C A S A N D R O W A S H
Wickenburg, Arizona

Alternatives for Flood Control

Maricopa County Community Development Agnecy
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October 22, 1980

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Oct. 22, 1980

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Maricopa County
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Phoenix, Ariz. 85003

Attn: Mr. J.A. Dickson, Director
Maricopa County Community Development Agency

Re: Project No. 48-13-017

Gentlemen,

In accordance with our agreement dated June 9, 1980, we respectfully submit this report on solutions for the flooding problems in the lower portions of Casandro Wash in Wickenburg.

We conclude, from the engineering and economic viewpoint that a retention dam on or near the alignment of Mariposa Drive is the best of the alternatives considered. Such a project would have the most favorable ratio of direct benefits to costs. Indirect benefits were not evaluated but would be substantial.

We appreciate the assistance and cooperation of the Soil Conservation Service, particularly the help received from Mr. Richard Reidhead, Economist of the Water Resources Planning office in Phoenix.

Very truly yours,

Yost and Gardner Engineers

By
John E. Schaefer

JES/jr

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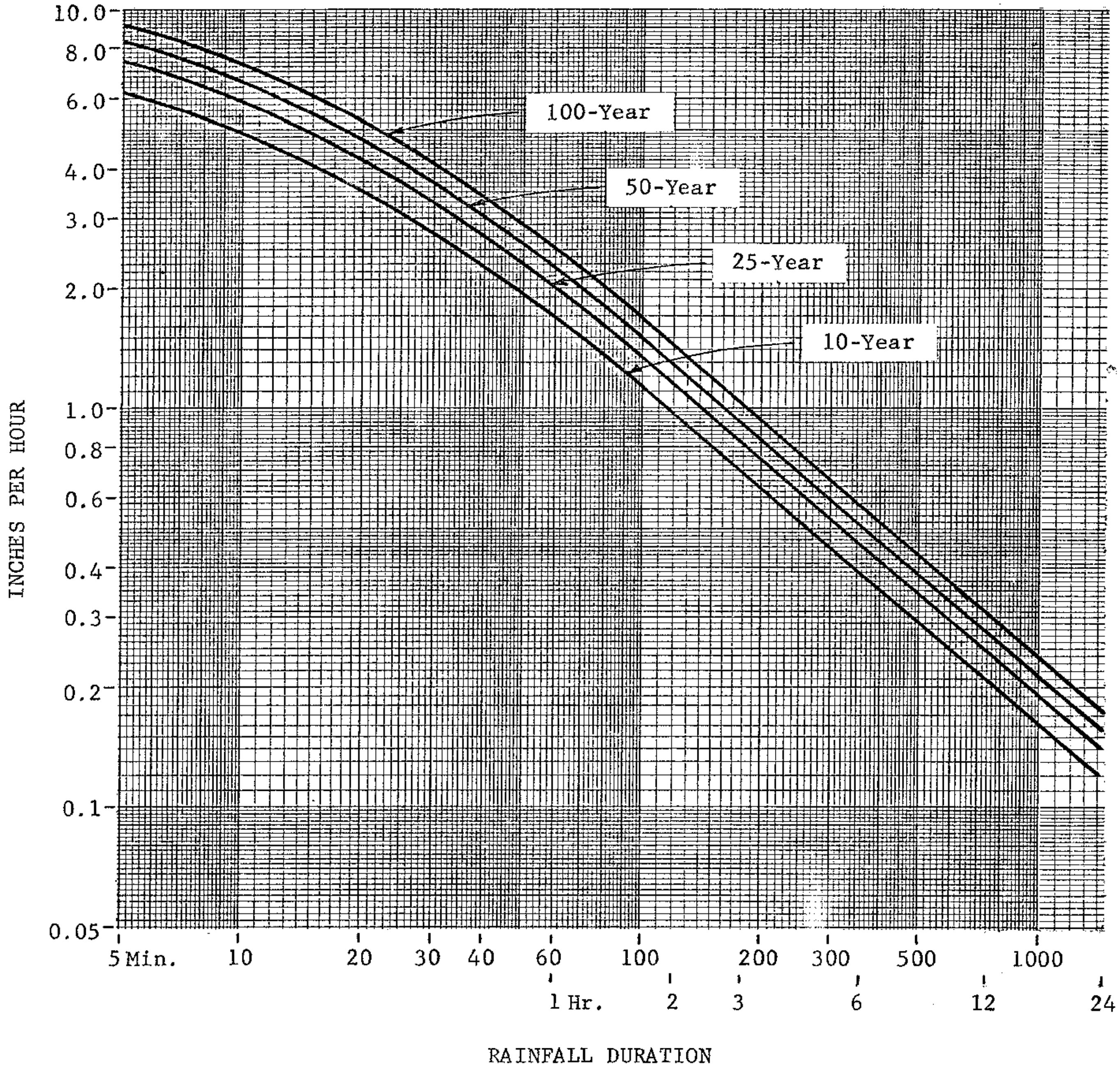


RAINFALL INTENSITY - DURATION - FREQUENCY RELATION
FOR WICKENBURG, ARIZONA

(Partial Duration Series)

Curves are based on methods of U.S. Weather Bureau Technical Memorandum, WR-44, October, 1969.

FIGURE 2

Appendices

References

1. Town of Wickenburg Ord. No. 505 (Floodplain Regulation).

2. Flood Plain Information Study for Maricopa County, Arizona, Vol. IV, Wickenburg Report, U.S. Army Engineer District Los Angeles, Corps of Engineers, Dec. 1965.

3. Watershed Work Plan, Wickenburg Watershed, Maricopa and Yavapai Counties Arizona, U.S. Dept. of Agriculture, Soil Conservation Service, Dec. 1974.

4. Flood Insurance Study, Town of Wickenburg, Arizona, Maricopa County, U.S. Dept. of Housing & Urban Development, Federal Insurance Administration, July, 1977.

5. Storm Drainage Report for the Maricopa Association of Governments, 1970. Yost and Gardner Engineers, Phoenix, Ariz.

6. General Soil Map, Maricopa County, Arizona, U.S. Dept. of Agriculture, Soil Conservation Service, June 1969.

7. Guide for Interpreting Engineering Uses of Soils, U.S. Dept. of Agriculture, Soil Conservation Service, Nov. 1971.

8. Generalized Computer Program, HEC-2 Water Surface Profiles, (Aug. 1979 version) U.S. Army Corps of Engineers Hydrologic Engineering Center, 609 Second St. Davis, California, 95616.

Casandro Wash

Wickenburg, Arizona

Alternatives for Flood Control

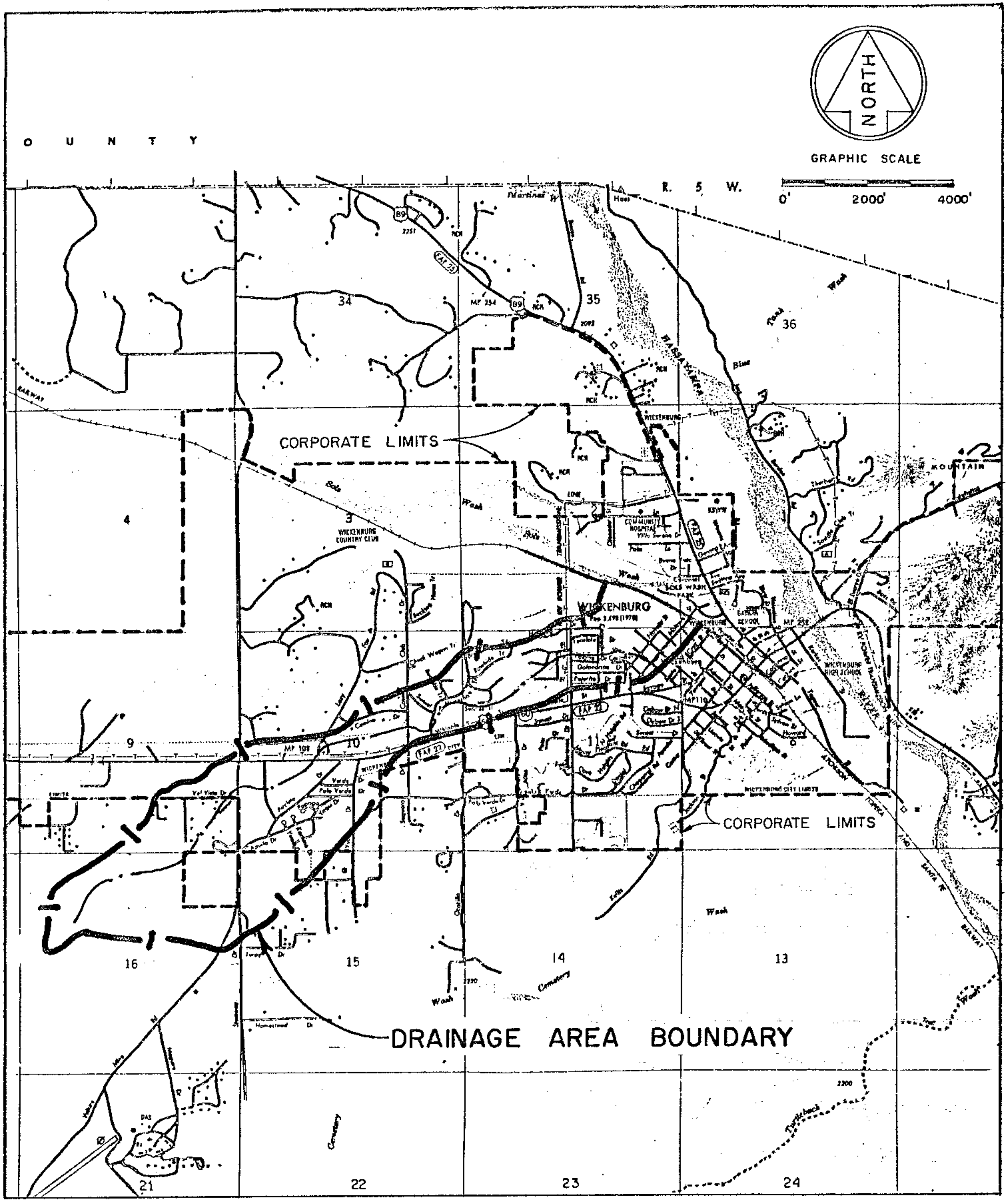
1. Background

1.1 Location and general description

Casandro Wash is a small normally dry watercourse tributary to Sols Wash just before it joins the Hassayampa River. Most of its watershed lies within the corporate limits of the Town of Wickenburg in northwest Maricopa County, Arizona. Fig. 1 shows the watershed in relation to the Town of Wickenburg.

Basin elevations range from 2075 to 2400 feet. The wash is about 3 miles long. Although mostly in the town, the basin remains essentially in its natural state with sparse upper Sonoran desert vegetation. Only the lower half mile traverses a developed area near the original Wickenburg townsite where the streets follow the regular gridiron pattern laid out in disregard of topography after the fashion customary in the 19th century.

A major highway, U.S. Route 60-70, crosses the watershed near the midpoint of Casandro Wash. The Santa Fe Railroad crosses just upstream of the junction with Sols Wash. Concrete box culverts have been provided for these crossings but the numerous town street crossings are made by means of "dips" and are generally not paved. In the last four blocks upstream of the railroad culvert, the wash follows the alignment of Mohave Street, which is also unpaved.



GENERAL LOCATION MAP

FIGURE I

1.2 The problem

Occasional flood flows in Casandro Wash have eroded portions of Mohave, Jackson and Navajo Streets to the point where the street surface is from 2 to 4 feet below the front yards of adjacent houses. In some places utility lines have been exposed. Storms leave streets rough and dangerous because of the removal or deposition of material. Much private property in the area has been shown to be subject to inundation in flood insurance studies and thus placed in a sort of limbo. Under Town ordinances such property cannot be improved substantially and no new construction can take place (Ref. 1). Access to existing residences is cut off, even for emergency vehicles, during periods of heavy runoff. The purpose of this study is to see if any measures have current economic and structural feasibility for alleviating this situation, permitting normal use and development. The study, insofar as improvements are concerned, is limited to that portion of Casandro Wash below Mariposa Drive, and is related primarily to Reeds Addition which is the principal area where existing structures are affected.

1.3 Previous studies

Flood magnitudes and frequency for Casandro Wash have been evaluated by the Corps of Engineers (Ref. 2), and by the Soil Conservation Service (Ref. 3). The Corps report included determination of inundation limits for 50 and 100-year and standard project floods, and introduced the concepts of designated floodway and floodway fringe as applied to Wickenburg. It recommended control of damage by zoning regulations.

The Soil Conservation Service study evaluated costs and benefits for two flood control alternatives and found both infeasible from the cost/benefit ratio standpoint. The first was construction of an earthfill dam 40 ft. high 1500 ft. upstream from Mariposa Drive. The second involved a lined channel extending about 1000 ft. above Mohave St., channelization of Mohave St., and enlargement of the Santa Fe box culvert. Consideration was also given to zoning and to the floodproofing of structures, but no costs were worked out for these approaches.

Delineation of a designated floodway and floodway fringe was provided by the Federal Insurance Administration Flood Insurance Study (Ref. 4) using discharge/frequency relations, topography, and water surface profiles provided by the Corps of Engineers. Boundaries of the floodway and fringes in Ref. 4 are shown in Fig. 13.

1.4 Reasons and authority for current study

The flood limits of Ref. 4 are based on conditions existing at the time of the field studies made between 1961 and 1965. The economic analyses of Ref. 3 were made using construction costs and land values current in 1972. The Flood Insurance Program of the Dept. of Housing and Urban Development had not been formulated at the time the SCS cost/benefit studies were made and the impact of this program on real estate values could not have been taken into consideration. There is also a general benefit to the entire community resulting from the reduction of flood hazard that is of direct benefit only to a limited part.

For these reasons the Wickenburg Town Council passed Ord. No. 698 on Mar. 5, 1979, authorizing application to the Maricopa County Community Development Agency for block grant funds for this study. The study was initiated under a contract awarded by the Maricopa County Board of Supervisors through its Community Development Agency on June 9, 1980.

2. Hydrology and determination of flood/frequency relationships and flood limits

2.1 Hydrology

The method used for the estimation of peak discharges for a range of frequencies of occurrence is the application of a modification of the "rational formula" (Ref.5):

$$Q = 0.9A_i \ (I_a-0.20)+0.8A_p(I_a-f_c)$$

where

Q = peak runoff in cu. ft. per sec.

A_i = impervious portion of drainage area in acres

I_a = rainfall intensity in inches per hour (average for the area)

A_p = pervious portion of the drainage area in acres.

f_c = infiltration rate of the soil in inches per hour. (saturated condition)

Application of this method begins with delineation of subsidiary watersheds less than 640 acres in area (Fig. 4). Peak runoff is computed for the uppermost area by the above formula, then for the next area downstream, then for the combination of the two, then for the third area downstream then for the combination, and so on. Computations for 10-year to 100-year recurrence intervals under existing watershed conditions are given in Appendix I. Similar calculations for projected land use conditions are set forth in Appendix II. Under this method, when cummulative peaks begin to diminish proceeding downstream, the selected design values are arbitrarily kept at the same or adjusted upward slightly as in the right hand columns of the calculation sheets.

Division of areas into pervious and impervious portions ($A_p$and A_i) are based on land use as indicated by zoning (Fig. 6). The ratios used for each category given in Table 2 are based on house counts and scaled measurements of paved areas in Wickenburg.

Infiltration rates (f_c) are taken from soils studies by the Soil Conservation Service. Values used are presented in Table 1 and Fig. 5. References 6 and 7 were utilized in this phase of the studies.

Time of concentration is used in selecting rainfall intensity from Fig. 2. Values were determined from length of flow path, obtained from Fig. 4, using flow velocities of 3.6 and 5.6 ft. per sec. for the portions above and below the Hwy 60 crossing respectively. These velocities were those used by the SCS in Ref. 3 and are based on Manning formula calculations for the slopes and channel conditions prevailing.

Rainfall intensity values for given concentration times and recurrence intervals from Fig. 2 were reduced to average values (I_a) for larger watersheds by use of Fig. 3.

Computed concentration times and peak flows for existing and projected land use conditions in the tributary watersheds are given in Tables 3 and 4. Design values for the main channel are given in Appendix I and Appendix II in the right hand columns. Fig. 8 shows locations where the design flows occur.

2.2 Flood limits

Using discharge rates determined in the manner described, the next step is to determine the water surface elevations and limits of flooding in Casandro Wash below Mariposa Drive for the recurrence intervals

Table 1 : Casandro Wash Drainage Area
Soil Types and Infiltration Capacities

Soil Designation	Description	Type	Permeability Rate (In. per hr)	Infiltration Rate (In. per hr)
A6	Gunsight, Cavelt Complex	Gravelly Loam	2.0 to 6.0	1.0
A7	Ebon, Contine, Cavelt	Gravelly Sand Loam (Limey)	2.0 to 6.0	1.0
IE	Antho, Carrizo	Sandy Loam	2.0 to 6.0	1.0
JI	House Mtn., Lehmans, Rock Outcrop Complex	Rocky Outcrop	0.6 to 2.0	0.3

NOTE: Infiltration rates shown reflect sustained capacity as compared to the higher rates of soil permeability. Provision is thereby made for infiltration of rainfall on the water shed following the initial storm.

Table 2 - Pervious/Impervious Factors for Various Land Uses - Design Values

Land Use	Zoning Categories	Percent Pervious	Percent Impervious
Residential - Low Density (to 5 units per acre)	R1-35 and R1-12	70	30
Residential - Medium Density (5 to 10 units per acre)	R1-6	65	35
Residential - High Density (over 10 units per acre)	RM-1, RM-2 and MHP	55	45
Commercial	PSC, C-1 and C-3	10	90
Industrial	IND-2	30	70

Table 3 - *Flows and Times of Concentration for Tributary Areas - Existing Development*

Area No.	Total Area Acres	t_c Mins.	Q10 cfs	Q25 cfs	Q50 cfs	Q100 cfs
1	283	28	450	586	674	776
2	62	19	138	173	201	229
3	55	16	136	171	199	225
4	276	45	303	395	462	539
5	33	13	90	123	128	147
6	82	16	193	246	286	325
7	47	25	80	102	120	138
8	60	18	145	182	210	237
9	86	15	216	271	317	358

Table 4 - Flows and Times of Concentration for Tributary Areas - Projected Land Use

Area No.	Total Area Acres	t_c Mins.	Q10 cfs	Q25 cfs	Q50 cfs	Q100 cfs
1	283	26	510	645	749	849
2	62	17	160	198	230	258
3	55	15	163	200	231	259
4	276	40	361	473	541	620
5	33	12	96	121	139	155
6	82	15	224	278	322	363
7	47	23	90	114	133	152
8	60	17	155	193	223	251
9	86	14	251	309	355	402

investigated. For any given rate of flow the water depth, velocity, and width of water surface are affected by channel cross-section, bed slope, and surface roughness. Accurate data are essential for the calculation.

Field surveys were made to provide design information on channel conditions. Fig. 9 shows the location of the traverse down the center of the existing wash below Mariposa Drive. The figures also shows where surveyed cross-sections were taken. The present alignment of Casandro Wash in relation to streets, alleys, and lot lines is shown in Fig. 10. The traverse was tied to the coordinate grid used in the Town's contour mapping project of 1977. Table 5 gives the control survey data.

Water surface profiles were computed using the Corps of Engineers computer program HEC 2 (Ref. 8) for the four required recurrence intervals and for present and future conditions of development. The channel and overbank areas were assigned Manning's "n" values of 0.035 and 0.125 respectively as measures of hydraulic roughness. The computations are too voluminous to include in this report but summaries are presented in Table 6 and the elevations, profiles and inundation limits are shown in Fig. 12, 13, 14 and 15. Fig. 13 shows the 100-year inundation limits computed for this study in relation to those of the Flood Insurance Rate Map (Ref. 4). Existing houses and lots subject to flooding under the calculations of the present study are shown in Fig. 12. The tabulation on this figure gives the floor level for each affected house and the estimated depth of flooding for the 100-year event. There are 34 houses that would be flooded under the projected 100-year event. Flood depth ranges up to 3.3 ft. There are 36 vacant lots in Reed's Addition and Casandro Tract lying within the 100-year flood limit. Over 3500 ft. of Town streets would be flooded in the two subdivisions.

Table 5 -Transit Line Coordinates and Cross Section Stationing

Location	Station	Coordinates North	Coordinates East	Bearing	Distance
Point A - S¼ Cor. Sec. 2	-(5+58.19)	110,604.46	87,421.30	S 0°26'00" E	558.79'
Point B - C_L Mariposa St.	0+00	110,045.64	87,425.53		
X - Sec 1	0+50			N 78°24'25" E	255.88'
Point C	2+55.88	110,097.06	87,676.19		
X - Sec 2	2+70				
X - Sec 3	6+60			S 87°27'25" E	713.87'
X - Sec 4	9+60				
Point D	9+69.75	110,065.39	88,389.35	N 79°44'43" E	276.54'
Point E	12+46.29	110,114.62	88,661.47		
X - Sec 5	13+39			S 79°52'47" E	294.46'
Point F	15+40.75	110,062.88	88,951.36		
X - Sec 6	16+72			S 61°19'00" E	420.43'
X - Sec 7	18+58				
Point G	19+61.18	109,861.08	89,320.20		
X - Sec 8	20+28			S 88°45'00" E	87.29'
Point H	20+48.47	109,859.18	89,407.47		
X - Sec 9	23+13			N 41°35'40" E	977.30'
X - Sec 10	26+58				
Point I - C_L Jefferson St.	30+25.77	110,590.07	90,056.25		
X - Sec 10.1	31+90			N 41°35'40" E	170.60'
Point J	31+96.37	110,717.65	90,169.51		
X - Sec 11	33+48			N 29°31'20" E	163.91'
Point K AT&SF Culvert	33+60.28	110,860.28	90,250.27		
Tie from Transit Line and C_L of Jefferson St. (Point I) to NE Cor. Sec. 11					
Point I	30+25.77	110,604.91	90,061.60	N 49°10'40" W	33.13'
N.Line Sec 11	—	110,626.57	90,036.52	N 89°27'20" E	22.70'
NE Cor Sec 11	—	110,611.94	90,053.88	S 6°11'20" E	22.00'
Point I	30+25.77	110,604.91	90,061.60		

Coordinates based on coordinate of N.E. Cor. Sec. 11 (Town of Wickenburg Contour Map, by Adam, Hamlyn, Anderson, Consulting Engineers (AHA #C-7680), 1977) and record bearing of Mariposa St. C_L (Casandro Tract, Maricopa County Recorders office Book 31 of Maps, Page 32).

Table 6 - Summaryof water surface profile computations

Sheet 1 of 4

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**************************************************
 HEC2 RELEASE DATED NOV 76 UPDATED JULY 1979
 ERROR CORR - 01,02,03
 MODIFICATION - 50,51,52,53
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NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

~~100 YEAR~~ - CASANDRO WASH

SUMMARY PRINTOUT TABLE 150

FREQ	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10K*S	VCH	AREA	.01K
100 E	11.000	0.	0.	0.	2061.80	750.00	2071.50	0.	2071.64	4.20	3.12	291.24	365.98
50 E	11.000	0.	0.	0.	2061.80	730.00	2071.35	0.	2071.49	4.19	3.09	285.04	356.65
25 E	11.000	0.	0.	0.	2061.80	710.00	2071.20	0.	2071.34	4.18	3.06	278.90	347.41
10 E	11.000	0.	0.	0.	2061.80	680.00	2070.80	0.	2070.94	4.43	3.08	262.75	323.19
100 P	11.000	0.	0.	0.	2061.80	760.00	2071.55	0.	2071.70	4.24	3.14	293.31	369.11
50 P	11.000	0.	0.	0.	2061.80	745.00	2071.45	0.	2071.59	4.22	3.12	289.17	362.86
25 P	11.000	0.	0.	0.	2061.80	720.00	2071.30	0.	2071.44	4.15	3.07	282.99	353.56
10 P	11.000	0.	0.	0.	2061.80	690.00	2071.05	0.	2071.19	4.16	3.03	272.80	338.26
(Typ.)													
	10.100	158.00	0.	0.	2066.50	750.00	2071.68	0.	2071.71	3.28	2.07	924.81	414.02
	10.100	158.00	0.	0.	2066.50	730.00	2071.53	0.	2071.56	3.51	2.09	888.64	389.66
	10.100	158.00	0.	0.	2066.50	710.00	2071.38	0.	2071.41	3.76	2.12	852.70	365.94
	10.100	158.00	0.	0.	2066.50	680.00	2070.99	0.	2071.03	4.89	2.26	760.85	307.59
	10.100	158.00	0.	0.	2066.50	760.00	2071.73	0.	2071.77	3.24	2.07	937.28	422.52
	10.100	158.00	0.	0.	2066.50	745.00	2071.63	0.	2071.66	3.37	2.08	912.90	405.95
	10.100	158.00	0.	0.	2066.50	720.00	2071.48	0.	2071.51	3.56	2.09	876.24	381.43
	10.100	158.00	0.	0.	2066.50	690.00	2071.23	0.	2071.26	4.05	2.14	816.99	342.86
	10.000	690.00	0.	0.	2068.00	1310.00	2072.05	0.	2072.06	7.74	1.23	1806.95	470.72
	10.000	690.00	0.	0.	2068.00	1125.00	2071.88	0.	2071.89	6.93	1.04	1688.77	427.31
	10.000	690.00	0.	0.	2068.00	955.00	2071.72	0.	2071.72	6.11	.85	1576.58	386.49
	10.000	690.00	0.	0.	2068.00	720.00	2071.35	0.	2071.36	5.56	.51	1343.44	305.37
	10.000	690.00	0.	0.	2068.00	1450.00	2072.13	0.	2072.14	8.69	1.37	1863.73	491.78
	10.000	690.00	0.	0.	2068.00	1250.00	2072.00	0.	2072.00	7.50	1.17	1768.39	456.49
	10.000	690.00	0.	0.	2068.00	1075.00	2071.83	0.	2071.83	6.76	.99	1650.64	413.40
	10.000	690.00	0.	0.	2068.00	820.00	2071.56	0.	2071.56	5.49	.69	1473.42	349.83
*	9.000	345.00	0.	0.	2074.90	1310.00	2077.92	2077.92	2078.55	116.48	8.97	493.10	121.38
*	9.000	345.00	0.	0.	2074.90	1125.00	2077.76	2077.76	2078.36	116.51	8.61	428.65	104.22
*	9.000	345.00	0.	0.	2074.90	955.00	2077.59	2077.59	2078.18	115.88	8.22	369.18	88.72
*	9.000	345.00	0.	0.	2074.90	720.00	2077.35	2077.35	2077.87	111.79	7.51	288.35	68.10
*	9.000	345.00	0.	0.	2074.90	1450.00	2078.03	2078.03	2078.67	117.13	9.23	540.40	133.98
*	9.000	345.00	0.	0.	2074.90	1250.00	2077.87	2077.87	2078.49	115.75	8.83	473.70	116.19
*	9.000	345.00	0.	0.	2074.90	1075.00	2077.71	2077.71	2078.31	117.05	8.52	410.11	99.36
*	9.000	345.00	0.	0.	2074.90	820.00	2077.46	2077.46	2078.01	113.21	7.82	323.83	77.07

Table 6 - Summary of water surface profile computations

Sheet 2 of 4

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10K*S	VCH	AREA	.01K
*	8.000	285.00	0.	0.	2079.10	1310.00	2081.62	2081.62	2082.22	144.13	9.10	472.23	109.12
*	8.000	285.00	0.	0.	2079.10	1125.00	2081.48	2081.48	2082.05	140.85	8.65	417.91	94.79
*	8.000	285.00	0.	0.	2079.10	955.00	2081.33	2081.33	2081.87	141.42	8.27	359.45	80.30
*	8.000	285.00	0.	0.	2079.10	720.00	2081.08	2081.08	2081.58	143.58	7.66	275.24	60.09
*	8.000	285.00	0.	0.	2079.10	1450.00	2081.71	2081.71	2082.34	146.50	9.42	511.05	119.80
*	8.000	285.00	0.	0.	2079.10	1250.00	2081.57	2081.57	2082.17	143.09	8.96	455.01	104.50
*	8.000	285.00	0.	0.	2079.10	1075.00	2081.44	2081.44	2082.00	139.91	8.52	402.56	90.88
*	8.000	285.00	0.	0.	2079.10	820.00	2081.19	2081.19	2081.71	143.80	7.96	309.95	68.38
	7.000	170.00	0.	0.	2081.70	1310.00	2084.24	0.	2084.75	124.26	8.42	483.15	117.52
	7.000	170.00	0.	0.	2081.70	1125.00	2084.07	0.	2084.55	125.50	8.06	433.50	100.42
	7.000	170.00	0.	0.	2081.70	955.00	2083.92	0.	2084.36	124.40	7.65	387.57	85.62
	7.000	170.00	0.	0.	2081.70	720.00	2083.68	0.	2084.08	123.78	7.03	316.37	64.72
	7.000	170.00	0.	0.	2081.70	1450.00	2084.36	0.	2084.88	123.68	8.68	518.67	130.38
	7.000	170.00	0.	0.	2081.70	1250.00	2084.19	0.	2084.68	124.58	8.31	467.44	111.99
	7.000	170.00	0.	0.	2081.70	1075.00	2084.02	0.	2084.49	125.84	7.96	419.58	95.83
	7.000	170.00	0.	0.	2081.70	820.00	2083.79	0.	2084.21	122.81	7.28	349.04	73.99
	6.000	186.00	0.	0.	2084.00	1310.00	2086.81	0.	2087.39	159.77	9.76	490.11	103.64
	6.000	186.00	0.	0.	2084.00	1125.00	2086.66	0.	2087.22	161.36	9.40	438.05	88.56
*	6.000	186.00	0.	0.	2084.00	955.00	2086.59	2086.59	2087.06	137.06	8.48	412.70	81.57
*	6.000	186.00	0.	0.	2084.00	720.00	2086.36	2086.36	2086.80	135.80	7.86	335.47	61.78
	6.000	186.00	0.	0.	2084.00	1450.00	2086.92	0.	2087.51	158.49	10.01	527.93	115.18
	6.000	186.00	0.	0.	2084.00	1250.00	2086.76	0.	2087.33	160.31	9.65	473.50	98.72
	6.000	186.00	0.	0.	2084.00	1075.00	2086.62	0.	2087.17	161.94	9.30	423.34	84.48
*	6.000	186.00	0.	0.	2084.00	820.00	2086.44	2086.44	2086.91	145.54	8.34	360.63	67.97
*	5.000	333.00	0.	0.	2088.60	1300.00	2091.94	2091.94	2092.63	92.29	8.47	476.89	135.32
*	5.000	333.00	0.	0.	2088.60	1115.00	2091.79	2091.79	2092.43	88.59	8.02	420.32	118.46
*	5.000	333.00	0.	0.	2088.60	945.00	2091.65	2091.65	2092.23	81.91	7.46	371.71	104.41
*	5.000	333.00	0.	0.	2088.60	710.00	2091.37	2091.37	2091.92	81.04	6.90	278.50	78.87
*	5.000	333.00	0.	0.	2088.60	1440.00	2092.05	2092.05	2092.77	94.68	8.78	518.36	147.99
*	5.000	333.00	0.	0.	2088.60	1240.00	2091.90	2091.90	2092.57	91.06	8.33	459.04	129.94
*	5.000	333.00	0.	0.	2088.60	1065.00	2091.75	2091.75	2092.38	87.92	7.90	403.61	113.58
*	5.000	333.00	0.	0.	2088.60	810.00	2091.49	2091.49	2092.06	83.35	7.21	315.43	88.72

Table 6 - Summary of water surface profile computations

Sheet 3 of 4

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**********************************************
  HEC2 RELEASE DATED NOV 76 UPDATED JULY 1979
  ERROR CORR -  01,02,03
  MODIFICATION -  50,51,52,53
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NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

100 YEAR - CASANDRO WASH

SUMMARY PRINTOUT TABLE 150

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10K*S	VCH	AREA	.01K
*	1.000	0.	0.	0.	2110.30	1300.00	2113.50	2113.50	2114.43	106.71	8.69	295.01	125.85
*	1.000	0.	0.	0.	2110.30	1115.00	2113.27	2113.27	2114.16	107.54	8.31	256.02	107.52
*	1.000	0.	0.	0.	2110.30	945.00	2113.05	2113.05	2113.88	107.95	7.91	219.24	90.95
*	1.000	0.	0.	0.	2110.30	710.00	2112.72	2112.72	2113.44	106.90	7.22	166.56	68.67
*	1.000	0.	0.	0.	2110.30	1440.00	2113.63	2113.63	2114.63	109.48	9.04	319.32	137.63
*	1.000	0.	0.	0.	2110.30	1240.00	2113.43	2113.43	2114.35	106.95	8.57	282.53	119.90
*	1.000	0.	0.	0.	2110.30	1065.00	2113.21	2113.21	2114.08	107.75	8.20	245.26	102.60
*	1.000	0.	0.	0.	2110.30	810.00	2112.88	2112.88	2113.64	105.03	7.48	191.62	79.04
*	2.000	110.00	0.	0.	2106.40	1300.00	2109.64	2109.83	2110.91	134.59	10.22	259.36	112.06
*	2.000	110.00	0.	0.	2106.40	1115.00	2109.43	2109.60	2110.60	133.34	9.68	227.47	96.56
*	2.000	110.00	0.	0.	2106.40	945.00	2109.22	2109.37	2110.29	130.86	9.11	196.53	82.61
*	2.000	110.00	0.	0.	2106.40	710.00	2108.90	2108.97	2109.79	126.10	8.18	152.75	63.23
*	2.000	110.00	0.	0.	2106.40	1440.00	2109.79	2109.99	2111.13	135.87	10.60	281.84	123.54
*	2.000	110.00	0.	0.	2106.40	1240.00	2109.57	2109.75	2110.81	134.50	10.06	249.04	106.92
*	2.000	110.00	0.	0.	2106.40	1065.00	2109.37	2109.53	2110.51	132.71	9.52	218.60	92.45
*	2.000	110.00	0.	0.	2106.40	810.00	2109.05	2109.16	2110.01	127.39	8.58	172.01	71.77
	3.000	390.00	0.	0.	2100.70	1300.00	2102.50	2102.72	2103.54	277.66	9.94	277.26	78.02
	3.000	390.00	0.	0.	2100.70	1115.00	2102.37	2102.57	2103.31	273.90	9.36	249.55	67.37
	3.000	390.00	0.	0.	2100.70	945.00	2102.24	2102.42	2103.08	273.92	8.81	221.29	57.10
	3.000	390.00	0.	0.	2100.70	710.00	2102.04	2102.17	2102.74	274.51	7.95	179.83	42.85
	3.000	390.00	0.	0.	2100.70	1440.00	2102.59	2102.83	2103.71	278.99	10.33	297.70	86.21
	3.000	390.00	0.	0.	2100.70	1240.00	2102.46	2102.67	2103.47	275.59	9.75	268.77	74.69
	3.000	390.00	0.	0.	2100.70	1065.00	2102.34	2102.52	2103.25	273.72	9.21	241.42	64.37
	3.000	390.00	0.	0.	2100.70	810.00	2102.13	2102.26	2102.90	276.59	8.36	197.24	48.70
*	4.000	300.00	0.	0.	2095.40	1300.00	2097.54	2097.54	2098.34	145.42	7.78	265.06	107.80
*	4.000	300.00	0.	0.	2095.40	1115.00	2097.38	2097.38	2098.11	147.26	7.38	236.02	91.88
*	4.000	300.00	0.	0.	2095.40	945.00	2097.22	2097.22	2097.88	149.50	6.98	207.59	77.29
*	4.000	300.00	0.	0.	2095.40	710.00	2096.99	2096.99	2097.54	151.71	6.31	165.57	57.64
*	4.000	300.00	0.	0.	2095.40	1440.00	2097.65	2097.65	2098.50	144.12	8.06	286.11	119.95
*	4.000	300.00	0.	0.	2095.40	1240.00	2097.49	2097.49	2098.26	145.92	7.65	255.66	102.65
*	4.000	300.00	0.	0.	2095.40	1065.00	2097.34	2097.34	2098.04	147.80	7.26	227.88	87.60
*	4.000	300.00	0.	0.	2095.40	810.00	2097.09	2097.09	2097.69	151.98	6.62	183.43	65.70

Table 6 - Summary of water surface profile computations

Sheet 4 of 4

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10K*S	VCH	AREA	.01K
	5.000	379.00	0.	0.	2088.60	1300.00	2092.03	2092.16	2093.20	125.25	10.06	284.56	116.16
	5.000	379.00	0.	0.	2088.60	1115.00	2091.80	2091.94	2092.91	126.79	9.61	249.27	99.02
	5.000	379.00	0.	0.	2088.60	945.00	2091.58	2091.73	2092.62	128.10	9.16	215.15	83.49
	5.000	379.00	0.	0.	2088.60	710.00	2091.21	2091.37	2092.14	132.49	8.45	161.81	61.68
	5.000	379.00	0.	0.	2088.60	1440.00	2092.19	2092.31	2093.41	124.20	10.36	310.13	129.21
	5.000	379.00	0.	0.	2088.60	1240.00	2091.96	2092.08	2093.11	125.78	9.92	273.27	110.56
	5.000	379.00	0.	0.	2088.60	1065.00	2091.74	2091.88	2092.82	127.22	9.49	239.40	94.42
	5.000	379.00	0.	0.	2088.60	810.00	2091.39	2091.54	2092.36	128.99	8.74	186.46	71.32
*	5.000	333.00	0.	0.	2084.00	1310.00	2087.92	2087.92	2089.22	133.20	11.43	266.49	113.51
*	6.000	333.00	0.	0.	2084.00	1125.00	2087.61	2087.61	2088.84	139.66	11.00	232.22	95.20
*	6.000	333.00	0.	0.	2084.00	955.00	2087.31	2087.31	2088.45	145.73	10.53	202.77	79.11
*	6.000	333.00	0.	0.	2084.00	720.00	2086.88	2086.88	2087.86	148.67	9.58	163.43	59.05
*	6.000	333.00	0.	0.	2084.00	1450.00	2088.15	2088.15	2089.49	128.49	11.69	296.13	127.92
*	6.000	333.00	0.	0.	2084.00	1250.00	2087.81	2087.81	2089.10	137.22	11.35	253.36	106.71
*	6.000	333.00	0.	0.	2084.00	1075.00	2087.54	2087.54	2088.73	138.40	10.80	225.25	91.38
*	6.000	333.00	0.	0.	2084.00	820.00	2087.06	2087.06	2088.12	148.15	10.02	180.18	67.37
	7.000	186.00	0.	0.	2081.70	1310.00	2083.66	2084.07	2085.06	436.16	13.08	309.10	62.73
	7.000	186.00	0.	0.	2081.70	1125.00	2083.59	2083.94	2084.77	376.50	11.88	291.32	57.98
	7.000	186.00	0.	0.	2081.70	955.00	2083.55	2083.82	2084.52	317.72	10.67	274.24	53.58
	7.000	186.00	0.	0.	2081.70	720.00	2083.42	2083.61	2084.17	261.43	9.19	236.95	44.53
	7.000	186.00	0.	0.	2081.70	1450.00	2083.70	2084.16	2085.27	478.89	13.92	321.94	66.26
	7.000	186.00	0.	0.	2081.70	1250.00	2083.65	2084.03	2084.96	410.88	12.63	305.19	61.67
	7.000	186.00	0.	0.	2081.70	1075.00	2083.57	2083.90	2084.72	370.69	11.66	263.08	55.83
	7.000	186.00	0.	0.	2081.70	820.00	2083.48	2083.70	2084.32	283.17	9.81	254.66	48.73

* CRITICAL DEPTH AT THIS SECTION.

3. Alternatives for management

Consideration is given below to three alternative approaches to a solution of the flooding problem in Reed's Addition. These are:

1. Detention and controlled release to reduce peak rates of runoff.
2. An artificial waterway with sufficient capacity to handle the peak 100-year discharge in a manner that will not flood adjacent property.
3. A return to the natural state for Casandro Wash.

This section will present descriptions and general information. Estimates of costs and benefits and a comparison of alternatives follow in Section 4.

3.1 Detention and controlled release

The Soil Conservation Service in its 1974 plan for Wickenburg (Ref. 3) considered construction of a 40-ft. earthfill dam on Casandro Wash 1500 feet upstream from Mariposa Drive. No details are given of the installation that was contemplated, only the overall costs and the estimated annual costs and benefits. Through the courtesy of the SCS we have obtained the breakdowns giving the quantities of work involved and were able to re-estimate the cost at current prices as shown in Sec. 4.

The scheme considered by the SCS included clearing the reservoir site, the dam, an emergency spillway, and a principal spillway of concrete pipe just long enough to pass through the dam. The principal spillway terminated in an impact type stilling basin at the toe. No provision was included for carrying released water below the stilling basin outlet.

As an independent approach to the detention alternative an investigation was made of a dam on the line of Mariposa Drive as shown in Fig. 26. A dam on this location would have a secondary function of providing an all weather crossing for what is potentially an arterial street, which could someday be extended into north Wickenburg. Costs for the alternative described in Fig. 26 are also estimated in Sec. 4.

3.2 Artificial waterways

Two alternative schemes for carrying the 100-year runoff in artificial channels were investigated. The channels would begin near Navajo St. since there is no problem of flooding of existing houses above this point. The aim is to provide an hydraulically efficient channel which will carry a discharge of about 1300 cfs with a water surface elevation low enough so that property in the area will not be flooded. A third scheme, utilizing pipe, would begin at Mariposa Drive because of the difficulty of attaining sufficient head at Navajo Street.

3.2.1 Dual purpose waterway

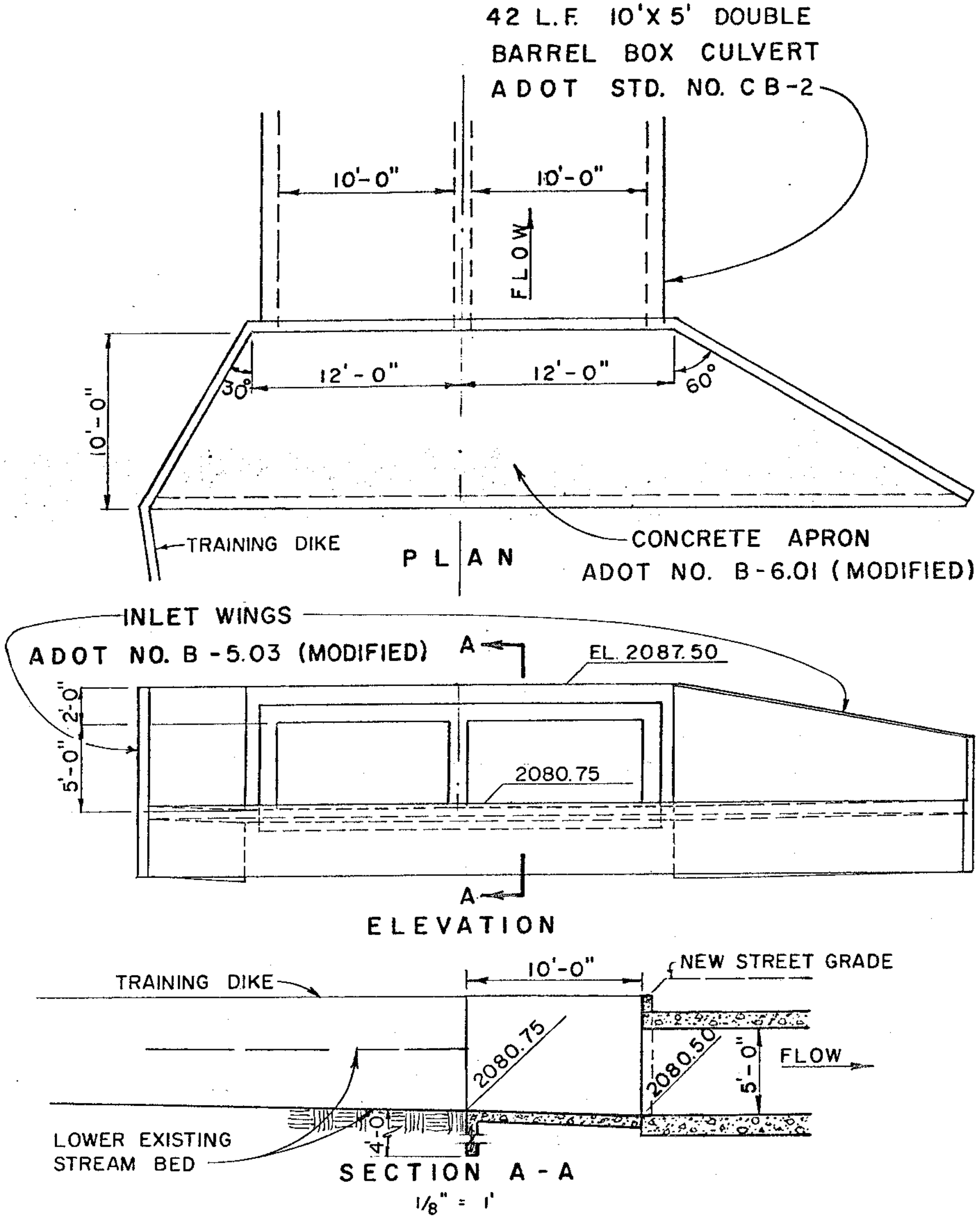
Jackson and Mohave Streets presently provide the route for Casandro Wash discharge through Reed's Addition. This suggests the alternative of providing a street pavement that can also serve as a waterway. The fact that there is ample fall (average ground slope is 1.37 percent) indicates that the hydraulic cross-section could be of reasonable size. Mohave Street is already eroded to the point where it is from 1 to 3 ft. below adjacent property, so the amount of excavation required to construct the improvement would be minimal. Right of way requirements would also be low since the present streets would provide most of what is needed.

The scheme for a street improvement that would also serve as a channel is shown in plan and in typical cross-section in Fig. 16 and in profile in Fig. 17. The plan would include a combined box culvert and inlet structure at Navajo and Jackson Streets. This structure would include a ramp to permit traffic from Navajo St. to enter the Jackson St. portion of the channel. Ramped entrances would also be provided at cross streets as shown in Fig. 19. An additional culvert would be required at the Santa Fe railroad and an earthen exit channel would be built from the railroad to Sols Wash.

There are some disadvantages to this scheme. The street would not be usable for traffic during major runoff periods. There would still be silt deposits to remove after storms. It would be difficult to make the improvement an attractive feature without compromising its hydraulic effectiveness. Extensive water and sewer reconstruction would be involved. In an area subject to flash flooding, it would introduce a degree of hazard, especially since velocities could approach 18 ft. per sec.

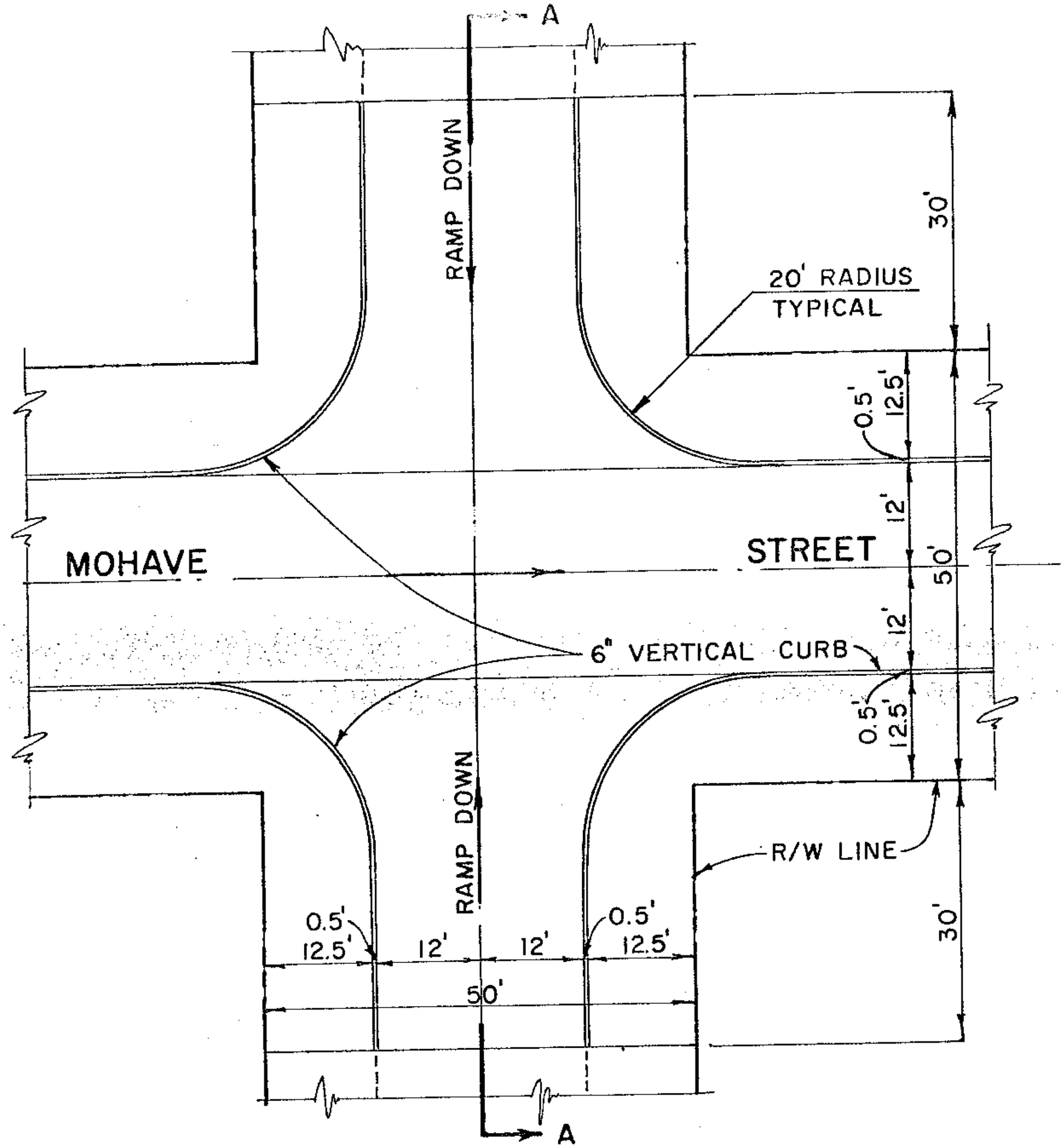
3.2.2 Rectangular lined channel

Fig. 20 illustrates an alternative installation in which the channel would serve solely as a waterway. It would begin as a dual box culvert at Navajo and Jackson Streets curving into an alignment parallel and adjacent to the alley between Navajo and Mohave Streets. Once around the curve the channel would become a rectangular concrete lined section except at street and railroad crossings where box culverts would be used. North of the railroad an earthen channel would make the connection to

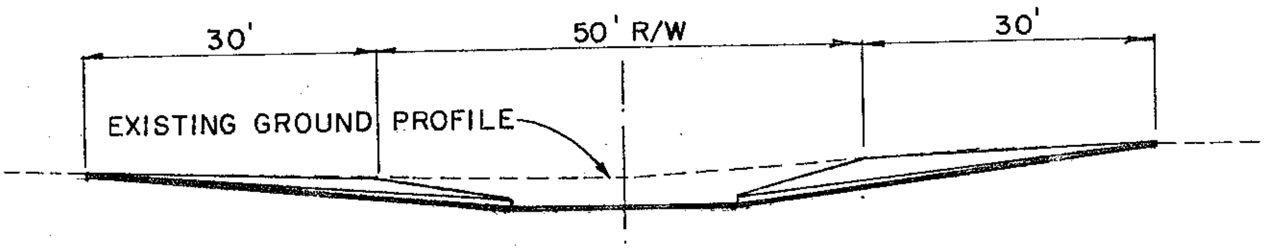


INLET STRUCTURE
NAVAJO ST. AT JACKSON ST.
ALTERNATE PLANS I AND II

FIGURE 18



PLAN



SECTION A-A

1" = 20' HORIZ. & VERT.

TYPICAL INTERSECTION DETAIL
ALTERNATE PLAN I

FIGURE 19

Sols Wash but a concrete lined transition would be required to control erosion at the outlet of the railroad culvert. Open portions of the rectangular channel would be fenced.

The old channel along Mohave Street would still function as a path for local drainage but it would be relieved of the main Casandro Wash discharge. The improvement would include restoring Mohave and a portion of Jackson St. to original grade using material excavated from the new channel. Mohave, Jackson, and Navajo Streets would then be paved as shown in Fig. 20 in order to stabilize the surface, protect existing utilities, and provide a path for local drainage. The existing railroad culvert would continue to function as at present.

This alternative involves much less utility reconstruction than the previous scheme. Silt deposits left after runoff periods would not be a hazard to traffic and the channel is more likely to be self-cleaning. Because it is located along the alley and is more compact, the channel would not be an esthetic detriment and the associated street paving would improve neighborhood appearance. Access to the area during runoff periods by emergency vehicles and general traffic would be unimpaired and, because open portions of the channel would be fenced, there would be little hazard.

The primary disadvantage of this alternative is the need to acquire privately held land for right of way. There is one house and several garage buildings that will have to be demolished or moved. Owners in the strip between the channel and Mohave St. will be cut off from access to the alley. The channel will be less readily accessible for maintenance with motorized equipment than in the scheme outlined in Sec. 3.2.1.

3.2.3 Closed conduit

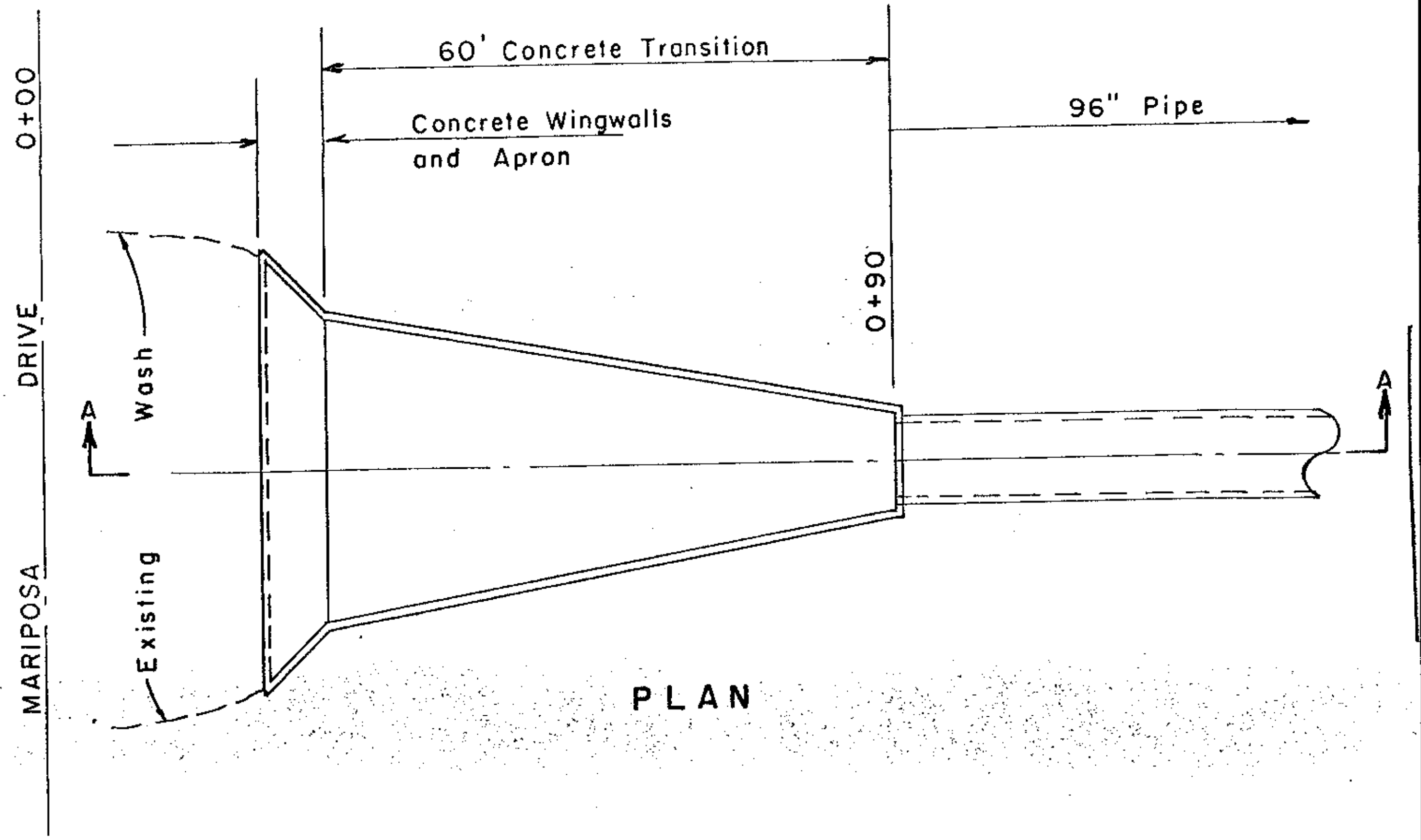
If the 1310 cfs design discharge could be carried in a pipe it would be possible to build through Reed's Addition entirely within existing street and alley right-of-way. Fig. 22 shows the alignment. It is similar to that of Fig. 20, but the use of pipe would permit shorter turns making the encroachment on private property at the corner of Jackson St. and the alley between Navajo and Mohave Streets unnecessary. The portion in the acreage north of Reed's Addition would require right-of-way just as the other alternatives. The project would include the paving of Mohave, Jackson, and Navajo Streets as shown.

The closed conduit alternative would be entirely self-cleaning and would have all the advantages of the rectangular channel discussed previously. It would not interfere with the use of the alley by adjacent residents. The 4-in. water main in the alley would have to be removed and relaid and temporary water service provided during construction. Sewer crossings would be handled as shown in the profile, Fig. 22 and 24.

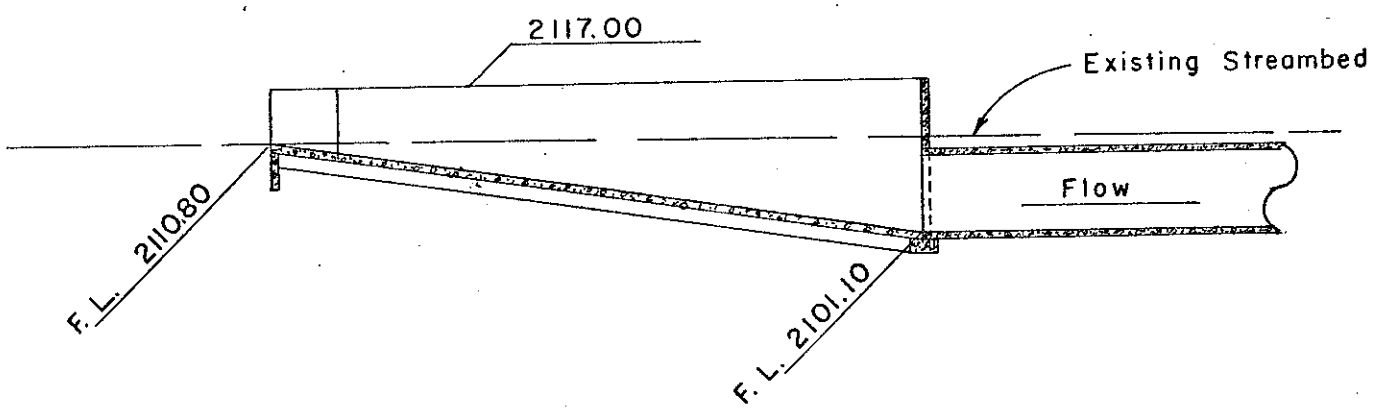
The entry structure at Mariposa Drive would need to be deeper and more massive than for the channel alternative because of the greater depth required for the pipe. Fig. 25 illustrates the concept.

3.3 Return to natural conditions

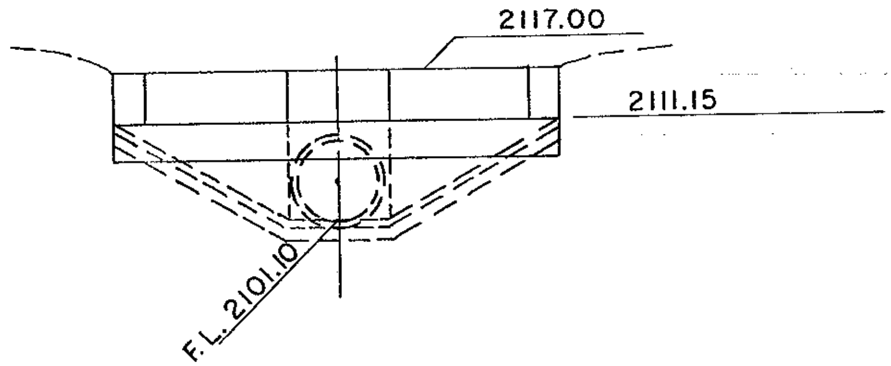
Obviously there would be no flooding problems in Reed's Addition if the original subdivision and development of the area had been done with respect for the potential of large discharges that must have been known to occur even in 1910 when the plat was recorded. The question now is whether it is feasible to turn the clock back 70 years.



PLAN



SECTION A - A



END VIEW

INLET STRUCTURE

ALTERNATE PLAN III

1" = 20'

FIGURE 25

There are two ways to do this. The direct approach is to buy the properties subject to flooding and demolish the structures on them. The land could then be resold or developed for public purposes consistent with uses permitted under the Floodplain Regulation (Ref. 1). The passive approach is the "no-action alternative" under which private property would continue in its present non-conforming uses but would deteriorate in value because of the restrictions on maintenance contained in the Floodplain Regulation. Structures would eventually be removed by owners or demolished as nuisances by the Town. Minimal maintenance would be given to municipal streets and utilities.

Purchase and clearing of the area could be done in a year or two if funds were available. There would be the immediate indirect benefits to the Community of the abatement of a potentially hazardous situation and some increase in the values of adjoining property, depending upon the uses to which the cleared land is put. There would of course, be no direct benefit to property in the flood zone. The second approach would take many years, the hazard would continue, albeit at a gradually diminishing level, and the deteriorating quality of the area would tend to pull down values of near-by property.

Considerations such as this are hard to evaluate in monetary terms. The estimates of Section 4 will give the costs that are quantifiable.

4. Cost estimates and comparison of alternatives

In the following pages we present our estimates of the cost of each of the alternatives discussed above. Although there is a considerable disparity in the various approaches we have tried to be as consistent and even-handed as possible. Unit costs were developed first, assuming that the work were done under construction contracts awarded by competetive bidding under current (Oct 1980) price conditions. The Engineering News Record Construction Cost Index stood at 3343.94 at the time of the estimate. Project costs include 12 percent for engineering and incidentials. There is also an allowance of 10 percent for contingencies. These allowances do not affect comparisons but may tend to understate benefit/cost ratios.

4.1 Unit cost

Unit prices used as applicable for all project alternatives are given in Table 7.

4.2 Project costs

Tables 8 through 11 present estimated construction costs of each of the four alternative structural measures, considering only that work directly chargeable to flood control purposes. In each case additional work is necessary, such as providing for local drainage, paving streets, and doing a certain amount of utility work. Work of this nature provides its own inherent benefit, irrespective of flood control, so the costs are shown separately in Tables 12 and 13. Costs of such supplemental work are not included in computing benefit/cost ratios.

Table 7 - Unit prices for cost estimates

Sheet 1 of 2

Item	Unit	Cost
Reinforced Concrete - R.R. Culvert	C.Y.	$ 400.00
Reinforced Concrete - Inlet Structure	C.Y.	350.00
Reinforced Concrete - 30' Rectangular Channel	L.F.	270.00
Reinforced Concrete - Street Channel Lining	S.F.	4.50
Reinforced Concrete - Spillway apron	C.Y.	280.00
Precase Concrete Box Culverts - Dbl. 10'x5'	L.F.	555.00
Reinforced Concrete - 20' Rectangular Channel	L.F.	245.00
Vertical Concrete Curb	L.F.	4.00
Structural Excavation	C.Y.	4.00
Compacted Embankment	C.Y.	3.00
Concrete Valley Gutter	L.F.	4.00
Vertical Curb and Gutter	L.F.	5.00
Asphaltic Concrete Pavement (2"on6"ABC)	S.Y.	6.00
Subgrade Preparation	S.Y.	2.00
Fabricated steel items	Lb.	1.50
Gunite Lining	S.F.	3.00
Earthwork	C.Y.	3.00
8" ACP	L.F.	18.00
6" VCP	L.F.	20.00
Sanitary Sewer Manholes	Ea.	1,200.00
Relocate 4" Water Line	L.F.	8.00
Raise Existing Sewer Manhole	Ea.	400.00
Lower Existing 8" Water Line	L.F.	10.00
Lower Existing 4" Water Line	L.F.	5.00
Flex beam guard rail & posts	L.F.	15.00
Channel Fencing (6' chain link)	L.F.	8.00
96" Class III pipe	L.F.	210.00
84" Class V pipe - jacked	L.F.	600.00
84" Class III pipe	L.F.	200.00
30" Class III pipe	L.F.	55.00

Table 7 - Unit prices for cost estimates

Sheet 2 of 2

Item	Unit	Cost
18" Ductile Iron Pipe	L.F.	$ 100.00
15" Ductile Iron Pipe	L.F.	90.00
18" V.C.P.	L.F.	80.00
8" A.C. Pipe	L.F.	18.00
8" V.C.P.	L.F.	22.00
15" V.C.P.	L.F.	40.00
8" Sewer Crossing	L.S.	3,000.00
Armor for 18" Ductile Iron Pipe	L.F.	50.00
Armor for 8" Water Line	L.F.	20.00
36" x ½" steel pipe - Jacked Casing	L.F.	450.00

Table 8 - Cost estimate alternate plan I (excluding A.C. Pavement)

Item No.	Description	Quantity & Unit	Unit Cost	Total Cost
1.	Reinforced Concrete - Railroad culvert	140 C.Y.	$400.00	$56,000
2.	Precast Concrete Box Culvert	42 L.F.	555.00	23,300
3.	Concrete Channel Lining	98,000 S.F.	4.50	441,000
4.	Reinforced Concrete - Inlet Structure	60 C.Y.	350.00	21,000
5.	Structural Excavation	8,100 C.Y.	4.00	32,400
6.	Compacted Embankment	450 C.Y.	3.00	1,400
7.	Vertical Concrete Curb	3,100 L.F.	4.00	12,400
8.	Earthwork	3,900 C.Y.	3.00	11,700
9.	8" V.C.P.	1,600 L.F.	22.00	35,200
10.	6" V.C.P.	300 L.F.	20.00	6,000
11.	Sanitary Sewer Manholes	3 Ea.	1,200.00	3,600
12.	Lower Existing 4" Water Line	600 L.F.	5.00	3,000
	Construction Cost			$647,000
	R/W:			18,000
	Subtotal			665,000
	Engineering & Incidentals @ 12%			79,800
	Subtotal			744,800
	Contingency Allowance @ 10%			74,500
	GRAND TOTAL			$819,300

Table 9 - Cost estimate alternate plan II (exlcuding A.C. Pavement)

Item No.	Description	Quantity & Unit	Unit Cost	Total Cost
1.	Reinforced Concrete - Railroad Culvert	240 C.Y.	$400.00	$96,000
2.	Precast Concrete Box Culvert (Double 10'x5')	461 L.F.	555.00	255,900
3.	30' Rectangular Channel	665 L.F.	270.00	179,600
4.	20' Rectangular Channel	422 L.F.	245.00	103,400
5.	Structural Excavation	11,000 C.Y.	4.00	44,000
6.	Compacted Embankment	1,000 C.Y.	3.00	3,000
7.	Reinforced Concrete - Inlet Structure	60 C.Y.	350.00	21,000
8.	Channel Fencing	2,200 L.F.	8.00	17,600
9.	Earthwork	7,300 C.Y.	3.00	21,900
10.	Gunite Channel	15,000 S.F.	3.00	45,000
11.	Lower Existing 4" Water Line	400 L.F.	5.00	2,000
	Construction Cost			$789,400
	R/W:			144,000
	Subtotal			933,400
	Engineering & Incidentals @ 12%			112,000
	Subtotal			1,045,400
	Contingency Allowance @ 10%			104,500
	GRAND TOTAL			1,149,900

Table 10 - Cost estimate alternate plan III (excluding A.C. Pavement)

Item No.	Description	Quantity & Unit	Unit Cost	Total Cost
1.	96" - Class III Pipe	2,500 L.F.	$210.00	$525,000
2.	84" - Class III Pipe	1,300 L.F.	200.00	260,000
3.	84" - Class V Pipe - Jacked	160 L.F.	600.00	96,000
4.	18" V.C.P.	280 L.F.	80.00	22,400
5.	18" Ductile Iron Pipe	180 L.F.	100.00	18,000
6.	15" V.C.P.	230 L.F.	40.00	9,200
7.	15" Ductile Iron Pipe	135 L.F.	90.00	12,200
8.	36" x ½" steel Pipe - Jacked Casing	60 L.F.	450.00	27,000
9.	Armor - 18" Ductile Iron Pipe	180 L.F.	50.00	9,000
10.	Reinforced Concrete - Inlet Structure	90 C.Y.	350.00	31,500
11.	8" Sewer Crossing	1 Job	L.S.	3,000
12.	Sanitary Sewer Manholes	3 Ea.	1,200.00	3,600
13.	Compacted Fill	1,000 C.Y.	3.00	3,000
14.	Earthwork	3,500 C.Y.	3.00	10,500
15.	Gunite Channel	20,000 S.F.	3.00	60,000
16.	Relocate 4" Water Line	700 L.F.	8.00	5,600
17	Armor 8" Water Line	100 L.F.	20.00	2,000
	Construction Cost			1,098,000
	R/W:			30,000
	Subtotal			1,128,000
	Engineering & Incidentals @ 12%			135,400
	Subtotal			1,263,400
	Contingency Allowance @ 10%			126,300
	GRAND TOTAL			$1,389,700

Table 11 - *Cost estimate alternate* Plan IV - Dam at Mariposa St.

Item No.	Description	Quantity & Unit	Unit Cost	Total Cost
1.	Earthwork	44,474 C.Y.	3.00	133,422
2.	Reinforced Concrete Structures	245 C.Y.	350.00	85,750
3.	Reinforced Concrete Apron	468 C.Y.	280.00	131,040
4.	Precast deck slab (15")	4,500 S.F.	20.00	90,000
5.	48" Spillway riser	30 L.F.	100.00	3,000
6.	Trash rack & platform	3,000 Lb.	1.50	4,500
7.	36" x 36" Slide gate	1 Ea.		10,000
8.	30" 1750D DRG Conc. Pipe	3,510 L.F.	55.00	193,050
9.	Jacking casing at railroad	60 L.F.	450.00	27,000
10.	Concrete cradle for 30" pipe	30 C.Y.	50.00	1,500
11.	Replace 8" water line	700 L.F.	18.00	12,600
	Construction Cost			$691,862
	R/W: for dam & flowage			98,176
	R/W: for 30" pipe			1,560
	Subtotal			791,598
	Engineering & Incidentals @ 12%			94,992
	Subtotal			886,590
	Contingency Allowance @ 10%			88,660
	GRAND TOTAL			$975,250

Note to Table 11

It is anticipated that right-of-way costs are limited to purchase of the house and lot at 245 North Mariposa Drive, small portions of vacant land abutting Mariposa Drive needed for the dam, and that part of the reservoir site needed for borrow material. The remainder of the reservoir area would be covered by the acquisition of flowage easements. It should be kept in mind that much of the proposed basin is already within the 100-year floodway as delineated in Ref. 4. The cost of flowage easements for this portion should reflect only the incremental deprivation to the owners resulting from the increased depth and increased frequency of minor flooding resulting from the construction of the dam.

Table 12 - A.C. Pavement for Alternate plan I

Item No.	Description	Quantity & Unit	Unit Cost	Total Cost
1.	Asphaltic Concrete Pvmt. (2" on 6" ABC)	2,800 S.Y.	6.00	16,800
2.	Subgrade Preparation	2,800 S.Y.	2.00	5,600
3.	Compacted Embankment	750 C.Y.	3.00	2,300
	Construction Cost			24,700
	Engineering & Incidentals @ 12%			3,000
	Subtotal			27,700
	Contingency Allowance @ 10%			2,800
	GRAND TOTAL			30,500

Table 13 - Cost estimate A.C. Pavement for Alternate Plans II, III & IV

Item No.		Quantity & Unit	Unit Cost	Total Cost
1.	Asphaltic Concrete (2" on 6" ABC)	8,800 S.Y.	6.00	52,800
2.	Vertical Curb and Gutter	2,150 L.F.	5.00	10,800
3.	Concrete Valley Gutter	312 L.F.	4.00	1,200
4.	Cut-off wall	4 C.Y.	350.00	1,400
5.	Subgrade Preparation	9,300 S.Y.	2.00	18,600
6.	Compacted Embankment	2,000 C.Y.	3.00	6,000
7.	Raise Existing Manholes	3 Ea.	400.00	1,200
	Subtotal			92,000
	Engineering & Incidentals @ 12%			11,000
	Subtotal			103,000
	Contingency Allowance @ 10%			10,300
	GRAND TOTAL			$113,300

Additional paving over dam on Mariposa Dr. (Alt. IV)

1.	Asphaltic Concrete (2"on6"ABC)	2,844 S.Y.	6.00	17,067
2.	Vertical Curb and Gutter	1,600 L.F.	5.00	8,000
3.	Guard Rail	1,500 L.F.	15.00	22,500
	Subtotal			47,567
	Engineering & Incidentals @ 12%			5,708
	Subtotal			53,275
	Contingency allowance @ 10%			5,325
	GRAND TOTAL			$58,600

Operating and maintenance costs for the four alternative structural measures are estimated as shown in Table 14. These costs include only those amounts directly related to flood control. Maintenance of streets, as streets, should not be charged against the flood control function.

Costs of the two non-structural alternatives are shown as negative benefits in Table 15.

4.3 Benefits

Benefits are by nature more difficult to evalutate than costs since some aspects of benefit have a subjective or intangible quality. Benefits are also more widely distributed. There are direct benefits to the property owner relieved of flood hazard. There are general benefits to the community arising from lower maintenance costs for streets and utilities and higher assessed valuations. There are indirect benefits to adjacent property from the improved appearance and general amenity of the area. Even the owner of remote upstream property whose extensive parking area paving has increased the hazard to the Reed's Addition resident benefits, whether he realizes it or not, because the adverse effects of his pavements on the severity of the flooding have been mitigated and his potential liability diminished.

We have not tried to evaluate the more diffuse and intangible benefits. Those that could be quantified are listed for each project in Table 15. Public and private benefits have not been differentiated in adding up the totals. The rational basis for computing benefits is given in the table or the footnotes thereto.

Table 14 - Estimated operating and maintenance costs.

Structural Alternative	Description		Unit Annual Maint. Cost	Total Annual Maint. Cost	Total for Alternate
I	1750'	Street/channel	$0.50	$875	
	630'	Earth channel	1.00	630	
	42'	2-10' x 5' culvert		100	
	53'	10 x 8' culvert		100	$1,705
II	422'	20', rect. channel	0.25	105	
	655'	30' rect. channel	0.25	164	
	165'	40'-60' gunited channel	0.50	82	
	550'	earth channel	1.00	550	
	461'	2 - 10' x 5' culvert	0.25	115	
	60'	3 - 10' x 5' culvert	0.25	15	1,031
III	2462'	96" pipe	0.10	246	
	730'	2 - 84" pipe	0.20	146	
	200'	30' - 60' gunited channel	0.50	100	
	510'	earth channel	1.00	270	762
IV	35'	high x 750' earth dam			
	18	ac. detention basin	20.00	360	
	3390'	30" outlet pipe	0.20	678	1,038

Table 15 - Estimate of direct benefits for various project alternatives

	(1) Flood Damage Reduction	(2) Maint. Cost Reduction	(3) Appreci-ation in Prop. Val.	(4) Property Taxes	(5) Profit on Util. Revenue	(6) Total Equiv. Annual Benefit
STRUCTURAL ALTERNATIVES						
1. Projects affecting area below Avispa Street						
a. Community benefit						
2) Continuing annually		$830.				
3) Increasing annually to maximum				$7,700	$6,336	
b. Private benefit						
1) At time of improvement			$481,045			
2) Continuing annually	$8,300					
Total equivalent annual value	$8,300	$830.	$ 41,938	$3,313	$2,726	$57,107
2. Projects affecting area below Mariposa Street						
a. Community benefit						
1) At time of improvement			$ 69,000			
2) Continuing annually		$830.				
3) Increasing annually to maximum				$17,150	$14,122	
b. Private benefit						
1) At time of improvement			$567,055			
2) Continuing annually	$8,300					
Total equivalent annual value	$8,300	$830.	$ 55,451	$7,380	$6,077	$78,038
NON-STRUCTURAL ALTERNATIVES						
3. Purchase of floodway below Avispa Street						
a. Community benefit						
1) At time of improvement			($1,400,260)			
2) Continuing annually		($1,000)		($7,993)	($14,700)	
b. Private benefit - none						
Total equivalent annual value		($1,000)	($122,075)	($7,993)	($14,700)	($145,768)
4. Attrition (no action)						
a. Community benefit						
2) Continuing annually		($784)				
3) Increasing annually to maximum				($7,993)	($14,700)	
b. Private benefit						
2) Continuing annually			($122,075)			
Total equivalent annual value		($784)	($122,075)	($3,439)	($6,325)	($132,623)

Notes to Table 15

1. Principles of benefit analysis as applied herein:

   a. Benefits are:

      1) Direct

      2) Indirect (not evaluated or included in Table 15)

   b. Benefits accrue:

      1) To the community ("a" headings in Table 15)

      2) To property owners in the flood area ("b" headings)

      3) To different areas, depending on location of project ("1" below Avispa St. i.e. Reed's Addn. and "2" below Mariposa Dr. i.e. Reed's Addn. and Casandro Tract)

   c. Benefits occur:

      1) Once only at the time improvement is completed ("1)" heading in Table 15).

      2) Annually thereafter at a fixed value ("2)" headings).

      3) Annually thereafter in uniformly changing amounts trending to the maximum annual value shown in ("3)" headings).

   d. Benefits include:

      1) Reduction in flood damage (Col. 1).

      2) Reduction in maintenance costs (Col.2).

      3) Appreciation in values for publicly and privately held residential, commercial, and industrial property (Col. 3).

      4) Increase in property tax revenue resulting from project (Col. 4).

      5) A portion of the increase in public utility revenue resulting from the project (Col. 5).

   e. Negative benefits are treated as costs and are shown in parentheses in Table 15.

2. Total equivalent annual values of one-time benefits accruing at the completion of the project are computed by a factor of 0.08718 which is the annual level principal and interest equivalent for the lump sum benefit computed at 6% interest for a 20-year amortization period.

3. Total equivalent annual values for benefits which increase in uniform annual increments to the maximum value shown in Table 15 are computed by use of the factor 0.4303 applied to the maximum annual value, which is the sum of the present worths of each of the annual amounts computed at 6% interest over 20 years.

4. Reduction in flood damage (Col. 1) and reduction in maintenance costs (Col. 2) were computed using a value obtained by the Soil Conservation Service (Ref. 3, p. 20) adjusted as follows:

Annual value given = $4,400.

Say $4,000. of this is for private flood damage.
$ 400. is for repair to streets and utilities.

Adjust to current dollar values

CPI* 4/71 (when estimates were made)	= 120.2
8/80	= 249.4
Percent change	= 207

$4,000 x 207% = $8,300
$ 400 x 207% = $ 830

* Consumer price index

5. Appreciation in property values is computed by summing the differences between the estimated present value and estimated value with the project for 84 parcels lying wholly or substantially inside the 100-year inundation limits of Casandro Wash as shown in Ref. 4. Present value of the typical 50 x 140 ft. lot is assumed to be $2,000. Present value of improvements is assumed to be 3 times the Maricopa County Assessor's "full cash value" (See App. IV). Value with the project is computed by increasing land values to $8,000. for the typical lot and raising improvement value by 5%. Some arbitrary adjustments have been made for the sake of reasonableness.

6. Negative benefits are shown in parentheses. These represent the cost of the non-structural alternatives.

We do not consider that any direct benefit will result if either of the two non-structural alternatives are selected. There would of course, be a benefit in that the flood control problem will have been "solved" and no further damage will result, however, this benefit applies so generally that it falls into the indirect category which we have not tried to evaluate in any case.

4.4 Comparison of alternatives

Table 16 lists the alternatives considered and compares them on the basis of benefit/cost ratios considering only direct benefits that are quantifiable in monetary terms. Alternative IV, the dam on Mariposa Drive, has the most favorable ratio.

Indirect benefits have been discussed previously for each of the alternatives. Since they apply primarily to the community as a whole, they are not affected very much by the alternative selected, except that Alternative IV provides an incidental benefit in the all-weather crossing of Casandro Wash on Mariposa Drive.

Some explanation is in order to account for the fact that we have shown a favorable benefit/cost ratio for some alternatives whereas the Soil Conservation Service could not do so in 1972 (Ref. 3). The difference lies primarily in the credit given to the factor of appreciation. This is not credited under SCS methodology, presumably because it is a nebulous sort of concept and because leaving it out leans toward fiscal conservatism. Another factor is the credit given to the increased tax and public utility revenue that becomes possible if the area is freed for development. We have shown as a benefit, 50 percent of the typical per house water, sewer, and electrical billings (publicly owned utilities in

Table 16 - Benefit/cost ratio comparison of alternatives

Alt. No.	Description	See Fig. No.	Installed Cost	Annual Equiv. @ 6% 50-Yrs	Est. O&M Cost (Table 14)	Total Annual Cost	Annual Benefit (Table 15)	Benefit/ Cost Ratio
I	Paved Street/channel	16	$ 819,300	$51,976	$1,705	$53,681	$57,107	1.06
II	Rectangular channel	20	1,149,900	72,950	1,031	73,981	57,107	0.77
III	Pipe drain!	22	1,389,700	88,163	762	88,925	78,038	0.88
IV	Dam and outlet	26	975,250	61,870	1,038	62,909	78,038	1.24
V	Purchase floodway					145,768	0 *	0
VI	Attrition (no action)					132,623	0 *	0

* Benefits are indirect

Wickenburg) increasing from zero in straight line fashion over 20 years as the presently vacant lots are built upon. No credit was taken for gas or telephone service expansion. Conversely, we have taken the loss of existing tax and utility revenue as a negative benefit, or cost, of alternatives V and VI. We do not believe that these were included in the SCS analysis.

We consider that including appreciation in the analysis is appropriate, provided the values used are reasonable. Appreciation, as indicated by increased productivity of the land, is really the principal reason for the feasibility of the great national water projects that brought agriculture to much of the west. We believe that the values we have used are reasonable. A town lot with residential zoning that can't be built on because of flooding is really worth very little. We have used $2,000 because two such lots were recently sold for that price to an adjacent landowner (whose house is on high ground). Lots in the same area, of the same size, but above the flood level have sold for over $8,000. We have assumed that removing the threat of flooding will increase the value of vacant lots in the area by the ratio indicated. Similar reasoning leads us to conclude that, apart from the land, a house on high ground is worth 5% more than the same house in the flood zone.

5. Recommendation

From the engineering and economic studies summarized herein, we recommend the adoption of Alternate IV, the Mariposa Drive dam and detention basin, with appropriate spillways, as the best solution to flooding problems in Casandro Tract and Reed's and Collins Additions. The appurtenant street paving, local drainage, and utility work should be undertaken concurrently but the costs of such work should not be assessed against the flood control function.

EXISTING DEVELOPMENT

EXPECTED FLOWS 10 Year Rainfall intensity and duration unless noted

LOCATION	AREA IN ACRES: Total Area A	AREA IN ACRES: Pervious Area A_p	AREA IN ACRES: Imperv's Area A_i	Infiltr'n (final) in/hr f_c	Concentration Time: Street Slope	Concentration Time: Min. t_c	RAIN: Point Intensity I	RAIN: Average Intensity Ia	RUNOFF Pervious: $(Ia-f_c).8$ = Inches	RUNOFF Pervious: $InxA_p$ = CFS	RUNOFF Impervious: $(Ia-0.2).9$ = Inches	RUNOFF Impervious: $InxA_i$ = CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
Area #1	283	279	4	0.9		28	2.90	2.87	1.58	440	2.40	10	450	450
Area #2	62	53	9	1.0		19	3.60	3.60	2.08	110	3.06	28	138	
Sum	345	332	13	0.92		32	2.68	2.65	1.38	459	2.21	29	488	490
Area #3	55	47	8	1.0		16	3.90	3.90	2.32	109	3.33	27	136	
Sum	400	379	21	0.93		39	2.35	2.33	1.12	424	1.92	40	464	495
Area #4	276	255	21	0.8		45	2.13	2.11	1.05	267	1.72	36	303	
Sum	676	634	42	0.88		45	2.13	2.10	0.98	619	1.71	72	691	690
Area #5	33	32	1	1.0		13	4.35	4.35	2.68	86	3.74	4	90	
Sum	709	666	43	0.88		46	2.10	2.07	0.95	634	1.68	72	706	705
Area #6	82	79	3	1.0		16	3.90	3.90	2.32	183	3.33	10	193	
Area #7	47	46	1	1.0		25	3.10	3.10	1.68	77	2.61	3	80	
Sum	838	791	47	0.90		60	1.72	1.69	0.63	500	1.34	63	563	710
Area #8	60	44	16	1.0		18	3.70	3.70	2.16	95	3.15	50	145	
Sum	898	835	63	0.91		64	1.63	1.61	0.56	468	1.27	80	548	715
Area #9	86	80	6	1.0		15	4.05	4.05	2.44	195	3.47	21	216	
Sum	984	915	69	0.91		68	1.55	1.53	0.50	454	1.20	83	537	720

EXISTING DEVELOPMENT

EXPECTED FLOWS 25 Year Rainfall intensity and duration unless noted

LOCATION	AREA IN ACRES: Total Area A	AREA IN ACRES: Pervious Area A_p	AREA IN ACRES: Imperv's Area A_i	Infiltr'n (final) in/hr f_c	Concentration Time: Street Slope	Concentration Time: Min. t_c	RAIN: Point Intensity I	RAIN: Average Intensity Ia	RUNOFF: Pervious: $(Ia-f_c).8$ = Inches	RUNOFF: Pervious: $InxA_p$ = CFS	RUNOFF: Impervious: $(Ia-0.2).9$ = Inches	RUNOFF: Impervious: $InxA_i$ = CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
Area #1	283	279	4	0.9		28	3.5	3.47	2.06	574	2.94	12	586	585
Area #2	62	53	9	1.0		19	4.3	4.3	2.64	140	3.69	33	173	
Sum	345	332	13	0.92		32	3.23	3.20	1.82	606	2.70	35	641	640
Area #3	55	47	8	1.0		16	4.7	4.7	2.96	139	4.05	32	171	
Sum	400	379	21	0.93		39	2.85	2.82	1.51	573	2.36	50	623	645
Area #4	276	255	21	0.8		45	2.55	2.52	1.38	351	2.09	44	395	
Sum	676	634	42	0.88		45	2.55	2.51	1.30	827	2.08	87	914	915
Area #5	33	32	1	1.0		13	5.2	5.2	3.36	108	4.50	5	123	
Sum	709	666	43	0.88		46	2.52	2.48	1.28	852	2.05	88	940	940
Area #6	82	79	3	1.0		16	4.7	4.7	2.96	234	4.05	12	246	
Area #7	47	46	1	1.0		25	3.7	3.7	2.16	99	3.15	3	102	
Sum	838	791	47	0.90		60	2.08	2.05	0.92	728	1.67	78	806	945
Area #8	60	44	16	1.0		18	4.45	4.45	2.76	121	3.83	61	182	
Sum	898	835	63	0.91		64	1.97	1.94	0.82	688	1.57	99	787	950
Area #9	86	80	6	1.0		15	4.85	4.85	3.08	246	4.19	25	271	
Sum	984	915	69	0.91		68	1.87	1.84	0.74	681	1.48	102	783	955

EXISTING DEVELOPMENT

EXPECTED FLOWS 50 Year Rainfall intensity and duration unless noted

LOCATION	AREA IN ACRES			Infiltr'n (final) in/hr f_c	Concentration Time		RAIN		RUNOFF					DESIGN FLOW AND REMARKS
	Total Area A	Pervious Area A_p	Imperv's Area A_i		Street Slope	Min. t_c	Point Intensity I	Average Intensity Ia	Pervious $(Ia-f_c).8$ = Inches	Pervious $InxA_p$ = CFS	Impervious $(Ia-0.2).9$ = Inches	Impervious $InxA_i$ = CFS	Total Flow CFS	
Area #1	283	279	4	0.9		28	3.90	3.86	2.37	661	3.29	13	674	675
Area #2	62	53	9	1.0		19	4.85	4.85	3.08	163	4.19	38	201	
Sum	345	332	13	0.92		32	3.6	3.56	2.11	701	3.02	39	740	740
Area #3	55	47	8	1.0		16	5.3	5.3	3.44	162	4.59	37	199	
Sum	400	379	21	0.93		39	3.18	3.15	1.78	673	2.66	56	729	745
Area #4	276	255	21	0.8		45	2.85	2.82	1.62	412	2.36	50	462	
Sum	676	634	42	0.88		45	2.85	2.81	1.54	979	2.35	99	1078	1080
Area #5	33	32	1	1.0		13	5.8	5.8	3.84	123	5.04	5	128	
Sum	709	666	43	0.88		46	2.82	2.78	1.52	1012	2.32	100	1112	1110
Area #6	82	79	3	1.0		16	5.3	5.3	3.44	272	4.59	14	286	
Area #7	47	46	1	1.0		25	4.15	4.15	2.52	116	3.56	4	120	
Sum	838	791	47	0.90		60	2.30	2.27	1.10	867	1.86	88	955	1115
Area #8	60	44	16	1.0		18	5.0	5.0	3.20	141	4.32	69	210	
Sum	898	835	63	0.91		64	2.20	2.17	1.01	842	1.77	112	954	1120
Area #9	86	80	6	1.0		15	5.5	5.5	3.60	288	4.77	29	317	
Sum	984	915	69	0.91		68	2.10	2.07	0.93	849	1.68	116	965	1125

EXISTING DEVELOPMENT

EXPECTED FLOWS 100Year Rainfall intensity and duration unless noted

LOCATION	AREA IN ACRES: Total Area A	Pervious Area A_p	Imperv's Area A_i	Infiltr'n (final) in/hr f_c	Concentration Time: Street Slope	Min. t_c	RAIN: Point Intensity I	Average Intensity Ia	RUNOFF: Pervious: $(Ia-f_c).8$ = Inches	$InxA_p$ = CFS	Impervious: $(Ia-0.2).9$ = Inches	$InxA_i$ = CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
Area #1	283	279	4	0.9		28	4.35	4.31	2.73	761	3.70	15	776	775
Area #2	62	53	9	1.0		19	5.4	5.4	3.52	187	4.68	42	229	
Sum	345	332	13	0.92		32	4.00	3.96	2.43	807	3.38	44	851	850
Area #3	55	47	8	1.0		16	5.9	5.9	3.92	184	5.13	41	225	
Sum	400	379	21	0.93		39	3.53	3.49	2.05	776	2.96	62	838	855
Area #4	276	255	21	0.8		45	3.20	3.17	1.90	483	2.67	56	539	
Sum	676	634	42	0.88		45	3.20	3.15	1.82	1151	2.66	112	1263	1265
Area #5	33	32	1	1.0		13	6.5	6.5	4.40	141	5.67	6	147	
Sum	709	666	43	0.88		46	3.15	3.10	1.78	1183	2.61	112	1295	1295
Area #6	82	79	3	1.0		16	5.9	5.9	3.92	310	5.13	15	325	
Area #7	47	46	1	1.0		25	4.65	4.65	2.92	134	4.01	4	138	
Sum	838	791	47	0.90		60	2.58	2.54	1.31	1038	2.11	99	1137	1300
Area #8	60	44	16	1.0		18	5.55	5.55	3.64	160	4.82	77	237	
Sum	898	835	63	0.91		64	2.45	2.41	1.20	1002	1.99	125	1127	1305
Area #9	86	80	6	1.0		15	6.1	6.1	4.08	326	5.31	32	358	
Sum	984	915	69	0.91		68	2.35	2.31	1.12	1025	1.90	131	1156	1310

PROJECTED LAND USE

1. Zoned Areas Developed
2. Floodway considered as Pervious Area (Presently Undeveloped).
3. Tributary Area t_c decreased to reflect future street flow.

EXPECTED FLOWS 10 Year Rainfall intensity and duration unless noted

LOCATION	AREA IN ACRES			Infiltr'n (final) in/hr f_c	Concentration Time		RAIN		RUNOFF					DESIGN FLOW AND REMARKS
	Total Area A	Pervious Area A_p	Imperv's Area A_i		Street Slope	Min. t_c	Point Intensity I	Average Intensity Ia	Pervious $(Ia-f_c).8$ = Inches	Pervious $InxA_p$ = CFS	Impervious $(Ia-0.2).9$ = Inches	Impervious $InxA_i$ = CFS	Total Flow CFS	
Area #1	283	248	35	0.9		26	3.05	3.02	1.70	421	2.54	89	510	510
Area #2	62	41	21	1.0		17	3.80	3.80	2.24	92	3.24	68	160	
Sum	345	289	56	0.91		30	2.80	2.77	1.49	430	2.31	130	560	560
Area #3	55	27	28	1.0		15	4.05	4.05	2.44	66	3.47	97	163	
Sum	400	316	84	0.92		37	2.45	2.43	1.21	382	2.01	169	551	565
Area #4	276	225	51	0.8		40	2.30	2.28	1.18	266	1.87	95	361	
Sum	676	541	135	0.87		43	2.20	2.17	1.04	563	1.77	239	802	800
Area #5	33	29	4	1.0		12	4.50	4.50	2.80	81	3.87	15	96	
Sum	709	570	139	0.88		44	2.15	2.12	0.99	565	1.73	240	805	805
Area #6	82	59	23	1.0		15	4.05	4.05	2.44	144	3.47	80	224	
Area #7	47	42	5	1.0		23	3.25	3.25	1.80	76	2.75	14	90	
Sum	838	671	167	0.90		58	1.77	1.74	0.67	451	1.39	231	682	810
Area #8	60	39	21	1.0		17	3.80	3.80	2.24	87	3.24	68	155	
Sum	898	710	188	0.90		62	1.68	1.65	0.60	426	1.31	245	671	815
Area #9	86	56	30	1.0		14	4.20	4.20	2.56	143	3.60	108	251	
Sum	984	766	218	0.91		66	1.60	1.58	0.54	411	1.24	271	682	820

PROJECTED LAND USE

1. Zoned Areas Developed
2. Floodway considered as Pervious Area (Presently Undeveloped).
3. Tributary Area t_c decreased to reflect future street flow.

EXPECTED FLOWS 25 Year Rainfall intensity and duration unless noted

LOCATION	AREA IN ACRES: Total Area A	AREA IN ACRES: Pervious Area A_p	AREA IN ACRES: Imperv's Area A_i	Infiltr'n (final) in/hr f_c	Concentration Time: Street Slope	Concentration Time: Min. t_c	RAIN: Point Intensity I	RAIN: Average Intensity Ia	RUNOFF: Pervious: $(Ia-f_c).8$ = Inches	RUNOFF: Pervious: $InxA_p$ = CFS	RUNOFF: Impervious: $(Ia-0.2).9$ = Inches	RUNOFF: Impervious: $InxA_i$ = CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
Area #1	283	248	35	0.9		26	3.65	3.61	2.17	538	3.07	107	645	645
Area #2	62	41	21	1.0		17	4.55	4.55	2.84	116	3.92	82	198	
Sum	345	289	56	0.91		30	3.35	3.32	1.93	557	2.81	157	714	715
Area #3	55	27	28	1.0		15	4.85	4.85	3.08	83	4.19	117	200	
Sum	400	316	84	0.92		37	2.95	2.92	1.60	506	2.45	206	712	720
Area #4	276	225	51	0.8		40	2.80	2.77	1.58	355	2.31	118	473	
Sum	676	541	135	0.87		43	2.65	2.61	1.39	753	2.17	293	1046	1045
Area #5	33	29	4	1.0		12	5.40	5.40	3.52	102	4.68	19	121	
Sum	709	570	139	0.88		44	2.60	2.56	1.34	766	2.12	295	1061	1060
Area #6	82	59	23	1.0		15	4.85	4.85	3.08	182	4.19	96	278	
Area #7	47	42	5	1.0		23	3.90	3.90	2.32	97	3.33	17	114	
Sum	838	671	167	0.90		58	2.12	2.09	0.95	639	1.70	284	923	1065
Area #8	60	39	21	1.0		17	4.55	4.55	2.84	111	3.92	82	193	
Sum	898	710	188	0.90		62	2.00	1.97	0.86	608	1.59	299	907	1070
Area #9	86	56	30	1.0		14	5.00	5.00	3.20	179	4.32	130	309	
Sum	984	766	218	0.91		66	1.92	1.89	0.78	601	1.52	332	933	1075

PROJECTED LAND USE

1. Zoned Areas Developed
2. Floodway considered as Pervious Area (Presently Undeveloped).
3. Tributary Area t_c decreased to reflect future street flow.

EXPECTED FLOWS 50 Year Rainfall intensity and duration unless noted

LOCATION	AREA IN ACRES			Infiltr'n (final) in/hr	Concentration Time		RAIN		RUNOFF					DESIGN FLOW AND REMARKS
	Total Area	Pervious Area	Imperv's Area		Street Slope	Min.	Point Intensity	Average Intensity	Pervious		Impervious		Total Flow	
	A	A_p	A_i	f_c		t_c	I	Ia	$(Ia-f_c).8$ = Inches	$InxA_p$ = CFS	$(Ia-0.2).9$ = Inches	$InxA_i$ = CFS	CFS	
Area #1	283	248	35	0.9		26	4.10	4.06	2.53	627	3.47	122	749	750
Area #2	62	41	21	1.0		17	5.15	5.15	3.32	136	4.46	94	230	
Sum	345	289	56	0.91		30	3.75	3.71	2.24	647	3.16	177	824	825
Area #3	55	27	28	1.0		15	5.50	5.50	3.60	97	4.77	134	231	
Sum	400	316	84	0.92		37	3.30	3.27	1.88	594	2.76	232	826	830
Area #4	276	225	51	0.8		40	3.10	3.07	1.82	409	2.58	132	541	
Sum	676	541	135	0.87		43	2.95	2.91	1.63	883	2.44	329	1212	1210
Area #5	33	29	4	1.0		12	6.10	6.10	4.08	118	5.31	21	139	
Sum	709	570	139	0.88		44	2.90	2.86	1.58	903	2.39	333	1236	1235
Area #6	82	59	23	1.0		15	5.50	5.50	3.60	212	4.77	110	322	
Area #7	47	42	5	1.0		23	4.40	4.40	2.72	114	3.78	19	133	
Sum	838	671	167	0.90		58	2.40	2.36	1.17	784	1.94	325	1109	1240
Area #8	60	39	21	1.0		17	5.15	5.15	3.32	129	4.46	94	223	
Sum	898	710	188	0.90		62	2.25	2.22	1.06	750	1.82	342	1092	1245
Area #9	86	56	30	1.0		14	5.65	5.65	3.72	208	4.91	147	355	
Sum	984	766	218	0.91		66	2.15	2.12	0.97	742	1.73	377	1119	1250

EXPECTED FLOWS 100 Year Rainfall intensity and duration unless noted

PROJECTED LAND USE

1. Zoned Areas Developed
2. Floodway considered as Pervious Area (Presently Undeveloped).
3. Tributary Area t_c decreased to reflect future street flow.

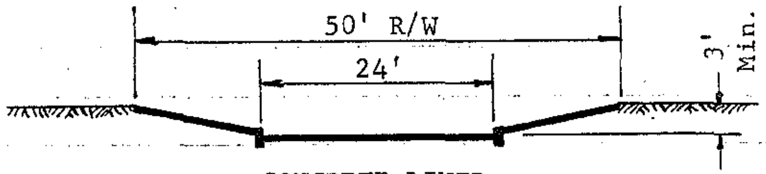
LOCATION	AREA IN ACRES: Total Area A	Pervious Area A_p	Imperv's Area A_i	Infiltr'n (final) in/hr f_c	Concentration Time: Street Slope	Min. t_c	RAIN: Point Intensity I	Average Intensity Ia	RUNOFF: Pervious: $(I_a-f_c).8$ = Inches	I_nxA_p = CFS	Impervious: $(I_a-0.2).9$ = Inches	I_nxA_i = CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
Area #1	283	248	35	0.9		26	4.55	4.50	2.88	714	3.87	135	849	850
Area #2	62	41	21	1.0		17	5.70	5.70	3.76	154	4.95	104	258	
Sum	345	289	56	0.91		30	4.15	4.11	2.56	740	3.52	197	937	935
Area #3	55	27	28	1.0		15	6.10	6.10	4.08	110	5.31	149	259	
Sum	400	316	84	0.92		37	3.65	3.61	2.15	680	3.07	258	938	940
Area #4	276	225	51	0.8		40	3.45	3.42	2.10	472	2.90	148	620	
Sum	676	541	135	0.87		43	3.30	3.25	1.90	1030	2.75	371	1401	1400
Area #5	33	29	4	1.0		12	6.70	6.70	4.56	132	5.85	23	155	
Sum	709	570	139	0.88		44	3.25	3.20	1.86	1058	2.70	375	1433	1435
Area #6	82	59	23	1.0		15	6.10	6.10	4.08	241	5.31	122	363	
Area #7	47	42	5	1.0		23	4.90	4.90	3.12	131	4.23	21	152	
Sum	838	671	167	0.90		58	2.65	2.61	1.37	918	2.17	362	1280	1440
Area #8	60	39	21	1.0		17	5.70	5.70	3.76	147	4.95	104	251	
Sum	898	710	188	0.90		62	2.52	2.48	1.26	897	2.05	386	1283	1445
Area #9	86	56	30	1.0		14	6.30	6.30	4.24	237	5.49	165	402	
Sum	984	766	218	0.91		66	2.40	2.36	1.16	889	1.94	424	1313	1450

AREA DESCRIPTION Casandro Wash - Wickenburg

Concrete Lined Channel in Jackson and Mohave Streets

Alternate Plan I

n = 0.011 Big Concrete Culverts
n = 0.012 Pipe Culverts 21" & Larger
n = 0.014 Concrete Lined Channels
n = 0.015 Street Paving
n = 0.020 Earth - Best
n = 0.0225 Corr. Culverts
n = 0.030 Earth - Brushy - Poor
n = 0.050 Rocky Streams

STA. OR LOCATION	WATERWAY DESCRIPTION	Rough-ness n	Slope Ft. Per 1000	Area Sq.Ft. A	p = Wet Per r = A/P	Vel. Ft./Sec V	Quant. c.f.s. Q
	 CONCRETE LINED STREET SECTION						
16+51 to 16+93	Triple Barrel 10'x5' Box Culvert, w.d. = 3.9 ft.	.014	25.0			21.8	457 x 3 = 1371
16+93 to 17+53	Water depth = 2.6'	.014	17.5			20.7	1379
17+53 to 20+28	Water depth = 2.4'	.014	10.0			15.8	1307
20+28 to 23+13	Water depth = 2.3'	.014	13.9			18.5	1383
23+13 to 26+58	Water depth = 2.4'	.014	10.5			16.1	1369
26+58 to 33+11	Water depth = 2.4'	.014	10.5			15.9	1394

Yost and Gardner Engineers

AREA DESCRIPTION Casandro Wash - Wickenburg

Concrete Lined Channel in Jackson and Mohave Streets

Alternate Plan I (Cont.)

n = 0.011 Big Concrete Culverts
n = 0.012 Pipe Culverts 21" & Larger
n = 0.014 Concrete Lined Channels
n = 0.015 Street Paving
n = 0.020 Earth - Best
n = 0.0225 Corr. Culverts
n = 0.030 Earth - Brushy - Poor
n = 0.050 Rocky Streams

STA. OR LOCATION	WATERWAY DESCRIPTION	Rough-ness n	Slope Ft.Per 1000	Area Sq.Ft. A	p =Wet Per $r = \frac{A}{p}$	Vel. Ft./Sec V	Quant. c.f.s. Q
33+11 to 33+71	Trans.-Channel to Culvert, w.d. varies	.014	10.5			Varies	--
33+71 to 34+24	New 10' x 8' Box Culvert, w.d. = 3.3'	.014	14.2			20.0	660
33+71 to 34+24	Existing 10' x 8' Box Culvert, w.d. = 3.3'	.014	14.2			20.0	660
34+24 to 34+84	Trans. - Culvert to Channel, w.d. varies	.020	13.2			Varies	--
34+84 to 40 +93	Earth Channel to Sol's Wash, w.d. = 1.8'	.020	13.2			11.8	1422

Yost and Gardner Engineers

AREA DESCRIPTION Casandro Wash - Wickenburg

Lined Channel between Navajo and Mohave Streets

from Jackson St. to Sols Wash.- Alternate Plan II

n = 0.011 Big Concrete Culverts
n = 0.012 Pipe Culverts 21" & Larger
n = 0.014 Concrete Lined Channels
n = 0.015 Street Paving
n = 0.020 Earth - Best
n = 0.0225 Corr. Culverts
n = 0.030 Earth - Brushy - Poor
n = 0.050 Rocky Streams

STA. OR LOCATION	WATERWAY DESCRIPTION	Roughness n	Slope Ft.Per 1000	Area Sq.Ft. A	p =Wet Per r = A/P	Vel. Ft./Sec V	Quant. c.f.s. Q
-(0+83) to 2+78	Double Barrel 10' x 5' Box Culvert, w.d. = 3.2'	.014	16.4			21.2	679x2+1358
2+78 to 4+00	Rect. Conc. Lined Channel, w=20', w.d. = 2.9'	.014	16.4			23.3	1353
4+00 to 4+50	Double Barrel 10' x 5' Box Culvert, w.d. = 3.2'	.014	16.4			21.2	679x2+1358
4+50 to 7+50	Rect. Conc. Lined Channel, w=20', w.d. = 2.9'	.014	16.4			23.3	1353
7+50 to 8+00	Double Barrel 10'x5' Box Culvert, w.d. = 3.2'	.014	16.4			21.2	679x2+1358
8+00 to 14+65	Rect. Conc. Lined Channel, w = 30', w.d. = 2.7'	.014	7.8			16.3	1318
14+65 to 15+25	Triple Barrel 10'x5' Box Culvert, w.d. = 2.4'	.014	16.7			18.9	454x3=1362
15+25 to 16+90	Gunite transition - Culvert to Earth Channel w.d. Varies	.017	12.7			Varies	--
16+90 to 22+40	Earth Channel, w = 60', s.s. = 4:1, w.d. = 1.8'	.020	12.7			11.5	1395

Yost and Gardner Engineers

Ratio of Assessed Value to Market Value

House Location	Current Market Value	How Determined	Assessed Land & Bldgs.	Ratio
#428 Adams Lots 1 & 2 Blk. 5 505-31-059	$30,000 (26,000)	Sale	$8759 Bldgs. 16000 Land	34%
#406 Madison Lot 7, Blk. 5	33,700 (31,700)	Sale	8283 Bldg. 8000 Land	26%
#381 Jackson Lot 3, Blk. 5 505-31-173	21,000 (19,000)	Owner	10242 Imp. 8000 Land	54%
#336 Jackson 505-31-139	45,000 (37,000)	Realtor	10315 Imp. 8000 Land	28%
Lot 9, Blk. 13 505-31-167	28,000 (20,000)	Sale	1183 Bldg. 8000 Land	6%
Lot 18 & N 17" Block 11 505-31-141A (Pt. 17) 505-31-142 (18)	49,000 (37,000)	Owner asking	17576 Imp. 12000 Land	48%
				Ave. 32.67%

Procedure

Estimate land @ $2,000/lot in floodway
8,000/lot out of floodway

Improvements 3 x assessed value in floodway
3 x + 5% out of floodway

Adjust on sq. ft. basis for reasonableness

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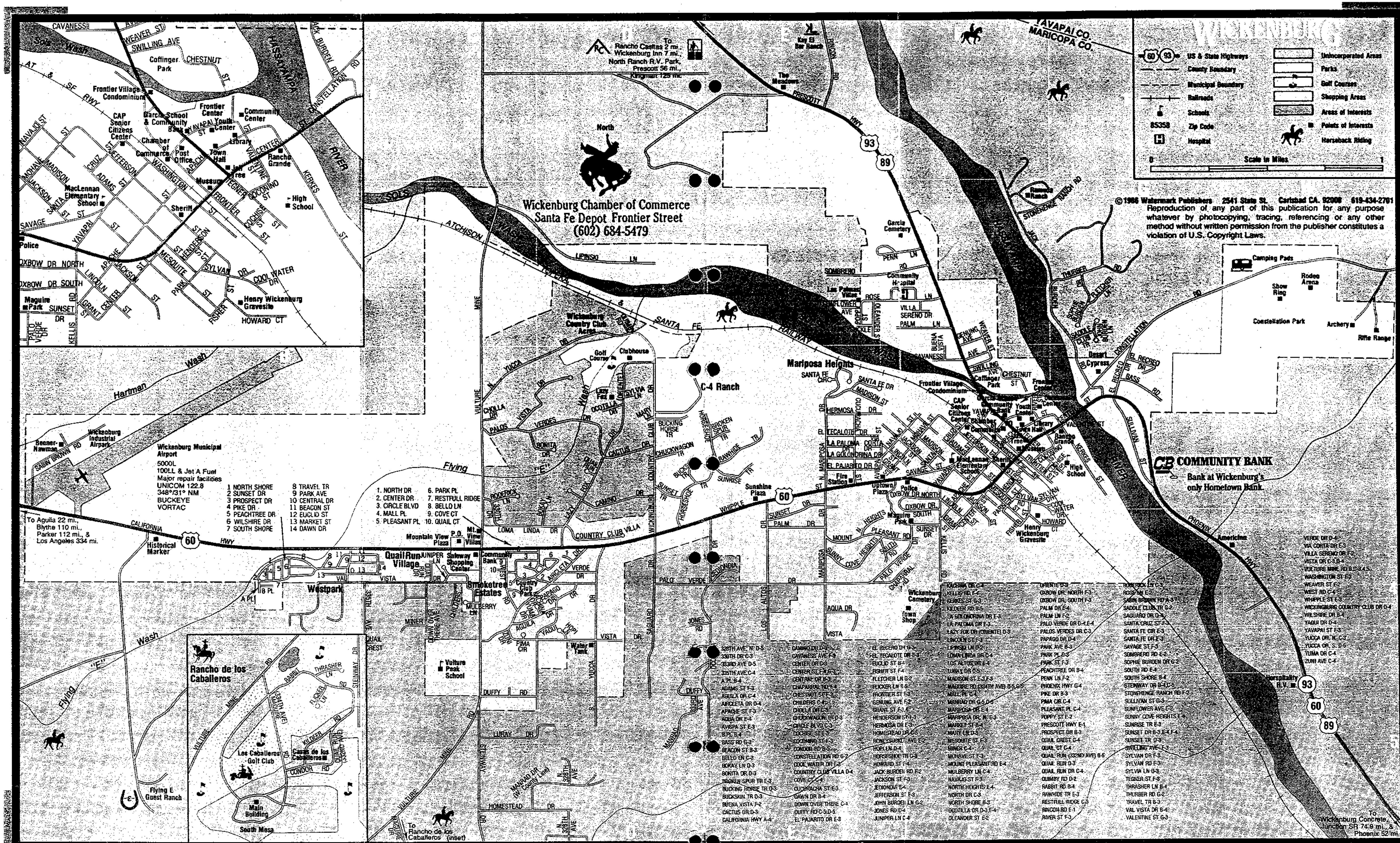

WICKENBURG
US & State Highways
County Boundary
Municipal Boundary
Railroads
Schools
85358 Zip Code
Hospital
Unincorporated Areas
Parks
Golf Courses
Shopping Areas
Areas of Interests
Points of Interests
Horseback Riding
Scale in Miles
Wickenburg Chamber of Commerce
Santa Fe Depot Frontier Street
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TAVAPAI CO.
MARICOPA CO.
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To Wickenburg Concrete, Junction SR 74 9 mi., & Phoenix 52 mi.
To Rancho Casitas 2 mi., Wickenburg Inn 7 mi., North Ranch R.V. Park, Prescott 56 mi., Kingman 125 mi.