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OUTER LOOP FREEWAY SUPERSTITION FREEWAY TO THE SALT RIVER

HYDROLOGY REPORT PART A - OFFSITE HYDROLOGY



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Corporation**

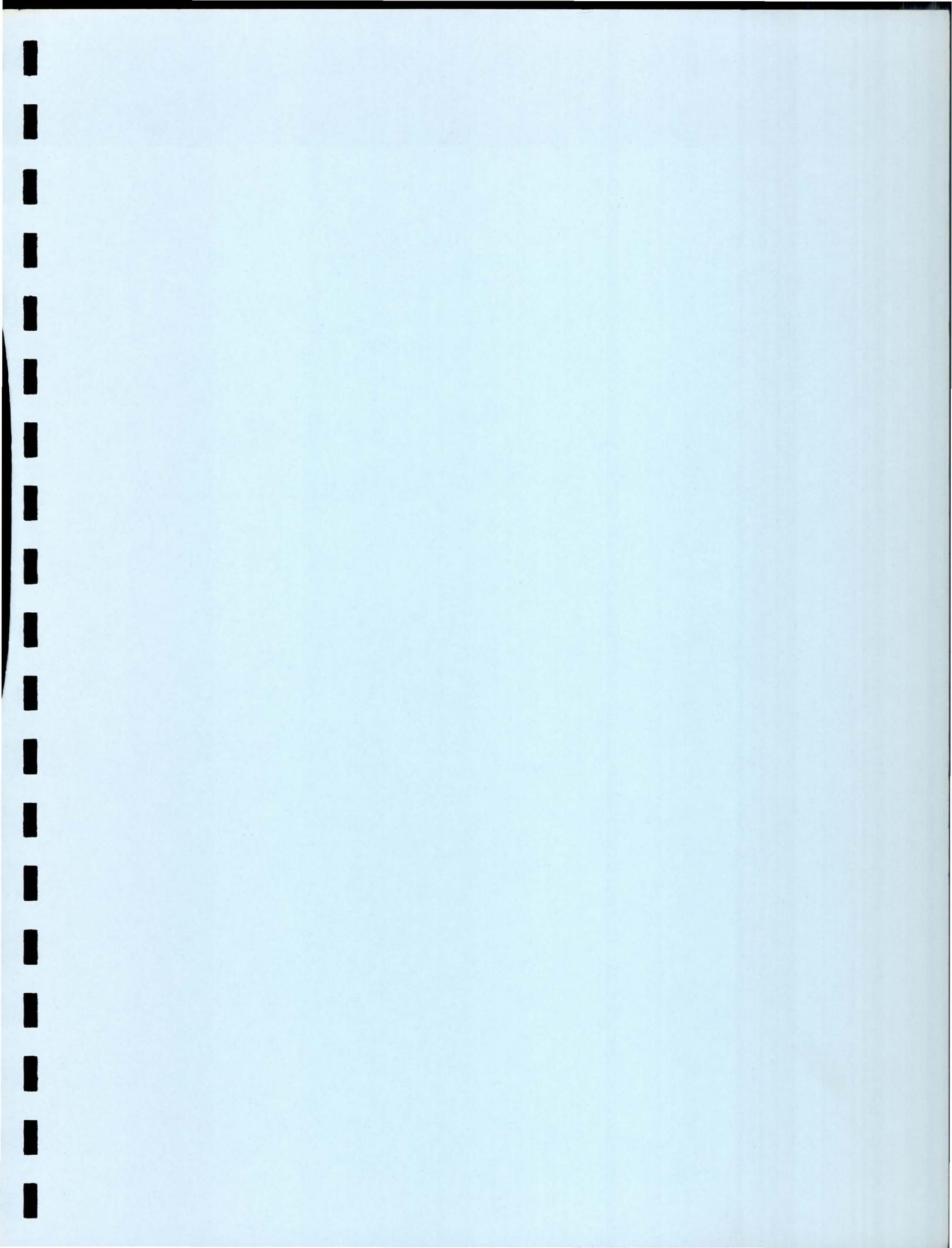
consulting engineers / architects

Suite 110
7600 North 16th Street
Phoenix, Arizona 85020

602 / 943-6800

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MAY 1986



OUTER LOOP FREEWAY
SUPERSTITION FREEWAY TO THE SALT RIVER

OFFSITE HYDROLOGY

The hydrology of the areas contributing runoff to the Outer Loop Freeway right-of-way between the Superstition Freeway and the Salt River has been investigated. Flows from the contributing areas have been calculated for 10, 50 and 100-year runoff events using Soil Conservation Service (SCS) methods in conjunction with the computer program HEC-1.

DRAINAGE AREA DESCRIPTION

The contributing offsite drainage areas are shown in Plate 1. Runoff flows in a generally western direction to the freeway right-of-way and the drainage boundary is defined on the south and east by the Tempe Canal. Flows will be collected at the right-of-way and routed north to the Salt River. Current land use in the drainage area varies from agriculture to residential to commercial and industrial. Newer developments have retention basins as required by the City of Tempe Drainage Code. Older developments and agricultural areas generally do not provide for retention of runoff, but it is assumed that future development will continue to have retention requirements.

Soils within the drainage areas are all classified as Hydrologic Soil Group B. Vegetation, other than in agricultural areas, is about two-thirds urban lawn and one-third desert landscaping.

Land use, existing retention areas, and subdrainage areas were delineated by field investigations and aerial photographs.

HYDROLOGIC METHOD

The hydrologic method used for calculation of runoff was the Soil Conservation Service (SCS) method. Specifically, the publications used were Urban Hydrology for Small Watersheds (TR-55) and the SCS National Engineering Handbook - Section 4 (NEH-4). The SCS method was used as available in the computer program HEC-1. The analysis was based on a preliminary hydrologic study by Water Resources Associates, Inc., who also used HEC-1.

INPUT DATA

Use of the SCS method requires as input data a design storm, sub-basin areas, curve numbers and lag time, and channel characteristics for routing hydrographs. The assumptions made in selecting the input data are discussed below and the data are summarized in Table 1.

TABLE 1
DRAINAGE BASIN CHARACTERISTICS

DRAINAGE BASIN	AREA (ACRES)	PERCENT RETENTION	EFFECTIVE AREA (ACRES)	BASE CURVE NUMBER	PERCENT IMPERVIOUS AREA	ADJUSTED CURVE NUMBER	HYDRAULIC LENGTH (FEET)	SLOPE (%)	LAG TIME (HOURS)
T-2A	52.7	80%	10.4	72	65%	89	2800	0.25	0.61
T-2B	63.6	-	63.6	72	50%	85	2400	0.25	0.61
T-2C	21.0	-	21.0	72	50%	85	3250	0.25	0.77
T-2D	22.3	70%	6.7	72	65%	89	2000	0.25	0.47
T-3A	6.4	-	6.4	72	50%	85	950	0.25	0.29
T-3B	11.0	75%	2.8	72	50%	85	1100	0.25	0.33
T-3C	13.7	30%	9.6	72	65%	89	1400	0.25	0.35
T-3D	98.0	-	98.0	72	50%	85	2800	0.25	0.69
T-3E	14.6	-	14.6	72	38%	82	1950	0.25	0.57
T-4A	56.0	-	56.0	72	50%	85	2300	0.25	0.59
T-4B	4.4	-	4.4	72	20%	78	700	0.25	0.30
T-5A	9.8	33%	6.5	72	60%	88	850	0.25	0.25
T-6A	35.3	-	35.3	72	26%	79	1900	0.25	0.65
T-7A	19.6	-	19.6	72	38%	82	2200	0.25	0.63
T-7B	24.1	-	24.1	72	38%	82	2450	0.25	0.68
T-7C	55.2	-	55.2	72	38%	82	2550	0.25	0.71
T-7D	32.0	-	32.0	72	38%	82	2400	0.25	0.67
T-7E	46.9	65%	16.4	72	65%	89	1850	0.25	0.44
T-7F	11.5	12%	10.1	72	38%	82	2330	0.25	0.66
T-8A	33.2	-	33.2	72	65%	89	2000	0.25	0.47
T-9A	23.6	60%	9.7	72	20%	85	2500	0.25	0.63
T-9B	63.6	-	63.6	72	20%	78	3100	0.25	1.00
T-10A	4.7	-	4.7	72	20%	78	800	0.25	0.34
T-10B	6.5	-	6.5	72	20%	78	900	0.25	0.37

Design Storm -HEC-1 will compute a design storm hyetograph given precipitation values for the desired storm frequencies. Water Resources Associates had input precipitation values for 50 and 100-year storms and these were confirmed by comparing them to data in Weather Bureau Technical Memorandum WR-44 - Estimated Return Periods for Short Duration Precipitation in Arizona and NOAA Atlas II, Volume III - Arizona. Ten-year precipitation values were obtained directly from the publications.

Sub-Basin Areas - Sub-basins were delineated based on land usage and the existence of retention facilities, with drainage divides located by field observations.

Effective drainage areas were calculated considering retention areas. Estimates were made of the percent effectiveness of each retention area (as they would function during a major storm) and the percentage of area for which runoff would be retained was subtracted from the total area.

Curve Numbers - Curve numbers for use with the SCS method are a function of the hydrologic soil group, the vegetative ground cover and the percentage of impervious area.

All soils within the drainage areas are classified as Hydrologic Soil Group B (SCS Soil Survey of Eastern Maricopa and Pinal Counties). Vegetation in developed areas is about two-thirds urban lawn in fair condition and one-third desert landscaping. It is assumed that the agricultural areas, which now have a lower curve number, will eventually be developed and will also have urban lawn/desert landscaping vegetation. The curve number for Type B soil and this vegetation is 72.

Curve numbers must be adjusted for impervious area using the methods in TR-55. The percentage of impervious area in each sub-basin was based on observed land use and the average percent impervious corresponding to that land use as published in TR-55 (for example, for residential areas with 1/4 acre lots, the average percent impervious used was 38%). A weighted-average curve number was found using the percent pervious times a curve number of 72 and the percent impervious times an impervious area curve number of 98.

For undeveloped areas, the effect of future development must be considered. Most future development will require retention, but as some development may occur without retention, it was assumed that 20% of the area will be impervious before retention is significant. This corresponds to a density of about one house per acre. Therefore, the minimum percent impervious that will be used for any area is 20%.

Lag Time - The lag time for each sub-basin was calculated by the modified curve number method:

$$L = \frac{1^{0.8} (S + 1)^{0.7}}{1900 Y^{0.5}}$$

where:

L = lag in hours

l = hydraulic length of watershed in feet

$S = \frac{1000}{CN} - 10$, where CN = curve number

Y = average basin land slope in percent

The lag computed is then modified by lag factors to account for the effects of urbanization.

The hydraulic length and slope were obtained from maps of the drainage areas and the curve numbers were obtained as described above. The hydraulic length was measured from 1" = 200' aerial photos. The average slopes were obtained from 7.5 minute USGS topographic maps which showed the slopes in the drainage areas ranging from 0.1 to 0.5 percent. An average slope of 0.25 percent was used for all sub-basins.

The computed lag is modified by two lag factors to account for the effects of urbanization. A factor for the percent of hydraulic length improved by urbanization (such as paved streets) is needed and it was estimated that 50% of the hydraulic length was modified in each sub-basin. A second lag factor depends on the percent impervious area and was also calculated for each sub-basin. Both factors were obtained from charts in TR-55.

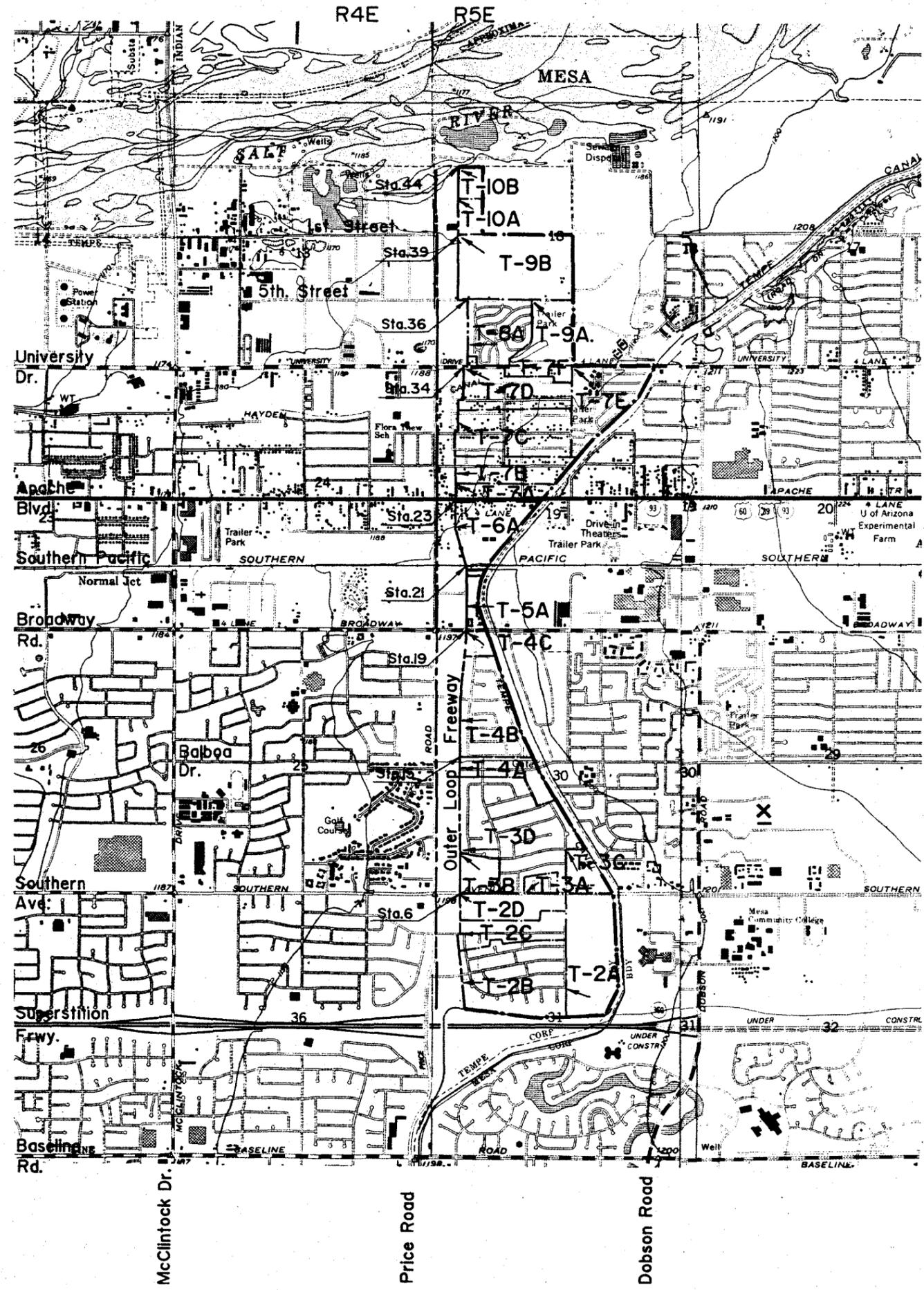
Routing Data - Hydrographs were routed using the kinematic wave routing method. Routing through sub-basins, in which flows would proceed through the streets or drainage swales, was simulated using a channel with a one-foot bottom width and 25:1 side slopes. Manning n values of 0.020 and 0.045 were used for streets and grassed swales, respectively. (n values about 25% higher than typical values are used for the kinematic wave routing.)

Routing the flows collected at the freeway right-of-way was simulated using a 10-foot wide rectangular channel. This approximates the channel or culvert that will eventually carry the flows to the Salt River. An n value of 0.018 was used for this channel.

RESULTS

The offsite hydrology results are summarized on Plates 1, 2 and 3. Detailed printouts of the calculations are in Appendices B, C and D.

Peak flows from the total drainage area are 330, 608 and 768 cfs for the 10, 50 and 100-year storms. Differences between the runoff values as calculated here and the preliminary values as calculated by Water Resources Associates are discussed in Appendix A.



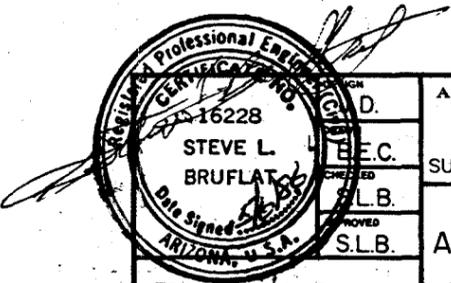
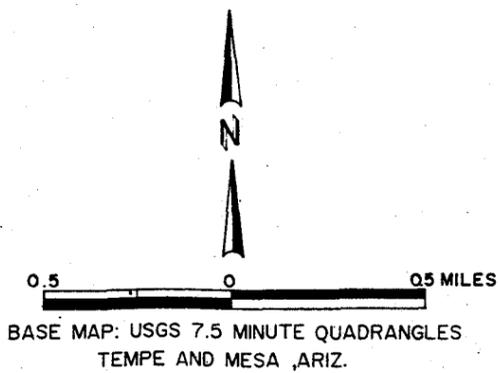
OUTER LOOP FREEWAY
 SUPERSTITION FREEWAY TO THE SALT RIVER
 ***** 10-YEAR 24-HOUR STORM *****
 BOYLE ENGINEERING CORPORATION

RUNOFF SUMMARY
 FLOW IN CFS. TIME IN HOURS. AREA IN ACRES

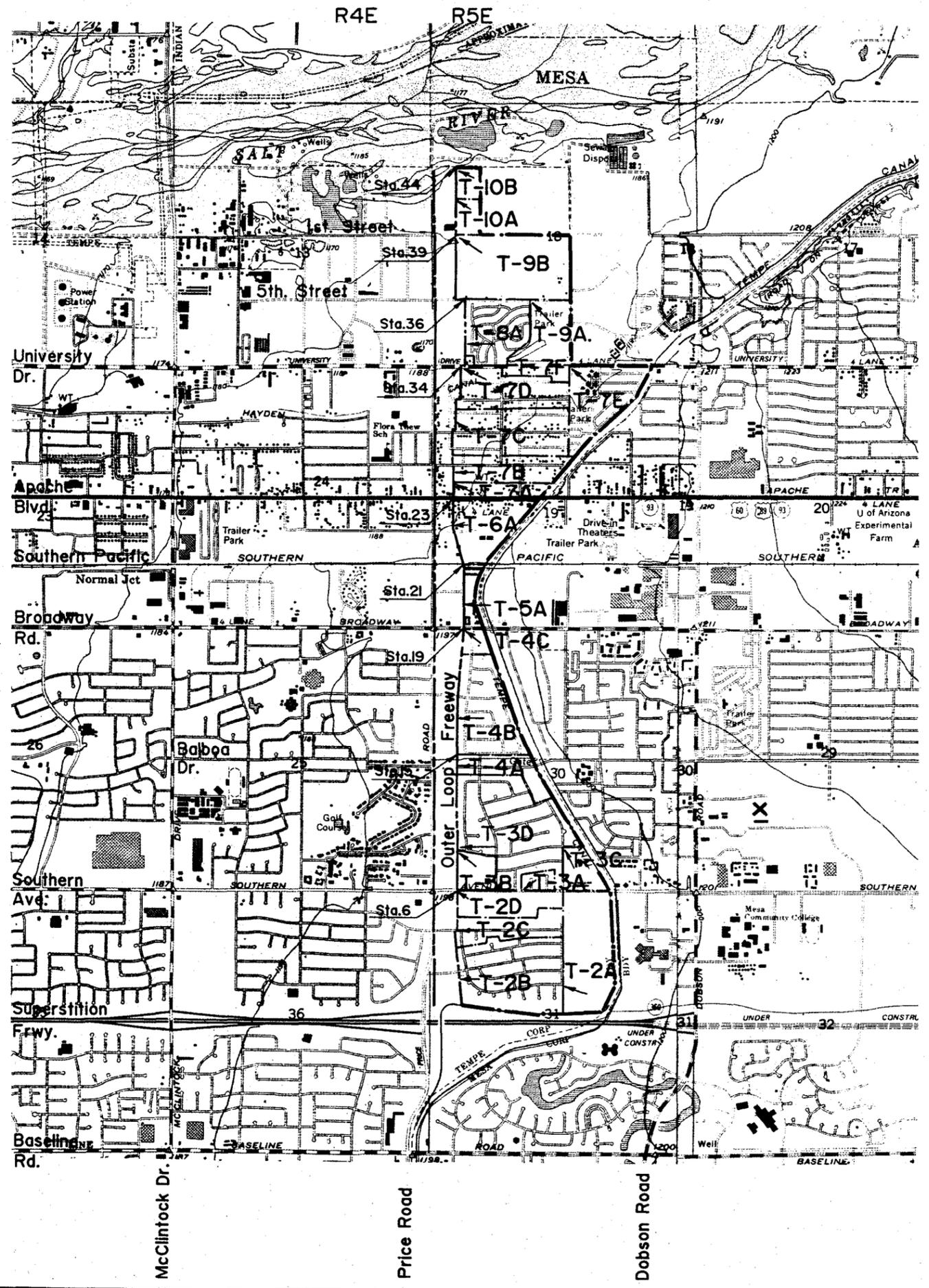
OPERATION	STATION	Basin Area	PERCENT RETENTION	EFFECTIVE BASIN AREA	PERCENT IMPERVIOUS	CURVE NUMBER	LAG TIME	PEAK FLOW	TIME OF PEAK	VOLUME (AC-FT)
HYDROGRAPHS AT	T-2A	52.7	89 %	10.4	65 %	89	0.61	10.	12.67	1.2
	T-2B	63.6	--	63.6	50 %	85	0.61	48.	12.83	6.0
	T-2C	21.0	--	21.0	50 %	85	0.77	16.	12.83	2.0
	T-2D	22.3	70 %	6.7	65 %	89	0.47	7.	12.67	0.8
COMBINED AND ROUTED TO (SOUTHERN AVENUE)	STA 6	159.6		101.7				77.	12.83	10.0
HYDROGRAPHS AT	T-3A	6.4	--	6.4	50 %	85	0.29	7.	12.33	0.6
	T-3B	11.0	75 %	2.8	50 %	85	0.33	3.	12.50	0.3
	T-3C	13.7	30 %	9.6	65 %	89	0.35	13.	12.50	1.1
	T-3D	99.0	--	98.0	50 %	85	0.69	70.	12.83	9.2
	T-3E	14.6	--	14.6	38 %	82	0.57	10.	12.67	1.2
COMBINED AND ROUTED TO (BALBOA DRIVE)	STA 15	303.3		233.1				168.	12.83	22.4
HYDROGRAPHS AT	T-4A	56.0	--	56.0	50 %	85	0.59	44.	12.67	5.3
	T-4B	4.4	--	4.4	20 %	78	0.30	3.	12.50	0.3
COMBINED AND ROUTED TO (BROADWAY ROAD)	STA 19	363.7		293.5				203.	13.00	28.0
HYDROGRAPH AT	T-5A	9.8	33 %	6.5	60 %	88	0.25	10.	12.33	0.7
COMBINED AND ROUTED TO (SOUTHERN PACIFIC RAILROAD)	STA 21	373.5		306.0				204.	13.00	28.7
HYDROGRAPH AT	T-6A	35.3	--	35.3	26 %	79	0.65	18.	12.83	2.3
COMBINED AND ROUTED TO (APACHE BOULEVARD)	STA 23	408.8		335.3				218.	13.00	31.0
HYDROGRAPHS AT	T-7A	19.6	--	19.6	38 %	82	0.63	12.	12.83	1.6
	T-7B	24.1	--	24.1	38 %	82	0.68	15.	12.83	1.9
	T-7C	55.2	--	55.2	38 %	82	0.71	32.	12.83	4.4
	T-7D	32.0	--	32.0	38 %	82	0.67	19.	12.83	2.5
	T-7E	46.9	65 %	16.4	65 %	89	0.44	20.	12.50	1.9
	T-7F	11.5	12 %	10.1	38 %	82	0.66	6.	12.83	0.8
	COMBINED AND ROUTED TO (UNIVERSITY DRIVE)	STA 34	598.1		492.7				297.	13.00
HYDROGRAPH AT	T-8A	33.2	--	33.2	65 %	89	0.47	38.	12.67	3.9
COMBINED AND ROUTED TO (FIFTH STREET)	STA 36	631.3		525.9				313.	13.00	48.0
HYDROGRAPHS AT	T-9A	23.6	60 %	9.7	50 %	85	0.63	17.	12.83	0.9
	T-9B	63.6	--	63.6	20 %	78	1.00	21.	13.17	3.7
COMBINED AND ROUTED TO (FIRST STREET)	STA 39	718.5		599.2				330.	13.17	52.6
HYDROGRAPHS AT	T-10A	4.7	--	4.7	20 %	78	0.34	3.	12.50	0.3
	T-10B	6.5	--	6.5	20 %	78	0.37	4.	12.50	0.4
COMBINED AND ROUTED TO (SALT RIVER)	STA 44	729.7		619.4				328.	13.17	53.3

LEGEND

- T-2A ___ Drainage Sub-basin Number
- Drainage Basin Boundary
- Drainage Sub-Basin Boundary
- ← Direction Of Flow
- Outer Loop Freeway Right-Of-Way



ARIZONA DEPARTMENT OF TRANSPORTATION HIGHWAY DIVISION OUTER LOOP HIGHWAY SUPERSTITION FRWY TO THE SALT RIVER			
RUNOFF SUMMARY AND DRAINAGE AREA MAP 10 Year Frequency			
ROUTE	MILEPOST	LOCATION OR STRUCTURE NO.	DWG. NO.
			1



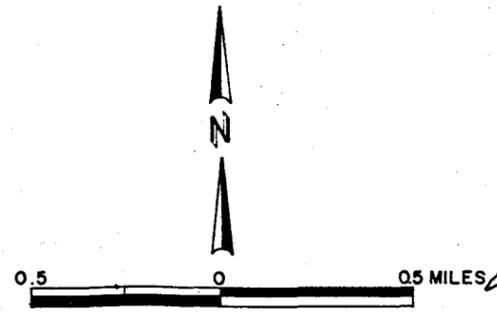
OUTER LOOP FREEWAY
 SUPERSTITION FREEWAY TO THE SALT RIVER
 ***** 50-YEAR 24-HOUR STORM *****
 BOYLE ENGINEERING CORPORATION

RUNOFF SUMMARY
 FLOW IN CFS. TIME IN HOURS. AREA IN ACRES

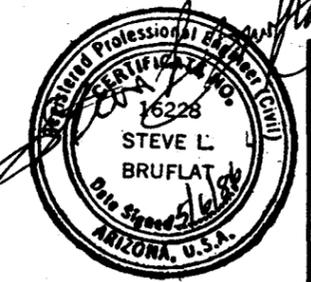
OPERATION	STATION	BASIN AREA	PERCENT RETENTION	EFFECTIVE BASIN AREA	PERCENT IMPERVIOUS	CURVE NUMBER	LAG TIME	PEAK FLOW	TIME OF PEAK	VOLUME (AC-FT)
HYDROGRAPHS AT	T-2A	52.7	80 %	10.4	65 %	89	0.61	16.	12.67	2.0
	T-2B	63.6	--	63.6	50 %	85	0.61	84.	12.67	10.3
	T-2C	21.0	--	21.0	50 %	85	0.77	28.	12.83	3.4
	T-2D	22.3	70 %	6.7	65 %	89	0.47	12.	12.50	1.3
COMBINED AND ROUTED TO (SOUTHERN AVENUE)	STA 6	159.6		101.7				133.	12.83	17.0
HYDROGRAPHS AT	T-3A	6.4	--	6.4	50 %	85	0.29	13.	12.33	1.0
	T-3B	11.0	75 %	2.8	50 %	85	0.33	5.	12.50	0.5
	T-3C	13.7	30 %	9.6	65 %	89	0.35	21.	12.50	1.8
	T-3D	98.0	--	98.0	50 %	85	0.69	121.	12.83	15.9
	T-3E	14.6	--	14.6	38 %	82	0.57	18.	12.67	2.1
COMBINED AND ROUTED TO (BALBOA DRIVE)	STA 15	303.3		233.1				298.	12.83	38.3
HYDROGRAPHS AT	T-4A	56.0	--	56.0	50 %	85	0.59	77.	12.67	9.1
	T-4B	4.4	--	4.4	20 %	78	0.30	6.	12.50	0.5
COMBINED AND ROUTED TO (BROADWAY ROAD)	STA 19	363.7		293.5				362.	12.83	47.9
HYDROGRAPH AT	T-5A	9.8	33 %	6.5	60 %	88	0.25	16.	12.33	1.2
COMBINED AND ROUTED TO (SOUTHERN PACIFIC RAILROAD)	STA 21	373.5		300.0				361.	12.83	49.1
HYDROGRAPH AT	T-6A	35.3	--	35.3	26 %	79	0.65	34.	12.83	4.4
COMBINED AND ROUTED TO (APACHE BOULEVARD)	STA 23	408.8		335.3				390.	12.83	53.5
HYDROGRAPHS AT	T-7A	19.6	--	19.6	38 %	82	0.63	23.	12.83	2.8
	T-7B	24.1	--	24.1	38 %	82	0.68	27.	12.83	3.5
	T-7C	55.2	--	55.2	38 %	82	0.71	58.	12.83	7.9
	T-7D	32.0	--	32.0	38 %	82	0.67	36.	12.83	4.6
	T-7E	46.9	65 %	16.4	65 %	89	0.44	32.	12.50	3.1
	T-7F	11.5	12 %	10.1	38 %	82	0.66	11.	12.83	1.4
	T-7G	11.5	12 %	10.1	38 %	82	0.66	11.	12.83	1.4
COMBINED AND ROUTED TO (UNIVERSITY DRIVE)	STA 34	598.1		492.7				551.	13.00	76.8
HYDROGRAPH AT	T-8A	33.2	--	33.2	65 %	89	0.47	60.	12.50	6.3
COMBINED AND ROUTED TO (FIFTH STREET)	STA 36	631.3		525.9				582.	13.00	83.1
HYDROGRAPHS AT	T-9A	23.6	60 %	9.7	50 %	85	0.63	12.	12.83	1.6
	T-9B	63.6	--	63.6	20 %	78	1.00	43.	13.17	7.6
COMBINED AND ROUTED TO (FIRST STREET)	STA 39	718.5		599.2				619.	13.00	92.3
HYDROGRAPHS AT	T-10A	4.7	--	4.7	20 %	78	0.34	6.	12.50	0.7
	T-10B	6.5	--	6.5	20 %	78	0.37	8.	12.50	0.8
COMBINED AND ROUTED TO (SALT RIVER)	STA 44	729.7		610.4				608.	13.17	93.7

LEGEND

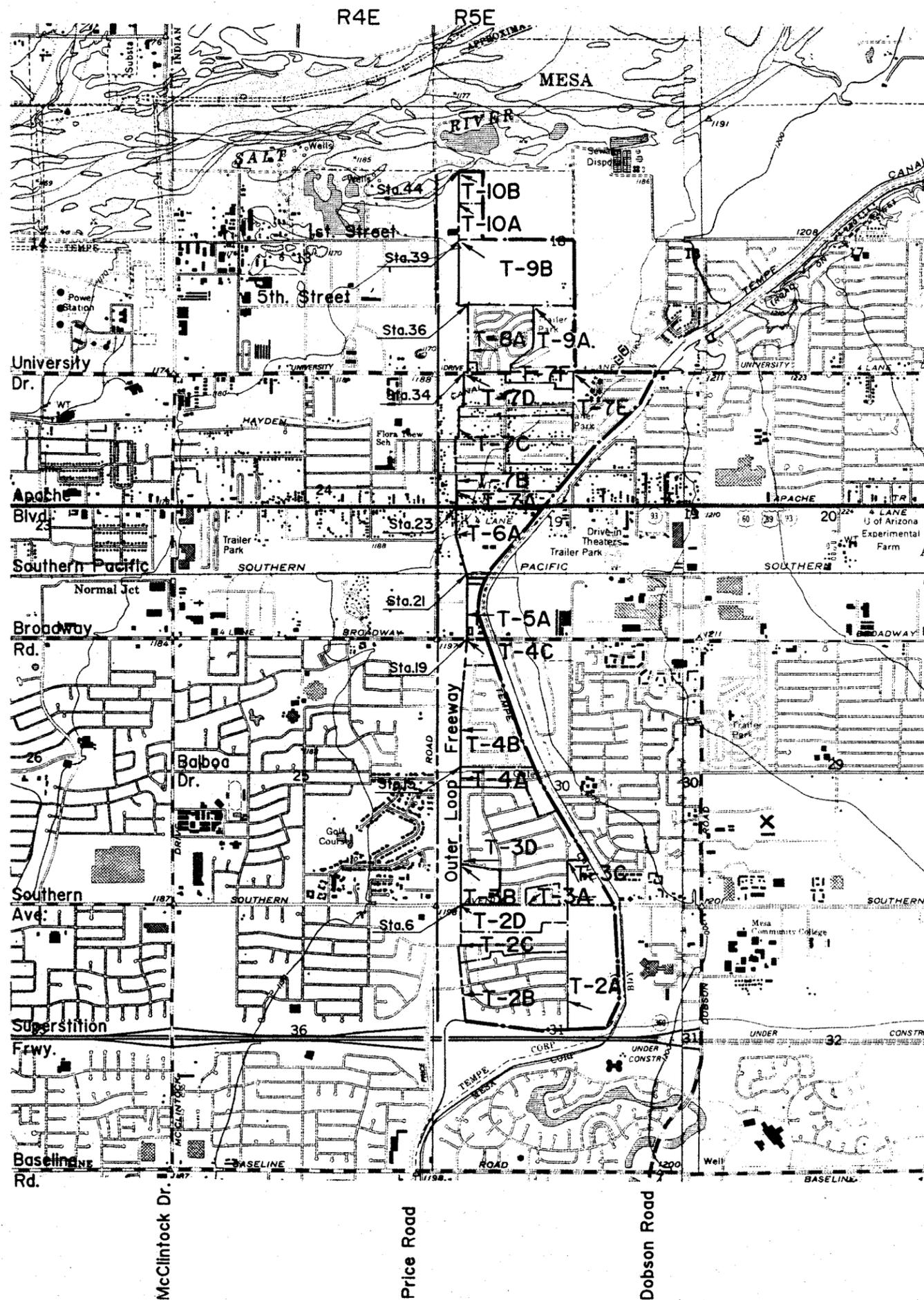
- T-2A__ Drainage Sub-basin Number
- Drainage Basin Boundary
- Drainage Sub-Basin Boundary
- ← Direction Of Flow
- Outer Loop Freeway Right-Of-Way



BASE MAP: USGS 7.5 MINUTE QUADRANGLES
 TEMPE AND MESA, ARIZ.



DESIGN J.D.	ARIZONA DEPARTMENT OF TRANSPORTATION HIGHWAY DIVISION OUTER LOOP HIGHWAY SUPERSTITION FRWY TO THE SALT RIVER		
DRAWN B.E.C.			
CHECKED S.L.B.			
APPROVED S.L.B.			
BOYLE ENGINEERING CORPORATION consulting engineers / architects			
RUNOFF SUMMARY AND DRAINAGE AREA MAP 50 Year Frequency			
ROUTE	MILEPOST	LOCATION OR STRUCTURE NO.	DWG. NO.
			2



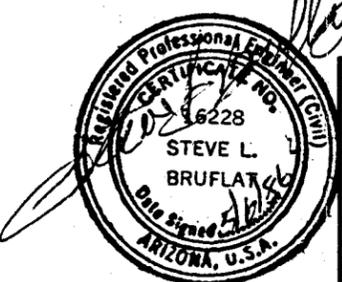
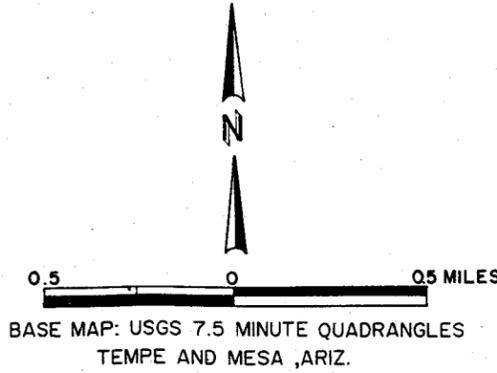
OUTER LOOP FREEWAY
 SUPERSTITION FREEWAY TO THE SALT RIVER
 ***** 100-YEAR 24-HOUR STORM *****
 ROYLE ENGINEERING CORPORATION

RUNOFF SUMMARY
 FLOW IN CFS. TIME IN HOURS. AREA IN ACRES

OPERATION	STATION	BASIN AREA	PERCENT RETENTION	EFFECTIVE BASIN AREA	PERCENT IMPERVIOUS	CURVE NUMBER	LAG TIME	PEAK FLOW	TIME OF PEAK	VOLUME (AC-FT)
HYDROGRAPHS AT	T-2A	52.7	80 %	10.4	65 %	89	0.61	19.	12.67	2.4
	T-2B	63.6	--	63.6	50 %	85	0.61	103.	12.67	12.6
	T-2C	21.0	--	21.0	50 %	85	0.77	24.	12.83	4.1
	T-2D	22.3	70 %	6.7	65 %	89	0.47	14.	12.50	1.5
COMBINED AND ROUTED TO (SOUTHERN AVENUE)	STA 6	159.6		101.7				163.	12.83	20.6
HYDROGRAPHS AT	T-3A	6.4	--	6.4	50 %	85	0.29	16.	12.33	1.3
	T-3B	11.0	75 %	2.8	50 %	85	0.33	6.	12.50	0.6
	T-3C	13.7	30 %	9.6	65 %	89	0.35	25.	12.50	2.2
	T-3D	98.0	--	98.0	50 %	85	0.59	149.	12.83	19.4
COMBINED AND ROUTED TO (BALBOA DRIVE)	STA 15	303.3		233.1				365.	12.83	46.5
HYDROGRAPHS AT	T-4A	56.0	--	56.0	50 %	85	0.59	94.	12.67	12.6
	T-4B	4.4	--	4.4	20 %	78	0.30	8.	12.50	0.7
COMBINED AND ROUTED TO (BROADWAY ROAD)	STA 19	363.7		293.5				447.	12.83	59.8
HYDROGRAPH AT	T-5A	9.8	33 %	6.5	60 %	88	0.25	19.	12.33	1.4
COMBINED AND ROUTED TO (SOUTHERN PACIFIC RAILROAD)	STA 21	373.5		300.0				447.	12.83	61.2
HYDROGRAPH AT	T-6A	35.3	--	35.3	26 %	79	0.65	44.	12.83	5.5
COMBINED AND ROUTED TO (APACHE BOULEVARD)	STA 23	408.8		335.3				480.	12.83	66.8
HYDROGRAPHS AT	T-7A	19.6	--	19.6	38 %	82	0.63	28.	12.83	3.5
	T-7B	24.1	--	24.1	38 %	82	0.68	33.	12.83	4.3
	T-7C	55.2	--	55.2	38 %	82	0.71	73.	12.83	9.8
	T-7D	32.0	--	32.0	38 %	82	0.67	44.	12.83	5.7
	T-7E	46.9	65 %	16.4	65 %	89	0.44	38.	12.50	3.7
	T-7F	11.5	12 %	10.1	38 %	82	0.66	14.	12.83	1.8
COMBINED AND ROUTED TO (UNIVERSITY DRIVE)	STA 34	598.1		492.7				682.	13.00	95.4
HYDROGRAPH AT	T-8A	33.2	--	33.2	65 %	89	0.47	72.	12.50	7.6
COMBINED AND ROUTED TO (FIFTH STREET)	STA 36	631.3		525.9				721.	13.00	103.0
HYDROGRAPHS AT	T-9A	23.6	60 %	9.7	50 %	85	0.63	15.	12.83	1.9
	T-9B	63.6	--	63.6	20 %	78	1.00	55.	13.17	9.6
COMBINED AND ROUTED TO (FIRST STREET)	STA 39	718.5		599.2				775.	13.00	114.5
HYDROGRAPHS AT	T-10A	4.7	--	4.7	20 %	78	0.34	8.	12.50	0.7
	T-10B	6.5	--	6.5	20 %	78	0.37	11.	12.50	1.0
COMBINED AND ROUTED TO (SALT RIVER)	STA 44	729.7		610.4				768.	13.00	116.2

LEGEND

- T-2A ___ Drainage Sub-basin Number
- Drainage Basin Boundary
- Drainage Sub-Basin Boundary
- ← Direction Of Flow
- Outer Loop Freeway Right-Of-Way



DESIGN J.D.	ARIZONA DEPARTMENT OF TRANSPORTATION HIGHWAY DIVISION OUTER LOOP HIGHWAY SUPERSTITION FRWY TO THE SALT RIVER		
DRAWN B.E.C.			
CHECKED S.L.B.			
APPROVED S.L.B.			
RUNOFF SUMMARY AND DRAINAGE AREA MAP 100 Year Frequency			
ROUTE	MILEPOST	LOCATION OR STRUCTURE NO.	DWG. NO. 3

REFERENCES

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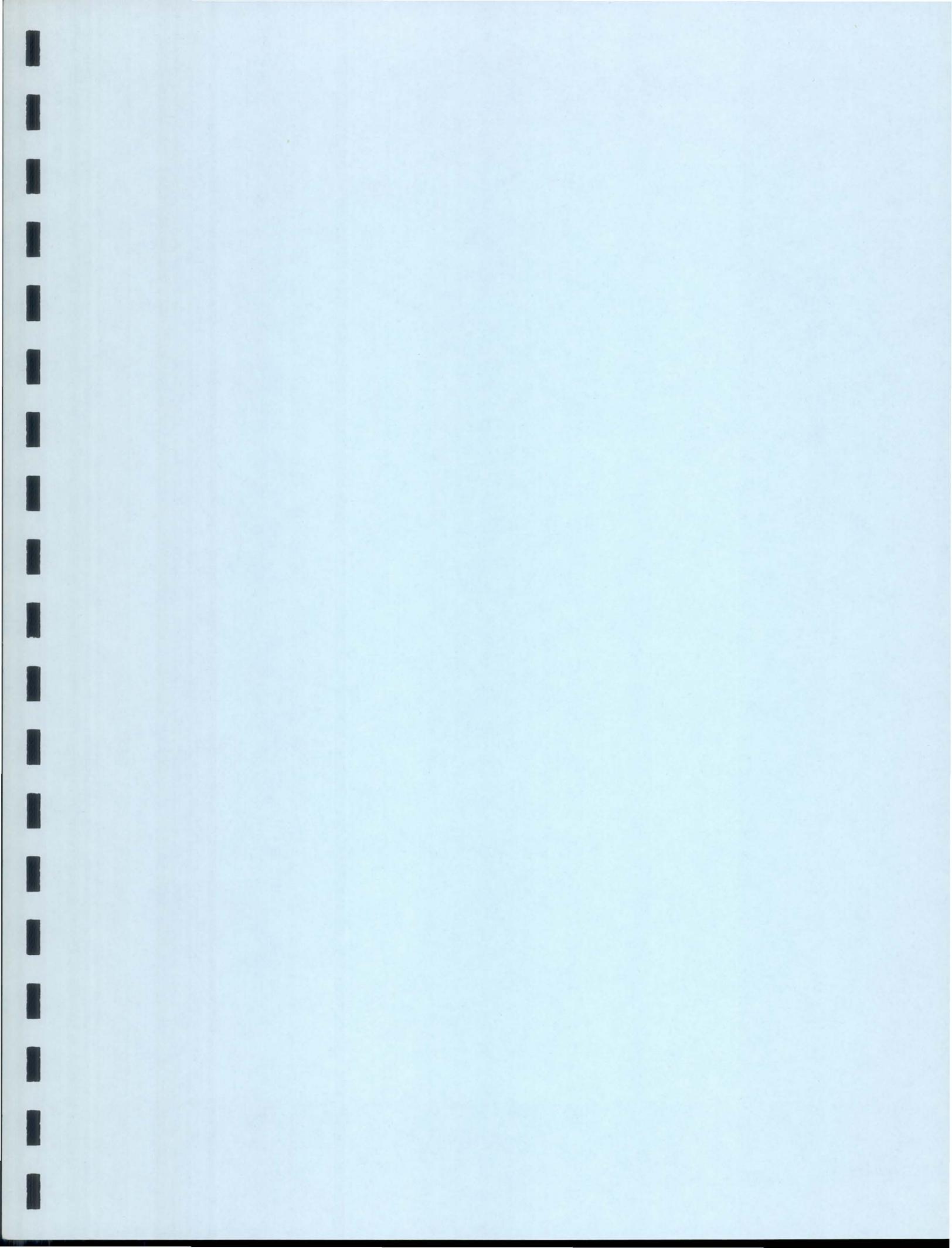
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APPENDIX 'A'

MAJOR CHANGES FROM THE
PRELIMINARY HYDROLOGIC ANALYSIS

MAJOR CHANGES FROM THE PRELIMINARY HYDROLOGIC ANALYSIS

The preliminary hydrologic study conducted by Water Resources Associates provided an excellent basis for this study. Due to the preliminary nature of their work, however, some of the assumptions made have subsequently been modified and refined based on recent field observations. Primarily due to fewer retention areas than assumed (the effective drainage area was increased from 0.40 to 0.96 square miles), the net result of the changes was approximately doubling the calculated discharges.

The major modifications and refinements are discussed below and the Water Resources Associates summary sheets are included for comparison.

DRAINAGE AREAS

- Additional areas added north of University Drive.
- ROW area deleted.
- 24 instead of 9 sub-basins used.

RETENTION AREAS

- Field investigations showed only new developments have retention areas, older areas do not.
- Of 24 sub-basins used, only 8 have retention.

CURVE NUMBERS

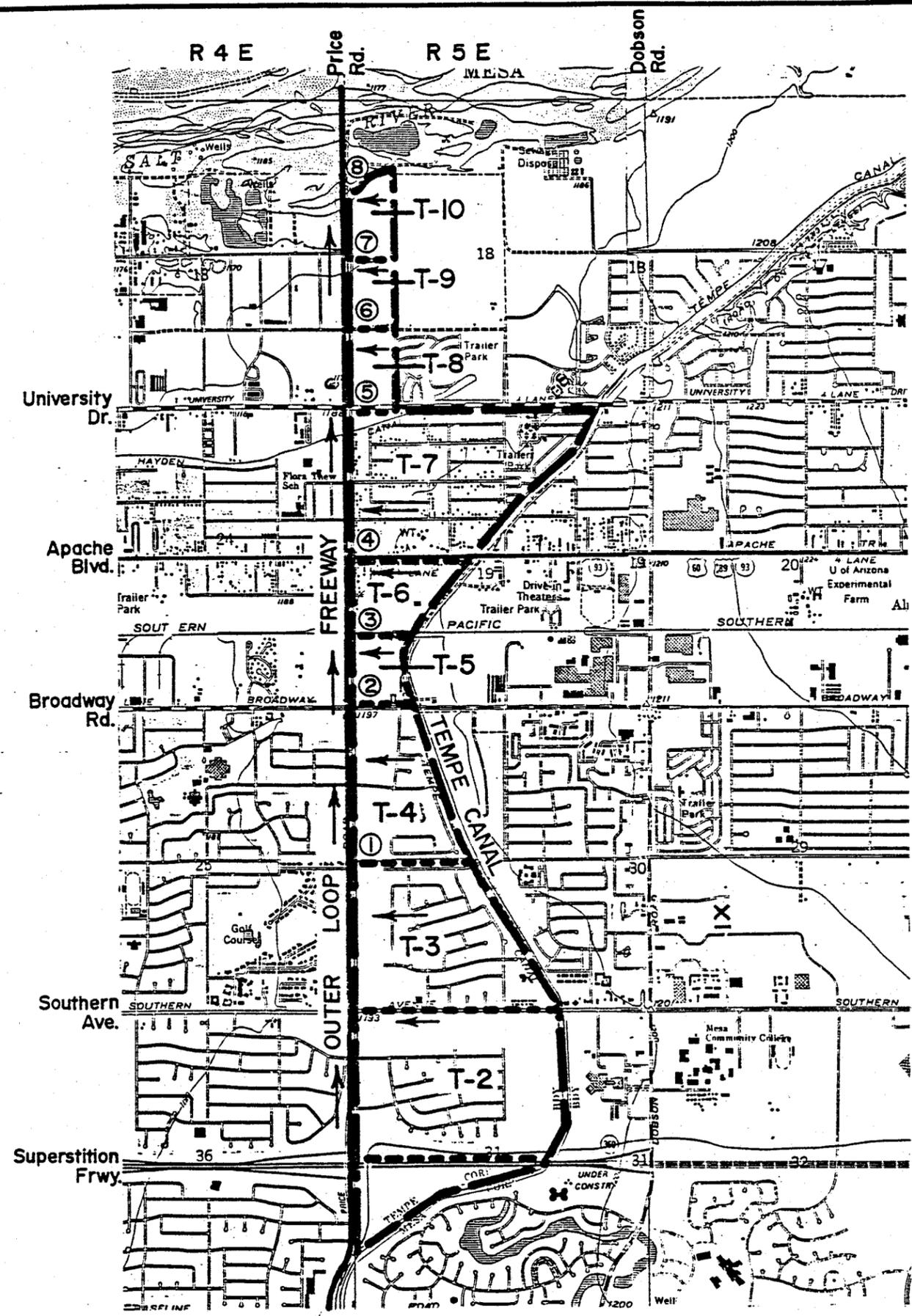
- Base curve numbers (without considering impervious areas) raised from 69 (all urban lawn) to 72 (2/3 urban lawn and 1/3 desert landscaping) based on field observations.

COMPUTATION INTERNAL

- Decreased from 15 minutes to 10 minutes to better fit requirement that $t \leq 0.29t_L$.

ROUTING

- Kinematic wave routing used instead of storage routing.



SUPERSTITION FREEWAY TO SALT RIVER
 50-YEAR 24-HOUR
 RUNOFF SUMMARY
 FLOW IN CUBIC FEET PER SECOND
 TIME IN HOURS, AREA IN SQUARE MILES

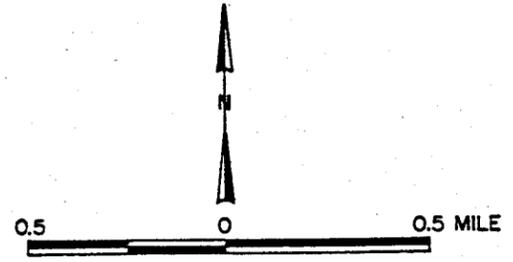
OPERATION	STATION	PEAK FLOW	TIME OF PEAK	BASIN AREA	EFFECTIVE BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE	VOLUME (AC-FT)	LAG TIME	CURVE NUMBER	PERCENT IMPERVIOUS
HYDROGRAPH AT	T-2	93.	13.00	.31	.09			17	.88	69	100
HYDROGRAPH AT	T-3	76.	13.00	.26	.08			14	.94	69	100
2 COMBINED AT	STA 1 ①	169.	13.00	.57	.17			31			
ROUTED TO	STA 2	164.	13.25	.57	.17	2.20	13.25	31			
HYDROGRAPH AT	T-4	60.	12.75	.15	.05			8	.53	69	100
2 COMBINED AT	STA 3 ②	208.	13.25	.72	.22			39			
ROUTED TO	STA 4	202.	13.25	.72	.22	2.74	13.25	39			
HYDROGRAPH AT	T-5	56.	12.25	.06	.02			3	.12	69	100
2 COMBINED AT	STA 5 ③	204.	13.25	.78	.23			42			
ROUTED TO	STA 6	204.	13.25	.78	.23	2.04	13.25	42			
HYDROGRAPH AT	T-6	56.	12.25	.08	.02			4	.17	69	100
2 COMBINED AT	STA 7 ④	208.	13.25	.86	.26			47			
ROUTED TO	STA 8	206.	13.25	.86	.26	1.65	13.25	47			
HYDROGRAPH AT	T-7	121.	13.00	.38	.11			21	.80	69	100
2 COMBINED AT	STA 9 ⑤	308.	13.25	1.24	.37			67			
ROUTED TO	STA 10	311.	13.25	1.24	.37	2.15	13.25	67			
HYDROGRAPH AT	T-8	18.	12.50	.03	.01			2	.26	69	100
2 COMBINED AT	STA 11 ⑥	313.	13.25	1.27	.38			69			
ROUTED TO	STA 12	312.	13.25	1.27	.38	2.08	13.25	69			
HYDROGRAPH AT	T-9	21.	12.25	.03	.01			2	.20	69	100
2 COMBINED AT	STA 13 ⑦	314.	13.25	1.30	.39			71			
ROUTED TO	STA 14	312.	13.25	1.30	.39	1.89	13.25	71			
HYDROGRAPH AT	T-10	18.	12.50	.03	.01			2	.33	69	100
2 COMBINED AT	STA 15 ⑧	315.	13.25	1.33	.40			73			

FOR REFERENCE ONLY NOT FOR USE

*NOTE: due to existing retention conditions assumed 30% of area (100% impervious) as contributing to runoff

LEGEND

- T-2 Drainage Sub-basin Number
- Drainage Basin Boundary
- Drainage Sub-basin Boundary
- ← Direction of Flow
- Outer Loop Freeway



BASE MAP: USGS 7.5 MINUTE QUADRANGLES TEMPE AND MESA, ARIZ.

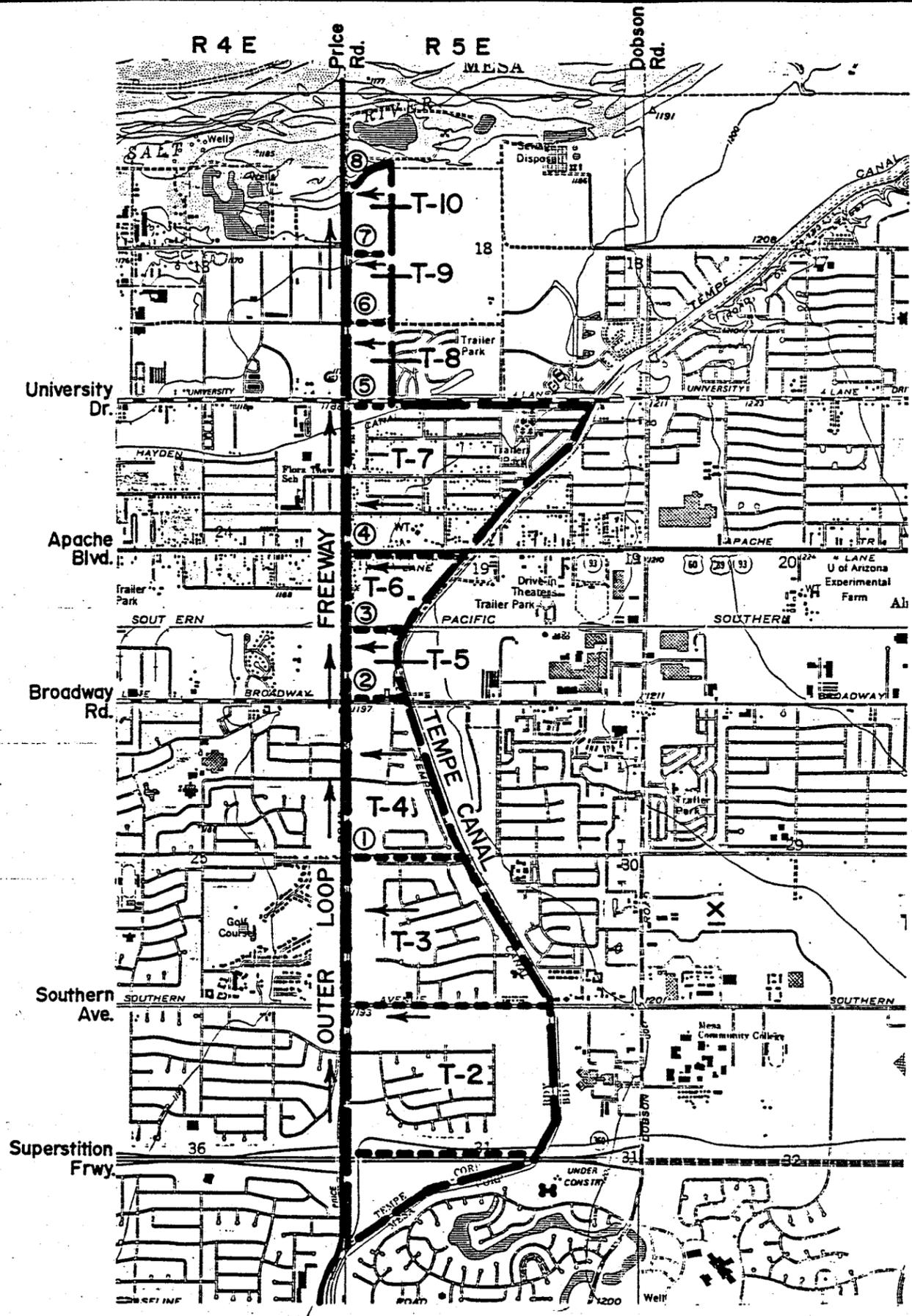
Water Resources Associates, Inc.	SUPERSTITION FRWY. TO THE SALT RIVER DRAINAGE BASIN MAP AND RUNOFF SUMMARY 50 YEAR FREQUENCY	FIGURE 5.2.1
PROJECT NO. 85C-0051	DATE 1/15/86	

SUPERSTITION FREEWAY TO SALT RIVER
 100-YEAR 24-HOUR
 RUNOFF SUMMARY
 FLOW IN CUBIC FEET PER SECOND
 TIME IN HOURS, AREA IN SQUARE MILES

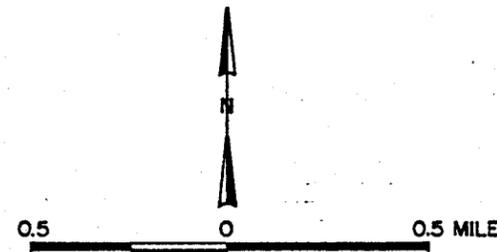
OPERATION	STATION	PEAK FLOW	TIME OF PEAK	BASIN AREA	EFFECTIVE BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE	VOLUME (AC-FT)	LAG TIME	CURVE NUMBER	PERCENT IMPERVIOUS
HYDROGRAPH AT	T-2	107.	13.00	.31	.09			19	.88	69	100
HYDROGRAPH AT	T-3	87.	13.00	.26	.08			16	.94	69	100
2 COMBINED AT	STA 1 ①	194.	13.00	.57	.17			35			
ROUTED TO	STA 2	188.	13.25	.57	.17	2.54	13.25	35			
HYDROGRAPH AT	T-4	69.	12.75	.16	.05			9	.53	69	100
2 COMBINED AT	STA 3 ②	227.	13.00	.72	.22			45			
ROUTED TO	STA 4	231.	13.25	.72	.22	3.15	13.25	45			
HYDROGRAPH AT	T-5	54.	12.25	.06	.02			4	.12	69	100
2 COMBINED AT	STA 5 ③	234.	13.25	.73	.23			48			
ROUTED TO	STA 6	234.	13.25	.78	.23	2.34	13.25	48			
HYDROGRAPH AT	T-6	64.	12.25	.08	.02			5	.17	69	100
2 COMBINED AT	STA 7 ④	238.	13.25	.86	.26			53			
ROUTED TO	STA 8	236.	13.25	.86	.26	1.89	13.25	53			
HYDROGRAPH AT	T-7	139.	13.00	.38	.11			24	.80	69	100
2 COMBINED AT	STA 9 ⑤	352.	13.25	1.24	.37			77			
ROUTED TO	STA 10	355.	13.25	1.24	.37	2.47	13.25	77			
HYDROGRAPH AT	T-8	20.	12.50	.03	.01			2	.26	69	100
2 COMBINED AT	STA 11 ⑥	358.	13.25	1.27	.38			79			
ROUTED TO	STA 12	357.	13.25	1.27	.38	2.38	13.25	79			
HYDROGRAPH AT	T-9	24.	12.25	.03	.01			2	.20	69	100
2 COMBINED AT	STA 13 ⑦	359.	13.25	1.30	.39			81			
ROUTED TO	STA 14	357.	13.25	1.30	.39	2.17	13.25	81			
HYDROGRAPH AT	T-10	20.	12.50	.03	.01			2	.33	69	100
2 COMBINED AT	STA 15 ⑧	361.	13.25	1.33	.40			83			

FOR REFERENCE ONLY USE
 IN ORDER FOR USE

*NOTE: due to existing retention conditions assumed 30% of area (100% impervious) as contributing to runoff



TIN



BASE MAP: USGS 7.5 MINUTE QUADRANGLES
 TEMPE AND MESA, ARIZ.

LEGEND

- T-2 Drainage Sub-basin Number
- Drainage Basin Boundary
- - - Drainage Sub-basin Boundary
- ← Direction of Flow
- Outer Loop Freeway

Water Resources Associates, Inc.

SUPERSTITION FRWY. TO THE SALT RIVER
 DRAINAGE BASIN MAP
 AND RUNOFF SUMMARY
 100 YEAR FREQUENCY

FIGURE 5.2.2

PROJECT NO. B5C-0051 DATE 1/15/86