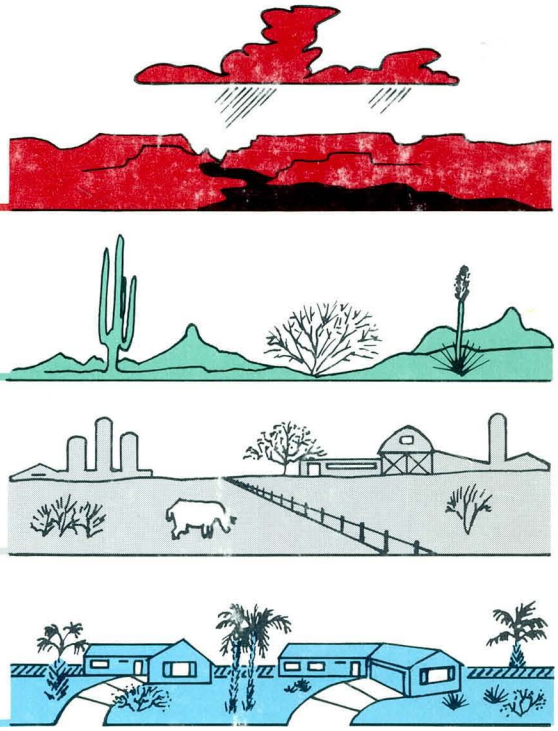
A470.702



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

A HYDROLOGIC ANALYSIS
OF THE
WHITE TANKS F.R.S. #3 & #4

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

16.9-01-1-10/89

Property of
Flood Control District of MC Library
Phoenix, AZ 85009

Report on

A HYDROLOGY ANALYSIS OF THE WHITE TANKS FLOOD RETARDING STRUCTURES #3 AND #4

Prepared by

Flood Control District of Maricopa County
Hydrology Division
Watershed Management Branch

Valerie Rice, Hydrologist
Doug Plasencia, Hydrologist

October 1989

A HYDROLOGIC ANALYSIS
OF THE
WHITE TANKS F.R.S. #3 & #4

TABLE OF CONTENTS

List of Tables iii

List of Figures iv

I. INTRODUCTION 1

1.1 Purpose 1
1.2 History 1
1.3 Land Use 3
1.4 Previous Studies 4

II. HYDROLOGIC METHOD 5

2.1 Physiography 5
2.2 Methodology 5
2.3 Precipitation Parameters 5
2.4 Maps 6

III. WATERSHED CONDITIONS 8

3.1 White Tanks #3 8
3.2 White Tanks #4 8

IV. RESULTS AND DISCUSSION 12

4.1 White Tanks #3 12
4.2 White Tanks #4 15

V. RECOMMENDATIONS 19

5.1 White Tanks #3 19
5.2 White Tanks #4 21

VI. REFERENCES 24

WHITE TANKS WATERSHED MAP ..... PLATE 1

I-10 PROFILE VS. NORTH GROUND ELEVATION ..... PLATE 2

COMPUTER DISK WITH INPUT FILES ..... PLATE 3

LIST OF TABLES

Table		Page
2.1	Hydrologic Parameters	7
3.1	Key to Map Features	10
4.1	White Tanks #3 Results	12
4.2	Breakout Along the Beardsley Canal for White Tanks #3	13
4.3	White Tanks #3 Results All Flows Reaching the Structure	14
4.4	White Tanks #4 Results	15
4.5	Breakouts Along Jackrabbit Trail for White Tanks #4	16
5.1	White Tanks #3 Final Results	20
5.2	White Tanks #4 Final Results	22

LIST OF FIGURES

Figure		Page
1.1	White Tanks #3 and #4 Maricopa County Location Map	2
3.1	Caterpillar Map	9
4.1	Location Map Breakout of Flows Along Jackrabbit Trail, South of I-10	18

I. INTRODUCTION

1.1 Purpose of Study

The purpose of this study was to determine current hydrologic conditions; evaluate the White Tanks Structures for stage, storage, and discharge requirements as specified by the Arizona Department of Water Resources (ADWR), Dam Safety Section; and to provide recommendations for modification of the structures if Dam Safety criteria were not met.

1.2 History

The White Tanks Planning Unit, originating in the White Tanks Mountains, is approximately 200 square miles in size. Two flood control structures, White Tanks #3 Flood Retarding Structure (F.R.S.) and White Tanks #4 (F.R.S.), exist within the White Tanks Planning Unit, as shown in Figure 1.1. The combined watershed area for these structures is 37.5 square miles. Both structures were designed and built in 1954 by the Soil Conservation Service (SCS). The Agua Fria Soil Conservation District (AFSCD) originally assumed overall responsibility for the operation and maintenance of the structures. The AFSCD made an agreement with the Maricopa County Municipal Water Conservation District #1 (hereafter to be referenced as the "Irrigation District") on December 2, 1953 to "assume specific responsibility for overall periodic inspection of the measures primarily for flood prevention and for maintenance of the floodwater retarding structures and directly associated measures".

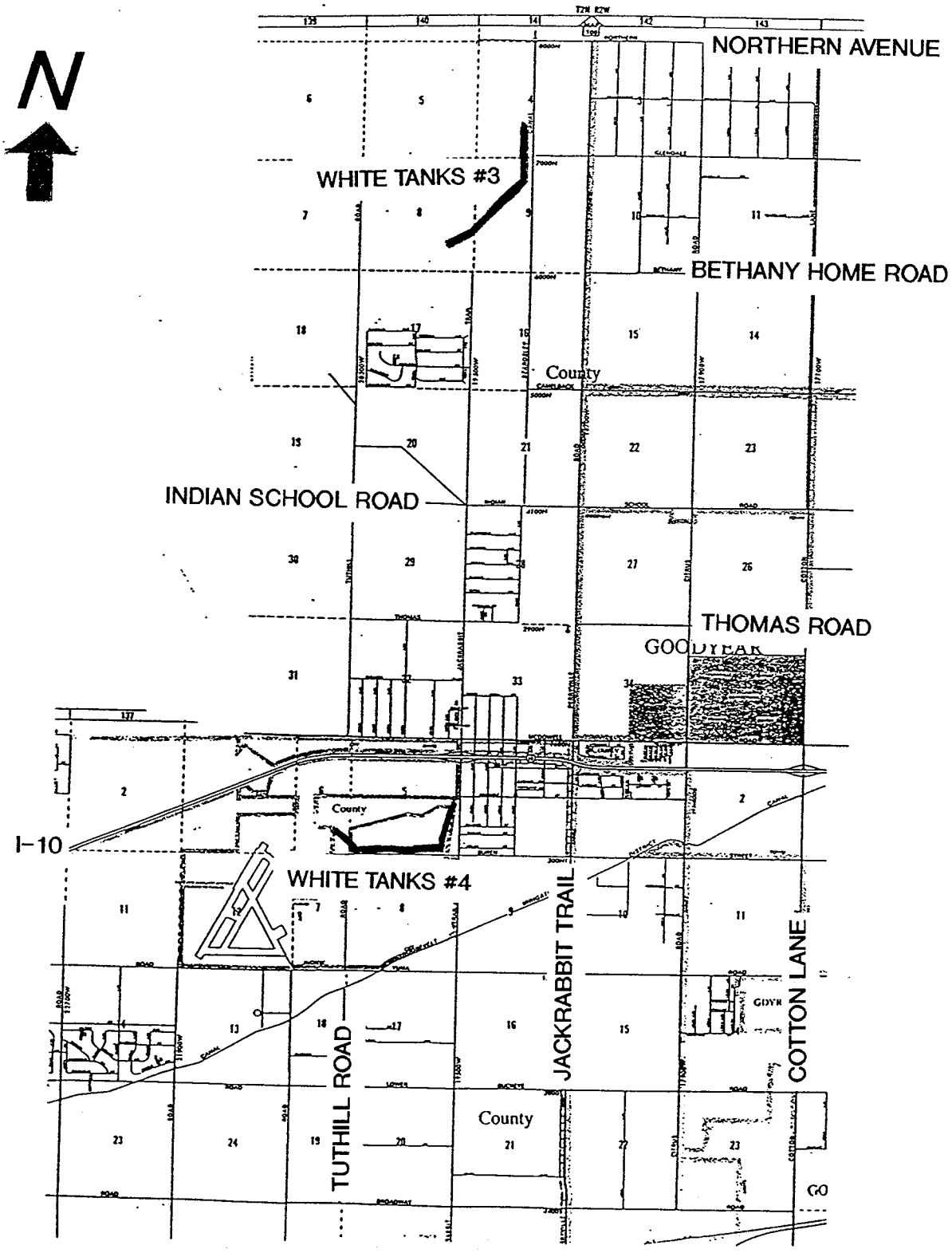
In November 1966, the Flood Control District of Maricopa County (FCD) entered into an agreement with the Irrigation District, and assumed the overall responsibility of operating and maintaining the White Tanks #3 and #4. (See Appendix A in Supplement #16.9-01-1-09/89 in the Hydrology Library for all contracts, letters, and agreements regarding the maintenance responsibility for the White Tanks Structures). Having been in existence for only a few years, the FCD staff was not large enough to take on the responsibility of operating and maintaining the structures. Therefore, the Irrigation District provided operations and maintenance on the structures with reimbursement from the Flood Control District.

Figure 1.1

White Tanks #3 and #4

Maricopa County, Arizona

Location Map



In May of 1975, when the FCD had sufficient personnel to operate and maintain the structures, the agreement of November 1966 between the FCD and the Irrigation District was absolved. This resulted in the FCD taking over all operations and maintenance for White Tanks #3 and #4. Resolution FCD 86-19 (Appendix A) stated that "the Flood Control District, for all intents and purposes, has assumed ownership and operation and maintenance responsibility for White Tanks Dams #3 and #4". The resolution also stated that "the Agua Fria Soil Conservation District, or the Agua Fria--New River Natural Resource Conservation District as it is now known, has no responsibility for the operation, maintenance, or control of White Tanks #3 or White Tanks #4...".

In 1978, the FCD started conducting monthly inspections of both structures. In 1979, cracks were noticed on the structures, indicating potential problems. In July 1981, the FCD and the SCS entered into an agreement to repair the structures. The SCS provided for the design, contracts, and money for the repairs. The District assumed responsibility for operation and maintenance after the repaired were complete. Currently, the FCD conducts annual inspections on the structures.

1.3 Land Use

White Tanks #3 is located west of the Beardsley Canal and north of Bethany Home Road. White Tanks #4 is located just south of Interstate-10 and west of Jackrabbit Trail (See Figure 1.1).

The land within the White Tanks Watershed is comprised of undisturbed desert lands, agricultural lands, a heavy equipment proving grounds, and low density residential housing.

The Caterpillar Tractor Company has changed the natural drainage patterns on the proving grounds. A telephone conversation with Don Swanson of the Caterpillar Tractor Company stated that the large perimeter berms were built for security with the intent to channel flows into the White Tanks Structures. Smaller dikes within the proving grounds were also built with the intent for divert flows towards the structures. The actual level of protection for development adjacent to the perimeter berm along the eastern border of the proving grounds has not been determined, but by a field investigation, without any structural analysis, the dike appears large enough to divert the flows resulting from the 100 year, 24 hour storm.

1.4 Previous Studies

Three previous studies have been conducted in the White Tanks watershed area. The first study was conducted by Ertec Western, Inc. for the State of Arizona Department of Water Resources in 1981, and two Studies conducted by the Flood Control District of Maricopa County.

The study conducted by Ertec Western was part of the "Phase I Inspection Report for White Tanks Retarding Dam No. 4." The results of the study indicated that with 1/2 PMF would overtop the structure without the consideration of the construction of Interstate 10. The recommendation of the Ertec Western Report was that a study be conducted to determine the effect of construction of I-10.

The first study by the Flood Control District for White Tanks #4 was in 1983. That study incorporated a detailed assessment of the impact of I-10 highway as recommended by the Ertec Western Report. The report concluded that the 1/2 PMF would not overtop the structure if it was initially empty.

The Special Projects Branch of the Hydrology Division prepared a general Dam Break analysis for White Tanks #3 and #4 in 1988. Their assumption of the watershed boundaries, which was appropriate for the Dam Break analysis, was that all the flows from the contributing drainage area would reach the structures. However, due to low capacity collector channels on the east boundaries of the watershed, a high potential for breakout does exist. In this study the channel capacities were quantified and existing flow conditions were established.

II. HYDROLOGIC METHODS

2.1 Physiography

The White Tanks #3 watershed is 21.3 square miles with elevations ranging from 1210 to 4083 feet (amsl). The White Tanks #4 watershed is 16.2 square miles with elevations ranging from 1056 to 3151 feet (amsl). The soils in the area were identified using Soil Conservation Service Soil Survey maps from Central Maricopa County, (Reference 6) and include Gilmani-Estrella-Avondale Association in the broad valley plains and low stream terraces (loams and clay loams); Ebon-Pinamt- Tremant Association in the gently sloping old alluvial fans at the base of the White Tanks mountains (gravelly loams and gravelly clay loams); and Cherioni-Rock Outcrop Association in the mountainous areas. The natural vegetation was predominantly desert brush and cacti, with cover densities ranging from 10 to 40 percent.

2.2 Methodology

The U.S. Army Corps of Engineers HEC-1 Flood Hydrology computer program (Reference 4) was used to simulate rainfall-runoff response. The model simulates the basin as an interconnected system of hydrologic and hydraulic components. The watershed for White Tanks #3 was divided into 11 subbasins ranging in size from .66 to 5.24 square miles. The watershed for White Tanks #4 was divided into 16 subbasins ranging in size from .05 to 2.0 square miles.

The output for the computer runs can be found in the White Tanks Analysis Supplement #16.9-01-1-09/89 in the FCD hydrology library.

2.3 Precipitation Parameters

The 100 year, 24 hour storm and the Probable Maximum Precipitation (PMP) were used in modeling. The 100 year, 24 hour precipitation of 4.20 inches was computed using the 1973 publication NOAA Atlas No. 2, Precipitation - Frequency Atlas of the Western United States, Vol. VIII - Arizona (Reference 3). The PMP was calculated using the procedure outlined in the U.S. Department of Commerce's 1977 publication Hydrometeorological Report No. 49 - Probable Maximum Precipitation Estimates, Colorado River and Great Basin Drainages (Reference 8). The total 6 hour PMP was 13.4 inches. (See Appendix B for all tables, figures, and computations for the precipitation determinations).

The Guidelines for the Determination of Spillway Capacity Requirements (Reference 2) by the Arizona Department of Water Resources (ADWR), Division of Safety of Dams, was used to determine the Inflow Design Flood Magnitude (IDFM) for the structures. The White Tanks #3 F.R.S. has a maximum height of 25 feet and a storage capacity at the emergency spillway of 3432 acre-feet which classifies this structure as a medium dam. The area below White Tanks #3 has no urban development with only a small number of habitable structures, classifying the hazard category as "significant". The Division of Safety of Dam suggests that the IDFM for a medium dam with significant hazard category be the 1/2 PMF. When the area downstream of White Tanks #3 develops the hazard category will increase to "high", thus requiring the DF to be the range from the 1/2 PMF to the PMF.

The White Tanks #4 F.R.S. has a maximum height of 16 feet and a storage capacity at the emergency spillway of 1184 acre-feet which classifies this structure as a small dam. The area below White Tanks #4 can currently be classified as "significant"and "high" under future conditions. The Division of Safety of Dam suggests that the IDFM for a small dam with significant hazard category be the range from 100 year to the 1/2 PMF. A hazard category of high would required the IDFM to be 1/2 PMF.

Arizona Department of Water Resources would decide the IDFM for each structure. For the conditions where there was a range of IDFM, we used the most conservative for our analysis.

2.4 Maps

USGS 7.5 minute quadrangle maps (photorevised 1971) were used to delineate the watersheds for the White Tanks #3 and #4 Structures.

The Flood Control District had current aerial topographic maps developed at a scale of 1" = 400' and a contour elevation of two feet. These maps were used to determine storage capacity behind the structures. These maps were also used to analyze any problems that required more detailed maps.

All design elevations of the structures were compared to the elevations from the current mapping. There was a difference in the top of dam and spillway crest elevations for both White Tanks #3 and #4. Where necessary the elevations and corresponding stage-discharge rating curves were adjusted to meet current conditions.

Table 2.1

Hydrologic Parameters

100 Year Precipitation	:	24 hour duration 15 minute time increments 4.20 inches SCS Type II distribution
Probable Maximum Precipitation	:	6 hour duration 1 hour time increments 13.4 inches HR-49 for PMP distribution
Rainfall Excess	:	SCS Curve number loss rate
Unit Hydrograph Development	:	1) COE Phoenix Mountain S-Graph (used for mountainous subbasins) 2) SCS Unit hydrograph
Routing Method	:	1) Normal Depth Routing was used for the Channel along the west side of Jackrabbit Trail. 2) Kinematic Wave Routing for all other channel routing
Storage Routing	:	Reservoir Routing

III. WATERSHED CONDITIONS

3.1 White Tanks #3

The culverts under Olive Avenue and Northern Avenue, located west of Beardsley Canal, appeared to be undersized for the wash (see Appendix E for culvert capacities and locations). The two foot contour interval maps developed for the FCD did not provide sufficient resolution to determine the crest elevation of the two roads over the Beardsley Canal. A field survey (see Appendix G for field notes), in conjunction with the two foot topographic maps was used to determine road crest elevations and cross-sections. An analysis using the U.S. Army Corps of Engineer's Water Surface Profile computer model HEC-2 (Reference 5) was performed to determine culvert capacities and to establish a breakout rating curve for each intersection. (See Appendix E for the locations of the cross-sections and Plate 1 for White Tanks #3 watershed map).

3.2 White Tanks #4

The Caterpillar Proving Grounds contains a number of significant drainage features (see Figure 3.1 and Table 3.1). A dike existing along the east property boundary directs flows toward the south along the Tuthill Road alignment, whereas the natural flow pattern originally was toward the southeast. A large hole exists in the southeast corner of the property referenced to as a "tank" by the Caterpillar Tractor Company. The tank acts as a retention/detention basin. All the runoff flows into the basin until it is full, then overflows to the south into a wash along the Tuthill Road alignment.

An additional subbasin, #13, was added to the model developed by Special Projects. A field investigation showed an eastward sloping drainage ditch along the north side of I-10 with no underpasses or culverts under I-10 between the four culverts at Tuthill Road alignment and a dirt road underpass about two and a half miles to the west. A small drainage ditch sloping eastward exists along the north side of I-10. Using the topographic map, the grade break between Tuthill Road alignment and a dirt road underpass was identified and located on Plate 1 - White Tanks #4 watershed map.

Figure 3.1

Caterpillar Map

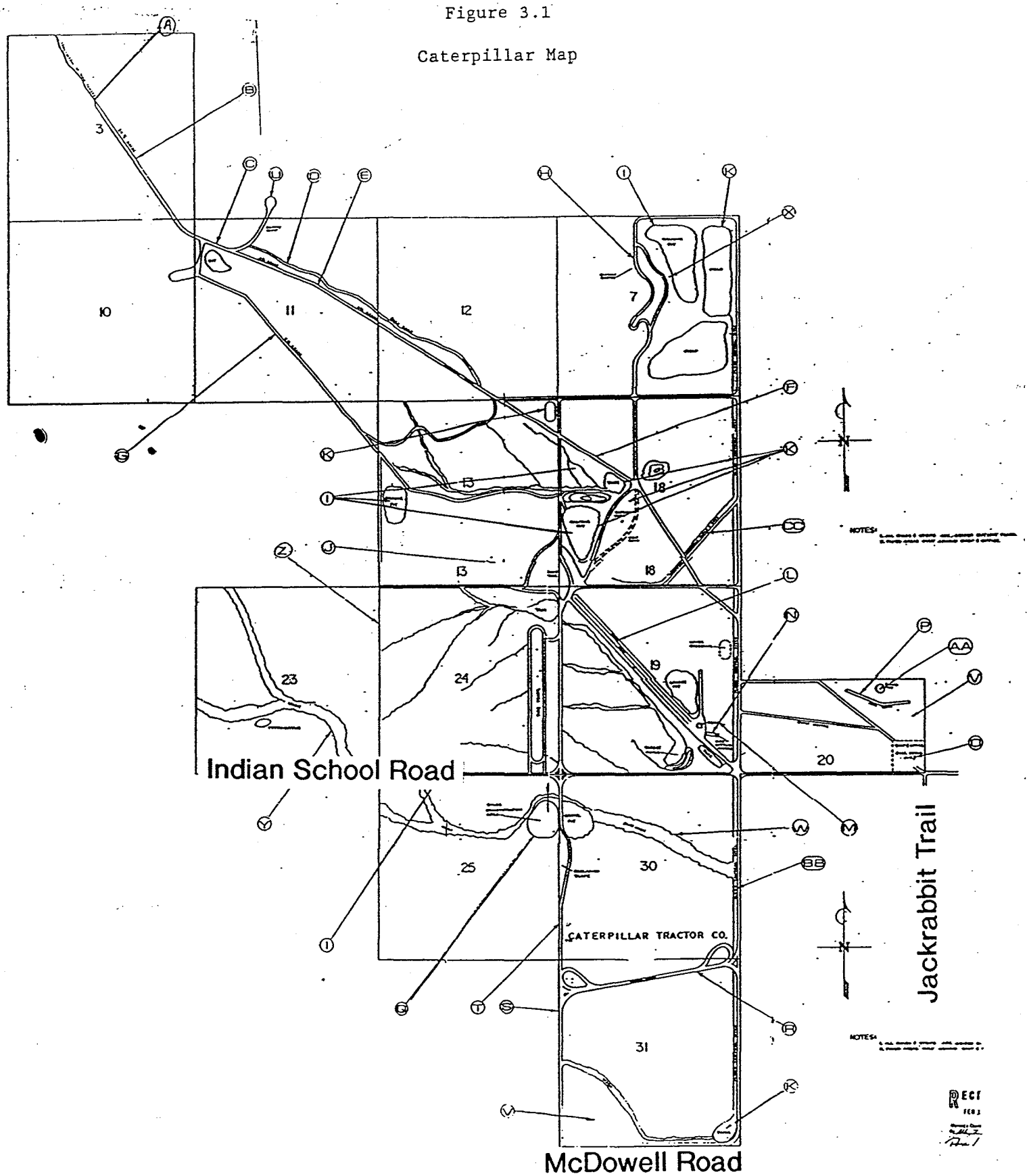


Table 3.1

KEY TO MAP FEATURES

A — Road to Radio Towers
B — 24% Grade 4000 ft. long
C — 11% Grade 4500 ft. long
D — Rock Road 6000 ft. long
E — 5% Grade 4000 ft. long
F — 3% Grade 3000 ft. long
G — 9% Grade 9000 ft. long
H — Switch Backs
I — Caliche Pits
J — Shot Rock Quarry (Granite)
K — Tanks (Reservoirs)
L — Abrasive Wear Course 5000 ft. long
M — Scales (250,000 lb. capacity)
N — Tire Cutting Course
O — Shop and Office Area
P — M.G. (ABC) Wire Following Road (2000 ft. long)
Q — Sales Demonstration Area 1967
R — Level Mile
S — Tire TMPH Course
T — 14% and 20% Grade 1000 ft. long
U — Safely Escape Ramp
V — Dust Track Soils
W — Sand Deposit
X — Scraper Loading Area (Sandy Loam)
Y — Loader Test Area (Dry Wash)
Z — Narrow Boundary Road
AA — Sound Pad
BB — Roadway/Flood Control Levee
CC — Flood Diversion Levee

A dike exists along the Tuthill Road alignment between the I-10 Freeway and McDowell Road, hereafter to be known as the Tuthill Dike. The Dam Break analysis showed a diversion of flows at the intersection of the wash west of the Tuthill Dike and I-10. The analysis assumed the backwater at the four box culverts under I-10 would cause some of the flows to be diverted over the Tuthill Dike to the east. A field investigation indicated storage behind the Tuthill Dike that was not accounted for in the original diversion rating curve. A stage-storage-discharge rating curve was developed using the two foot contour maps and a field survey to determine the profile of the Tuthill Dike and the minimum elevation at which flows would start to overtop the dike.

The Dam Break analysis also included a diversion of flows over I-10 between the Tuthill Dike and Jackrabbit Trail. A comparison of the profiles for the roadway of I-10 and the invert of the wash to determine the possibility of flows overtopping the freeway was conducted (see Plate 2 for profile). It was determined that flows would not overtop the freeway during the 100 year event, therefore, the diversion was not modeled for the 100 year storm. However, there was the possibility of overtopping during the 1/2 PMF, thus, the breakout over I-10 was modeled for the 1/2 PMF.

IV. RESULTS AND DISCUSSION

4.1 White Tanks #3

Using the Dam Safety guidelines, the Inflow Design Flood Magnitude (IDFM) for White Tanks #3 under current conditions is the 1/2 Probable Maximum Flood (PMF), while future conditions will be the full PMF. The results of the 100 year flood, the 1/2 PMF, and the PMF are shown in Table 4.1. The peak water surface elevation for the 100 year event was 1207.4 ft amsl. With the measured emergency spillway crest being at 1209.0 ft. amsl no emergency spills will occur during the 100-year event. The peak water surface elevation for the 1/2 PMF with the reservoir storage initially full was 1211.9 ft amsl which will not overtop the structure.

The White Tanks #3 structure appears to be in compliance with Dam Safety regulations for the IDFM of 1/2 PMF with the reservoir initially full, and protects downstream areas from the 100 year flood arising from its contributing watershed.

Under future conditions, with the IDFM requiring the PMF, for White Tanks #3 the maximum reservoir water surface elevation would be 1212.5 ft. amsl. Since the minimum elevation on the top of the dam is 1212.1 ft. amsl, there would be some overtopping which would occur near the east end of the dam.

Table 4.1

White Tanks #3 Results

Minimum Dam Elevation	:	1212.1 feet amsl
Emergency Spillway Crest Elevation	:	1210.0 feet amsl
Reservoir Volume to the Spillway Crest Elevation	:	3432 acre-feet
Inflow to White Tanks #3	:	100 year - 7640 cfs
		1/2 PMF - 18,130 cfs
		PMF - 35,410 cfs
Outflow from White Tanks #3 Reservoir Storage	:	100 year - 0 cfs
Initially Empty		1/2 PMF - 5540 cfs
		PMF - 21,040 cfs
Initially Full		1/2 PMF - 14,900 cfs
		PMF - 30,770 cfs
Peak Stage at White Tanks #3 Reservoir Storage	:	100 year - 1207.4 ft amsl
Initially Empty		1/2 PMF - 1210.3 ft amsl
		PMF - 1212.5 ft amsl
Initially Full		1/2 PMF - ~~1213.1~~ ft amsl 1211.93
		PMF 1213.1.

White Tanks #3 has three low level gated outlets, although our analysis assumed the outlets to be closed. One of the low level outlets discharges directly into the Beardsley Canal while the other two discharge overland. The latter two outlets discharge overland in a southeasterly direction toward the Beardsley Canal, where the flows then enter a wash along the west side of the Canal. Those flows and discharges from the emergency spillway cross the Beardsley Canal at an overchute near Bethany Home alignment and thus do not effect White Tanks #4.

The Special Project analysis assumed that all flows from the White Tanks #3 contributing watershed reached the structure. As described in Section 3.1, our analysis included the breakout rating curves for Olive and Northern Avenues. The breakout of flows is caused by undersized culverts at those locations. The flows would leave the White Tanks #3 watershed, and travel southeasterly. The results of the breakouts are located in Table 4.2

Table 4.2

White Tanks #3
Breakout Along the Beardsley Canal

Location	Peak Inflow (cfs)	Peak Breakout Flows (cfs)	Breakout Volume (ac-ft)
Olive Avenue			
100 year	6080	2110	270
1/2 PMF	14,360	7185	1200
Northern Ave.			
100 year	4980	1440	270
1/2 PMF	10,210	3320	770

An analysis was conducted to determine the size and number of culverts that would be required to pass under Olive and Northern Avenues without flows breaking out over the Beardsley Canal.

A preliminary design of 9 - 7 x 12 foot box culverts was modeled in the HEC-2 program for Olive Ave. to determine the backwater effects. The upstream wash was channelized, increasing the bottom width and stabilizing the banks. The preliminary design indicated no overtopping of the Beardsley Canal upstream from Olive Ave., although, there would need to be some increase in channel capacity downstream to Northern Ave. (See Appendix H for proposed channel design).

Preliminary designs for Northern Ave. indicated that 8 - 8 x 12 foot box culverts would be required to contain all the flows in the White Tanks #3 watershed.

If all the flows from the 100 year event were contained within the White Tanks #3 watershed there would be no problem with emergency spills during the 100 year event or overtopping during the 1/2 PMF with the reservoir storage initially empty. However, there would be a small amount of overtopping, .12 feet, during the 1/2 PMF with the reservoir storage initially full. Under future land use conditions downstream the flows would overtop the structure during the PMF.

Table 4.3

White Tanks #3 Results
All Flows Reaching the Structure

Inflow to White Tanks #3 :	100 year	-	11,130 cfs
	1/2 PMF	-	21,430 cfs
	PMF	-	38,630 cfs
Outflow from White Tanks #3 :	100 year	-	0 cfs
Reservoir Storage			
Initially Empty	1/2 PMF	-	9970 cfs
	PMF	-	25,360 cfs
Initially Full	1/2 PMF	-	17,670 cfs
	PMF	-	34,280 cfs
Peak Stage at White Tanks #3 :	100 year	-	1209.0 ft amsl
Reservoir Storage			
Initially Empty	1/2 PMF	-	1211.2 ft amsl
	PMF	-	1212.8 ft amsl
Initially Full	1/2 PMF	-	1212.2 ft amsl
	PMF	-	1213.2 ft amsl

Future condition

4.2 White Tanks #4

Using the Dam Safety guidelines (Reference 2), the Inflow Design Flood Magnitude (IDFM) for White Tanks #4 is the 1/2 PMF under current conditions. The results of the 100 year flood and the 1/2 PMF are located in Table 4.3. White Tanks #4 has two low level gated outlets. The Special Projects analysis assumed the gates to be closed. To be consistent with the rating curve developed by the Special Projects Branch we also assumed closed gates. The peak water surface elevation for the 100 year flood was 1050.2 feet amsl. White Tanks #4 has two emergency spillways, one at each end of the structure. The measured emergency spillway crest at the west end of the structure is at an elevation of 1049.0 feet amsl, and is 1048.5 feet amsl at the east end of the structure. The 100 year flood spills approximately 1260 cfs through the combined emergency spillways. The peak water surface elevation for White Tanks #4 for the 1/2 PMF did not overtop the structure.

White Tanks #4 appears to be in compliance with Dam Safety regulations for the 1/2 PMF. The structure, however, does not provide full protection from the 100 year flood.

Table 4.4

White Tanks #4 Results
All Flows Reaching the Structure

Minimum Dam Elevation	: 1054.9 feet amsl	
Emergency Spillway Crest Elevation		
West End	: 1049.0 feet amsl	
East End	: 1048.5 feet amsl	
Reservoir Volume to the Spillway Crest Elevation	: 1180 acre-feet	(1184?) pg. 6
Inflow to White Tanks #4	: 100 year	- 5830 cfs
	1/2 PMF	- 20,710 cfs
Outflow from White Tanks #4	: 100 year	- 1260 cfs
Reservoir Storage		
Initially Empty	1/2 PMF	- 8220 cfs
Initially Full	1/2 PMF	- 12,140 cfs
Peak Stage Elevation	: 100 year	- 1050.2 ft amsl
Reservoir Storage		
Initially Empty	1/2 PMF	- 1053.2 ft amsl
Initially Full	1/2 PMF	- 1054.6 ft amsl

The emergency spillway crest would need to be raised to an elevation of 1053.0 amsl to prevent spills under current conditions for the 100 year event. This would cause the 1/2 PMF to overtop the structure by .8 feet for a duration of 3.7 hours.

The hydrologic analysis included the flows that breakout over Jackrabbit Trail. A small wash exists along the west side of Jackrabbit Trail north of I-10 freeway. See Figure 4.1 for a location map. The flows that overtop the road will exit the White Tanks #4 watershed. A series of culverts exist under the I-10 freeway along the west side of Jackrabbit Trail. Although some backwater effect caused flows to overtop Jackrabbit Trail and leave the White Tanks #4 watershed, the true control for the wash system was at the point at which the dike started along Jackrabbit Trail south of I-10. Therefore, the diversion rating curve was based on the HEC-2 backwater analysis south of I-10. A break down of the flows is in Table 4.~~4~~. 5 (See Appendix I for cross-section locations).

Table 4.5

White Tanks #4
Breakouts Along Jackrabbit Trail

Location along Jackrabbit Trail	Peak Inflow (cfs)	Peak Breakout Flows (cfs)	Breakout Volume (ac-ft)
North of I-10 (Reach DIVA1)			
100 year	740	0	0
1/2 PMF	2090	1400	160
South of I-10			
100 year	3590	2140	190
1/2 PMF	4800	3310	780

To be able to contain all the 100 year flows within the White Tanks #4 watershed, the wash west of Jackrabbit Trail would need to have a channel cross-section with a bottom width of 60 feet, sideslopes of 2:1, and a depth of 5 feet. (See Appendix I for channel capacity). There would probably need to be some slope manipulation to decrease the siltation that is occurring through the wash.

If all the 100 year flows from the White Tanks #4 watershed were to reach the structure (proposed conditions), the peak stage for the 1/2 PMF would be at 1054.0 amsl. The flows would not overtop the structure but would cause outflow through the emergency spillway of 10,280 cfs.

Under the proposed conditions, the emergency spillway crest would need to be raised to an elevation of 1054.0 amsl to prevent spills during the 100 year event. This would cause the 1/2 PMF to overtop the structure by over 1.2 feet for a duration of about 5.4 hours.

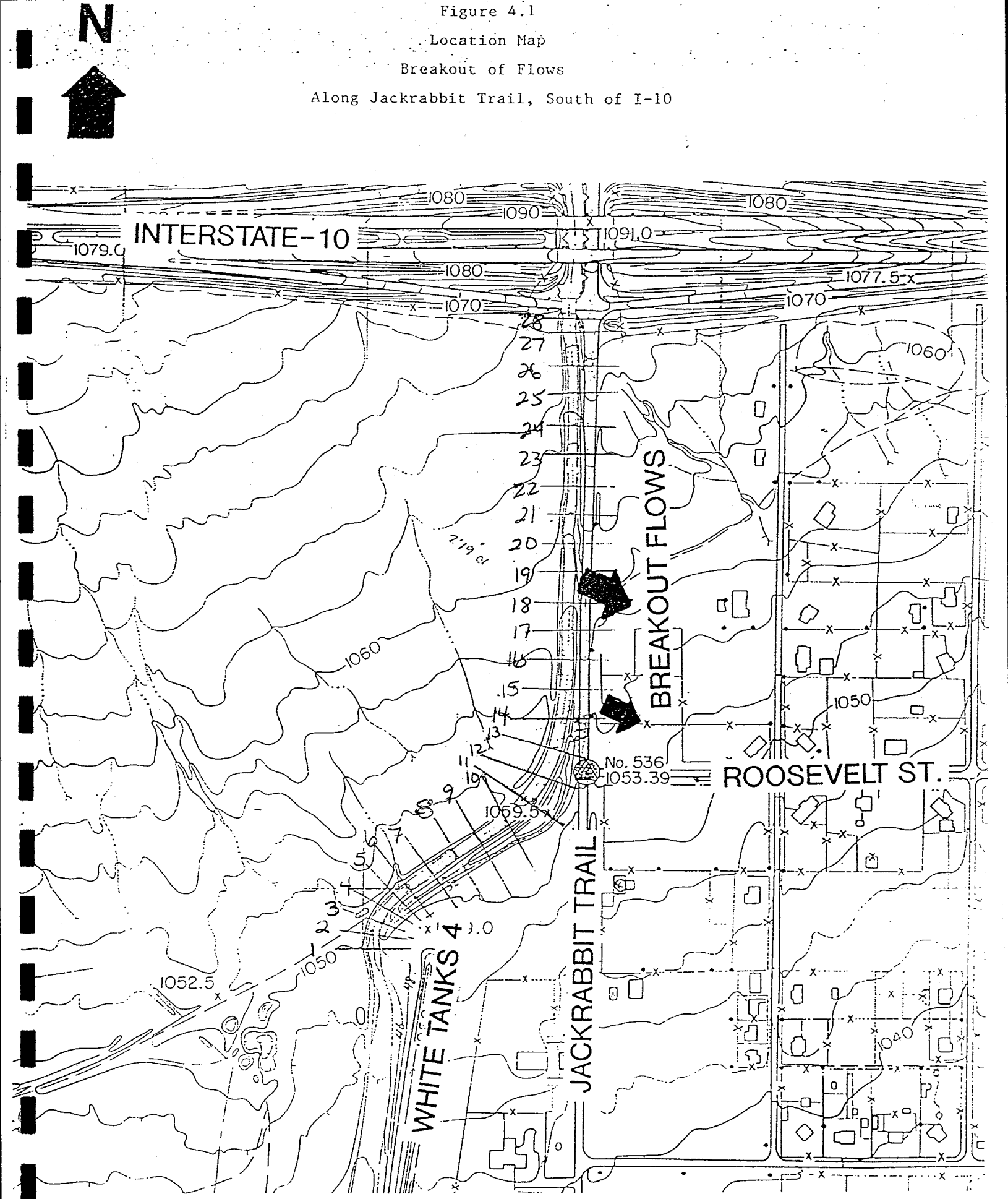
Another alternative to prevent flows from spilling during the 100 year event would be to increase the size of the storage area by excavating more volume from the excavation pit behind the structure. It would require an additional 650 ac-ft of storage for existing conditions and 850 ac-ft for proposed conditions to prevent spills during the 100 year event.

Figure 4.1

Location Map

Breakout of Flows

Along Jackrabbit Trail, South of I-10



V. RECOMMENDATIONS

5.1 White Tanks #3

In the study conducted by the Special Projects Branch all flows within the watershed reached the structure. The 100 year, 24 hour storm did not spill through the emergency spillways and the 1/2 PMF did not overtop the structure. Therefore, there appeared to be no adverse effects to the structure by allowing all of the 100 year, 24 hour flows to reach the structure. See Table 5.1 for a comparison of the different alternatives.

The area to the east of the watershed of White Tanks #3 is a rapidly developing area. To prevent breakout flows over the Beardsley Canal we recommend that the culverts at Olive Avenue and Northern Avenue just west of the Beardsley Canal be enlarged to pass the 100 year, 24 hour flood of 6080 cfs and 7040 cfs, respectively. We also recommend that the floodplain for the wash just west of the Beardsley Canal be delineated. Until the culverts can be enlarged to be able to carry the 100 year flows, we also recommend that the 100 year breakout flows at Olive and Northern Avenues be delineated for immediate floodplain management purposes.

White Tanks #3 has three low level outlets, we recommend that the floodplain for the low level outlets be delineated, or determine some other means to allow for conveyance of outflows from the structure to the Beardsley Canal for future conditions.

As development downstream of the structure occurs, White Tanks #3 will increase in the hazard category to "high". The inflow design flow magnitude for spillway design will be the full PMF, which will overtop the structure allowing for possible "unsafe" conditions downstream. At such time, there will need to be a detailed study to determine the alternatives, such as raising the minimum top elevation of the dam to its original design, that will allow the structure to meet all the dam safety criteria.

Table 5.1

White Tanks #3

Final Results

	Plan 1			Plan 2		
	100 year	1/2 PMF	PMF	100 year	1/2 PMF	PMF
Peak Inflow at Olive Ave. (cfs)	6080	14,360	28,780	6080	14,360	28,780
Peak Breakout (cfs)	2110	7185	16,080	0	4140	16,080
Peak Inflow at Northern Ave. (cfs)	4980	10,210	18,700	7060	13,190	23,340
Peak Breakout (cfs)	1440	3320	6590	0	3060	8140
Peak Inflow to WT#3 (cfs)	7640	18,130	35,410	11,130	21,430	38,630
Peak Outflow (cfs)						
Empty	0	5540	21,040	0	9970	25,360
Full	-	14,900	30,770	-	17,620	34,280
Peak Stage (ft.amsl)						
Empty	1207.4	1210.3	1212.5	1209.0	1211.2	1212.8
Full	-	1211.9	1213.1	-	1212.2	1213.2

Plan 1 : Existing Conditions

Plan 2 : All Flows Reaching the Structure

Emergency Spillway Elevation : 1209.0 (ft.amsl)

Minimum Dam Elevation : 1212.1 (ft.amsl)

5.2 White Tanks #4

A small wash exists along the west side of Jackrabbit Trail, and did not appear to overtop Jackrabbit Trail north of I-10 during the 100 year, 24 hour flood. Flows south of I-10 were shown to overtop Jackrabbit Trail and leave the watershed area. We recommend that some type of protections, such as a channel, be developed to prevent breakout flows
over Jackrabbit Trail. The area to the east of the White Tanks #4 watershed has a high potential for development, thus a channel would protect the area from the 100 year flood.

With current land use conditions, White Tanks #4 flows through its emergency spillways during the 100 year flood. It was estimated that an additional 650 acre-feet of storage would be required to prevent emergency spills during the 100 year flood. We recommend that if measures are not taken to ensure full protection downstream from the 100 year flood, then the floodplains downstream from the spillways should be delineated. See Table 5.2 for a comparison of the results for White Tanks #4.

Further it is recommended that the feasibility of using White Tanks #3 and #4 as regional detention basins be examined in the proposed White Tanks/Agua Fria Area Drainage Master Study. In lieu of on-site retention, developers would pay to modify the outlets to the structures, and provide outlet channels to the Gila River, or some other outfall.

The Caterpillar Tractor Company has changed the natural flow of runoff by building dikes and diverting flows. The Caterpillar Proving Grounds have been in existence for over 40 years. The developments downstream of the Proving Grounds are currently protected from the larger frequency floods because of these diversions. The Caterpillar Tractor Company is planning to sell the grounds which will enable development to occur on the land. We recommend that in the ADMS for this area, floodplains be mapped on the Proving Grounds to maintain the current drainage patterns.

An alternative that was not conducted in this analysis was the impacts of restoration of the natural drainage conditions which existed prior to the development of proving grounds. A new model would need to be developed with in-depth research to find aerial maps prior to 1945. There is also the legal question that needs to be answered about restoring the area back to its original drainage conditions and possibly adversely affecting downstream properties.

Table 5.2

White Tanks #4

Final Results

	Plan 1		Plan 2		Plan 3		Plan 4		Plan 5		Plan 6	
	100 year	1/2 PMF	100 year	1/2 PMF	100 year	1/2 PMF	100 year	1/2 PMF	100 year	1/2 PMF	100 year	1/2 PMF
Peak Inflow at A1 (cfs)	740	2190	740	2190	740	2190	740	2190	740	2190	740	2190
Peak Breakout at DIVA1 (cfs)	0	1400	0	1400	0	1400	0	1400	0	1400	0	1400
Peak Inflow at A4 (cfs)	1640	3750	1640	3750	1640	3750	1640	3750	1640	3750	1640	3750
Peak Breakout at DIVA4 (cfs)	0	240	0	240	0	240	0	240	0	240	0	240
Peak Inflow at Jackrabbit & I-10	3590	5800	3590	5800	3590	5800	3590	5800	3590	5800	3590	5800
Peak Breakout at Jack (cfs)	2140	3310	0	2070	2140	3310	0	2070	2140	3310	0	2070
Peak Inflow to WT#4 (cfs)	5830	20,710	7960	22,820	5,830	20,710	7,960	22,820	5830	20,710	7960	22,820
Peak Outflow (CFS)												
Empty	1260	8220	1260	9660	0	6200	0	7520	0	6570	0	10,210
Full	-	11,680	-	12,680	-	11,680	-	12,680	-	12,970	-	15,010
Peak Stage (amsl)												
Empty	1050.2	1053.2	1050.4	1053.7	1049.0	1052.5	1048.9	1053.0	1052.8	1055.7	1053.7	1056.1
Full	-	1054.5	-	1055.0	-	1055.5	-	1054.8	-	1056.1	-	1056.3

Plan 1 : Existing Conditions
Plan 2 : All 100 year flows reaching the structure (Proposed Conditions)
Plan 3 : Increase Storage (650 ac-ft) at the structure (Existing Conditions)
Plan 4 : Increase Storage by 850 ac-ft at structure (Proposed Conditions)
Plan 5 : Raise emergency spillway crest - existing conditions
Plan 6 : Raise Emergency Spillway crest (Proposed Conditions)

Emergency Spillway Elevation : Existing - 1049.00
Plan 5 - 1053.00
Plan 6 - 1054.00
All Plans - 1054.90

Finally, these facilities are nearly 35 years old. When constructed they had a design life of 25 to 50 years. It is recommended that the structural integrity of the structures be examined, and an estimate of the balance of the structures life span be developed. Prior to the expenditures of any funds on an alternative that would modify or utilize these facilities an economic analysis should be undertaken utilizing the new estimate of the structures life. From this data it would then be possible to determine whether it is cost effective to expend additional funds at this time on these facilities, based on their remaining life.

We suggest that all recommendations be incorporated into the White Tanks/Agua Fria Area Drainage Master Study.

REFERENCES

1. Culvert Program, developed using U.S. Department of Transportation's Hydraulic Design of Highway Culverts (Highway Engineering Circular #5) as a guide.

2. Lawrence, Dan Roger, Guidelines for the Determination of Spillway Capacity Requirements, Arizona State Department of Water Resources, Division of Dam Safety, February 1984.

3. Miller, J.F., R.H. Frederick and R.F. Tracey. Precipitation - Frequency Atlas of the Western United States, VIII: Arizona, NOAA Atlas 2, National Weather Service, National Oceanic and Atmospheric Administration, Silver Spring, MD., 1973.

4. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-1 Flood Hydrology Package, Version of January 31, 1985, Davis, California.

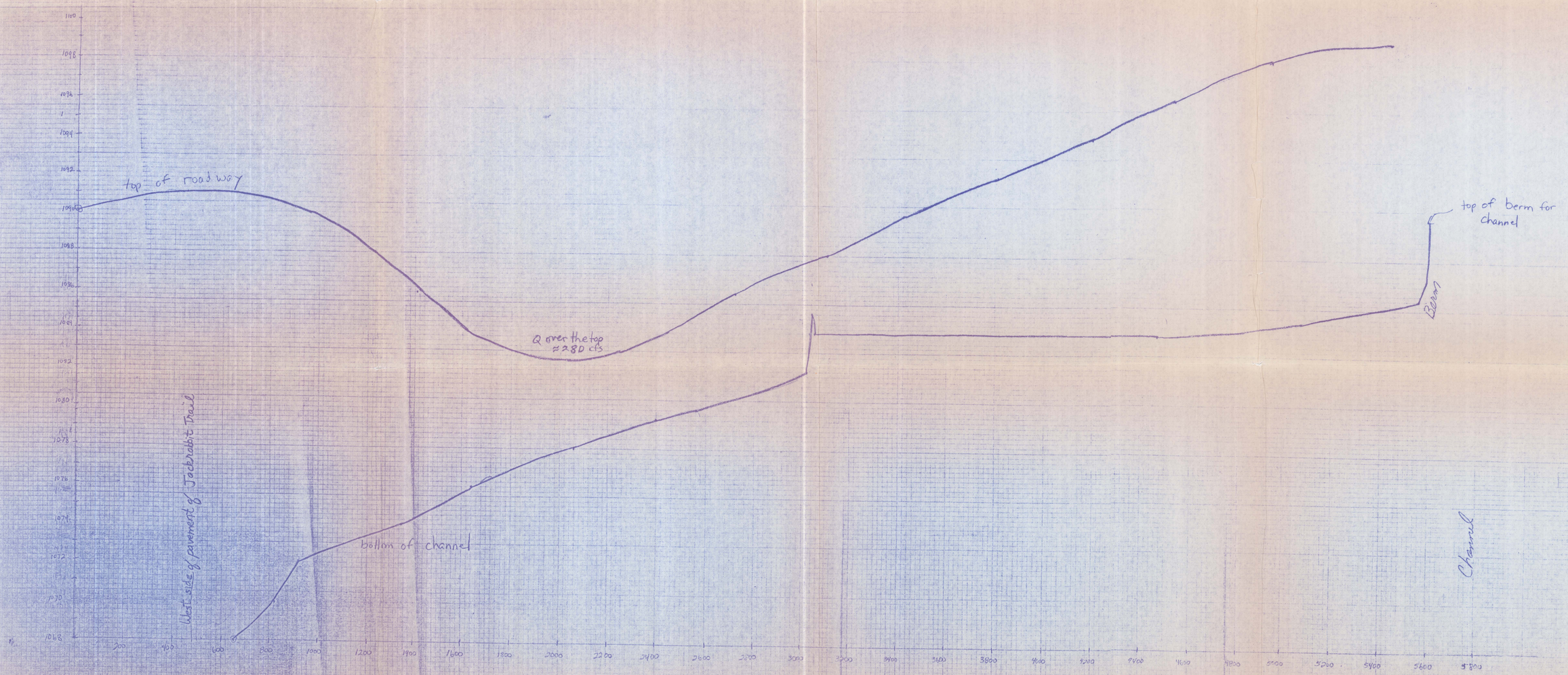
5. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water Surface Profiles, Version of September 1988, Davis California.

6. U.S. Department of Agriculture, Soil Conservation Service in cooperation with University of Arizona Agricultural Experiment Station, Soil Survey of Maricopa County, Arizona, Central Part, Issued September 1977.

7. U.S. Department of Agriculture, Soil Conservation Service, Technical Release 55 - Urban Hydrology for Small Watersheds, June 1986.

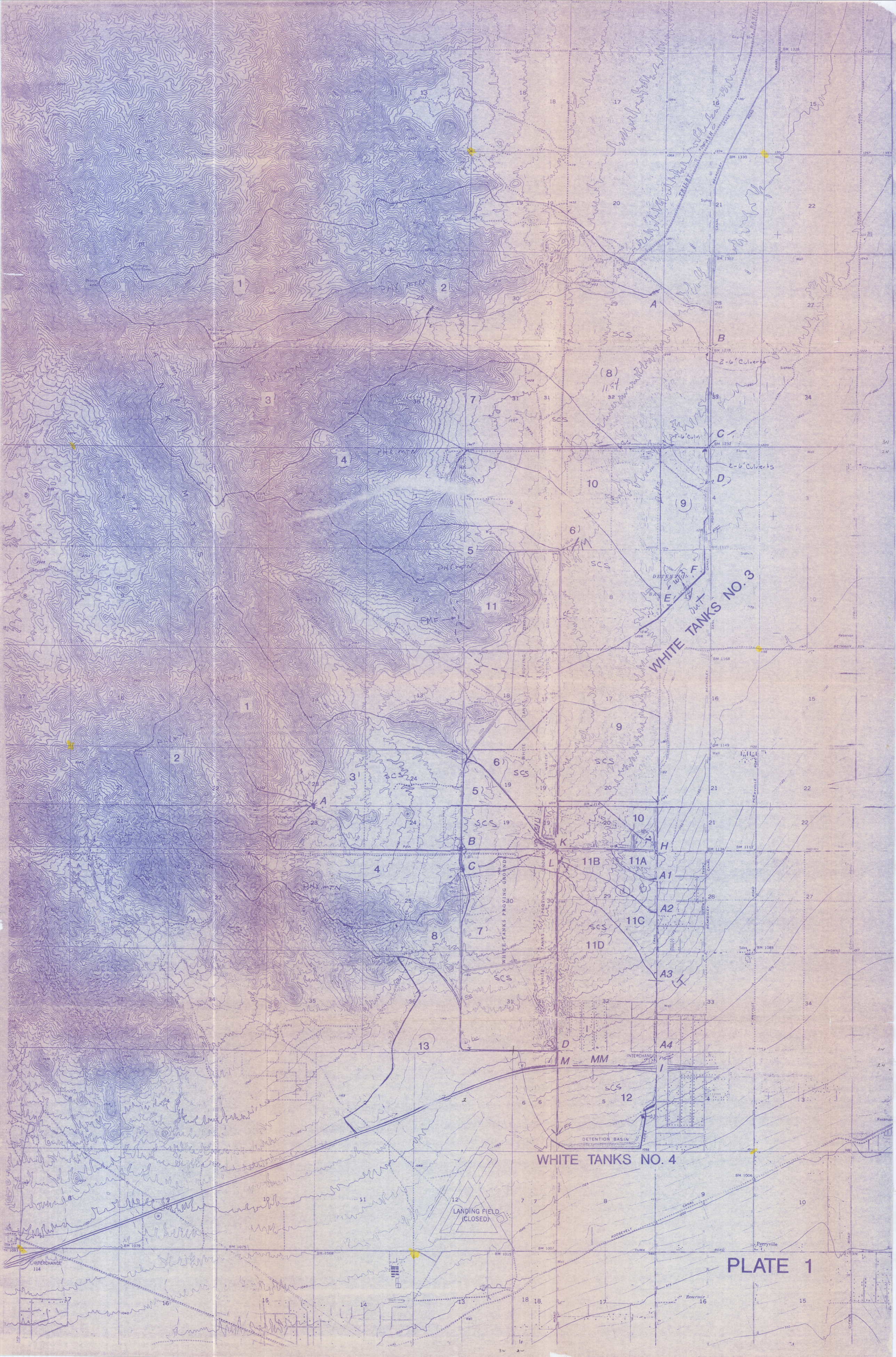
8. U.S. Department of Commerce, Hydrometeorological Report No. 49 - Probable Maximum Precipitation Estimates, Colorado River and Great Basin Drainages, 1977.

I-10 PROFILE VS. NORTH GROUND ELEVATION



South Lane of I-10
(west bound traffic)

PLATE 2


WHITE TANKS NO. 3
WHITE TANKS NO. 4
PLATE 1
WHITE TANKS MOUNTAINS
WHITE TANKS PROVING GROUND
DETENTION BASIN
LANDING FIELD (CLOSED)
INTERCHANGE
Perryville
Reservoir
SCS
BM 1328
BM 1330
BM 1307
BM 1278
BM 1232
BM 1149
BM 1168
BM 1214
BM 1112
BM 1089
BM 1006
BM 1079
BM 1075
BM 1068
BM 1015
BM 1007
BM 1052
Siphon
Well
Flume
Silos
BEARDSLEY ROAD
PERRYVILLE ROAD
CANAL
ROOSEVELT
YUMA ROAD
THOMAS
INDIAN
CITRUS
TUTHILL ROAD
A
B
C
D
E
F
H
I
K
L
M
A1
A2
A3
A4
11A
11B
11C
11D
2-6' Culverts
1-6' Culv.