Report of the September 1, 1984 Harquahala Valley Storm

By: J.M. Rumann, T. Sutko, Flood Control District of Maricopa Count

1984

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LARRY J. RICHMOND
BARBARA U. RODRIGUEZ
JULIE M. LEMMON
MARGARET Y. RAY

AREA CODE 602
TELEPHONE 271-0505

August 7, 1986

Mr. Dan E. Sagramoso
Mr. Stan Smith
Flood Control District
of Maricopa County
3335 West Durango
Phoenix, Arizona 85009

Re: Jake Stephens Flooding Claim

Dear Dan and Stan:

On Monday, August 18, 1986, we will meet with Jake Stephens, his attorney Ken Mangum, and their engineer Gene Franzoy, to discuss the possible flooding claim by Stevens.

The meeting will be in the District's conference room A at 2:30 p.m. I would like to discuss the information with the Staff at 1:00 p.m. the same day, before our meeting with Stephens. The District needs to have its information ready, as well as any maps or photos which may be helpful. Please notify the appropriate SCS representatives to attend if possible.

Please call me if you have any questions.

Sincerely and cordially,

Julie M. Lemmon

Julie M. Lemmon

JML:tc
cc: Ed Opstein
Bob Payette
Dave Johnson
Joe Tram
Cora Fernandez
Nick Karan

FLOOD CONTROL DISTRICT
RECEIVED
AUG 11 '86

	CH ENG		HYDRO
	ASST		LMgt
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	ENGR		DESTROY
	FINANCE		
REMARKS			

FLOOD CONTROL DISTRICT
of
Maricopa County

3335 West Durango Street • Phoenix, Arizona 85009
Telephone (602) 262-1501

D. E. Sagramoso, P.E., Chief Engineer and General Manager

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AUG 21 1986

Ms. Julie Lemmon
1419 North 3rd Street, Suite 100
Phoenix, Arizona 85004

Subject: Meeting with Engineer on Steven's Property

Dear Julie:

On 8-20-86, Tim Sutko and myself met with Mr. Doug Toy from Franzoy-Corey Engineers to discuss the technical data on the flooding in the Harquahala Valley which occurred on 9/2/84.

We explained to him the circumstances which lead to this event as we understood them as a result of our initial gathering of data. In particular, we discussed precipitation and high water marks in the area. We explained that with this information there is no justifiable reason for moving the center of the storm further east over the structures.

In addition, he requested and we supplied him with a reduced copy of the topo work sheet with isohyets for his use. He also inquired if the modeling was available to which we responded that without further advice from our attorneys, we could not give it to him since it is still preliminary.

The meeting lasted approximately 30 minutes.

Sincerely,

Joe Rumann

J. M. Rumann
Hydrologist

JMR/DTO COORD: INFO: FILE:

INTRODUCTION

DRAFT

This report addresses the results of a preliminary hydrologic study on the rainstorm which occurred on September 1st and 2nd, 1984 in the Harquahala Valley. The site is located approximately 60 miles west of Phoenix along Interstate 10 See figure 1. The main land use is agriculture.

The major geographic features within the study area are the Saddleback Mountains to the east, Eagletail Mountains to the south, Big Horn Mountains to the north, and Centennial Wash flowing from northwest to southeast through the center of the valley. The significant structures are Interstate 10, the Central Arizona Project (C.A.P.) Canal, the Harquahala Flood Retarding Structure (F.R.S.) and Floodway, and the Saddleback F.R.S. and Diversion Channel.

The purpose of this study is to determine what the runoff from the September 1984 rainstorm would be without the Flood Control District structures. To accomplish this the contributing watersheds were modeled using HEC-1. Both pre-structure and post-structure runs were put together for calibration and comparison.

HYDROLOGY

To prepare the modeling for this rainfall-runoff event precipitation data and high water mark information were gathered from a variety of sources; one of which was a recording gage. This gage recorded 6.67 inches of rain in four hours See figure 2. Other precipitation values were obtained by the Soil Conservation Service from conversations with local residents. The location of these rainfall values are plotted on Plate 1 and were used to produce the isohyets for this storm. In addition, National Weather Service radar plots support the location, areal distribution, and intensities of this storm.

The watersheds which contibute runoff from this storm cover approximately 500 square miles and are designated on U.S. Geological Survey 15 minute quadrant topographic maps. Plate 1 show the structures plotted using as-built plans and air photos. The differences between pre- and post-structure subbasin boundaries are evident on Plate 1.

The charateristics of the watershed consist of a typical Mohave Desert vegatation with elevations ranging from 1050 to 3500 feet above sea level and agricultural farms across a broad alluvial valley floor. Slopes on the foothills of the surrounding mountains, such as those for Subbasin A, are approximately 1%; while those on the valley floor are very flat, typically 0.01%. For modeling purposes SCS curve numbers of 79 and 87 were used for agricultural and desert soils respectively.

DRAFT

FIGURE 1. STUDY AREA

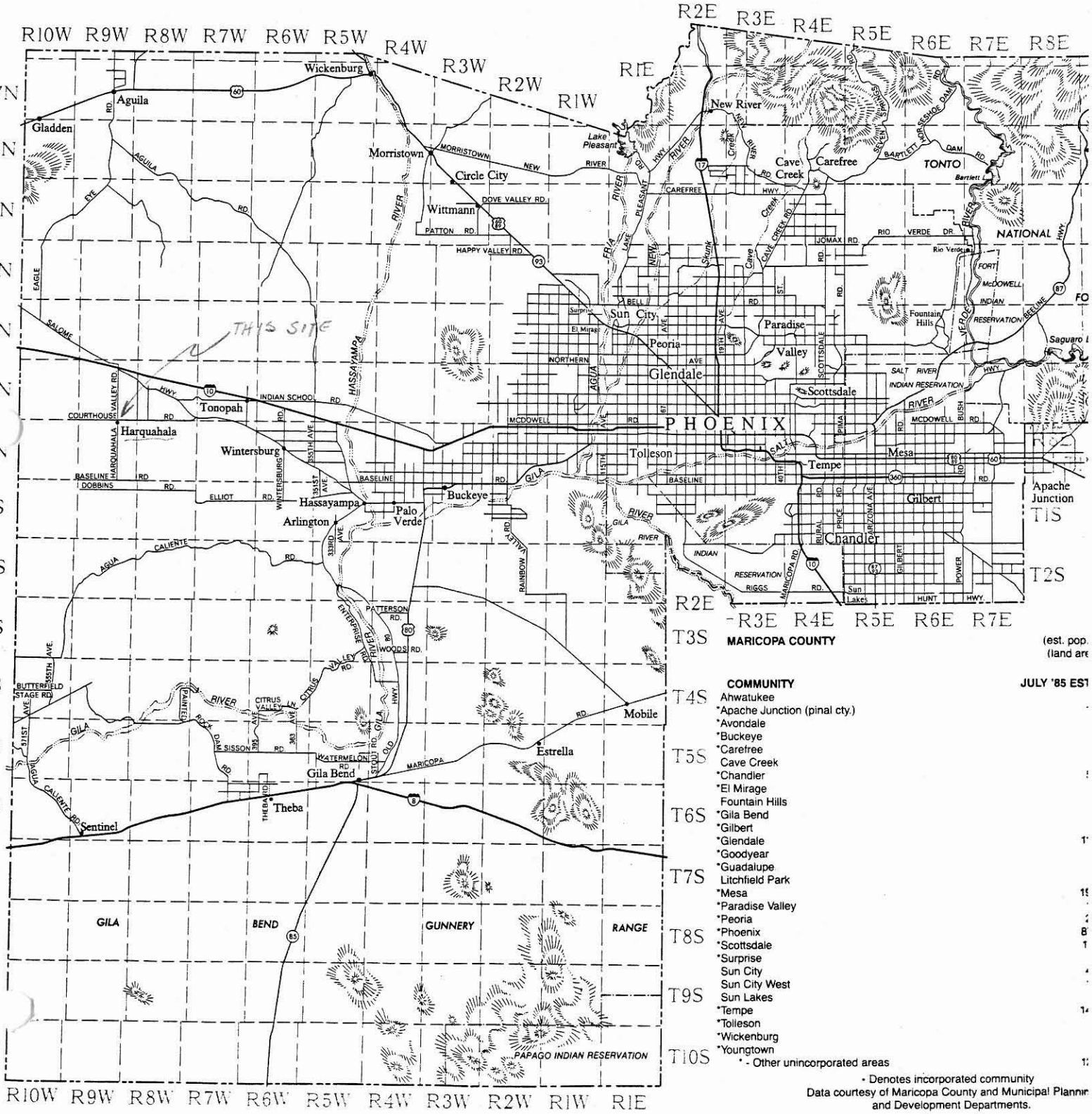


FIGURE 2. RECORDING RAIN GAGE

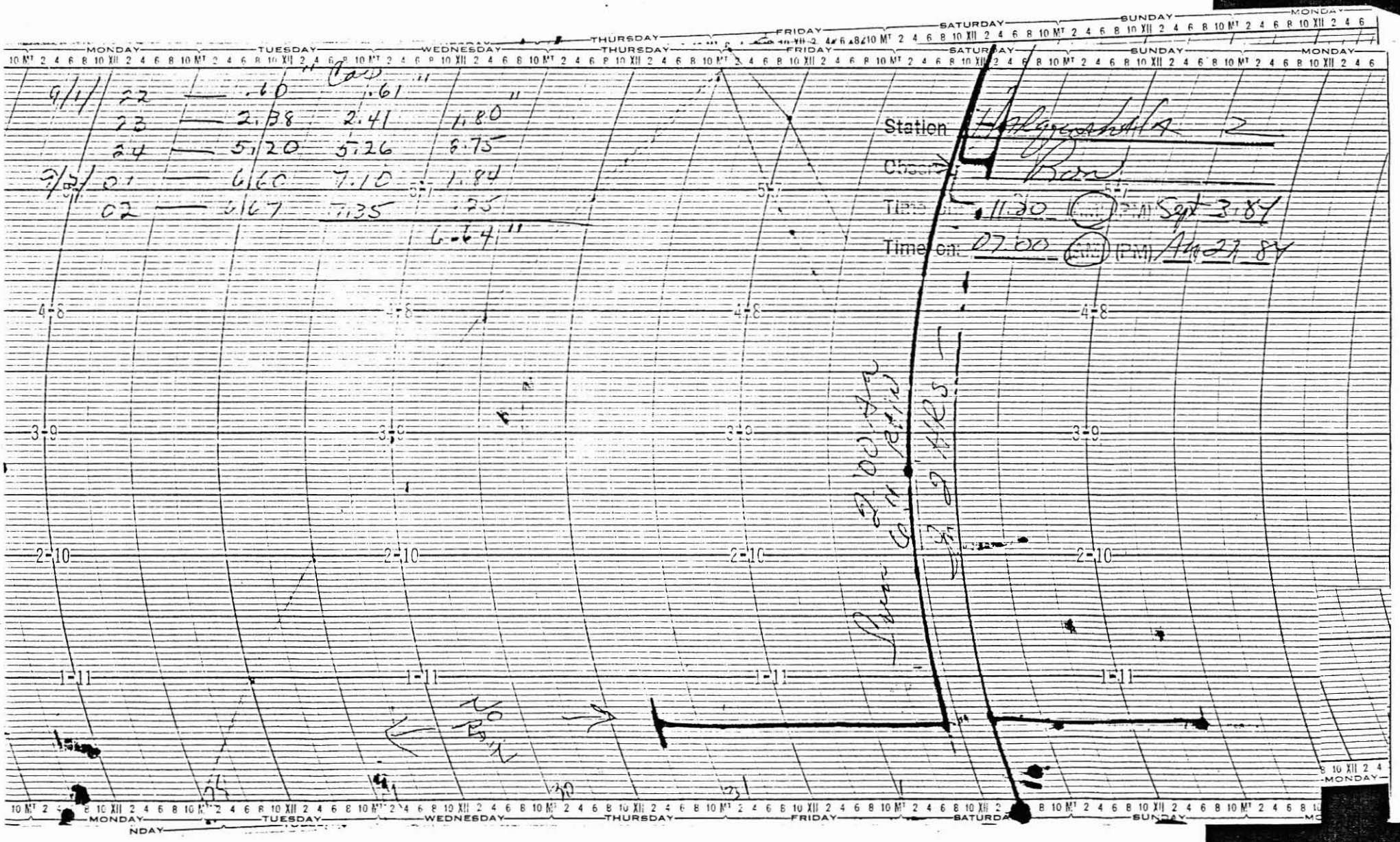
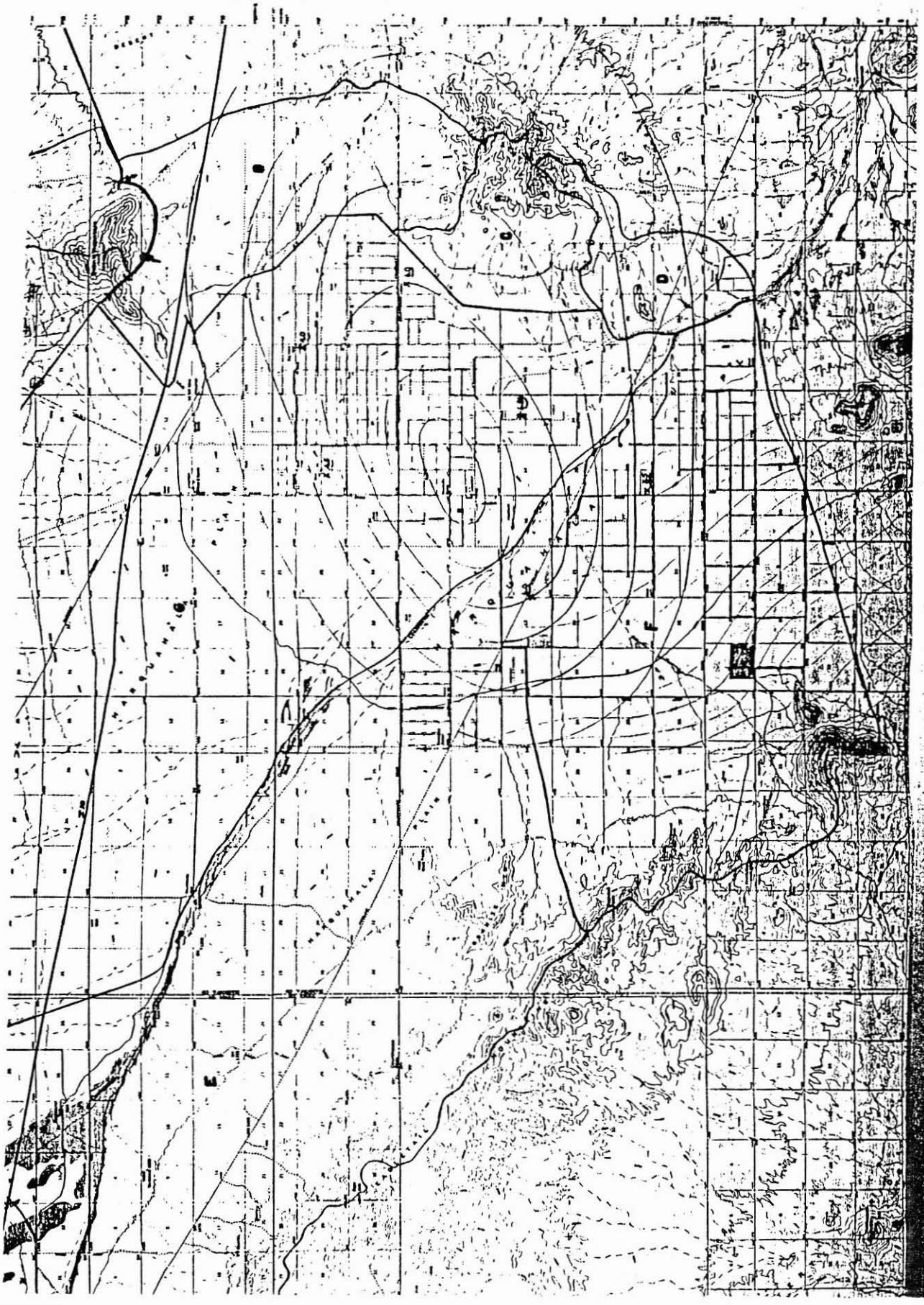


FIGURE 3. STUDY AREA



MODELING

Two separate Hec-1 models were run. One to model the storm runoff for conditions as they exist, with the structures (post-structure). The other to model the runoff for conditions prior to the installation of the structures (pre-structure). Comparing the results of the two reveals the affect of the structures on the study location.

The basin was divided into subbasins for modeling purposes. Since the majority of runoff from this site occurs as overland flow, the kinematic wave routing method of HEC-1 was used on most of the subbasins. The unit hydrograph technique was used on the remaining subbasin.

The subbasin precipitation amounts were measured using the isohyetal method. The storm distributions for these amounts were estimated using intensities from the recording gage.

Table 1 compares the pre- and post-structure subbasin areas and precipitation values. The subbasins that show differences between pre- and post-structure area and precipitation indicate that the areas and their respective precipitation amounts were affected by the structures.

TABLE 1

SUBBASIN	PRE-STRUCTURE		POST-STUCTURE	
	AREA SQ.MI.	PRECIPITATION INCHES	AREA SQ. MI.	PRECIPITATION INCHES
A	25.73	1.25	25.73	1.25
B	38.61	3.65	23.75	3.17
C	13.62	5.25	9.25	5.08
D	7.03	3.61	7.03	3.61
E	100.87	2.82	100.87	2.82
F	58.06	2.88	58.06	2.88
G	62.00	3.81	115.61	3.72
H	133.72	1.25	104.84	1.25

Figure 3 is a topographic map showing subbasin delineation for the post-structure condition. Additional maps will be included in the final draft.

The modeling scheme for the pre- and post-structure Hec-1 runs are depicted as flow charts in Figures 4 and 5, respectively. Each number in parenthesis represents the peak discharge for the hydrograph at that location. Some hydrographs are for individual subbasins; others are for combined or routed hydrographs.

POST-STRUCTURE

ROUTING SCHEME
PEAK DISCHARGES (CFS)

FIGURE 4.

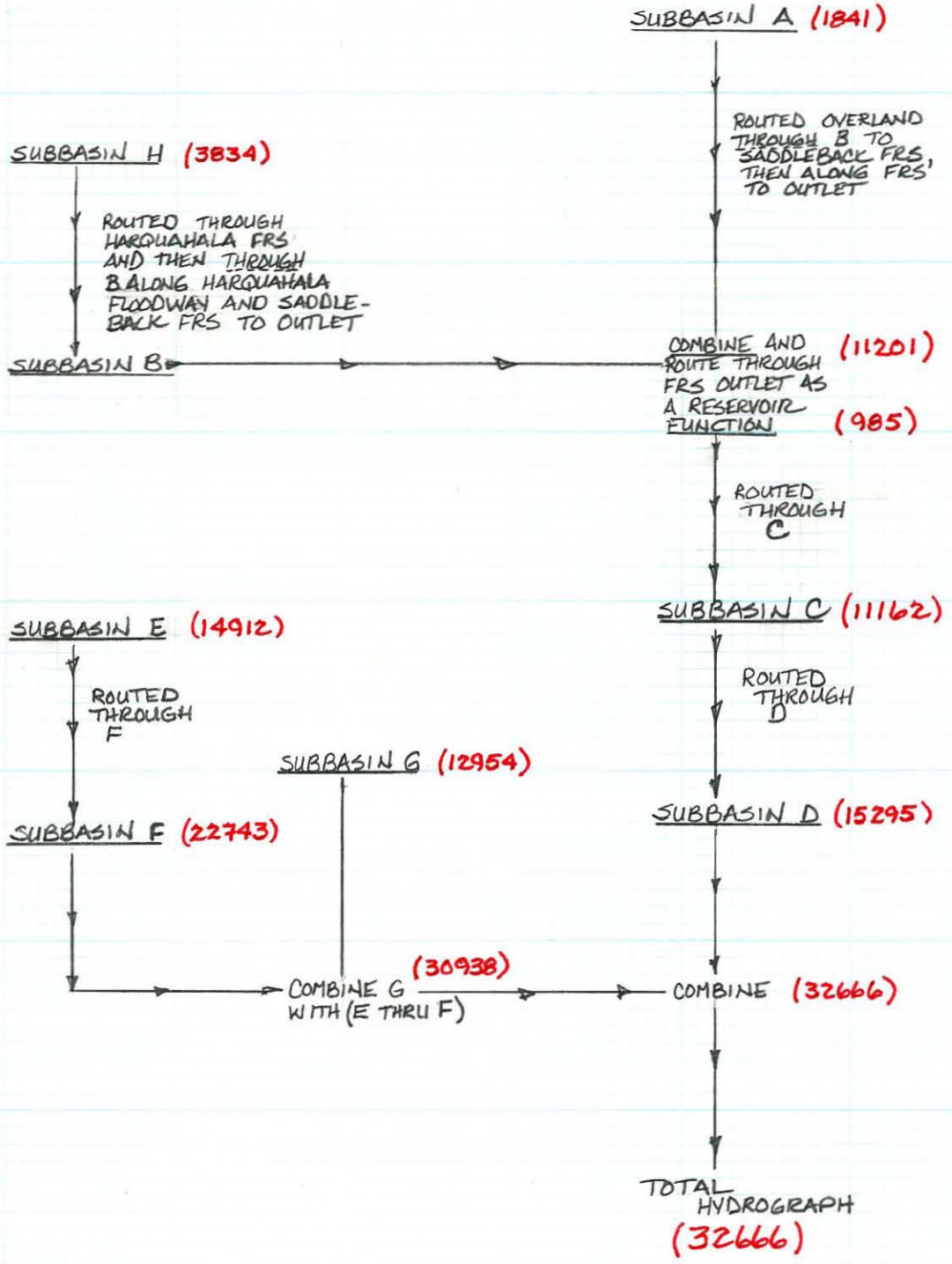


FIGURE 5.

PRE-STRUCTURE

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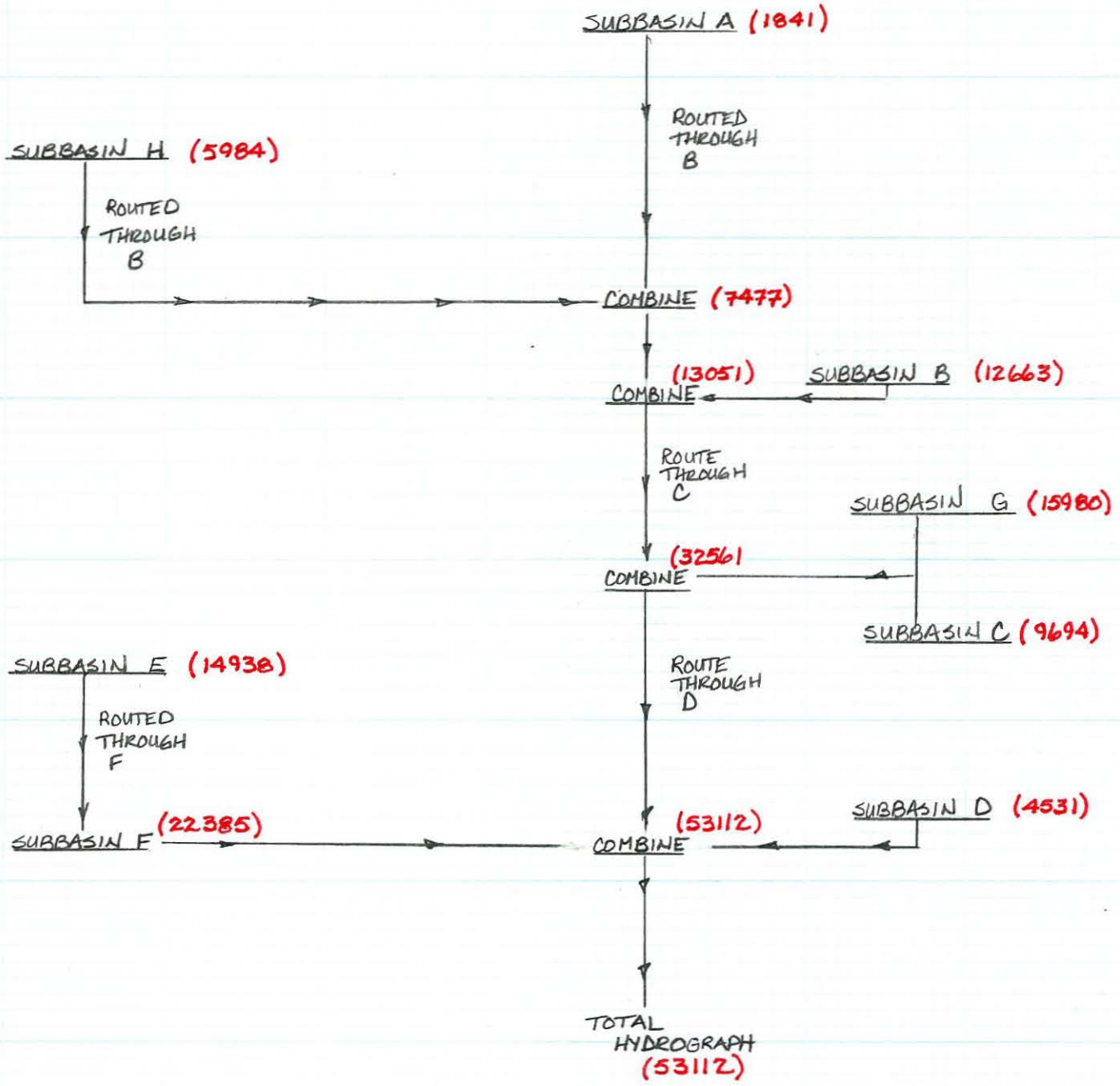
PEAK DISCHARGES (CFS)



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The modeled runoff for pre- and post-structure conditions reveal significant differences. The peak discharge without the structures is 53112 cfs. The peak discharge with the structures is 32666 cfs. This represents a 32 % reduction in the flood peak.

The storm cell was centered over the lower portion of the watershed. A large volume of runoff was intercepted and passed through the flood retarding structures before runoff from the remaining watershed reached the study location.

Figure 6 is a hydrograph illustrating differences in the runoff peak and the effect on the runoff distribution. It is evident that the structures effectively reduced the peak discharge, thus, "flattened the peak".

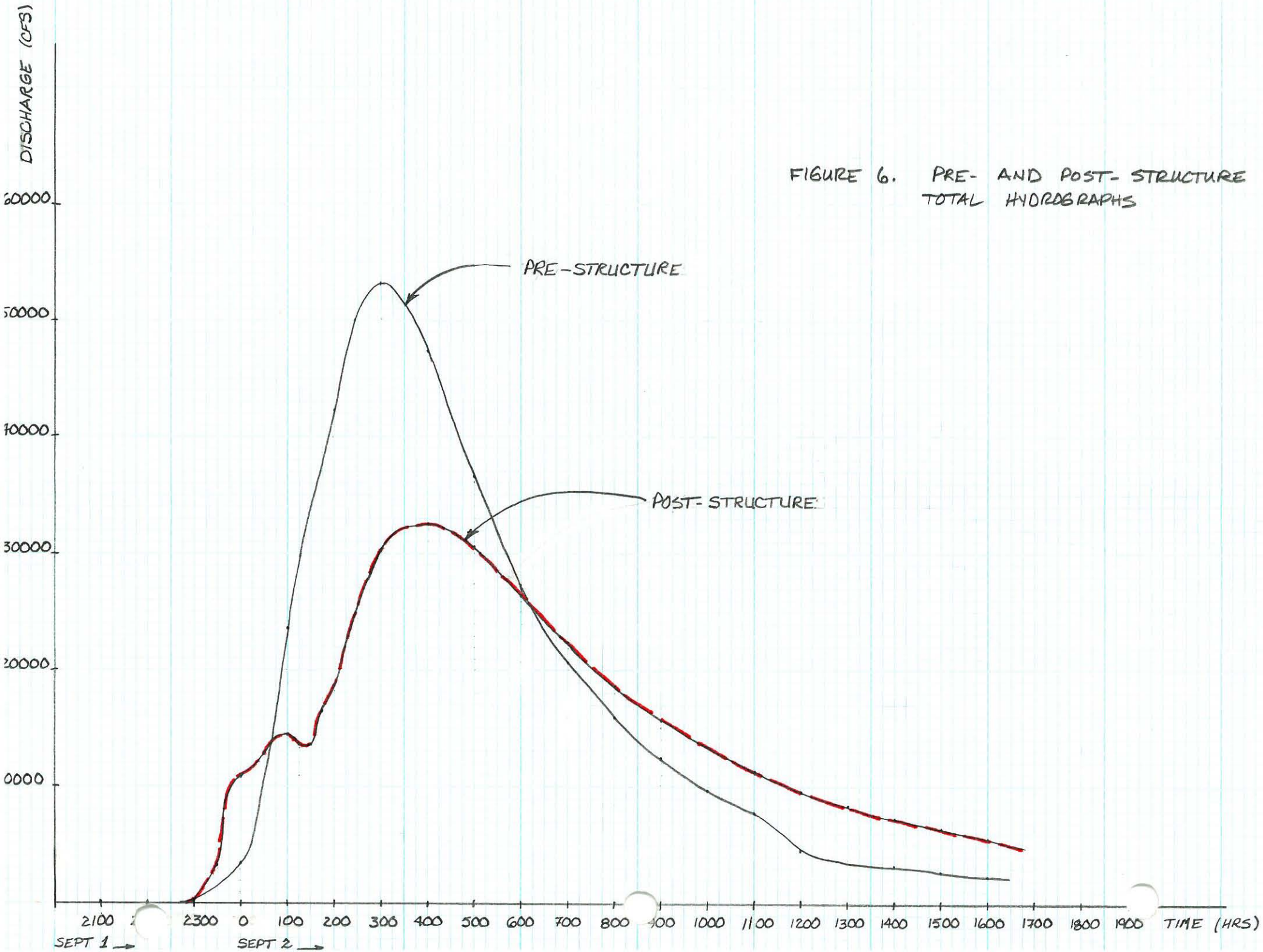
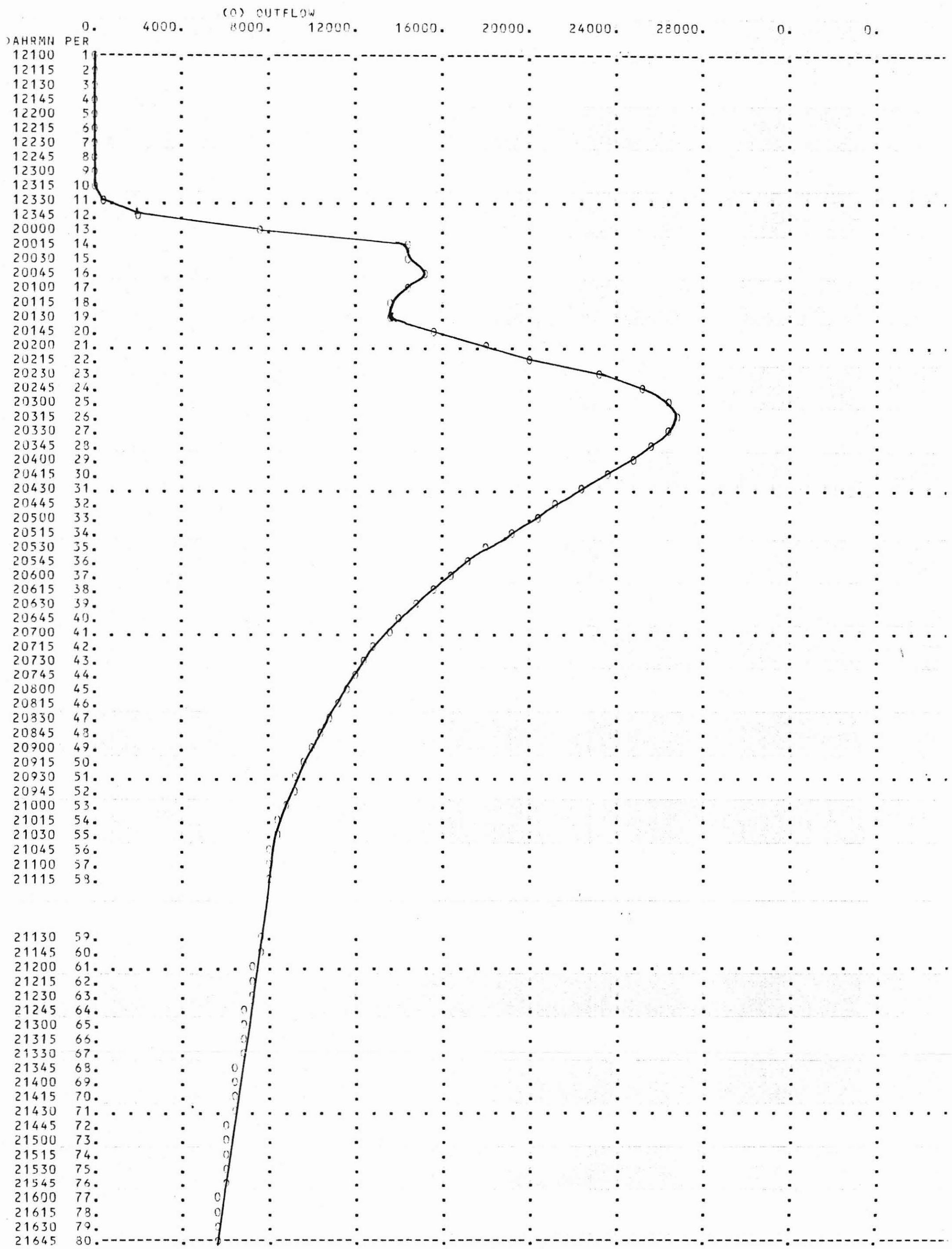


FIGURE 6. PRE- AND POST- STRUCTURE TOTAL HYDROGRAPHS

STATION COMBINE



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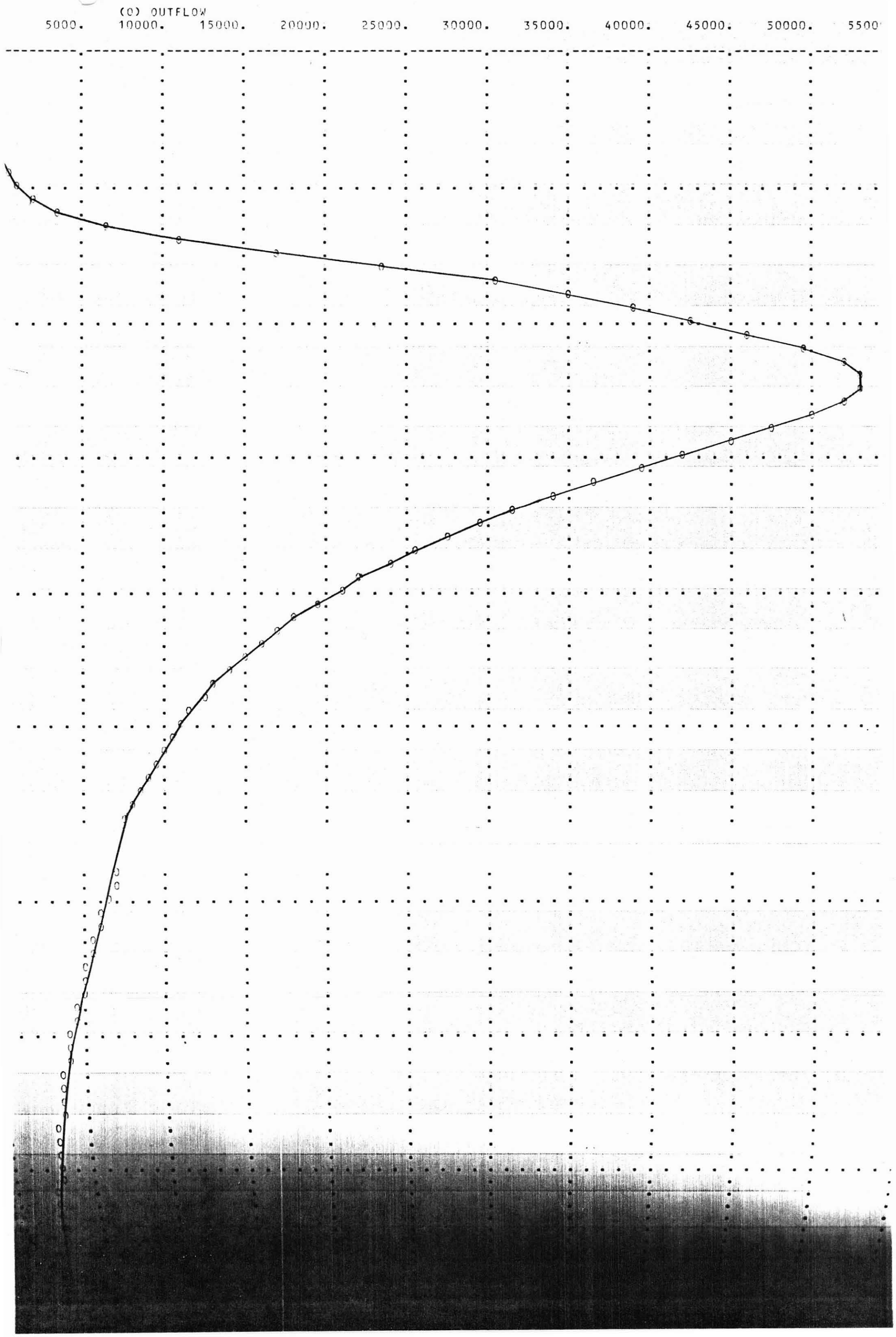

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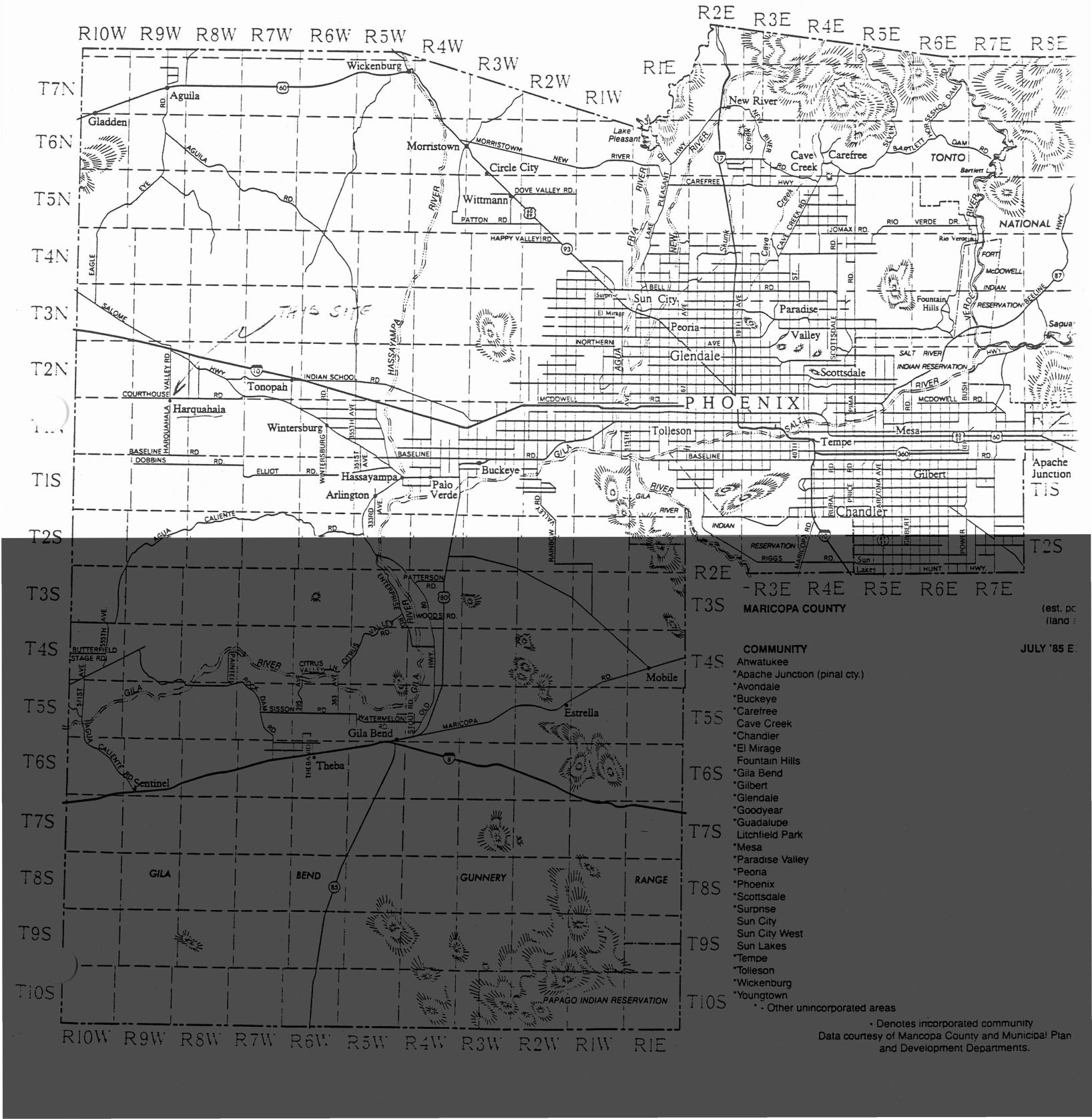

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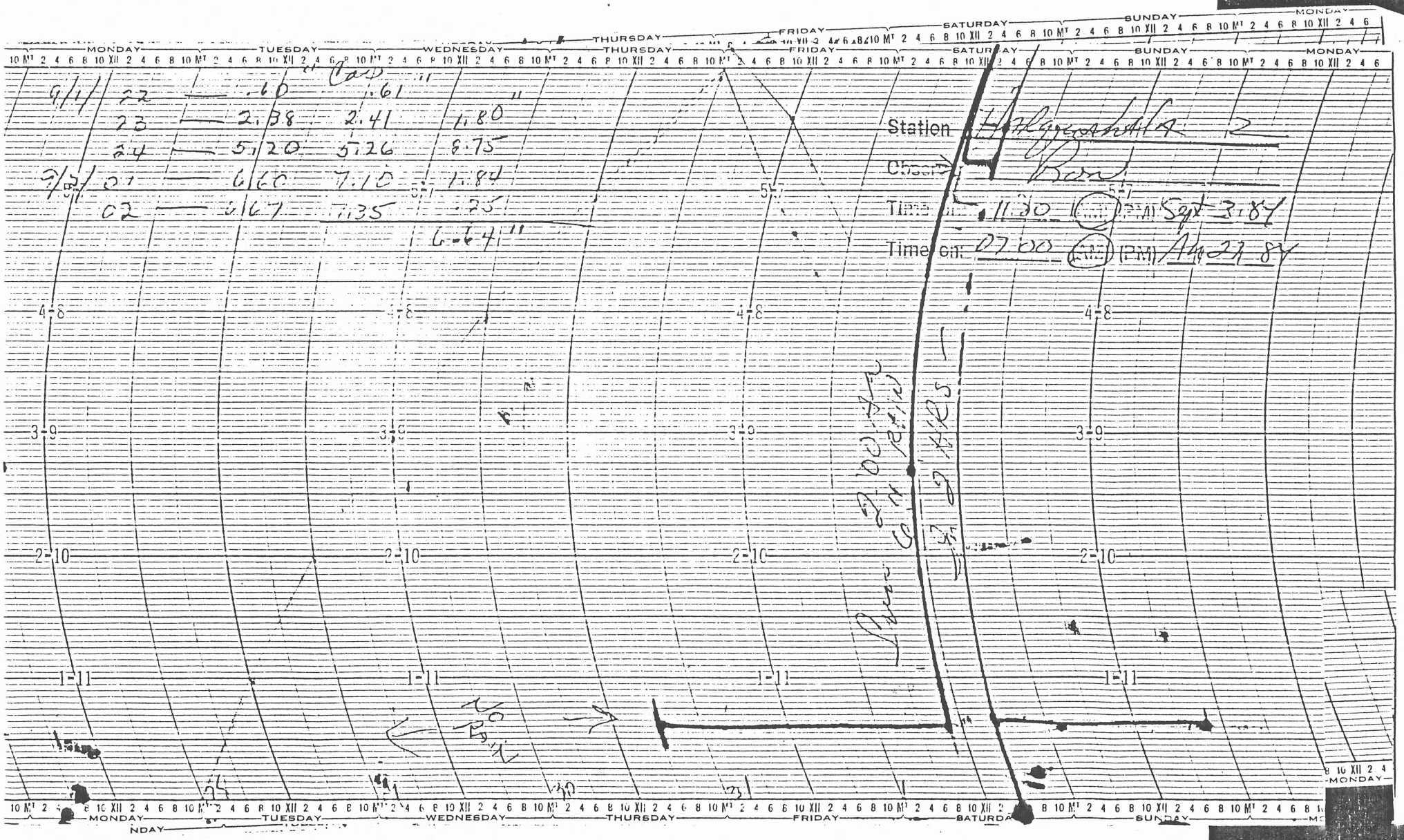

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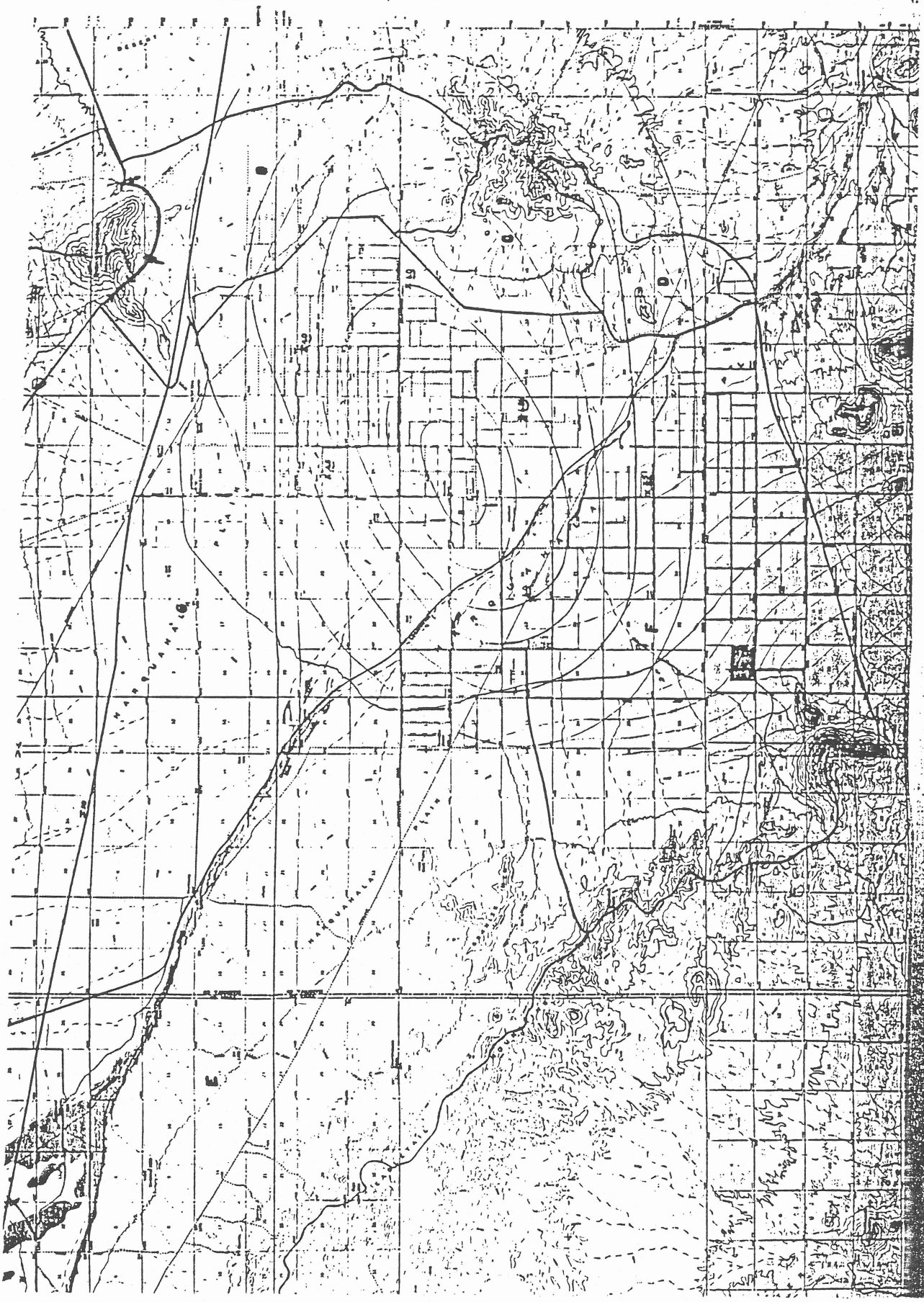

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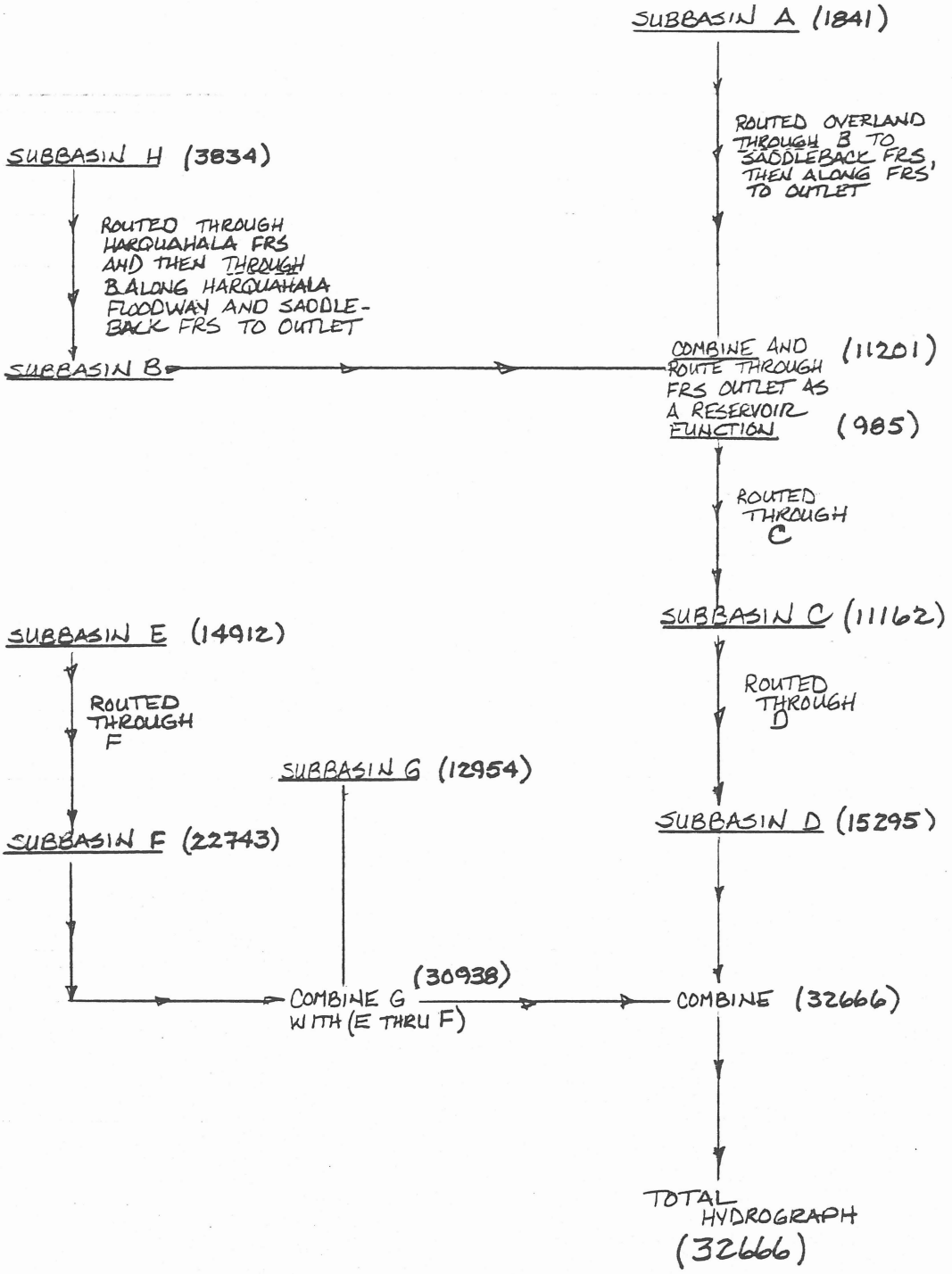

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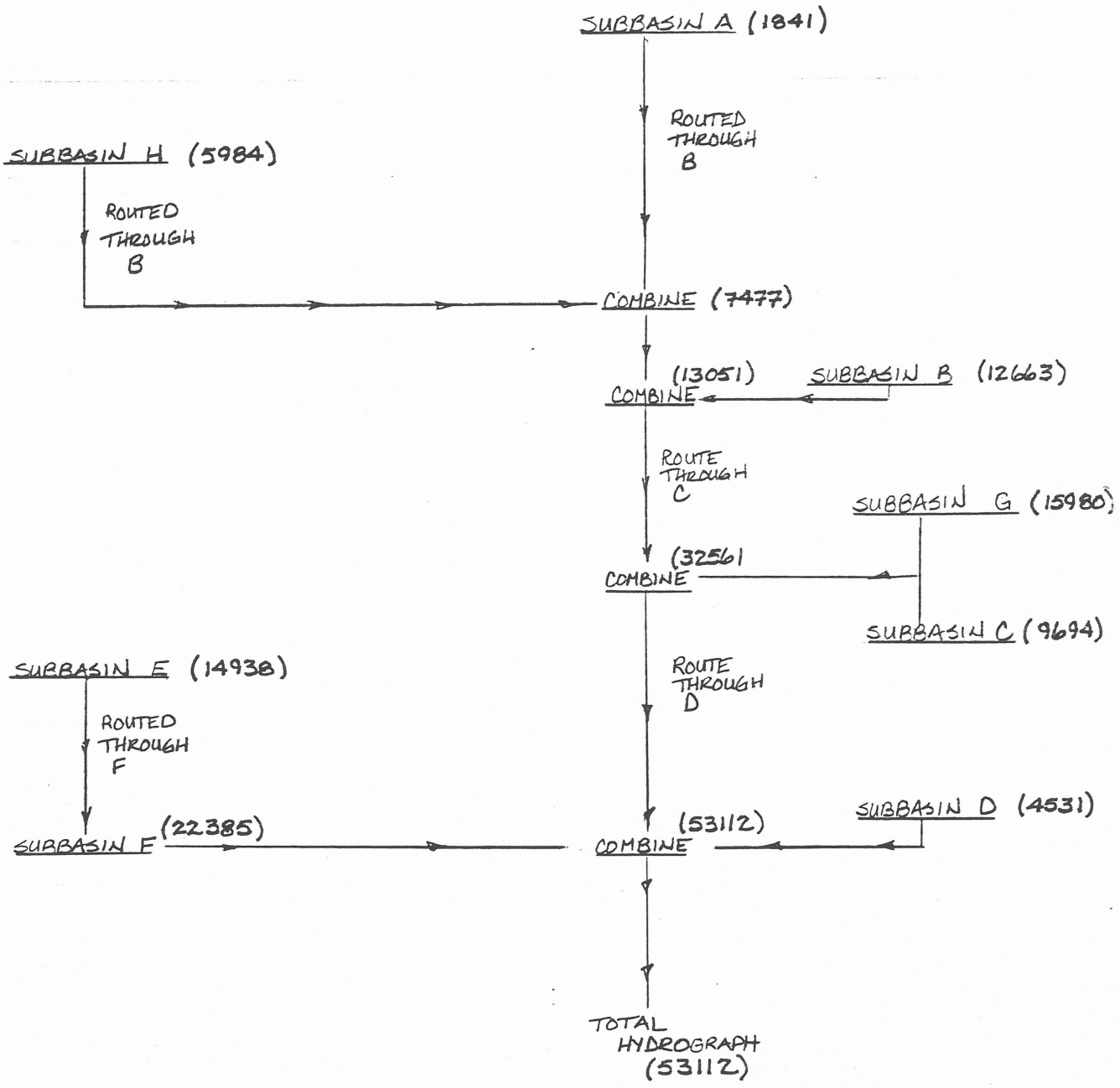

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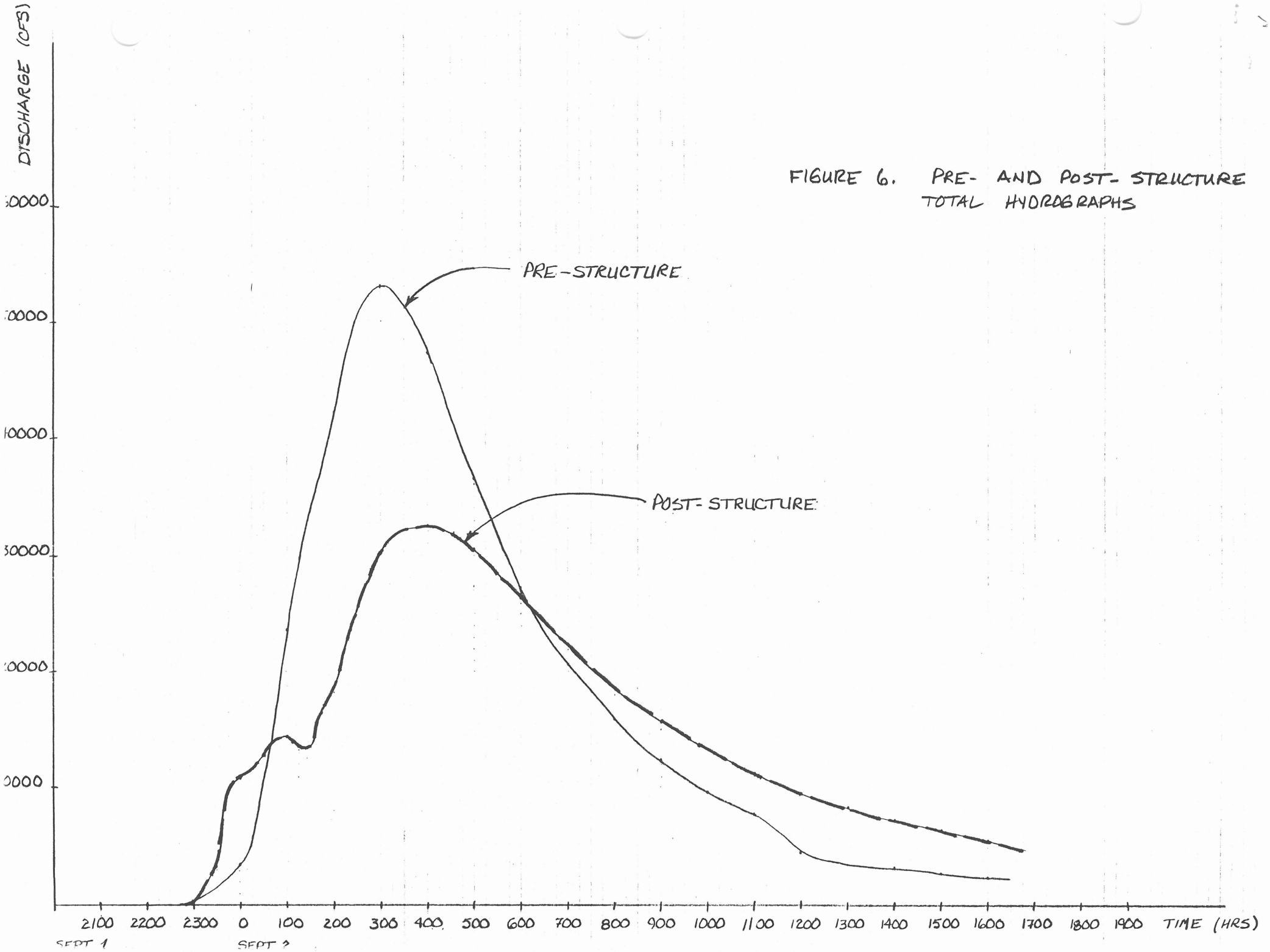

FIGURE 6. PRE- AND POST- STRUCTURE TOTAL HYDROGRAPHS

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UNIT HYDROGRAPH (ASUB) – DHX.MTN

$LAG = 1.1 \left(\frac{L \cdot L_{CA}}{S^{1/2}} \right)^{.38}$

$= \cancel{1.02 \text{ (hrs)}}$

$\cancel{14.29 \text{ min}}$ 2.8 hrs. = 168.1 min

$BA = 25.73 \text{ mi}^2$

TIME INTERVAL – 10 MIN.

$S^{1/2} = .1449$

$L = \cancel{71280 \text{ FT.}} = \cancel{13.5 \text{ Mi}}$ 14.5 Mi

$L_{CA} = \cancel{71280/2 = 35640 \text{ FT} = 6.75 \text{ Mi}}$

$S = 0.021$

$.021 \times \frac{5280 \text{ FT}}{1 \text{ Mi}} = 110.88 \text{ FT/Mi}$

5.8

4.7

$\cancel{5.75 \text{ IN}}$

$7.5 \text{ IN} \times \frac{6000 \text{ FT}}{1 \text{ IN}} = 45000 \text{ FT}$

$= 8.5 \text{ Mi}$

$12.8 \text{ IN} \times \frac{6000 \text{ FT}}{\text{IN}} = 76800$

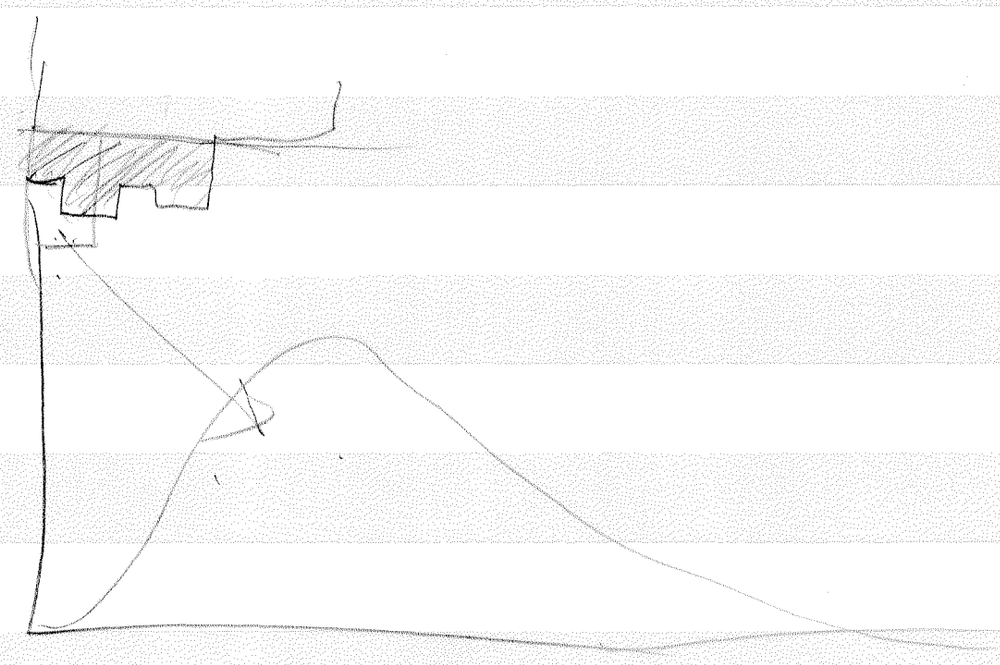
$= 14.5 \text{ Mi}$

NATIONAL 42-381 50 SHEETS 5 SQUARE 42-382 100 SHEETS 5 SQUARE 42-389 200 SHEETS 5 SQUARE Made in U.S.A.

UNIT HYDROGRAPH SUBBASIN A

BASIN: ASUB

TIME	ORDINATE	DISCHARGE
0.	.0000	0.
15.	.0044	293.
30.	.0089	593.
45.	.0162	1074.
60.	.0255	1695.
75.	.0383	2544.
90.	.0504	3347.
105.	.0632	4200.
120.	.0641	4259.
135.	.0714	4741.
150.	.0714	4741.
165.	.0714	4741.
180.	.0577	3832.
195.	.0503	3338.
210.	.0465	3090.
225.	.0378	2513.
240.	.0351	2331.
255.	.0353	2346.
270.	.0247	1643.
285.	.0234	1555.
300.	.0222	1475.
315.	.0180	1196.
330.	.0164	1087.
345.	.0156	1039.
360.	.0150	994.
375.	.0144	954.
390.	.0146	970.
405.	.0095	628.
420.	.0091	605.
435.	.0088	584.
450.	.0085	564.
465.	.0055	368.
480.	.0045	297.
495.	.0043	288.
510.	.0042	279.
525.	.0041	271.
540.	.0033	220.
555.	.0024	159.
570.	.0023	155.
585.	.0023	151.
600.	.0022	147.
615.	.0022	143.
630.	.0021	140.
645.	.0021	137.
660.	.0022	146.
675.	.0011	72.
690.	.0011	71.
705.	.0010	69.
720.	.0010	68.
735.	.0010	66.
750.	.0010	65.
765.	.0010	64.
780.	.0009	62.
795.	.0001	8.
810.	.0000	0.
825.	.0000	0.
1.0000		



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MILLSAPS

United States Department of Agriculture
Soil Conservation Service
101 South Main
Temple, Texas
76501-7682

Subject: ENG - Special Study of September 2, 1984 Storm- Harquahala Valley Watershed

Date: January 8, 1985

File Code: 210-7

To: Harry Milsaps
Hydraulic Engineer
SCS, Phoenix, Arizona

A copy of the study report of the 1984 storm is enclosed. The "As Built" plans for the construction of Saddleback Diversion are being sent by Certified Mail under separate cover.

The enlarged aerial photograph has been mailed. The other reference material I got from you, the WSP2 and TR-20 program printouts, and other generated data are also being sent separately. We will keep the computer programs on tape so we can make additional runs if needed or we can transmit a copy of the material to you.

I appreciate the opportunity to work with you again and with other members of the Arizona staff. This has been an interesting assignment.

Please call if additional information is needed.

Herman N. McGill

HERMAN N. McGILL
Hydraulic Engineer

Enclosure

HARQUAHALA VALLEY WATERSHED
Saddleback Diversion
Study of September 2, 1984 Storm

Surveys

Surveys included carrying a level line along the upstream side of the channel. The elevation of high water marks in the diversion and side inlet channels were recorded. The location of side entrance problems were documented. Survey results are summarized on Table 1.

Rainfall

Box Inlet Ignored Outlets

.8 mi² that went into structure but actually enters floodway

Figure 1 shows the rainfall amounts reported at locations near the watershed. The red values were obtained by work unit staff, the green during the study. Reported amounts range from 2 to 11 inches. There are no residences in the drainage area of Saddleback diversion, thus no rainfall information was available there. It appears, however, that the most intense part of the storm traveled from NW to SE and traversed the central and lower portion of the diversion watershed. High water marks at FRS 1 showed that the maximum stage was 4.8 feet over the principal spillway crest. The total capacity at this stage is 1732 acre-feet or .32 inches runoff from the watershed. The sediment pool capacity is 424 acre-feet or .08 inches. Because of the short duration of the storm, and small principal spillway capacity of FRS 1, rainfall above the site was not used in the Saddleback Diversion Study.

The storm distribution was taken from the recorder chart (Figure 2). The tabulated values were used because it was not possible to accurately read shorter time increments from the chart. It is probable that more intensive rainfall occurred during shorter time increments.

Runoff

Soil cover complex runoff curve number 90 was used to determine the runoff volume. This approximates the work plan value that was used for determining the 50-year design storm for the diversion. This appears high but runoff volume is not important for this study. The comparison of peak discharges and flow stage elevations determined by high water marks to the design values was the objective of the study.

Storm Evaluation Studies

Water surface profiles were prepared by Toups Corporation engineers using the Corps of Engineers HEC II program. The 10-yr and 50-yr frequency storms and the floodwater retarding structure principal spillway outflow discharge and elevation are recorded in Volume II of their design report. This did not provide enough information to make cross section hydraulic ratings. The planned cross section dimensions were input for the SCS WSP2 program. The planned dimensions were used

instead of the "as built" ones because differences were not significant and they were more readily available. The design engineer used .030 "n value" for the central portion of the channel and .035 for the bank sections. Because most of the flow is carried in the central segment and the bank segments flow differences between the use of .030 and .035 are small, one segment sections using .030 were entered in the WSP2 program.

The output from the WSP2 program was used in a TR-20 program to model the watershed. The convex routing method was used in the original study and in this study. The point that incremental drainage areas enter the diversion was altered based on a recent aerial photograph of the watershed and the location where it was noted that excessive inflow occurred. Selected time of concentrations are consistent with those used in the watershed plan. Table 2 is a schematic of the watershed showing incremental drainage areas and Tc values used in this study.

Five storms were routed through the watershed beginning with FRS 2. The Type II, 24-hour, 50-year storm (3.6 inches) was routed to evaluate the model. The resulting discharges and elevations compared favorably with those used in the plan except in the upper reaches of the diversion. It was later discovered that in this study it was assumed that an .84 square mile drainage area flowed into the FRS. The original plan entered this flow near the upstream end of the diversion. Because the discharge from the FRS is the principal contributor to the peak discharge in the upper reaches of the diversion, changes were not made.

Four additional storms using the 1984 storm time distribution were routed through the watershed. Aerial distributions were varied to obtain the best flow - high water mark relationship. Storm No. 5 appears to provide the best relationship, though the high water marks are generally higher than the generated elevations in the central and lower reaches of the watershed. This could be partly due to the reduced channel capacity caused by silt bars. Table 3 is a summary of these results. This shows that rainfall above the floodwater retarding structures probably averaged less than 3 inches and ranged from 5 to 7 inches below the FRS.

The incremental drainage area peak discharges for each of the five storms and the capacity of each side inlet structure are shown on Table 4. It is noted that Storm 1 discharges compare favorably to the capacity of the side inlet structures. This is expected in as much as the same storm and Tc were used. However, the location of side inlet inflow differs somewhat. A study of the drainage area flow patterns shows that the location of inlet flow is subjective.

Generally, channels were used to divert flow to the inlet structure location. Flow in these were partially blocked by sediment bars resulting in over-bank flow before the inlet structure capacity was reached. In some locations these breached the bank between the training channel and diversion. This occurred in the upper reaches of the diversion where the design flow of the structure was not exceeded as well as in the central and lower reaches.

Conclusions

The study shows that the September 2, 1984 storm exceeded the 50-year frequency design storm in the central and lower reaches of the diversion. Flows, based on high water marks, were estimated to be about 2 times design flows near the diversion outlet. This did not appear to have caused significant damage to the diversion channel.

The location of inflow to the diversion is subjective, but a recent aerial photograph and onsite studies show that side inlet structures were not always located where needed. Also the limited capacity of the below natural ground channels used to divert flow to the side inlet structures were reduced by sediment bars resulting in over-bank inflow to the diversion. This caused damage to the upstream bank of the diversion and in some locations, left sediment bars in the diversion channel.

TABLE 4
HAROUAHALA VALLEY WATERSHED
Saddleback Diversion

Peak Discharge from Incremental Drainage Ar

STATION	DESIGN Drainage Area Mi^2	DESIGN Discharge cfs	TYPE II STORM DIST. Drainage Area Mi^2	TYPE II STORM DIST. Storm 1 cfs	1984 STORM DIST Storm 2 cfs	1984 STORM DIST Storm 3 cfs	1984 STORM DIST Storm cfs
1000	.840	773					
1090			.27	362	250	250	250
1500			.02	44	20	20	20
2200	.293	355					
3000			.15	271	142	142	142
4500			.29	471	272	353	353
5500			.10	193	95	123	123
6500			.02	44	20	26	26
6800	.554	739					
7500			.53	512	451	591	732
8500			.53	512	451	591	732
8700	1.075	956					
9500			.14	253	132	171	210
11000			.60	643	524	766	847
12200	1.304	1220					
12500			.61	653	533	779	861
13000			.16	206	147	214	236
16000			1.06	880	856	1390	1655
17000			1.07	888	864	1404	1670
17500			.16	204	147	235	279
18000	2.323	1740					
18500			.26	320	235	377	448
20500			1.17	894	917	1490	1774
22500			1.08	825	846	1375	1637
23500			.10	181	94	150	178
23800	2.623	1792					
23900			.43	528	389	626	743
24400	.4323	437					

NOTE: Storm 1 is 24-hour 50-year Type II Storm - 3.6 inches
Storm 2 is 1984 storm distribution - 4.00 inches
Storm 3 is 1984 storm FRS to Sta 3000 - 4.0"; Sta 3 000 to Sta 9500 - 5.0"; Sta
Storm 4 is 1984 storm FRS to 3000 - 4.0"; Sta 3000 to Sta 6500 - 5.0"; Sta 650(
Storm 5 is 1984 storm FRS - 3.0"; FRS to Sta [illegible]0 - 5.0"; Sta 6500 - Sta 13000

TABLE 2
Harquahala Valley Watershed
Saddleback Diversion

1984 Storm TR-20 Schematic

	Station	Drainage Area		Tc
		Increment	Total	
FRS 2	0	29.56	29.56	3.26
Sec 1	1090	.27	29.83	.37
Sec 2	1500	.02	29.85	.09
Sec 3	3000	.15	30.00	.23
Sec 4	4500	.29	30.29	.28
Sec 5	5500	.10	30.39	.20
Sec 6	6500	.02	30.41	.08
Sec 7	7500	.53	30.94	.78
Sec 8	8500	.53	31.47	.78
Sec 9	9500	.14	31.61	.23
Sec 10	11000	.60	32.21	.67
Sec 11	12500	.61	32.82	.67
Sec 12	13000	.16	32.98	.41
Sec 13	14000	0	32.98	
Sec 14	15000	0	32.98	
Sec 15	16000	1.06	34.04	1.00
Sec 16	17000	1.07	35.11	1.00
Sec 17	17500	.16	35.27	.45
Sec 18	18500	.26	35.53	.52
Sec 19	19500	0	35.53	
Sec 20	20500	1.17	36.70	1.12
Sec 21	21500	0	36.70	
Sec 22	22500	1.08	37.78	1.12
Sec 23	23500	.10	37.79	.23
Sec 24	23900	.43	38.22	.53

TABLE 3
HARQUAHALA VALLEY WATERSHED
Saddleback Diversion
Summary of TR20 Flood Routings

Station	TR20 Sec #	50-yr Storm HECII Disc. cfs	50-yr Storm HECII Elev. ft.	Storm No. 1 Disc. cfs	Storm No. 1 Elev. ft.	HWM 1984 Storm Elev. ft.	Storm No. 2 Disc. cfs	Storm No. 2 Elev. ft.	Storm No. 2 HWM Diff.	Storm No. 3 Disc. cfs	Storm No. 3 Elev. ft.	Storm No. 3 HWM Diff.	Storm No. 4 Disc. cfs	Storm No. 4 Elev. ft.	Storm No. 4 HWM Diff.	Storm No. 5 Disc. cfs	Storm No. 5 Elev. ft.	Storm No. 5 HWM Diff.
FWS 2		764	1189.4	755	1189.1	1182.9	802	1190.5		802	1190.5		802	1190.5		739	1188.6	
82		950	1179.1															
100					(1177.9)	1177.6		(1178.1)	-.5		(1178.1)	-.5		(1178.1)	-.5		(1177.8)	-.8
1090	1	1090	1177.1	762	1175.9		802	1176.1		802	1176.1		802	1176.1		739	1175.8	
1500	2	1160	1176.3	762	1175.0	1175.8	802	1175.1	.7	802	1175.1	.7	802	1175.1	.7	748	1174.9	.6
2950						1167.2		(1167.3)	-.1		(1167.3)	-.1		(1167.3	-.1			
3000	3	1370	1167.1	896	1167.6		835	1167.4		835	1167.4		835	1167.4		852	(1167.4)	-.1
3500		1370	1165.8															
3700					(1165.5)	1164.9		(1165.1)	-.2		(1165.1)	-.2		1165.1	-.2		1165.2	-.1
4000		1370	1164.7															
4100					(1164.5)	1164.3		(1164.1)	.2		(1164.2)	.1		(1164.2)	.1		(1164.3)	.2
4250					(1164.1)	1163.8		(1113.7)	.1		(1113.8)	0		(1113.8)	0		(1113.9)	.1
4500	4	1500	1163.5	1242	1163.3		1012	1162.9		1073	1163.0		1073	1163.0		1140	1163.1	
5000		1500	1162.3															
5200					(1161.6)	1162.1		(1161.2)	.9		(1161.4)	.7		(1161.4)	.7		(1161.5)	.8
5500	5	1500	1161.1	1311	1160.9		1069	1160.5		1172.6	1160.7		1172.8	1160.7		1244	1160.8	
6000		1500	1160.3															
6125					(1160.0)	1160.0		(1159.7)	.3		(1159.9)	.1		(1159.9)	.1		(1160.0)	.2
6500	6	1900	1159.2	1211	1158.5		1078	1158.2		1182	1158.4		1182	1158.4		1252	1158.5	
7000		1900	1158.1															
7500	7	1900	1157.2	1682	1156.5		1522	1156.4		1768	1156.6		1907	1156.7		1977	1156.8	
7700					(1156.0)	1157.1		(1155.8)	1.3		(1156.1)	1.0		(1156.2)	.9		(1156.3)	1.0
7900					(1154.4)	1156.9		(1154.2)	2.7		(1154.5)	2.4		(1154.7)	2.2		(1154.7)	2.2
8000		2350	1155.8															
8500	8	2350	1150.6	2137	1150.4		1962	1150.2		2350	1150.6		2628	1150.8		2698	1150.8	
8800					(1149.6)	1151.1		(1149.6)	1.5		(1150.0)	1.1		(1150.3)	.8		(1150.3)	.8
9000		2350	1149.6															
9500	9	2590	1148.6	2103	1148.2		2049	1148.2		2465	1148.5		2773	1148.8		2843	1148.8	
10000		2590	1147.7															
10400					(1146.8)	1148.7		(1146.8)	1.9		(1147.3)	1.4		(1147.6)	1.1		(1147.6)	1.1
10500		2860	1146.7															
11000	10	2860	1145.8	2583	1145.9		2591	1145.9		3180	1146.5		3572	1146.8		3640	1146.9	
11500		3250	1144.7		(1144.8)	1145.8		(1144.8)	1.0		(1145.4)	.4		(1145.7)	.1		(1145.7)	.1
12000		3250	1143.6		(1143.7)	1145.1		(1143.7)	1.4		(1144.4)	.7		(1144.7)	.4		(1144.7)	.4
12500	11	3250	1142.7	3044	1142.6		2996	1142.6		3902	1143.3		4376	1143.6		4440	1143.6	
12700					(1142.3)	1143.7		(1142.3)	1.4		(1143.0)	.7		(1143.3)	.4		(1143.3)	.4

Station	T&O Sec. #	50-yr Storm HECII Disc. cfs	50-yr Storm HECII Elev. ft.	Storm No. 1 Disc. cfs	Storm No. 1 Elev. ft.	HWM 1984 Storm Elev. ft.	Storm No. 2 Disc. cfs	Storm No. 2 Elev. ft.	Storm No. 2 HWM Diff.	Storm No. 3 Disc. cfs	Storm No. 3 Elev. ft.	Storm No. 3 HWM Diff.	Storm No. 4 Disc. cfs	Storm No. 4 Elev. ft.	Storm No. 4 HWM Diff.	Storm No. 5 Disc. cfs	Storm No. 5 Elev. ft.	Storm No. 5 HWM Diff.
13000	12	3500	1141.6	3105	1141.9		3107	(1141.9)		4070	1142.6		4565	1142.9		4627	1143.0	
13500		3500	1140.6															
13800					(1139.8)	1140.3		(1139.9)	.4		(1140.4)	-.1		(1140.7)	-.4		1140.7	-.4
14000	13	3740	1139.5	3051	1139.3		3101	1139.4		4059	1139.8		4552	1140.1		46.14	1140.1	
14400		3740	1138.3															
14430					(1138.0)	1137.4		(1138.1)	-.7		(1138.5)	-1.1		(1138.8)	-1.4		(1138.8)	-1.4
14467		3740	1137.8															
14519		3740	1132.4															
14700					(1131.3)	1132.5		(1131.4)	1.1		(1131.9)	.6		(1132.1)	.4		(1132.1)	.4
15000	14	3970	1131.2	2994	1130.6		3094	1130.7		4049	1131.2		4543	1131.4		4605	1131.4	
15500		3970	1130.1															
16000	15	4320	1129.0	3792	1128.8		3916	1128.8		5404	1129.5		6170	1129.8		6228	1129.8	
16300					(1128.2)	1130.8		(1128.2)	2.6		(1129.0)	1.8		(1129.3)	1.5		(1129.3)	1.5
16500		4320	1127.9															
17000	16	4320	1126.9	4571	1126.9		4742	1126.9		6769	1127.8		7803	1128.1		7854	1128.1	
17500	17	4720	1125.8	4587	1125.7	1127.7	4847	1125.8	1.9	6943	1126.7	1.0	8005	1127.1		8060	1127.1	
17900					(1124.8)	1126.9		(1124.9)	2.0		(1125.8)	1.1		(1126.2)	.7		(1126.2)	.7
18000		4720	1124.8															
18200					(1124.1)	1126.4		(1124.3)	2.1		(1125.1)	1.3		(1125.5)	.9		(1125.5)	.9
18500	18	4720	1123.6	4601	1123.4		5019	1123.6		7229	1124.4		8350	1124.8		8404	1124.8	
18800					(1122.8)	1125.0		(1122.9)	2.1		(1123.8)	1.2		(1124.2)	.8		(1124.2)	.8
19000		5110	1122.5															
19500	19	5110	1121.4	4542	1121.2		5013	1121.3		7217	1122.2		8338	1122.5		8393	1122.5	
19800					(1120.7)	1123.7		(1120.8)	2.9		(1121.7)	2.0		(1122.1)	1.6		(1122.1)	1.6
20000		5110	1120.2															
20100					(1120.0)	1122.7		(1120.2)	2.5		(1121.1)	1.6		(1121.5)	1.2		(1121.5)	1.2
20500	20	5110	1119.2	5326	1119.3		5889	1119.5		8668	1120.4		10082	1120.9		10134	1120.9	
21000																		
21200					(1118.0)	1120.0		(1118.1)	1.9									
21500	21	5430	1117.0	5257	1117.2		5881	1117.5		8657	1118.6		10063	1119.1		10115	1119.1	
21900					(1116.3)	1118.6		(1116.5)	2.1		(1117.5)	1.1		(1118.0)	.6		(1118.0)	.6
22000		5430	1116.0															
22500	22	5750	1114.8	5939	1114.9		6678	1115.1		9979	1116.1		11649	1116.5		11700	1116.5	
23000		5750	1113.7		(1113.5)	1115.2		(1113.8)	1.4		(1114.8)	.4		(1115.2)	.2		(1115.2)	.2
23500	23	5750	1112.3	5891	1112.2		6738	1112.5		10070	1113.4		11758	1113.8		11810	1113.8	
23600			(1112.0)		(1111.9)	1114.2		(1112.2)	2.0		(1113.2)	1.0		(1113.6)	.6		(1113.6)	.6
23650		5970	1111.9															
23696		5970	1111.4															
23700					(1111.2)	1113.7		(1111.5)	2.2		(1112.5)	1.2		(1113.0)	.7		1113.0	.7
23711		5970	1110.9															
23900	24			5995	1101.8		7025	1102.2		10530	1103.3		12307	1103.8		12355	1103.9	

NOTE:
1. 50-yr storm discharge and elevation taken from Design Report Volume II, Page 3.1-27 to 33
2. FRS 2 spillway rating Hydrology Documentation supplement No. 1, Page 107
3. Storm No. 1 is 24-hour 50-year Type II storm 3.6 inches
   Storm No. 2 is 1984 Storm distribution -- 4.0 inches
   Storm No. 3 is 1984 storm distribution FRS to Sta 3000-4.0"; Sta 3000 to Sta 9500-5.0"; Sta 9500 to Sta 13000-5.5"; Sta 13000 to Sta 23900-6.0"
   Storm No. 4 is 1984 storm distribution FRS to Sta 3000-4.0"; Sta 3000 to Sta 6500-5.0"; Sta 6500 to Sta 13000-6.0"; Sta 13000 to 23900-7.0"
   Storm No. 5 is 1984 storm distribution FRS-3.0"; FRS to Sta 6500-5.0"; Sta 6500 to Sta 13000-6.0"; Sta 13000 to Sta 23900-7.0"
4. Elevations shown in parenthesis are interpolated values.

TABLE 4
HAROUAHALA VALLEY WATERSHED
Saddleback Diversion

Peak Discharge from Incremental Drainage Areas

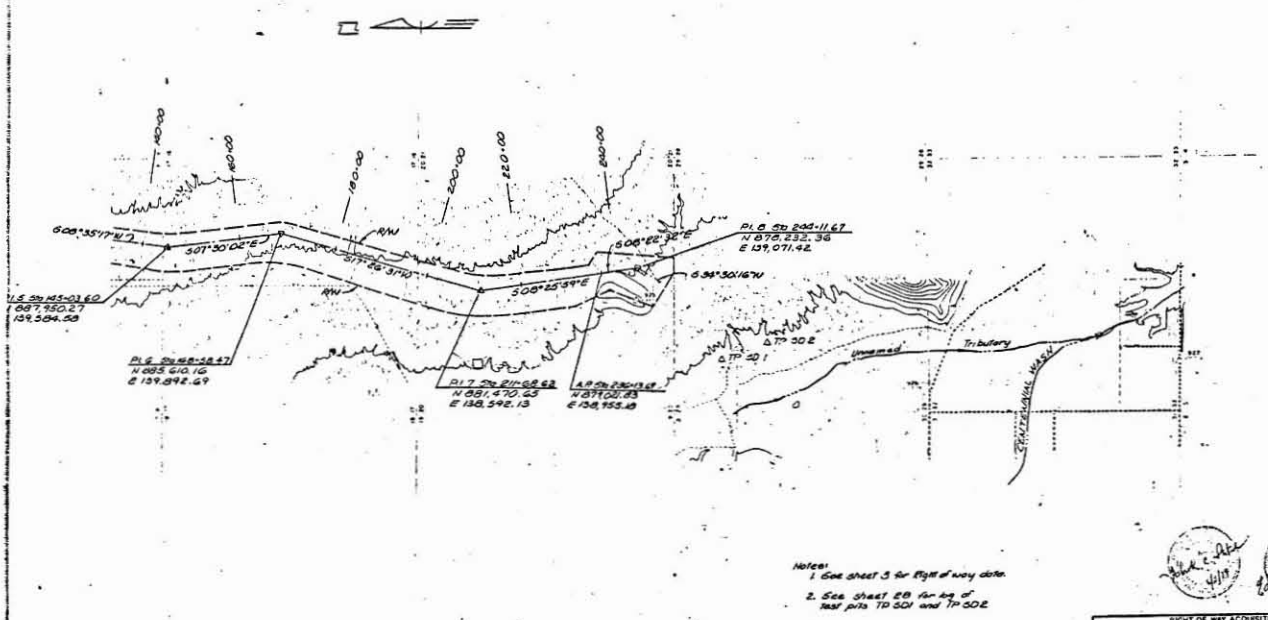
STATION	DESIGN Drainage Area Mi²	Discharge cfs	TYPE II STORM DIST. Drainage Area Mi²	Storm 1 cfs	Storm 2 cfs	1984 STORM DISTRIBUTIONS Storm 3 cfs	Storm 4 cfs	Storm 5 cfs	SIDE INLET Station	Capacity cfs
1000	.840	773	1 0.84						700	780
1090			2 .27	362	250	250	250	325		
1500			2A .02	44	20	20	20	26	1390	360
2200	.293	355								
3000			3 .15	271	142	142	142	184	2900	180
4500			4 .29	471	272	353	353	353	4161	180
5500			5 .10	193	95	123	123	123	5200	210
6500			6 .02	44	20	26	26	26	6125	180
6800	.554	739								
7500			7 .53	512	451	591	732	732		
8500			7 .53	512	451	591	732	732	8012	1020
8700	1.075	956								
9500			8 .14	253	132	171	210	210	9408	205
11000			9 .60	643	524	766	847	847	10814	545
12200	1.304	1220							12126	535
12500			10 .61	653	533	779	861	861		
13000			11 .16	206	147	214	236	236	12832	185
16000			12 1.06	880	856	1390	1655	1655	15796	880
17000			13 1.07	888	864	1404	1670	1670	17005	470
17500			14 .16	204	147	235	279	279	17398	180
18000	2.323	1740								
18500			15 .26	320	235	377	448	448	18365	255
20500			16 1.17	894	917	1490	1774	1774	20200	800
22500			17 1.08	825	846	1375	1637	1637	22080	805
23500			.10	181	94	150	178	178		
23800	2.623	1792								
23900			18 .43	528	389	626	743	743		471
24400	.4323	437								

NOTE: Storm 1 is 24-hour 50-year Type II Storm - 3.6 inches
Storm 2 is 1984 storm distribution - 4.00 inches
Storm 3 is 1984 storm FRS to Sta 3000 - 4.0"; Sta 3000 to Sta 9500 - 5.0"; Sta 9500 to Sta 13000 - 5.5"; Sta 13000 to Sta 23900 -6.0"
Storm 4 is 1984 storm FRS to 3000 - 4.0"; Sta 3000 to Sta 6500 - 5.0"; Sta 6500 - Sta 13000 - 6.0"; Sta 13000 to Sta 23900 - 7"
Storm 5 is 1984 storm FRS - 3.0"; FRS to Sta 6500 - 5.0"; Sta 6500 - Sta 13000 - 6.0"; Sta 13000 to Sta 23900 - 7"

HWM

DIKE FOUNDATION EXCAVATION SCHEDULE		
Stations	*Approx. Depth	Bottom width
122+00 to 123+00	3'	12'
123+00 to 127+00	5'	12'
134+50 to 145+00	3'	12'
161+00 to 178+50	4'	12'
184+00 to 185+50	3'	12'
189+50 to 199+50	4'	12'
225+00 to 236+50	5'	12'

*Final dike foundation to extend into caliche or firm material as directed by the Engineer.



Notes:
1. See sheet 3 for Right of way data.
2. See sheet 2B for log of test pits TP 50I and TP 50E.

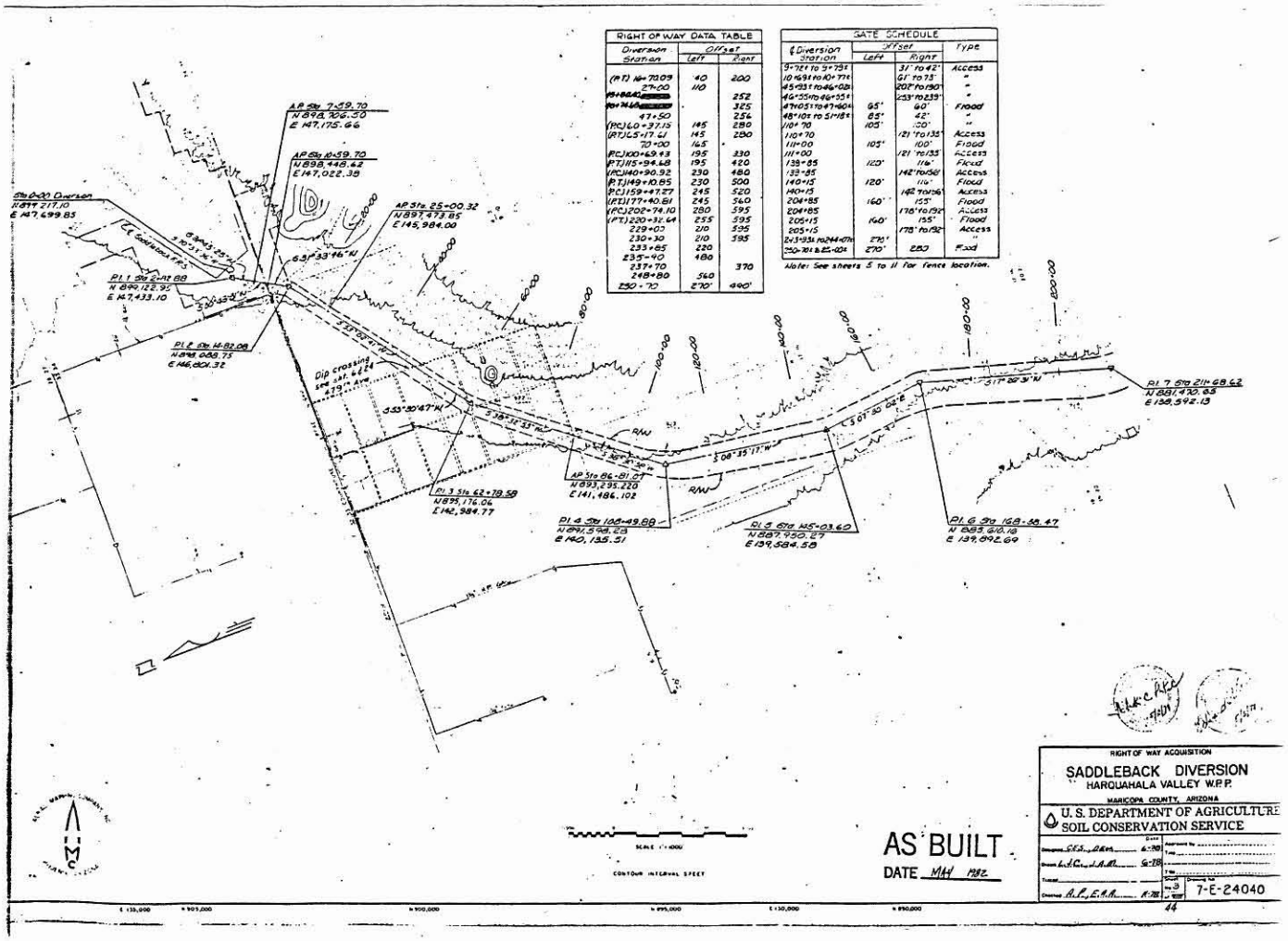
SCALE 1"=1000'

CONTOUR INTERVAL 5 FEET

AS BUILT
DATE MAY 1982

RIGHT OF WAY ACQUISITION
SADDLEBACK DIVERSION
HAROUAHALA VALLEY W.P.P.
MARICOPA COUNTY, ARIZONA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed C.E.S., D.E.M. 6-78
Drawn L.J.C. 6-78
Traced
Checked E.F., E.A.R. 6-78
Date
Approved by
Title
Date
Drawing No. 7-E-24040



RIGHT OF WAY DATA TABLE

Diversion Station	Offset Left	Offset Right
(PT) 16+70.09	40	200
27+00	110	
[illegible]		252
[illegible]		325
47+50		256
(PC) 60+37.15	145	280
(PT) 65+17.61	145	280
70+00	165	
(PC) 100+69.43	195	330
(PT) 115+94.68	195	420
(PC) 140+90.93	230	480
(PT) 149+10.85	230	500
(PC) 159+47.27	245	520
(PT) 177+40.81	245	560
(PC) 200+74.10	280	595
(PT) 220+32.64	255	595
229+00	210	595
230+30	210	595
233+85	220	
235+40	480	
237+70		370
248+80	560	
250+70	270'	490'

GATE SCHEDULE

℄ Diversion Station	Offset Left	Offset Right	Type
9+72.5 to 9+79.5		31' to 42'	Access
10+69.5 to 10+77.5		61' to 73'	"
45+23.5 to 46+02.5		207' to 190'	"
46+55.5 to 46+55.5		253' to 239'	"
47+05.5 to 47+60.5	65'	60'	Flood
48+10.5 to 51+18.5	65'	42'	"
110+70	105'	120'	"
110+70		121' to 135'	Access
111+00	105'	100'	Flood
111+00		121' to 135'	Access
139+85	120'	116'	Flood
139+85		142' to 156'	Access
140+15	120'	116'	Flood
140+15		142' to 156'	Access
204+85	160'	155'	Flood
204+85		176' to 192'	Access
205+15	160'	155'	Flood
205+15		176' to 192'	Access
243+93.5 to 244+07.5	270'		"
250+70.1 & 251+00.1	270'	280	Flood

Note: See sheets 5 to 11 for fence location.

TABLE 1
Harquahala Valley Watershed
Saddleback Diversion

Structure Damage Study - September 1984 Storm

Str 2	-	Sta 13+90	Structure did not overtop but overtopped training dike DS of structure.	
		Sta 15+00	HWM side entrance channel	1180.6
		Sta 15+00	HWM diversion	1175.8
Str 3	-	Sta 29+00	Structure Overtopped .4 foot	
		Sta 29+50	HWM side entrance channel	1171.1
		Sta 29+50	HWM diversion	1167.2
		Sta 31+00 to 35+00 overbank inflow to diversion		
Str 4	-	Sta 35+50	Begin side entrance channel	
		Sta 37+00	Flow over side entrance channel bank .4'	
		Sta 37+00	HWM diversion	1164.9
		Sta 38+50	Flow over entrance channel bank	
		Sta 41+00	HWM side entrance channel	1167.4
		Sta 41+00	HWM diversion	1164.3
		Sta 41+54	Side entrance channel bank breached	
		Sta 41+61	Str 4	
		Sta 42+50	HWM diversion	1163.8
		Sta 44+00	Side entrance channel bank overtopping	
		Sta 51+90	HWM side entrance	1164.2
			HWM diversion	1162.1
Str 5	-	Sta 52+00		
		Sta 52+50	Side entrance overtopped	
Str 6	-	Sta 61+25	Not overtopped	
		Sta 61+25	HWM diversion	1160.0
		Sta 63+50-66+00	Side entrance overtopped and breached in places.	
		Sta 68+50	Side entrance overtopped & breached	
		Sta 73+00	Side entrance channel begins overtopped in/out	
		Sta 77+00	HWM side entrance channel	1161.6
			HWM diversion	1157.1
		Sta 79+00	HWM diversion	1156.9

Str 7	-	Sta 80+12	Eroded around both abutments	
		Sta 86+00	Over bank flow to here narrow Terrace begins-breached at 86+80	
		Sta 88+00	HWM diversion	1151.1
		Sta 88+60	Terrace breach	
		Sta 89+00	Begin breach & severe bank erosion	
		Sta 90+00	Begin side inlet to Str 8	
		Sta 91+60	Begin side inlet embankment overtop	
		Sta 93+00	Severe bank erosion	
Str 8	-	Sta 94+08	Eroded around both abutments	
		Sta 101+00	Side entrance overtopped to here	
		Sta 103+00	Begin side entrance channel to Str 9 some flow around end	
		Sta 104+00	HWM diversion	1148.7
		Sta 105+00	Entrance overtopped severe bank erosion	
		Sta 107+00	Entrance overtopped-severe bank erosion	
Str 9		Sta 108+00	N. abutment overtopped	
		Sta 109+00	Sheet flow severe bank erosion	
		Sta 115+00	HWM diversion	1145.8
		Sta 117+00	Begin side inlet channel to Str 10	
		Sta 120+00	Side inlet channel overtopping begins	
			HWM diversion	1145.1
			HWM side inlet channel	1147.6
Str 10	-	Sta 121+00	Str 10	
		Sta 127+00	HWM diversion	1143.7
		Sta 127+00	Side inlet overtopped	
Str 11	-	Sta 128+30	Str overtopped	
		Sta 128+80	HWM side inlet	1146.3
		Sta 134+00	Side inlet channel overtopped	
		Sta 135+90	Side inlet channel breached	
		Sta 138+00	HWM diversion	1140.3
		Sta 139+40	Side inlet channel overtopped and breached-severe erosion	
		Sta 144+30	HWM diversion	1137.4
		Sta 147+00	HWM diversion	1132.5
			Side inlet channel overtopped and breached.	
		Sta 155+75	Side inlet channel overtopped and breached.	
			Side inlet channel blocked with gravel bar.	
Str 12	-	Sta 158+00	Breached around both abutments	
		Sta 161+00	Begin side inlet channel to Str 13	
		Sta 163+00	HWM diversion	1130.8
			Side inlet channel overtopping begins severe erosion.	

Str 13	-	Sta 170+00		
		Sta 171+20	Side inlet channel breached.	
Str 14	-	Sta 174+00	Washed around both abutments	
		Sta 175+00	HWM side inlet channel	1129.6
			HWM diversion	1127.7
		Sta 177+00	Severe erosion to here	
		Sta 179+00	HWM diversion	1126.9
		Sta 179+00	HWM side inlet channel	1128.7
		Sta 182+00	HWM side inlet channel	1127.3
			HWM diversion	1126.4
		Sta 182+70	Side inlet channel breached to Sta 183+50	
Str 15	-	Sta 184+00	Eroded both abutments	
		Sta 188+00	HWM diversion	1125.0
		Sta 190+00	Stream starting to cut into Div	
		Sta 195+00	Begin overtopping DS	
		Sta 196+00	HWM side inlet channel	1125.4
		Sta 196+30	Breach into diversion	
		Sta 197+50	End breach into diversion	
		Sta 198+00	HWM side inlet	1125.4
			HWM diversion	1123.7
		Sta 199+50	Begin breach into diversion	
		Sta 201+00	End breach into diversion	
			HWM side inlet	1123.3
			HWM diversion	1122.7
Str 16	-	Sta 202+00	The structure not referenced in notes and does not appear on photo. As built plans show it in place. It appears that the inlet may have been shaped and no structure built.	
		Sta 202+75	Cut into diversion 3' deep 30' wide	
		Sta 207+50	Begin breach into diversion	
		Sta 212+00	HWM side inlet	1121.7
			HWM diversion	1120.0
		Sta 219+00	HWM side inlet	1120.1
			HWM diversion	1118.6
Str 17	-	Sta 220+80	Eroded US abutment overtopped US & DS 25'	
		Sta 221+50	HWM side inlet	1120.0
			HWM diversion	1117.6
		Sta 230+00	HWM diversion	1115.5
		Sta 236+00	HWM diversion	1114.2
		Sta 237+00	HWM diversion	1113.7

STR 18 - Not included, design [illegible] but Str 18 [illegible]

① Lady on 481 st said they had gage ~~in~~
; She was in Calif when storm came other
members of family said 6"

② 4". Charlie Nye - Big Horn Ranch
491st Farm Manager - 4" in less than
2 hours - Occurred at Midnight
Had rain about week before.

③ 4.5" Tom Sykes in less than 2 hrs
511st Dadly Greer Farm

4. Mr Rogers - Had rain about 10 days before
3 barrell set Water Office - Caught 8"
Thinks rained more in flat than on
Mountain.

5. Steve Pocock Hdg 6"+
Vineyard

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For future work:

1) include info. on total watershed TIBER and upper Centennial
2.) include volume check
3.) rate Centennial using SCS data.

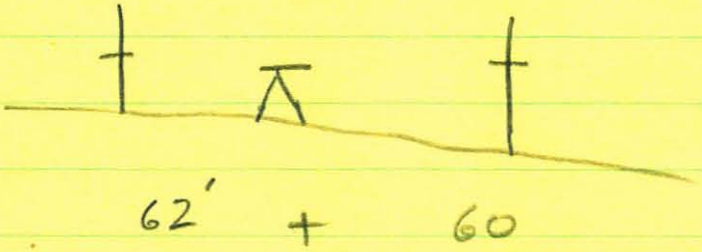
CENTENNIAL WASH

OPE CALCULATIONS:

LB 4.53 - 5.07 - 4.87

.54 + .2 = .74/122

= 0.006 ft/ft



62' + 60

CH 1.62 + .69 = 2.31/126

= 0.018 ft/ft.

RB .3 + .01 = .31/

= 0.003 ft./ft. 62+

	BS	HI	FS	ELEV.		DIST.		COMMENTS
STATION: 0				0				0
1		5.05	6.12	1.07		6.41/5.86		55
2.			8.72	3.67				113
3				4.5				174
4				6.08				242
5				6.26				274
6				6.17				366
7				6.40				432
8				2.61				489
9				6.38			(+	505)
10	7.27	5.07	4.16 +	2.2	6.36			428 ~~604~~
				.61	4.77	612		371 789
12				2.1	6.26	669		3.14 796
13				2.03	6.19	730		253 857
14				1.02	5.18	791		192 918
15				.57	4.73	851		132 978
16				.36	4.52	911		72 1038
17				.69	3.47	1044		61 1099
18				1.42	2.74	1106		123 1161
19				2.28	1.88	1169		186 1224
20				3.14	1.02	1231		248 1286
				5.59				1231 ft.

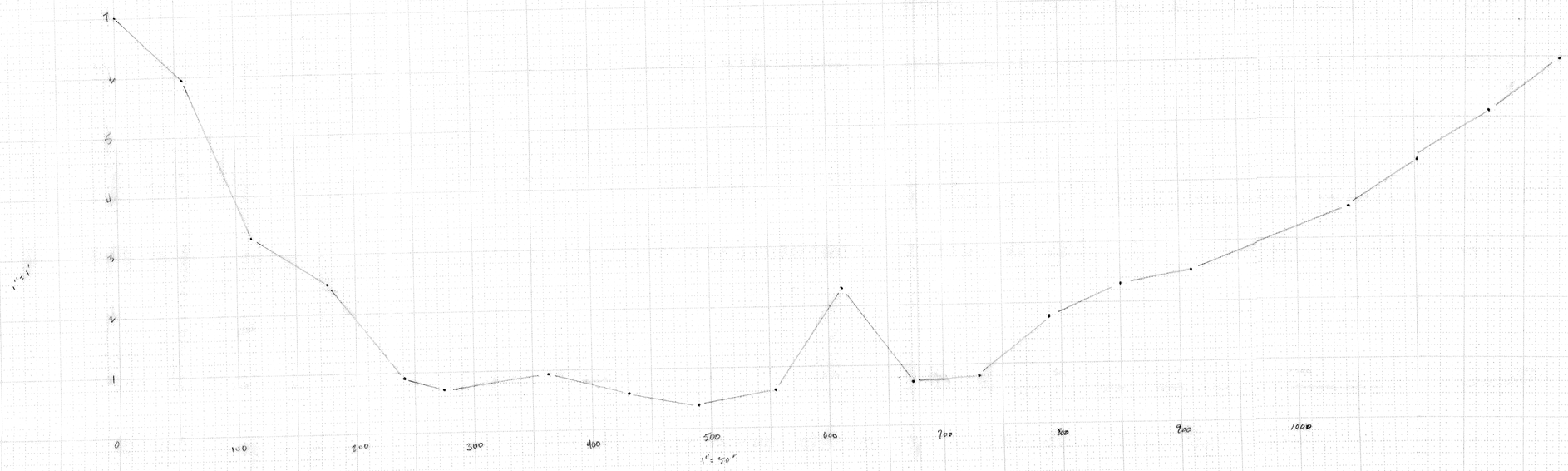
X-S BASELINE RD.

WSE HI = 5.05

ST		FS	T	B	D
1.		6.12	6.41	5.86	ON ROAD
2.		8.72	9.28	8.15	ON ROAD
3.		9.55	10.41	8.67	TOP OF BERM
4		11.13	12.32	9.90	IN WASH
5		11.31	12.82	10.78	
6.		11.22	13.04	9.38	
7		11.45	13.60	9.28	
8		11.66	14.10	9.21	
TP 9	HI = 7.29	11.43	14.18	9.63	TP
TP 10		7.27	9.39	5.11	BOTTOM OF TRENCH
11		5.68	7.55	3.84	BACK UP TO WASH
12		7.17	8.74	5.60	
13		7.10	8.36	5.83	
14		6.09	7.05	5.13	
15		5.64	6.30	4.98	
16		5.43	5.79	5.07	
17	5.07	TP			
18		4.30	4.69	4.08	
19		3.65	4.26	3.03	
20		2.79	3.72	1.86	
21		1.93	3.17	0.69	BANK

FINAL SURVEY	SURVEYED	BY	DATE
NOTE BOOK	PLOTTED		
NO.	VOLUME		
	AREAS		
	AREAS CHECKED		

ORIGINAL SURVEY	SURVEYED	BY	DATE
NOTE BOOK	PLOTTED		
NO.	VOLUME		
	AREAS		
	AREAS CHECKED		



PLAT 3 CROSS SECTION - DOTTED
CHARLES BRUNING COMPANY
MADE IN U.S.A.

COPY Given
HCFCD on 12/12/85
Hm

CHANNEL X-SECTIONS
CENTENNIAL WASH

FLOOD CONTROL DISTRICT
RECEIVED
AUG 20 '86

	CH ENG		HYDRO
	ASST		LMgt
	ADMIN		SUSP
	C & O		FILE
	ENGR		DESTROY
	FINANCE		BCD
REMARKS			

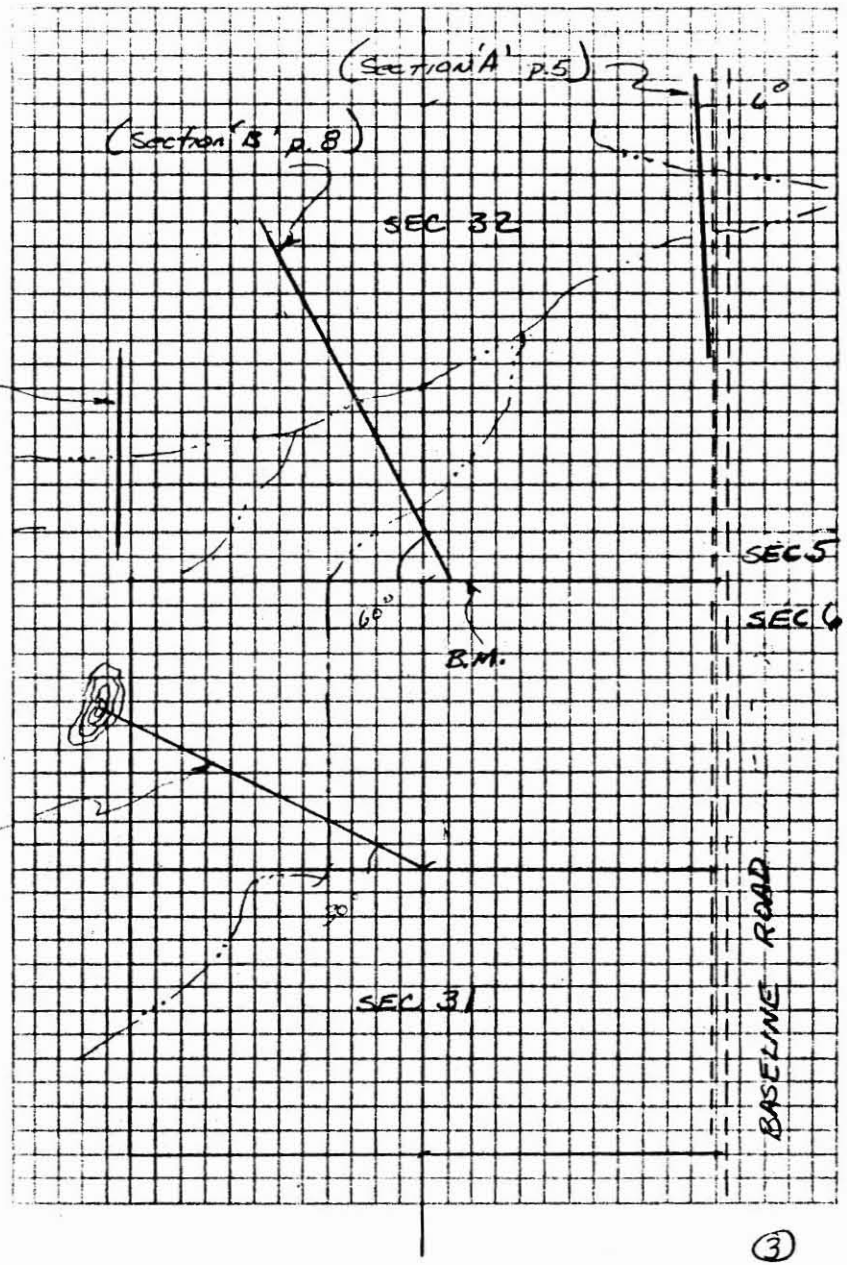
CHANNEL X-SECTIONS
OF
CENTENNIAL WASH

(SECTION 'C' p.10)

North ← T. 1 N.
R. 8 W.

(SECTION 'D' p.12)

0+00 is Lt Side of
Channel for ALL Sections



CENTENNIAL WASH

12-12-84

D. Clough P. Jose

SECTION 'A'

STA	BS	HI	F.S.	Elev	
BM	0.46			1000.00	(Assigned)
TBM	4.10	997.23	7.33	993.13	
	0+00 is Lt. Side of Channel				
13+24			5.3	991.9	
13+09			5.6	91.6	
12+78			11.3	85.9	
12+32			10.4	86.8	
11+82			11.7	85.5	
10+82			11.0	86.2	
T.P.	4.61	989.94	11.90	~~85.3~~	
9+82			4.5	85.4	
T.P.	5.11	990.71	4.34	~~85.~~	

2 1/4" Salinity Pipe in Ground, reads: E 1/4.
200' S of Mid-section Line Sec 31/Sec 32
W. Side of Road.

Nail in Power Pole, N. side of Baseline Rd.
1800' E. of Sec 31/32
6/5

Top of Dike around Pond

H.W.L. is 5 3 above ground.

SECTION 'A'

		990.71			
8+97			4.8	985.9	
8+22			5.0	85.7	
7+72			5.2	85.5	
7+40			4.7	86.0	
7+07			6.8	83.9	
6+99			5.2	85.5	
6+74	13.28	999.47	4.52	86.2	
6+36			13.4	86.1	
			8.9	90.6	
5+80			12.7	86.8	
5+72			15.6	83.9	

High water line at sta. 6+09 (Not ground!)

SECTION 'A'

		999.47			
5+56			14.8	984.7	
5+53			12.7	86.8	
5+27			12.4	87.1	
4+25			12.4	87.1	
3+10			10.8	88.7	
2+07			10.1	89.4	
1+04			7.9	91.6	
0+00			5.2	94.3	

High water line (?)

SECTION 'B'

12-12-84

STA	BS	FS	1st Red.	Elev.	
BM	+7.99			1000.00	(ASSIGNED)
0+00		+6.6	-1.4	998.6	
1+88		+4.5	-3.5	96.5	
3+11		+2.8	-5.2	94.8	
4+89		+1.1	-6.9	93.1	
6+28		+0.4	-7.6	92.4	
7+78		-0.3	-8.3	91.7	
9+54		-0.5	-8.5	91.5	
11+23		-0.3	-8.3	91.7	
13+09		-0.3	-8.3	91.7	

2 1/4 Salinity Pipe in ground. 200' S of Mid section line, Sec 31/ Sec 32

HIGH WATER LINE IS 1.0' above ground

HIGH WATER LINE IS 3.8' above ground

HIGH WATER LINE IS 3.5' above ground

SECTION 'B'

STA		FS	1st Rod	ELEV	
14+49		+0.3	-7.7	992.3	
16+29		+0.9	-7.1	92.9	
17+95		+1.5	-6.5	93.5	
18+36		-0.7	-8.7	91.3	
18+43		+3.2	-4.8	95.2	
19+24		+2.2	-5.8	94.2	
21+40		+4.6	-3.4	96.6	
23+48					

Location Date 12-12-84

HIGH WATER LINE IS 4' above ground

HIGH WATER LINE IS 3' above ground

Bottom of WASH 12' width 4' Depth

Top of Road @ Sec Line Sec 31/Sec 32

SECTION 'C'

CENTENNIAL WASH

Date 12-13-84

D. Clough P. Jose

STA	BS	FS	1st Red	ELEV	
BM	-8.90			1000.00	(ASSIGNED)
TBM	-0.88	-5.64		1003.26	
0+00		-0.2	+0.7	1004.0 ~~1001.0~~	
0+21		-3.2	-2.3	1001.0	
0+48		-5.7	-4.8	998.5	
1+33		-5.9	-5.0	98.3	
2+57		-6.7	-5.8	97.5	
3+61		-6.2	-5.3	98.0	
4+90		-6.7	-5.8	97.5	
5+89		-7.3	-6.4	96.9	
6+73		-6.8	-5.9	97.4	

2 1/4" SALINITY PIPE in Ground, 200' S of MIDSECTION Line Sec 31/Sec 32

TOP of Salinity Pipe

HIGH WATER LINE

SECTION 'C'

12-13-84

STA	BS	FS	1st Rad.	Elev
	-0.88			1003.24
8+04		-7.9	-7.0	996.3
8+26		-6.7	-5.8	97.5
9+96		-5.4	-4.5	98.8
10+66		-5.1	-4.2	99.1
~~11+12~~		-3.4	-2.5	1000.8
~~11+12~~ ~~0+0~~		-4.0	-3.1	1000.2
0+00		+2.3	+3.2	1006.5

HIGH WATER LINE @ sta 10+85

SECTION 'D'

12-13-84

STA	BS	FS	1st Red.	Elev	
BM	-8.90			1000.00	(ASSIGNED)
0+00		+4.0	+12.9	1012.9	
0+63		-4.0	+4.9	1004.9	
2+71		-4.9	+4.0	1004.0	
5+98		-5.3	+3.6	1003.6	
11+07		-6.5	+2.4	1002.4	
15+73		-8.0	+0.9	1000.9	
19+45		-8.8	+0.8	1000.8	
20+97		-9.6	-0.7	999.3	
21+81		-10.2	-1.3	998.7	
22+33		-10.5	-1.6	998.4	

2¼" SALINITY PIPE, 200' S of Midsection Pt. Sec Line Sec 31/Sec 32

SECTION 'D'

12-13-84

STA	BS	ES	1st Rath	Elev.
	-8.90			1000.00
22+40		-9.6	-0.7	999.3
22+54		-9.5	-0.6	99.4
22+61		-13.8	-4.9	95.1
22+76		-9.8	-0.9	99.1
22+97		-9.4	-0.5	99.5
~~23+03~~ ?		-6.9	+2.0	1002.0
23+90		-10.3	-1.4	98.6
24+57		-10.1	-1.2	98.8
25+98		-10.4	-1.5	98.5
27+10		-10.6	-1.7	98.3
27+39		-8.5	+0.4	1000.4

High Water Line @ sta 23+03

SECTION 'D'

12-13-84

STA	BS	FS	1st Rod	Elev
	-8.90			1000.00
29+53		-8.0	+0.9	1000.9
31+20		-7.8	+1.1	1001.1
31+92		-6.7	+2.2	1002.2

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PROJECT TITLE: Saddleback F. R. S. & Diversion

WATERSHED AND RELATIONSHIP TO OTHER STRUCTURES: Harquahala Valley Watershed
This structure sits just below the Harquahala F. R. S. & Floodway

LOCATION: T2N R8W Sections 34, 27, 28, 21, 16, & 17
This project is about 8 miles west of Tonopah, Arizona, and just south of Interstate 10. Travel south of Tonopah to Salome Road, then west about 7.5 miles to south end of structure.

AUTHORIZATION: Watershed Pretection and Flood Prevention Act, Public Law 566, 83rd Congress

FEDERAL SPONSOR: Soil Conservation Service

LOCAL SPONSOR: Flood Control District of Maricopa County
Buckeye - Roosevelt NRCD
Wickenberg NRCD

DOCUMENTATION: Final Environmental Impact Statement dated March 1977
Harquahala Valley Watershed
Supplemental Watershed Work Plan No. 1, March 1977

CONTRACTOR: M & B Contracting Corp.

DATE OF CONSTRUCTION AWARD: September, 1980

DATE OF FINAL ACCEPTANCE: April 7, 1982

FUNCTIONTAL DESCRIPTION:
This structure receives water from the Harquahala F. R. S. discharge and runoff water from a 29.6 square mile drainage area. This water is routed through the principal spillway at the south end of the structure into the Saddleback Diversion Channel to a tributary of the Centennial Wash.

PROJECT FEATURES:

Type of structure.....Compacted earthfill with center drainage core
Top of structure elevation...1193.0
Length of structure.....5.27 feet
Maximum height.....22 feet
Top crest width.....12 feet
Spillway crest elevation.....No emergency spillway
Spillway capacity....." " "

Drainage area.....29.6 square miles
Storage capacity.....42.47 acre feet
Maximum water surface elevation....1193.0
Freeboard.....
Peak inflow.....
Peak outflow.....
Drawdown time.....8.5 days
Principal outlet discharge rate....1100 CFS
Principal outlet structure.....8' x 10' concrete conduit

LEVEL OF PROTECTION: 100-year flood

Costs:

Federal: $1,800,000.00

Local: Land, relocations, engineers; total $349,460.00

ADWR OPERATIONAL CERTIFICATE ISSUED: date

ENCLOSURES: Site Map - Attached

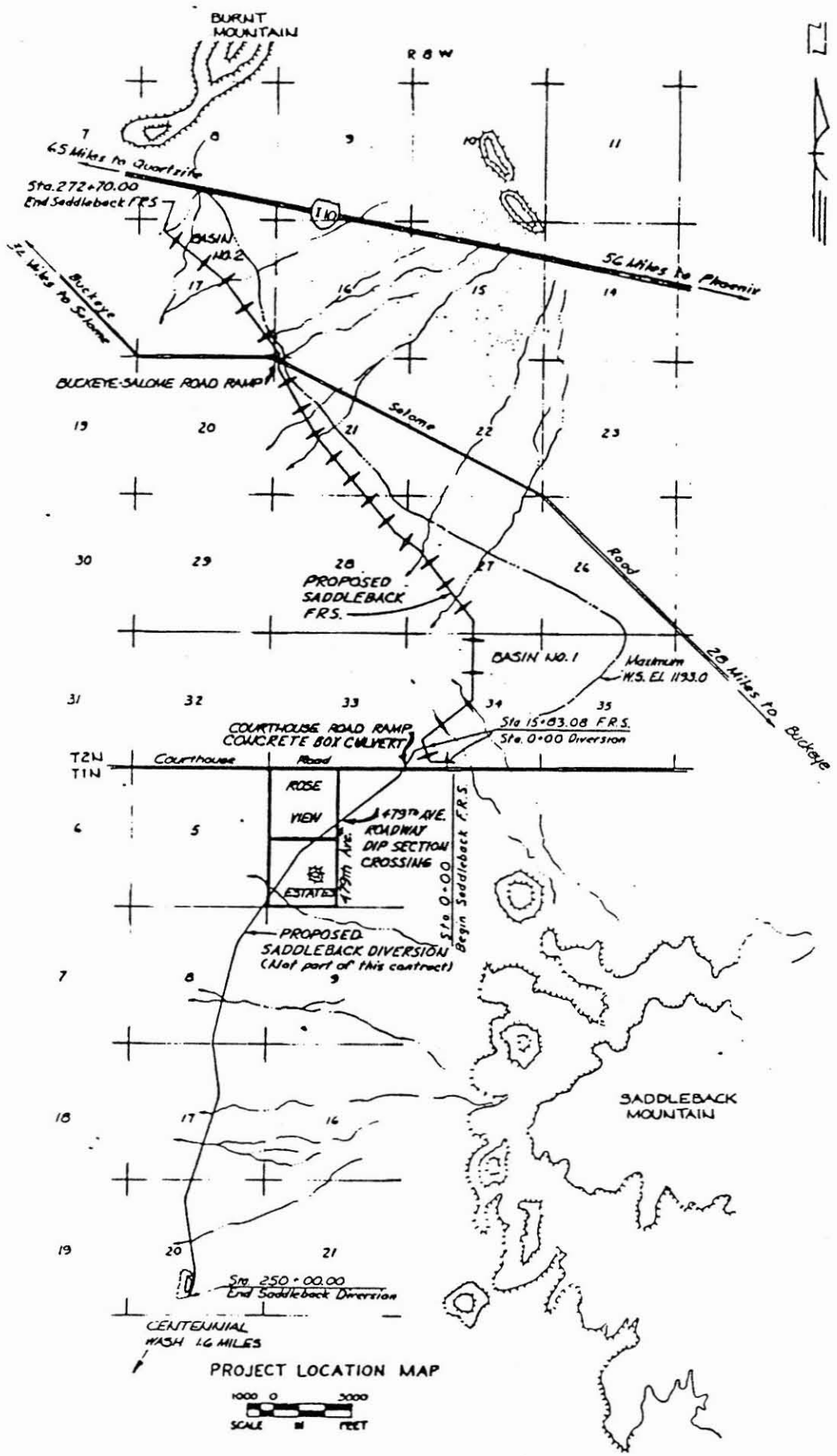
Stage Storage Curve

Stage Discharge Curve - Attached

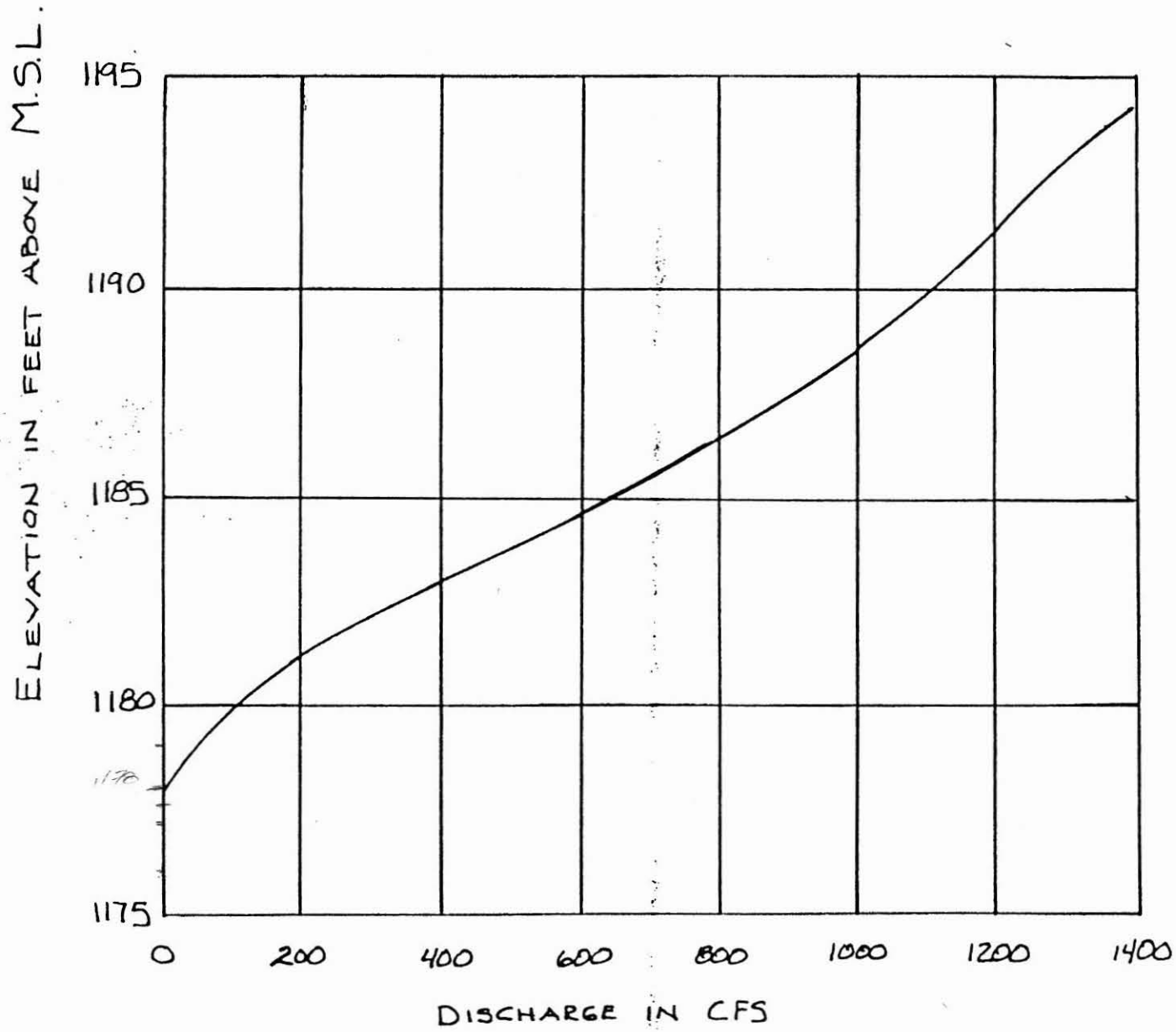
Storage Discharge Summary

Area and Capacity Curve - Attached

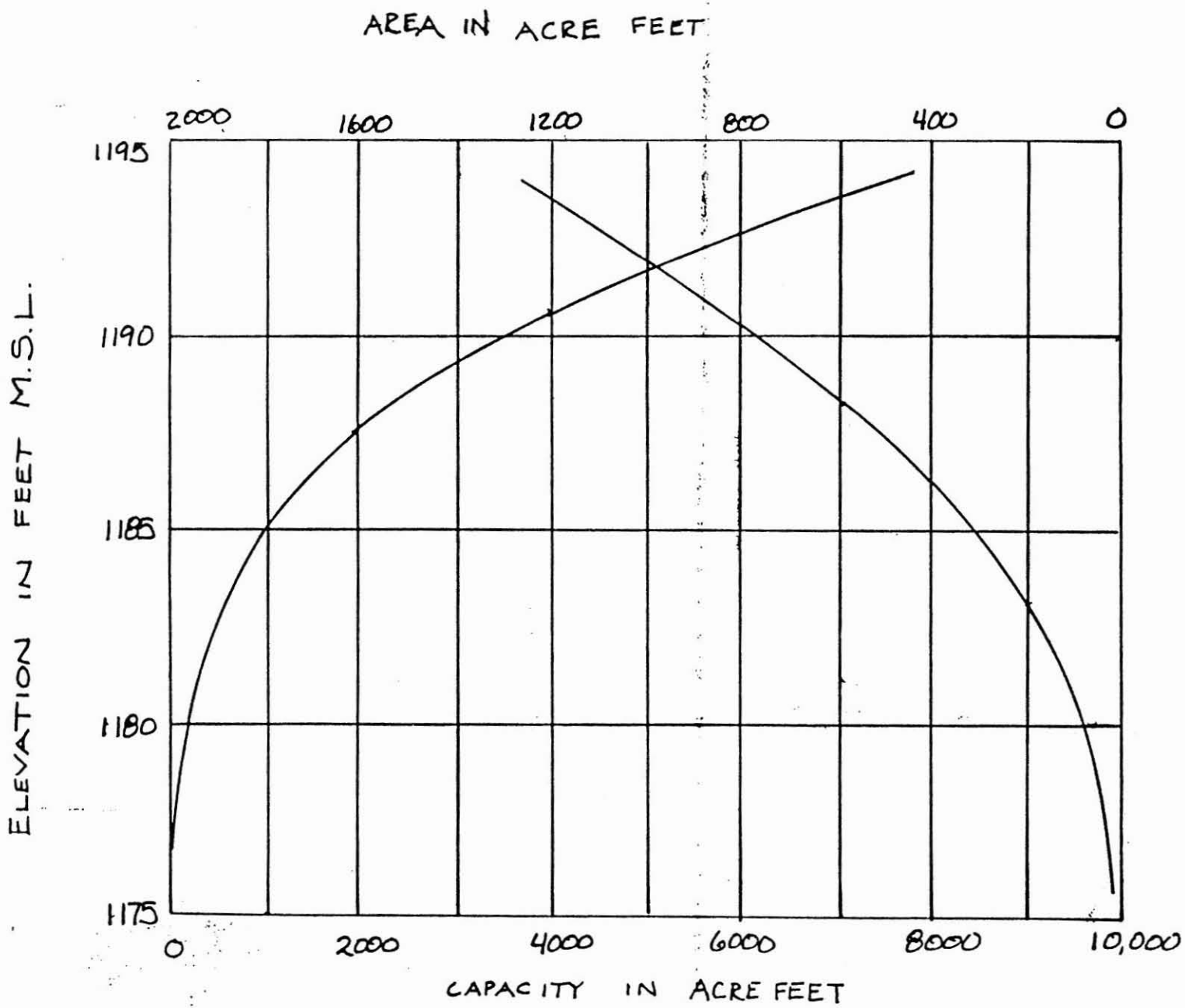
DAM SAFETY STATUS



PROJECT LOCATION MAP



OUTLET DISCHARGE CURVE — SADDLEBACK F.R.S.



AREA & CAPACITY CURVES - SADDLEBACK F.R.S.

MAINTENANCE RESPONSIBILITIES

Structure:
Saddleback FRS 6A331

Bank Protection - Riprap		acres
Bridges - Pedestrian		each
Bridges - Vehicle		each
Culverts, Box		each
Culverts, Pipe		each
Drainage Channel - Lined		feet
Drainage Channel - Unlined		miles
Drop Structure	2	each
Embankment	24	acres
Embankment, Soil Cement		acres
Fencing	54,912	feet
Floodway - Lined		feet
Floodway - Unlined		acres
Gated Outlet	2	each
Gates	24	each
Gutters, Concrete		feet
High Flow		acres
Landscape		acres
Low Flow	92.7	acres
Manholes		each
Meter Houses		each
Outlet Structure	1	each
Pilot Channel		miles
Pool Area	879	acres
Principal Outlet	65	feet
Ramps, Concrete		feet
Retaining Wall		feet
Right-of-Way		acres
River Clearing		acres
Roads - Asphalt		miles
Roads - Dirt	10.4	miles
Side Inlet		each
Spillway - Earth		acres
Spillway - Lined		feet
Stilling Basins	2	each
Stormdrain Pipe		feet
Trash Racks	2	each
Vegetative Drains	2	each

PROJECT TITLE: HARQUAHALA F. R. S.

WATERSHED AND RELATIONSHIP TO OTHER STRUCTURES:
Harquahala Valley Watershed
This Structure sits above the Saddleback F. R. S. and just above and parallel to the Central Arizona Project.

LOCATION: T2N R8W Sections 4 & 5
T3N R8W Sections 30,31 & 32
T3N R9W Sections 26,25,24,23,22,21,20 & 19
T3N R10W Sections 24,23,22 & 15
This project is about 13 miles west of Tonopah, Arizona, just north of Interstate 10. It is just north of and adjacent to to CAP Aqueduct west of Burnt Mountain.

AUTHORIZATION: Watershed Protection and Flood Prevention Act, Public Law, 566, 83rd Congress.

FEDERAL SPONSOR: Soil Conservation Service

LOCAL SPONSOR: Flood Control District of Maricopa County
Buckeye - Roosevelt NRCD
Wickenberg NRCD

DOCUMENTATION: Final Environmental Impact Statement dated March, 1977

CONTRACTOR: M. M. Sundt Construction Company

DATE OF CONSTRUCTION AWARD: September, 1981

DATE OF FINAL ACCEPTANCE:

FUNCTIONTAL DESCRIPTION: How it works - It collects runoff water from a 102.3 square mile area and routes it to the east end of the structure. The water is routed through the principal spillway and then through several drop structures of the Harquahala Floodway to the low flow channel of the Saddleback F. R. S.

PROJECT FEATURES:

Type of structure.....Compacted earthfill with center drainage core
Top of structure elevation.....1419.7
Length of structure.....11.5 miles
Maximum height.....55 feet
Top crest width.....14 feet
Spillway crest elevation.....1408.4

Spillway capacity.....9650 CFS
Drainage area.....102.3 sqyae miles
Storage capacity.....10,911 acre feet
Maximum water surface elevation....1412.66
Freeboard.....
Peak inflow.....
Peak outflow.....
Drawdown time.....9 days
Principal outlet discharge rate....485 CFS
Principal outlet structure.....4' x 12' concrete structure into 48" diameter ungated pipe

LEVEL OF PROTECTION: 100-year Flood

COSTS:

Federal: $8,500,000.00

Local: Land, relocations, engineers; total $

ADWR OPERATIONAL CERTIFICATE ISSUED: date

ENCLOSURES: Site Map - Attached

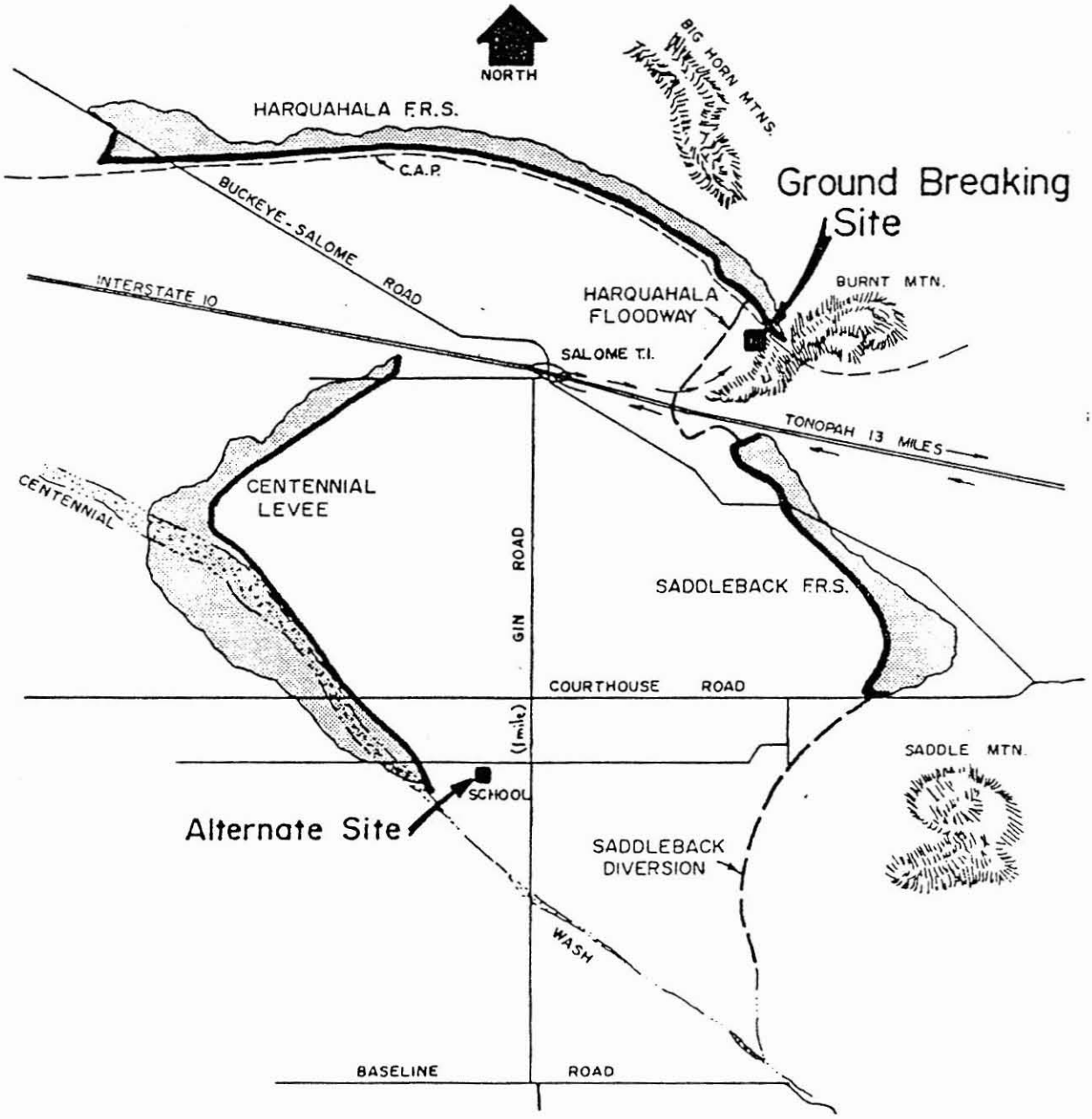
Stage Storage Curve - Attached

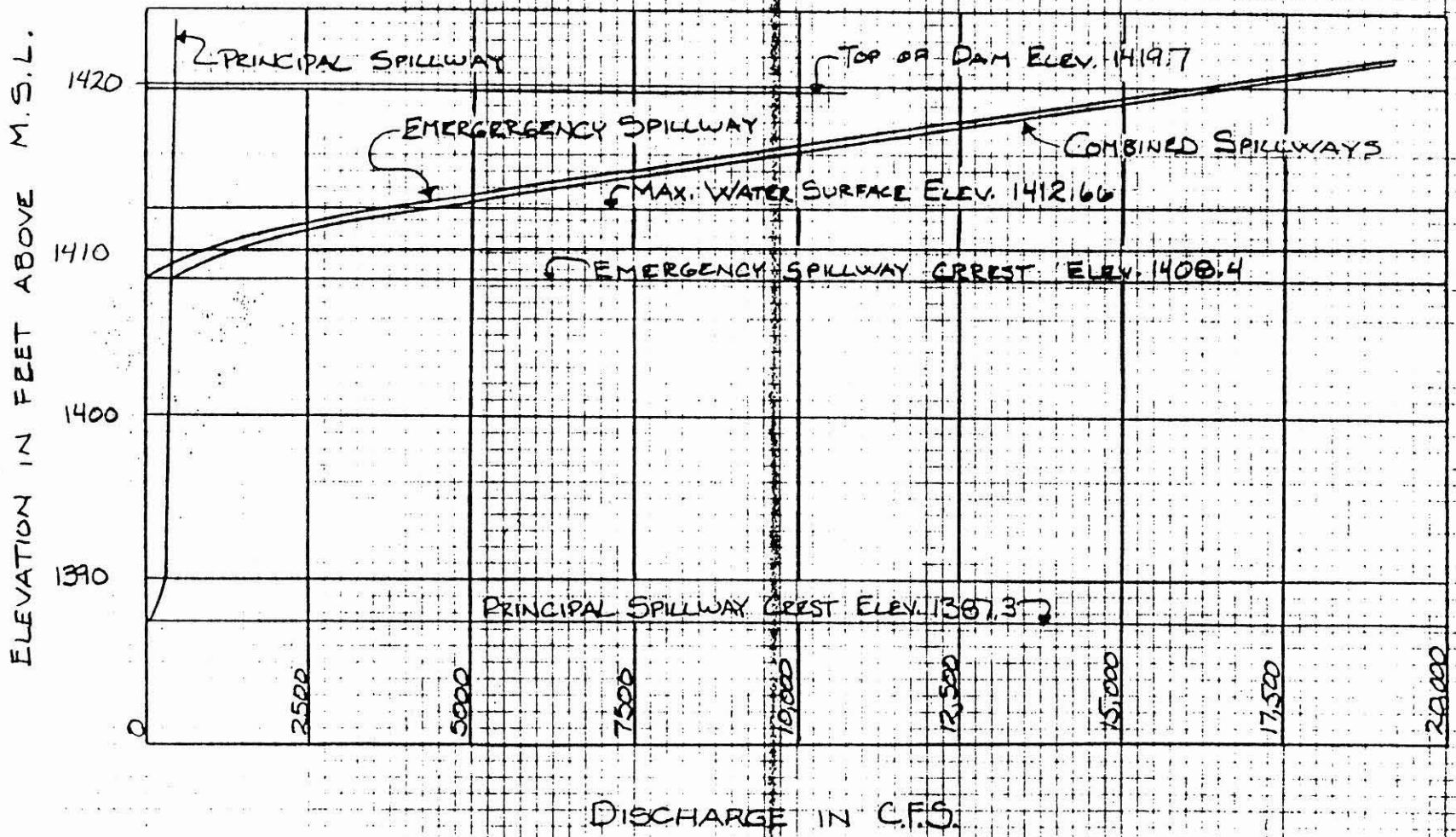
Stage Discharge Curve - Attached

Storage Discharge Summary - Attached

Area and Capacity Chart - Attached

DAM SAFETY STATUS

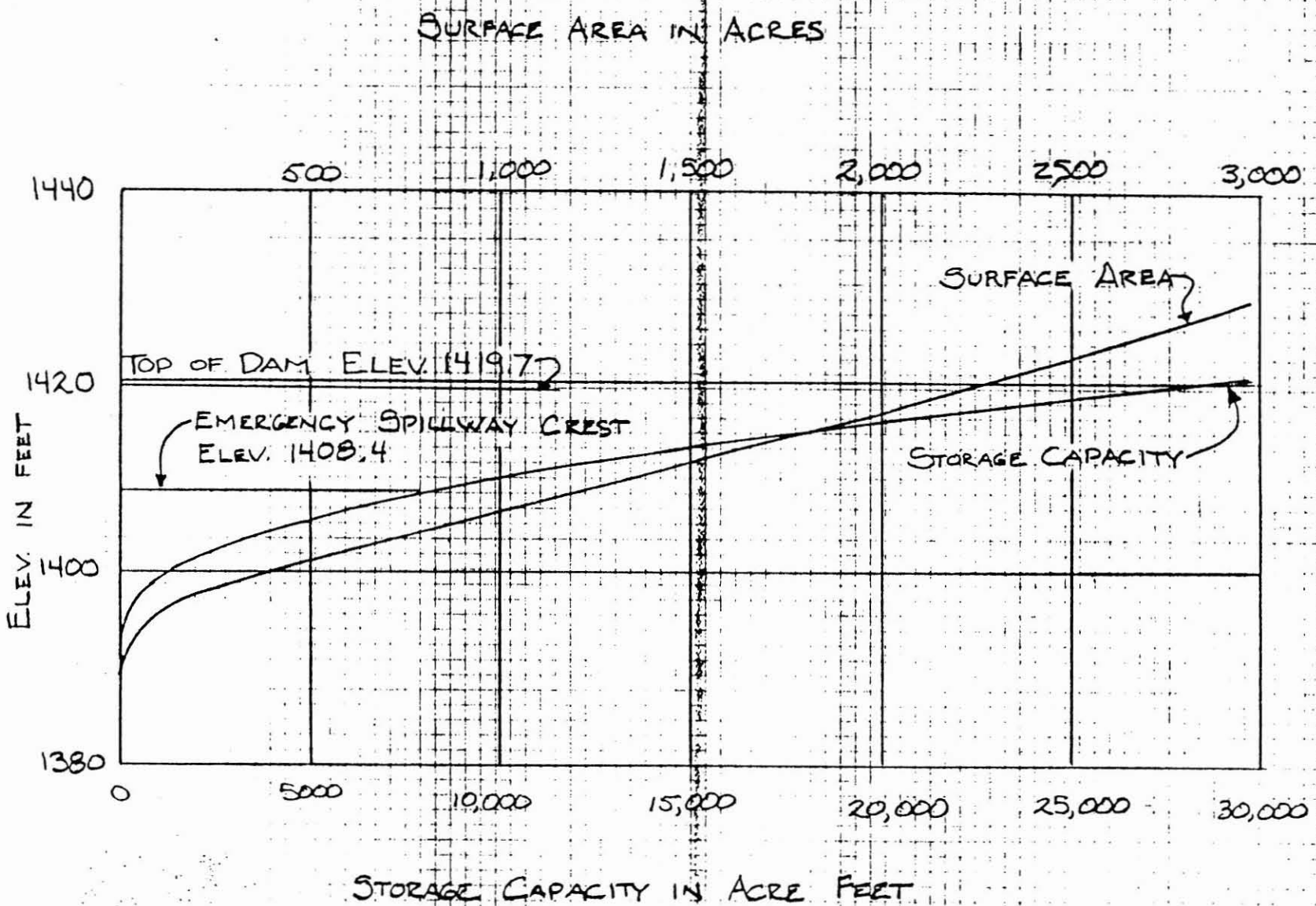

NORTH
BIG HORN MTNS.
HARQUAHALA F.R.S.
C.A.P.
Ground Breaking Site
BUCKEYE-SALOME ROAD
INTERSTATE 10
HARQUAHALA FLOODWAY
BURNT MTN.
SALOME T.I.
TONOPAH 13 MILES
CENTENNIAL
CENTENNIAL LEVEE
GIN ROAD
SADDLEBACK F.R.S.
COURTHOUSE ROAD
(1 mile)
SADDLE MTN.
SCHOOL
Alternate Site
SADDLEBACK DIVERSION
WASH
BASELINE ROAD



SPILLWAY DISCHARGE CURVE — HARQUAHALA F.R.S.

SHEET NO. ____ OF ____

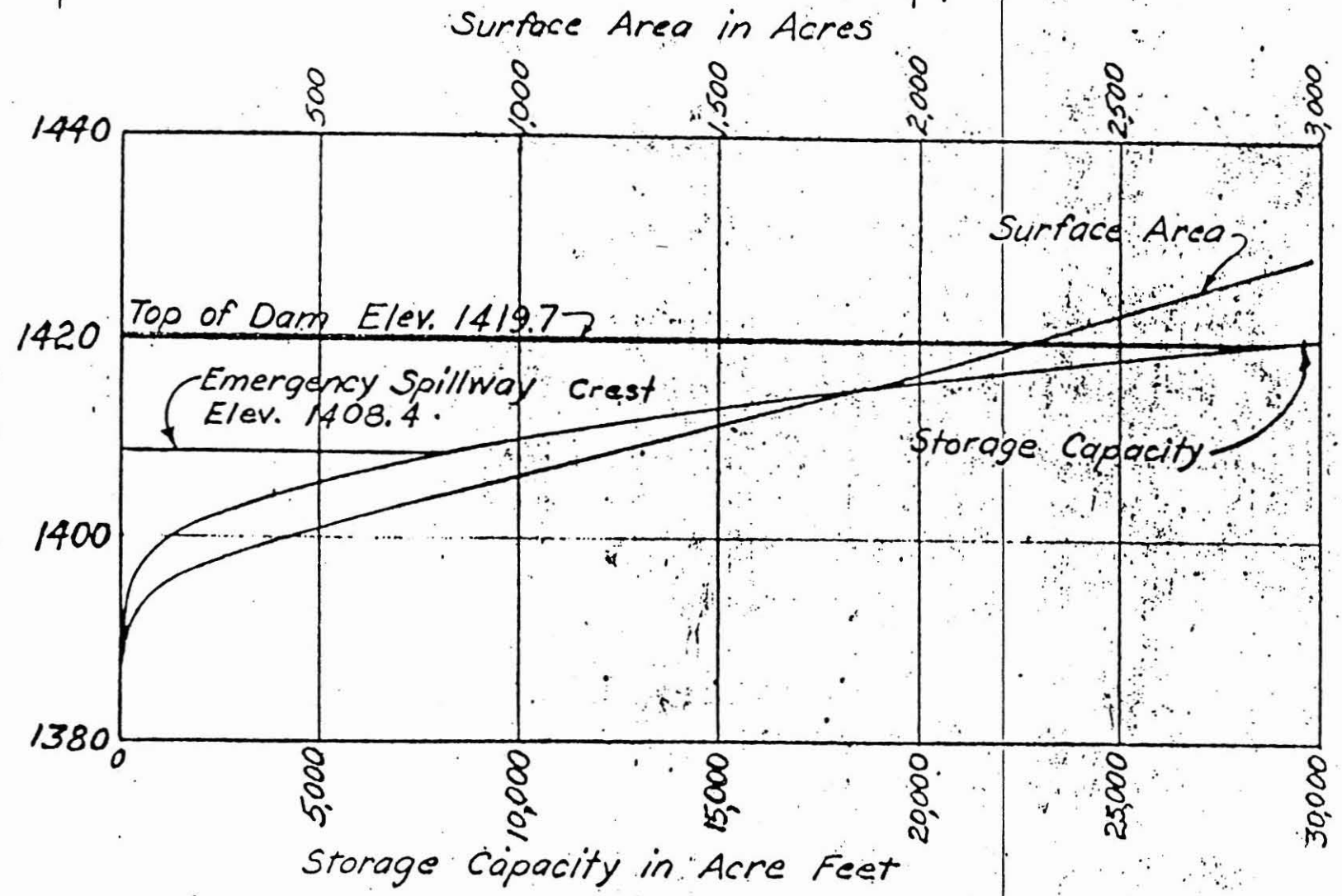
JOB NO. ____



AREA & CAPACITY CURVES - HARQUAHALA FRS

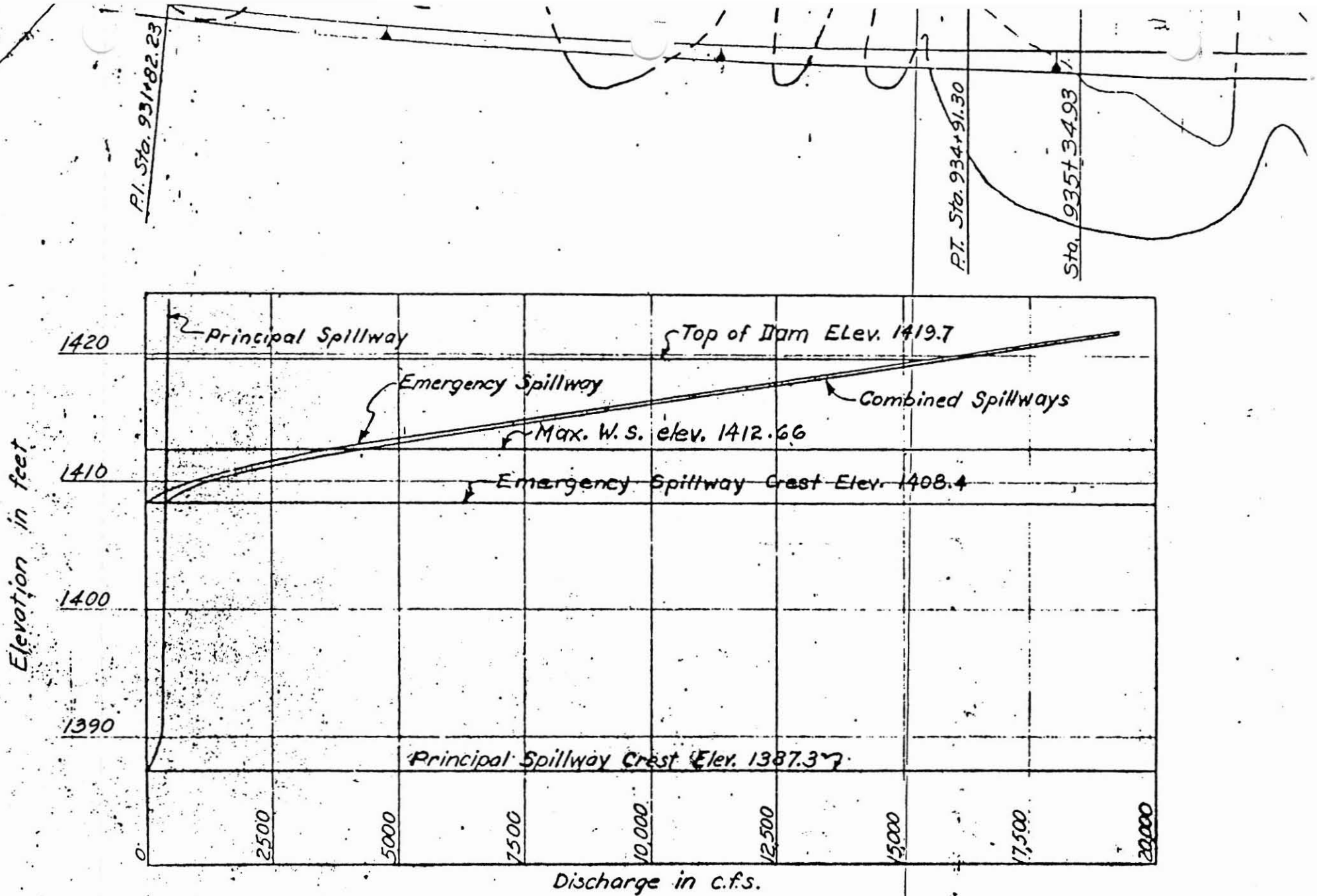
SHEET NO. ___ OF ___

JOB NO. ___



RESERVOIR STAGE STORAGE CURVE

Harquahala



SPILLWAYS STAGE DISCHARGE CURVE

Harguahala FRS

MAINTENANCE RESPONSIBILITIES

Structure: Harquahala FRS 6A330

Bank Protection - Riprap		acres
Bridges - Pedestrian		each
Bridges - Vehicle		each
Culverts, Box		each
Culverts, Pipe		each
Drainage Channel - Lined		feet
Drainage Channel - Unlined		miles
Drop Structure	1	each
Embankment	400	acres
Embankment, Soil Cement		acres
Fencing	62,000	feet
Floodway - Lined		feet
Floodway - Unlined		acres
Gated Outlet	3	each
Gates	20	each
Gutters, Concrete		feet
High Flow	10	acres
Landscape		acres
Low Flow	57	acres
Manholes		each
Meter Houses		each
Outlet Structure	1	each
Pilot Channel		miles
Pool Area	1,304	acres
Principal Outlet	464	feet
Ramps, Concrete		feet
Retaining Wall		feet
Right-of-Way		acres
River Clearing		acres
Roads - Asphalt		miles
Roads - Dirt	29.5	miles
Side Inlet		each
Spillway - Earth		acres
Spillway - Lined	150	feet
Stilling Basins	3	each
Stormdrain Pipe		feet
Trash Racks	3	each
Vegetative Drains		each

COMPUTATION SHEET
SCS–ENG–523 Rev. 8–69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

STATE ARIZONA		PROJECT HARQUHALA W.P.P.		
BY ML Gertsch	DATE 11-15-78	CHECKED BY WE Payne	DATE 11-15-78	JOB NO. F.R.S.
SUBJECT Stage Storage				SHEET 1 OF

ELEV.	Surface Area Ac.	Ave. Surface Area Ac.	Δ depth ft.	Δ Storage Ac. ft.	Storage Ac. ft.
1370	0.00				0.00
		0.03	2.0	0.06	
1374	0.06				0.06
		0.13	↓	0.26	
1376	0.20				0.32
		0.38	↓	0.76	
1378	0.55				1.08
		1.04	↓	2.08	
1380	1.52				3.16
		2.40	↓	4.80	
1382	3.27				7.96
		4.30	↓	8.60	
1384	5.33				16.56
		7.02	↓	14.04	
1386	8.70				30.60
		11.08	↓	22.16	
1388	13.45				52.76
		17.63	↓	35.26	
1390	21.81				88.02
		27.70	↓	55.40	
1392	33.59				143.42
		43.20	↓	86.40	
1394	52.81				229.82
		80.07	↓	160.14	
1396	107.32				389.96
		172.14	↓	344.28	
1398	236.96				734.24
		322.52	↓	645.04	
1400	408.08				1379.28
		512.95	↓	1025.90	
1402	617.81				2405.18

COMPUTATION SHEET
SCS-ENG-523 Rev. 8-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

STATE ARIZONA	PROJECT HARQUAHALA W.P.P.		
BY ML Gerbson / DATE 11-15-78	CHECKED BY WE Payne / DATE 11-15-78		JOB NO. F.R.S.
SUBJECT Stage Storage			SHEET 2 OF

Elev	Surface AREA Ac.	Ave Surface Area Ac.	Δ depth ft.	Δ Storage Ac. ft.	Storage Ac ft.
1402	617.81				2405.18
		711.77	2.0	1423.54	
1404	805.72				3828.72
		900.95	↓	1801.90	
1406	996.17				5630.62
		1089.67	↓	2179.34	
1408	1183.16				7809.96
		1280.14	↓	2560.28	
1410	1377.12				10370.24
		1474.67	↓	2949.34	
1412	1572.22				13319.58
		1662.15	↓	3324.30	
1414	1752.07				16643.88
		1846.12	↓	3692.24	
1416	1940.16				20336.12
		2032.47	↓	4064.93	
1418	2124.77				24401.05
		2189.01	↓	4378.02	
1420	2253.24				28779.07

COMPUTATION SHEET
SCS-ENG-523 Rev. 8-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

STATE	PROJECT		
ARIZONA	HARQUAHALA W.P.P.		
BY: M.L. Pertsch	DATE: 11-16-78	CHECKED BY	DATE	JOB NO.
SUBJECT			SHEET ___ OF ___

1410.0	1377.12				10370.24
		1382.00	x0.1	138.2	
1410.1	1386.87⁵				10508.44
		1391.8		139.18	
.2	1396.63				10647.62
		1401.51		140.15	
.3	1406.38⁵				10787.77
		1411.26		141.13	
1410.4	1416.14				10928.90
		1421.02		142.10	
.5	1425.89⁵				11071.00
		1430.77		143.08	
.6	1435.65				11214.08
		1440.53		144.05	
.7	1445.40⁵				11358.13
		1450.28		145.03	
.8	1455.16				
		1460.04		146.00	
.9	1464.91⁵				
		1469.79		146.98	
1411.0	1474.67				

1474.67
1377.12
97.55 ÷ 10
= 9.755

COMPUTATION SHEET
SCS-ENG-523 Rev. 8-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

STATE ARIZONA		PROJECT HARQUAHALA W.P.P.		
BY M.L. Gortson	DATE 11-16-78	CHECKED BY	DATE	JOB NO.
SUBJECT				SHEET ___ OF ___

Problem - arrive @ elev to contain 414 Ac. ft.

	1396	106.94 ~~107.32~~			389.96
			110.56	0.1	11.06
1396.2	.1	113.80			401.02
-1392.8			117.04		11.70
3.4'	1396.2	120.28			412.72
			123.53		12.35
	.3	126.77			425.07
			130.01		13.00
	.4	133.25			
			136.49		13.65
172.14	.5	139.73			
-107.32					
64.82 ÷10 =	.6	146.21			
6.482					
	.7	152.69			
	.8	159.18			
	.9	165.66			
	1397.0	~~172.14~~			

Void. Since

TIM, MAKE NOTE

PHONE CONV. WITH HARRY MILSAP 8/20
X-SECT. WILL BE SENT

HYDROL. DOC. SUP #1
- WORKPLAN
CREST - 1392.8 + 4.8 = 1397.6 → CORRECT DISTANCE

~1700 AF → THIS IS ~~THE~~ USING THE STAGE-STORAGE CURVE HERMAN McGILL USED

FINAL - 1387?
(AS BUILT)

WE'RE AROUND 10'

HARRY THINKS SOME MATERIAL WAS REMOVED AFTER AS-BUILTS FINALIZED
- ROAD RAMPS CUT INTO STORAGE AREA AND MAY PREVENTED WATER ~~WATE~~ FROM REACHING
- VEGETATIVE? OUTLETS WILL WITHDRAWAL WATER FROM THE SYSTEM

we need actual storage curve (ie derive our own to verify)

BOR - may have adjustments to curve

↓

I WILL CALL

870-2495

- LOWELL HEATON (BOR) SAID BORROWING FROM HAR FRS (#1) WAS MINIMAL
∴ NO NEW CURVES WERE DERIVED

NATIONAL 42-381 50 SHEETS 5 SQUARE 42-382 100 SHEETS 5 SQUARE 42-389 200 SHEETS 5 SQUARE Made in U.S.A.

PROJECT TITLE: Centennial Levee #1-Reach 1 of 2 (Under Construction 1984-85)

WATERSHED AND RELATIONSHIP TO OTHER STRUCTURES:

Harquahala Valley Watershed
This structure is just upstream of the west side canal which is a part of the Harquahala Valley Irrigation system originating from the Central Arizona Project Canal.

LOCATION: Township, range, section; description from well known physical feature; how to get there:

T2N, R9W, Sections 5, 6 and 7
T2N, R10W, sections 1, 11, 12, 14 and 15
This structure is on the west side of Harquahala Valley, south of Interstate #10 and about 13 miles west of Tonopah.

AUTHORIZATION: Watershed Protection and Flood Prevention Act, Public Law 566

FEDERAL SPONSOR:

U.S. Department of Interior
Soil Conservation Service

LOCAL SPONSOR(S):

Flood Control District of Maricopa County
Harquahala Valley Irrigation District
Buckeye-Roosevelt NRCD
Winckenburg NRCD

DOCUMENTATION:

Watershed Workplan title/date; supplements EIS date approved:
Final Environmental Impact Statement accepted in March 1977

CONTRACTOR:

DATE OF CONSTRUCTION AWARD: October 1984

DATE OF FINAL ACCEPTANCE:

FUNCTIONAL DESCRIPTION:

It collects sheetflow from a 21 square mile area and directs it to the Centennial Wash. It also stops heavy flows in the Centennial Wash from spreading out over a large agricultural area.

Reach 2 of the Levee will further contain the wash from spreading out over agricultural lands.

PROJECT FEATURES:

Type of structure	Compacted earth embankment with floodway channel along upstream side

Length	= 4.53 miles
Drainage area	= 21 square miles
Dike Height	= 8 feet to 10.5 feet above Floodway invert
Centerline of Dike to centerline of Floodway	= 260 feet
Top of Dike	= 12' wide with 4:1 slope to floodway
Capacity	= 7,540 CFS
Bottom width of Floodway	80 feet with soil side slopes There is a rock sill near the outlet end of this floodwy at Centennial wash.

LEVEL OF PROTECTION: 100-year storm event

COSTS:

FEDERAL:

LOCAL:

ADWR OPERATIONAL CERTIFICATE ISSUED:

ENCLOSURES: Site Map Attached

Stage Storage Curve

Stage Discharge Curve

Storage Discharge Summary

Cardinal®

MEETING WITH HARRY MILSAP SCS

RE: SEPT '84 HARQUAHALA STORM & MODELING EFFORTS

GAVE ME COPIES OF HERMAN McGILL'S COMPUTER RUNS
- HE ESTIMATED SEVERAL PPT SCENARIOS
  EX. STORM 1 ESTIMATED 3.6 IN OVER ENTIRE WATERSHED
  STORM 5 DISTRIBUTED THE RAINFALL

WSP2 USED 15 DIFFERENT Q'S TO DERIVE RATING TABLES
(EX) FOR SADDLEBACK DIVERSION

REQ 11/26/84 HARQUAHALA VALLEY WATERSHED (ENG0357/WSP2.CF) PAGE 3 (10)
REV 09/01/82 SADDLEBACK DIVERSION MCGILL 11/23/84

G TABLE FOR SECTION 3500. DA= 0.7

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	CHANNEL	NON-DAM	STARTING CSM	CRIT ELEV	FRICTION SLOPE
0	1161.8	0.0	0.0						
1	1162.1	14.8	7.3	0.0	0.0	0.0	10.00	1161.9	0.00051
2	1162.2	19.9	14.6	0.0	0.0	0.0	20.00	1161.9	0.00078
3	1162.5	35.6	36.5	0.0	0.0	0.0	50.00	1162.1	0.00074
4	1162.9	57.8	73.0	0.0	0.0	0.0	100.00	1162.2	0.00064
5	1163.2	75.3	146.0	0.0	0.0	0.0	200.00	1162.4	0.00113
6	1163.6	99.7	219.0	0.0	0.0	0.0	300.00	1162.6	0.00107
7	1164.0	125.4	292.0	0.0	0.0	0.0	400.00	1162.8	0.00095
8	1164.2	138.6	365.0	0.0	0.0	0.0	500.00	1163.0	0.00110
9	1164.5	159.5	438.0	0.0	0.0	0.0	600.00	1163.1	0.00104
10	1164.8	180.5	511.0	0.0	0.0	0.0	700.00	1163.2	0.00098
11	1165.1	202.9	584.0	0.0	0.0	0.0	800.00	1163.4	0.00091
12	1165.3	217.9	657.0	0.0	0.0	0.0	900.00	1163.5	0.00093
13	1165.4	225.4	730.0	0.0	0.0	0.0	1000.00	1163.6	0.00104
14	1166.3	298.5	1095.0	0.0	0.0	0.0	1500.00	1164.2	0.00104
15	1167.1	369.0	1460.0	0.0	0.0	0.0	2000.00	1164.6	0.00104

- THIS IS ALL INDEPENDENT OF THE SEPT '84 STORM

THE RATING TABLES WERE THEN INPUTED INTO TR20 FOR ROUTING. THEY (BOTH TR20 & HWM) THEN COMPARED WITH THE HIGH WATER MARKS. THIS OUTPUT IS ALSO INCL.

modeled

TO CALIBRATE HEC 1 WE SHOULD BE ABLE TO IDENTFY THE STATION FOR OUTLETS OF BSUB & CSUB. KNOWING THE Q AT THESE POINTS WE CAN ENTER THE RATING TABLE AND READ THE CORRESPONDING ELEVATION. THE ELEVATION IS THE COMPARED TO THE HIGH WATER MARKS

ASSUME: THEIR RATING TABLE IS ACCURATE
ie. APPROPRIATE n AND CN

THAT COMPARISON AT TWO POINTS IS ADEQUATE TO CALIBRATE HEC 1 FOR THE ENTIRE BASIN. IT IS CONSIDERING OUR PURPOSE OF A RELATIVE COMPARISON.

COMPARE RAINFALL DIST. AS ANOTHER QUAL. CHECK

- COMPARE OUTFLOW FOR FRS WITH CAPACITIES AND DECIDE IF A RESERVOIR ROUTING ROUTINE IS NECESSARY

- ALSO CHECK FOR REASONABLE RUNOFF EFFICIENCIES

SUBBASIN D | ISOHYETAL METHOD

BASIN MEAN RAIN

ISOHYET RANGE (IN)	MEAN DEPTH (IN)	EFFECTIVE AREA (MI^2)	VOLUME (MI^2-IN)
2-3	2.5	1.63	4.08
3-4	3.5	2.67	9.35
4-4.75	4.38	2.73	11.96
		7.03	25.39

$$\text{BASIN MEAN} = \frac{25.39}{7.03} = 3.61 \text{ IN}$$

SUBBASIN C

IGNORE STATION VALUE

BASIN MEAN RAIN

ISOHYET RANGE (IN)	MEAN DEPTH (IN)	EFFECTIVE AREA (MI^2)	VOLUME (MI^2-IN)
4.25-5	4.63	4.47	20.70
5-6	5.5	4.78	26.29
		9.25	46.99

$$\text{BASIN MEAN} = \frac{46.99}{9.25} = 5.08 \text{ IN.}$$

SUBBASIN B

BASIN MEAN RAIN

ISOHYET RANGE (IN)	MEAN DEPTH (IN)	EFFECTIVE AREA (MI^2)	VOLUME (MI^2-IN.)
1.6-2	1.8	4.87	8.77
2-3	2.5	7.47	18.68
3-4	3.5	5.07	17.75
4-5	4.5	6.33	28.49
5-5.35	5.18	0.82	4.25
		24.56	77.94

→ V 23.6, 23.9 } BA 23.75

$$\text{BASIN MEAN} = \frac{77.94}{24.56} = 3.17 \text{ IN.}$$

DIST FACTORS FOR REP STATION

GAGE = 6.67 IN

DIST.	0.6	1.78	2.82	1.4	0.07
FACTORS	0.09	0.27	0.42	0.21	0.01

BASIN AVG PPT (IN)

~~ASUB (PI) (2.0)~~	.18	.54	.84	.42	.02
BSUB (PI) (3.17)	.29	.86	1.33	.67	.03
CSUB (PI) (5.08)	.46	1.37	2.13	1.07	.05
DSUB (PI) (3.61)	.32	.98	1.52	.76	.04

HSUB see below

TAKE OUT

PBREP 6.67

PI 0.6 1.78 2.82 1.40 0.07

BASIN AVG PPT (IN)

ESUB (2.82) PI	.25	.76	1.18	.59	.028
FSUB (2.88) PI	.26	.78	1.21	.61	.029
GSUB (3.72) PI	.34	1.00	1.56	.78	.037

Change

ASUB (1.25)	.113	.334	.53	.26	.01
HSUB (1.25)	"	"	"	"	"

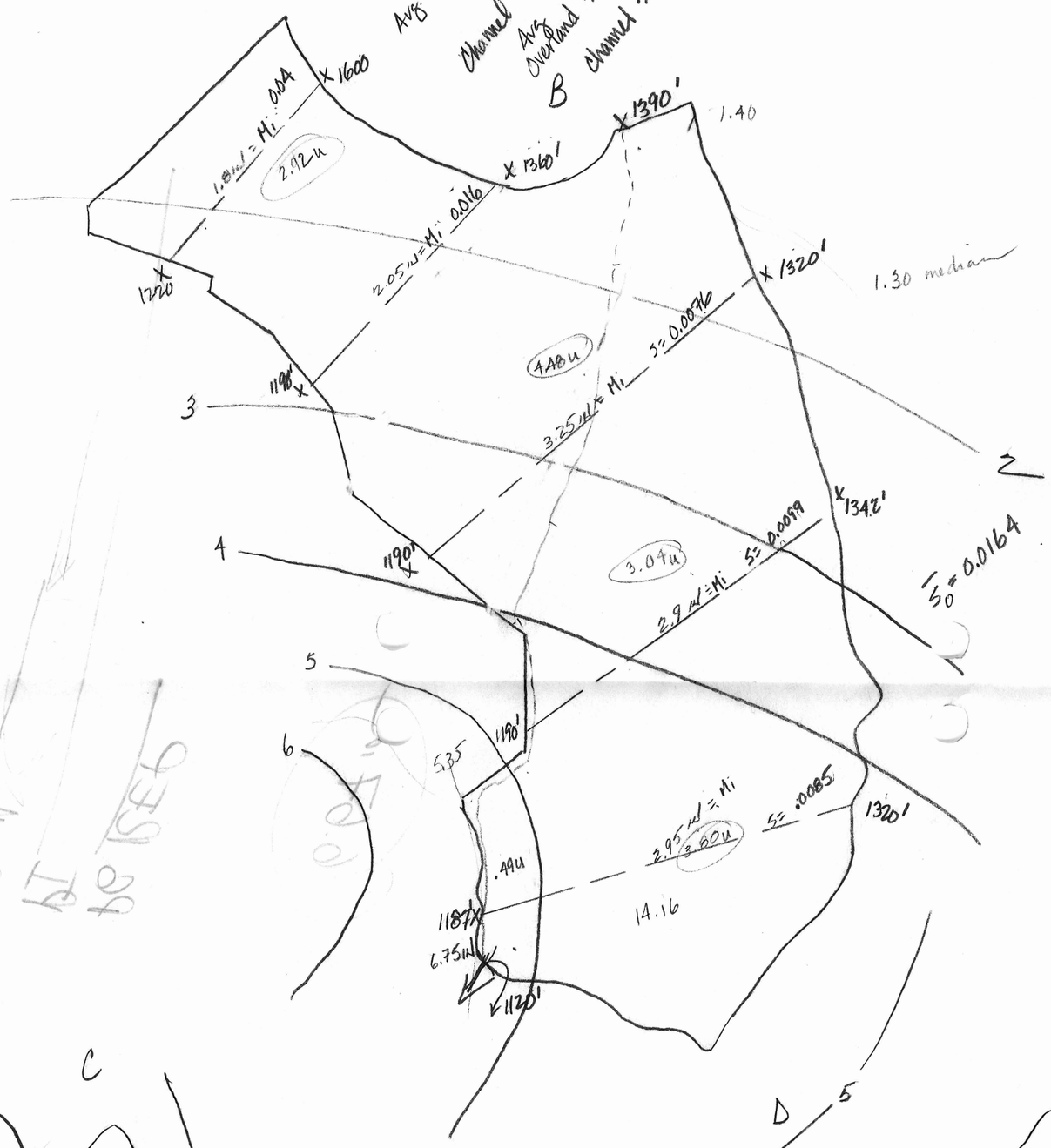
B

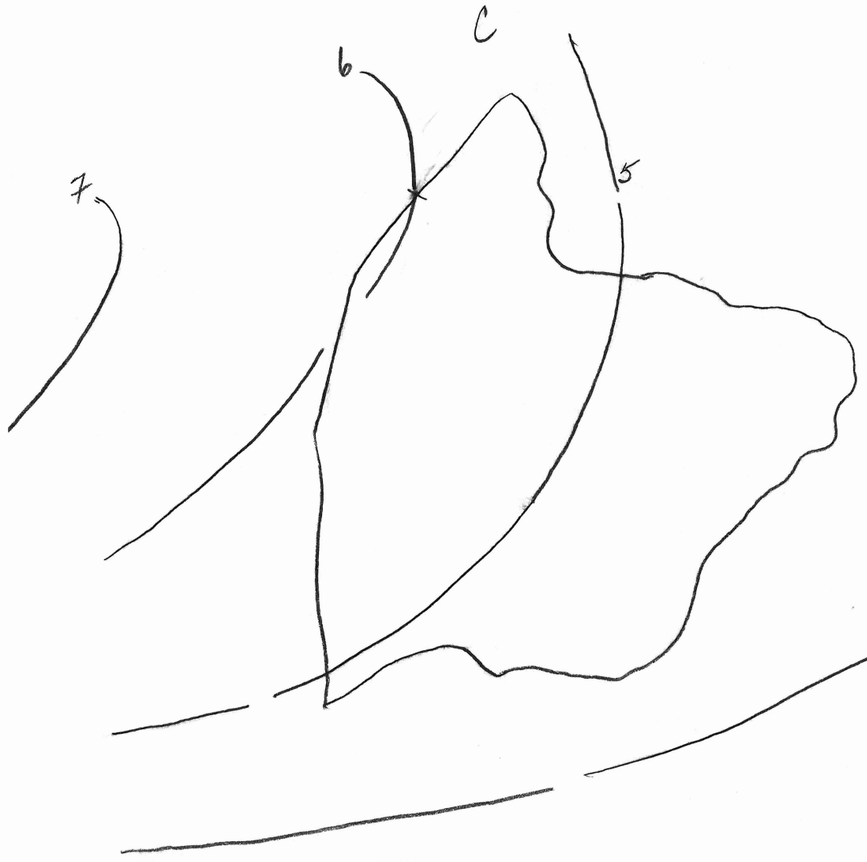
Avg overland flow distance = 2.59 Mi × 5280 ft / 1 Mi = 13675

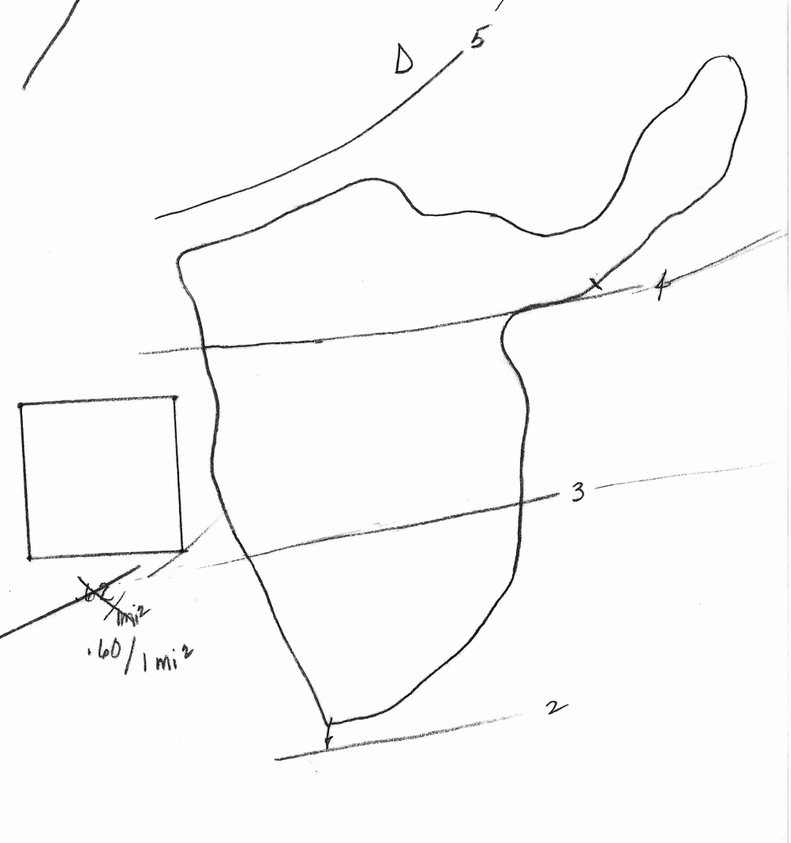
Channel length = 6.75 Mi × 5280 / 1 Mi = 35,640 FT

Avg overland slope = 0.0164

B channel slope = (1390-1120) / (6.75)(5280) = 0.00716







.60 / 1 mi²

1100 FT

(16)

VS 25000 AT OUTLET TO SUBBASIN C

RATING TABLE FOR SECTION 23900. DA= 8.7

NO.	ELEV	AREA	CFS	ACRES FLOODED DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED NON-DAM	STARTING CSM	CRIT ELEV	FRICTION SLOPE
0	1098.0	0.0	0.0						
1	1098.3	107.1	87.5	0.0	0.0	0.0	10.00	1098.1	0.00169
2	1098.5	157.7	175.0	0.0	0.0	0.0	20.00	1098.2	0.00187
3	1098.8	269.0	437.5	0.0	0.0	0.0	50.00	1098.4	0.00200
4	1099.2	409.6	875.0	0.0	0.0	0.0	100.00	1098.6	0.00199
5	1099.8	627.7	1750.0	0.0	0.0	0.0	200.00	1098.9	0.00196
6	1100.3	801.0	2625.0	0.0	0.0	0.0	300.00	1099.2	0.00199
7	1100.8	960.0	3500.0	0.0	0.0	0.0	400.00	1099.5	0.00196
8	1101.2	1099.7	4375.0	0.0	0.0	0.0	500.00	1099.7	0.00198
9	1101.5	1228.1	5250.0	0.0	0.0	0.0	600.00	1100.0	0.00199
10	1101.9	1353.7	6125.0	0.0	0.0	0.0	700.00	1100.2	0.00198
11	1102.2	1466.3	7000.0	0.0	0.0	0.0	800.00	1100.4	0.00200
12	1102.5	1581.6	7875.0	0.0	0.0	0.0	900.00	1100.6	0.00199
13	1102.8	1685.3	8750.0	0.0	0.0	0.0	1000.00	1100.7	0.00200
14	1104.1	2179.7	13125.0	0.0	0.0	0.0	1500.00	1101.6	0.00199
15	1105.2	2610.3	17500.0	0.0	0.0	0.0	2000.00	1102.3	0.00200

HARRY WILSAP: SCS
FIELD OFFICE GATHERED DATA
BILL PAINE - RETIRED - DESIGNED STRUCTURE

241-5421

FRAN GILINIE: USGS 9/1/84 0
mean daily q's 9/2/84 3320
partial data 9/3/84 160
HWM 11.34 @ 1
Centenial Wash on South Pacific Bridge nr. ARLINGTON
09517490
discontinued 9/85

✓ 1.) Generate runoff from A

✓ 2.) ROUTE A through B

✓ 3.) Generate runoff from H

✓ 4.) ROUTE H thru B

✓ 5.) Combine H and A

✓ 6.) Generate runoff from B

✓ 7.) Combine H and A with B

✓ 8.) Route HAB thru C.

✓ 9.) Generate runoff from G

✓ 10.) Generate runof from C

✓ 11.) Combine HAB WITH G AND C

✓ 11A) Route HABGC THRU D

✓ 12.) Generate runoff from E

✓ 13.) Generate runoff from F

✓ 14.) Route E thru F

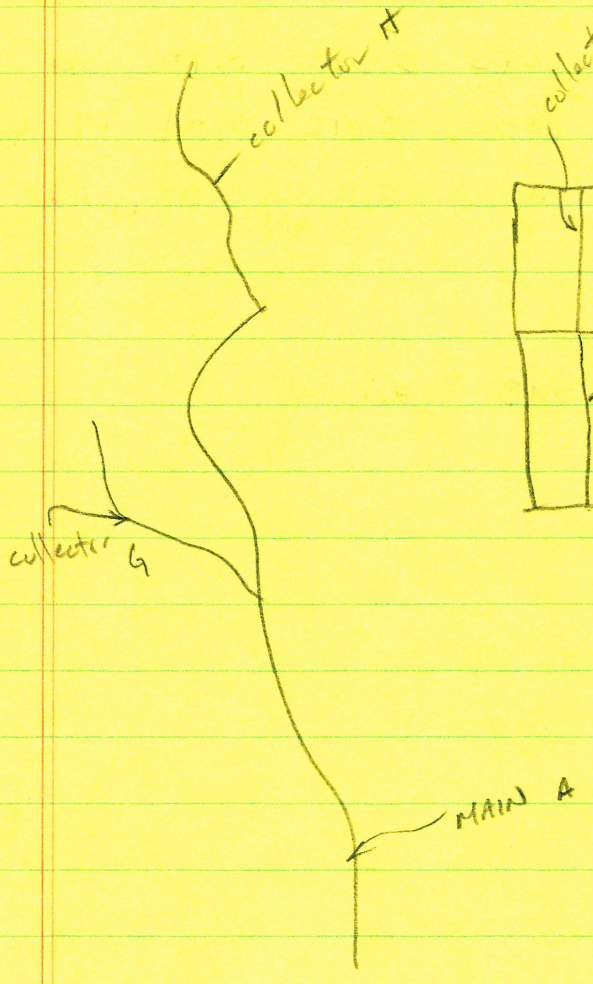
✓ 15.) Generate runoff from D

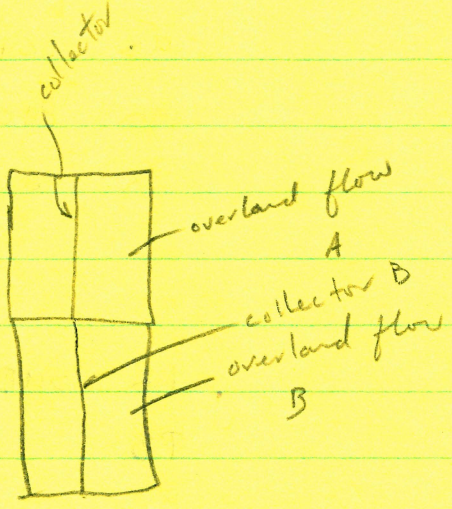
16.) Combine EF with D AND HABGC

$$22{,}176\ ft \times \frac{\cancel{sec}}{4\ \cancel{ft} \times \frac{1\ \cancel{hr}}{60\ \cancel{min}} \times \frac{1\ \cancel{min}}{60\ \cancel{sec}}} = 1.5$$

CALCULATION OF AREAS:

H	G	B - ~~C~~
11.58	24.88	20.97
23.16	49.73	41.89
11.58 ÷ 0.401	24.865 ÷ .401	20.95 ÷ .401
28.88 mi² +	62.0 mi²	~~52.23~~ mi²
104.84		38.61
133.72		





C
5.46
10.92
5.46 ÷ .401
13.62 mi²

15.313
81000

PRE STRUCTURE

KK SUB H
PB 1.50
PI 0.13 .40 .64 .32 0.01
BA 133.72
LS 0 87
UK 2640 0.012 0.15 100
RK 81000 0.012 0.04 15 TRAP 30 3
RK 16000 0.003 0.04 ,, TRAP 50 3 ES

Joe Walker - Cave
PA86-16

KK SUB
PB
PI
BA
LS 0 84
UK 1300
UK
RK
RK
RK

PRE STRUCTURE DECK


```
*  FREE
*  DIAGRAM
ID HARQUAHALA VALLEY
ID PRE STRUCTURE RUN
IT 15 01SEP84 2100 120
IO 0 1
IN 60 01SEP84 2100
KK SUBA
PB 2.0
PI .18 .54 .84 .92 .02
BA 25.73
LS 0 87
UK 2640 0.021 0.04 100
RK 71280 0.021 0.035,, TRAP 30 3
KK ROUTE A THRU B
RK 46000 0.01 0.04,, TRAP 30 2 YES
KK SUB B
PB 3.65
PI .33 .97 1.54 .77 .04
BA 38.61
LS 0 84,, 0 87
UK 1300 0.001 0.3 40
UK 2640 0.01 0.2 60
RK 46000 0.01 0.046 TRAP 20 2
RK 41000 0.005 0.035,, TRAP 50 2 YES
KK SUB H
PB 1.50
PI 0.13 0.4 0.64 0.32 0.01

BA 133.72
LS 0 87
UK 2640 0.012 0.15 100
RK 81000 0.012 0.04 15 TRAP 30 3
RK 16000 0.003 0.04,, TRAP 40 3 NO
KK COMBINE SUBS A AND B WITH H
HC 2 0
KK SUB G
PB 3.81
PI .34 1.02 1.61 0.90 0.04
BA 62.0
LS 0 87,, 0 84
UK 2640 0.005 0.2 65
UK 1300 0.001 0.3 35
RK 63000 0.005 0.04 10 TRAP 20 3
RK 31000 0.002 0.04,, TRAP 40 3 YES
KK SUB C
PB 5.25
PI 0.47 1.40 2.22 1.10 0.06
BA 13.62
LS 0 84,, 0 87
UK 1300 0.001 0.3 25
UK 1300 0.005 0.2 75
RK 26000 0.020 0.04 3 TRAP 10 3
RK 31000 0.002 0.04,, TRAP 40 3 YES
KK COMBINE GROUP ABH WITH GC
HC 2 0
KK SUB E

PB 2.82
PI .25 .76 1.18 .59 .028
BA 100.87
LS 0 87
UK 1650 0.009 0.3 100
RK 35000 0.009 0.04 6 TRAP 20 3
RK 95300 0.003 0.035,, TRAP 200 3 NO
KK SUB F
PB 2.88
PI .26 .78 1.21 .61 .029
BA 58.06
LS 0 84,, 0 87
UK 1300 0.001 0.4 50
UK 2640 0.005 0.3 50
RK 45000 0.005 0.035 9 TRAP 20 3
RK 41000 0.003 0.04,, TRAP 250 3 YES
KK COMBINE GROUP ABCGH WITH EF
HC 2 0
KK SUB D
PB 3.61
PI .32 .98 1.52 .76 .04
BA 6.70
LS 0 87
UK 2900 0.044 0.3 100
RK 15000 0.044 0.035 2 TRAP 10 3
RK 17000 0.002 0.03,, TRAP 100 3 NO
KK COMBINE
HC 2 0
ZZ
```

POST STRUCTURE

PLANIMETER: Scale: 1" = 62,500"

$1 mi^2 = 0.407$ units

AREA:

A	B	C	D
10.48	8.08	3.36	2.75
20.97 (10.47)	16.39 (8.277)	6.84 (3.373)	5.46
31.41	24.83	10.12	8.19
25.73 mi^2	20.34 mi	8.29 mi^2	6.7 mi

E1/E2	F	G	H
23.20 17.74	23.63	47.10	42.62
46.42 35.61	47.21 (23.63)	94.22 (47.053)	85.14 (42.57)
69.67 53.49	70.89	141.16	127.76
100.87 mi^2	58.06 mi^2	115.61 mi^2	104.84

TOTAL: 440.44

A in Areas

7.33
14.68 (7.33)
21.99
18.01 mi^2

G − A + H =

115.61 − 18.01 + 104.84 = 202.44

5.87 = 14.42 mi^2 = C

13.00 = 31.94 = B

AVAILABLE RAINFALL DATA

OMIT	11.0	
	6.0	
	4.5	
	8.0	
	4.0	
	6.86	
	6.90	
	3.50	
	2.70	42.46 / 8 = 5.308
OMIT	0.5	53.96 / 10 = 5.396 ←
	2.0	
	4.0	59.96 / 12 = 4.997
	12	

AVERAGE VALUES:

Lengths:

A: $L_a = 13.125$ in =

$L_c = 8.375$ in

1 ft' = 1 mi = 5208 ft.

B: = 4.0 in

=

C: = 3.25 in 3.0 in = 17,160 ft.

= 3.25 in.

D: =

=

E: =

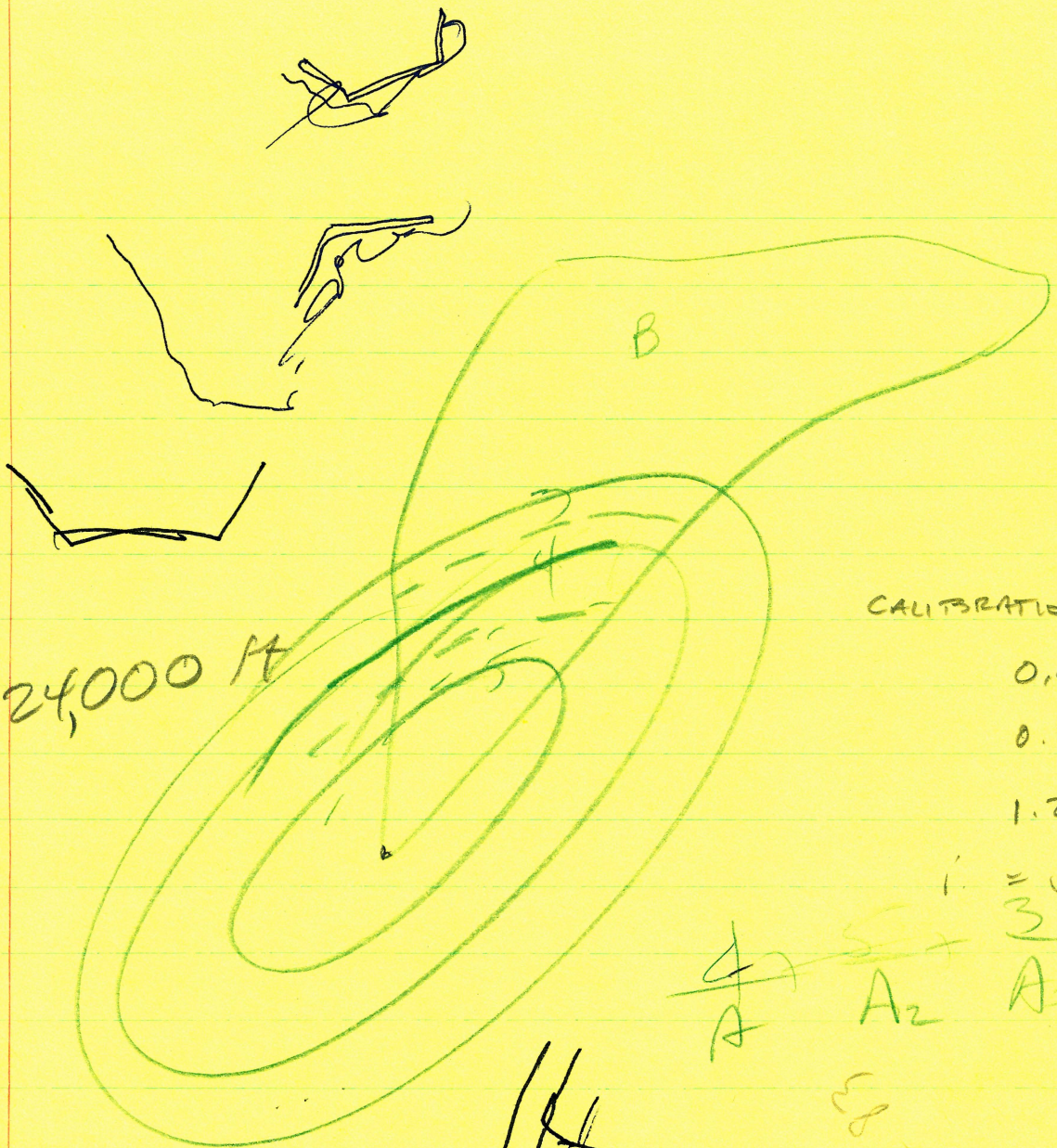
=

F: =

=

G: =

=



CALIBRATION

0.42

0.82

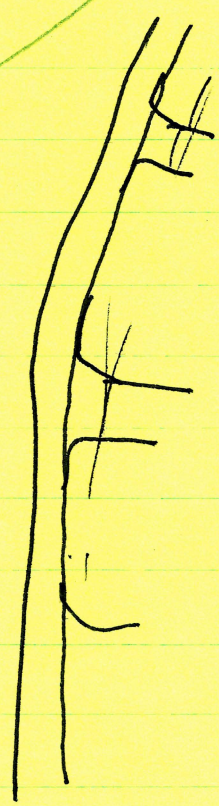
1.23

$\bar{i} = \frac{3}{3} = 0.41$

$\frac{A_1}{A}$ A_2 A_3

9 gages

200/8910



0.022

Verification: 9+5 total point

11.0" Ron Howe - foreman of ranch
Wallis - 778-3008

6.9 — lady on property
4.0" — Charlie Nye - Big Hoken ranch former
< 2hr.
4.5" — Tom Sykes - 511TH Dublin - Greer Farm
< 2hr.
8.0" — F. Rogers - F.D.O maybe
6.0+ — Steve Palisch Vinjord

Phone conversation with Harvey Wilson
7/29/86

SUBBASIN D

TOTAL AREA

9.637

PT 3.000

2-3 $.98u \times \frac{1 mi^2}{.60u} = 1.63 mi^2$

3-4 $1.60u \times \frac{1 mi^2}{.60u} = 2.67 mi^2$

4-4.75 $1.64u \times \frac{1 mi^2}{.60u} = 2.73 mi^2$

C

4.25-5 $2.68 \times \frac{1 mi^2}{.60u} = 4.47 mi^2$

5-6 $2.87u \times \frac{1 mi^2}{.60u} = 4.78 mi^2$

2.87

3.7

$3.4\,\cancel{mi} \times \frac{5280\ ft}{1\ \cancel{mi}} = 17{,}952$

RK = 2370

RK 16,896 ft.

Slope = $\frac{30\ ft}{16896\ ft}$

= .0018

15

2455
1060
1395

1535
1070
465

1265
1040
225

4.4

23232
8976
11088

3

UK = 14432

Slopes

0.060
0.052
0.0203

Slope UK = 0.044

PRE STRUCTURE:

AREA	LENGTHS:
A = 25.73 mi^2	71,280
B = 31.97 mi^2	38,610
C = 14.42 mi^2	40,593
D = 6.70 mi^2	37,620
E = 100.87 mi^2	SAME
F = 58.06 mi^2	SAME
G = 202.44 mi^2	167,970
TOTAL 440.44	

PRE STRUCTURE PRECIP VALUES:

B

2.5	x .365	.913
3.5	x .250	.875
4.5	x .220	.990
5.5	x .095	.523
6.5	x .031	.202
	.96	3.50

C

4.5 x .3	=	1.485
5.5 x .3	=	1.815
6.5 x .3	=	2.145
		5.45

G

0.5	x .51	0.255
1.5	x .25	.375
2.5	x .065	.163
3.5	x .040	.140
4.5	x .035	.158
5.5	x .030	.165
6.5	x .025	.163
7.5	x .02	.150
		1.57

E

23. 8/32 = 23.25 in × 5280 ft/mi.

UK ~~122,760 FT.~~ 95 300

1.5 + 4/32 = 1.625 × 5280 = 8580 FT.

SLOPE : 80/8580 = 0.009

5.2 × 5280 = 27450

5.15 × 5280 = 27190 × 0.003 (80)

(C)

2.5"	−.85	2.125
3.5"	−.05.5	.193
4.5"	−.04.5	.203
5.5"	−.03	.165
6.5"	.02	.130
	−.0	2.816
	−100	

(B)

2.5	−.45	1.125
3.5	.30	1.05
4.5	.20	.9
5.5	0.05	.275
		3.35

SUB G

18.688 X 5280 = 45870

80/12,240 = 0.007 2.313 x 5280

2.5	.500	1.25
3.5	.150	.525
4.5	.140	.630
5.5	.100	.550
6.5	.065	.423
7.5	.035	.263
8.0	.016	.080
	1.00	3.72 in

2.0
3.17
5.08
3.61

L B F

PRECIP

1.5	.30	.45
2.5	.29	.725
3.5	.25	.875
4.5	.08	.360
5.5	.05	.275
6.5	.03	.195
		2.88

UK 9.188 x 48,510

80/15840 0.005 = slope

RK 7.75 x 5280 = 40,920

40/15840 0.003 = slope

PR
PW
PT
PW

Pre structure

Lengths:

B = 7.313

C = 7.688

G = 12×2 = 24 + 7 + .813 = 31.813 × 5280

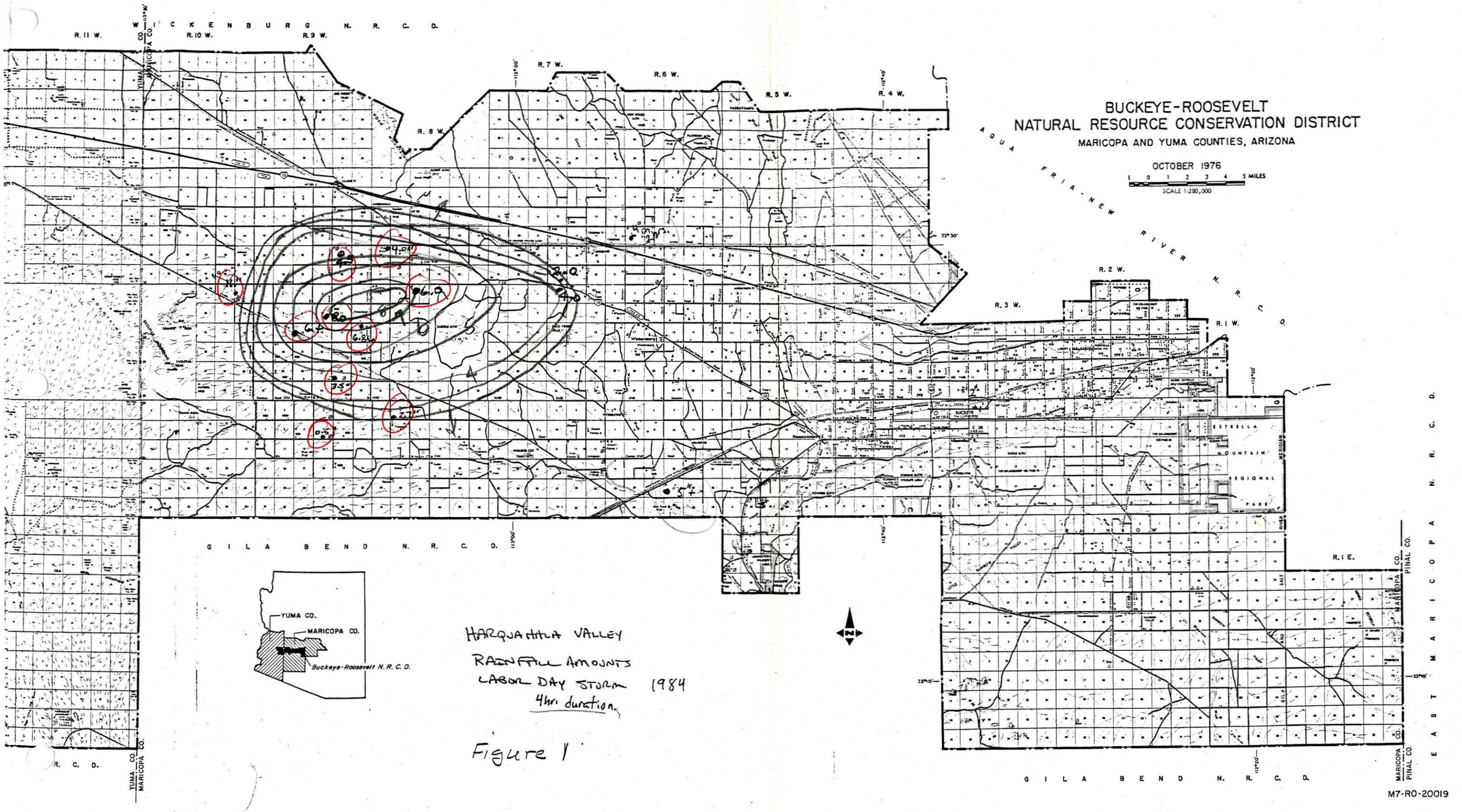
Cardinal®

TABLE 4
HARQUAHALA VALLEY WATERSHED
Saddleback Diversion

Peak Discharge from Incremental Drainage Areas

STATION	DESIGN Drainage Area Mi^2	DESIGN Discharge cfs	TYPE II STORM DIST. Drainage Area Mi^2	TYPE II STORM DIST. Storm 1 cfs	1984 STORM DISTRIBUTIONS Storm 2 cfs	1984 STORM DISTRIBUTIONS Storm 3 cfs	1984 STORM DISTRIBUTIONS Storm 4 cfs	1984 STORM DISTRIBUTIONS Storm 5 cfs	SIDE INLET Station	SIDE INLET Capacity cfs
1000	.840	773								
1090			.27	362	250	250	250	325	700	780
1500			.02	44	20	20	20	26		
2200	.293	355							1390	360
3000			.15	271	142	142	142	184	2900	180
4500			.29	471	272	353	353	353	4161	180
5500			.10	193	95	123	123	123	5200	210
6500			.02	44	20	26	26	26	6125	180
6800	.554	739								
7500			.53	512	451	591	732	732		
8500			.53	512	451	591	732	732	8012	1020
8700	1.075	956								
9500			.14	253	132	171	210	210	9408	205
11000			.60	643	524	766	847	847	10814	545
12200	1.304	1220							12126	535
12500			.61	653	533	779	861	861		
13000			.16	206	147	214	236	236	12832	85
16000			1.06	880	856	1390	1655	1655	15796	880
17000			1.07	888	864	1404	1670	1670	17005	470
17500			.16	204	147	235	279	279	17398	180
18000	2.323	1740								
18500			.26	320	235	377	448	448	18365	255
20500			1.17	894	917	1490	1774	1774	20200	800
22500			1.08	825	846	1375	1637	1637	22080	805
23500			.10	181	94	150	178	178		
23800	2.623	1792								
23900			.43	528	389	626	743	743		
24400	.4323	437								

NOTE: Storm 1 is 24-hour 50-year Type II Storm - 3.6 inches
Storm 2 is 1984 storm distribution - 4.00 inches
Storm 3 is 1984 storm FRS to Sta 3000 - 4.0"; Sta 3 000 to Sta 9500 - 5.0"; Sta 9500 to Sta 13000 - 5.5"; Sta 13000 to Sta 23900 -6.0"
Storm 4 is 1984 storm FRS to 3000 - 4.0"; Sta 3000 to Sta 6500 - 5.0"; Sta 6500 - Sta 13000 - 6.0"; Sta 13000 to Sta 23900 - 7"
Storm 5 is 1984 storm FRS - 3.0"; FRS to Sta 6500 - 5.0"; Sta 6500 - Sta 13000 - 6.0"; Sta 13000 to Sta 23900 - 7"


BUCKEYE-ROOSEVELT
NATURAL RESOURCE CONSERVATION DISTRICT
MARICOPA AND YUMA COUNTIES, ARIZONA
OCTOBER 1976
1 0 1 2 3 4 5 MILES
SCALE 1:280,000
WICKENBURG N. R. C. D.
GILA BEND N. R. C. D.
EAST MARICOPA N. R. C. D.
AQUA FRIA-NEW RIVER N. R. C. D.
R. 11 W.
R. 10 W.
R. 9 W.
R. 8 W.
R. 7 W.
R. 6 W.
R. 5 W.
R. 4 W.
R. 3 W.
R. 2 W.
R. 1 W.
R. 1 E.
YUMA CO.
MARICOPA CO.
PINAL CO.
ESTRELLA MOUNTAIN REGIONAL PARK
RAINBOW VALLEY
YUMA CO.
MARICOPA CO.
Buckeye-Roosevelt N. R. C. D.
HARQUAHALA VALLEY
RAINFALL AMOUNTS
LABOR DAY STORM 1984
4hr. duration.
Figure 1
M7-RO-20019

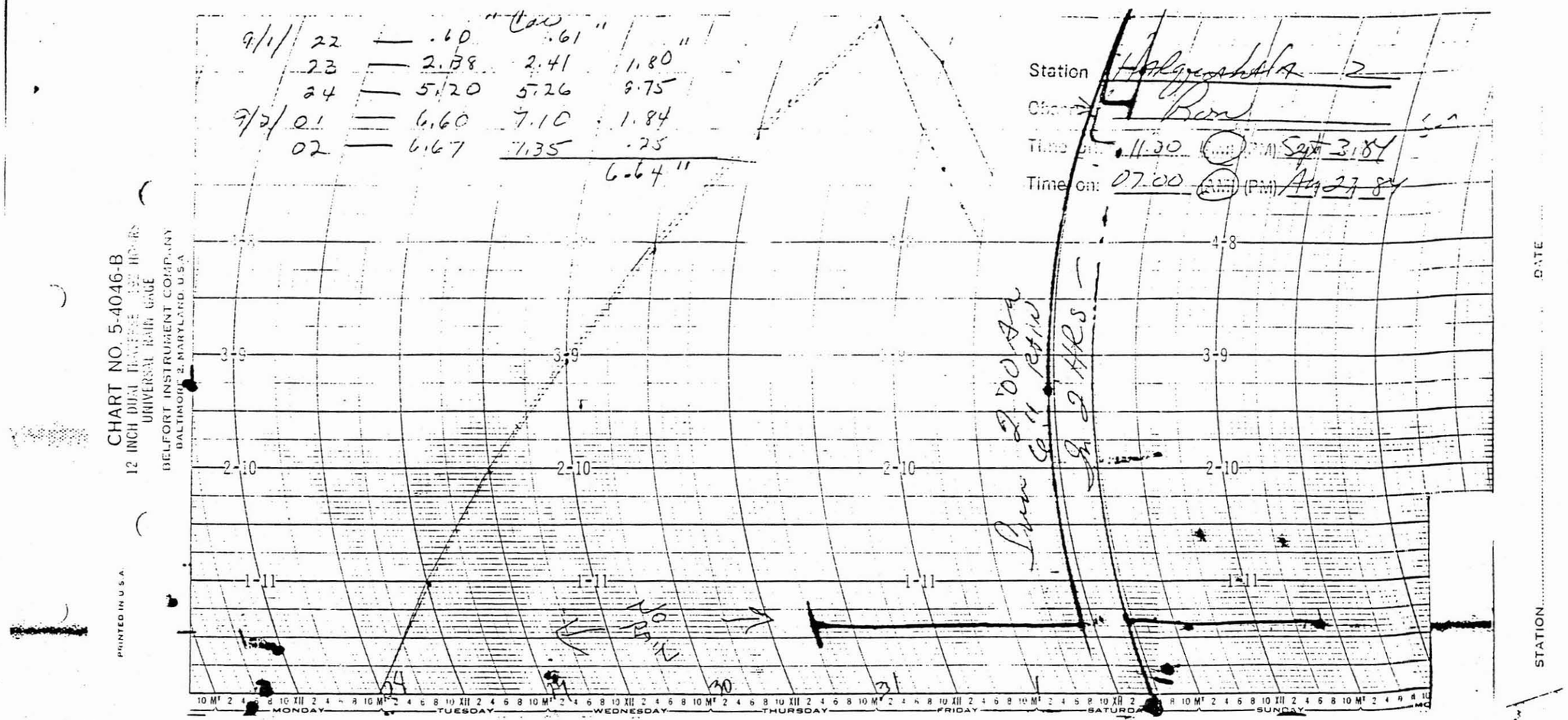

9/1/ 22 — .60 .61 "
23 — 2.38 2.41 1.80"
24 — 5.20 5.26 3.75
9/2/ 01 — 6.60 7.10 1.84
02 — 6.67 7.35 .25
6.64"
Station
Time on: 11.30 (AM) (PM) Sept 3 84
Time on: 07.00 (AM) (PM) Aug 27 84
CHART NO. 5-4046-B
12 INCH DIAL
UNIVERSAL RAIN GAGE
BELFORT INSTRUMENT COMPANY
BALTIMORE 2, MARYLAND U.S.A.
PRINTED IN U.S.A.
DATE
STATION
MONDAY
TUESDAY
WEDNESDAY
THURSDAY
FRIDAY
SATURDAY
SUNDAY

Figure 2

FIGURE 2. RECORDING RAIN GAGE

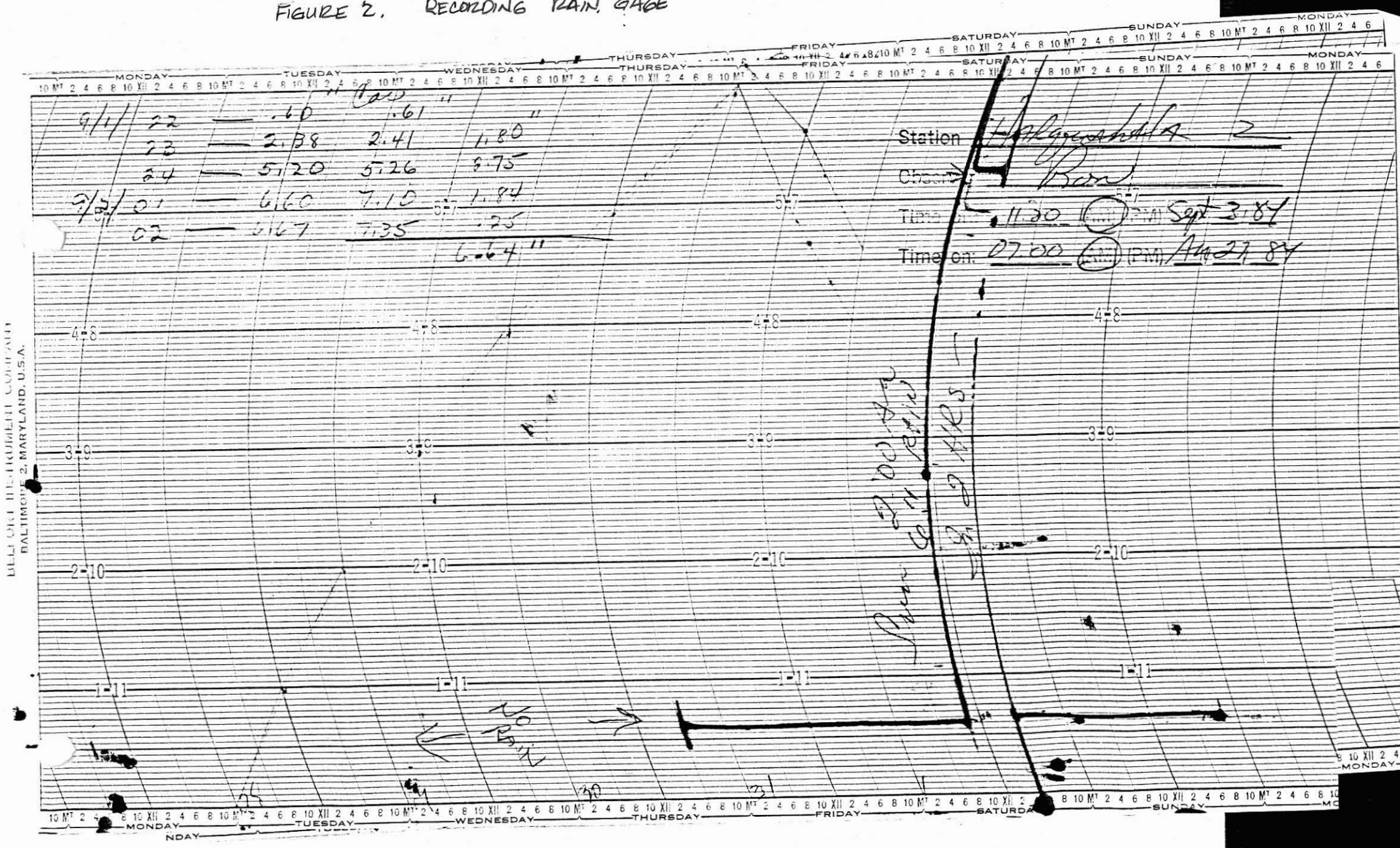
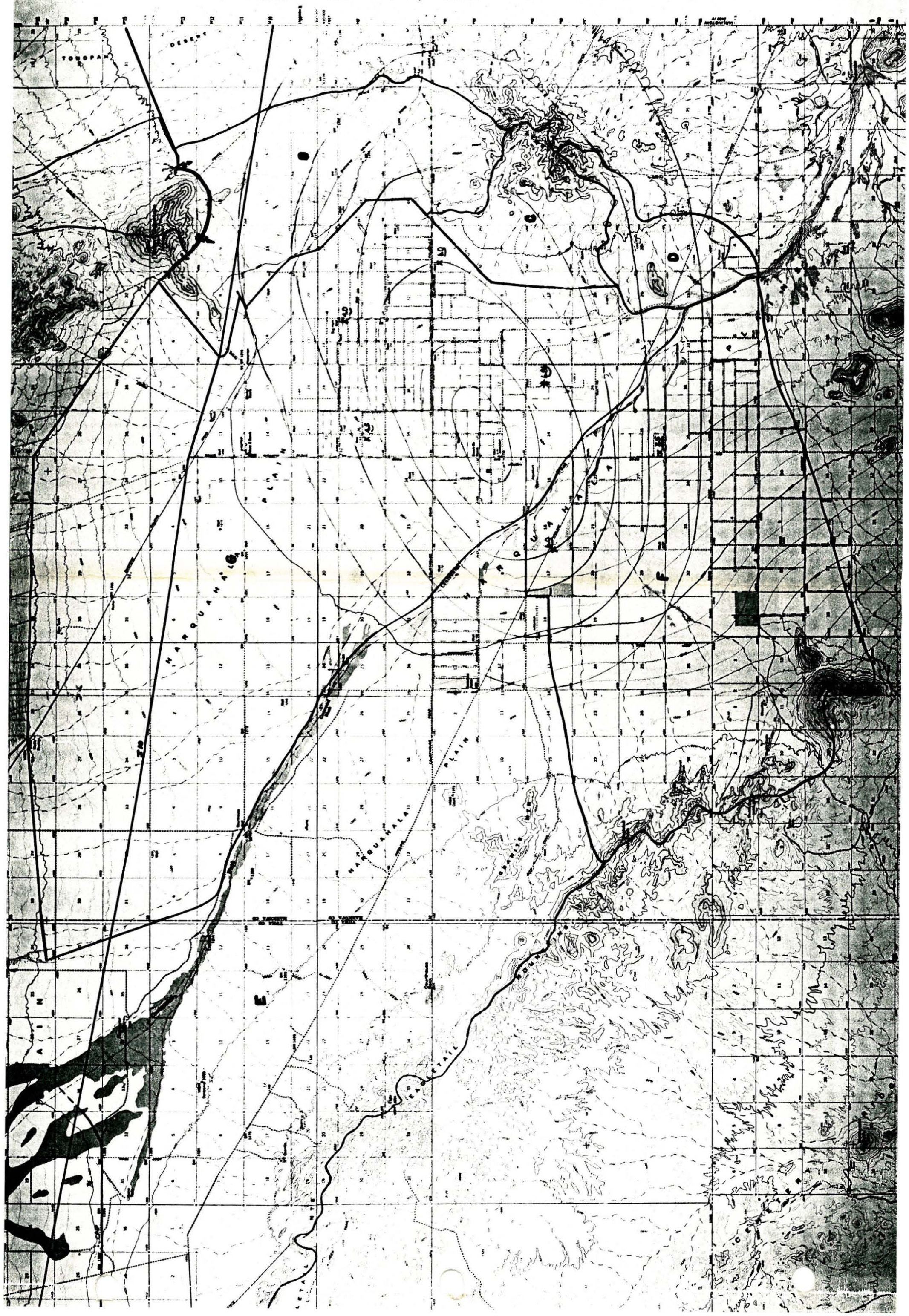
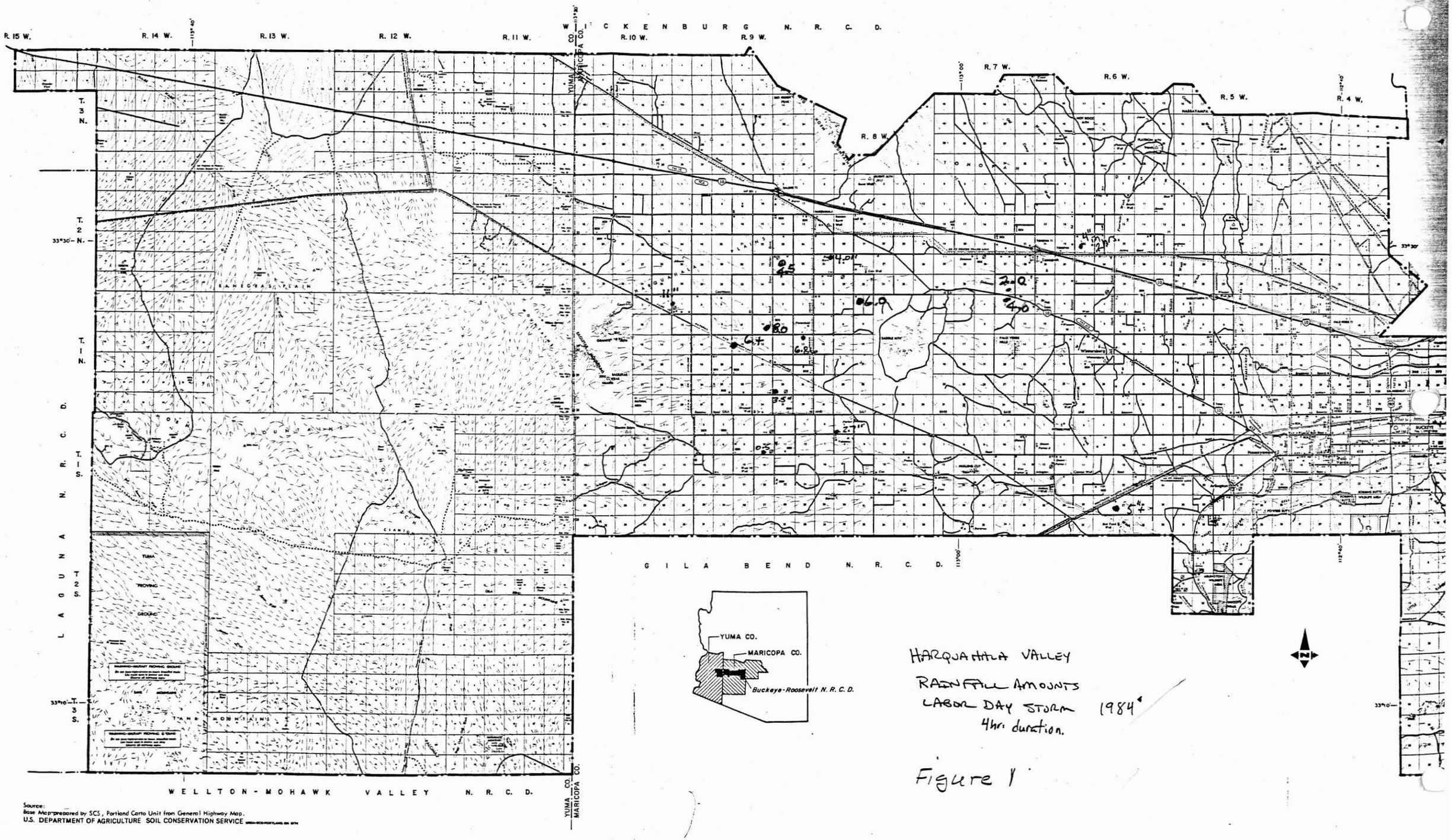


FIGURE 3. STUDY AREA

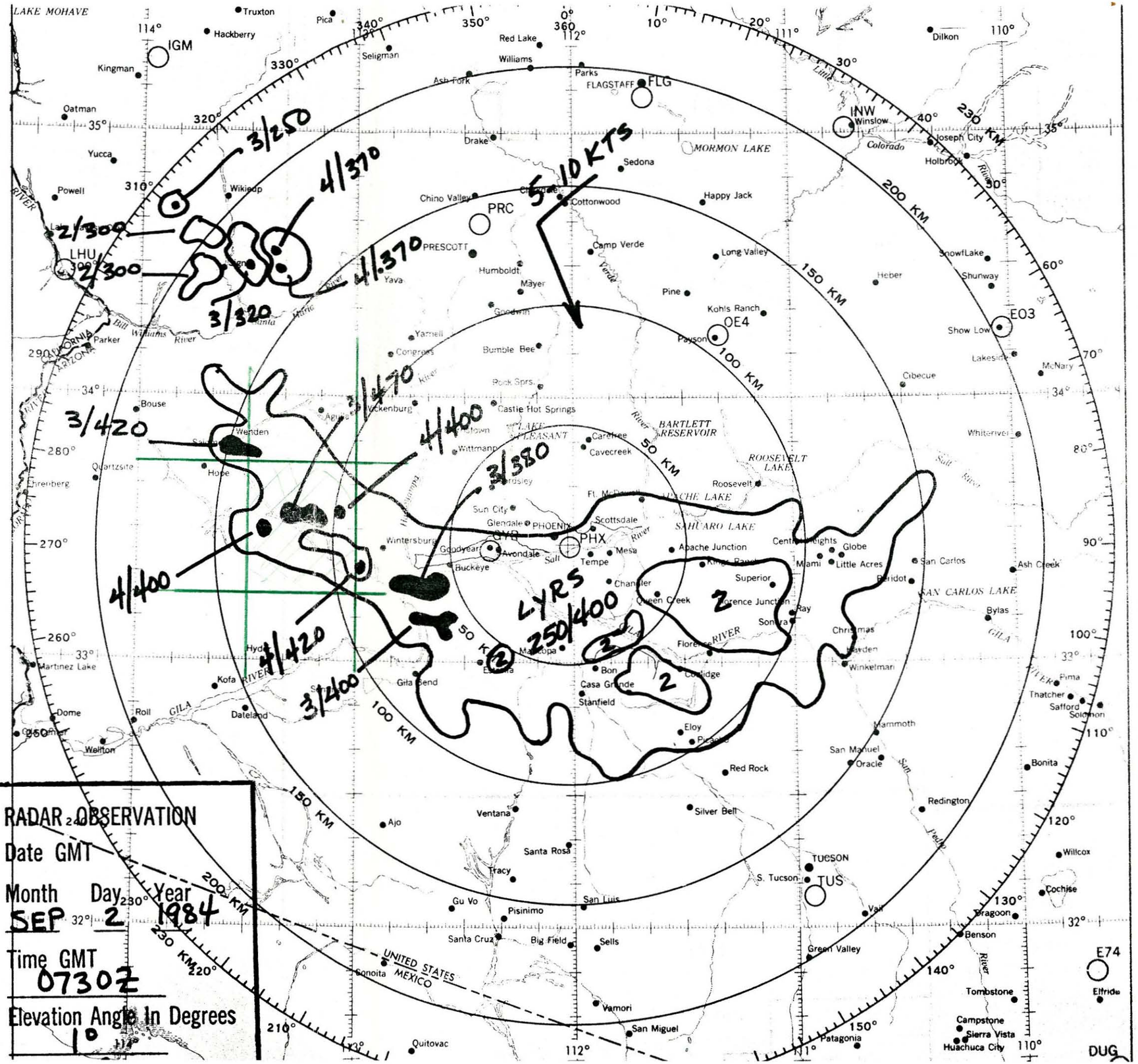


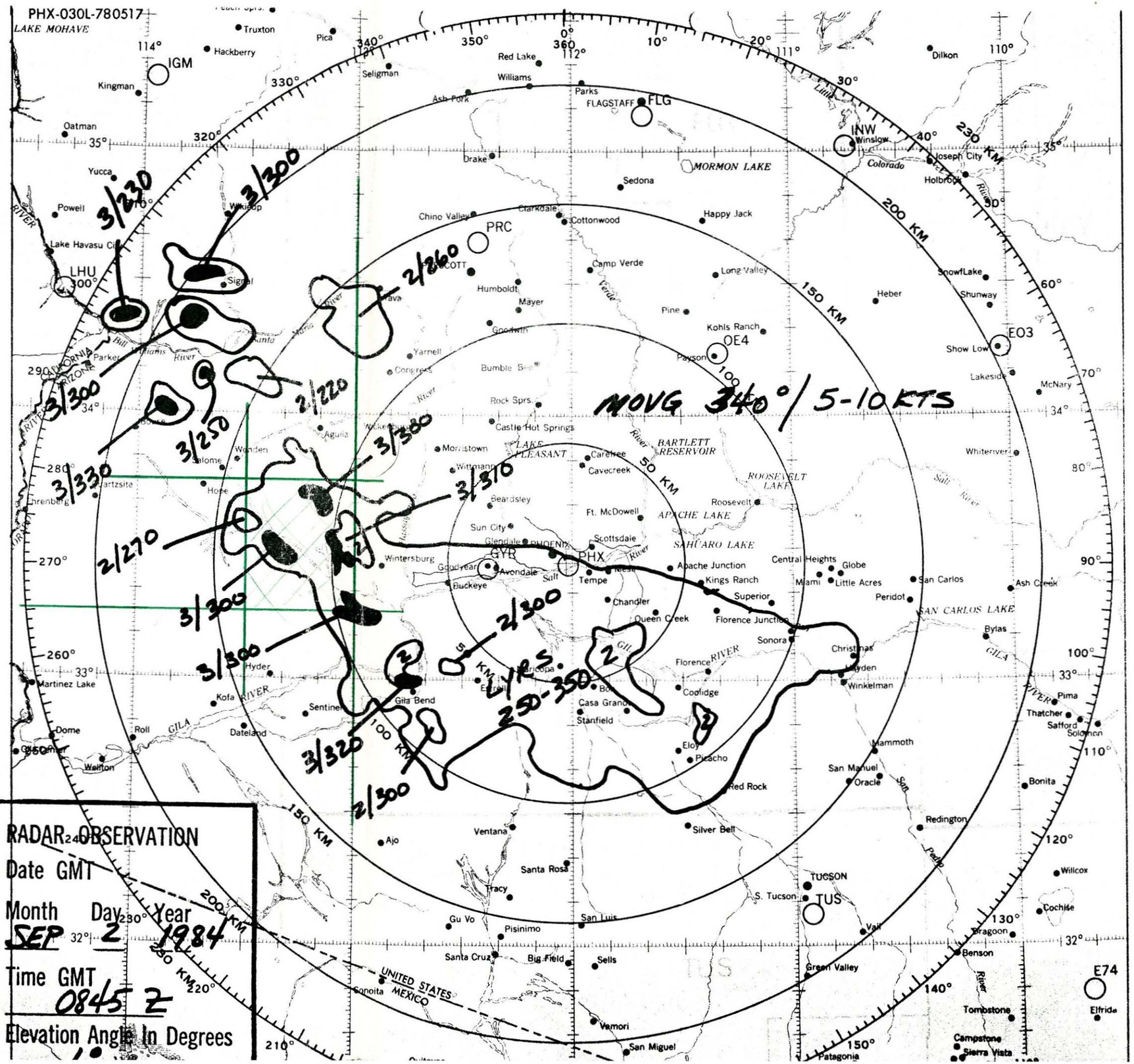


HARQUAHALA VALLEY
RAINFALL AMOUNTS
LABOR DAY STORM 1984
4hr. duration.

Figure 1

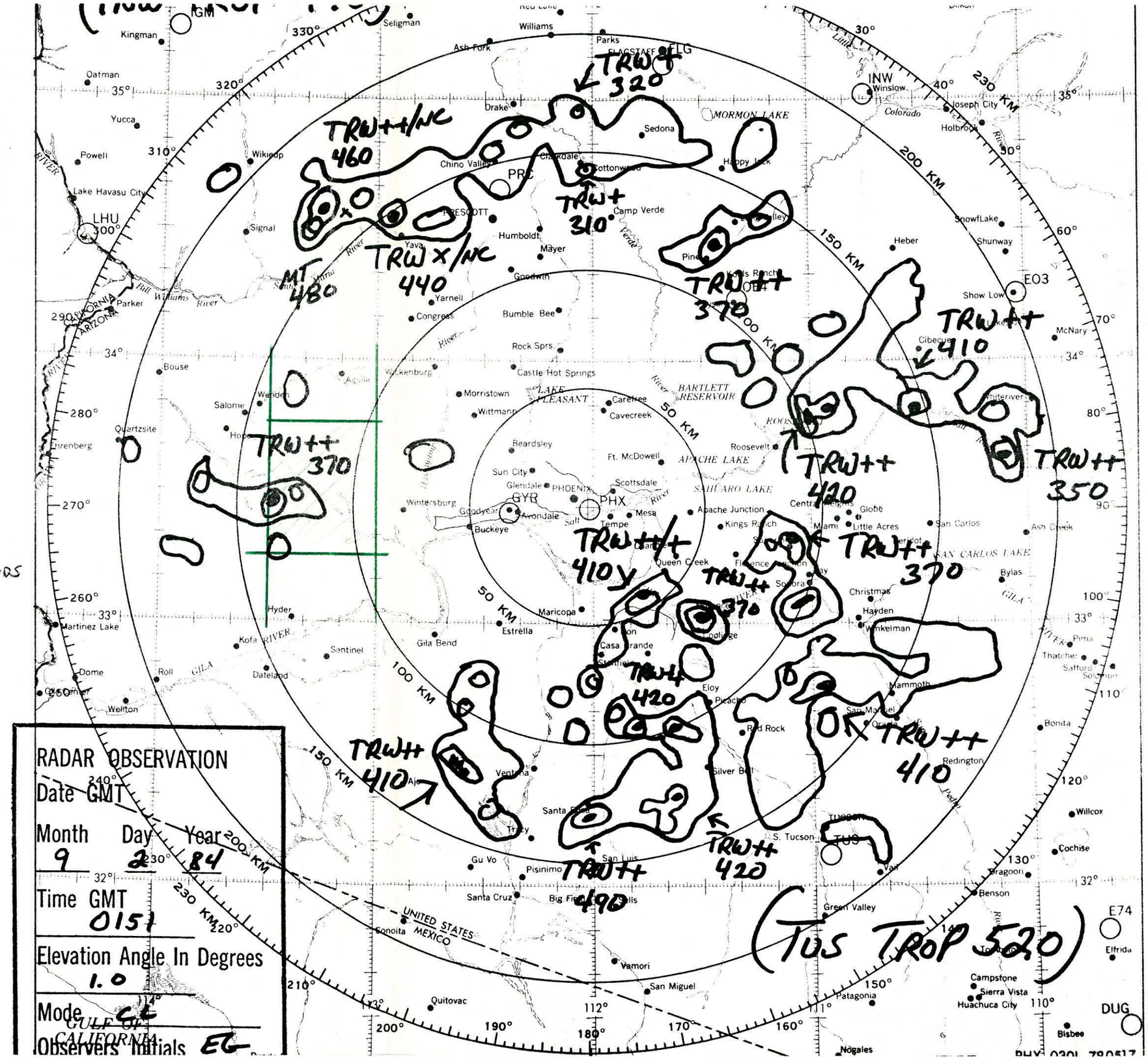
Source:
Base Map prepared by SCS, Portland Carto Unit from General Highway Map.
U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE


RADAR OBSERVATION
Date GMT
Month Day Year
SEP 2 1984
Time GMT
0730Z
Elevation Angle In Degrees
10
IGM
FLG
INW
PRC
LHU
OE4
EO3
PHX
TUS
E74
DUG
50 KM
100 KM
150 KM
200 KM
230 KM
3/250
4/370
2/300
2/300
3/320
4/370
5/10 KTS
3/420
3/470
4/400
3/380
4/400
4/420
3/400
LYRS
250/400
2
2
2
LAKE MOHAVE
MORMON LAKE
BARTLETT RESERVOIR
ROOSEVELT LAKE
APACHE LAKE
SAHUARO LAKE
SAN CARLOS LAKE
UNITED STATES
MEXICO

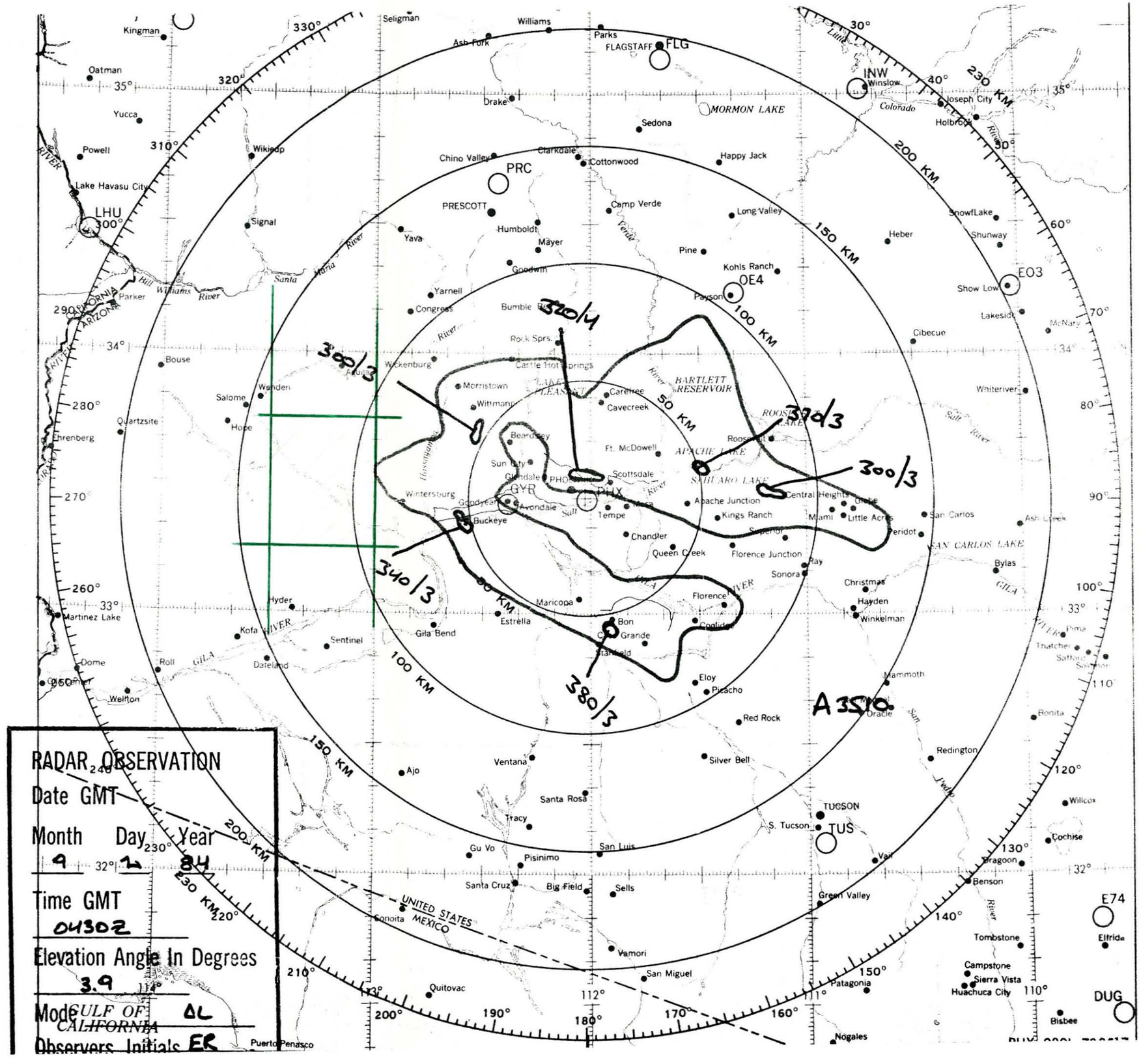

PHX-030L-780517
LAKE MOHAVE
IGM
LHU
FLG
INW
PRC
OE4
EO3
E74
TUS
PHX
GYR
MOVG 340°/5-10 KTS
3/230
3/300
2/260
3/300
2/220
3/250
3/330
3/380
3/310
2/270
3/300
3/300
2/300
2/300
3/320
2/300
50 KM
100 KM
150 KM
200 KM
230 KM
250 KM
UNITED STATES
MEXICO
MORMON LAKE
BARTLETT RESERVOIR
ROOSEVELT LAKE
APACHE LAKE
SAHUARO LAKE
SAN CARLOS LAKE
LAKE PLEASANT
Truxton
Pica
Hackberry
Kingman
Oatman
Yucca
Powell
Lake Havasu City
Seligman
Red Lake
Williams
Parks
FLAGSTAFF
Ash Fork
Drake
Sedona
Dilkon
Winslow
Joseph City
Holbrook
Chino Valley
Clarkdale
Cottonwood
Happy Jack
Camp Verde
Long Valley
Humboldt
Mayer
Pine
Heber
Kohls Ranch
Payson
Snowflake
Shunway
Show Low
Lakeside
McNary
Whiteriver
Yarnell
Congress
Bumble Bee
Rock Sprs.
Castle Hot Springs
Morristown
Wittmann
Carefree
Cavecreek
Beardsley
Sun City
Glendale
Scottsdale
Ft. McDowell
Roosevelt
Apache Junction
Kings Ranch
Superior
Florence Junction
Central Heights
Globe
Miami
Little Acres
San Carlos
Peridot
Ash Creek
Bylas
Christmas
Hayden
Winkelman
Sonora
Coolidge
Florence
Casa Grande
Stanfield
Eloy
Picacho
Red Rock
Mammoth
San Manuel
Oracle
Pima
Thatcher
Safford
Solomon
Bonita
Redington
Willcox
Cochise
Dragoon
Benson
Tombstone
Elfrida
Campstone
Sierra Vista
Patagonia
Green Valley
Vail
S. Tucson
TUCSON
Sells
Big Field
Santa Cruz
Pisinimo
Gu Vo
San Luis
Santa Rosa
Tracy
Ventana
Ajo
Conoita
Vamori
San Miguel
Martinez Lake
Dome
Welton
Roll
Dateland
Kofa
Hyder
Sentinel
Gila Bend
Maricopa
Buckeye
Tempe
Chandler
Queen Creek
Avondale
Goodyear
Wintersburg
Tonopah
Wickenburg
Aguila
Salome
Wenden
Hope
Quartzsite
Parker
Bill Williams River
Signal
Wikieup
Tuba
Scott
Seligman
Little Colorado River
Salt River
Verde River
Gila River
San Pedro River
Santa Maria River
Bill Williams River
CALIFORNIA
ARIZONA
RADAR OBSERVATION
Date GMT
Month Day Year
SEP 2 1984
Time GMT
0845 Z
Elevation Angle In Degrees

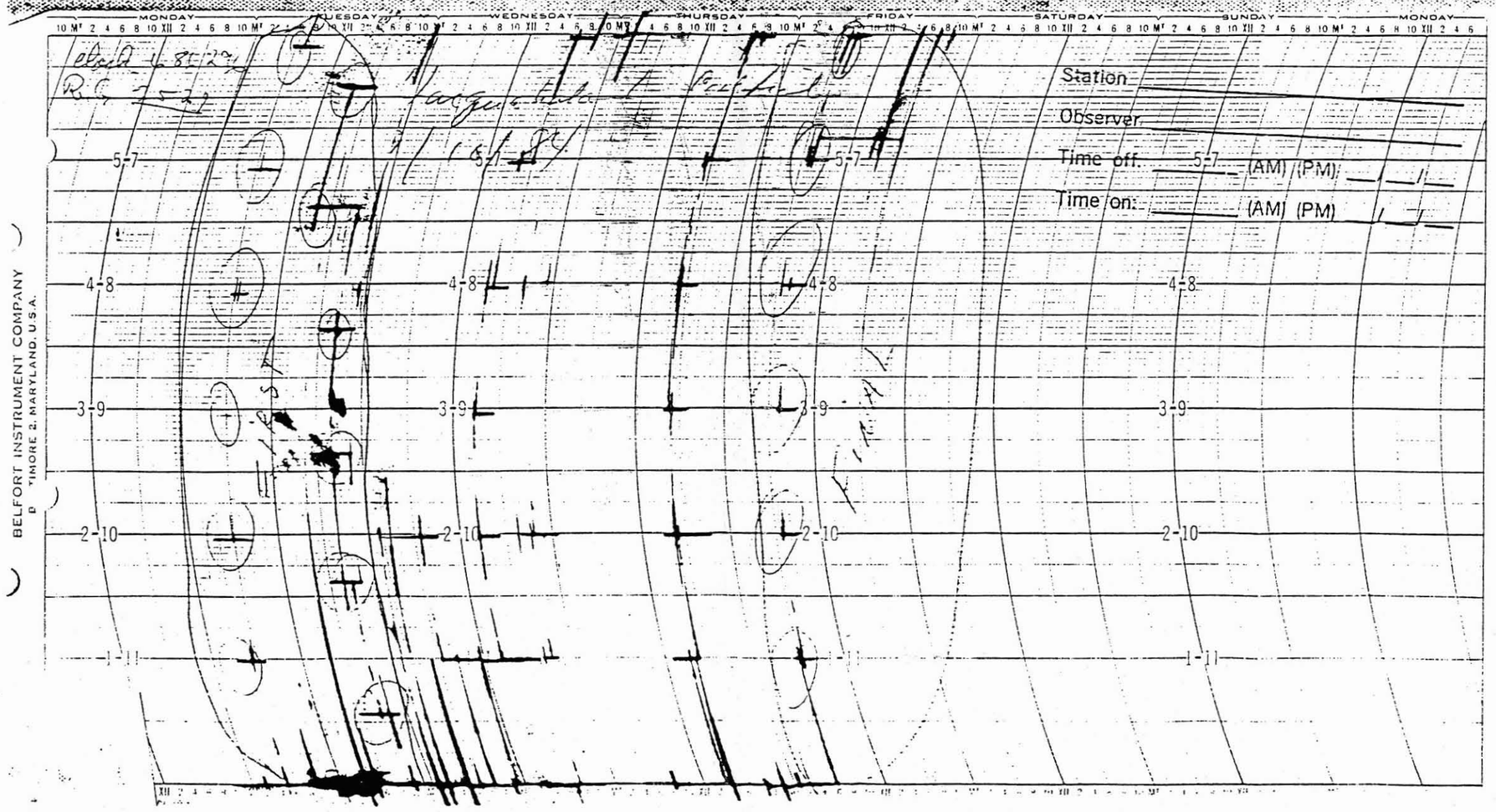
1 < 0.2 (in/hr)
2 0.2 - 1.1
3 1.1 - 2.2
4 2.2 - 4.5 in/hr
5 4.5 - 7.1

TOP OF CLOUDS
41000



RADAR OBSERVATION
Date GMT
Month 9 Day 2 Year 84
Time GMT 0151
Elevation Angle In Degrees 1.0
Mode CL
Observers Initials EG


RADAR OBSERVATION
Date GMT
Month Day Year
9 2 84
Time GMT
0430Z
Elevation Angle In Degrees
3.9
Mode
AL
Observers Initials
ER
FLG
INW
PRC
LHU
OE4
EO3
E74
DUG
TUS
PHX
GVR
A 3510
300/3
320/4
340/3
380/3
330/3
300/3
50 KM
100 KM
150 KM
200 KM
230 KM
Kingman
Oatman
Yucca
Powell
Lake Havasu City
Parker
Seligman
Williams
Ash Fork
Parks
FLAGSTAFF
Winslow
Joseph City
Holbrook
Drake
Sedona
MORMON LAKE
Chino Valley
Clarkdale
Cottonwood
Happy Jack
PRESCOTT
Camp Verde
Long Valley
Humboldt
Mayer
Yava
Pine
Kohls Ranch
Payson
Heber
Snowflake
Shunway
Show Low
Lakeside
Cibecue
Whiteriver
Yarnell
Congress
Bumble Bee
Rock Sprs.
Cattle Hot Springs
Wickenburg
Morristown
Wittmann
Carefree
Cavecreek
BARTLETT RESERVOIR
ROOSEVELT LAKE
Roosevelt
Ft. McDowell
APACHE LAKE
SALT RIVER
Scottsdale
Sun City
Glendale
Wintersburg
Goodyear
Avondale
Buckeye
Tempe
Chandler
Queen Creek
Apache Junction
Kings Ranch
Central Heights
Globe
Miami
Little Acres
Peridot
San Carlos
SAN CARLOS LAKE
Florence Junction
Sonora
Ray
Bylas
Christmas
Hayden
Winkelman
Florence
Coolidge
Maricopa
Estrella
Gila Bend
Bouse
Salome
Wenden
Hope
Quartzsite
Ehrenberg
Hyder
Kofa
Sentinel
Dateland
Martinez Lake
Dome
Roll
Wellton
Eloy
Picacho
Red Rock
Mammoth
Oracle
Bonita
Redington
Silver Bell
Ajo
Ventana
Santa Rosa
Tracy
Gu Vo
Pisinimo
San Luis
Santa Cruz
Big Field
Sells
Conoita
UNITED STATES
MEXICO
Vamori
San Miguel
Quitovac
Green Valley
TUCSON
S. Tucson
Vail
Dragoon
Benson
Tombstone
Campstone
Sierra Vista
Huachuca City
Patagonia
Nogales
Bisbee
Elfrida
Cochise
Willcox
Thatcher
Safford
Pima
GULF OF CALIFORNIA
Puerto Penasco
CALIFORNIA
ARIZONA
COLORADO RIVER
GILA RIVER
SALT RIVER
Verde
Colorado
Little Colorado
Bill Williams River
Santa Maria River
Hassayampa River
Agua Fria River
Salt River
Pecos River
Gila River


MONDAY
TUESDAY
WEDNESDAY
THURSDAY
FRIDAY
SATURDAY
SUNDAY
MONDAY
Station
Observer
Time off. 5-7 (AM) (PM)
Time on: (AM) (PM)
5-7
4-8
3-9
2-10
1-11
BELFORT INSTRUMENT COMPANY
BALTIMORE 2, MARYLAND, U.S.A.
DATE