Re: Estrella Freeway - Hydrologic Investigation Report
CBA File No. 40955-02-30

Dear Mr. Jordan:

We are submitting this letter to respond to each of the review comments contained in your memorandum dated September 2, 1987 pertaining to the Estrella Freeway - Hydrologic Investigation Report, which we submitted to your office on July 14. We are responding to your comments in this manner in accordance with discussions held during our October 13 monthly meeting for this project.

The following is a brief discussion of each of your comment items:

Item No. 1

You have indicated that the hydrologic investigation appears to conform with procedures recommended and established during our earlier meeting with you and Mr. Art May on May 28, 1987. I don't believe we will dispute this assessment.

Item No. 2

According to the report entitled New River Dam, Including New River to Skunk Creek, Design Memorandum No. 3, U.S. Army Corps of Engineers, November, 1982, the emergency spillway for New River Dam would pass a peak flow rate of 29,850 cfs during the Probable Maximum Flood (PMF). The report also indicates that there would not be any flow over the emergency spillway during the 100-year flood or even the Standard Project Flood as their respective minor outflows (less than 3,000 cfs) are controlled by the constructed outlet conduit in the main embankment.

You have expressed the opinion (as did the staff of the Flood Control District of Maricopa County in a separate meeting) that the design of the Estrella Freeway should not impact the functional capability of the New River Dam emergency spillway. We agree, and in our professional opinion, we do not feel that any of the freeway alignments proposed in this area will have an adverse impact on the ability of the emergency spillway to function for the following reasons:

a. The impacted alignment segments (17 and 18) are located 1,200 feet and 2,600 feet downstream of the emergency spillway, respectively. The crest elevation of the emergency spillway is 1,456.2 feet. The proposed elevations for the immediate downstream roadway segments are approximately 1,405 feet for Segment 17 and 1,380 feet for Segment 18. Thus, the minimum drop from the spillway crest to any obstruction produced by roadway alignments is in excess of 51 feet.

b. Segment 17 has a maximum fill height of 15 feet above the local low spot immediately downstream of the emergency spillway. Segment 18 has a maximum fill height of 8 feet. Since drainage structures at these locations will only be sized to accommodate the 50-year discharge generated by a minor local watershed, backwater ponding will be temporarily induced along the upstream side of these roadway segments during more extreme flooding events. However, the discharge of the PMF through the emergency spillway (29,850 cfs) will result in the obliteration, or washout, of the segment of the freeway in its downstream path, as the roadway drainage system has not even remotely been designed to accommodate this flow.

Item No. 3

A 50-year design frequency will not be utilized for onsite roadway drainage unless the roadway is depressed. A 50-year design frequency will be utilized for offsite drainage, except at the locations noted in the report, as long as ADOT can be assured that during the 100-year event, flooding of adjacent properties outside of the proposed freeway right-of-way has not been increased.

Item No. 4

The following describes procedures which have been used for detention basin sizing of single basin systems comprising the "pass thru" concept for control of drainage impacting the Cotton Lane segments:

Chapter 6 in Urban Hydrology for Small Watersheds (TR-55) contains a manual method for quick estimates of the effects of temporary detention on peak discharges. This method is principally used to develop preliminary estimates of storage volumes and peak outflow discharges and is also adequate for final design of small detention basins. Worksheet 6a was used to calculate the storage volume required to reduce the peak discharges at selected locations to an acceptable value. The necessary volume was derived in acre-feet and a rough set of detention basin dimensions were calculated. These dimensions took into account property lines, grades, existing right-of-way and the future roadway.

Available charts in the TR-55 manual do not extend beyond a desired ratio of peak outflow to peak inflow greater than 0.8. In those instances where the TR-55 quick estimate procedures could not be used, similar procedures prescribed in the draft version of Pima County's manual entitled Drainage and Channel Design Standards for Local Drainage, Section VI were used for detention basin sizing.

The following describes procedures which will be used for detention basin sizing and flood routing comprising the "continuous channel with various amounts of storage" concept for control of drainage impacting the Cotton Lane segments:

We are in the process of investigating the concept of a continuous channel (with possible intermediate detention/retention structures) extending southward along the Cotton Lane segments for discharge into the Gila River. This concept will be evaluated and compared with the incremental "pass through" concept previously presented to ADOT, in terms of overall costs, including construction and right-of-way. Flood routings for multiple detention basin concepts will be accomplished using a preliminary level of detail application of the TR-20 or HEC-1 procedures. This concept will be presented to you in the near future.

Phase III:

As a part of Phase III, hydrograph routings for the selected drainage and detention basin scheme along the Cotton Lane portion of the Estrella Freeway will be performed to a greater level of detail using TR-20, HEC-1, or other appropriate methodologies to provide a more accurate determination of right-of-way needs.

We hope that this letter satisfactorily addresses your September 2, 1987 review comments pertaining to our submitted hydrologic investigation for the Estrella Freeway. If you have any questions or additional comments, please do not hesitate to call.

Sincerely,

CELLA BARR ASSOCIATES

James H. Nelson, P.E.
Hydrology Task Leader

JHN-47/ef

cc: Mr. Art May, ADOT
Mr. John Louis, ADOT
Mr. Jim Lee, CBA
Mr. Dave Potter, CBA
Ms. Melinda Cuff, CBA
Mr. Greg Evans, KHA

LEGEND

STUDY CORRIDOR

ESTRELLA FREEWAY

0 1 5 10 MILES

VICINITY MAP

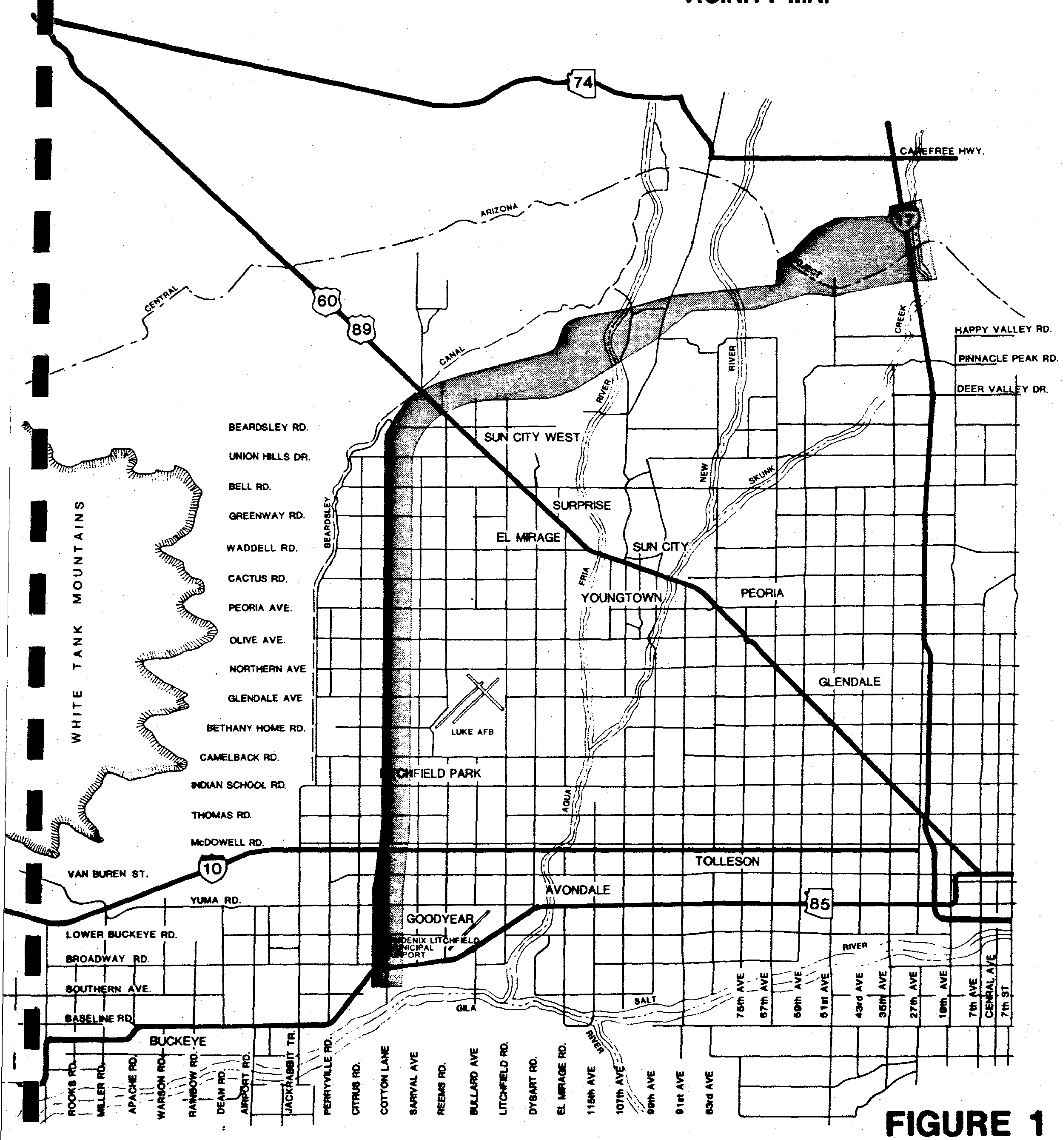


FIGURE 1

00 - 4500
.107 - 4460
.159 - 4500
.238 -

Jackie

Iloilo

10-8day

- SPRR -

- WLB -

- Jim Nelson — 242 2999

Undetailed - built — 20 -
- estimated -
Sample 4 us dated to Cottonwood loop
4 NW loop.
dev- curved DA - Q
added 50% - used

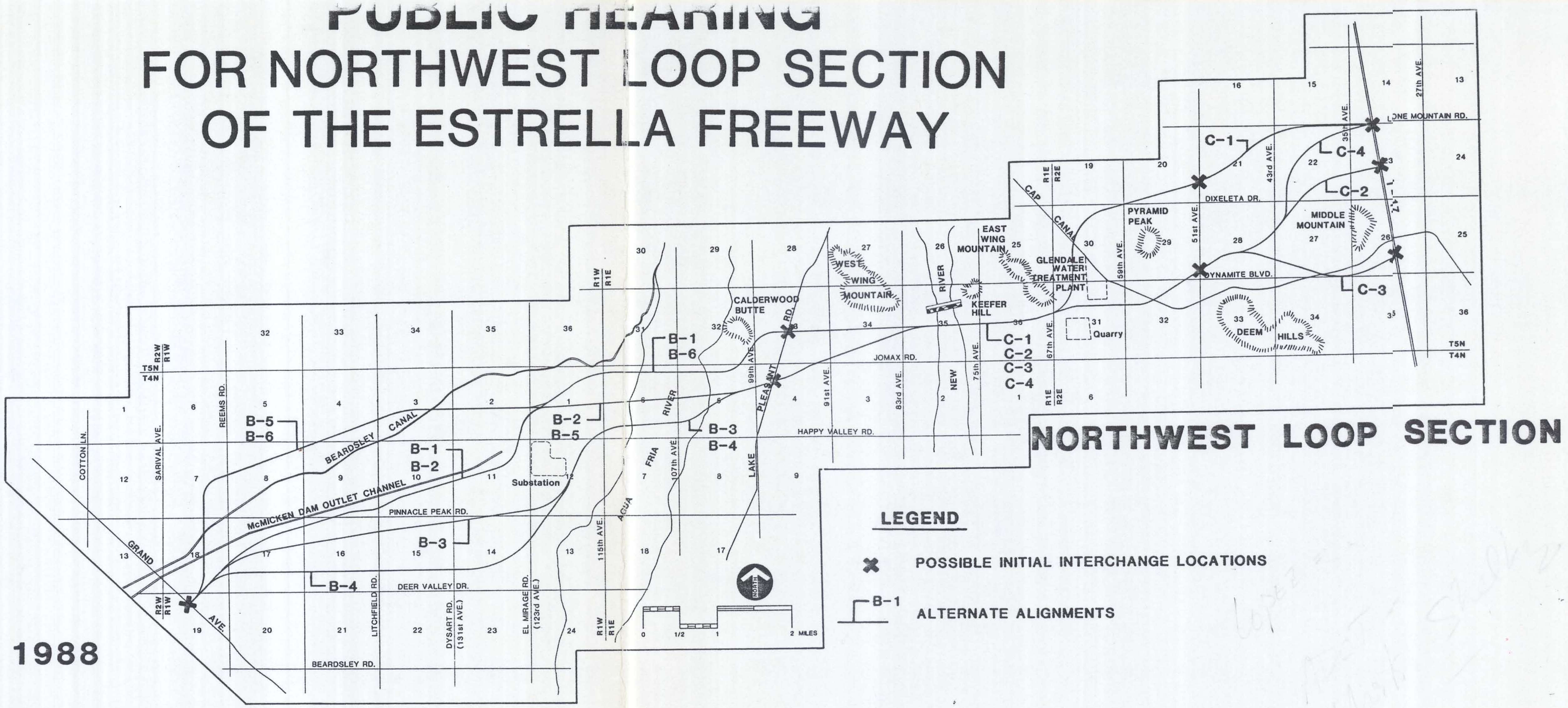
300 cfs pts -

2. 5000 - 3. over chut
- 15,000 cfs -

George Lopez - Cepero
Bridge Drainage Eng. Supervisor
ADOT

* Marv Sheldon 255-7481
Ray Jordon - 2557197
* Art May

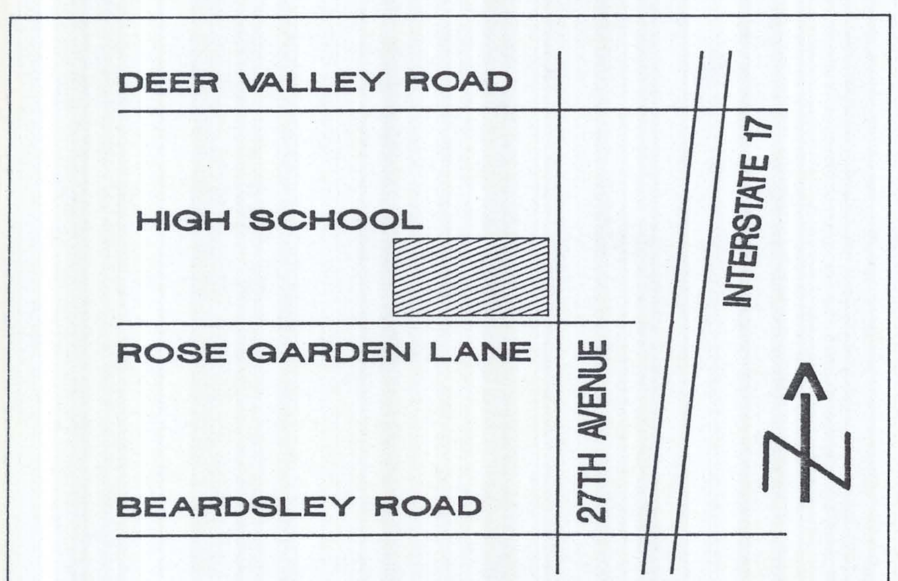
PUBLIC HEARING
FOR NORTHWEST LOOP SECTION OF THE ESTRELLA FREEWAY



TUESDAY MAY 17, 1988

5:30 PM VIEWING OF EXHIBITS
7:30 PM PUBLIC HEARING

BARRY GOLDWATER HIGH SCHOOL
2820 WEST ROSE GARDEN LANE



Public Hearing for Northwest Loop Section

The public hearing for the Northwest Loop section of the Estrella Freeway will be held on Tuesday, May 17, 1988. The Barry Goldwater High School auditorium is the location of this hearing which officially documents all comments from public and private concerns. A map showing the location and schedule is shown to the left.

The purpose of the hearing is to present for public discussion alternative alignments for that portion of the Estrella Freeway between Grand Avenue and Interstate 17. Preliminary Design concepts will also be reviewed.

Initially, the Estrella Freeway will be a four-lane facility with possible initial interchange locations at Grand Avenue, Lake Pleasant Road, 51st Avenue and I-17. Design of the freeway will accommodate expansion to an eight-lane freeway.

The Northwest Loop Section Draft Environmental Assessment Report may be reviewed at ADOT, Cella Barr Associates, City of Surprise and City of Peoria.

New right-of-way will be required for the construction of this project. The right-of-way process will be discussed at the hearing.

Additional written statements will be received by the Arizona Department of Transportation through May 30, 1988. These statements should be addressed to:

Environmental Planning Services
Arizona Department of Transportation
205 South 17th Avenue, Room 240E
Phoenix, Arizona 85007

Newsletter Available

The public is encouraged to stay involved in the various activities connected with the location of the Estrella Freeway. If you are not on the newsletter mailing list, please call the Arizona Department of Transportation or Cella Barr Associates at the number below.

If you have any questions, at any time, feel free to contact:

Art May
Arizona Department of Transportation
205 South 17th Avenue, Room 216E
Phoenix, Arizona 85007
(602) 255-7545

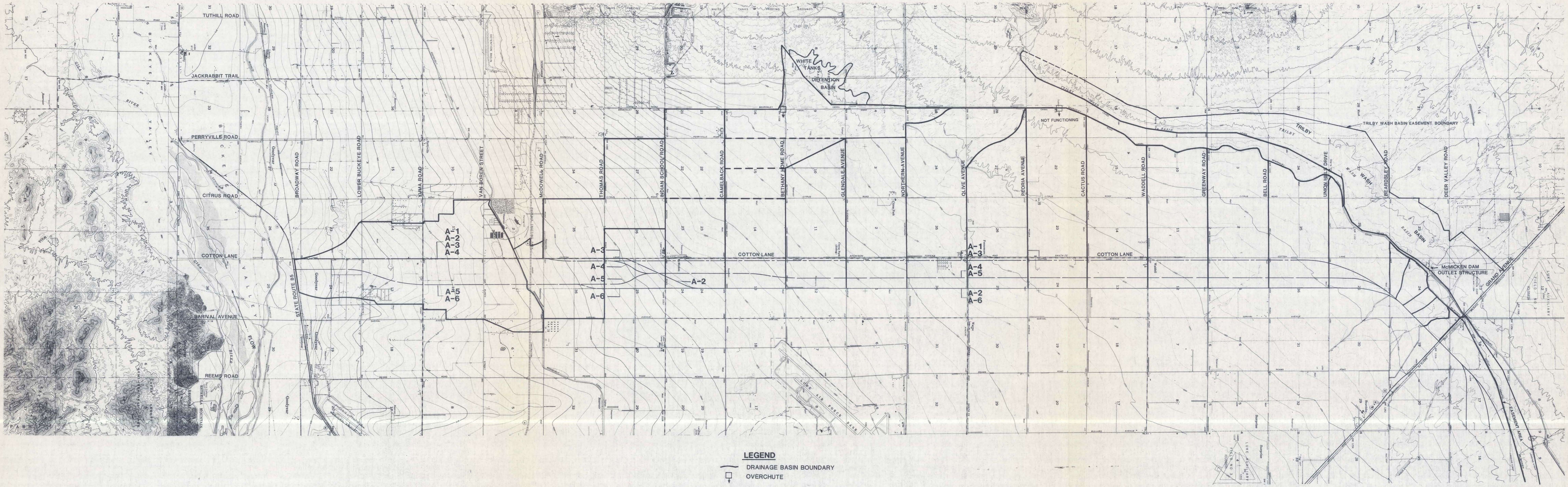
or

David E. Potter
Cella Barr Associates
5062 North 19th Avenue
Phoenix, Arizona 85015
(602) 242-2999

Requested copy of Draft EA 5/12/88

ESTRELLA FREEWAY

DRAINAGE BASIN BOUNDARIES



LEGEND

DRAINAGE BASIN BOUNDARY

OVERCHUTE

FIGURE 2

ESTRELLA FREEWAY

JULY 1987

ESTRELLA FREEWAY

DRAINAGE BASIN BOUNDARIES

FIGURE 3

ESTRELLA FREEWAY

JULY 1987

FIGURE 3A

WATERSHEDS CONTRIBUTING TO

McMICKEN DAM OUTLET CHANNEL

ESTRELLA FREEWAY

DRAINAGE CONCENTRATION POINTS

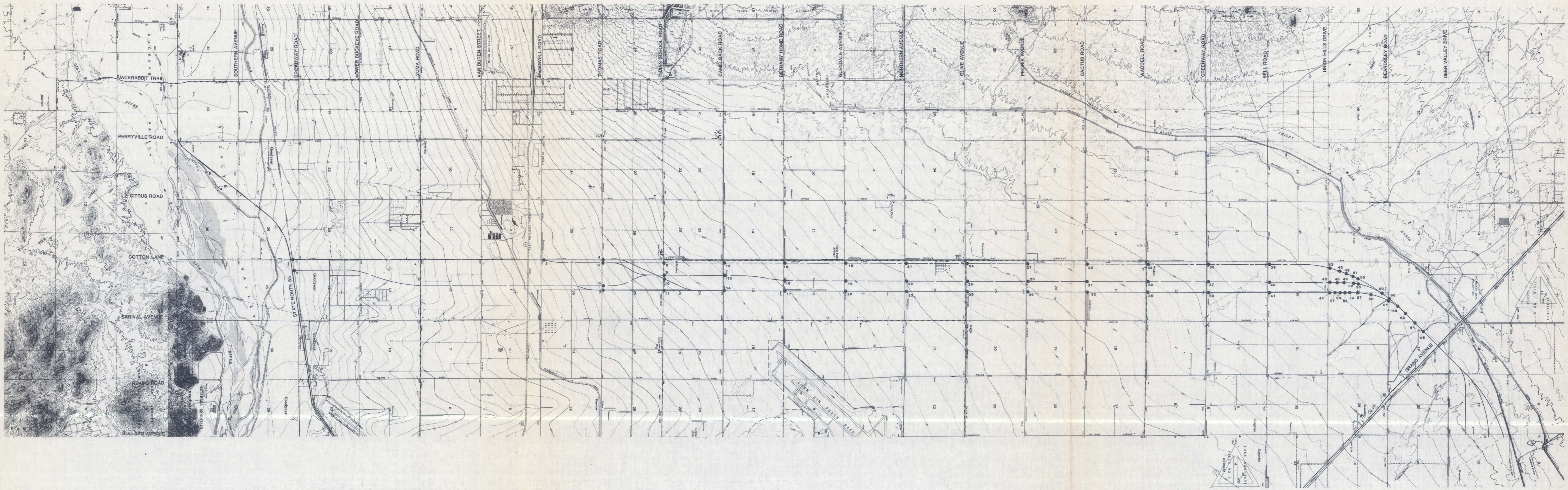


FIGURE 4

ESTRELLA FREEWAY

JULY 1987

ESTRELLA FREEWAY

DRAINAGE CONCENTRATION POINTS

FIGURE 5

ESTRELLA FREEWAY

JULY 1987

ESTRELLA FREEWAY

COTTON LANE SECTION

50-YEAR DRAINAGE AREA/DISCHARGE CURVES

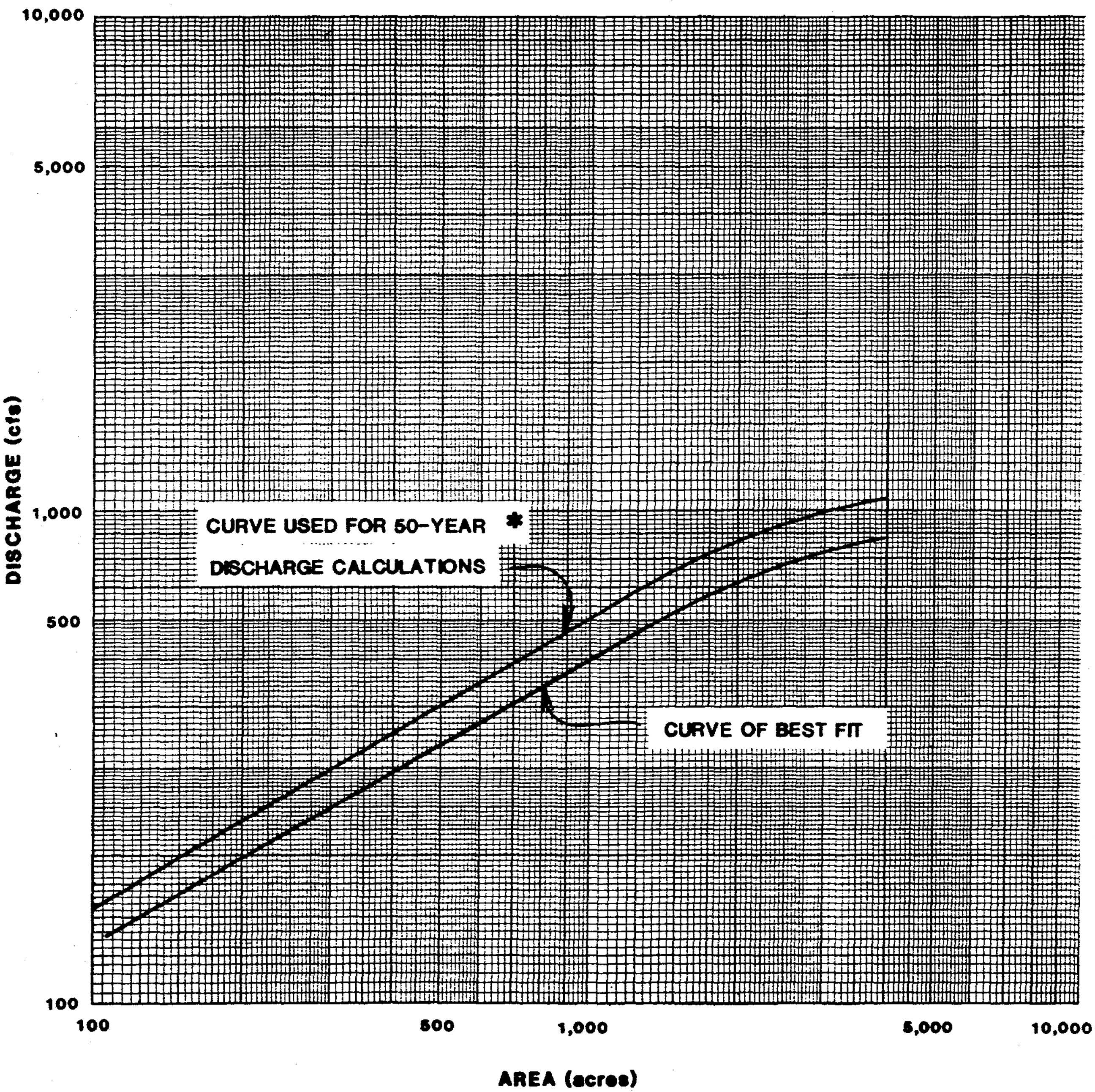


FIGURE 6

* DERIVED BY ADDING 20% SAFETY FACTOR TO CURVE OF BEST FIT

ESTRELLA FREEWAY

NORTHWEST LOOP AREA

50-YEAR DRAINAGE AREA/DISCHARGE CURVES

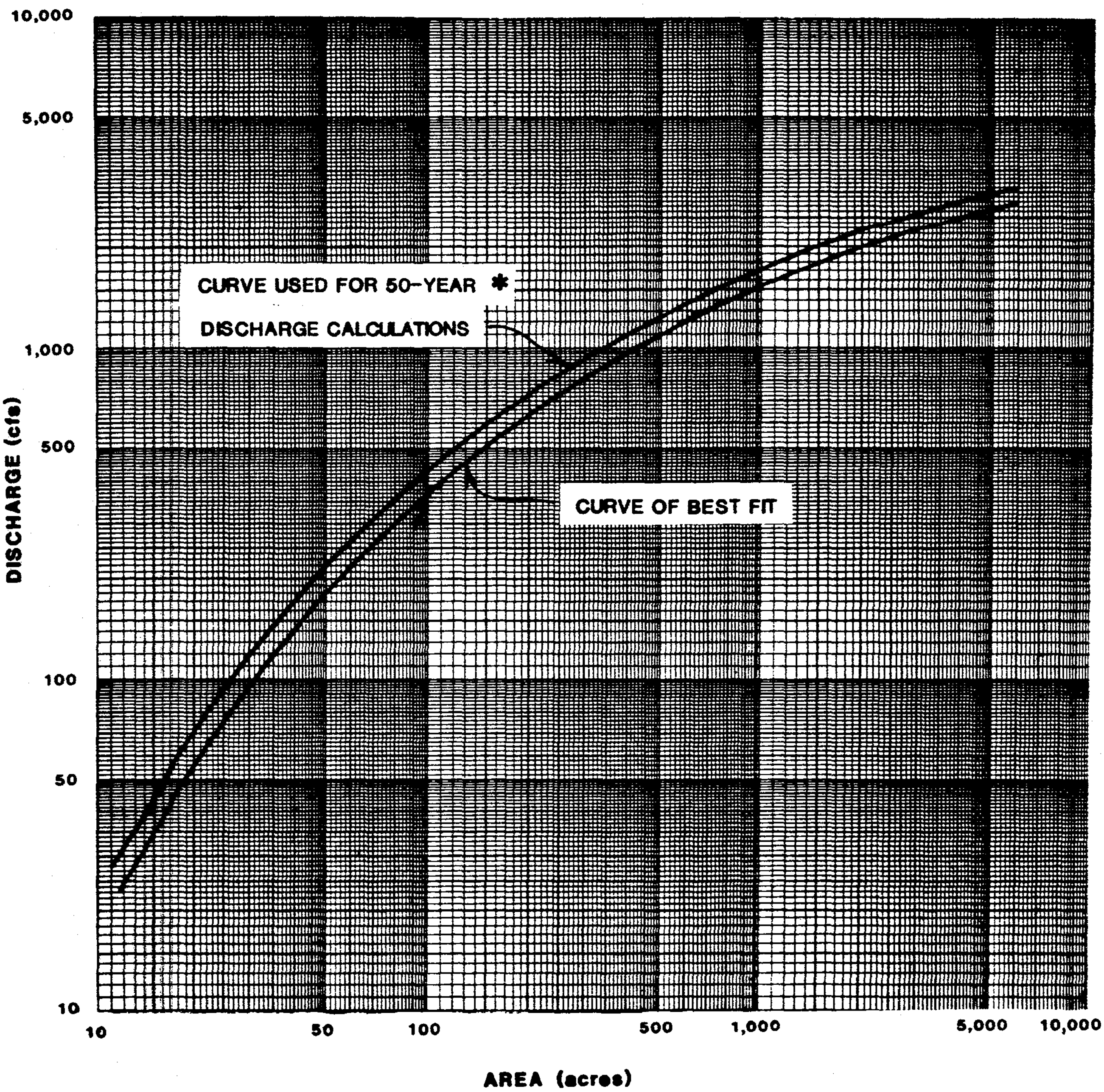


FIGURE 7

* DERIVED BY ADDING 20% SAFETY FACTOR TO CURVE OF BEST FIT

APPENDIX A

SAMPLE TR-55 CALCULATIONS AND WATERSHEDS FOR DRAINAGE AREA/DISCHARGE CURVES

Worksheet 4: Graphical Peak Discharge method

Project Cotton Ln / NW Loop By MKC Date 4/15/87

Location McDowell Rd. & Cotton Ln Checked ____ Date ____

Circle one: (Present) Developed Conc. pt. 3 - figures 2 & 4

1. Data:

Drainage area .... A_m = 2.50 mi^2 (acres/640)

Runoff curve number .... CN = 87 (From worksheet 2)

Time of concentration .. T_c = 4.26 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0.1 percent of A_m (____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	50		
3. Rainfall, P (24-hour)	in	3.49		
4. Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.299		
5. Compute I_a/P		0.09		
6. Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	127		
7. Runoff, Q .... (From worksheet 2).	in	2.17		
8. Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		0.985		
9. Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	679		

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Cotton Ln / NW Loop By MKC Date 4/15/87

Location McDowell Rd. & Cotton Ln Checked ____ Date ____

Circle one: (Present) Developed — Conc. pt. 3

Circle one: (T_c) T_t through subarea — figures 2 & 4

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Seems too low for sheet flow!

(OK for Cultivated soil w/Residue cover ≤ 20%)

Sheet flow (Applicable to T_c only)

		Unit	Segment ID		Total
1.	Surface description (table 3-1)		Cult. Soil / res. ≤ 20%		
2.	Manning's roughness coeff., n (table 3-1)		0.06		
3.	Flow length, L (total L ≤ 300 ft)	ft	300		
4.	Two-yr 24-hr rainfall, P_2	in	1.41		
5.	Land slope, s	ft/ft	0.009		
6.	$T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr	0.39	+	= 0.39

Shallow concentrated flow

		Unit	Segment ID		Total
7.	Surface description (paved or unpaved)		unpaved		
8.	Flow length, L	ft	17,160		
9.	Watercourse slope, s	ft/ft	0.006		
10.	Average velocity, V (figure 3-1)	ft/s	1.23		
11.	$T_t = \frac{L}{3600\,V}$ Compute T_t	hr	3.87	+	= 3.87

Channel flow

		Unit	Segment ID		Total
12.	Cross sectional flow area, a	ft^2			
13.	Wetted perimeter, p_w	ft			
14.	Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft			
15.	Channel slope, s	ft/ft			
16.	Manning's roughness coeff., n				
17.	$V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft/s			
18.	Flow length, L	ft			
19.	$T_t = \frac{L}{3600\,V}$ Compute T_t	hr		+	=

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) .... hr **4.26**

SCS soil maps show B soils

Worksheet 2: Runoff curve number and runoff

Project Cotton Ln / NW Loops By MKC Date 4/14/87

Location McDowell Rd. & Cotton Ln Checked ____ Date ____

Circle one: (Present) Developed conc. pt. 3 - figures 2 & 4

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/ Table 2-2	Fig. 2-3	Fig. 2-4	Area ☐ acres ☒ mi^2 ☐ %	Product of CN x area	
C	SR Crops, good (78)	85			1.75	148.75	136.5
C	Fallow, bare soil (86)	91			0.67	60.97	57.62
C	Prison Bldgs. & yards? (81)	86			0.08	6.88	6.48
				Totals =	2.50	216.60	200.6

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{216.60}{2.50} = 86.6$; Use CN = 87 (80)

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	50		
Rainfall, P (24-hour)	in	3.49		
Runoff, Q (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)	in	2.17 (2.60)		

Worksheet 4: Graphical Peak Discharge method

Project Cotton Ln / NW Loop By MKC Date 4/14/87

Location Thomas Rd. & Cotton Ln Checked ____ Date ____

Circle one: (Present) Developed conc. pt. 4 - figures 2&4

1. Data:

Drainage area .... A_m = 0.5 mi^2 (acres/640)

Runoff curve number .... CN = 85 (From worksheet 2)

Time of concentration .. T_c = 1.67 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	50		
3. Rainfall, P (24-hour)	in	3.49		
4. Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.353		
5. Compute I_a/P		0.10		
6. Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	258		
7. Runoff, Q .... (From worksheet 2).	in	2.01		
8. Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9. Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	259		

(210-VI-TR-55, Second Ed., June 1986)

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Cotton Ln/NW Loop By MKC Date 4/14/87

Location Thomas Rd. & Cotton Ln Checked ____ Date ____

Circle one: (Present) Developed — conc. pt. 4

Circle one: (T_c) T_t through subarea — figures 2 & 4

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)

Item	Unit	Segment ID	Segment ID	Total
1. Surface description (table 3-1)		Cult. Soil Res. ≤20%		
2. Manning's roughness coeff., n (table 3-1) ..		0.06		
3. Flow length, L (total L ≤ 300 ft)	ft	300		
4. Two-yr 24-hr rainfall, P_2	in	1.41		
5. Land slope, s	ft/ft	0.008		
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\, s^{0.4}}$ Compute T_t	hr	0.41	+	= 0.41

Shallow concentrated flow

Item	Unit	Segment ID	Segment ID	Total
7. Surface description (paved or unpaved)		unpaved		
8. Flow length, L	ft	5,600		
9. Watercourse slope, s	ft/ft	0.006		
10. Average velocity, V (figure 3-1)	ft/s	1.23		
11. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr	1.26	+	= 1.26

Channel flow

Item	Unit	Segment ID	Segment ID	Total
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, p_w	ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft			
15. Channel slope, s	ft/ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\, r^{2/3}\, s^{1/2}}{n}$ Compute V	ft/s			
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr		+	=

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) .... hr 1.67

Worksheet 2: Runoff curve number and runoff

Project Cotton Ln / NW Loop By MKC Date 4/14/87

Location Thomas Rd. & Cotton Ln Checked ____ Date ____

Circle one: (Present) Developed Conc. pt. 4 - figures 2 & 4

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/ Table 2-2	CN 1/ Fig. 2-3	CN 1/ Fig. 2-4	Area ☐ acres ☒ mi² ☐ %	Product of CN x area
C	SR Crops, good	85			0.5	42.5
				Totals =	0.5	42.5

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{42.5}{0.5} = 85.0$; Use CN = 85

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	50		
Rainfall, P (24-hour)	in	3.49		
Runoff, Q (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)	in	2.01		

Worksheet 4: Graphical Peak Discharge method

Project Cotton Ln / NW Loop By MKC Date 4/16/87

Location Camelback Rd. & Cotton Ln Checked ____ Date ____

Circle one: (Present) Developed Conc. pt. 12 - figures 2&4

1. Data:

Drainage area .... A_m = 4.50 mi^2 (acres/640)

Runoff curve number .... CN = 85 (From worksheet 2)

Time of concentration .. T_c = 6.86 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	50		
3. Rainfall, P (24-hour)	in	3.56		
4. Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.353		
5. Compute I_a/P		0.10		
6. Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	84		
7. Runoff, Q .... (From worksheet 2).	in	2.06		
8. Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9. Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	779		

(210-VI-TR-55, Second Ed., June 1986)

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Cotton Ln / NW Loop By MKC Date 4/16/87

Location Camelback Rd. & Cotton Ln Checked ____ Date ____

Circle one: (Present) Developed Conc. pt. 12

Circle one: (T_c) T_t through subarea figures 2 & 4

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)

	Unit	Segment ID		
1. Surface description (table 3-1)		scattered brush, weeds		
2. Manning's roughness coeff., n (table 3-1)		0.035		
3. Flow length, L (total L $\leq$ 300 ft)	ft	300		
4. Two-yr 24-hr rainfall, P_2	in	1.46		
5. Land slope, s	ft/ft	0.01		
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr	0.24	+	= 0.24

Shallow concentrated flow

	Unit	Segment ID		
7. Surface description (paved or unpaved)		unpaved		
8. Flow length, L	ft	29,300		
9. Watercourse slope, s	ft/ft	0.006		
10. Average velocity, V (figure 3-1)	ft/s	1.23		
11. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr	6.62	+	= 6.62

Channel flow

	Unit	Segment ID		
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, p_w	ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft			
15. Channel slope, s	ft/ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft/s			
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr		+	=

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) .... hr 6.86

Worksheet 2: Runoff curve number and runoff

Project Cotton Ln / NW Loop By MKC Date 4/16/87

Location Camelback Rd. & Cotton Ln Checked ______ Date ______

Circle one: (Present) Developed conc. pt. 12 - figures 2 & 4

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN [1/] Table 2-2	CN [1/] Fig. 2-3	CN [1/] Fig. 2-4	Area ☐ acres ☒ mi^2 ☐ %	Product of CN x area
C	Desert Shrub, poor	85			2.50	212.50
C	SR Crops, good	85			2.00	170.0
				Totals =	4.50	382.50

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = $\frac{382.50}{4.50}$ = 85.0; Use CN = 85

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	50		
Rainfall, P (24-hour)	in	3.56		
Runoff, Q (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)	in	2.06		

Worksheet 4: Graphical Peak Discharge method

Project Cotton Ln / NW Loop By MKC Date 4/14/87

Location Bethany Home & Cotton Ln Checked ____ Date ____

Circle one: (Present) Developed conc. pt. 15 - figures 2&4

1. Data:

Drainage area .... A_m = 1.71 mi^2 (acres/640)

Runoff curve number .... CN = 84 (From worksheet 2)

Time of concentration .. T_c = 3.25 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	50		
3. Rainfall, P (24-hour)	in	3.49		
4. Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.381		
5. Compute I_a/P		0.11		
6. Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	157		
7. Runoff, Q .... (From worksheet 2).	in	1.95		
8. Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9. Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	524		

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Cotton Ln / NW Loop By MKC Date 4/14/87

Location Bethany Home & Cotton Ln Checked ____ Date ____

Circle one: (Present) Developed — conc. pt. 15

Circle one: (T_c) T_t through subarea — figures 2 & 4

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)	Unit	Segment 1	Segment 2	Total
Segment ID				
1. Surface description (table 3-1)		Cult. Soil res. ≤20%		
2. Manning's roughness coeff., n (table 3-1)		0.06		
3. Flow length, L (total L ≤ 300 ft)	ft	300		
4. Two-yr 24-hr rainfall, P_2	in	1.41		
5. Land slope, s	ft/ft	0.007		
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\, s^{0.4}}$ Compute T_t	hr	0.43	+	= 0.43

Shallow concentrated flow	Unit	Segment 1	Segment 2	Total
Segment ID				
7. Surface description (paved or unpaved)		unpaved		
8. Flow length, L	ft	13,600		
9. Watercourse slope, s	ft/ft	0.007		
10. Average velocity, V (figure 3-1)	ft/s	1.34		
11. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr	2.82	+	= 2.82

Channel flow	Unit	Segment 1	Segment 2	Total
Segment ID				
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, p_w	ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft			
15. Channel slope, s	ft/ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\, r^{2/3}\, s^{1/2}}{n}$ Compute V	ft/s			
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr		+	=

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) .... hr 3.25

Worksheet 2: Runoff curve number and runoff

Project Cotton Ln / NW Loop By MKC Date 4/14/87

Location Bethany Home & Cotton Ln Checked ____ Date ____

Circle one: (Present) Developed Conc. pt. 15 - figures 2&4

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN [1/] Table 2-2	CN [1/] Fig. 2-3	CN [1/] Fig. 2-4	Area ☐ acres ☒ mi^2 ☐ %	Product of CN x area
C	SR Crops, good	85			0.96	81.60
C	Farmsteads	82			0.75	61.50
				Totals =	1.71	143.10

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{143.10}{1.71} = 83.7$; Use CN = 84

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	50		
Rainfall, P (24-hour)	in	3.49		
Runoff, Q .... (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)	in	1.95		

Worksheet 4: Graphical Peak Discharge method

Project Cotton Ln / NW Loop By MKC Date 4/9/87

Location NW-1 Checked ____ Date ____

Circle one: (Present) Developed ____________

1. Data:

   Drainage area .... A_m = 1.0 mi^2 (acres/640)

   Runoff curve number .... CN = 85 (From worksheet 2)

   Time of concentration .. T_c = 0.66 hr (From worksheet 3)

   Rainfall distribution type = II (I, IA, II, III)

   Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	50		
3. Rainfall, P (24-hour)	in	3.65		
4. Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.353		
5. Compute I_a/P		0.10		
6. Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	450		
7. Runoff, Q .... (From worksheet 2).	in	2.15		
8. Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9. Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	968		

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Cotton Ln / NW Loop By MKC Date 4/9/87

Location NW-1 Checked ____ Date ____

Circle one: (Present) Developed

Circle one: (T_c) T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)

	Unit	Segment ID		
1. Surface description (table 3-1)				
2. Manning's roughness coeff., n (table 3-1)				
3. Flow length, L (total L ≤ 300 ft)	ft			
4. Two-yr 24-hr rainfall, P_2	in			
5. Land slope, s	ft/ft			
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr		+	=

Shallow concentrated flow

	Unit	Segment ID		
7. Surface description (paved or unpaved)		unpaved		
8. Flow length, L	ft	3,000		
9. Watercourse slope, s	ft/ft	0.093		
10. Average velocity, V (figure 3-1)	ft/s	4.85		
11. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr	0.172	+	= 0.172

Channel flow

	Unit	Segment ID		
12. Cross sectional flow area, a	ft^2	300		
13. Wetted perimeter, p_w	ft	150		
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft	2		
15. Channel slope, s	ft/ft	0.011		
16. Manning's roughness coeff., n		0.04		
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft/s	6.2		
18. Flow length, L	ft	11,000		
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr	0.49	+	= 0.49

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) .... hr 0.66

Worksheet 2: Runoff curve number and runoff

Project Cotton Ln / NW Loop By MKC Date 4/9/87

Location NW-1 Checked ____ Date ____

Circle one: (Present) Developed ________________

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/ Table 2-2	CN 1/ Fig. 2-3	CN 1/ Fig. 2-4	Area ☐ acres ☒ mi² ☐ %	Product of CN x area
D	Desert brush, poor	88			0.1	8.80
C	Desert brush, poor	85			0.9	76.50
				Totals =	1.0	85.30

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{85.30}{1.0} = 85.3$; Use CN = 85

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	50		
Rainfall, P (24-hour)	in	3.65		
Runoff, Q .... (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)	in	2.15		

Worksheet 4: Graphical Peak Discharge method

Project Cotton Ln / NW Loop By MKC Date 6/5/87

Location NW-2 Checked ____ Date ____

Circle one: (Present) Developed ____________________

1. Data:

   Drainage area .... A_m = 3.28 mi^2 (acres/640)

   Runoff curve number .... CN = 91 (From worksheet 2)

   Time of concentration .. T_c = 1.52 hr (From worksheet 3)

   Rainfall distribution type = II (I, IA, II, III)

   Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	50		
3. Rainfall, P (24-hour)	in	3.65		
4. Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.198		
5. Compute I_a/P		0.05		
6. Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	280		
7. Runoff, Q .... (From worksheet 2).	in	2.68		
8. Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9. Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	2461		

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Cotton Ln/NW Loop By MKC Date 6/5/87

Location NW-2 Checked ____ Date ____

Circle one: (Present) Developed

Circle one: (T_c) T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)	Unit	Segment ID		
1. Surface description (table 3-1)				
2. Manning's roughness coeff., n (table 3-1)				
3. Flow length, L (total L ≤ 300 ft)	ft			
4. Two-yr 24-hr rainfall, P_2	in			
5. Land slope, s	ft/ft			
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr		+	=

Shallow concentrated flow	Unit	Segment ID		
7. Surface description (paved or unpaved)		unpaved		
8. Flow length, L	ft	2,300		
9. Watercourse slope, s	ft/ft	0.10		
10. Average velocity, V (figure 3-1)	ft/s	5.20		
11. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr	0.12	+	= 0.12

Channel flow	Unit	Segment ID		
12. Cross sectional flow area, a	ft^2	300		
13. Wetted perimeter, p_w	ft	200		
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft	1.5		
15. Channel slope, s	ft/ft	0.01		
16. Manning's roughness coeff., n		0.035		
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft/s	5.57		
18. Flow length, L	ft	28,000		
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr	1.40	+	= 1.40
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr			1.52

Worksheet 2: Runoff curve number and runoff

Project Cotton Ln / NW Loop By MKC Date 6/5/87

Location NW-2 Checked ____ Date ____

Circle one: (Present) Developed

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/ Table 2-2	CN 1/ Fig. 2-3	CN 1/ Fig. 2-4	Area ☐ acres ☒ mi² ☐ %	Product of CN x area
D	Herbaceous, poor	93			2.12	197.16
C	Herbaceous, poor	87			1.16	100.92
				Totals =	3.28	298.08

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{298.08}{3.28} = 90.9$; Use CN = 91

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	50		
Rainfall, P (24-hour)	in	3.65		
Runoff, Q (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)	in	2.68		

SAMPLE WATERSHEDS USED IN TR-55 CALCULATIONS

Worksheet 4: Graphical Peak Discharge method

Project Cotton Ln / NW Loop By MKC Date 7/15/87

Location NW 27-1 Checked ____ Date ____

Circle one: (Present) Developed ____________

1. Data:

Drainage area .... A_m = 0.02 mi^2 (acres/640)

Runoff curve number .... CN = 85 (From worksheet 2)

Time of concentration .. T_c = 0.30 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	50		
3. Rainfall, P (24-hour)	in	3.54		
4. Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.353		
5. Compute I_a/P		0.099		
6. Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	690		
7. Runoff, Q .... (From worksheet 2).	in	2.05		
8. Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9. Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	28		

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Cotton Ln / NW Loop By MKC Date 7/15/87

Location NW 27-1 Checked ____ Date ____

Circle one: (Present) Developed

Circle one: (T_c) T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)

	Unit	Segment ID		
1. Surface description (table 3-1)				
2. Manning's roughness coeff., n (table 3-1)				
3. Flow length, L (total L ≤ 300 ft)	ft			
4. Two-yr 24-hr rainfall, P_2	in			
5. Land slope, s	ft/ft			
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr		+	=

Shallow concentrated flow

	Unit	Segment ID		
7. Surface description (paved or unpaved)		unpaved		
8. Flow length, L	ft	1450		
9. Watercourse slope, s	ft/ft	0.0083		
10. Average velocity, V (figure 3-1)	ft/s	1.34		
11. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr	0.30	+	= 0.30

Channel flow

	Unit	Segment ID		
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, p_w	ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft			
15. Channel slope, s	ft/ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft/s			
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr		+	=
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr			0.30

Worksheet 2: Runoff curve number and runoff

Project Cotton Ln / NW Loop   By MKC   Date 7/15/87

Location NW 27-1   Checked ____   Date ____

Circle one: (Present) Developed ____________________

1. Runoff curve number (CN)

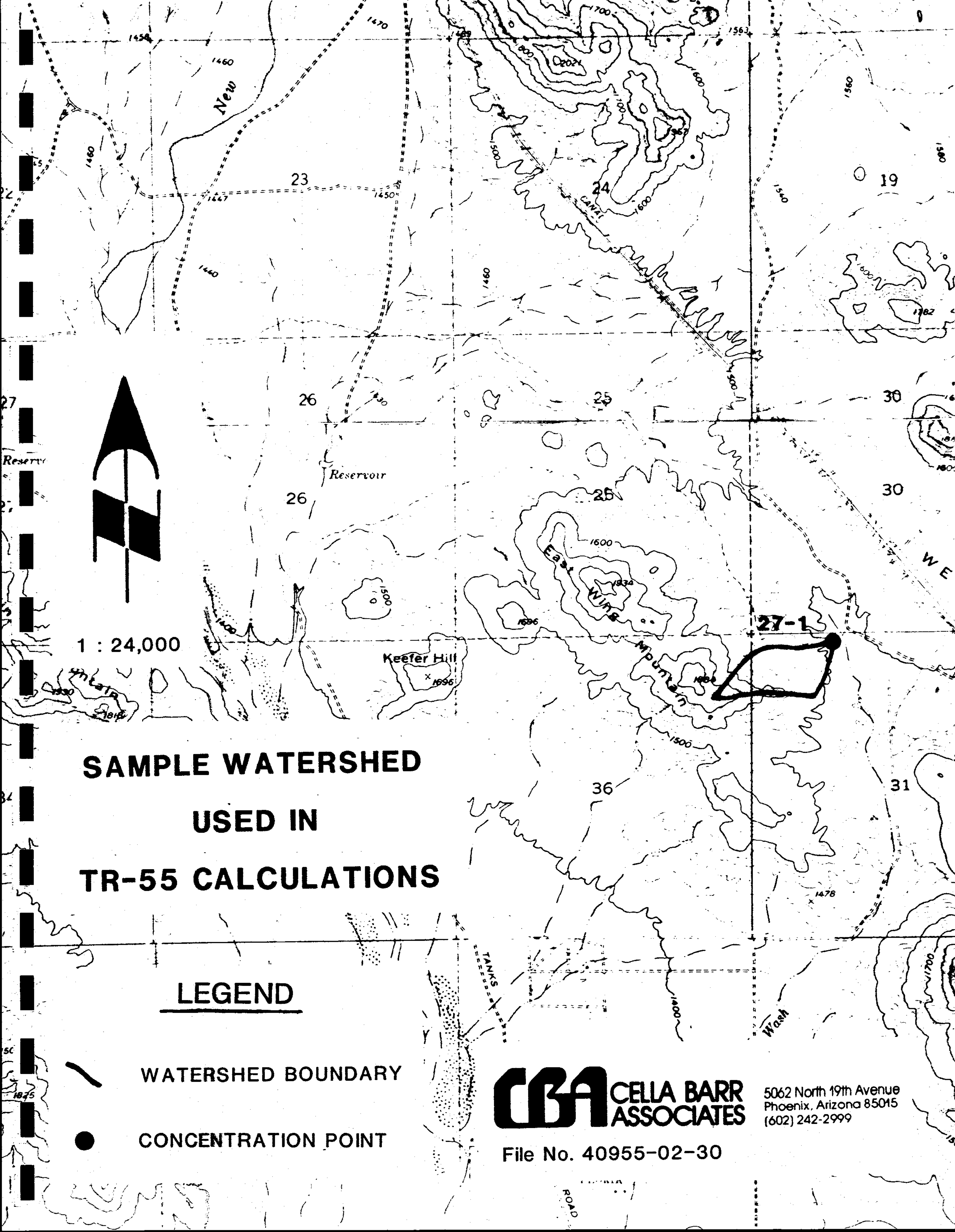
Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/ Table 2-2	CN 1/ Fig. 2-3	CN 1/ Fig. 2-4	Area ☐acres ☒mi² ☐%	Product of CN x area
C	Desert Brush, poor	85			0.02	1.70
				Totals =	0.02	1.70

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{1.70}{0.02} = 85$;   Use CN = 85

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	50		
Rainfall, P (24-hour)	in	3.54		
Runoff, Q (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)	in	2.05		



SAMPLE WATERSHED USED IN TR-55 CALCULATIONS

LEGEND

WATERSHED BOUNDARY

CONCENTRATION POINT

CELLA BARR ASSOCIATES
5062 North 19th Avenue
Phoenix, Arizona 85015
(602) 242-2999

File No. 40955-02-30

Worksheet 4: Graphical Peak Discharge method

Project Cotton Ln / NW Loop By MKC Date 7/15/87

Location NW 27-12 Checked ____ Date ____

Circle one: (Present) Developed ____

1. Data:

Drainage area .... A_m = 0.05 mi^2 (acres/640)

Runoff curve number .... CN = 86 (From worksheet 2)

Time of concentration .. T_c = 0.11 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	50		
3. Rainfall, P (24-hour)	in	3.54		
4. Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.326		
5. Compute I_a/P		0.09		
6. Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	980		
7. Runoff, Q .... (From worksheet 2).	in	2.17		
8. Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9. Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	106		

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Cotton Ln/NW Loop By MKC Date 7/15/87

Location NW 27-12 Checked ____ Date ____

Circle one: (Present) Developed

Circle one: (T_c) T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)

Item	Unit	Segment 1	Segment 2	Total
Segment ID				
1. Surface description (table 3-1)				
2. Manning's roughness coeff., n (table 3-1)				
3. Flow length, L (total L $\leq$ 300 ft)	ft			
4. Two-yr 24-hr rainfall, P_2	in			
5. Land slope, s	ft/ft			
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr		+	=

Shallow concentrated flow

Item	Unit	Segment 1	Segment 2	Total
Segment ID				
7. Surface description (paved or unpaved)		unpaved		
8. Flow length, L	ft	2300		
9. Watercourse slope, s	ft/ft	0.13		
10. Average velocity, V (figure 3-1)	ft/s	5.75		
11. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr	0.11	+	= 0.11

Channel flow

Item	Unit	Segment 1	Segment 2	Total
Segment ID				
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, p_w	ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft			
15. Channel slope, s	ft/ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft/s			
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr		+	=

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) .... hr 0.11

Worksheet 2: Runoff curve number and runoff

Project Cotton Ln/NW Loop By MKC Date 7/15/87

Location NW 27-12 Checked ____ Date ____

Circle one: (Present) Developed

1. Runoff curve number (CN)

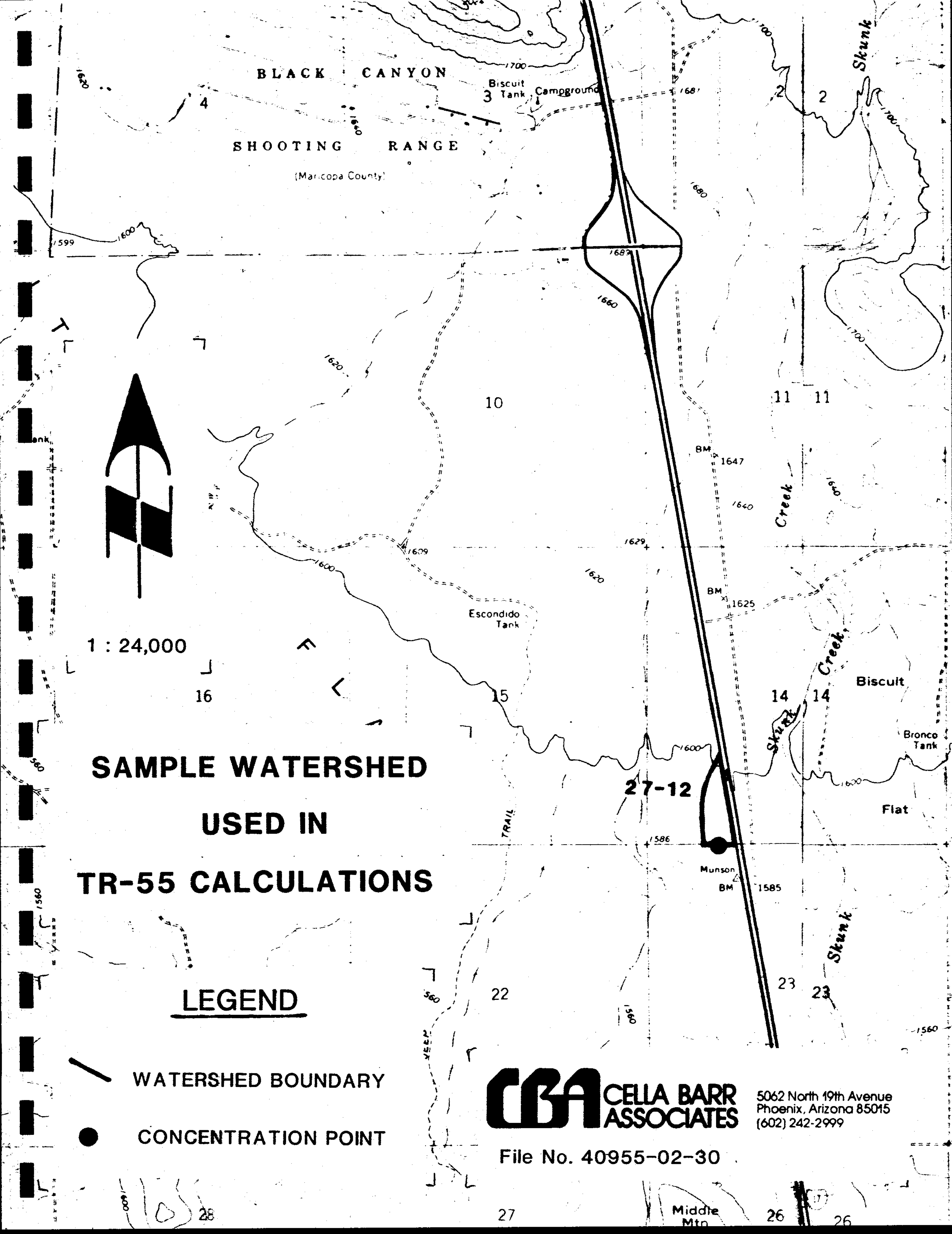
Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/ Table 2-2	CN 1/ Fig. 2-3	CN 1/ Fig. 2-4	Area ☒ acres ☐ mi² ☐ %	Product of CN x area
C	Desert Brush, poor	85			16	1360
D	Desert Brush, poor	88			15	1320
				Totals =	31	2680

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{2680}{31} = 86.4$; Use CN = 86

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	50		
Rainfall, P (24-hour)	in	3.54		
Runoff, Q .... (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)	in	2.17		



SAMPLE WATERSHED USED IN TR-55 CALCULATIONS

LEGEND

WATERSHED BOUNDARY

CONCENTRATION POINT

CELLA BARR ASSOCIATES
5062 North 19th Avenue
Phoenix, Arizona 85015
(602) 242-2999

File No. 40955-02-30

APPENDIX B

TR-55 CALCULATIONS FOR BEARDSLEY CANAL OVERCHUTES

Worksheet 4: Graphical Peak Discharge method

Project Cotton Ln / NW Loop By MKC Date 7/27/87

Location West Beardsley Overchute Checked ____ Date ______

Circle one: (Present) Developed Conc. pt. 281 - figures 3A & 5

1. Data:

Drainage area .... A_m = 29.9 mi^2 (acres/640)

Runoff curve number .... CN = 86 (From worksheet 2)

Time of concentration .. T_c = 14.78 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	50		
3. Rainfall, P (24-hour)	in	3.6		
4. Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.326		
5. Compute I_a/P		0.091		
6. Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	60		
7. Runoff, Q .... (From worksheet 2).	in	2.13		
8. Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9. Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	3821		

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Cotton Ln/NW Loop By MKC Date 7/27/87

Location West Beardsley Overchute Checked ____ Date ______

Circle one: (Present) Developed — Conc. pt. 281

Circle one: (T_c) T_t through subarea — figures 3A & 5

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)

Item	Units	Segment ID	Segment ID	Total
1. Surface description (table 3-1)				
2. Manning's roughness coeff., n (table 3-1)				
3. Flow length, L (total L $\leq$ 300 ft)	ft			
4. Two-yr 24-hr rainfall, P_2	in			
5. Land slope, s	ft/ft			
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T_t	hr		+	=

Shallow concentrated flow

Item	Units	Segment ID	Segment ID	Total
7. Surface description (paved or unpaved)		unpaved		
8. Flow length, L	ft	127,200		
9. Watercourse slope, s	ft/ft	0.022		
10. Average velocity, V (figure 3-1)	ft/s	2.39		
11. $T_t = \frac{L}{3600 V}$ Compute T_t	hr	14.78	+	= 14.78

Channel flow

Item	Units	Segment ID	Segment ID	Total
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, P_w	ft			
14. Hydraulic radius, $r = \frac{a}{P_w}$ Compute r	ft			
15. Channel slope, s	ft/ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V	ft/s			
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600 V}$ Compute T_t	hr		+	=

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) .... hr 14.78

Worksheet 2: Runoff curve number and runoff

Project Cotton Ln/NW Loop By MKC Date 7/27/87

Location West Beardsley Overchute Checked ____ Date ____

Circle one: (Present) Developed Conc. pt. 281- figures 3A & 5

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/ Table 2-2	CN 1/ Fig. 2-3	CN 1/ Fig. 2-4	Area ☐ acres ☒ mi² ☐ %	Product of CN x area
D	Desert Shrub, fair	86			29.9	2571.4
				Totals =	29.9	2571.4

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{2571.4}{29.9} =$ 86.0; Use CN = 86

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	50		
Rainfall, P (24-hour)	in	3.6		
Runoff, Q .... (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)	in	2.13		

Worksheet 4: Graphical Peak Discharge method

Project Cotton Ln/NW Loop By HPS Date 12/5/86

Location Middle Beardsley Overchute Checked ____ Date ______

Circle one: (Present) Developed Conc. pt. 282 - figures 5A & 5

1. Data:

Drainage area .... A_m = 32.9 mi^2 (acres/640)

Runoff curve number .... CN = 86 (From worksheet 2)

Time of concentration .. T_c = 9.97 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	50		
3. Rainfall, P (24-hour)	in	3.6		
4. Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.326		
5. Compute I_a/P		0.091		
6. Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	60		
7. Runoff, Q .... (From worksheet 2).	in	2.13		
8. Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9. Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	4204.6		

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Cotton Ln / NW Loop By HPS Date 12/5/86

Location Middle Beardsley Overchute Checked ____ Date ______

Circle one: (Present) Developed conc. pt. 282

Circle one: (T_c) T_t through subarea figures 3A & 5

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)

Item	Unit	Segment ID	Segment ID	Total
1. Surface description (table 3-1)				
2. Manning's roughness coeff., n (table 3-1) ..				
3. Flow length, L (total L $\leq$ 300 ft)	ft			
4. Two-yr 24-hr rainfall, P_2	in			
5. Land slope, s	ft/ft			
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr		+	=

Shallow concentrated flow

Item	Unit	Segment ID	Segment ID	Total
7. Surface description (paved or unpaved)		unpaved		
8. Flow length, L	ft	79,000		
9. Watercourse slope, s	ft/ft	0.018		
10. Average velocity, V (figure 3-1)	ft/s	2.2		
11. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr	9.97	+	= 9.97

Channel flow

Item	Unit	Segment ID	Segment ID	Total
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, p_w	ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft			
15. Channel slope, s	ft/ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft/s			
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr		+	=

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) .... hr **9.97**

Worksheet 2: Runoff curve number and runoff

Project Cotton Ln/NW Loop By HPS Date 12/5/86

Location Middle Beardsley Overchute Checked ____ Date ____

Circle one: (Present) Developed Conc. pt. 282 - figures 3A & 5

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/			Area ☐ acres ☒ mi² ☐ %	Product of CN x area
		Table 2-2	Fig. 2-3	Fig. 2-4		
D	Desert Shrub, fair	86			32.9	2829.4
				Totals =	32.9	2829.4

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{2829.4}{32.9}$ = 86.0; Use CN = 86

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	50		
Rainfall, P (24-hour)	in	3.6		
Runoff, Q (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)	in	2.13		

Worksheet 4: Graphical Peak Discharge method

Project Cotton Ln / NW Loop By HPS Date 12/5/86

Location East Beardsley Overchute Checked ____ Date ____

Circle one: (Present) Developed Conc. pt. 283 - figures 3 & 5

1. Data:

Drainage area .... A_m = 8.73 mi^2 (acres/640)

Runoff curve number .... CN = 86 (From worksheet 2)

Time of concentration .. T_c = 5.69 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	50		
3. Rainfall, P (24-hour)	in	3.6		
4. Initial abstraction, I_a (Use CN with table 4-1.)	in	0.326		
5. Compute I_a/P		0.091		
6. Unit peak discharge, q_u (Use T_c and I_a/P with exhibit 4-II)	csm/in	100		
7. Runoff, Q (From worksheet 2).	in	2.13		
8. Pond and swamp adjustment factor, F_p (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9. Peak discharge, q_p (Where $q_p = q_u A_m Q F_p$)	cfs	1859.5		

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project: Cotton Ln / NW Loop By: HPS Date: 12/5/86

Location: East Beardsley Overchute Checked: ____ Date: ____

Circle one: (Present) Developed — Conc. pt. 283

Circle one: (T_c) T_t through subarea — figures 3A & 5

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)

	Item	Units	Segment ID	Segment ID	Total
1.	Surface description (table 3-1)				
2.	Manning's roughness coeff., n (table 3-1)				
3.	Flow length, L (total L ≤ 300 ft)	ft			
4.	Two-yr 24-hr rainfall, P_2	in			
5.	Land slope, s	ft/ft			
6.	$T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr		+	=

Shallow concentrated flow

	Item	Units	Segment ID	Segment ID	Total
7.	Surface description (paved or unpaved)		unpaved		
8.	Flow length, L	ft	43,000		
9.	Watercourse slope, s	ft/ft	0.0177		
10.	Average velocity, V (figure 3-1)	ft/s	2.1		
11.	$T_t = \frac{L}{3600\,V}$ Compute T_t	hr	5.69	+	= 5.69

Channel flow

	Item	Units	Segment ID	Segment ID	Total
12.	Cross sectional flow area, a	ft^2			
13.	Wetted perimeter, p_w	ft			
14.	Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft			
15.	Channel slope, s	ft/ft			
16.	Manning's roughness coeff., n				
17.	$V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft/s			
18.	Flow length, L	ft			
19.	$T_t = \frac{L}{3600\,V}$ Compute T_t	hr		+	=

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) .... hr 5.69

Worksheet 2: Runoff curve number and runoff

Project Cotton Ln / NW Loop By HPS Date 12/5/86

Location East Beardsley Overchute Checked ____ Date ____

Circle one: (Present) Developed Conc. pt. 283 - figures 3A & 5

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/ Table 2-2	CN 1/ Fig. 2-3	CN 1/ Fig. 2-4	Area ☐ acres ☒ mi^2 ☐ %	Product of CN x area
D	Desert Shrub, fair	86			8.73	750.78
					Totals = 8.73	750.78

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{750.78}{8.73} =$ 86.0; Use CN = 86

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	50		
Rainfall, P (24-hour)	in	3.6		
Runoff, Q (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)	in	2.13		

APPENDIX C

TABLE OF DISCHARGES

CONC. PT.	CONTRIB. AREA ACRES	Q50 (CFS)
1	3,368	1,020
2	3,368	1,020
3	1,600	795
4	320	310
5	390	347
6	173	217
7	320	310
8	1,600	795
9	147	204
10	288	290
11	320	310
12	2,880	960
13	141	200
14	320	310
15	1,094	630
16	192	235
17	320	310
18	1,280	699
19	166	218
20	320	310
21	1,843	890
22	166	218
23	320	310
24	1,267	695
25	192	235
26	320	310
27	1,574	790
28	192	235
29	320	310
30	1,350	720

CONC. PT.	CONTRIB. AREA ACRES	Q50 (CFS)
31	192	235
32	320	320
33	1,165	660
34	192	235
35	320	310
36	1,165	660
37	192	235
38	320	310
39	1,024	387
40	192	235
41	320	310
42	70	315
43	77	340
44	83	365
45	96	415
46	115	485
47	128	523
48	19	62
49	70	315
50	96	415
51	13	39
52	134	545
53	147	585
54	102	440
55	122	505
56	90	390
57	51	222
58	32	130
59	128	523
60	141	570
61	147	585

CONC. PT.	CONTRIB. AREA ACRES	Q50 (CFS)
62	134	545
63	70	315
64	96	415
65	83	370
66	19	415
67	70	315
68	64	285
69	51	222
70	45	189
71	19	62
72	6	10
73	77	340
74	32	130
75	26	96
76	26	96
77	19	62
78	38	158
79	19	62
80	13	39
81	32	130
82	13	39
83	6	10
84	51	222
85	13	39
86	6	10
87	179	670
88	51	222
89	13	39
90	6	10
91	83	365

CONC. PT.	CONTRIB. AREA ACRES	Q50 (CFS)
92	38	158
93	6	10
94	70	315
95	38	158
96	13	39
97	38	158
98	19	62
99	6	10
100	45	189
101	19	62
102	6	10
103	45	189
104	26	96
105	6	10
106	70	315
107	26	96
108	6	10
109	109	460
110	19	62
111	19	62
112	3	10
113	3	10
114	58	257
115	19	62
116	3	10
117	45	189
118	19	62
119	3	10
120	90	390
121	19	62

CONC. PT.	CONTRIB. AREA ACRES	Q50 (CFS)
152	205	730
153	6	10
154	83	370
155	45	189
156	51	222
157	38	158
158	26	96
159	32	130
160	32	130
161	70	315
162	51	222
163	5,594	3,140
164	13	39
165	32	130
166	19	62
167	6	10
168	5,715	3,180
169	6	10
170	5,645	3,150
171	13	39
172	26	96
173	13	39
174	51	222
175	32	130
176	13	39
177	32	130
178	6	10
179	19	62
180	6	10
181	Agua Fria	121,000

CONC. PT.	CONTRIB. AREA ACRES	Q50 (CFS)
122	3	10
123	154	600
124	26	96
125	6	10
126	58	257
127	45	189
128	6	10
129	122	503
130	32	130
131	3	10
132	70	315
133	26	96
134	6	10
135	147	585
136	109	460
137	13	39
138	90	390
139	3	10
140	3	10
141	6	10
142	6	10
143	13	39
144	51	222
145	13	39
146	McMicken Outlet	17,860
147	102	440
148	McMicken Outlet	17,630
149	19	62
150	6	10
151	McMicken Outlet	16,300

CONC. PT.	CONTRIB. AREA ACRES	Q50 (CFS)
182	Agua Fria	121,000
183	Agua Fria	121,000
184	70	315
185	64	285
186	6	10
187	13	39
188	6	10
189	13	39
190	26	96
191	58	257
192	301	940
193	13	39
194	64	285
195	128	523
196	192	700
197	77	340
198	13	39
199	13	39
200	26	96
201	6	10
202	32	130
203	26	96
204	19	62
205	26	96
206	19	62
207	19	62
208	13	39
209	13	39
210	26	96
211	19	62

CONC. PT.	CONTRIB. AREA ACRES	Q50 (CFS)
212	13	39
213	13	39
214	26	96
215	32	130
216	58	257
217	435	1,150
218	26	96
219	51	222
220	32	130
221	New River	2,350
222	New River	2,350
223	134	545
224	128	523
225	77	340
226	64	285
227	70	315
228	70	315
229	64	285
230	6	10
231	19	62
232	13	39
233	6	10
234	13	39
235	6	10
236	3	10
237	19	62
238	13	39
239	32	130
240	96	415
241	13	39

CONC. PT.	CONTRIB. AREA ACRES	Q50 (CFS)
242	13	39
243	19	62
244	26	96
245	19	62
246	26	96
247	13	39
248	13	39
249	19	62
250	13	39
251	13	39
252	13	39
253	13	39
254	13	39
255	13	39
256	19	62
257	96	415
258	77	340
259	13	39
260	13	39
261	32	130
262	19	62
263	128	523
264	2,227	2,300
265	3,616	2,700
266	96	415
267	83	365
268	160	620
269	90	390
270	179	670
271	397	1,100

CONC. PT.	CONTRIB. AREA ACRES	Q50 (CFS)
272	1,939	2,200
273	109	460
274	467	1,190
275	141	570
276	122	503
277	13	39
278	26	96
279	70	315
280	Skunk Creek	16,600
281	1,805	529
282	21,056	4,205
283	5,587	1,860
284	McMicken Dam	4,400