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TUCSON MOUNTAIN BASIN STUDY
TECHNICAL REPORT

MARCH 15, 1986

FOR

PIMA COUNTY DEPARTMENT OF TRANSPORTATION
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(602) 792-3573

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1.0 INTRODUCTION

1.1 AUTHORIZATION

In October, 1984, the Pima County Department of Transportation and Flood Control District selected Camp Dresser & McKee Inc. to study and report upon the existing drainage characteristics of the Tucson Mountain Drainage Basin. In August, 1985, the Pima County Board of Supervisors approved the selection of CDM, and the notice to proceed was issued on August 29, 1985. The study, and the calculations which are presented in this report, were accomplished between September 1, 1985, and December 30, 1985.

1.2 PURPOSE

This report is the first phase of a study to provide a basin management plan for the Tucson Mountain Drainage Basin. It is concerned primarily with existing conditions and the effect they have on flood protection measures. To accomplish this it is necessary to determine the adequacy or inadequacy of existing drainage improvements such as culverts, existing natural and improved channels, and roadway dip sections to convey the estimated 100 year storm runoff for three development scenarios. In addition, the locations of detention ponds were identified; such ponds may play a part in basin management if the downstream improvements that are required to handle the flood magnitudes are deemed too expensive. Phase II will identify and evaluate alternative specific solutions to flood plain management measures with Phase III accomplishing conceptual designs for the selected alternatives.

1.3 SCOPE

The Tucson Mountain Drainage Basin as discussed in this report is an approximate 54 square mile area bounded on the north by Ina Road and Cortaro Road, and on the south by a line extending westerly from West 22nd Street. The westerly boundary of the basin is the uppermost ridge line of the Tucson Mountains. The easterly boundary is formed by the Santa Cruz

River from approximately a mile north of Grant Road, north to Cortaro Road. The Santa Cruz River conveys the runoff in a northwesterly direction from the entire Tucson Mountain Drainage Basin. Refer to Plate No. 1.

The scope of our study, and the items that will be addressed further in this report, includes, but is not limited to, the following:

1.3.1 FIELD AND OFFICE INVESTIGATIONS

1.3.1.1 Drainage Basins

Field inspections were conducted to determine the characteristics of the major and minor sub-basins that exist within the encompassing Tucson Mountain Drainage Basin. Vegetation type and density, existing development and impervious cover, and slopes were verified in the field to substantiate estimates derived from a variety of reference materials.

1.3.1.2 Roadway Crossings

Inspection and measurements were made of all major drainage crossings of Pima County maintained roadways and of private roads lying upon section or quarter section lines. During this inspection 164 dip sections and 77 culverts of various types were recorded. Refer to Plate No. 6.

1.3.1.3 Detention Basins

Possible detention basin locations were sought during field trips. All basins reported upon occur at the inlet side of culverts found beneath roadways. Refer to Plate No. 6 for roadway crossings.

1.3.1.4 Washes

Inspections were made and cross sections taken of the major washes draining the basin so that an estimated 100-year flood width could be determined at each section. A total of 88 cross sections were made; 23 using topographic maps, and 65 by field surveys. Refer to Plates No. 7, 8 and 9.

1.3.1.5 Santa Cruz River Flood Plain

The area between Silverbell Road, which lies near the eastern boundary of the basin, and the Santa Cruz River was inspected in the field and in the office (using topographic maps) to determine the extent of any flooding problems that could occur should a 100-year storm be experienced. This area will be referred to as the "flat lands area" in this report.

1.3.1.6 References

Publications covering a variety of subjects were collected from many public agencies and reviewed. Pertinent information relevant to the study area has been used to prepare this report. See reference list.

1.4 PROCEDURE

1.4.1 FIELD AND OFFICE INVESTIGATIONS

1.4.1.1 Basin Drainage Characteristics

The majority of the investigations to determine the characteristics of the basins and sub-basins were done using an aerial photograph dated May, 1985, and U.S.G.S. topographic maps. In addition, current zoning maps and the Tucson Mountain Area Plan were used to estimate the potential for development of each sub-basin. Slopes and basin boundaries

were found using the U.S.G.S. maps. Impervious cover was estimated in accordance with the Pima County method based upon existing and potential development density. Soil types and rainfall depths were determined using the Pima County manual. Vegetation types and densities were determined by field inspection.

1.4.1.2 Roadway Crossings

All investigations measuring roadway dip sections and culverts were conducted in the field. Dip sections were measured for the effective depth and width of the lowest portion at each location. The width measured roughly corresponded to the width of the channel immediately upstream of the roadway.

The depth then became the difference between the elevations of the lowest point and the elevation at the edge of the measured width. Several assumptions were made to expedite the measurement of the roadway dip sections. It was assumed that all dips were parabolic and symmetrical. This permitted actually measuring only one-half of the width with a 100-foot tape, and the depth with a hand level and a graduated range pole. A cross-slope of 2.5 percent was assumed for all dip sections.

Culverts were measured for length, diameter, available head at the inlet, and relative elevation difference of the inlet and outlet inverts.

1.4.1.3 Detention Ponds

All detention ponds noted occur immediately upstream of culvert inlets. The widths were estimated in the field. The average depth was taken as one-half of the available head at the culvert

inlet. The pond length was determined by calculating the length required to attain the average depth elevation, according to the indicated slope shown on the U.S.G.S. topographic map.

1.4.1.4 Channel Cross Sections

Natural washes and improved channels were measured from available maps and in the field. Data for those channels measured in the office were obtained from topographic maps supplied by Pima County Department of Transportation and Flood Control District. The maps were at a scale of 1" = 200' with a contour interval of 2 feet. Twenty-three channel cross sections were prepared from maps. Sixty-five cross sections were obtained by field surveys. Relative elevations and distances between elevations were surveyed and noted. Actual elevation above sea level was not determined. However, a steel pin was set at each cross section as a bench mark with an assumed elevation of 100.00.

1.4.1.5 Flat Lands Area

These areas were subjected to a general overview inspection in the field, however, the topographic maps supplied by the County enabled a more detailed evaluation of the existing conditions, and therefore proved to be a more valuable tool. Most of the investigations regarding these areas were done using these maps.

1.4.2 CALCULATIONS

1.4.2.1 Runoff Calculations

Calculations to estimate runoff were performed in accordance with the "Hydrology Manual for Engineering Design and Flood Plain Management within Pima County, Arizona," September, 1979. The actual computations were performed by an IBM XT personal

computer, using a program written in conformance with the above referenced manual. Points of concentration for each basin and sub-basin were located at the points of confluence of the washes draining adjacent sub-basins, at Ina Road, at Cortaro Road, or at the Santa Cruz River. Storm frequencies calculated for basin runoff were the 10-year and the 100-year events under existing conditions, fully developed conditions according to existing zoning, and fully developed conditions in accordance with the Tucson Mountain Area Plan as of August, 1985. Additional runoff calculations were made for drainage areas concentrating at roadway dip sections and culverts, and at each channel cross section. Only the 100-year event was computed for these points.

1.4.2.2 Roadway Crossings

The capacities of dip sections were computed using the Mannings equation. Areas of flow were determined using the equation $1.33(Lh)$, where $L = 1/2$ the water surface length and $h =$ depth of flow. The wetted perimeter was taken as the width of the dip. Roughness coefficients were assigned as .018 for paved roadways and .025 for unpaved. Slopes were assumed to be .025 feet per foot in all cases. Culvert capacities were found using the inlet control nomograph (HEC-5).

1.4.2.3 Detention Ponds

All detention ponds noted exist immediately upstream of culvert inlets. Hydrographs were developed utilizing the method developed in "Drainage Development and Channel Design Standards," distributed by Pima County (see Section 6). A hydrograph was created for each pond based upon the runoff (Q_{100}) concentrating at the culvert inlet and the time of concentration, with the outflow being supplied by the culvert as concentrated runoff reached it. It was thus possible to determine the adequacy of each pond to detain the estimated

inflow without overtopping the roadway. All inflow hydrographs were generated by the IBM XT computer using Pima County guidelines. Flood routing through the pond was performed by hand.

1.4.2.4 Channel Cross Sections

Water surface elevations and widths of flow for the 100-year event were determined at each channel cross section based upon the Mannings equation using the IBM XT and a program written for natural channel hydraulics. Each cross section was subjected to the 100-year event for the three development scenarios mentioned earlier. Roughness coefficients vary from .025 to .040.

2.0 DRAINAGE BASINS

2.1 TOPOGRAPHY

2.1.1 BASIN IDENTIFICATION

The Tucson Mountain Drainage Basin as addressed in this report contains approximately 54 square miles which can be divided into 15 major basins. Many of these basins contain three or more smaller, yet important sub-basins of their own. Identification of the hierarchy of the basins discussed in this report is as follows:

- Level 1 - Tucson Mountain Drainage Basin
- Level 2 - Numbered Basins and "Off-Site"
- Level 3 - Lower Case Lettered Sub-Basins

Of the fifteen numbered basins, eight may be more familiar by the names given to the washes that drain them.

<u>Basin Number</u>	<u>Wash Name</u>
1	Greasewood Wash
2	Painted Hills Wash
3	Camino Del Oeste Wash
4	Trails End Wash
5	Roger Wash
6	Ayers Wash
8*	Idle Hour Wash
10	Yuma Mine Wash

*Basin 8 is actually two basins; 8 and 8A, being Idle Hour West Wash and Idle Hour East Wash respectively.

Basins 7, 9, and 11 consist of large fan shaped areas, each with several distinct sub-basins that have been grouped together for convenience. Basins 12 through 15 are much smaller in land area than the others; since they do not form a part of the other basins, they are treated separately.

Please refer to the Aerial Photograph (Plate No. 1) and to the Drainage Map, Existing Conditions (Plate No. 2), for delineation of the various basins and sub-basins. Each Level 2 numbered basin has been subdivided as follows:

TABLE 2A
Basin Subdivisions

<u>Level 2</u> <u>Basin Number</u>	<u>Level 3</u> <u>Subdivision</u>
1	a, b, & c
2	a, b, & c
3	a, b, c, & d
4	a, b, & c
5	a, b, b, & d
6	a, b, & c
7	a through f
8	a & b
8A	a, b, c, & d
9	a through g
10	a, b, c, & d
11	a through g
12	No subdivision
13	a & b
14	No subdivision
15	a & b

It should be noted by readers of this report that except for the fan basins 7, 9, and 11, and except for basins 13 and 15, each drainage basin has only one crossing of Silverbell Road, and only one outlet into the Santa Cruz River.

A sixteenth basin, considered during the preparation of this report has been named "Off-site" and has been treated in the same manner as the other basins discussed with the exception that sub-basins have not been defined. It is satisfactory to estimate the concentrated runoff from the off-site area only at the point where it enters this report's area of interest. Silvercroft Wash drains the Off-Site area. Drainage Basin 1 and 2 also discharge into the Silvercroft Wash prior to its confluence with the Santa Cruz River.

2.1.2 VEGETATION - SLOPES - SOILS

Vegetation in the Tucson Mountain Basin is a relatively dense distribution of palo verde and mesquite, creosote bush, salt bush, cat claw, desert grasses and cacti found throughout the Tucson Valley. Very little importation of domestic trees, shrubs, and grasses has occurred, even in the more urban areas in the southeastern portion of the Basin. Of note is the density of the growth occurring in this area. The Tucson Mountain Basin must be considered lush when compared with other areas in the Valley. Vegetation densities used in calculating runoff for this report have usually been assigned at 40 percent for both mountain and desert brush.

Slopes occurring in the overall basin range from approximately 40 percent in the uppermost reaches to less than 1 percent nearest the Santa Cruz River. The average slope for all 15 basins occurring within the Tucson Mountain Basin is 2.43 percent. Table 2B is a basin summary of mean slopes.

TABLE 2B
MEAN SLOPES

<u>BASIN</u>	<u>MEAN SLOPE</u>	<u>CONCENTRATION POINT</u>
1	2.87%	J3-Silvercroft Wash
2	2.31%	J6-Silvercroft Wash
3	2.83%	Santa Cruz River
4	3.01%	Santa Cruz River
5	3.44%	Santa Cruz River
6	3.10%	Santa Cruz River
7	2.34%	Santa Cruz River
8	4.54%	J21-Confluence
8A	2.73%	J21-Confluence
9	2.51%	Santa Cruz River
10	4.00%	J26-Confluence
11	2.24%	Ina & Cortaro Roads
12	0.67%	Santa Cruz River
13	1.91%	Santa Cruz River
14	1.85%	Santa Cruz River
15	1.67%	Santa Cruz River
OFFSITE	2.21%	J3-Silvercroft Wash

Soil types occurring in the study area are types D and B as identified in the Pima County Hydrology Manual and combinations of both. Type D soils consist of rock and shallow semiarid soils in the higher elevations of the basins with runoff potential. Type B soils are deep, arid, gravelly soils closer to the River.

2.1.3 EXISTING IMPROVEMENTS

Although encroachment into the Tucson Mountains is not new, the basin as a whole is sparsely populated and concentrated along the eastern boundary, with approximately 95 percent of human habitation and improvements within 1.5 miles west of Silverbell Road. Almost no improvements are found further than 3.5 miles west of Silverbell. The extent of existing impervious surfaces basin wide is approximately 3 percent. Should the basin be developed to its fullest potential it is expected that impervious surfaces will increase to an average of 9 percent (existing zoning) or 7 percent (existing Area Plan).

Many Hohokam archeological sites have been recorded along the Santa Cruz River bordering the study area. Resources investigated did not indicate archeological sites within the study area west of those locations along the Santa Cruz River. Improvements considered in future phases of this project should be coordinated with the University of Arizona and other agencies with an archeological interest in the area. See reference list.

2.2 LAND USE

The existing density of construction does not approach that of a fully developed basin for either the existing zoning case or the current Tucson Mountain Area Plan. Of greatest significance is the reduction of undeveloped areas that will occur as a result of future development. Table 2C-1 summarizes the approximate land use within the Tucson Mountain Drainage Basins for existing conditions. Tables 2C-2 and 2C-3 presents the same information for developed conditions according to existing zoning and the current land use plan, respectively.

As will be shown in future sections of this report the figures in Tables 2C-1, 2, and 3 are reflected in the runoff amounts computed for the various basins and sub-basins by the fact that in most instances the greatest increase in runoff occurs for the existing zoning condition.

TABLE 2C-1
EXISTING LAND USE

<u>BASIN NO.</u>	<u>PERCENT UNDEVELOPED</u>	<u>% <1R*</u>	<u>% 1-2R*</u>	<u>% 3-5R*</u>	<u>% >5-R*</u>	<u>% COM./IND.</u>
OFFSITE	85	0	0	10	5	0
1	63	0	20	17	0	0
2	75	12	0	13	0	0
3	88	10	0	2	0	0
4	54	36	10	0	0	0
5	81	19	0	0	0	0
6	87	13	0	0	0	0
7	37	51	12	0	0	0
8	87	13	0	0	0	0
8A	75	25	0	0	0	0
9	78	19	3	0	0	0
10	98	0	2	0	0	0
11	72	28	0	0	0	0
12	100	0	0	0	0	0
13	59	15	26	0	0	0
14	54	46	0	0	0	0
15	100	0	0	0	0	0
<hr/>						
AVERAGE =	78			22		0

*R = Residences Per Acre.

TABLE 2C-2
PROPOSED LAND USE
EXISTING ZONING

<u>BASIN NO.</u>	<u>PERCENT UNDEVELOPED</u>	<u>% <1R*</u>	<u>% 1-2R*</u>	<u>% 3-5R*</u>	<u>% >5-R*</u>	<u>% COM./IND.</u>
OFFSITE	19	12	1	23	34	11
1	13	0	16	30	35	6
2	5	16	39	23	16	1
3	62	22	8	2	5	1
4	13	53	33	0	0	1
5	36	58	4	0	0	1
6	47	52	1	0	0	0
7	0	61	37	0	0	2
8	49	51	0	0	0	0
8A	27	43	30	0	0	0
9	3	74	23	0	0	0
10	50	39	1	0	0	0
11	0	91	9	0	0	0
12	0	0	0	0	100	0
13	0	66	8	4	22	0
14	0	94	6	0	0	0
15	0	52	48	0	0	0
<hr/>						
AVERAGE =	26		73			1

*R = Residence Per Acre.

TABLE 2C-3
PROPOSED LAND USE
TUCSON MOUNTAIN AREA PLAN

<u>BASIN NO.</u>	<u>PERCENT UNDEVELOPED</u>	<u>% <1R*</u>	<u>% 1-2R*</u>	<u>% 3-5R*</u>	<u>% >5-R*</u>	<u>% COM./IND.</u>
OFFSITE	19	12	11	26	26	6
1	13	15	44	10	15	3
2	5	51	21	11	12	0
3	64	26	3	3	3	1
4	14	86	0	0	0	0
5	48	52	0	0	0	0
6	50	50	0	0	0	0
7	6	72	22	0	0	1
8	51	48	1	0	0	0
8A	27	72	1	0	0	0
9	3	85	10	0	0	2
10	65	33	0	1	0	1
11	0	91	0	6	0	3
12	56	0	0	44	0	0
13	20	51	13	2	14	0
14	11	89	0	0	0	0
15	0	93	0	0	0	7
<u>AVERAGE =</u>		29		70		1

*R = Residences Per Acre.

2.3 EXISTING DRAINAGE IMPROVEMENTS

2.3.1 IMPROVED CHANNELS

Man-made improvements within the Basin are limited to those areas that have experienced development. Most channelized washes were found in the vicinity of Silverbell Road and the Santa Cruz River. Even in the developed areas existing washes have for the most part been left natural. Specific information concerning the capacity of washes and channels will be addressed in Sections 3 and 4.

2.3.2 DRAINAGE STRUCTURES

Drainage structures as used herein refers to improvements allowing the passage of runoff either beneath or over roadways. Two hundred and forty-one roadway crossings were recorded during our investigation. Of these, 71 were pipe culverts, 5 were box culverts, and 1 was a structural pipe arch. The remaining 167 crossings allowed surface flow (dips). Tables in Section 3.0, Hydrology/Hydraulics, lists each dip crossing and culvert crossing. Shown in the tables are the crossing number, the type of crossing, the basin the crossing is in, the roadway crossed, and the crossing's capacity.

3.0 HYDROLOGY/HYDRAULICS

3.1 PEAK DISCHARGE

Runoff was computed for three areas of investigation:

1. General runoff for all level 3 sub-basins with concentration points at wash confluences and at the Santa Cruz River. Storm frequencies computed were the Q_{10} and Q_{100} events for each of the three development possibilities stated earlier.
2. The runoff concentrating at each recorded dip section roadway crossing was computed for the 100-year event using the Pima County method. To determine the changes that would occur because of future development, the computed existing flows for each crossing were factored by the amount indicated by the changes found in the general runoff computation. For example: If a dip section within sub-basin 3c experiences a Q_{100} runoff of 450 cfs under existing conditions, and it was discovered that the general runoff for sub-basin 3c increased by 1.78 percent if developed according to existing zoning, and was reduced by 1.93 percent if developed according to the Area Plan, these percentages were applied to the 450 cfs, giving Exist $Q_{100} = 450$ cfs, As Zoned $Q_{100} = 458$ cfs, Area Plan $Q_{100} = 441$ cfs. Culvert crossings were treated with an individual computation according to the County method for each of the three development cases.
3. Each channel cross section investigated received a runoff calculation for Q_{100} under existing conditions. Expected changes were determined in the same manner as for the dip section roadway crossings.

3.1.1 GENERAL RUNOFF-LEVEL 3 SUB-BASINS

Table 3A presents the results of Level 3 sub-basin runoff computation. Refer to Plates 2, 3, and 4 for Existing, As Zoned, and Area Plan drainage maps respectively. For clarification, the maximum flow computed has been underlined.

TABLE 3A
EXISTING AND POTENTIAL BASIN RUNOFF (CFS)

SUB-BASIN	LAND AREA	RUNOFF						CONCENTRATION POINT
		EXISTING		AS ZONED		AREA PLAN		
		Q ₁₀	Q ₁₀₀	Q ₁₀	Q ₁₀₀	Q ₁₀	Q ₁₀₀	
Offsite	8.22 sm.	2904	9232	<u>7261</u>	<u>15685</u>	6286	14353	J3
1a	496.00 ac.	588	1627	<u>898</u>	<u>2064</u>	703	1790	J1
1b	312.00 ac.	587	1372	<u>843</u>	<u>1697</u>	583	1363	J1
1ab	1.41 sm.	957	2601	<u>1608</u>	<u>3613</u>	1106	2789	J2
1c	184.00 ac.	325	783	<u>524</u>	<u>1063</u>	321	772	J2
1	2.33 sm.	1480	3977	<u>2769</u>	<u>5834</u>	1927	4646	J3
1+Offs.	10.60 sm.	3798	12023	<u>8481</u>	<u>18937</u>	7062	16672	J6
2a	459.00 ac.	649	1684	<u>829</u>	<u>1941</u>	708	1775	J4
2b	193.00 ac.	349	901	<u>444</u>	<u>1002</u>	405	941	J4
2ab	1.53 sm.	1096	2835	<u>1485</u>	<u>3474</u>	1332	3201	J5
2c	197.00 ac.	235	652	<u>467</u>	<u>990</u>	384	869	J5
2	1.96 sm.	1288	3414	<u>1909</u>	<u>4350</u>	1620	3864	J6
2+1+Offs.	12.56 sm.	4393	13943	<u>9492</u>	<u>21463</u>	8295	18561	J6
2+1+Offs.	12.64 sm.	4191	13492	<u>9205</u>	<u>21282</u>	7957	18224	S.C.River
3a	2.86 sm.	1949	4566	<u>1971</u>	<u>4664</u>	<u>1971</u>	<u>4664</u>	J7
3b	1.04 sm.	<u>877</u>	<u>2138</u>	858	2072	839	2057	J7
3ab	3.98 sm.	2884	7193	<u>2916</u>	<u>7233</u>	<u>2916</u>	<u>7233</u>	J8
3c	483.00 ac.	806	1968	<u>838</u>	<u>2003</u>	824	1930	J8
3abc	5.76 sm.	2011	6295	2081	6375	<u>2099</u>	<u>6375</u>	J9
3d	193.00 ac.	219	652	<u>603</u>	<u>1202</u>	513	1027	J9
3	6.19 sm.	2266	5899	<u>2492</u>	<u>6465</u>	2448	6328	S.C.River

TABLE 3A
EXISTING AND POTENTIAL BASIN RUNOFF (CFS)
-CONTINUED-

SUB-BASIN	LAND AREA	RUNOFF						CONCENTRATION POINT
		EXISTING		AS ZONED		AREA PLAN		
		Q ₁₀	Q ₁₀₀	Q ₁₀	Q ₁₀₀	Q ₁₀	Q ₁₀₀	
4a	1.58 sm.	981	2664	<u>1037</u>	<u>2718</u>	979	2651	J10
4b	626.00 ac.	772	1865	<u>869</u>	<u>2028</u>	769	1899	J11
4c	90.00 ac.	124	348	<u>156</u>	<u>388</u>	121	334	J10
4ac	1.86 sm.	1053	2727	<u>1137</u>	<u>2992</u>	1010	2786	J11
4	3.02 sm.	1679	4366	<u>1886</u>	<u>4591</u>	1644	4309	S.C.River
5a	321.00 ac.	488	1245	<u>631</u>	<u>1434</u>	462	1218	J12
5b	1.99 sm.	1302	3369	<u>1371</u>	<u>3474</u>	1268	3262	J12
5c	624.00 ac.	743	1927	<u>891</u>	<u>2128</u>	673	1772	J13
5d	450.00 ac.	638	1575	<u>722</u>	<u>1707</u>	644	1581	J13
5abcd	4.50 sm.	2733	7142	<u>3281</u>	<u>8090</u>	2785	6877	J14
5	5.17 sm.	2113	6289	<u>2663</u>	<u>7072</u>	2009	6565	S.C.River
6a	165.00 ac.	209	<u>580</u>	<u>215</u>	577	<u>215</u>	577	J15
6b	1.22 sm.	583	1754	<u>649</u>	<u>1906</u>	<u>649</u>	<u>1906</u>	J16
6c	2.32 sm.	1243	3308	1261	<u>3384</u>	<u>1314</u>	3300	J16
6bc	3.60 sm.	1752	4647	<u>1868</u>	<u>4794</u>	1804	4659	J15
6	5.00 sm.	1269	3943	<u>1380</u>	4075	1361	<u>4084</u>	S.C.River
7a	92.00 ac.	149	383	<u>209</u>	<u>460</u>	139	373	S.C.River
7b	216.00 ac.	278	<u>744</u>	277	734	<u>281</u>	741	J27
7c	344.00 ac.	442	1184	<u>487</u>	<u>1239</u>	447	1180	J27
7bc	1.08 sm.	726	1995	<u>796</u>	<u>2060</u>	745	1989	J28
7d	109.00 ac.	161	419	<u>182</u>	<u>446</u>	163	418	J28
7abcd	1.34 sm.	760	2143	<u>962</u>	<u>2380</u>	782	2136	S.C.River

TABLE 3A
EXISTING AND POTENTIAL BASIN RUNOFF (CFS)
-CONTINUED-

SUB-BASIN	LAND AREA	RUNOFF						CONCENTRATION POINT
		EXISTING		AS ZONED		AREA PLAN		
		Q ₁₀	Q ₁₀₀	Q ₁₀	Q ₁₀₀	Q ₁₀	Q ₁₀₀	
7e	85.00 ac.	148	374	<u>204</u>	<u>453</u>	152	376	S.C.River
7f	118.00 ac.	173	459	<u>255</u>	<u>574</u>	191	484	S.C.River
7g	372.00 ac.	411	1130	<u>443</u>	<u>1165</u>	439	1148	S.C.River
7h	283.00 ac.	240	683	282	729	<u>314</u>	<u>785</u>	S.C.River
7i	429.00 ac.	447	1259	518	1380	<u>569</u>	<u>1420</u>	S.C.River
8Aa	532.00 ac.	456	1228	<u>521</u>	<u>1324</u>	444	1210	J17
8Ab	1.24 sm.	950	2403	<u>1112</u>	<u>2622</u>	1032	2516	J17
8Aab	2.11 sm.	1396	3618	<u>1614</u>	<u>3907</u>	1438	3640	J18
8Ac	340.00 ac.	381	1012	<u>421</u>	<u>1036</u>	405	1024	J18
8Aabc	2.70 ac.	1560	4103	<u>1773</u>	<u>4497</u>	1595	4189	J19
8Ad	288.00 ac.	261	790	<u>287</u>	<u>803</u>	269	767	J19
8A	3.38 sm.	1456	4119	<u>1719</u>	<u>4466</u>	1552	4246	J21
8a	2.05 sm.	1344	3344	<u>1410</u>	<u>3473</u>	<u>1410</u>	<u>3473</u>	J20
8b	394.00 ac.	388	1113	<u>409</u>	<u>1145</u>	<u>409</u>	<u>1145</u>	J20
8	3.10 sm.	1467	3959	<u>1542</u>	<u>4074</u>	1525	4042	J21
8+8A	6.56 sm.	2589	7675	<u>2994</u>	<u>8139</u>	2816	7892	S.C.River
9a	112.00 ac.	165	456	196	493	<u>223</u>	<u>511</u>	S.C.River
9b	404.00 ac.	416	1254	502	1322	<u>516</u>	<u>1384</u>	S.C.River
9c	157.00 ac.	259	684	290	729	<u>293</u>	<u>735</u>	S.C.River
9d	1.11 sm.	524	1505	526	1561	<u>533</u>	<u>1573</u>	S.C.River
9e	528.00 ac.	412	1257	513	1422	<u>520</u>	<u>1436</u>	S.C.River
9f	270.00 ac.	203	600	239	654	<u>274</u>	<u>700</u>	J22

TABLE 3A
EXISTING AND POTENTIAL BASIN RUNOFF (CFS)
-CONTINUED-

SUB-BASIN	LAND AREA	RUNOFF						CONCENTRATION POINT
		EXISTING		AS ZONED		AREA PLAN		
		Q ₁₀	Q ₁₀₀	Q ₁₀	Q ₁₀₀	Q ₁₀	Q ₁₀₀	
9g	177.00 ac.	269	677	275	689	<u>281</u>	<u>699</u>	J22
9fg	495.00 ac.	530	1485	610	1597	<u>642</u>	<u>1675</u>	J26
10a	1.24 sm.	1048	2572	<u>1071</u>	<u>2633</u>	1048	2572	J23
10b	354.00 ac.	593	1449	<u>610</u>	<u>1449</u>	593	1409	J23
10ab	2.09 sm.	1419	3643	<u>1459</u>	<u>3660</u>	1419	3592	J24
10c	455.00 ac.	<u>801</u>	<u>1914</u>	<u>801</u>	<u>1914</u>	784	1862	J24
10abc	4.08 sm.	2406	5960	<u>2485</u>	<u>6012</u>	2292	5727	J25
10d	242.00 ac.	217	643	<u>251</u>	682	248	<u>684</u>	J25
10	4.46 sm.	1942	5493	<u>2004</u>	5550	1986	<u>5603</u>	J26
10+9gf	5.23 sm.	2466	6814	<u>2676</u>	<u>7063</u>	2475	6857	S.C.River
11a	388.00 ac.	437	1265	560	1440	<u>670</u>	<u>1549</u>	S.C.River
11b	42.00 ac.	65	178	80	198	<u>81</u>	<u>199</u>	CortaroRd.
11c	110.00 ac.	141	400	<u>169</u>	<u>426</u>	<u>169</u>	<u>426</u>	CortaroRd.
11d	145.00 ac.	211	580	<u>254</u>	<u>617</u>	<u>254</u>	<u>617</u>	Ina Rd.
11e	80.00 ac.	113	311	<u>133</u>	<u>330</u>	<u>133</u>	<u>330</u>	Ina Rd.
11f	90.00 ac.	144	382	<u>178</u>	<u>424</u>	<u>178</u>	<u>424</u>	Ina Rd.
11g	28.00 ac.	53	143	<u>63</u>	<u>154</u>	<u>63</u>	<u>154</u>	Ina Rd.
12	64.00 ac.	33	121	<u>227</u>	<u>442</u>	96	251	S.C.River

TABLE 3A
 EXISTING AND POTENTIAL BASIN RUNOFF (CFS)
 -CONTINUED-

SUB-BASIN	LAND AREA	RUNOFF						CONCENTRATION POINT
		EXISTING		AS ZONED		AREA PLAN		
		Q ₁₀	Q ₁₀₀	Q ₁₀	Q ₁₀₀	Q ₁₀	Q ₁₀₀	
13a	69.00 ac.	128	331	<u>246</u>	<u>491</u>	187	422	S.C.River
13b	386.00 ac.	417	1224	<u>512</u>	<u>1349</u>	468	1283	S.C.River
14	166.00 ac.	143	421	<u>169</u>	<u>462</u>	166	448	S.C.River
15a	117.00 ac.	177	493	208	514	<u>225</u>	<u>529</u>	S.C.River
15b	148.00 ac.	128	417	162	466	<u>167</u>	<u>472</u>	S.C.River

3.1.2 RUNOFF AT ROADWAY CROSSINGS

Several combinations of features were found during the field investigations of roadway crossings. The dominant type of crossing existing within the Tucson Mountain Drainage Basin is the simple dip section. Second to that is one or more pipe culverts beneath roadways with no overflow dip in the road. There are several locations where the roadway does dip over the culvert, providing a controlled overflow section, and there are several box culverts of a variety of sizes.

Table 3B summarizes the information gathered and computed pertaining to the dip sections measured in the field. It will be noticed that there are seven crossings numbered and computed where no dip in the roadway was apparent. Also, one dip section was thought to be insignificant and was not measured. Capacity of dip sections is at a depth of one foot. Refer to Plate No. 6 for crossing locations.

Table 3C presents the information concerning the culvert crossings. In those cases where an overflow dip exists at the culvert, the dip capacity at 1 foot of depth is given. Capacity of culverts is derived assuming inlet control at the available head. Refer to Plate No. 6 for crossing locations.

Table 3D expands upon the culvert crossings by the addition of information used to evaluate potential detention ponds.

TABLE 3B
ROADWAY DIP SECTIONS

BASIN NUMBER	CROSSING NUMBER	DIP TYPES	ROADWAY	CAPACITY (CFS) @ 1'	ESTIMATED RUNOFF (CFS)		
					EXISTING	ZONED	PLANNED
1.	181	Paved	Silverbell	679	4008	5879	4682
	223	Paved	Painted Hills	366	145	179	144
	225	Paved	Camino Claveres	400	311	422	307
	231	Paved	Anklam Road	400	476	617	531

TABLE 3B
ROADWAY DIP SECTIONS
-CONTINUED-

BASIN NUMBER	CROSSING NUMBER	DIP TYPES	ROADWAY	CAPACITY (CFS) @ 1'	ESTIMATED RUNOFF (CFS)		
					EXISTING	ZONED	PLANNED
2.	178	Paved	Silverbell	639	2738	3489	3099
	179	Paved	Silverbell	1838	2893	3686	3274
	180	Paved	Silverbell	1039	652	990	869
	201	Unpaved	Rising Star Trail	173	115	175	153
	202	Unpaved	Shannon	230	253	384	337
	204	Paved	Raphael	306	3186	3904	3597

3.	155	Paved	Goret Road	405	6741	6700	6782
	156	Paved	Silverbell	531	5923	6325	6187
	161	Paved	Silverbell	651	383	706	603
	162	Paved	Goret Road	531	111	205	175
	167	Paved	Lloyd Bush Dr.	458	7431	7386	7476
	168	Unpaved	Tomas Road	1912	7251	7207	7295
	170	Unpaved	Peter Steward Rd.	1912	51	53	53
	171	Unpaved	Peter Steward Rd.	259	6429	6390	6468
	172	Paved	Ironwood Hills	1531	6641	6601	6681
	203	Unpaved	Granneo Rd.	738	7004	6962	7046
	205	Unpaved	Camino De Oeste	940	1964	1871	1816
	207	Paved	Via Roma	599	4	4	4
	209	NO DIP	Via Roma	SECTION	338	344	331
	211	Paved	Camino De Oeste	400	1968	2003	1930

4.	151	Unpaved	Morgana	885	1687	1834	1718
	152	Paved	Goret Road	1162	2664	2718	2651
	153	Paved	Goret Road	398	348	388	334
	160	Paved	Silverbell	581	4366	4591	4309
	165	Paved	Lloyd Bush Dr.	797	2616	2669	2603

TABLE 3B
ROADWAY DIP SECTIONS
-CONTINUED-

BASIN NUMBER	CROSSING NUMBER	DIP TYPES	ROADWAY	CAPACITY (CFS) @ 1'	ESTIMATED RUNOFF (CFS)		
					EXISTING	ZONED	PLANNED
4.	166*	Paved	Lloyd Bush Dr.	598	32	38	32
	186	Paved	Ironwood Hills	599	84	86	84
	187	Paved	Ironwood Hills	283	155	158	154
	188	Paved	Ironwood Hills	932	1943	1982	1934
	191	Unpaved	Crestview	388	1232	1340	1254
	192	Unpaved	Summit	1438	294	300	293
	193	Unpaved	Westhaven Circle	834	5	5	5
	212	Paved	Camino De Oeste	1039	1976	2016	1966
	213	Paved	Placita Tuberia	160	156	170	159

5.	146	Paved	Sweetwater	750	6662	7491	6954
	142	Paved	Silverbell	730	6289	7072	6565
	148	Unpaved	Kay T. Drive	387	1791	1941	1798
	149	Unpaved	Kay T. Drive	273	1927	1987	1866
	176	Paved	Camino De Oeste	559	55	63	54
	190	Unpaved	Crestview Road	360	5	6	5

6.	136	Unpaved	Lost Horizon Dr.	383	4794	4954	4965
	138	Unpaved	Newland Drive	153	4694	4851	4862
	139	NO DIP	Silverbell	SECTION	4854	5016	5028
	140	Paved	Silverbell	797	266	289	289

7.	58	Paved	Sunset Road	981	604	623	614
	63	Paved	Sunset Road	587	73	80	82
	64	Paved	Sunset Road	479	146	160	165
	64A	Paved	Sunset Road	496	126	138	142

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TABLE 3B
ROADWAY DIP SECTIONS
-CONTINUED-

BASIN NUMBER	CROSSING NUMBER	DIP TYPES	ROADWAY	CAPACITY (CFS) @ 1'	ESTIMATED RUNOFF (CFS)		
					EXISTING	ZONED	PLANNED
7.	65	Paved	Sunset Road	784	87	93	100
	66	Paved	Sunset Road	617	499	533	574
	67	Paved	Sunset Road	364	117	125	134
	69	Paved	Silverbell	566	581	620	668
	70	NO DIP	Silverbell		301	330	339
	71**	Paved	Silverbell	140	1259	1380	1420
	72	Paved	Silverbell	337	911	999	1027
	73	NO DIP	Silverbell		1099	1133	1117
	74**	Paved	Silverbell	106	109	136	115
	75**	Paved	Silverbell	320	389	486	410
	76	NO DIP	Silverbell		339	411	341
	77	Paved	Silverbell	519	2174	2414	2167
	78	Paved	El Camino del Cerro	629	2005	2070	1999
	79	Paved	El Camino del Cerro	270	332	353	331
	80	Paved	El Camino del Cerro	217	512	620	515
	81	Paved	Camino De Oeste	404	171	207	172
	82	Paved	Camino De Oeste	472	57	69	57
	83	Paved	Camino De Oeste	506	423	451	486
	118	Paved	Paseo de las Rancheros	301	154	161	153
	119	Paved	Playa de los Ventos	190	210	220	209
	121	Paved	Placida del Quetzal	712	74	77	74
	122	Paved	Placida del Quetzal	427	125	131	125
	123	Paved	Paseo Rancho	697	233	244	232
	124	Paved	Placitas de las Colinas	823	279	292	278
	130	NOT MEASURED			29	31	33
	132	Paved	Paseo Rancho	221	293	313	337
	135	Paved	Silverbell	597	132	159	129
	137	Unpaved	Lost Horizon Dr.	1291	1928	1902	1920

TABLE 3B
ROADWAY DIP SECTIONS
-CONTINUED-

BASIN NUMBER	CROSSING NUMBER	DIP TYPES	ROADWAY	CAPACITY (CFS) @ 1'	ESTIMATED RUNOFF (CFS)		
					EXISTING	ZONED	PLANNED
8.	42	Paved	Silverbell	2024	7675	8139	7892
	45	Unpaved	Sunset Road	606	403	415	415
	46	Unpaved	Sunset Road	107	181	186	186
	47	Unpaved	Sunset Road	231	191	196	196
	48	Unpaved	Sunset Road	237	582	599	599
	52	Unpaved	Gerhardt Road	319	977	1005	1005
	53	Unpaved	Gerhardt Road	273	228	235	235
	54	Unpaved	Sunset Road	211	4122	4242	4208
	55	Unpaved	Blue Bonnet	178	4760	4898	4860
	56	Paved	Sunset Road	297	345	355	352
	59	Unpaved	Gerhardt Road	971	3520	3656	3656
	97	Unpaved	Blue Bonnet	171	144	148	147
	98	Unpaved	Blue Bonnet	106	142	146	145
	101	Unpaved	Sunray Circle	538	4474	4604	4568
	105	Unpaved	El Camino del Cerro	338	264	274	274
106	Unpaved	El Camino del Cerro	119	781	811	811	
107A	Unpaved	El Camino del Cerro	255	121	124	122	
8A.	57	Paved	Sunset Road	174	4632	5022	4775
	60	Unpaved	Gerhardt Road	971	374	380	363
	61	Paved	Sunset Road	196	28	30	29
	61A	Paved	Sunset Road	394	32	35	33
	62	Paved	Sunset Road	210	177	192	182
	90*	Paved	Camino del Cerro	421	2470	2643	2599
	92	Unpaved	Avenida Largo	285	1043	1067	1055
	93	Unpaved	Avenida Largo	388	720	732	699
	94	Unpaved	Avenida Largo	243	32	33	31
	95	Unpaved	Avenida Largo	164	753	765	731

TABLE 3B
ROADWAY DIP SECTIONS
-CONTINUED-

BASIN NUMBER	CROSSING NUMBER	DIP TYPES	ROADWAY	CAPACITY (CFS) @ 1'	ESTIMATED RUNOFF (CFS)		
					EXISTING	ZONED	PLANNED
8A.	96	Unpaved	Blue Bonnet	202	594	604	577
	99	Unpaved	El Camino del Cerro	236	758	776	767
	107	Unpaved	El Camino del Cerro	159	173	177	175
	108**	Unpaved	El Camino del Cerro	90	152	156	154
	109**	Unpaved	El Camino del Cerro	147	289	296	292
	110	Unpaved	El Camino del Cerro	263	390	399	395
	111	Unpaved	El Camino del Cerro	287	469	480	475
	112	Paved	El Camino del Cerro	166	495	507	501
	113**	Paved	El Camino del Cerro	220	764	782	773
	114	Paved	El Camino del Cerro	199	92	94	93
	115	Paved	Tortolita	478	720	776	709
	9.	19**	Paved	Broom Tail	283	331	337
20		Paved	Silverbell and Ina Roads	672	615	626	635
22		Paved	Silverbell	506	562	613	656
23		Paved	Silverbell	607	1295	1465	1479
24		Unpaved	Belmont	219	160	174	187
25		Unpaved	Belmont	835	1173	1327	1340
26		Unpaved	Belmont	301	218	226	228
27		Unpaved	Belmont	192	211	219	221
28		Unpaved	Belmont	245	1116	1158	1166
29		Unpaved	Belmont	260	177	184	185
30		Unpaved	Waycross Road	118	1225	1386	1399
31		Unpaved	Waycross Road	165	81	92	93
32		Unpaved	Abington Road	260	131	136	137
33*		Paved	Silverbell	431	1492	1512	1525

TABLE 3B
ROADWAY DIP SECTIONS
-CONTINUED-

BASIN NUMBER	CROSSING NUMBER	DIP TYPES	ROADWAY	CAPACITY (CFS) @ 1'	ESTIMATED RUNOFF (CFS)			
					EXISTING	ZONED	PLANNED	
9.	34	Unpaved	DeGreen Lane	260	1196	1241	1250	
	36	Paved	Silverbell	712	254	271	273	
	37	Paved	Silverbell	607	234	249	251	
	38	Paved	Silverbell	368	875	922	966	
	39**	Paved	Silverbell	418	357	376	394	
	40	NO DIP	Panorama		82	86	91	
	43	Unpaved	Sunset Road	332	189	196	198	
	44	Unpaved	Sunset Road	97	59	61	62	
	49	Unpaved	Sunset Road	178	148	154	155	
	50	Unpaved	Sunset Road	307	541	561	565	
	51	Unpaved	Sunset Road	875	538	558	562	
	100	Unpaved	Jimsen Lane	132	78	82	86	
<hr/>								
10.	12	Paved	Ina Road	1080	6515	6583	6645	
	17a&17b	Paved	Silverbell	304	} 466	5493	5550	5603
	17c&17d	Paved	Silverbell	162		5493	5550	5603
	18	Paved	Camino de los Caballos	314		643	682	684
	104	Unpaved	El Camino del Cerro	219	2789	2855	2789	
	<hr/>							
11.	1	Paved	Ina Road	300	143	152	152	
	2	Paved	Ina Road	213	230	245	245	
	2A	Paved	Ina Road	270	174	185	185	
	3*	Paved	Ina Road	222	311	330	330	
	4*	Paved	Ina Road	1328	580	617	617	
	6*	Paved	Wade Road	980	103	106	106	
	16b	Paved	Silverbell	209	216	246	264	
	16d	Paved	Silverbell	131	904	1029	1107	

TABLE 3B
ROADWAY DIP SECTIONS
-CONTINUED-

BASIN NUMBER	CROSSING NUMBER	DIP TYPES	ROADWAY	CAPACITY (CFS) @ 1'	ESTIMATED RUNOFF (CFS)		
					EXISTING	ZONED	PLANNED
13.	157	Paved	Silverbell	996	112	166	143
	158	Paved	Silverbell	757	758	835	795
	159	NO DIP	Silverbell		366	403	384
	163	Paved	Goret Road	690	48	71	61
	164	Paved	Goret Road	359	127	188	162
14.	141	Paved	Silverbell	398	31	34	33
	147	Paved	Sweetwater	259	175	192	186
15.	143	Paved	Silverbell	664	365	381	392
	144	Paved	Silverbell	797	157	164	168

See Volumes 4 through 7 of Detached Appendices.

*Also has a culvert.

**Dip is less than 1' deep.

TABLE 3C
CULVERT CROSSINGS

*Culvert
Capacities
3-15 to 3-19
Plate 6
for locations*

BASIN CROSSING				CAPACITY (CFS) ESTIMATED RUNOFF (CFS)			
NO.	NO.	CULVERT TYPE	ROADWAY	AT HEAD	EXIST.	ZONED	PLANNED
1.	182	18"RCP/24"CMP	Ironwood Hills	22/9'	815	828	828
	183	9-6'x10' CBC	Ironwood Hills	6120/9'	2160	3613	2789
	217	48" CMP	Speedway	160/12'	298	458	380
	218	2-72" CMP	Speedway	580/8'	970	1288	1280
	222	48" CMP	Painted Hills	80/4.5'	545	571	560
	224	2-60" CMP	Gardinier	340/7'	1243	1444	1232
	226	48" CMP	Westridge	155/11'	249	275	271
	227	5-48" CMP	Saddlewood Ranch	1125/13'	3009	3551	3239
	228	5-48" CMP	Saddlewood Ranch	875/8.6'	523	628	531
	2.	184	6-5'x10' CBC	Ironwood Hills	6000/19.8'	2586	3123
185		2-42" RCP	Ironwood Hills	300/11.4'	124	143	131
200		2-24" CMP	Broken Arrow Tr.	66/7'	142	195	152
216		2-48" CMP	Speedway	370/15'	6	6	6
219		3-36" CMP	West Speedway	360/16'	1862	1966	1930
220		36" CMP	West Speedway	55/5'	203	273	254
221		2-48" CMP	West Speedway	260/8'	1648	2001	1852
229		2-48" CMP	West Speedway	260/8'	1024	1165	1153
230		48" CMP	Anklam Road	115/6'	82	89	85
3.		206	Stone Culvert	Gates Pass Road	80/5'	2040	1977
	208	48" CMP	Monte Carlo	120/7'	334	370	350
	210	36" CMP	Via Roma	93/12'	1	2	1
	215	7-8'x12' CBC	Speedway	8820/12'	6600	6613	6613

3-15.
035

TABLE 3C
CULVERT CROSSINGS
-CONTINUED-

BASIN CROSSING				CAPACITY (CFS) ESTIMATED RUNOFF (CFS)			
NO.	NO.	CULVERT TYPE	ROADWAY	AT HEAD	EXIST.	ZONED	PLANNED
4.	166	3-30" CMPw/Dip	Lloyd Bush Dr.	CMP= 102/4' DIP= 598	32	38	32
	169	36" CMP	Morgan	45/4'	168	200	171
	173	2-48" CMP	Camino De Oeste	370/11'	1222	1437	1274
	189	18" CMP	Ironwood Hills	16/5.5'	314	346	319
	214	72" CMP	Placita La Zarca	350/12'	599	676	640
5.	150	2-72" CMP	Sweetwater	560/8'	3729	3918	3690
	174	72" CMP	Camino De Oeste	263/8.5'	89	88	88
	175	42" CMP	Camino De Oeste	105/9'	916	1247	1031
	177	2-72" CMP	Camino De Oeste	480/8'	3683	3818	3580
	194	12" CMP	Crestview Road	6/3.5'	2	2	2
	195	2-48" CMP	Crestview Road	200/6	276	351	330
	196	2-48" CMP	Crestview Road	240/7.6'	323	493	421
	197	36" CMP	Sundance Trail	80/8'	61	69	63
	198	2-48" CMP	Sundance Trail	200/6'	62	66	66
	199	48" CMP	Sundance Trail	103/6'	49	54	51
6.	NONE						
7.	68	36" CMP	Silverbell	35/3.2'	683	729	785
	84	4-48" CMP	La Amapola	436/6.4'	370	421	372
	85	2-42" CMP	La Amapola	124/4.4'	446	521	508
	86*	2-24" CMP	Tortolita and La Amapola	No Measurement	11	13	12
	87*	21" CMP	De La Girasol	No Measurement	45	50	47
	117	24" CMP	Baranco	45/15'	131	143	140

TABLE 3C
 CULVERT CROSSINGS
 -CONTINUED-

BASIN CROSSING				CAPACITY (CFS) ESTIMATED RUNOFF (CFS)			
NO.	NO.	CULVERT TYPE	ROADWAY	AT HEAD	EXIST.	ZONED	PLANNED
7.	120	3-50x31 CMPA	Playa De Los Ventos	195/4.5'	368	410	
	129	24" CMP	Camino De La Cordoniz	26/5.2'	40	44	
	131	24" CMP	Plaza Del Herrero	26/5'	34	37	
	133	2-48" CMP	Camino Del Cerro	90/5.2'	327	360	
	134	3-36" CMP	Camino De Oeste	255/4.4'	333	345	
8.	NONE						
8A.	88	2-72" CMP	Tortolita	680/11'	1211	1324	1210
	89	2-78" CMP	Camino Del Cerro	590/7.4'	1278	1384	1278
	90	78" CMP w/Dip	Camino Del Cerro	CMP= 320/8.5' DIP= 421	2470	2643	2599
	91	24" CMP	Avenida Largo	15/2.4'	59	67	64
	102	4-42" CMP	Gerhardt Road	296/5.2'	716	889	878
	103	2-42" CMP	Gerhardt Road	130/4.4'	92	96	88
	116	4-48" CMP	Paseo Del Barranco	460/7'	870	1102	1043
	125	3-60"x40" CMPA	Paseo De Las Colinas	405/8'	824	1054	970
	126	3-36" CMP	Paseo De Las Colinas	240/8'	548	642	513
	127	60" CMP	East of Tortolita	220/10'	575	636	490
	128	48" CMP	East of Tortolita	150/10.5'	1060	1249	1147

36" cutoff
 AVULSION +
 OVERTOPPING
 FLOODING
 Santa Cruz River

TABLE 3C
CULVERT CROSSINGS
-CONTINUED-

BASIN CROSSING				CAPACITY (CFS) ESTIMATED RUNOFF (CFS)				
NO.	NO.	CULVERT TYPE	ROADWAY	AT HEAD	EXIST.	ZONED	PLANNED	
9.	21	36" CMP	Broom Tail	60/5.6'	34	37	36	
	33	8'x22' ARCH w/Dip	Silverbell	PIPE=2500/14' DIP = 431	1492	1512	1525	
	35	36" CMP	Silverbell	75/5.5'	87	89	89	
	41	24" CMP	Silverbell	15/2.5'	456	465	511	
10.	NONE							
11.	3	30" CMP w/Dip	Ina Road	CMP= 40/4.8' DIP=222	311	330	330	
	4	2-36" CMPw/Dip	Ina Road	CMP= 130/7' DIP=1328	580	617	617	
	5	48" CMP	Wade Road	110/6'	85	87	87	
	6	24" CMPw/Dip	Wade Road	CMP= 26/5.2' DIP= 980	103	106	106	
	7	18" CMP	Wade Road	10/3.5'	54	56	56	
	8	24" CMP	Wade Road	20/3.4'	93	95	95	
	9	3-48" CMP	Ina Road	255/5'	154	169	169	
	10	30"x43" CMPA	Ina Road	50/4.6'	226	248	248	
	11	24" CMP	Ina Road	27/5'	98	108	108	
	13	7'x8' CBC	Cortaro Road	520/8.2'	400	426	425	
	14	4'x6' CBC	Cortaro Road	198/5.2'	178	198	199	
	15	24" CMP	Cortaro Road	23/8'	57	64	64	
	12.	NONE						

TABLE 3C
CULVERT CROSSINGS
-CONTINUED-

BASIN CROSSING				CAPACITY (CFS) ESTIMATED RUNOFF (CFS)			
NO.	NO.	CULVERT TYPE	ROADWAY	AT HEAD	EXIST.	ZONED	PLANNED
13.	154	2-18" RCP	Neosha Street	30/3.6'	245	251	236
14.	NONE						
15.	145	36" CMP	Sweetwater	75/8'	272	300	300

* No measurements were taken where upstream basins were very small and Q was known to be less than or equal to 50 cfs.

See Volumes 4 through 7 of Detached Appendices.

TABLE 3D
POTENTIAL DETENTION PONDS

BASIN CROSSING			DETENTION POND			
NUMBER	NUMBER	CROSSING TYPE	AVG. DEPTH	WIDTH	LENGTH*	AVAIL. VOLUME (Cubic Feet)
1.	182	18" RCP Inlet/24" CMP Outlet	4.50'	100'	260'	117,000
	183	9-6'x10' CBC	4.50'	350'	210'	330,750
	217	48" CMP	6.00'	300'	190'	342,000
	218	2-72" CMP	4.00'	150'	150'	90,000
	222	48" CMP	2.25'	55'	105'	12,990
	224	2-60" CMP	3.50'	80'	160'	44,800
	226	48" CMP	5.50'	300'	205'	338,250
	227	5-48" RCP	6.50'	200'	240'	312,000
	228	5-48" RCP	4.30'	300'	160'	206,400
2.	184	6-5x10 CBC	9.90'	300'	500'	1,485,000
	185	2-42" RCP	5.70'	200'	285'	324,900
	200	2-24" CMP	3.50'	150'	160'	84,000
	216+	2-48" CMP	7.50'	300'	225'	506,250
	219	3-36" CMP	8.00'	200'	150'	240,000
	220	36" CMP	2.50'	150'	45'	16,875
	221	2-48" CMP	4.00'	150'	75'	45,000
	229	2-48" CMP	4.00'	200'	75'	60,000
	230	48" CMP	3.00'	300'	84'	75,600
3.	206	Stone Culvert	2.50'	35'	65'	5,690
	170	Dip Crossing	4.00'	150'	200'	120,000
	208	48" CMP	3.50'	150'	20'	10,500
	210+	36" CMP	6.00'	90'	35'	18,900
	215	7-8'x12' CBC	6.00'	150'	160'	144,000

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TABLE 3D
 POTENTIAL DETENTION PONDS
 -CONTINUED-

BASIN CROSSING		DETENTION POND				
NUMBER	NUMBER	CROSSING TYPE	AVG. DEPTH	WIDTH	LENGTH*	AVAIL. VOLUME (Cubic Feet)
4.	166	3-30" CMP**	2.00'	75'	105'	15,750
	169	36" CMP	2.00'	75'	85'	12,750
	173	2-48" CMP	5.50'	250'	130'	178,750
	189	18" CMP	2.75'	100'	65'	17,875
	214	72" CMP	6.00'	120'	140'	100,800
5.	150	2-72" CMP	4.00'	200'	60'	48,000
	174	72" CMP	4.25'	200'	80'	68,000
	175	42" CMP	4.50'	200'	200'	180,000
	177	2-72" CMP	4.00'	250'	170'	170,000
	194+	12" CMP	1.75'	100'	50'	8,750
	195	2-48" CMP	3.00'	100'	70'	21,000
	196	2-48" CMP	3.80'	125'	85'	40,375
	197	36" CMP	4.00'	200'	50'	40,000
	198	2-48" CMP	3.00'	250'	70'	52,500
	199	48" CMP	3.00'	150'	30'	13,500
7.	68	36" CMP	NO DETENTION POND			
	84	4-48" CMP	NO DETENTION POND			
	85	2-42" CMP	NO DETENTION POND			
	86+	2-24" CMP	NO MEASUREMENTS TAKEN			
	87	21" CMP	NO MEASUREMENTS TAKEN			
	117	24" CMP	7.50'	200'	175'	262,500
	120	3-48"x32" CMPA	2.25'	60'	80'	10,800
	129	24" CMP	2.60'	60'	210'	32,760
	131	24" CMP	2.50'	40'	150'	15,000
	133	2-48" CMP	2.60'	100'	150'	39,000
134	3-36" CMP	2.20'	80'	100'	17,600	

TABLE 3D
 POTENTIAL DETENTION PONDS
 -CONTINUED-

BASIN CROSSING			DETENTION POND				
NUMBER	NUMBER	CROSSING TYPE	AVG. DEPTH	WIDTH	LENGTH*	AVAIL. VOLUME (Cubic Feet)	
8A.	88	2-72" CMP	5.50'	200'	390'	429,000	
	89	2-78" CMP	3.70'	300'	260'	288,600	
	90	78" CMP**	4.25'	250'	170'	180,625	
	91	24" CMP	1.20'	60'	60'	4,320	
	102	4-42" CMP	2.60'	200'	115'	59,800	
	103	2-42" CMP	2.20'	125'	50'	13,750	
	116	4-48" CMP	3.50'	150'	165'	86,625	
	125	3-60'x40' CMPA	4.00'	150'	285'	171,000	
	126	3-36" CMP	4.00'	175'	135'	94,500	
	127	60" CMP	5.00'	200'	170'	170,000	
128	48" CMP	5.25'	60'	250'	78,750		
9.	21	36" CMP	2.80'	100'	55'	15,400	
	33	8'x22' ARCH**	7.00'	75'	350'	183,750	
	35	36" CMP	NO DETENTION POND				
	41	24" CMP	1.25'	150'	60'	11,250	
11.	3	30" CMP**	2.40'	75'	100'	18,000	
	4	2-36" CMP**	3.50'	100'	125'	43,750	
	5	48" CMP	3.00'	200'	115'	69,000	
	6	24" CMP**	2.60'	75'	90'	17,550	
	7	18" CMP	1.75'	150'	90'	23,625	
	8	24" CMP	1.70'	125'	65'	13,813	
	9	3-48" CMP	2.50'	200'	105'	52,500	
	10	43" x 30" CMPA	2.30'	100'	100'	23,000	
	11	24" CMP	2.50'	100'	155'	38,750	
	13	8'x7' CBC	4.20'	35'	180'	26,460	
	14	6'x4' CBC	2.60'	35'	145'	13,195	
	15	24" CMP	4.00'	500'	225'	450,000	

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TABLE 3D
 POTENTIAL DETENTION PONDS
 -CONTINUED-

BASIN CROSSING			DETENTION POND			
NUMBER	NUMBER	CROSSING TYPE	AVG. DEPTH	WIDTH	LENGTH*	AVAIL. VOLUME (Cubic Feet)
13.	154	2-18" RCP	1.80'	50'	100'	9,000
15.	145	36" CMP	4.00'	200'	255'	204,000

* From U.S.G.S. 7-1/2 maps.

** With overflow dip section, see Tables 3B and 3C.

+ No hydrographs generated - very low runoff.

NOTE: A safety factor of 2 has been used to determine the available volume of detention ponds to account for irregularities that will exist in the bottoms and sides of the pond area, and obstruction that will exist, reducing the actual capacity. This has been applied by using only one-half the maximum head attainable at the roadway. This figure is given as the average depth in Table 3D.

3.1.3 RUNOFF AT CHANNEL SECTIONS

Each of the 88 cross sections taken at various locations throughout the Tucson Mountain Drainage Basin were used as points of concentration with a 100-year runoff amount computed individually for each point under the three development conditions. Table 3E presents the cross section number, the basin where the cross section is located, Q_{100} runoff under the three conditions calculated, and the width of the 100-year flood for each case. Refer to Plate No. 5 for cross section locations, and to Plates 7, 8, and 9 for Flood Plain Delineation. Maximum flows and widths have been underlined in the Table.

TABLE 3E
100-YEAR FLOOD WIDTH - CHANNELS

BASIN	CROSS SECT. NO.	EXIST.	PEAK RUNOFF (CFS)		100-YEAR FLOOD WIDTH		
			AS ZONED	AS PLANNED	EXIST.	AS ZONED	AS PLANNED
GREASEWOOD WASH							
1	61	523	<u>710</u>	516	295'	<u>299'</u>	295'
	62	2711	<u>3573</u>	2897	224'	<u>228'</u>	225'
	63	1319	<u>1631</u>	1310	84'	<u>86'</u>	84'
	64	1152	<u>1493</u>	1285	108'	<u>112'</u>	110'
	65	970	<u>1257</u>	1082	66'	<u>69'</u>	67'
	66*	4272	<u>6267</u>	4991	382'	<u>596'</u>	389'
	67*	4009	<u>5881</u>	4683	555'	<u>602'</u>	573'
	68*	3977	<u>5834</u>	4646	UNCONTAINED - ALL CASES		
1+0.S.	69*	12023	<u>18937</u>	16672	278'	<u>1035'</u>	921'
PAINTED HILLS WASH							
2	58	2586	<u>3169</u>	2920	487'	<u>492'</u>	490'
	59	1689	<u>1947</u>	1780	248'	<u>250'</u>	249'
	60	1648	<u>1900</u>	1737	<u>59'</u>	<u>61'</u>	<u>61'</u>

FP widths
@ X Sections
6/21/2017

Plate 5
X Sect. Loc

Plates 7-9
for FP delin.

TABLE 3E
100-YEAR FLOOD WIDTH - CHANNELS
-CONTINUED-

BASIN	CROSS SECT. NO.	PEAK RUNOFF (CFS)			100-YEAR FLOOD WIDTH		
		EXIST.	AS ZONED	AS PLANNED	EXIST.	AS ZONED	AS PLANNED
2	70*	2543	<u>3116</u>	2871	345'	<u>352'</u>	349'
	71*	2738	<u>3355</u>	3091	396'	<u>400'</u>	399'
	72*	2835	<u>3474</u>	3201	482'	<u>493'</u>	488'
2+1+0.S.	73*	13943	<u>21463</u>	18561	372'	X	X
CAMINO DEL OESTE WASH							
3	50	6295	6257	<u>6333</u>	301'	301'	<u>302'</u>
	51	6429	6390	<u>6468</u>	BRAIDED - ALL CASES		
	52	7914	7866	<u>7962</u>	293'	293'	293'
	53	<u>6600</u>	6581	6581	199'	199'	199'
	54	4266	4295	<u>4331</u>	147'	147'	<u>148'</u>
	55	<u>1866</u>	1778	1725	<u>147'</u>	144'	143'
	56	<u>1881</u>	1792	1739	65'	65'	65'
	74*	5923	5887	<u>5959</u>	403'	403'	403'
	75*	5191	<u>5543</u>	5422	355'	<u>367'</u>	363'
	88	6641	6600	<u>6681</u>	557'	556'	557'
TRAILS END WASH							
4	43*	4406	<u>4633</u>	4348	417'	<u>418'</u>	417'
	44*	1890	<u>2055</u>	1924	236'	<u>238'</u>	236'
	45*	2782	<u>3052</u>	2842	181'	<u>184'</u>	182'
	46	1350	<u>1468</u>	1375	317'	<u>324'</u>	318'
	47	2466	<u>2516</u>	<u>2454</u>	151'	151'	151'
	48	1222	<u>1329</u>	1244	50'	50'	50'
	49	1607	<u>1640</u>	1599	37'	37'	37'
	76*	4366	<u>4591</u>	4309	328'	<u>347'</u>	323'
	85	2616	<u>2670</u>	2603	76'	<u>77'</u>	75'
	86	1194	<u>1298</u>	1215	94'	<u>95'</u>	94'
	87	1943	<u>1983</u>	1933	<u>160'</u>	<u>160'</u>	159'

TABLE 3E
100-YEAR FLOOD WIDTH - CHANNELS
 -CONTINUED-

BASIN	CROSS SECT. NO.	PEAK RUNOFF (CFS)			100-YEAR FLOOD WIDTH		
		EXIST.	AS ZONED	AS PLANNED	EXIST.	AS ZONED	AS PLANNED
ROGER WASH							
5	34*	6662	<u>7491</u>	6954	410'	<u>412'</u>	411'
	35	7113	<u>7999</u>	7425	322'	<u>323'</u>	322'
	36	7142	<u>8098</u>	6877	203'	<u>205'</u>	202'
	37	4160	<u>4425</u>	4039	224'	<u>225'</u>	224'
	38	3616	<u>3960</u>	3462	228'	<u>234'</u>	226'
	39	2043	<u>2256</u>	1879	63'	<u>64'</u>	62'
	40	1491	<u>1616</u>	1497	123'	<u>124'</u>	123'
	41	3640	<u>3753</u>	3524	114'	<u>115'</u>	113'
	42	3115	<u>3212</u>	3016	46'	<u>46'</u>	46'
	77*	6289	<u>7072</u>	6565	661'	<u>662'</u>	661'
AYERS WASH							
6	28+	4168	4308	<u>4317</u>	284' / 92'	287' / 92'	287' / 92'
	29	4532	4684	<u>4694</u>	171'	<u>172'</u>	<u>172'</u>
	30	4997	<u>5135</u>	5006	112'	<u>114'</u>	112'
	31	5102	<u>5263</u>	5115	144'	<u>146'</u>	145'
	32	1825	<u>1983</u>	<u>1983</u>	96'	<u>97'</u>	<u>97'</u>
	33	3441	3520	3433	151'	151'	151'
	79*	3943	4075	<u>4084</u>	357'	<u>358'</u>	358'
	84	4105	4242	<u>4252</u>	139'	139'	139'
7	26	446	489	<u>503</u>	53'	<u>54'</u>	<u>54'</u>
	27	1928	<u>1991</u>	1922	174'	<u>176'</u>	173'
	80*	2174	<u>2257</u>	2168	147'	<u>151'</u>	147'
	81*	683	729	<u>785</u>	243'	244'	<u>246'</u>
	82*	1259	1380	<u>1420</u>	104'	<u>107'</u>	106'

TABLE 3E
100-YEAR FLOOD WIDTH - CHANNELS
 -CONTINUED-

BASIN	CROSS SECT. NO.	EXIST.	PEAK RUNOFF (CFS)		100-YEAR FLOOD WIDTH		
			AS ZONED	AS PLANNED	EXIST.	AS ZONED	AS PLANNED
IDLE HOUR WASH							
8+8A	12	7410	<u>7858</u>	7620	638'	<u>639'</u>	<u>639'</u>
8	13	4474	<u>4604</u>	4568	317'	317'	317'
	14	4122	<u>4271</u>	<u>4271</u>	273'	<u>275'</u>	<u>275'</u>
	15	1076	<u>1107</u>	<u>1107</u>	100'	100'	100'
	16	3508	<u>3643</u>	<u>3643</u>	178'	<u>179'</u>	<u>179'</u>
	17	4241	<u>4405</u>	<u>4405</u>	243'	<u>244'</u>	<u>244'</u>
8A	18	4632	<u>5017</u>	4692	119'	<u>121'</u>	120'
	19	4527	<u>4962</u>	4622	184'	<u>185'</u>	<u>185'</u>
	20	3805	<u>4109</u>	3828	169'	<u>170'</u>	169'
	21	1269	<u>1368</u>	1250	100'	<u>101'</u>	100'
	22	2226	<u>2429</u>	2331	75'	<u>76'</u>	75'
	23	953	<u>976</u>	964	69'	<u>71'</u>	70'
	24	554	<u>563</u>	538	<u>132'</u>	<u>132'</u>	131'
	25	1060	<u>1143</u>	1044	117'	<u>118'</u>	116'
<hr/>							
9	6+	544	593	<u>635</u>	86'/43'	86'/67'	86'/80'
	7	1295	1465	<u>1479</u>	128'	<u>131'</u>	<u>131'</u>
	8	1492	1548	<u>1559</u>	42'	42'	<u>43'</u>
	9	1194	1259	<u>1318</u>	99'	<u>100'</u>	<u>100'</u>
	10	1171	1325	<u>1338</u>	96'	97'	<u>98'</u>
	11	1155	1198	<u>1207</u>	141'	<u>142'</u>	<u>142'</u>
<hr/>							
YUMA MINE WASH							
10	1	6515	6583	<u>6645</u>	219'	220'	<u>221'</u>
	2	4798	<u>4840</u>	4610	<u>260'</u>	<u>260'</u>	257'
	3	4983	<u>5026</u>	4788	<u>94'</u>	<u>94'</u>	93'
	4	3933	<u>3952</u>	3878	83'	83'	83'

TABLE 3E
100-YEAR FLOOD WIDTH - CHANNELS
 -CONTINUED-

BASIN	CROSS SECT. NO.	PEAK RUNOFF (CFS)			100-YEAR FLOOD WIDTH		
		EXIST.	AS ZONED	AS PLANNED	EXIST.	AS ZONED	AS PLANNED
10	5	2961	<u>3031</u>	2961	56'	<u>57'</u>	56'
	83*	5493	5550	<u>5603</u>	386'	387'	<u>388'</u>
13	57*	429	<u>473</u>	450	58'	<u>60'</u>	59'
14	78*	421	<u>462</u>	448	132'	<u>136'</u>	135'

See Volumes 8 & 9 of Detached Appendices.

O.S. = "Off-Site" Area.

* Indicates cross sections taken from topographic maps.

X Indicates spill over into Santa Cruz River.

+ Indicates threading.

Computation of runoff amounts within the channel sections indicated many locations where lesser runoff (attenuation) was experienced even though the channel section carried the flow from an area larger than the channel section upstream on the same wash. While this is not a usual occurrence, it has been noted in other studies and can be explained because of the increased times of concentration resulting from flatter slopes and more absorbent soil/ground cover types which exist between mountains and river valleys. Since the time of concentration will influence greatly the total runoff, the longer time gives a lesser flow even for a greater land area. This attenuation phenomena occurs in approximately 18 sections of those investigated and in amounts varying up to 21% reduction in runoff.

3.2 HYDROGRAPHS

3.2.1 INFLOW HYDROGRAPHS

Each point of concentration created by a culvert carrying runoff beneath a roadway received a calculation to determine the 100 year concentration occurring at that point. The calculation was performed for each of the three development possibilities: existing conditions, existing zoning, and according to the current Tucson Mountain Area Plan. Based upon the runoff supply rate, time of concentration, and the peak discharge, an inflow hydrograph was generated for the detention pond existing upstream of each culvert found in the field.

Table 3F contains inflow information for each detention pond. Included in the table are the crossing point numbers, culvert type, local sub-basin area in acres, time of concentration in minutes, runoff supply rate, and the total volume of runoff generated in cubic feet. Refer to Plate No. 6 for crossing locations.

TABLE 3F
INFLOW HYDROGRAPHS

BASIN	CROSSING NO.	LOCAL SUB-BASIN AREA (AC)	CULVERT TYPE	EXISTING			AS ZONED			AS PLANNED		
				R	TC	VOLUME (CF)	R	TC	VOLUME (CF)	R	TC	VOLUME (CF)
1.	182	165	18" RCP/24" CMP	.65	23	1086195	.71	26	1186460	.71	27	1186460
	183	902	9-6'x10' CBC	.63	51	5757719	.72	40	6580250	.65	50	5940504
	217	59	48" CMP	.63	20	376446	.79	11	472052	.73	18	436200
	218	303	2-72" CMP	.59	40	1810528	.64	29	1963963	.66	31	2025337
	222	84	48" CMP	.66	12	561479	.70	11	595508	.68	12	578494
	224	238	2-60" CMP	.69	23	1663170	.72	18	1735482	.68	23	1639066
	226	44	48" CMP	.61	15	271827	.64	14	285196	.63	13	280739
	227	806	5-48" CMP	.63	36	5145195	.69	32	5635214	.66	35	5390205
	228	119	5-48" CMP	.62	26	747221	.66	20	795429	.63	26	759273
2.	184	736	6-5'x10' CBC	.68	46	5159548	.75	40	5690678	.73	42	5538927
	185	23	2-42" RCP	.66	21	156493	.73	19	173091	.70	20	165978
	200	29	2-24" CMP	.54	18	161442	.68	12	203297	.61	18	182369
	216*	0.83	2-48" CMP									
	219	289	3-36" CMP	.68	15	2025963	.72	14	2145138	.70	15	2085551
	220	38	36" CMP	.63	19	246802	.72	13	282059	.70	14	274224
	221	285	2-48" CMP	.68	19	1997922	.74	16	2174210	.72	17	2115447
	229	182	2-48" CMP	.66	19	1238341	.71	16	1332154	.70	16	1313392
	230	12	48" CMP	.69	11	85360	.74	9	91545	.72	10	89071

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CAMP DRESSER & MCKEE INC

TABLE 3F
INFLOW HYDROGRAPHS
 -CONTINUED-

BASIN	CROSSING NO.	LOCAL SUB-BASIN AREA (AC)	CULVERT TYPE	EXISTING			AS ZONED			AS PLANNED		
				R	TC	VOLUME (CF)	R	TC	VOLUME (CF)	R	TC	VOLUME (CF)
3.	206**	607	STONE	.66	45	4115529	.65	47	4053172	.65	46	4053172
	208	55	48" CMP	.64	14	361606	.68	14	384206	.67	14	378556
	210*	0.20	36" CMP									
	215**	2496	7-8'x12' CBC	.65	61	16666753	.65	61	16666753	.65	61	16666753
4.	166	6	3-30" CMP	.55	15	34379	.62	14	38755	.56	15	35004
	169	39	36" CMP	.55	23	223468	.62	20	251909	.56	23	227531
	173	269	2-48" CMP	.71	33	1989752	.76	29	2129876	.72	32	2017777
	189	51	18" CMP	.64	14	340046	.67	12	355986	.62	14	329420
	214	103	72" CMP	.71	21	761875	.76	18	815528	.72	20	772606
5.	150	1152	2-72" CMP	.68	53	8189559	.70	52	8430428	.68	54	8189559
	174**	14	72" CMP	.63	9	92207	.62	9	90744	.62	9	90744
	175	231	42" CMP	.54	28	1304082	.65	22	1569728	.59	25	1424830
	177	1261	2-72" CMP	.68	59	8963018	.69	58	9094827	.68	62	8963017
	194*	0.30	12" CMP									
	195	64	2-48" CMP	.45	15	301086	.54	13	361304	.51	14	341231

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CAMP DRESSEFF & MCKEE, INC

TABLE 3F
INFLOW HYDROGRAPHS
 -CONTINUED-

BASIN	CROSSING NO.	LOCAL SUB-BASIN AREA (AC)	CULVERT TYPE	EXISTING			AS ZONED			AS PLANNED		
				R	TC	VOLUME (CF)	R	TC	VOLUME (CF)	R	TC	VOLUME (CF)
5.	196	83	2-48" CMP	.45	19	390471	.62	15	537983	.55	16	477243
	197	12	36" CMP	.51	10	63980	.57	9	71508	.52	10	65235
	198	13	2-48" CMP	.47	13	63876	.50	13	67953	.50	13	67953
	199	10	48" CMP	.48	8	50181	.54	7	56453	.50	51	52272
7.	68	283	36" CMP	.58	62	1710027	.60	59	1768993	.62	56	1827959
	84	109	4-48" CMP	.57	38	647276	.62	36	704055	.58	39	658632
	85	127	2-42" CMP	.55	33	727704	.60	30	793859	.58	31	767397
	86*	2	2-24" CMP									
	87	8	21" CMP	.56	9	46673	.62	8	51673	.58	9	48339
	117	23	24" CMP	.56	12	134185	.62	11	148562	.60	11	143769
	120	86	3-50x31 CMPA	.57	25	510695	.61	23	546533	.60	25	537573
	129	7	24" CMP	.56	13	40838	.62	12	45214	.60	13	43756
	131	6	24" CMP	.57	12	35629	.62	12	38755	.60	12	37505
	133	77	2-48" CMP	.58	26	465272	.62	26	497360	.60	27	481316
	134	73	3-36" CMP	.58	23	441102	.60	23	456312	.60	24	456312

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CAMP DRESSER & MCKEE INC

TABLE 3F
INFLOW HYDROGRAPHS
 -CONTINUED-

BASIN	CROSSING NO.	LOCAL SUB-BASIN AREA (AC)	CULVERT TYPE	EXISTING			AS ZONED			AS PLANNED		
				R	TC	VOLUME (CF)	R	TC	VOLUME (CF)	R	TC	VOLUME (CF)
8A.	88	532	2-72" CMP	.57	66	3181200	.61	63	3404442	.57	66	3181200
	89	509	2-78" CMP	.58	60	3097064	.61	57	3257257	.58	60	3097064
	90	768	78" CMP	.65	50	5236957	.67	47	5398095	.66	49	5317526
	91	9	24" CMP	.65	13	61370	.73	12	68923	.70	13	66091
	102	232	4-42" CMP	.55	42	1338613	.63	37	1533320	.62	38	1508982
	103	14	2-42" CMP	.65	13	95465	.67	12	98402	.62	13	91059
	116	330	4-48" CMP	.53	49	1834823	.59	43	2042539	.57	44	1973300
	125	360	3-60x40 CMPA	.53	59	2001625	.60	51	2265991	.57	53	2152691
	126	138	3-36" CMP	.60	32	868630	.63	28	912061	.57	34	825198
	127	132	60" CMP	.61	29	844711	.63	26	872406	.57	33	789320
128	335	48" CMP	.59	45	2073486	.64	40	2249206	.62	43	2178918	
9.	21	6	36" CMP	.55	9	34739	.61	9	38528	.58	10	36633
	33	678	8'x22' ARCH	.55	66	3927834	.55	64	3927834	.56	64	3999249
	35	15	36" CMP	.57	13	90005	.58	13	91584	.58	13	91584
	41	112	24" CMP	.57	29	672043	.58	28	683833	.62	26	730994

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CAMP DRESSER & MCKEE, INC

TABLE 3F
INFLOW HYDROGRAPHS
 -CONTINUED-

BASIN	CROSSING NO.	LOCAL		EXISTING			AS ZONED			AS PLANNED		
		SUB-BASIN AREA (AC)	CULVERT TYPE	R	TC	VOLUME (CF)	R	TC	VOLUME (CF)	R	TC	VOLUME (CF)
11.	3	80	30" CMP	.55	31	467979	.59	30	502014	.59	30	502014
	4	145	2-36" CMP	.55	29	848213	.59	28	909901	.59	28	909901
	5	16	48" CMP	.55	14	91256	.57	14	94574	.57	14	94574
	6	20	24" CMP	.55	17	116994	.57	16	121249	.57	16	121249
	7	10	18" CMP	.55	15	58497	.57	15	60624	.57	15	60624
	8	17	24" CMP	.55	15	99445	.57	14	103061	.57	14	103061
	9	36	3-48" CMP	.55	24	210590	.59	24	225906	.59	24	225906
	10	64	43"x30" CMPA	.55	35	374383	.59	35	401611	.59	35	401611
	11	23	24" CMP	.55	25	134544	.59	23	144329	.59	23	144329
	13	110	7'x8' CBC	.55	35	643471	.59	34	690269	.59	34	690269
	14	42	4'x6' CBC	.55	25	245689	.59	24	263557	.59	24	263557
	15	11	24" CMP	.55	17	64347	.59	16	69026	.59	16	69026
13.	154	64	2-18" RCP	.58	32	385372	.60	32	398661	.58	34	385372

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CAMP DRESSER & MCKEE INC

TABLE 3F
INFLOW HYDROGRAPHS
 -CONTINUED-

BASIN	CROSSING NO.	LOCAL SUB-BASIN AREA (AC)	CULVERT TYPE	EXISTING			AS ZONED			AS PLANNED		
				R	TC	VOLUME (CF)	R	TC	VOLUME (CF)	R	TC	VOLUME (CF)
15.	145	76	36" CMP	.54	32	426069	.58	31	457629	.58	31	457629

* Indicates no hydrograph computed because of very low runoff.

R - Runoff supply rate factor.

TC - Time of concentration in minutes.

** Indicates that runoff from existing conditions is greater than any planned developed condition.

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3.2.2 INFLOW-OUTFLOW HYDROGRAPH

Once the inflow hydrograph for each pond and culvert was determined, an outflow hydrograph was applied to the same location based upon the culvert capacity. By comparing the data for the inflow and outflow hydrographs, it was possible to determine the adequacy of the culvert to transport the concentrated flow during the 100 year rainfall event without the roadway being flooded.

Detention ponding on the upstream side of culverts, in conjunction with the culvert capacity, determined the adequacy of the crossing to be stable without topping the roadway causing potential damage and flooding.

The information compiled during this procedure is presented in Table 3G. The table includes the basin in which the culvert is found, the crossing number, the type of culvert and its capacity, and the adequacy of the detention pond to store sufficient runoff to prevent roadway flooding. Also given in the table are the times of concentration for the three runoff conditions, the approximate amount of time required to overtop the roadway at inadequate crossings, and the peak flow for the crossing under existing, as zoned, and as planned development conditions. Note that in the event a detention pond and culvert were found adequate, the maximum discharge at that point will be either the culvert capacity or the peak runoff if the culvert is capable to carry more runoff than that concentrated at its inlet. In the event the crossing was found to be inadequate, it was assumed the discharge would equal the concentrated runoff. All flows are given in cubic feet/second. All times are given in minutes. Refer to Plate No. 6 for crossing locations.

Note that stage discharge rates for the culverts were not determined. To simplify the procedure the assumption was made that any particular culvert would discharge all flows concentrating at its inlet until the peak flow for the drainage basin exceeded the maximum capacity of the culvert at the available head. Thus, the assumption was also made that no storage of runoff occurs within the detention pond at the culvert inlet until the ?

TABLE 3G
INFLOW-OUTFLOW HYDROGRAPHS

BASIN	CROSSING NUMBER	CULVERT TYPE	CULVERT CAPACITY	PONDS		TIME		DISCHARGE RATE		
				ADEQUATE	INADEQUATE	TC	OF	E	Z	P
1.	182	18"RCP/24"CMP	22		X	23-27	15	815	828	828
	183	9-6'x10'CBC	6120	X		40-51		2610	3613	2789
	217	48" CMP	160	X		11-20		160	160	160
	218	2-72" CMP	580	X		29-40		580	580	580
	222	48" CMP	80		X	11-12	6	545	571	560
	224	2-60" CMP	340		X	18-23	15-20	1243	1444	1232
	226	48" CMP	155	X		13-15		155	155	155
	227	5-48" CMP	1125		X	32-36	31-33	3009	3551	3239
	228	5-48" CMP	875	X		20-26		523	628	531
2.	184	6-5'x10'CBC	6000	X		40-46		2586	3123	2970
	185	2-42" RCP	300	X		19-21		124	143	131
	200	2-24" CMP	66	X		12-18		66	66	66
	219	3-36" CMP	360		X	14-15	18	1862	1966	1930
	220	36" CMP	55		X	13-19	15-18	203	273	254
	221	2-48" CMP	260		X	16-19	9-11	1648	2001	1852
	229	2-48" CMP	260		X	16-19	17-18	1024	1165	1153
	230	48" CMP	115	X		9-11		82	89	85

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CAMP DRESSEP & MOORE, INC.

TABLE 3G
INFLOW-OUTFLOW HYDROGRAPHS
 -CONTINUED-

BASIN	CROSSING NUMBER	CULVERT TYPE	CULVERT CAPACITY	PONDS		TIME		DISCHARGE RATE		
				ADEQUATE	INADEQUATE	TC	OF	E	Z	P
3.	206	STONE	80		X	45-47	7-8	2040	1977	2024
	208	48" CMP	120		X	14	15-18	334	370	350
	215	7-8'x12'CBC	8820	X		61		6600	6613	6613
4.	166	3-30" CMP	102	X		14-15		32	38	32
	169	36" CMP	45		X	20-23	19-23	168	200	171
	173	2-48" CMP	370		X	29-33	26-31	1222	1437	1274
	189	18" CMP	16		X	12-14	10	314	346	319
	214	72" CMP	350	X		18-21		350	350	350
5.	150	2-72" CMP	560		X	52-54	17	3729	3918	3690
	174	72" CMP	263	X		9		89	88	88
	175	42" CMP	105		X	22-28	17-23	916	1247	1031
	177	2-72" CMP	480		X	58-62	19-23	3683	3818	3850
	195	2-48" CMP	200	X		13-15		200	200	200
	196	2-48" CMP	240	X		15-19		240	240	240
	197	36" CMP	80	X		9-10		61	69	63

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CAMP DRESSER & MAYER INC

TABLE 3G
INFLOW-OUTFLOW HYDROGRAPHS
 -CONTINUED-

BASIN	CROSSING NUMBER	CULVERT TYPE	CULVERT CAPACITY	PONDS		TIME		DISCHARGE RATE		
				ADEQUATE	INADEQUATE	TC	OF	E	Z	P
5.	198	2-48" CMP	200	X		13		62	66	66
	199	48" CMP	103	X		7-8		49	54	51
7.	68*	36" CMP	35		X	56-62	*	683	729	785
	84	4-48" CMP	436	X		36-39		370	421	372
	85*	2-42" CMP	124		X	30-33	*	446	521	508
	117	24" CMP	45	X		11-12		45	45	45
	120	3-50x31 CMPA	195		X	23-25	30-32	368	410	392
	129	24" CMP	26	X		12-13		26	26	26
	131	24" CMP	26	X		12		26	26	26
	133	2-48" CMP	90		X	26-27	24-28	327	360	339
	134	3-36" CMP	255	X		23-24		255	255	255
8A.	88	2-72" CMP	680	X		63-66		680	680	680
	89 ¹	2-78" CMP	590	X	X	57-60	59	590	1384	590
	90	78" CMP	320		X	47-50	20-25	2470	2643	2599
	91	24" CMP	15		X	12-13	15-17	59	67	64

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CAMP PRESSED & MCKEE INC

TABLE 3G
INFLOW-OUTFLOW HYDROGRAPHS

-CONTINUED-

BASIN	CROSSING NUMBER	CULVERT TYPE	CULVERT CAPACITY	PONDS		TIME		DISCHARGE RATE		
				ADEQUATE	INADEQUATE	TC	OF	E	Z	P
8A.	102	4-42" CMP	296		X	37-42	34-40	716	889	878
	103	2-42" CMP	130	X		12-13		92	96	88
	116 ^{·2}	4-48" CMP	460	X	X	43-49	41	460	1102	1043
	125 ^{·2}	3-60x40 CMPA	405	X	X	51-59	46-52	405	1054	970
	126 ^{·1}	3-36" CMP	240	X	X	28-34	37	240	642	240
	127	60" CMP	220	X		26-33		220	220	220
	128	48" CMP	150		X	40-45	18-23	1060	1249	1147
9.	21	36" CMP	60	X		9-10		34	37	36
	33	8'x22' ARCH	2500	X		64-66		1492	1512	1525
	35*	36" CMP	75		X	13	*	87	89	89
	41	24" CMP	15		X	26-29	8-11	456	465	511
11.**	3	30" CMP	40		X	30-31	15-18	311	330	330
	4	2-36" CMP	130	X		28-29	20-23	580	617	617
	5	48" CMP	110	X		14		85	87	87
	6	24" CMP	26	X		16-17	21-24	103	106	106

TABLE 3G
INFLOW-OUTFLOW HYDROGRAPHS
 -CONTINUED-

BASIN	CROSSING NUMBER	CULVERT TYPE	CULVERT CAPACITY	PONDS		TIME		DISCHARGE RATE		
				ADEQUATE	INADEQUATE	TC	OF	E	Z	P
11.	7	18" CMP	10		X	15	30-33	54	56	56
	8	24" CMP	20		X	14-15	18-20	93	95	95
	9	3-48" CMP	255	X		24		154	169	169
	10	43x30 CMPA	50		X	35	23-26	226	248	248
	11	24" CMP	27		X	23-25	41-46	98	108	108
	13	7'x8' CBC	520	X		34-35		400	426	426
	14	4'x6' CBC	198	X		24-25		178	198	199
	15	24" CMP	23	X		16-17		23	23	23
13.	154	2-18" RCP	30		X	32	16	245	251	236
15.	145	36" CMP	75	X		31-32		75	75	75

TC = Time of concentration.
 OF = Time of overflow.
 E = Existing.
 Z = As zoned.
 P = Area plan.

* No detention pond.
 .1 Inadequate for existing zoning only.
 .2 Adequate for existing conditions only.
 ** Dip sections in Basin II contain overflow of roadway.

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3.2.3 INADEQUATE ROADWAY CROSSINGS

To summarize, Table 3H shows the inadequate roadway crossings of all types found throughout the area of study. Of a total of 238 crossings examined, 116 (49%) were found to be inadequate under existing conditions. Eight additional crossings, adequate for existing conditions are inadequate when subjected to runoff from more developed basins.

3H
INADEQUATE ROADWAY CROSSINGS

BASIN NO.	CROSSING NO.	CROSSING TYPE		ROADWAY
		DIP SECTION	CULVERT	
1.	181	X		Silverbell Road
	182		X	Ironwood Hills
	222		X	Painted Hills
	224		X	Gardinier
	225 (.1)	X		Camino Claveres
	227		X	Saddlewood Ranch Dr.
	231	X		Anklam Road
2.	178	X		Silverbell Road
	179	X		Silverbell Road
	204	X		Raphael
	219		X	West Speedway
	220		X	West Speedway
	221		X	West Speedway
	229		X	West Speedway
	202	X		Shannon Road
3.	155	X		Goret Road
	156	X		Silverbell Road
	167	X		Lloyd Bush Drive
	168	X		Tomas Road
	171	X		Peter Steward
	172	X		Ironwood Hills
	203	X		Granneo Road
	205	X		Camino De Oeste

3H

INADEQUATE ROADWAY CROSSINGS

-CONTINUED-

BASIN NO.	CROSSING NO.	CROSSING TYPE		ROADWAY
		DIP SECTION	CULVERT	
3.	206		X	Gates Pass Road
	208		X	Monte Carlo
	211	X		Camino De Oeste
4.	160	X		Silverbell Road
	151	X		Morgana
	165	X		Lloyd Bush Drive
	152	X		Goret Road
	169		X	Morgan
	173		X	Camino De Oeste
	188	X		Ironwood Hills
	189		X	Ironwood Hills
	191	X		Crestview
	212	X		Camino De Oeste
	213 (.1)	X		Placita Tuberia
5.	142	X		Silverbell Road
	146	X		Sweetwater Driver
	148	X		Kay T. Drive
	149	X		Kay T. Drive
	150		X	Camino De Oeste
	175		X	Camino De Oeste
	177		X	Camino De Oeste
6.	136	X		Lost Horizon Drive
	138	X		Newland Drive
7.	69	X		Silverbell Road
	68		X	Silverbell Road
	72	X		Silverbell Road
	70	X		Silverbell Road
	74 (.2)	X		Silverbell Road
	71	X		Silverbell Road
	73	X		Silverbell Road

INADEQUATE ROADWAY CROSSINGS
-CONTINUED-

BASIN NO.	CROSSING NO.	CROSSING TYPE		ROADWAY
		DIP SECTION	CULVERT	
7.	75	X		Silverbell Road
	76	X		Silverbell Road
	77	X		Silverbell Road
	79	X		El Camino del Cerro
	80	X		El Camino del Cerro
	78	X		El Camino Del Cerro
	119	X		Playa de los Ventos
	120		X	Playa De Los Ventos
	132	X		Paseo RAncho
	133		X	El Camino Del Cerro
	137	X		El Camino Del Cerro
8.	42	X		Silverbell Road
	46	X		Sunset Road
	52	X		Gerhardt Road
	48	X		Sunset Road
	54	X		Sunset Road
	55	X		Blue Bonnet Road
	56	X		Sunset Road
	59	X		Gerhardt Road
	98	X		Blue Bonnet Road
	101	X		Sunray Circle
8A.	57	X		Sunset Road
	89 (.1)		X	Camino Del Cerro
	90		X	Camino Del Cerro
	91		X	Avenida Largo
	92	X		Avenida Largo
	93	X		Avenida Largo
	95	X		Avenida Largo
	96	X		Blue Bonnet Road
99	X		El Camino Del Cerro	

3H

INADEQUATE ROADWAY CROSSINGS

-CONTINUED-

BASIN NO.	CROSSING NO.	CROSSING TYPE		ROADWAY
		DIP SECTION	CULVERT	
8A.	102		X	Gerhardt Road
	107	X		El Camino Del Cerro
	113	X		El Camino Del Cerro
	108	X		El Camino Del Cerro
	116 (.2)		X	Paseo Del Barranco
	109	X		El Camino Del Cerro
	125 (.2)		X	Paseo De Las Colinas
	110	X		El Camino Del Cerro
	126 (.1)		X	Paseo De Las Colinas
	111	X		El Camino Del Cerro
	128		X	East of Tortolita
	112	X		El Camino Del Cerro
	115	X		Tortolita
9.	19	X		Broom Tail
	25	X		Belmont Road
	22	X		Silverbell
	28	X		Belmont Road
	23	X		Silverbell
	30	X		Waycross Road
	27	X		Belmont
	33	X		Silverbell Road
	34	X		DeGreen Lane
	35		X	Silverbell Road
	40	X		Panorama Road
	41		X	Silverbell Road
	50	X		Sunset Road
10.	12	X		Ina Road
	17	X		Silverbell Road
	18	X		Camino de los Caballos
	104	X		El Camino Del Cerro

3-45

065

INADEQUATE ROADWAY CROSSINGS
-CONTINUED-

BASIN NO.	CROSSING NO.	CROSSING TYPE		ROADWAY
		DIP SECTION	CULVERT	
11.	2	X		Ina Road
	3		X	Ina Road
	7		X	Wade Road
	8		X	Wade Road
	10		X	Ina Road
	11		X	Ina Road
	16d&c	X		Silverbell Road
	16b&a	X		Silverbell Road
13.	154		X	Neosha Street
	159	X		Silverbell Road
	158 (.2)	X		Silverbell Road

(.1) - Inadequate under existing zoning condition.

(.2) - Adequate under existing conditions only.

4.0 FLOOD PLAINS AND POTENTIAL FLOODING

4.1 HISTORIC FLOODING PROBLEMS

4.1.1 CITIZEN COMPLAINTS

The Pima County Department of Transportation and Flood Control District has received many drainage related complaints from citizens living within the Tucson Mountain Basin. Standard procedure has been to log the complaint on a service request form, perform an on-site inspection of the condition, and program remedial action if necessary.

Copies of service requests, dating to the late 1970's were reviewed for follow-up inspection. The requests were examined for applicability to this project, and a follow-up field inspection made. Many were found to be local problems involving small washes crossing driveways or inadequate culverts placed by property owners. Others, more significant, were found to be the result of inadequate culverts under major streets and roadways, flooding dip sections, or major washes crossing roadways at extreme acute angles, diverting flow into the road. The worst of these latter problems occurs at crossing number 40 where the flow from a large wash is diverted into Panorama Road immediately south of Orange Grove Road, west of Silverbell Road. Flooding of the roadway has existed at this point since the roadway was constructed and will continue until major improvements such as realignment of the roadway or channelization of flood waters are performed.

4.1.2 PIMA COUNTY D.O.T. EXPERIENCE

Discussions with County staff indicate major concern regarding flooding at the inadequate dip crossings of Silverbell Road and the general flooding conditions occurring between Silverbell Road and the Santa Cruz River. Inspections of the area and analysis substantiate these concerns because the crossings of Silverbell Road in all but one case are inadequate to convey the flow within the major washes at an

acceptable depth or in a controlled manner. Badly eroded washes downstream of Silverbell require attention, as does the easterly pavement edge of the roadway. Grades in the land area between Silverbell Road and the Santa Cruz River vary from 0.33 percent to 2.50 percent and runoff from this area is in the form of sheet flow except within the channels of the major washes. Small, local channels and irrigation ditches are unable to convey adequately any expected 100-year flood, and it is certain that improvements of this nature existing within the flat lands area will be destroyed by erosion, scour, and flooding, or become filled with silt.

4.1.3 FIELD OBSERVATIONS

Flooding problems noted during field inspections were primarily related to roadway dip crossings. Downstream erosion of the pavement edge and channel flowline has occurred in many locations. Evidence was not found indicating inadequate culverts were the cause of roadway failure. Some dirt driveways are in danger should these culverts be tested with a 100-year flood. Severe erosion of channel flow lines and banks was noted within the main washes downstream of Silverbell Road. Natural washes upstream of Silverbell and throughout the study area appear stable without evidence of flood damage. Inadequate roadway crossings are discussed in Section 3.0.

4.2 EFFECTS OF URBANIZATION

Examination has shown the effects of urbanization upon the Tucson Mountain Basin to be minimal. Of 240 roadway crossings analyzed, four were found to be balanced according to Pima County's definition of the term. The remainder were either inadequate under existing conditions or are adequate under all conditions.

The percentage increase of general runoff within the sub-basin due to maximum proposed development averages 11 percent for the 100-year storm and 24 percent for the 10-year storm. Although the increased runoff due to a 100-year storm is more likely to cause damage, an

increased number of citizens complaints can be expected because of the runoff from more frequent storms. Table 4A-1 contains runoff data associated with the 100-year storm event. Table 4A-2 provides the same information for the 10-year event. Refer to Plates 2, 3, and 4 for existing and urbanized drainage maps.

TABLE 4A-1
SUB-BASIN RUNOFF (Q₁₀₀)(CFS)

SUB-BASIN	AREA	EXISTING	PERCENT INCREASE DUE TO URBANIZATION	
			RUNOFF AS ZONED (%)	AREA PLAN (%)
OFFSITE	8.22 sm	9232	+ 70.0%	+ 55.0%
1a	496 ac	1627	+ 27.0%	+ 10.0%
1b	312 ac	1372	+ 24.0%	- 1.0%
1ab	1.41 sm	2601	+ 39.0%	+ 7.0%
1c	184 ac	783	+ 36.0%	- 1.0%
1	2.33 sm	3977	+ 47.0%	+ 17.0%
1+OFFSITE	10.6 sm	12023	+ 58.0%	+ 39.0%
<hr/>				
2a	459 ac	1684	+ 15.0%	+ 5.0%
2b	193 ac	901	+ 11.0%	+ 4.0%
2ab	1.53 sm	2835	+ 23.0%	+ 13.0%
2c	197 ac	652	+ 52.0%	+ 33.0%
2	1.96 sm	3414	+ 27.0%	+ 13.0%
2+1+OFFSITE	12.56 sm	13943	+ 54.0%	+ 33.0%
2+1+OFFSITE	12.64 sm	13492	+ 58.0%	+ 35.0%
<hr/>				
3a	2.86 sm	4566	+ 2.0%	+ 2.0%
3b	1.04 sm	2138	- 3.0%	- 4.0%
3ab	3.98 sm	7193	+ .5%	+ .5%
3c	483 ac	1968	+ 2.0%	- 2.0%
3abc	5.76 sm	6295	+ 1.0%	+ 1.0%
3d	193 ac	652	+ 84.0%	+ 57.0%
3	6.19 sm	5899	+ 10.0%	+ 7.0%
<hr/>				
4a	1.58 sm	2664	+ 2.0%	- .5%
4b	626 ac	1865	+ 9.0%	+ 2.0%
4c	90 ac	348	+ 11.0%	- 4.0%
4ac	1.86 sm	2727	+ 10.0%	+ 2.0%
4	3.02 sm	4366	+ 5.0%	- 1.0%

TABLE 4A-1
 SUB-BASIN RUNOFF (Q₁₀₀)(CFS)
 -CONTINUED-

SUB-BASIN	AREA	EXISTING	PERCENT INCREASE DUE TO URBANIZATION	
			RUNOFF AS ZONED(%)	AREA PLAN(%)
5a	321 ac	1245	+ 15.0%	- 2.0%
5b	1.99 sm	3369	+ 3.0%	- 3.0%
5c	624 ac	1927	+ 10.0%	- 9.0%
5d	450 ac	1575	+ 8.0%	+ .4%
5abcd	4.50 sm	7142	+ 13.0%	- 4.0%
5	5.17 sm	6289	+ 12.0%	+ 8.0%
<hr/>				
6a	165 ac	580	- .5%	- .5%
6b	1.22 sm	1754	+ 9.0%	+ 9.0%
6c	2.32 sm	3308	+ 2.0%	- .2%
6bc	3.60 sm	4647	+ 3.0%	+ .3%
6	5.00 sm	3943	+ 3.0%	+ 4.0%
<hr/>				
7a	92 ac	383	+ 20.0%	- 3.0%
7b	216 ac	744	- 1.0%	- .4%
7c	344 ac	1184	+ 5.0%	- .3%
7bc	1.08 sm	1995	+ 3.0%	- .3%
7d	109 ac	419	+ 6.0%	- .2%
7abcd	1.34 sm	2143	+ 11.0%	- .3%
7e	85 ac	374	+ 21.0%	- .5%
7f	118 ac	459	+ 25.0%	+ 5.0%
7g	372 ac	1130	+ 3.0%	+ 2.0%
7h	283 ac	683	+ 7.0%	+ 15.0%
7i	429 ac	1259	+ 10.0%	+ 13.0%
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8Aa	532 ac	1228	+ 8.0%	- 1.0%
8Ab	1.24 sm	2403	+ 9.0%	+ 5.0%
8Aab	2.11 sm	3618	+ 8.0%	+ 1.0%
8Ac	340 ac	1012	+ 2.0%	+ 1.0%

TABLE 4A-1
 SUB-BASIN RUNOFF (Q₁₀₀)(CFS)
 -CONTINUED-

SUB-BASIN	AREA	EXISTING	PERCENT INCREASE DUE TO URBANIZATION	
			RUNOFF AS ZONED(%)	AREA PLAN(%)
8Aabc	2.70 sm	4103	+ 10.0%	+ 2.0%
8Ad	288 ac	790	+ 2.0%	- 3.0%
8A	3.38 sm	4119	+ 8.0%	+ 3.0%
8a	2.05 sm	3344	+ 4.0%	+ 4.0%
8b	394 ac	1113	+ 3.0%	+ 3.0%
8	3.10 sm	3959	+ 3.0%	+ 2.0%
8+8A	6.56 sm	7675	+ 6.0%	+ 3.0%
9a	112 ac	456	+ 8.0%	+ 12.0%
9b	404 ac	1254	+ 5.0%	+ 10.0%
9c	157 ac	684	+ 7.0%	+ 7.0%
9d	1.11 sm	1505	+ 4.0%	+ 5.0%
9e	528 ac	1257	+ 13.0%	+ 14.0%
9f	270 ac	600	+ 9.0%	+ 17.0%
9g	117 ac	677	+ 2.0%	+ 3.0%
9gf	495 ac	1485	+ 8.0%	+ 13.0%
10a	1.24 sm	2572	+ 2.0%	0
10b	354 ac	1449	0	- 3.0%
10ab	2.09 sm	3643	+ .5%	- 1.0%
10c	455 ac	1914	0	- 3.0%
10abc	4.08 sm	5960	+ 1.0%	- 4.0%
10d	242 ac	643	+ 6.0%	+ 6.0%
10	4.46 sm	5493	+ 1.0%	+ 2.0%
10+9gf	5.23 sm	6814	+ 4.0%	+ 1.0%

TABLE 4A-1
 SUB-BASIN RUNOFF (Q₁₀₀)(CFS)
 -CONTINUED-

SUB-BASIN	AREA	EXISTING	PERCENT INCREASE DUE TO URBANIZATION	
			RUNOFF AS ZONED(%)	AREA PLAN(%)
11a	388 ac	1265	+ 14.0%	+ 22.0%
11b	42 ac	178	+ 11.0%	+ 12.0%
11c	110 ac	400	+ 7.0%	+ 7.0%
11d	145 ac	580	+ 6.0%	+ 6.0%
11e	80 ac	311	+ 6.0%	+ 6.0%
11f	90 ac	382	+ 11.0%	+ 11.0%
11g	28 ac	143	+ 8.0%	+ 8.0%
<hr/>				
12	64 ac	121	+265.0%	+107.0%
<hr/>				
13a	69 ac	331	+ 48.0%	+ 27.0%
13b	386 ac	1224	+ 10.0%	+ 5.0%
<hr/>				
14	166 ac	421	+ 10.0%	+ 6.0%
<hr/>				
15a	117 ac	493	+ 4.0%	+ 7.0%
15b	148 ac	417	+ 12.0%	+ 13.0%

TABLE 4A-2
SUB-BASIN RUNOFF (Q₁₀)(CFS)

SUB-BASIN	AREA	EXISTING	PERCENT INCREASE DUE TO URBANIZATION	
			RUNOFF AS ZONED(%)	AREA PLAN(%)
OFFSITE	8.22 sm	2412	+186.0%	+148.0%
1a	496 ac	499	+ 63.0%	+ 22.0%
1b	312 ac	587	+ 44.0%	- 1.0%
1ab	1.41 sm	957	+ 12.0%	+ 16.0%
1c	184 ac	325	+ 61.0%	- 1.0%
1	2.33 sm	1480	+ 87.0%	+ 30.0%
1+OFFSITE	10.6 sm	3798	+123.0%	+ 86.0%
2a	459 ac	649	+ 28.0%	+ 9.0%
2b	193 ac	349	+ 27.0%	+ 16.0%
2ab	1.53 sm	1096	+ 35.0%	+ 22.0%
2c	197 ac	235	+ 99.0%	+ 63.0%
2	1.96 sm	1288	+ 48.0%	+ 26.0%
2+1+OFFSITE	12.56 sm	4393	+116.0%	+ 89.0%
2+1+OFFSITE	12.64 sm	4191	+120.0%	+ 90.0%
3a	2.86 sm	1589	+ 1.0%	+ 3.0%
3b	1.04 sm	751	- 4.0%	- 7.0%
3ab	3.98 sm	2461	- 1.0%	- 1.0%
3c	483 ac	806	+ 4.0%	+ 2.0%
3abc	5.76 sm	1994	+ 2.0%	+ 2.0%
3d	193 ac	219	+175.0%	+134.0%
3	6.19 sm	1899	+ 14.0%	+ 9.0%
4a	1.58 sm	981	+ 6.0%	- .2%
4b	626 ac	772	+ 13.0%	- .4%
4c	90 ac	124	+ 26.0%	- 2.0%
4ac	1.86 sm	1053	+ 8.0%	- 4.0%
4	3.02 sm	1679	+ 12.0%	- 2.0%

TABLE 4A-2
 SUB-BASIN RUNOFF (Q_{10})(CFS)
 -CONTINUED-

SUB-BASIN	AREA	EXISTING	PERCENT INCREASE DUE TO URBANIZATION	
			RUNOFF AS ZONED(%)	AREA PLAN(%)
5a	321 ac	488	+ 29.0%	- 6.0%
5b	1.99 sm	1302	+ 5.0%	- 3.0%
5c	624 ac	743	+ 20.0%	- 10.0%
5d	450 ac	638	+ 13.0%	+ 1.0%
5abcd	4.50 sm	2733	+ 20.0%	+ 2.0%
5	5.17 sm	2113	+ 26.0%	- 5.0%
6a	165 ac	209	+ 3.0%	+ 3.0%
6b	1.22 sm	583	+ 11.0%	+ 11.0%
6c	2.32 sm	1243	+ 1.0%	+ 6.0%
6bc	3.60 sm	1752	+ 7.0%	+ 3.0%
6	5.00 sm	1269	+ 9.0%	+ 7.0%
7a	92 ac	149	+ 40.0%	- 7.0%
7b	216 ac	278	- .4%	+ 1.0%
7c	344 ac	442	+ 10.0%	+ 1.0%
7bc	1.08 sm	726	+ 10.0%	+ 3.0%
7d	109 ac	161	+ 13.0%	+ 1.0%
7abcd	1.34 sm	760	+ 27.0%	+ 3.0%
7e	85 ac	148	+ 38.0%	+ 3.0%
7f	118 ac	173	+ 47.0%	+ 10.0%
7g	372 ac	411	+ 8.0%	+ 27.0%
7h	283 ac	240	+ 18.0%	+ 31.0%
7i	429 ac	447	+ 16.0%	+ 27.0%
8Aa	532 ac	456	+ 14.0%	- 3.0%
8Ab	1.24 sm	950	+ 17.0%	+ 9.0%
8Aab	2.11 sm	1396	+ 16.0%	+ 3.0%
8Ac	340 ac	381	+ 11.0%	+ 6.0%
8Aabc	2.70 sm	1560	+ 14.0%	+ 2.0%

TABLE 4A-2
 SUB-BASIN RUNOFF (Q₁₀)(CFS)
 -CONTINUED-

SUB-BASIN	AREA	EXISTING	PERCENT INCREASE DUE TO URBANIZATION	
			RUNOFF AS ZONED(%)	AREA PLAN(%)
8Ad	288 ac	261	+ 10.05	+ 3.0%
8A	3.38 sm	1456	+ 18.0%	+ 7.0%
8a	2.05 sm	1344	+ 5.0%	+ 5.0%
8b	394 ac	388	+ 5.0%	+ 5.0%
8	3.10 sm	1467	+ 5.0%	+ 4.0%
8+8A	6.56 sm	2589	+ 16.0%	+ 9.0%
9a	112 ac	165	+ 19.0%	+ 35.0%
9b	404 ac	416	+ 21.0%	+ 24.0%
9c	157 ac	259	+ 12.0%	+ 13.0%
9d	1.11 sm	524	+ .4%	+ 2.0%
9e	528 ac	412	+ 25.0%	+ 26.0%
9f	270 ac	203	+ 18.0%	+ 35.0%
9g	177 ac	269	+ 2.0%	+ 4.0%
9fg	495 ac	530	+ 15.0%	+ 21.0%
10a	1.24 sm	1048	+ 2.0%	0
10b	354 ac	593	+ 3.0%	0
10ab	2.09 sm	1419	+ 3.0%	0
10c	455 ac	801	0	- 2.0%
10abc	4.08 sm	2406	+ 3.0%	- 5.0%
10d	242 ac	217	+ 16.0%	+ 14.0%
10	4.46 sm	1942	+ 3.0%	+ 2.0%
11a	388 ac	437	+ 28.0%	+ 53.0%
11b	42 ac	65	+ 23.0%	+ 25.0%
11c	110 ac	141	+ 20.0%	+ 20.0%
11d	145 ac	211	+ 20.0%	+ 20.0%
11e	80 ac	113	+ 18.0%	+ 18.0%

TABLE 4A-2
 SUB-BASIN RUNOFF (Q₁₀)(CFS)
 -CONTINUED-

SUB-BASIN	AREA	EXISTING	PERCENT INCREASE DUE TO URBANIZATION	
			RUNOFF AS ZONED(%)	AREA PLAN(%)
11f	90 ac	144	+ 24.0%	+ 24.0%
11g	28 ac	53	+ 19.0%	+ 19.0%
12	64 ac	33	+588.0%	+191.0%
13a	69 ac	128	+ 92.0%	+ 46.0%
13b	386 ac	417	+ 23.0%	+ 12.0%
14	166 ac	143	+ 18.0%	+ 16.0%
15a	117 ac	177	+ 18.0%	+ 27.0%
15b	148 ac	128	+ 27.0%	+ 30.0%

4.3 ESTIMATED 100-YEAR FLOOD PLAINS BOUNDARIES

4.3.1 STUDY RESULTS

One of the primary purposes of this study is to determine the 100-year flood width for each of the eight major washes draining the Tucson Mountains. To accomplish this task eighty-eight cross sections were established along with the peak flow for each. The peak flow was found for each of the three development cases utilizing the Pima County method. The channel slope was calculated using U.S.G.S. 7-1/2 minute maps. Each cross-section was plotted and the 100-year flood width and depth determined using Mannings' equation. The water surface for each development case was then added to the plotted cross section. The 100-year flood plain widths most often increase less than one percent for the most dense development option, while the depth increases less than 3 percent. Since the average existing depth of flow is approximately 4.2 feet this represents an increase of less than .10 feet. Table 4B contains the data for the existing 100-year flood plain widths and depths and the percentage increase over existing conditions for each of the development options. Refer to Plates 7,8, and 9 where the 100-year flood plain for the densest development condition, as indicated in Table 3E, is shown. Refer to Table 3E for complete flood plain widths.

TABLE 4B
100-YEAR FLOOD PLAIN WIDTHS

BASIN NUMBER	CROSS SECTION NO.	<u>INCREASE DUE TO URBANIZATION</u>					
		<u>WIDTH</u>			<u>DEPTH</u>		
		EXIST.	AS ZONED	AREA PLANNED	EXIST.	AS ZONED	AREA PLANNED
GREASEWOOD WASH							
1	61	295'	+ 1.4%	0%	1.7'	+ 5.9%	0%
	62	224'	+ 1.8%	+ 0.5%	3.3'	+15.0%	+ 3.0%
	63	84'	+ 2.4%	0%	3.8'	+ 7.9%	0%

TABLE 4B
100-YEAR FLOOD PLAIN WIDTHS
-CONTINUED-

INCREASE DUE TO URBANIZATION

BASIN NUMBER	CROSS SECTION NO.	EXIST.	WIDTH		EXIST.	DEPTH	
			AS ZONED	AREA PLANNED		AS ZONED	AREA PLANNED
GREASEWOOD WASH							
1	64	108'	+ 3.7%	+ 1.9%	3.7'	+ 8.1%	+ 2.7%
	65	66'	+ 4.6%	+ 1.5%	2.3'	+13.0%	+ 8.7%
	66	382'	+56.0%	+ 1.8%	4.8'	+ 7.9%	+ 3.1%
	67	555'	+ 8.5%	+ 3.2%	4.0'	+11.0%	+ 4.2%
	68	UNCONTAINED - ALL CASES			----	-----	-----
PAINTED HILLS WASH							
2	58	487'	+ 1.0%	+ 0.6%	2.8'	+10.9%	+ 7.3%
	59	248'	+ 0.8%	+ 0.4%	4.2'	+ 4.8%	+ 2.4%
	60	59'	+ 3.4%	+ 3.4%	5.2'	+ 5.8%	+ 1.9%
	70	345'	+ 2.0%	+ 1.2%	1.8'	+11.1%	+ 5.6%
	71	396'	+ 1.0%	+ 0.8%	2.6'	+ 7.7%	+ 3.9%
	72	482'	+ 2.3%	+ 1.2%	5.1'	+ 3.9%	+ 2.0%
2+1+0.S.	73	372'	X	X	15.0'	X	X
CAMINO DEL OESTE WASH							
3	50	301'	0%	+ 0.3%	3.4'	0%	0%
	51	BRAIDED - ALL CASES			----	-----	-----
	52	293'	0%	0%	6.6'	0%	0%
	53	199'	0%	0%	7.6'	0%	0%
	54	147'	0%	+ 0.7%	6.8'	0%	0%
	55	147'	- 2.0%	- 2.7%	3.9'	- 2.6%	- 2.6%
	56	65'	0%	0%	3.1'	- 3.2%	- 3.2%
	74	403'	0%	0%	5.6'	0%	0%
	75	355'	+ 3.4%	+ 2.3%	4.4'	+ 2.3%	+ 2.3%
	88	557'	- 0.2%	0%	BRAIDED - ALL CASES		

TABLE 4B
100-YEAR FLOOD PLAIN WIDTHS
-CONTINUED-
INCREASE DUE TO URBANIZATION

BASIN NUMBER	CROSS SECTION NO.	EXIST.	WIDTH		EXIST.	DEPTH	
			AS ZONED	AREA PLANNED		AS ZONED	AREA PLANNED
TRAILS END WASH							
4	43	417'	+ 0.2%	0%	4.6'	+ 2.2%	0%
	44	236'	+ 0.9%	0%	4.4'	+ 2.3%	0%
	45	181'	+ 1.7%	+ 0.6%	3.8'	+ 5.3%	+ 2.6%
	46	317'	+ 2.2%	+ 0.3%	3.1'	+ 3.3%	+ 3.3%
	47	151'	0%	0%	2.5'	0%	0%
	48	50'	0%	0%	4.6'	+ 4.4%	+ 2.2%
	49	37'	0%	0%	4.7'	0%	- 2.1%
	76	328'	+ 5.8%	- 1.5%	3.5'/1.7'	0%/+5.9%	0%/-5.9%
	85	76'	+ 1.3%	- 1.3%	2.5'	0%	- 4.0%
	86	94'	+ 1.1%	0%	4.2'	+ 2.4%	+ 2.4%
	87	160'	0%	- 0.6%	3.6'	0%	- 2.8%
ROGER WASH							
5	34	410'	+ 0.5%	+ 0.2%	3.3'	+ 6.1%	+ 3.0%
	35	322'	+ 0.3%	0%	5.3'	+ 3.8%	0%
	36	203'	+ 1.0%	- 0.5%	5.5'	+ 5.5%	- 1.8%
	37	224'	+ 0.5%	0%	6.1'	+ 1.6%	0%
	38	228'	+ 2.6%	- 0.9%	3.7'	+ 5.4%	0%
	39	63'	+ 1.6%	- 1.6%	4.8'	+ 4.2%	- 4.2%
	40	123'	+ 0.8%	0%	3.2'	+ 3.1%	0%
	41	114'	+ 0.9%	- 0.9%	4.2'	0%	- 2.4%
	42	46'	0%	0%	6.1'	+ 1.6%	- 1.6%
	77	661'	+ 0.2%	0%	3.1'	+ 3.2%	+ 3.2%

TABLE 4B
100-YEAR FLOOD PLAIN WIDTHS

-CONTINUED-

INCREASE DUE TO URBANIZATION

BASIN NUMBER	CROSS SECTION NO.	EXIST.	WIDTH		EXIST.	DEPTH		
			AS ZONED	AREA PLANNED		AS ZONED	AREA PLANNED	
AYERS WASH								
6	28	284' / 92'	+ 1.1%	+ 1.1%	3.1' / 2.7'	0% / 0%	+3.2% / 0%	
	29	171'	+ 0.6%	+ 0.6%	4.2'	+ 2.4%	+ 2.4%	
	30	112'	+ 1.8%	0%	5.8'	+ 1.7%	0%	
	31	144'	+ 1.4%	+ 0.7%	5.2'	+ 1.9%	0%	
	32	96'	+ 1.0%	+ 1.0%	3.2'	+ 3.1%	+ 3.1%	
	33	151'	+ 0%	0%	3.9'	0%	0%	
	79	357'	+ 0.3%	+ 0.3%	2.1'	0%	0%	
	84	139'	0%	0%	4.6'	+ 2.2%	+ 2.2%	
<hr/>								
7	26	53'	+ 1.9%	+ 1.9%	3.0'	+ 3.3%	+ 3.3%	
	27	174'	+ 1.2%	- 0.6%	3.6'	+ 2.8%	0%	
	80	147'	+ 2.7%	0%	5.1'	+ 2.0%	0%	
	81	243'	+ 0.4%	+ 1.2%	0.7'	+ 3.0%	+ 7.6%	
	82	104'	+ 2.9%	+ 1.9%	3.5'	+ 2.9%	+ 5.7%	
<hr/>								
IDLE HOUR WASH								
8+8A	12	638'	+ 0.2%	+ 0.2%	6.4'	+ 1.6%	+ 1.6%	
8	13	317'	0%	0%	5.1'	+ 2.0%	0%	
	14	273'	+ 0.7%	+ 0.7%	3.9'	0%	0%	
	15	100'	0%	0%	2.0'	+ 5.0%	+ 5.0%	
	16	178'	+ 0.6%	+ 0.6%	3.8'	+ 2.6%	+ 2.6%	
	17	243'	+ 0.4%	+ 0.4%	5.7'	+ 1.8%	+ 1.8%	
8A	18	119'	+ 1.7%	+ 0.8%	4.4'	+ 4.6%	0%	
	19	184'	+ 0.5%	+ 0.5%	5.2'	+ 1.9%	0%	
	20	169'	+ 0.6%	0%	4.7'	+ 4.3%	+ 2.1%	
	21	100'	+ 1.0%	0%	3.0'	+ 3.3%	0%	
	22	75'	+ 1.3%	0%	4.0"	+ 5.0%	+ 2.5%	

TABLE 4B
100-YEAR FLOOD PLAIN WIDTHS
-CONTINUED-
INCREASE DUE TO URBANIZATION

BASIN NUMBER	CROSS SECTION NO.	EXIST.	WIDTH		EXIST.	DEPTH	
			AS ZONED	AREA PLANNED		AS ZONED	AREA PLANNED
8A	23	69'	+ 2.9%	+ 1.5%	4.5'	+ 2.2%	+ 2.2%
	24	132'	0%	- 0.8%	2.6'	0%	0%
	25	117'	+ 0.9%	- 0.9%	2.5'	+ 4.0%	0%
9	6	86'/43'	+56.0%	+86.0%	3/5'/0.4'	0%/75%	0%/100%
	7	128'	+ 2.3%	+ 2.3%	3.3'	+ 6.1%	+ 6.1%
	8	42'	0%	+ 2.4%	7.2'	+ 1.4%	+ 1.4%
	9	99'	+ 1.0%	+ 1.0%	3.4'	0%	+ 2.9%
	10	96'	+ 1.0%	+ 2.1%	2.1'	+ 4.8%	+ 9.5%
	11	141'	+ 0.7%	+ 0.7%	2.0'	+ 5.0%	+ 5.0%
YUMA MINE WASH							
10	1	219'	+ 0.5%	+ 0.9%	5.7'	0%	0%
	2	260'	0%	- 1.2%	5.1'	0%	- 2.0%
	3	94'	0%	- 1.1%	5.6'	0%	- 1.8%
	4	83'	0%	0%	5.8'	0%	- 1.7%
	5	56'	+ 1.8%	0%	6.2'	+ 1.6%	0%
	83	386'	+ 0.3%	+ 0.5%	4.2'	0%	0%
13	57	58'	+ 3.5%	+ 1.7%	1.5'	0%	0%
14	78	132'	+ 3.0%	+ 2.3%	1.5'	0%	0%

O.S. = Off-Site Area

X = Indicates spill over into Santa Cruz River.

4.3.2 COMPARISON WITH FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA) MAPS

There is general agreement between the findings of this study and the FEMA maps, relating to the location of floodways along the major washes draining the Tucson Mountains. A marked difference is noted in the widths associated with the floodways. The study indicated a narrower width. This is especially true of Idle Hour Wash where the FEMA maps shows a floodplain approximately 2500 feet wide immediately south of Sunset Road while this study finds a group of distinct channels which merge south of Sunset, the main channel being able to carry the entire estimated flood at a width of from 180 to 245 feet. The widths presented on Plates 7, 8, and 9 represent the flood from the most dense (as zoned) development while the FEMA maps are predicated on existing conditions. Table 4C presents a general comparison of the estimated flood widths for the "as zoned" development condition and those shown on the latest FEMA maps. Accuracy of the widths shown on the FEMA maps cannot be assured because of measurements from a Xeroxed reproduced map at a scale of 1"=1000'.

TABLE 4C
100-YEAR FLOOD PLAIN WIDTHS - F.E.M.A. COMPARISON

<u>WASH NAME</u>	<u>SECTION NO.</u>	<u>STUDY WIDTH</u>	<u>SCALED F.E.M.A. WIDTH</u>	
GREASEWOOD	61	299'	*	*
(Basin 1)	62	228'	*	*
	63	86'	*	*
	64	112'	*	*
	65	69'	*	*
	66	596'	*	*
	67	602'	*	*
	68	UNCONFINED	UNCONFINED	
	69	921'	*	*

TABLE 4C
100-YEAR FLOOD PLAIN WIDTHS - F.E.M.A. COMPARISON
 -CONTINUED-

WASH NAME	SECTION NO.	STUDY WIDTH	SCALED F.E.M.A. WIDTH
PAINTED HILLS (Basin 2)	58	492'	* *
	59	250'	* *
	60	61'	* *
	70	352'	300'
	71	400'	500'
	72	493'	580'
	73*	UNCONFINED	* *
CAMINO DEL OESTE (Basin 3)	50	302'	650'
	51	670'	580'
	52	293'	* *
	53	199'	* *
	54	184'	* *
	55	147'	* *
	56	65'	* *
	74	403'	380'
	75	367'	* *
	88	557'	* *
TRAILS END (Basin 4)	43	518'	600'
	44	238'	* *
	45	184'	380'
	46	324'	* *
	47	151'	* *
	48	50'	* *
	49	37'	* *
	76	511'	500'
	85	152'	* *
	86	95'	* *
87	160'	* *	

TABLE 4C
100-YEAR FLOOD PLAIN WIDTHS - F.E.M.A. COMPARISON
 -CONTINUED-

<u>WASH NAME</u>	<u>SECTION NO.</u>	<u>STUDY WIDTH</u>	<u>SCALED F.E.M.A. WIDTH</u>
ROGER	34	412'	380'
(Basin 5)	35	323'	350'
	36	205'	* *
	37	225'	* *
	38	234'	* *
	39	64'	* *
	40	124'	* *
	41	115'	* *
	42	46'	* *
	77	662'	600'
<hr/>			
AYERS	28	287'/92'	700'
(Basin 6)	29	172'	350'
	30	114'	* *
	31	146'	* *
	32	97'	* *
	33	151'	* *
	79	358'	1200'
	84	139'	* *
<hr/>			
IDLE HOUR	12	639'	650'
(Basins 8 & 8A)	13	317'	300'
	14	275'	320'
	15	100'	1305'
	16	179'	
	17	244'	350'
	18	121'	200'
	19	185'	* *
	20	170'	* *

TABLE 4C
100-YEAR FLOOD PLAIN WIDTHS - F.E.M.A. COMPARISON
 -CONTINUED-

WASH NAME	SECTION NO.	STUDY WIDTH	SCALED F.E.M.A. WIDTH	
IDLE HOUR (Basins 8 & 8A)	21	101'	*	*
	22	76'	*	*
	23	71'	*	*
	24	132	*	*
	25	118'	*	*
YUMA MINE (Basin 10)	1	221'	200'	
	2	260'	500'	
	3	94'	300'	
	4	83'	*	*
	5	57'	*	*
	83	388'	1300'	

* Spills into Santa Cruz River.

** FEMA width not shown on maps supplied by County.

NOTE: The study width of the 100-year flood will vary somewhat depending upon the development condition being examined. See Table 3E for additional information.

The widest flood has been plotted on Plates 7, 8, & 9.

4.4 POTENTIAL FLOODING

The potential for flooding in the Tucson Mountain Basin is the greatest at those locations where it may occur because of existing conditions. With few exceptions, drainage improvements existing within the study area either exist in an inadequate condition or are adequate regardless of whether development occurs according to existing zoning or according to the current Tucson Mountain Area Plan.

There are four main areas to be considered when examining the potential for flooding within the basin.

4.4.1 ROADWAY CROSSINGS

4.4.1.1 Dip Sections

Of the 166 dips recorded 85 were found to be inadequate by being unable to pass the estimated existing runoff at a depth of one foot or less. Of these, 64 occur on major roadways existing at section or quarter section lines or on Silverbell Road or Ina Road. Should one or more of the basins within the Tucson Mountains experience the estimated 100 year storm, access to the homes west of Silverbell and North of 22nd Street may be seriously curtailed. Damage to private entry drives is also likely, especially where not paved.

4.4.1.2 Culvert Crossings

Seventy-seven culverts were examined, together with the detention ponds immediately upstream. Thirty-four were found to be inadequate under existing conditions and four likely to become inadequate under more developed conditions. Flooding due to inadequate culverts is unlikely to cause damage to residential property or other permanent improvements. The

flooding of public roadways and private land may occur. Of the culverts determined to be undersized, 26 exist beneath Silverbell Road and section/quarter section line roadways.

4.4.2 FLAT LANDS AREA

Flooding of this area in the event of a 100-year storm is certain to occur. The severity of the flood is not expected to be great except in the most easterly portion of basin 1 and 2 along the alignment of the Silvercroft Wash. Because of the inadequate crossings of Silverbell Road, channels through this area are severely eroded. Each storm that occurs causes further damage, reducing the amount of usable land. Flooding of approximately 350 acres of the flat lands area will likely occur in the event a 100-year flood is experienced. Though there is a danger to this area from a 100-year storm occurring in the Tucson Mountains, the Santa Cruz River poses a greater threat because of the volume of water involved and the greater possibility of an occurrence. For further discussion of this threat and the condition imposed on the flat land areas by the Santa Cruz, please refer to Reference 9 of Section 7. —?

4.4.3 WASHES AND CHANNELS

Natural washes surveyed in the Tucson Mountains west of Silverbell Road are adequate to safely contain the estimated runoff under existing or developed conditions except along the Silvercroft Wash's confluence with the Santa Cruz River. Under existing conditions the Silvercroft Wash will contain runoff (Q_{100}) from the combined areas of the "off-site" basin and basins 1 and 2. However, any planned development condition results in an overtopping of the channels' banks and a generalized flooding of the area with runoff flowing uncontrolled into the Santa Cruz River across its westerly bank.

4.4.4 GENERAL BASIN RUNOFF

Increased runoff due to development is a certainty regardless of the area investigated. The likelihood of localized flooding because of the increase is difficult to access. Calculations show a per acre increase of 0.62 cfs for the 100-year storm under existing zoning and 0.33 cfs for the Area Plan development. The increase resulting during a 10-year storm equals 0.41 cfs for existing zoning and 0.22 cfs for the Area Plan. The potential for flooding, given these figures, is dependent upon the placement of structures and the surface area collecting the runoff. A precise evaluation is only possible on an individual case basis.

4.5 CRITICAL BASINS

Under the Pima County Critical Basin Criteria with few exceptions the entire Tucson Mountain Drainage Basin must be considered critical. The total basin contains approximately 54 square miles. Approximately five square miles can be considered neither critical or balanced under existing conditions. Most of this land area is within basin 9 where approximately 371 acres need not be restrained by drainage considerations. Basin 11 with 203 acres, also meets this condition. The remaining non-classified areas are located in basins 1 through 3, 6, 7, and 12 through 15. Basins 4, 5, 8 & 8A, and 10 are considered critical. These critical basins are as shown on Plate 6. Plate 6A indicates the additional areas which become non-critical when improvements to Ina Road and Silverbell are considered.

Pima County flood plain policy defines a critical basin as that drainage area upstream of a culvert or dip crossing which does not adequately accommodate the calculated design flow, utilizing the characteristics of only the crossing being analyzed.

If detention characteristics of all upstream structures on a particular channel are considered, including the storage capability of the channel itself, some critical basin areas could be removed from this classification. Analysis of the crossings in the Tucson Mountains indicates that through this mechanism the critical areas designated on Plates 6 and 6A could be reduced. It must be noted that if these areas are reclassified from critical to unclassified or balanced, that the detention capabilities of upstream structures must be maintained.

On a preliminary basis those culverts and ponding basins which must be maintained or left "as is" to retain detention characteristics are listed in Table 4D. In all assumptions for marginal and critical basin areas it was assumed that channel configuration would be maintained as existing or the storage capacity increased.

Through the use of these existing detention/retention facilities, areas considered critical can be reduced. Removal of dip crossings and replacement with culverts and detention/retention ponds would result in greater land use availability and benefits to downstream properties because of less flooding liability while affording enhanced "all weather" transportation corridors. This is particularly true for crossings on section and quarter section roadways.

Examination of the Tucson Mountains drainage basin for dual access roadways to areas of existing, light density development indicates that additional areas within the basin could be reclassified from critical. Reclassification is dependent upon six or less residences in a given location which are served by two or more county maintained roadways that provide "all weather" access. Areas satisfying these criteria are classified as marginally critical. See Plates 6 and 6A.

Further analysis of critical basins based on adequate access and existing development revealed that additional areas might be termed marginally critical. The criteria assumed during this analysis was the availability of an alternate acceptable county road and an existing occupancy of six or less residences in the area analyzed. Where these conditions prevailed the areas were classified marginally critical and are so designated on Plates 6 and 6A.

TABLE 4D
STRUCTURES MAINTAINED FOR MARGINAL
CRITICAL BASIN CLASSIFICATION

BASIN	INADEQUATE CROSSING AFFECTED	CROSSING STRUCTURES TO BE UNALTERED
1.	224 227	222 217 - 218
2.	229 219 221	216 - 230 216-229-230 216-219-229-230
4.	173 191	214 173 - 214
5.	175	191-196-197
7.	137	120
8.	42	80-90-102-103-116-125-126-127-128

Note that roadway dip sections are not considered when reducing the area of the critical basins since property damage is expected to be minimal because of inadequate crossings of this type, and the inconvenience experienced because of loss of access is expected to be of a very short duration.

5.0 ADDITIONAL STUDIES

During the preparation of this report it was realized that a clearer, more accurate analysis of drainage characteristics could be realized if additional field surveys and topography were available. It is recommended that topographic mapping of the Tucson Mountain Basin be accomplished prior to initiation of Phase II of the study.

Braided areas of the major washes upstream of Silverbell Road require close scrutiny in order to determine accurately the widths of the 100 year floodplains. The scope of this study did not permit the detailed examination required. Additional topographic mapping would facilitate the location of potential detention pond areas not adjacent to roadways. The location of such pond areas could alter the status of some of the inadequate drainage facilities presented in this report.

The method of runoff computation adopted by Pima County does not consider runoff storage within the channels. Examinations conducted comparing the storage in the channel, between channel cross-sections showed the stored volume to be greater than the amount of rainfall that had fallen on the contributing area. Additional modeling techniques should be employed to thoroughly evaluate the Basin. We recommend that "Flow-2D" and SWMM be used to provide a clear picture of events occurring throughout the study area. This modeling procedure would facilitate the formulation of Basin Management Alternatives for Phase II of this study.

Because of the absence of detailed topography and restrictions and limitations on the hydrologic methods utilized, the results of Phase I of the "Tucson Mountains Basin Study" are broad and general and should not be utilized for detailed design and regulatory purposes. Their use should be incorporated in the development of interim basin management guidelines, a plan and basis for further study, and as a broad look at existing conditions in the study area.

It is recommended that Phase II of the Tucson Mountain Basin Study be initiated for the following reasons:

1. The accelerated growth of development within the area is projected along with the supporting infrastructure. Adequate specific basin objectives should be identified prior to this development.
2. Detailed studies would allow routing techniques, allowing a multitude of various conditions to be imposed on the specific channel utilization.
3. Structural design concepts would be evaluated where applicable; drainage channels, culverts, storm drains, upstream/downstream, detention/retention facilities, velocity dissipation structures, grade control structures, erosion protection facilities, levees, and diversions of runoff and combinations of the above.
4. Hydraulic evaluation of proposed improvements would determine the specific design parameters.
5. To address storms of greater frequency than the one hundred year storm where such storms have been known to or have the potential to inflict damage.
6. To formulate land use restrictions establishing detention and retention guidelines by area. Identify possible sites for neighborhood detention/retention facilities.
7. To determine areas at which flood proofing of individual property is a viable option.
8. To prepare basin management alternatives on the basis of the preceding concepts and show alternatives on maps and describe them.

9. To evaluate the alternatives of basin management plans with specific solutions considering all costs versus benefits, effectiveness, environmental impact, acceptability to the public, and compatibility with other projects planned for specific areas.

6.0 REFERENCES AND INTERVIEWS

1. United States Geological Survey 7-1/2 minute topographic maps.
2. Topographic maps scale: 1"=200', C.I=2'.
3. "Hydrology Manual for Engineering Design and Flood Plan Management Within Pima County, Arizona," September, 1979 - Pima County, Arizona.
4. "Drainage Development and Channel Design Standards," November, 1982 - Pima County, Arizona.
5. "Estimation of Magnitude and Frequency of Floods in Pima County, Arizona, with Comparisons of Alternative Methods," U.S. Geological Survey, Water Resources Division, Report #84-4142, August 1984.
6. "An Archeological Assessment of the Middle Santa Cruz River Basin, Rillito to Green Valley, Arizona, for the Proposed Tucson Aqueduct Phase B, Central Arizona Project," Cultural Resource Management Division, Arizona State Museum, University of Arizona, Archeological Series No. 164, 1983.
7. "Biological Resource Inventory: Tucson Division - Phase B Central Arizona Project Aqueduct," Arizona Game and Fish Department, Special Services Division, Phoenix, Arizona, 1983.
8. "The Tucson Urban Study," Cultural Resource Management Section, Arizona State Museum, University of Arizona, 1980.
9. "Santa Cruz River Management Plan Study," Pima County Department of Transportation and Flood Control District, 1985.

10. Susan Brew, Director, Cultural Resource Management Division,
Arizona State Museum.
11. Robert Buecher, P.E., R.L.S.
12. Michael Borens, U.S. Forest Service.
13. Maurice Bossnyt, U.S. Soil Conservation Service.
14. Hjalmar W. Hjalmarson, U.S. Geological Survey Water Resource
Division.
15. Chris Martinez, Pima County Department of Transportation and Flood
Control District.
16. Vashti Supplee, Arizona Game and Fish Department.
17. John Keever, U.S. Corps of Engineers, Tucson, Arizona.
18. Mark Trexler, Pima County Department of Transportation and Flood
Control District.



PHOTO MAY 1985

APPROVED BY	ARCHITECTURAL	DATE	APPROVED BY	STRUCTURAL	DATE	APPROVED BY	ELECTRICAL	DATE	APPROVED BY	METHEANIGATION	DATE	APPROVED BY	HAZARDOUS	DATE	APPROVED BY	PROJECT ENGINEER	DATE	APPROVED BY	PROJECT MANAGER	DATE
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Date: <input type="text"/>		Revision: <input type="text"/>		TUCSON MOUNTAIN BASIN STUDY AERIAL PHOTOGRAPH		SHEET NO. 098
Designer: WS	Checker: RF	Date: <input type="text"/>	Scale: 1" = 2000'			
Drawn by: MH	Approved by: ASJ					

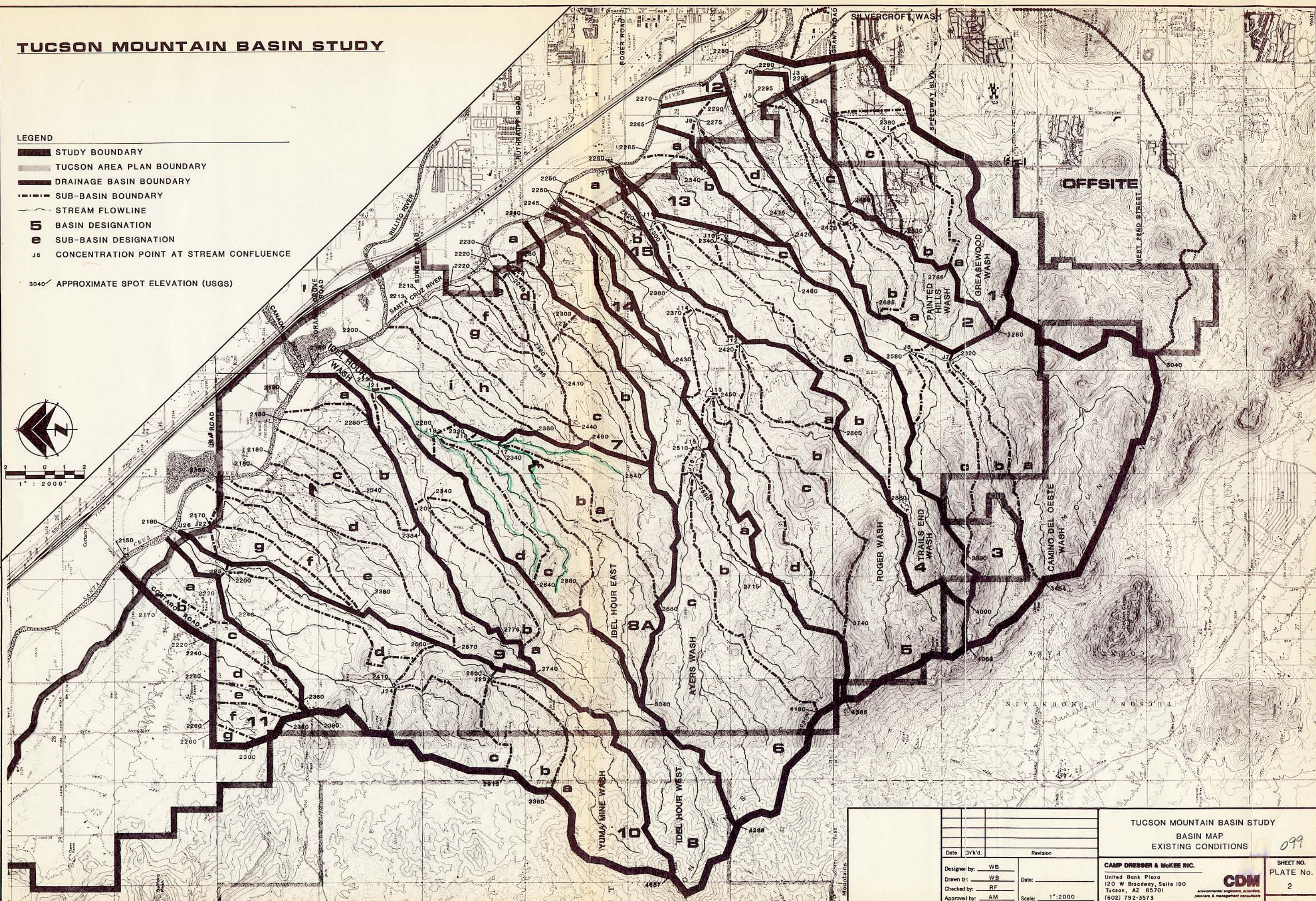
TUCSON MOUNTAIN BASIN STUDY

- LEGEND**
- STUDY BOUNDARY
 - TUCSON AREA PLAN BOUNDARY
 - DRAINAGE BASIN BOUNDARY
 - SUB-BASIN BOUNDARY
 - STREAM FLOWLINE
 - 5** BASIN DESIGNATION
 - e** SUB-BASIN DESIGNATION
 - J6** CONCENTRATION POINT AT STREAM CONFLUENCE

3040 APPROXIMATE SPOT ELEVATION (USGS)



PROJECT MANAGER Approved by: _____ Date: _____
 PROJECT ENGINEER Approved by: _____ Date: _____
 PLUMBING Approved by: _____ Date: _____
 HVAC Approved by: _____ Date: _____
 INSTRUMENTATION Approved by: _____ Date: _____
 ELECTRICAL Approved by: _____ Date: _____
 STRUCTURAL Approved by: _____ Date: _____
 ARCHITECTURAL Approved by: _____ Date: _____



Date		Ch'k'd.	Revision	
Design by:	WB			
Drawn by:	WB			
Checked by:	RF			
Approved by:	AM			
Date:		Scale:	1" = 2000'	

TUCSON MOUNTAIN BASIN STUDY
 BASIN MAP
 EXISTING CONDITIONS

CAMP DRESSER & MCKEE INC.
 United Bank Plaza
 120 W Broadway, Suite 190
 Tucson, AZ 85701
 (602) 792-3573

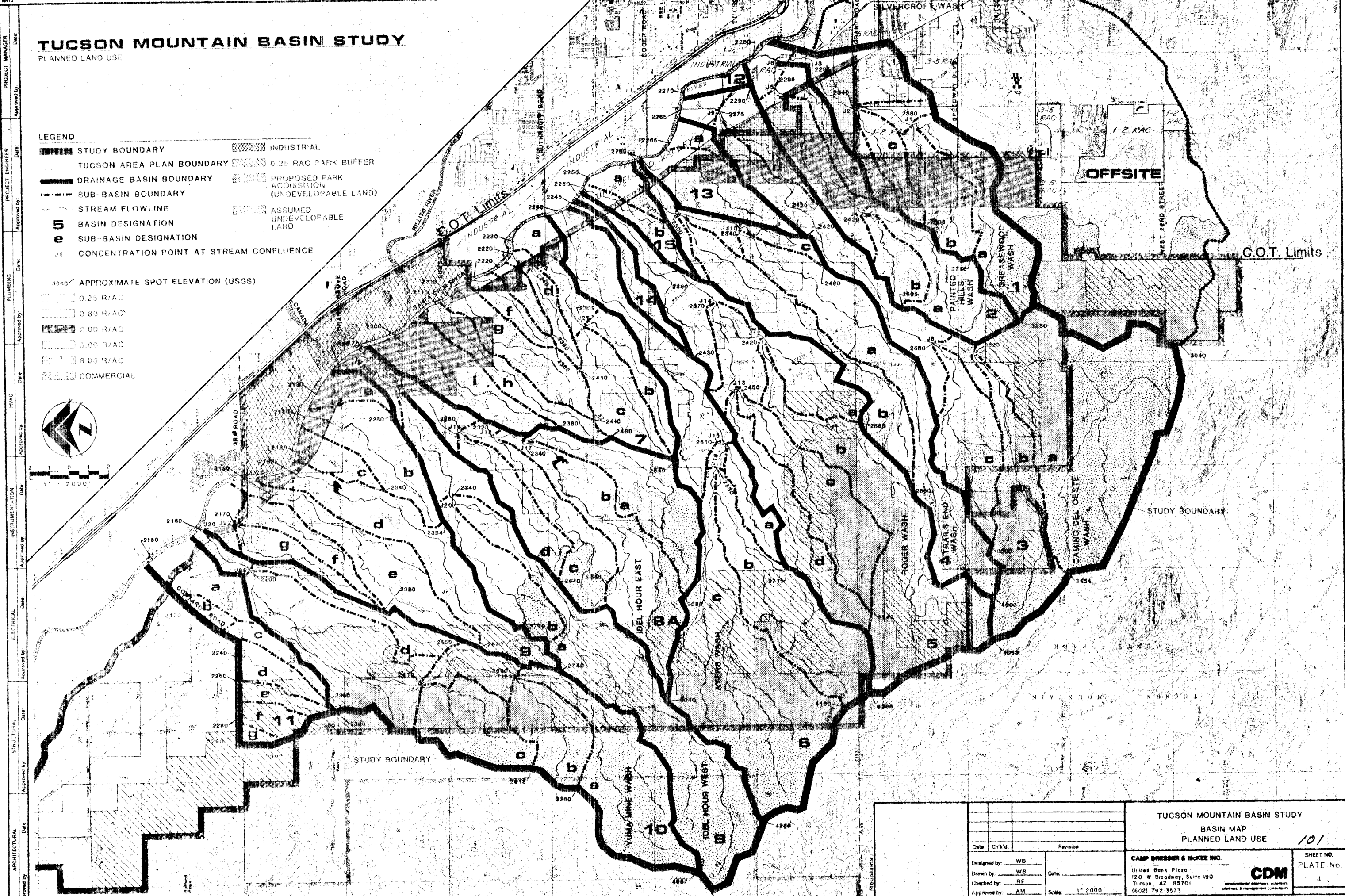
SHEET NO. 099
 PLATE No. 2

TUCSON MOUNTAIN BASIN STUDY

PLANNED LAND USE

- LEGEND**
- STUDY BOUNDARY
 - TUCSON AREA PLAN BOUNDARY
 - DRAINAGE BASIN BOUNDARY
 - SUB-BASIN BOUNDARY
 - STREAM FLOWLINE
 - BASIN DESIGNATION
 - SUB-BASIN DESIGNATION
 - CONCENTRATION POINT AT STREAM CONFLUENCE
 - INDUSTRIAL
 - 0.25 RAC PARK BUFFER
 - PROPOSED PARK ACQUISITION (UNDEVELOPABLE LAND)
 - ASSUMED UNDEVELOPABLE LAND

- 3040 APPROXIMATE SPOT ELEVATION (USGS)
- 0.25 RAC
 - 0.80 RAC
 - 2.00 RAC
 - 5.00 RAC
 - 8.00 RAC
 - COMMERCIAL

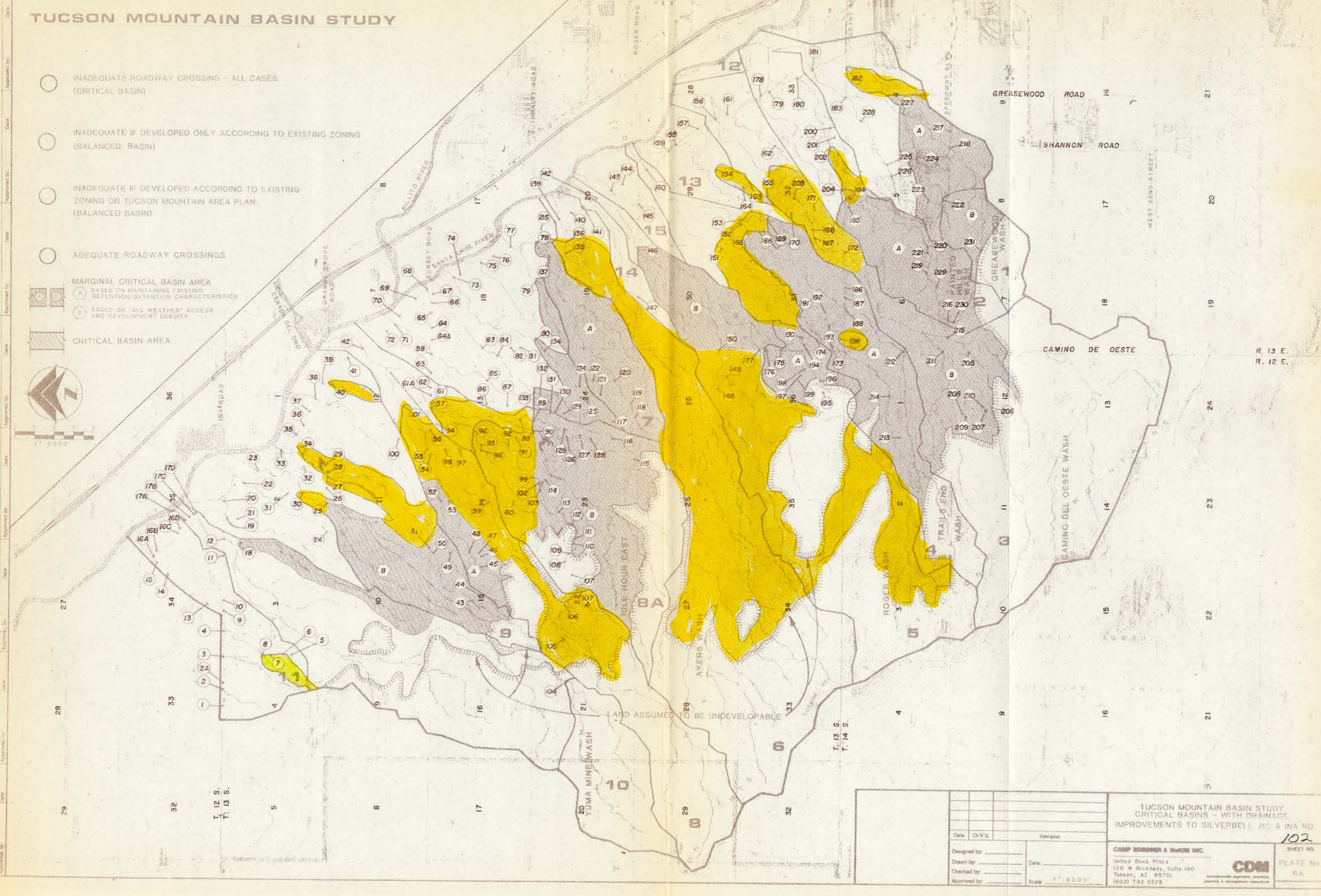


PROJECT MANAGER
 PROJECT ENGINEER
 PLUMBING
 HVAC
 INSTRUMENTATION
 ELECTRICAL
 STRUCTURAL
 ARCHITECTURAL

TUCSON MOUNTAIN BASIN STUDY BASIN MAP PLANNED LAND USE		SHEET NO. 101 PLATE No. 4
Date: _____ Ch'k'd: _____ Drawn by: WB Checked by: RF Approved by: AM	Revision: _____ Date: _____ Scale: 1" = 2000'	CAMP DRESSER & MCKEE INC. United Bank Plaza 120 W Broadway, Suite 190 Tucson, AZ 85701 (602) 792-3573

TUCSON MOUNTAIN BASIN STUDY

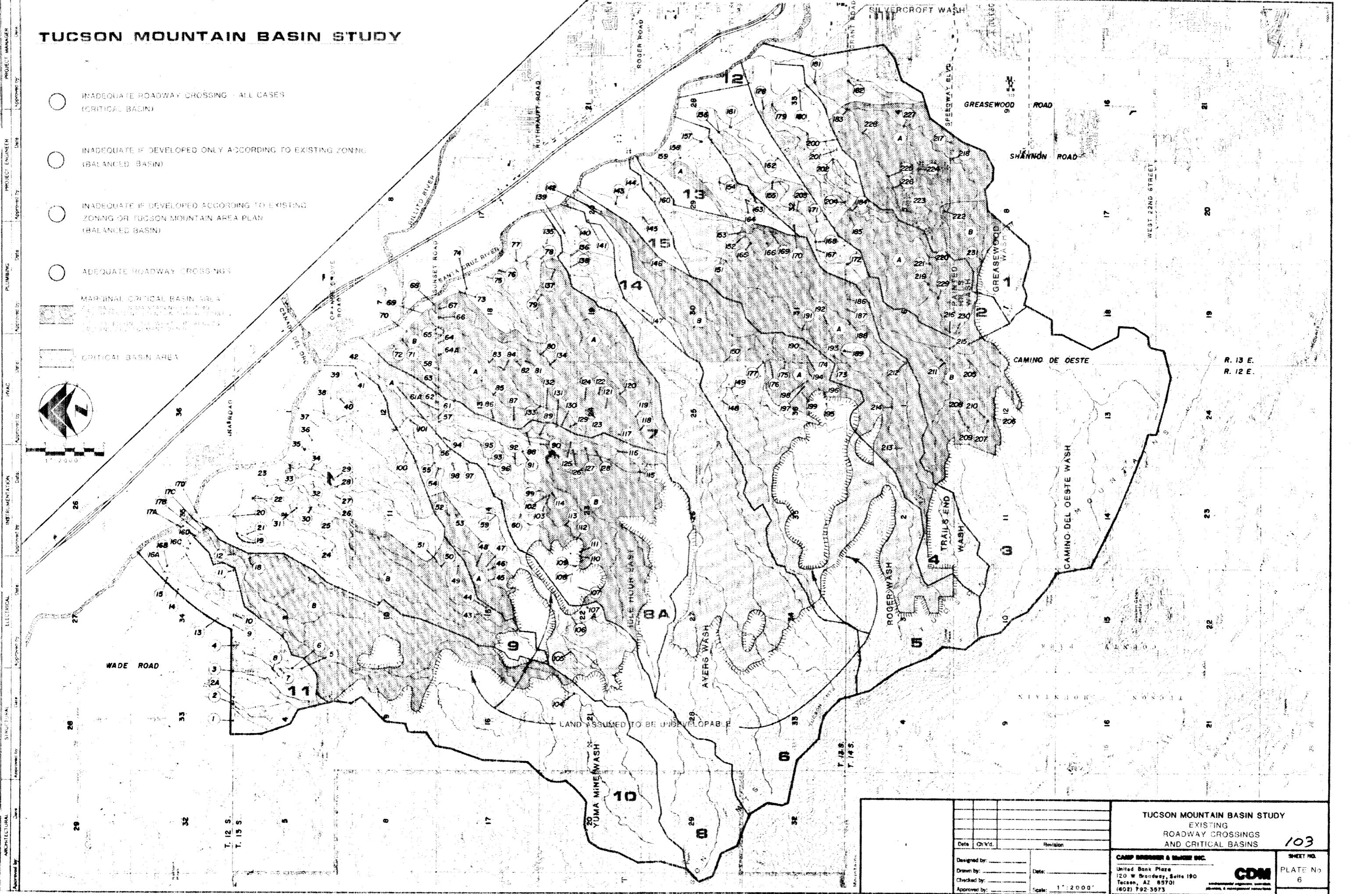
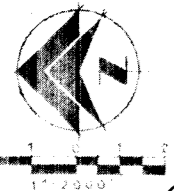
- INADEQUATE ROADWAY CROSSING - ALL CASES (CRITICAL BASIN)
- INADEQUATE IF DEVELOPED ONLY ACCORDING TO EXISTING ZONING (BALANCED BASIN)
- INADEQUATE IF DEVELOPED ACCORDING TO EXISTING ZONING OR TUCSON MOUNTAIN AREA PLAN (BALANCED BASIN)
- ADEQUATE ROADWAY CROSSINGS
- ⓐ MARGINAL CRITICAL BASIN AREA
BASED ON MAINTAINING EXISTING RETENTION/DETENTION CHARACTERISTICS
 - ⓑ MARGINAL CRITICAL BASIN AREA
BASED ON "ALL WEATHER" ACCESS AND DEVELOPMENT DENSITY
- ▨ CRITICAL BASIN AREA



TUCSON MOUNTAIN BASIN STUDY CRITICAL BASINS - WITH DRAINAGE IMPROVEMENTS TO SILVERBELL RD & INA RD.		SHEET NO. 102
Designed by: _____ Drawn by: _____ Checked by: _____ Approved by: _____	Date: _____ Scale: 1" = 2000'	CAMP ENGINEER & SURVEY INC. United Bank Plaza 120 W Broadway, Suite 190 Tucson, AZ 85701 (602) 792-3573
PLATE No 6A		

TUCSON MOUNTAIN BASIN STUDY

-  INADEQUATE ROADWAY CROSSING - ALL CASES (CRITICAL BASIN)
-  INADEQUATE IF DEVELOPED ONLY ACCORDING TO EXISTING ZONING (BALANCED BASIN)
-  INADEQUATE IF DEVELOPED ACCORDING TO EXISTING ZONING OR TUCSON MOUNTAIN AREA PLAN (BALANCED BASIN)
-  ADEQUATE ROADWAY CROSSINGS
-  MARGINAL CRITICAL BASIN AREA
-  CRITICAL BASIN AREA

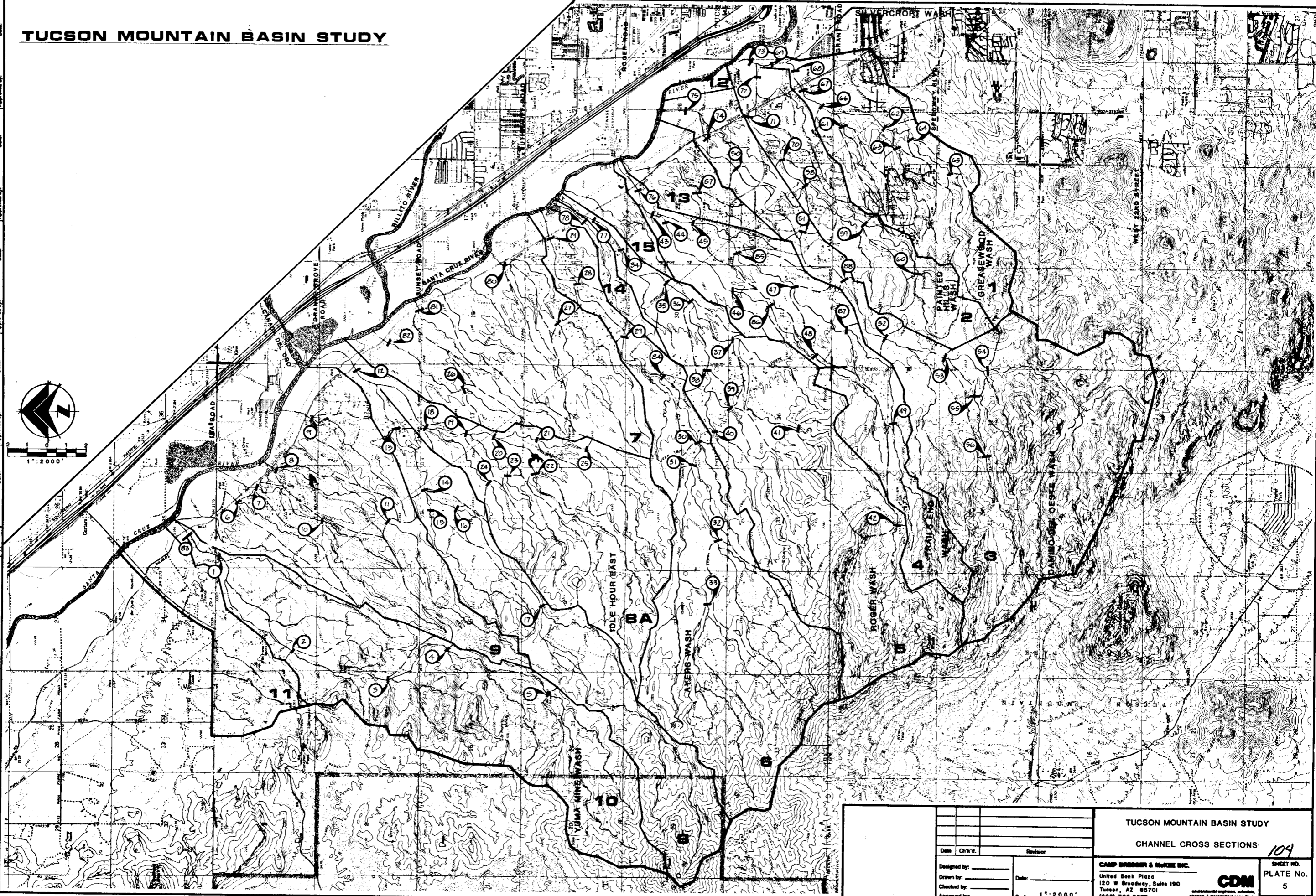
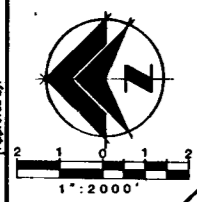


TUCSON MOUNTAIN BASIN STUDY EXISTING ROADWAY CROSSINGS AND CRITICAL BASINS		103 SHEET NO. PLATE NO. 6
Designed by: _____ Drawn by: _____ Checked by: _____ Approved by: _____	Date: _____ Scale: 1" = 2000'	CAMP BRUNNER & MAIZE INC. United Bank Plaza 120 W Broadway, Suite 190 Tucson, AZ 85701 (602) 792-3573

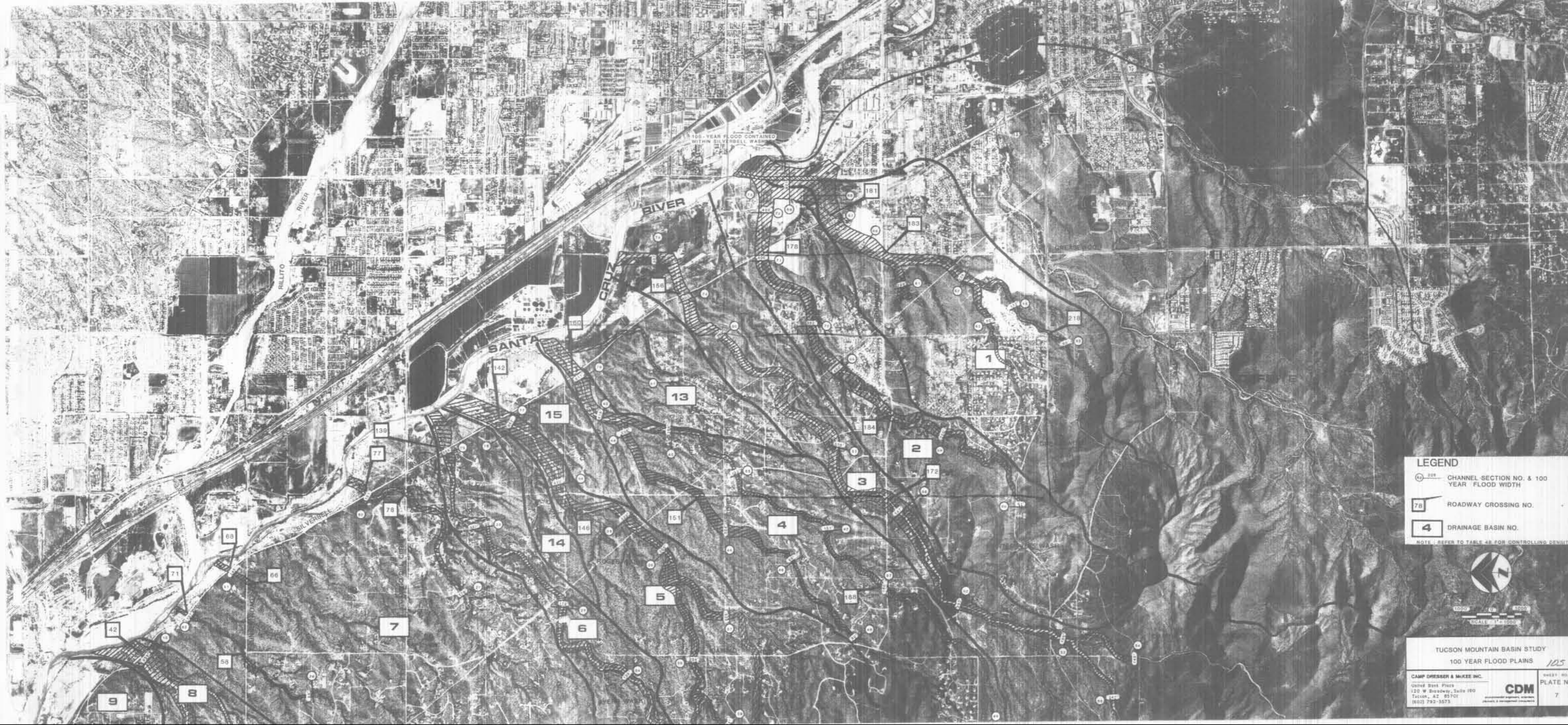
PROJECT MANAGER: _____
 PROJECT ENGINEER: _____
 PLUMBING: _____
 HVAC: _____
 ELECTRICAL: _____
 STRUCTURAL: _____
 ARCHITECTURAL: _____

PROJECT MANAGER: _____ Date: _____
 Approved by: _____ Date: _____
 PROJECT ENGINEER: _____ Date: _____
 Approved by: _____ Date: _____
 PLUMBING: _____ Date: _____
 Approved by: _____ Date: _____
 HVAC: _____ Date: _____
 Approved by: _____ Date: _____
 INSTRUMENTATION: _____ Date: _____
 Approved by: _____ Date: _____
 ELECTRICAL: _____ Date: _____
 Approved by: _____ Date: _____
 STRUCTURAL: _____ Date: _____
 Approved by: _____ Date: _____
 ARCHITECTURAL: _____ Date: _____
 Approved by: _____ Date: _____




TUCSON MOUNTAIN BASIN STUDY



Date: _____ Ch'g'd: _____ Revision: _____		TUCSON MOUNTAIN BASIN STUDY CHANNEL CROSS SECTIONS	
Designed by: _____ Drawn by: _____ Checked by: _____ Approved by: _____	Date: _____ Scale: 1" = 2000'	CAMP BRIDGER & MURKIN INC. United Bank Plaza 120 W Broadway, Suite 190 Tucson, AZ 85701 (602) 792-3573	CDM <small>CONSTRUCTION DOCUMENT PREPARATION & MANAGEMENT</small>
SHEET NO. 104 PLATE NO. 5			



LEGEND

-  CHANNEL SECTION NO. & 100 YEAR FLOOD WIDTH
-  ROADWAY CROSSING NO.
-  DRAINAGE BASIN NO.

NOTE: REFER TO TABLE 4E FOR CONTROLLING DENSITY

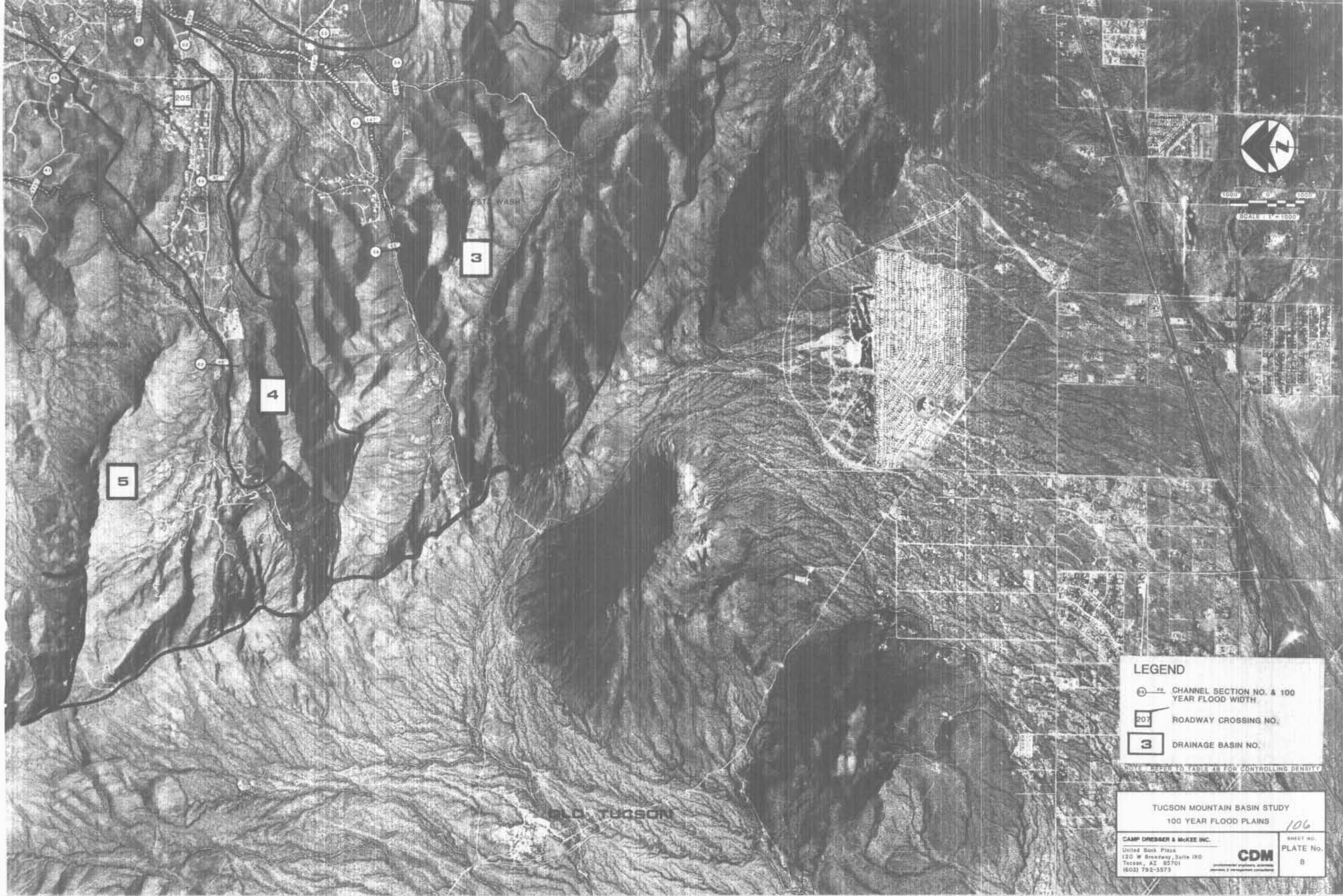


TUCSON MOUNTAIN BASIN STUDY
100 YEAR FLOOD PLAINS *125*




CAMP DRESSER & MCKEE INC.
United Best Price
120 W. Broadway, Suite 190
Tucson, AZ 85701
(602) 792-3573

CDM
CONSULTANTS AND ENGINEERS

SHEET NO.
PLATE NO.
7



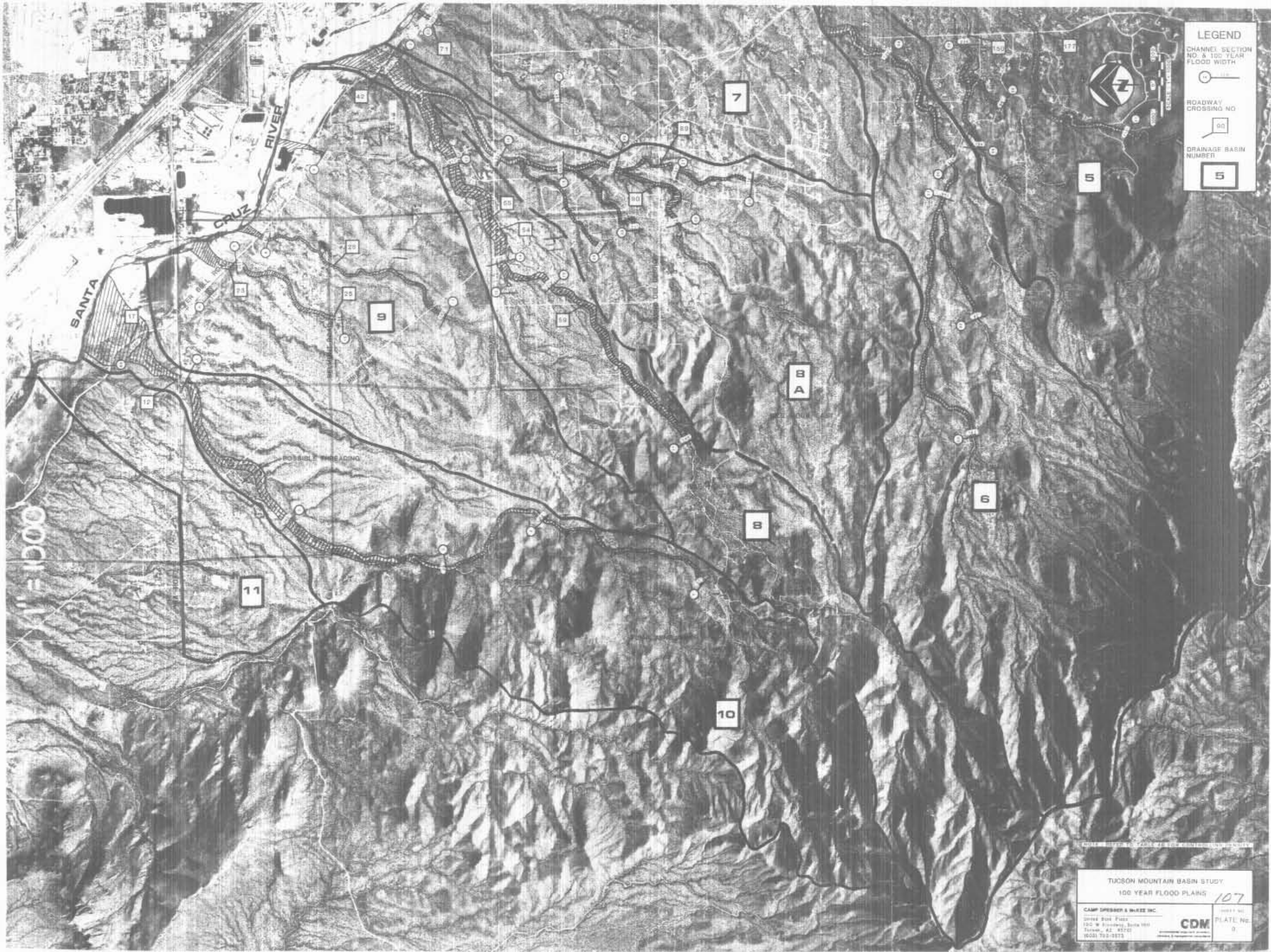
LEGEND

-  CHANNEL SECTION NO. & 100 YEAR FLOOD WIDTH
-  ROADWAY CROSSING NO.
-  DRAINAGE BASIN NO.

NOTE: REFER TO TABLE 4B FOR CONTROLLING DENSITY

TUCSON MOUNTAIN BASIN STUDY
100 YEAR FLOOD PLAINS 106

<p>CAMP DRESSER & MCKEE INC. United Bank Plaza 120 W Broadway, Suite 190 Tucson, AZ 85701 (602) 792-3573</p>	<p>CDM environmental programs, planning, design & management consulting</p>	<p>SHEET NO. PLATE No. 8</p>
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LEGEND

CHANNEL SECTION NO. & 100 YEAR FLOOD WIDTH



ROADWAY CROSSING NO.



DRAINAGE BASIN NUMBER



1" = 1000'

TUCSON MOUNTAIN BASIN STUDY		100 YEAR FLOOD PLANS		107
CAMP DRESSER & WILKE INC.		1000 E. 10th Ave., Suite 100		PLATE NO.
100 W. Broadway, Santa Ana		Orange, CA 92701		9
CDM		1000 E. 10th Ave., Suite 100		
1000 E. 10th Ave., Suite 100		Orange, CA 92701		