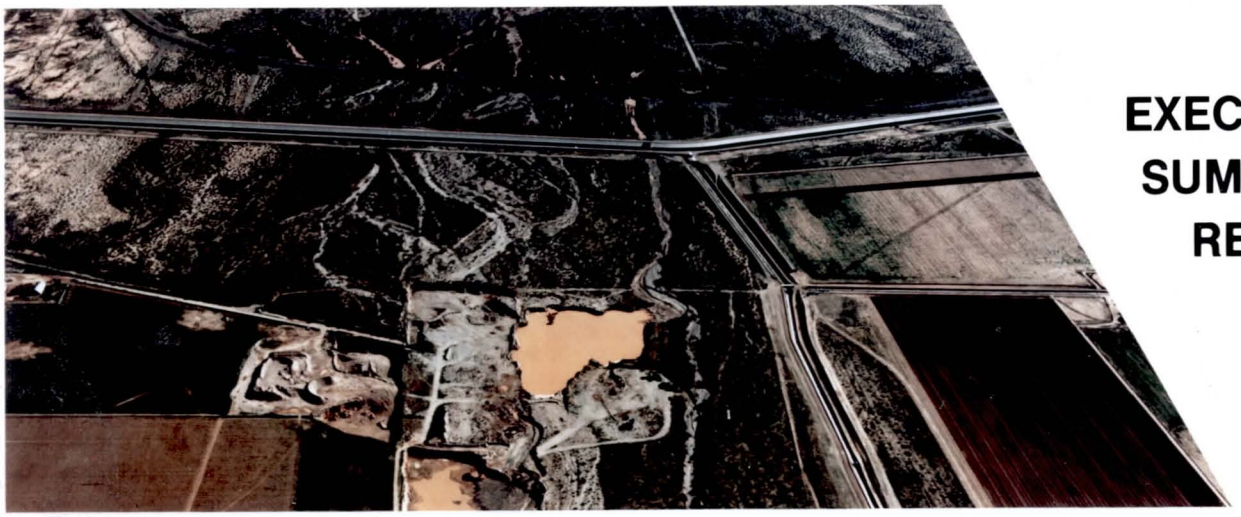


EXECUTIVE SUMMARY REPORT

GROUNDWATER RECHARGE FEASIBILITY INVESTIGATION

CH2M HILL

in association with

ERROL L. MONTGOMERY & ASSOCIATES, INC.

and

L.G. WILSON, RECHARGE SPECIALIST

805.013

GROUNDWATER RECHARGE FEASIBILITY INVESTIGATION

EXECUTIVE SUMMARY REPORT

Prepared for

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
PLANNING & PROJECTS
MANAGEMENT DIVISION

Property of
Flood Control District of MC Library
Please Return to
2801 W. Durango
Phoenix, AZ 85009

by
CH2M HILL
In Association With

Errol L. Montgomery & Associates, Inc.
and
L. G. Wilson, Recharge Specialist

April 1988

This Document Has Been Prepared Under the Direction
of a Professional Engineer Registered in the
State of Arizona

N22984.A0

PREFACE

This document summarizes the work performed during the Groundwater Recharge Feasibility Investigation for the Flood Control District of Maricopa County. An Executive Summary briefly describes the study approach and findings. The summary report contains excerpts from a series of technical memoranda that were prepared during the investigation. These technical memoranda are bound separately and are shown as appendices to the summary report. For additional information and details of the investigation, the reader should consult the appended documents.

EXECUTIVE SUMMARY

STUDY PURPOSE

The purpose of this study was to determine which facilities of the Flood Control District of Maricopa County (FCD) have potential for conducting artificial groundwater recharge. Emphasis was given to conjunctive use of flood control facilities for recharge of both stormwater runoff and supplementary water sources (i.e., CAP water and reclaimed wastewater). Permitting requirements for operating a recharge project were to be identified. The potential for enhancing natural recharge of stormwater runoff at existing and proposed flood control facilities was also to be determined.

STUDY APPROACH

The work completed during this study was divided into five major tasks. The study objectives for each of these tasks are described below:

- Perform an initial screening of the FCD facilities using previously defined site suitability and evaluations criteria to determine which sites are suitable for groundwater recharge.

- Select three sites from the most feasible sites identified and prepare conceptual facilities plans. Prepare cost estimates for construction of recharge facilities and estimate annual costs for operations and maintenance. Identify the additional data required for detailed evaluation of these three sites, including the appropriate methods and costs for obtaining the data.

- Review the rules and regulations of state and federal agencies with regard to permit requirements for recharge. Identify pertinent procedures and requirements an estimate the time required to obtain the needed permits.

- Evaluate selected projects currently planned or proposed by the FCD for potential changes in design and/or operations which could promote incidental, beneficial recharge.

The work product resulting from each of these tasks was presented in a technical memorandum. The technical memoranda, numbered 1 through 5, were reviewed by the FCD Review Committee and finalized in accordance with the committee's review comments. The study findings are summarized in a final report. The technical memoranda are appendices to the report.

INITIAL EVALUATION OF SITES

A total of 34 potential recharge sites associated with FCD flood control facilities were identified and evaluated. The initial screening identified fatal technical flaws which eliminated 19 of the 34 potential sites from further consideration. Reasons for rejecting sites included unfavorable hydrogeologic conditions for recharge, existing groundwater contamination, and a general lack of stormwater runoff or supplemental sources of recharge water. From the remaining 15 sites the FCD Review Committee selected nine feasible sites for further evaluations.

EVALUATION AND RANKING OF THE MOST FEASIBLE SITES

The nine potential recharge sites chosen for evaluation during this task were located near Saddleback Dam and Centennial Wash west of the Palo Verde Nuclear Generating Station, McMicken Dam west of Youngtown, Cave Buttes Dam near Deer Valley Airport, New River south of Bell Road, Agua Fria River south of Glendale Avenue and north of I-10, and Queen Creek west of the Central Arizona Project (CAP) aqueduct.

The criteria used to evaluate these sites included:

- Recharge Water Availability. The availability of stormwater runoff and/or supplemental water for recharge.
- Flood Control Considerations. The potential for adapting existing structures or modifying operations to accommodate or enhance recharge.
- Water Quality Impacts. The potential for negative impacts on groundwater quality due to movement of contamination from landfills or existing contaminate plumes.
- Hydrogeologic Conditions. The ability of the aquifer to accept, transmit, and store recharged water for later recovery.
- Soils and Infiltration Rates. The suitability for recharge and estimated infiltration rates.
- Land Ownership and Use. Compatibility of recharge operations with current land ownership and use, and with future land uses.

The ability to derive flood control benefits from recharge projects was addressed during this task. It was determined that flood control benefits can be direct benefits from reducing flood damage costs or indirect benefits from

contributions to the local economy, improvements to the environment, and contributing to the social well-being of the citizenry. While recharge projects have the potential to provide flood control benefits, it was determined that the direct benefits would probably be small in comparison to other economic factors when considering project feasibility.

Following the evaluations and ranking of the nine sites, three sites were chosen for conceptual facilities planning.

CONCEPTUAL FACILITIES PLANS AND COST ESTIMATES

As a result of prior evaluations it was determined that spreading basins would be the preferred recharge method for the candidate recharge sites. Therefore, design criteria were developed and conceptual layouts prepared of spreading facilities for the three candidate recharge sites previously chosen. The designs prepared for each site include the configuration of basin levees, interbasin spillway and drain structures, conveyance facilities and hydraulic structures, pump stations, and river channel diversion facilities. An operations plan with estimates of the annual recharge capacity was developed for each site. The requirements for a monitoring program for each site were also developed. Estimated capital costs were annualized and estimates of annual and operations and maintenance costs were prepared. From these cost data the cost per acre-foot of water recharged was developed for each site. The facilities plans were developed using readily available data; therefore, many uncertainties remain, particularly site-specific hydrogeologic conditions. Additional data collection and field investigations are needed at these sites prior to final determination of project feasibility. Required data collection and field investigation efforts for hydrogeology, soils and infiltration rates, land ownership and use, floodplain impacts, water sources, and other site-specific data needs were developed. Where feasible, costs for individual data collection tasks were estimated.

McMicken Dam Recharge Site

This 200-acre site is located within the McMicken Dam detention area just south of Bell Road as shown on Figure 1. Depth to water is about 490 feet. There are five soil types characteristic of the site. The estimated composite infiltration rate is 1.7 ft/day. All of the property is currently owned by the Maricopa Water District. For this project, CAP water is delivered to the site for recharge via the Beardsley Canal and pumped upgradient to the spreading basins. Major features of the facilities plan include spreading basins covering 200 acres, canal turnout and pump station, transmission pipeline, hydraulic structures, and monitor wells. Project costs are summarized below:

TOTAL PROJECT COSTS	$2,621,000
Annualized Capital Costs (including Land Lease Costs)	$389,000
Annual Operations & Maintenance	$342,000
Total Annual Cost	$731,000
Cost per Acre-Foot For 56,000 ac-ft/yr Recharge	$12

Agua Fria/New River Recharge Site

This 590-acre site is located at the confluence of New River and the Agua Fria just north of the river crossing at Camelback Road as shown on Figure 1. Depth to water is about 160 feet. There are four characteristic soil types with an estimated composite infiltration rate of 2.0 ft/day. Approximately one-third of the property is privately owned and the remainder is owned by the State Land Department, the City of Glendale, and the Bureau of Land Management. CAP water is delivered to the site for recharge via the Salt River Project (SRP) Grand Canal. Stormwater runoff from New River and spills from Waddell Dam can also be recharged. Based on fourteen years of historical stream flow data, it was estimated that an average of 4,400 ac-ft/yr. could be recharged from the flows in New River. Computer modeling of the New River watershed and existing system of flood control facilities demonstrated that modifying the outlet structures to increase the detention time of stormwater flow could provide a 14 percent increase in recharge potential. Modifying New River Dam showed an average 600 ac-ft/yr increase in recharge. Assuming favorable operation of additional flood control and joint use storage at the proposed New Waddell Dam, it was estimated that average of 5,100 ac-ft/yr of Agua Fria River flow could be recharged at the proposed recharge site and an additional 12,600 ac-ft/yr could be recharged in the river channel.

Major features of the facilities plan include both in-channel and off-channel spreading basins totaling 318 acres, an inflatable dam and intake structure on New River, a conveyance channel, hydraulic structures, and monitor wells. Project costs are summarized below:

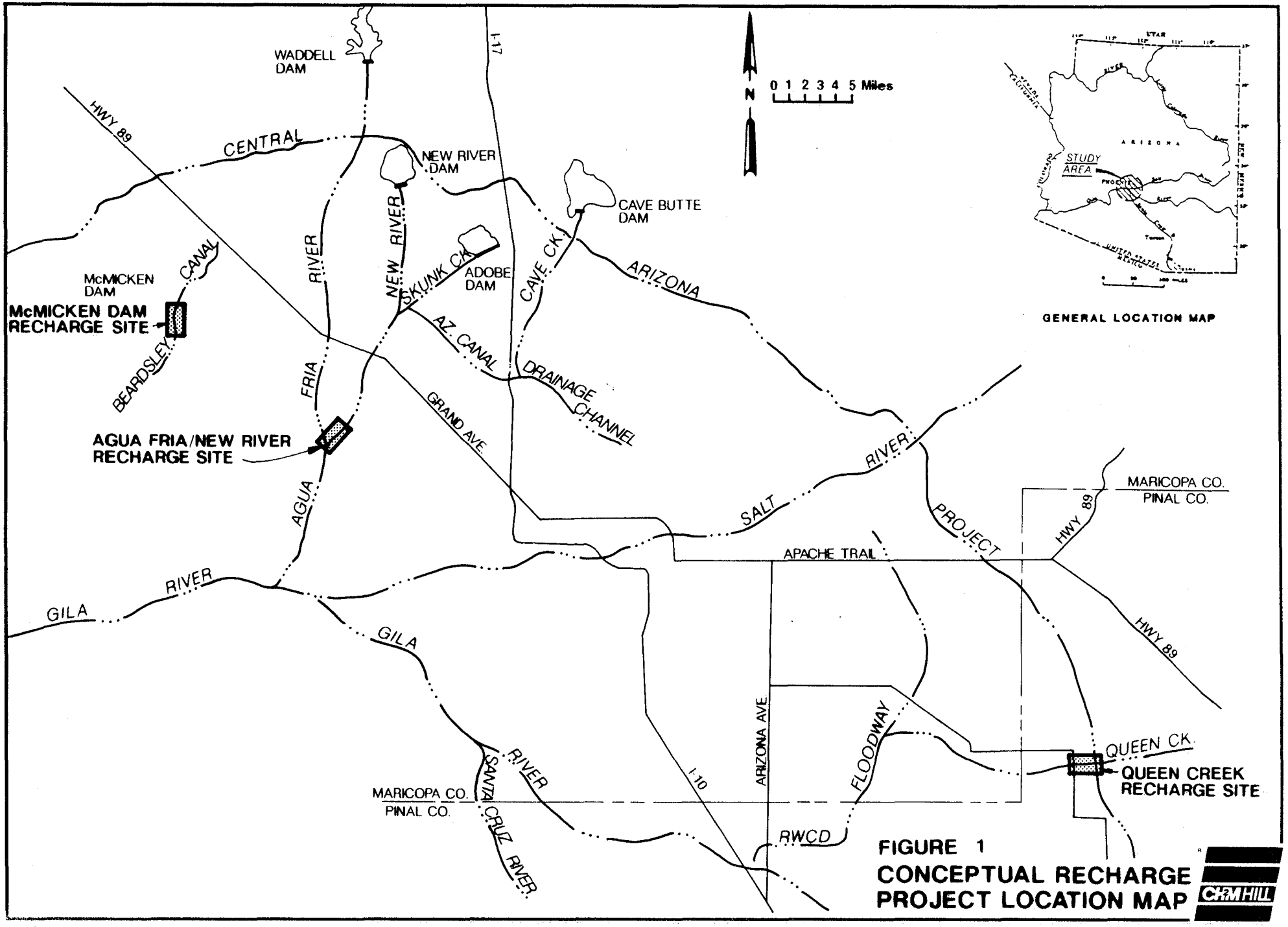


FIGURE 1
CONCEPTUAL RECHARGE PROJECT LOCATION MAP

CH2M HILL

TOTAL PROJECT COSTS	$5,191,000
Annualized Capital Costs (including land lease costs)	$754,000
Annual Operations & Maintenance	$320,000
Total Annual Cost	$1,074,000
Cost per Acre-Foot For 116,000 ac-ft/yr Recharge	$9

Queen Creek Recharge Site

This site is located on Queen Creek just west of the CAP aqueduct near Queen Creek Road as shown on Figure 1. Depth to water is about 540 feet. There are six characteristic soil types with an estimated composite infiltration rate of 1.0 ft/day. This project plan consists of two parcels about one mile apart. The west 230 acres is private land held by six different owners and the east 600 acres is owned by the State Land Department. CAP water is delivered to the site for recharge via the Salt-Gila aqueduct and pumped to the spreading basins near the aqueduct and conveyed via the Queen Creek channel to the west basins. Major features of the facilities plan include spreading basins covering 702 acres, canal turnout and pump station, conveyance channel, transmission pipeline, hydraulic structures, and monitor wells. Project costs are summarized below:

TOTAL PROJECT COSTS	$7,914,000
Annualized Capital Costs (including land lease costs)	$1,147,000
Annual Operations & Maintenance	$572,000
Total Annual Cost	$1,719,000
Cost per Acre-Foot For 128,000 ac-ft/yr Recharge	$13

RULES AND REGULATIONS FOR RECHARGE

Specific legislation and permitting requirements for implementing an artificial groundwater recharge project were reviewed, including: (1) federal legislation, (2) state legislation, (3) rules and regulations of cooperating agencies (SRP, Maricopa Water District, CAWCD, etc.), and (4) planning and permitting activities for the FCD recharge project. It was determined that the more complicated and time consuming permits will be those required by the State Groundwater Recharge Act and the Dredge and Fill Permit required by the

Army Corps of Engineers (COE), assuming stream channel modifications are needed.

Dredge and Fill permits generally require 60 to 90 days, provided that the environmental assessment completed by COE does not identify significant impacts. If an Environmental Impact Statement is required then a minimum of one year is usually required.

The permit application required by ADWR and ADEQ under the Groundwater Recharge Act are filed simultaneously. It is anticipated that a Recharge and Recovery Permit and Aquifer Protection Permit can be obtained within the same time frame. Permits for a demonstration project could be obtained within two months. Short-term permits will require four to six months and long-term permits will require six to eight months to obtain.

EVALUATION OF PLANNED AND PROPOSED PROJECTS

Several planned and proposed flood control projects were given a cursory review to identify potential changes in design and/or operations which could promote incidental, beneficial recharge of groundwater. Suggestions were made for ways to increase channel infiltration rates, wetted area, and opportunity time for infiltration to promote the natural recharge of stormwater runoff.

TSR11/006

CONTENTS

CONTENTS Cont'd

CONTENTS Cont'd

FIGURES

INITIAL SCREENING OF SITES

INTRODUCTION

Technical Memorandum No. 1 was prepared to identify Technical Rating Criteria and Initial Ranking of Potential Sites (Appendix A) locations of potential recharge sites for Maricopa County Flood Control District (FCD) facilities, present a technical rating sheet for the initial evaluation of the potential sites, and define the technical rating criteria. The technical rating criteria used to determine suitability of potential sites for recharge operations were defined and available data sources for evaluation of the technical rating criteria were identified.

FCD has 15 flood control facilities where floodwaters are diverted or detained. Another flood control structure near Queen Creek that is not a FCD facility was also identified. From the 16 facilities, 34 potential recharge sites near or downstream from these facilities were identified during the initial evaluations. A map of the FCD projects with corresponding map identification numbers is attached.

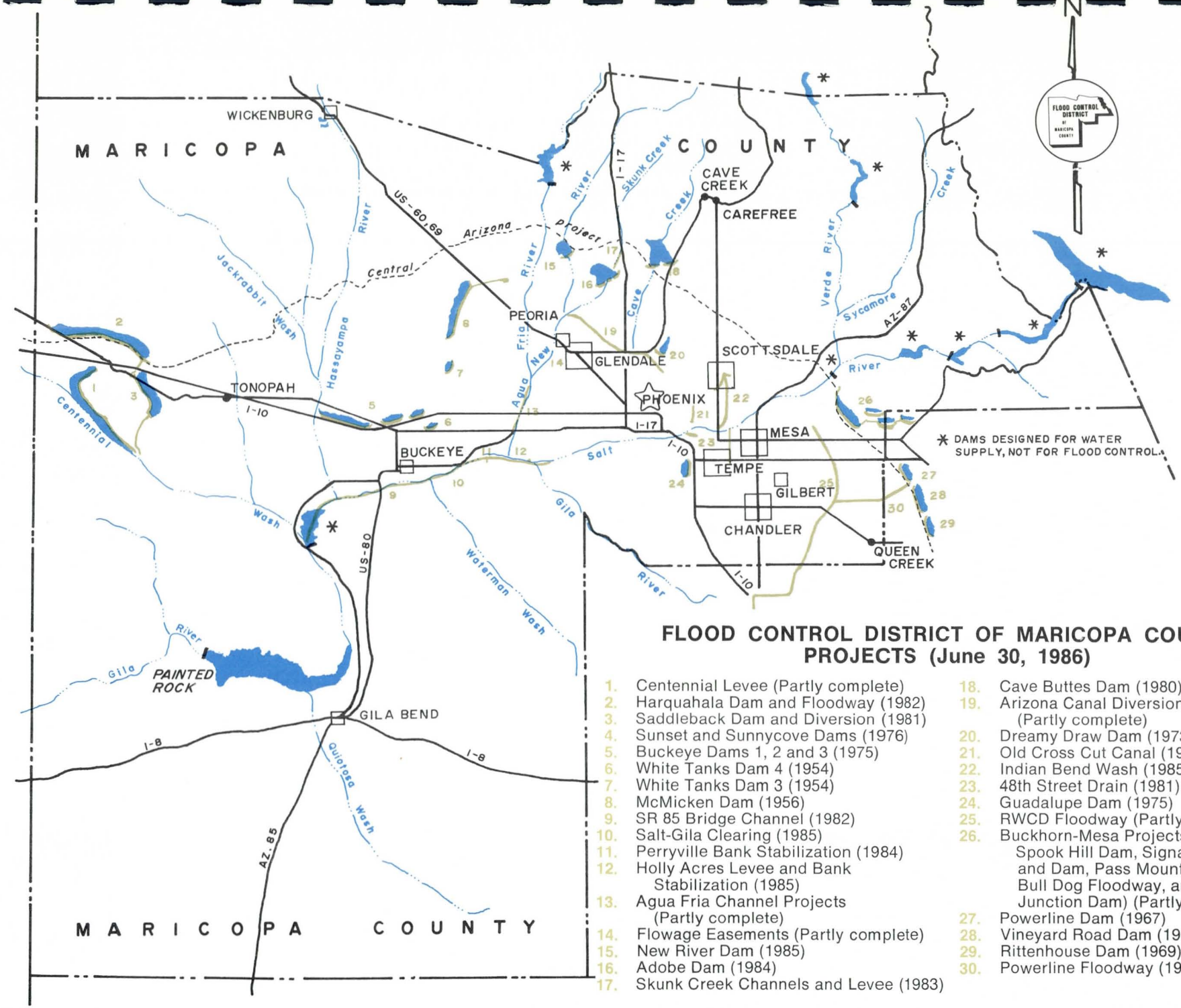
The initial evaluation identified fatal technical flaws for potential recharge sites. Table 1 is a technical rating sheet for recharge potential of the 34 identified FCD sites. Inspection of Table 1 indicates that 19 of the 34 potential sites were eliminated from further consideration.

EVALUATIONS CRITERIA

An outline of the criteria used to evaluate the potential recharge sites is shown below:

RECHARGE WATER AVAILABILITY
- Excess Floodwaters
- Potential for a Joint Project using:
  - CAP Water
  - Sewage Effluent
  - SRP Water
  - Beardsley Canal (Maricopa Water District)

FLOOD CONTROL CONSIDERATIONS
- Flood Control Benefits
- Adaptation of Existing Structures
- Operational Changes



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
PROJECTS (June 30, 1986)

1. Centennial Levee (Partly complete)
2. Harquahala Dam and Floodway (1982)
3. Saddleback Dam and Diversion (1981)
4. Sunset and Sunnycove Dams (1976)
5. Buckeye Dams 1, 2 and 3 (1975)
6. White Tanks Dam 4 (1954)
7. White Tanks Dam 3 (1954)
8. McMicken Dam (1956)
9. SR 85 Bridge Channel (1982)
10. Salt-Gila Clearing (1985)
11. Perryville Bank Stabilization (1984)
12. Holly Acres Levee and Bank Stabilization (1985)
13. Agua Fria Channel Projects (Partly complete)
14. Flowage Easements (Partly complete)
15. New River Dam (1985)
16. Adobe Dam (1984)
17. Skunk Creek Channels and Levee (1983)
18. Cave Buttes Dam (1980)
19. Arizona Canal Diversion Channel (Partly complete)
20. Dreamy Draw Dam (1973)
21. Old Cross Cut Canal (1975) (Restudy)
22. Indian Bend Wash (1985)
23. 48th Street Drain (1981)
24. Guadalupe Dam (1975)
25. RWCD Floodway (Partly complete)
26. Buckhorn-Mesa Projects (including Spook Hill Dam, Signal Butte Floodway and Dam, Pass Mountain Diversion, Bull Dog Floodway, and Apache Junction Dam) (Partly complete)
27. Powerline Dam (1967)
28. Vineyard Road Dam (1968)
29. Rittenhouse Dam (1969)
30. Powerline Floodway (1968)

Table 1
TECHNICAL RATING SHEET FOR RECHARGE POTENTIAL OF MARICOPA COUNTY FLOOD CONTROL DISTRICT SITES

Name		Map I.D. Number	Floodwater Availability	Depth to Groundwater Level (feet)	Occurrence of Perched Water	Thickness of Upper Alluvium[b] (feet)	Depth to Basement Complex (feet)	Proximity to Landfills or Contaminated Groundwater[c]	Chemical Quality Fluoride[d] mg/l	Chemical Quality Specific Electrical Conductance[e] umhos/cm	Comments
Harquahala Valley	Centennnial Levee	29	good	304 - 510	present	400 - 1300	700->1200		2.6-6.5	1090-3900	reject: shallow clay layers (up to 1000 ft thick)
	Harquahala Dam	25	fair	ND[a]		400 - 1300	700->1200		ND	ND	
	Saddleback Dam	27	fair	450		400 - 600	700->1200		ND	ND	
Centennial Wash from Levee to Narrows			good	146 - 322		200 - 400	<300-700		ND	ND	
Centennial Wash from Narrows to Railroad			good	194 - 219	present ?[f]	<100	<400-1200		7 - 15	1950-5000	reject: shallow clay layers, high fluoride concentration in groundwater
Buckeye Dams	Dam #1	6	poor	147 - 234		300 - 400	<400	A	ND	ND	reject: lack of floodwater
	Dam #2	7	poor	ND		SB[b]	<400		ND	ND	reject: shallow depth to basement complex, lack of floodwater
	Dam #3	8	poor	ND		SB	<400		ND	ND	reject: shallow depth to basement complex, lack of floodwater
White Tanks	Dam #4	5	poor	348		300	>1200		3	795-1020	reject: lack of floodwater
	Dam #3	4	poor	198 - 245		<400 ?	>1200		0.3-1.8	360-715	reject: lack of floodwater
McMicken Dam		3	fair	474 - 504		500 - 700	>1200		1 - 1.5	295-440	
Outlet Channel			fair	484		<550	>1200	A	ND	ND	
Tributary to Agua Fria			fair	345		<550 - 700	>1200		ND	ND	
New River Dam		34	good	ND		ND	<400		ND	ND	
Dam to Skunk Creek			good	343 - 475		<500 - 800	>1200		0.3-0.6	445-615	
Adobe Dam		31	poor	505 - 550		ND	<400->1200		0.9	390	reject: lack of floodwater
Skunk Creek from Dam to New River			poor	389 - 550		<500 - 800	>1200		0.3-0.9	390-1750	reject: lack of floodwater
Cave Buttes Dam		33	good	379		ND	<400		ND	ND	
Cave Creek from Dam to ACDC			good	272 - 533		<500	800	C	0.3-0.5	335-720	
ACDC from I-17 to Skunk Creek		32	fair	293 - 365		500 - 700	>1200		0.5-0.6	500-1150	
New River from Skunk Creek to Agua Fria			good	158 - 278		700 - 800	>1200		0.2-0.5	405-960	
Lower Agua Fria from New River to I-10			good	95 - 153		600 - 750	>1200	D, C, V	0.3-1.4	405-1500	
Dreamy Draw		30	poor	ND		SB	<400		ND	ND	reject: shallow depth to basement complex, lack of floodwater

Table 1 (continued)
TECHNICAL RATING SHEET FOR RECHARGE POTENTIAL OF MARICOPA COUNTY FLOOD CONTROL DISTRICT SITES

Name		Map I.D. Number	Floodwater Availability	Depth to Groundwater Level (feet)	Occurrence of Perched Water	Thickness of Upper Alluvium[b] (feet)	Depth to Basement Complex (feet)	Proximity to Landfills or Contaminated Groundwater[c]	Chemical Quality .....of Groundwater.... Fluoride mg/l[d]	Specific Electrical Conductance umhos/cm[e]	Comments
Indian Bend Wash		17 - 20	good	191 - 409		100 - 200	500-600	V	0.0-1.2	385-1400	reject: groundwater contamination by volatile organic compounds
Buckhorn Mesa Projects	Spookhill Dam	35	poor	ND (500 ?)		SB ?	<400	V	ND	ND	reject: shallow depth to basement complex, lack of floodwater
	Floodway		poor			SB	0				reject: shallow depth to basement complex, lack of floodwater
Powerline Projects	Powerline Dam	21	poor	ND (500 ?)		100 - 200	800-1200		ND	ND	reject: lack of floodwater
	Vineyard Road Dam	23	poor	410		100 - 200	>1200		ND	ND	reject: lack of floodwater
	Rittenhouse Dam	24	poor	ND (500 ?)		100 - 200	800-1200		ND	ND	reject: lack of floodwater
	Powerline Floodway	22	poor	287 - 326		100 - 200	>1200		ND	ND	reject: lack of floodwater
East Maricopa Floodway (RWCD)		41	poor	132 - 291	present	200 - 1100?	>1200		0.9	800	reject: lack of floodwater
Guadalupe Dam		14	poor	60 - 195		SB	<400		0.5	2540	reject: shallow depth to basement complex
Queen Creek	CAP to Rittenhouse Road		excellent	438 - 500		200 - 300	>1200	A	0.5-0.6	680-840	
	Rittenhouse Road to RWCD		excellent	291 - 444		200 - 300	>1200		0.4-1.0	840-2150	

[a]
[b] ND - no data
SB - shallow depth to basement complex estimated from geologic maps from the Bureau of Reclamation and the Arizona Bureau of mines
[c] A - active
C - construction debris
D - disposal site
V - volatile organic compounds
[d] mg/l - milligrams per liter
[e] umhos/cm - micromhos per centimeter
[f] ? - queried where uncertain

WATER QUALITY IMPACTS
- Chemical Quality of Groundwater
- Known Groundwater Contamination
- Presence of Landfills and Waste Disposal Sites

HYDROGEOLOGIC CONDITIONS
- Depth to Groundwater Level
- Thickness of Upper Alluvial Unit
- Depth to Middle Alluvial Unit
- Depth to Bedrock Complex
- Aquifer Transmissivity
- Occurrence of Perched Groundwater Conditions
- Recoverability of Recharged Water
  - Ratio of Invested to Recoverable Water
  - Existing Groundwater Users

SOILS AND INFILTRATION RATES
- Suitability of Soils for Recharge
- Estimated Infiltration Rates
- Potential Geochemical Reactions

LAND OWNERSHIP AND USE
- Land Ownership
- Availability of Undeveloped Lands
- Compatibility of Recharge Operations with Present and Future Land Use

A discussion of each criterion and how it applies to the site evaluation process and a description of the available data sources for these criteria is contained in Appendix A.

EVALUATION OF THE MOST FEASIBLE SITES

INTRODUCTION

Technical Memorandum No. 2, Evaluation and Ranking of the Most Feasible Potential Recharge Sites (Appendix B), documents preliminary evaluations of nine potential recharge sites for Flood Control District of Maricopa County (FCD) facilities. The following nine sites were previously selected by the Review Committee:

- Saddleback Dam Detention Area
- Centennial Wash from Levee to Mullens Cut
- McMicken Dam Detention Area
- Cave Buttes Dam to CAP Aqueduct
- Cave Creek from CAP to 7th Street
- New River from Skunk Creek to Agua Fria
- Lower Agua Fria from New River to I-10
- Queen Creek from CAP to Rittenhouse Road
- Queen Creek from Rittenhouse to RWCD

The locations of these sites are shown on Figures 1, 2, and 3. Site evaluations were based on previously selected criteria. The most important criteria for ranking of sites were recharge water availability, water quality impacts, and hydrogeologic conditions. The other criteria used to evaluate the sites include: flood control considerations, soils and infiltration rates, and land ownership and use. A detailed discussion of each of these criteria is contained in Appendix B.

SUMMARY OF POTENTIAL SITES

Table 2, Technical Rating Sheet for Recharge Potential of the Nine Selected Sites, summarizes the preliminary evaluations for the major criteria. A more detailed discussion of the suitability of each potential recharge site is found in the Recharge Site Evaluations section of Appendix B.

New River and Lower Agua Fria Sites

These two sites represent approximately 12 miles of stream channel which have favorable hydrogeologic conditions, suitable soils, and available land for recharge. Potential water quality problems due to landfills and contaminated groundwater would require additional investigation. Potential for a cooperative project participant has been identified. Supplemental recharge water is available by delivery via SRP canals, and present and proposed locations of wastewater treatment facilities located in the vicinity of the sites.

Cave Buttes Dam Sites

Sufficient data are not available to determine water quality, hydrogeologic, and soils conditions at these sites. Indications are that the sites are limited by small aquifer storage capacity. There is high potential for a cooperative project for recharge and recovery of effluent at these sites, but the storage capabilities of the sites will be a limiting factor. The combined recharge storage capacity of both sites is probably less than 5,000 acre-feet.

Queen Creek Sites

These sites comprise approximately 16 miles of the Queen Creek channel and flood plain below the CAP aqueduct. The last 4 miles of Queen Creek are not suitable for recharge by spreading methods due to perched groundwater conditions. An active sanitary landfill is located within 1.5 miles of the downstream site. The potential for a cooperative project at this site is considered marginal since the potential participant identified is currently pursuing a recharge project at a location on the Salt River.

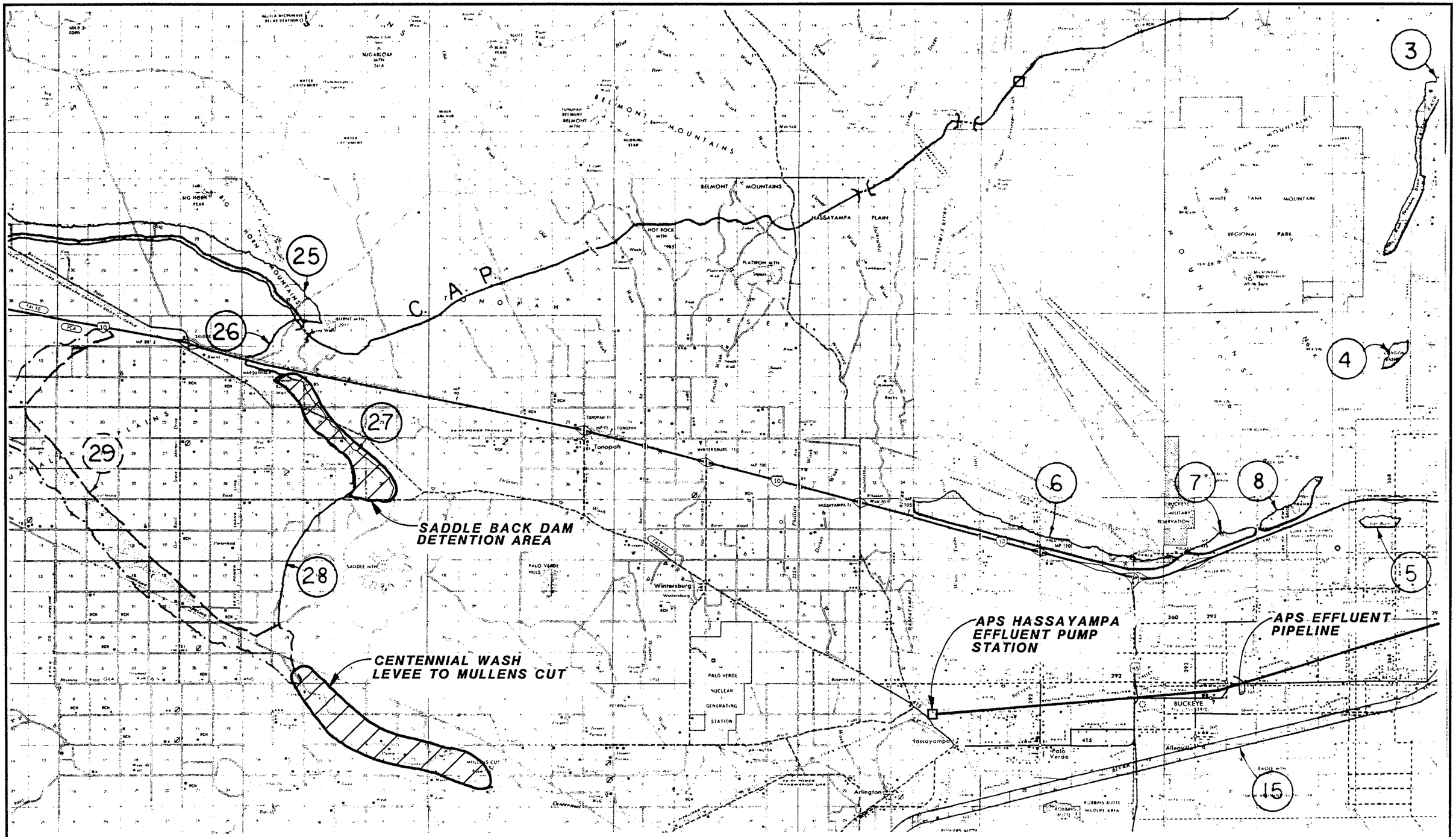


FIGURE 1
SADDLEBACK DAM AND CENTENNIAL WASH RECHARGE SITES

CH2M HILL

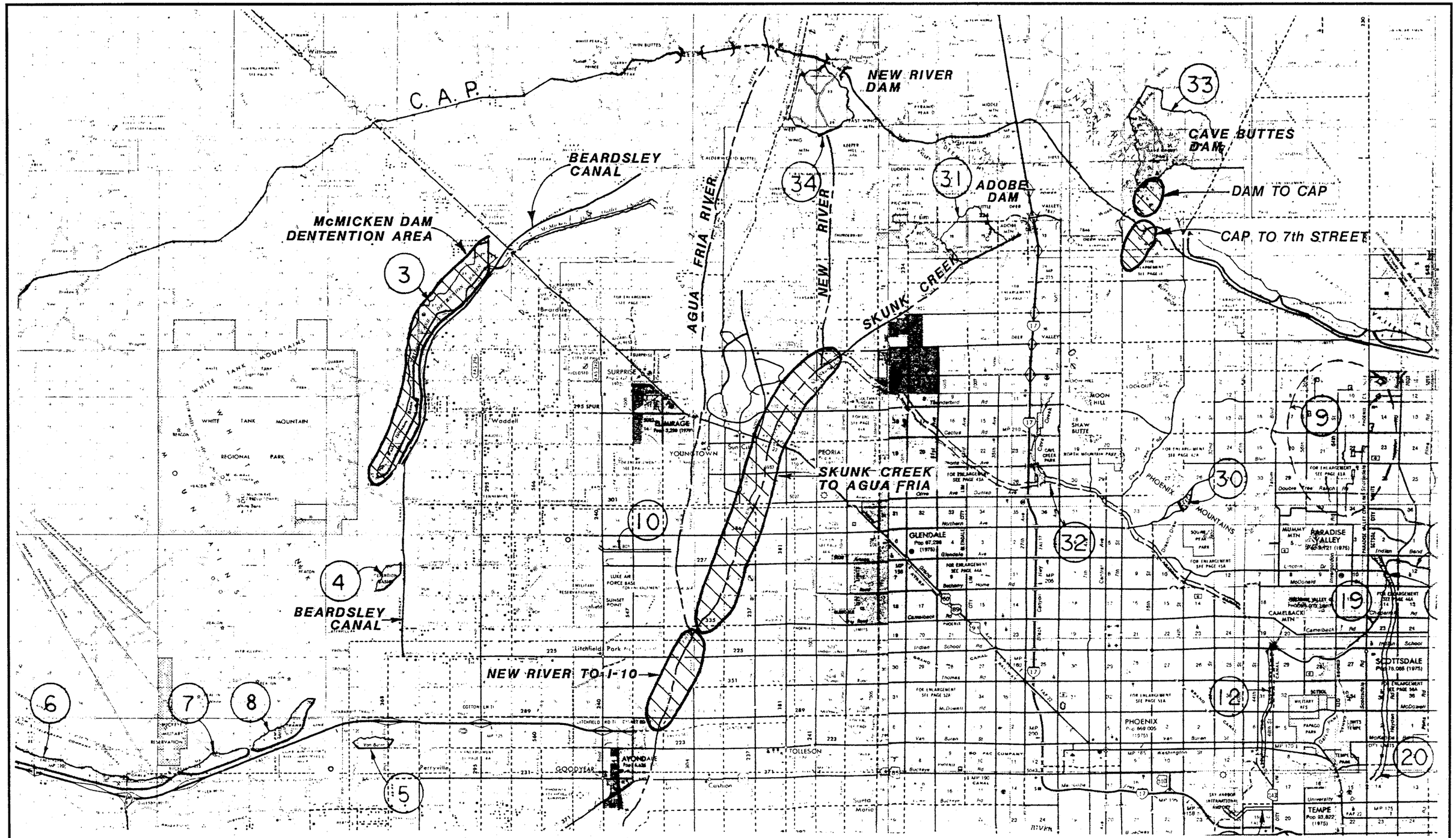


FIGURE 2
McMICKEN DAM, NEW RIVER, AGUA FRIA, AND CAVE BUTTES RECHARGE SITES

CH2M HILL

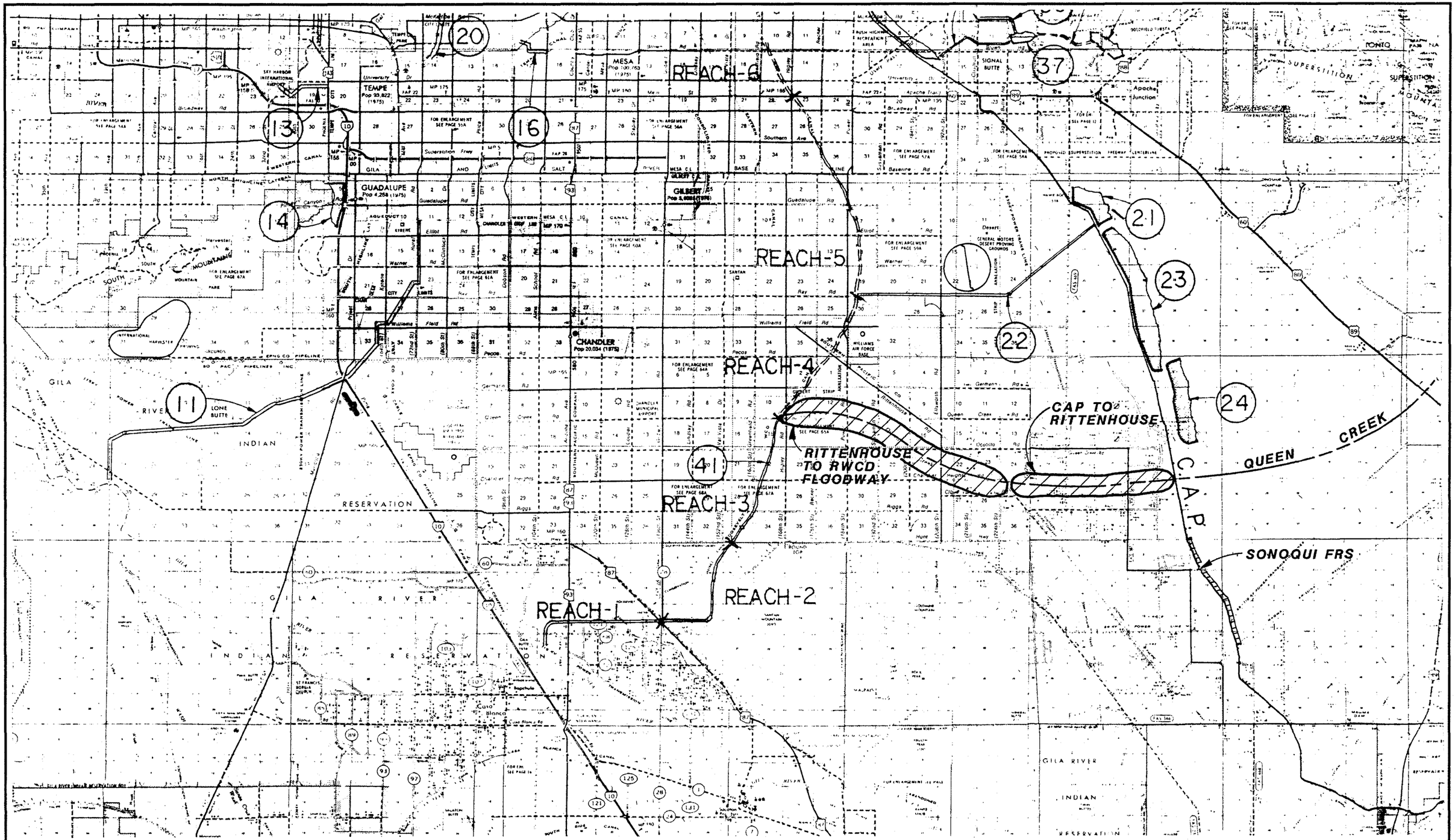


FIGURE 3
QUEEN CREEK RECHARGE SITES

CH2MHILL

Table 2

TECHNICAL RATING SHEET FOR RECHARGE POTENTIAL OF SELECTED MARICOPA COUNTY FLOOD CONTROL DISTRICT SITES

Name	Depth to Groundwater Level (feet)	Thickness of Upper Alluvium (feet)	Depth to Basement Complex (feet)	Proximity to Landfills or Contaminated Groundwater[a]	Chemical Quality .....of Groundwater..... Fluoride mg/l[b]	Total Dissolved Solids (TDS[c]) mg/l	Water Availability Water Source . Distance . Conveyance	Potential Cooperative Project Participant
Saddleback Dam detention area	426 - 510	300 - 600	300 - 1120		2.8 - 3.1[d]	470 - 570[d]	CAP . 2 miles . stream channel Effluent . 23 miles . pipeline	
Centennial Wash from Levee to Mullens Cut	174 - 400	200 - 500	<300 - 700		3.3 - 4.8[d]	810 - 880[d]	CAP . 15 miles . stream channel Effluent . 19 miles . pipeline	
McMicken Dam detention area	329 - 504	500 - 700	>1200	A	0.1 - 1.5	190 - 290	CAP . --- . Beardsley Canal Effluent[f]	Maricopa Water District
Cave Buttes Dam to CAP Aqueduct	ND[e]	<400	<400		ND	ND	CAP . 1 mile . Pipeline Effluent[f]	City of Phoenix
Cave Creek from CAP to 7th Street	68[d]	<400	<400	C	ND	ND	CAP . 0.25 mile . Effluent[f]	City of Phoenix
New River from Skunk Creek to Agua Fria	144 - 278	650 - 800	>1200	A, C, V	0.2 - 0.5	260 - 1030	CAP . 10 miles . stream channel CAP . --- . Arizona Canal Effluent[f]	City of Glendale City of Peoria
Lower Agua Fria from New River to I-10	95 - 153	600 - 750	>1200	C, V	0.3 - 1.4	380 - 980	CAP. ---. Grand Canal Effluent[f]	City of Glendale
Queen Creek from CAP to Rittenhouse Road	436 - 500	200 - 300	>1200		0.5 - 0.7	370 - 520	CAP . 0.25 mile . stream channel	City of Mesa
Queen Creek from Rittenhouse to RWCD	254 - 444	200 - 300	>1200	A	0.4 - 1.0	550 - 2080	CAP . 6 miles . stream channel	

[a] A - active landfill
C - construction debris landfill
V - groundwater contaminated with volatile organic compounds

[b] mg/l - milligrams per liter

[c] Estimated from measurements of specific electrical conductance (EC) and approximate relation: total dissolved solids (mg/l) = 0.65 x EC (micromhos per centimeter)

[d] One data point onsite, or 4 or less data points offsite

[e] ND - no data

[f] Wastewater reuse program in planning stages; no estimate of distance available

TSR10/027

N22984.AO

McMicken Dam Site

The retention area behind McMicken Dam is approximately 8 miles long. The soils at the north half of the site are marginal for surface recharge and the southern half has favorable soils, although soil conditions are less favorable than most of the other sites. Supplemental water sources can be delivered via the Beardsley Canal or through future wastewater reuse facilities.

Centennial Wash Site

This site includes about 7 miles of Centennial Wash below the levee. Because fluoride content for the groundwater in this area exceeds federal drinking water standards, recharge operations could be considered for this area if dilution of the existing groundwater to drinking water standards could be achieved. A potential participant in a cooperative project cannot be identified at this time.

Saddleback Dam Site

The 5 miles of retention area behind Saddleback Dam appear to be favorable for recharge; however, depth to groundwater level is greater than 400 feet. A potential participant for a cooperative project cannot be identified at this time.

CONCLUSIONS

1. New River from the confluence with Skunk Creek to Agua Fria and the lower Agua Fria reach are assigned the highest favorability for continued investigations for potential recharge projects by surface methods. Favorable criteria for recharge sites were identified as those where; an available water source occurs within two miles of the site, a potential participant for a cooperative project has been identified, depth to groundwater level is more than 50 but less than 200 feet, and thickness of the upper alluvium unit is more than 200 feet. Additional investigations are required for both sites to determine the potential for recharged water to move or mingle with reported contaminated groundwater.

2. Cave Creek from Cave Buttes Dam to 7th Street could be considered for a short-term recharge and recovery operation by surface methods. Available data suggest that the volume of aquifer storage is small.

3. Queen Creek from the CAP canal to Rittenhouse Road, Saddleback Dam, and McMicken Dam are assigned the highest favorability for continued investigations for large volume, long duration recharge projects. The depth to

groundwater level for these sites is generally greater than 400 feet. Because the amount of infiltrated water which may be required or "invested" in the vadose zone prior to reaching a water content equal to the specific retention may be large, areas where average depth to groundwater level is more than 200 feet are generally less favorable for recharge operations by surface methods. The hydraulic loading rates (acre-feet per year per acre of spreading area) for recharge operations and the estimated life of the recharge project must also be known for the final evaluation of a potential site with depth to groundwater level more than 200 feet.

In the early years of a project, the ratio of invested water to recoverable water could be large. For subsequent years of recharge operations with appreciable loading rates, the ratio of invested water to recoverable water would decrease, and would continue to decrease for the life of the project. For potential recharge projects with large total volume of water available for recharge and of long duration in years, the ratio of invested water to recoverable water may be large in the early years of a project, but in subsequent years the loss to invested water would become small.

CONCEPTUAL FACILITY PLANS AND COST ESTIMATES

INTRODUCTION

TECHNICAL Memorandum No. 3, Conceptual Facility Plans and Cost Estimates for Selected Recharge Sites (Appendix C), presents the conceptualized plans and costs for operating recharge facilities at three selected sites located near existing Flood Control District of Maricopa County (FCD) facilities. Based on previous evaluations the following three sites were selected by the Review Committee:

- McMicken Dam Detention Area
- Agua Fria/New River to Camelback Road
- Queen Creek from CAP to Rittenhouse Road

Assessments for each site were conducted based on previously selected criteria, a facilities plan, and estimated project costs.

PROJECT LOCATIONS AND RECHARGE SPECIFICS

Areas for locating recharge facilities were previously selected based on suitable hydrogeologic conditions, availability of recharge water, suitable land use and soils, and institutional factors. The locations of the study areas

are shown on Figure 4. To develop a conceptual recharge project within each of the three study areas requires the selection of a project location and a determination of the project specifics. The objective is to develop a project plan, for each site, to recharge water for storage that is economical and environmentally sound. The priority criteria used to locate the recharge projects were areas with suitable soils and high infiltration rates, lands that are publicly owned, and lands that are presently undeveloped and where recharge might be an acceptable use during the next 20 years. Project specifics include sources of water to be recharged, expected modes of operations, and expected benefits to be derived from the project.

An important criterion for assessing recharge site suitability is the rate of recharge. Generally, one of two things controls the rate of recharge. First is the infiltration rate at the land surface. The second control is the effect of recharge groundwater mounding up to the land surface. Evaluation of this latter condition is quite intensive and technical and beyond the scope of this feasibility investigation. An Evaluation of groundwater mounding potential is necessary before final design of any recharge site and evaluation of unit recharge cost. The findings during extensive site data collection and analysis may even dictate that another recharge method (i.e., injection wells), be used. For this investigation, surface spreading is the assumed recharge method and the estimated infiltration rates at the land surface are considered the controlling factors for site assessments and economic evaluations.

DETERMINING SITE SUITABILITY

Many factors are necessary to determine recharge site feasibility. For the three selected sites, hydrogeology, soils and infiltration rates, and land ownership were assessed to evaluate technical suitability of the selected sites. Discussions of these factors are contained in Appendix C.

CONCEPTUAL DESIGN CRITERIA AND COSTS

In an effort to tap all available resources for recharge design criteria and estimates of costs, team members researched literature, held discussions with recharge operators, and made field visits to operating facilities. Prior to development of recharge facilities plans, members of the project team met and discussed the major issues affecting the conceptual designs. Major issues discussed were annual recharge rates, sizing basins and hydraulic structures, basin operations plan, floodwater diversion structures, and impacts of land ownership. Project team members are indebted to the staff at Los Angeles County

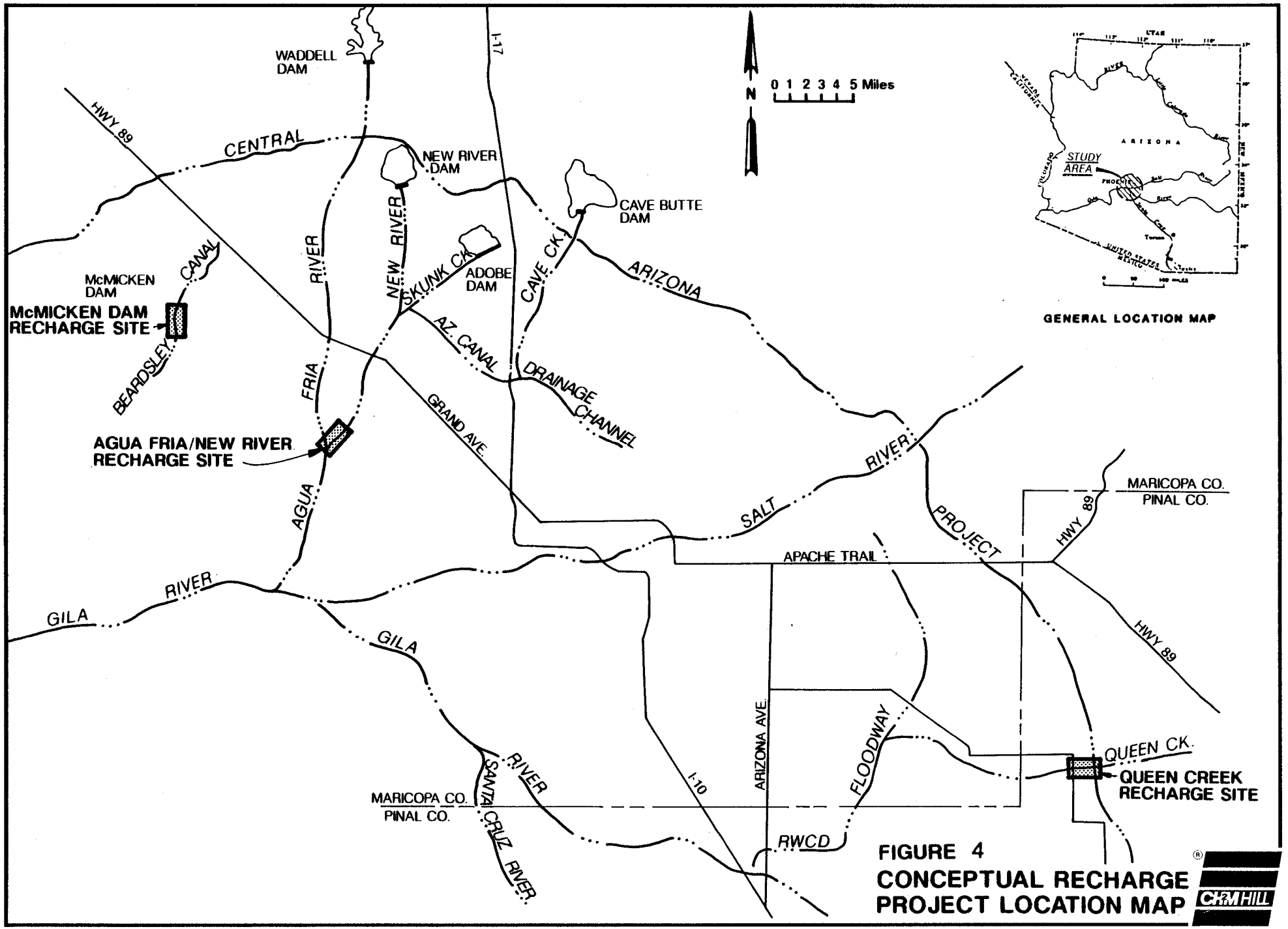


FIGURE 4
CONCEPTUAL RECHARGE PROJECT LOCATION MAP

CH2M HILL

Flood Control District for their suggestions and assistance in developing the recharge facilities design criteria and in providing construction details of hydraulic structures.

Conceptual cost estimates were prepared for recharge facilities using information available from local agencies, vendors, contractors, cost estimating guides, and recent projects of a similar nature.

Operation and maintenance (O&M) costs were developed from similar facilities operated by the Orange County Water District and Los Angeles County. Typical operations and maintenance activities include patrols of the facilities during recharge operations, control of diversions, gates, and pump stations. Maintenance activities include repair of flood damaged facilities, weed abatement, pond bed scarification, and removal of sediments.

Land costs for the project sites were estimated based on discussions with realtors, land owners, and Arizona State Land Department.

Details of the facilities design criteria and cost estimtes are contained in Appendix C.

McMICKEN DAM RECHARGE PROJECT

The McMicken Dam recharge project is located west of McMicken Dam detention levee and south of Bell Road. Selection of this location within the study area was based primarily on finding the best soils for high infiltration rates, publicly owned lands, and undeveloped lands.

The recharge water source is Central Arizona Project (CAP) water transported via the Beardsley Canal. The possibility of purchasing excess surface water during wet years from the Maricopa Water District (MWD) also exists. The project would be operated to maximize recharge depending on availability of water and conveyance capacity in the Beardsley Canal. The major benefit of recharging CAP water is the underground storage of an imported water supply. A benefit from recharging excess water from MWD would be conservation of a local surface water supply.

Conceptual Facilities Plan

Locating the recharge basins for this plan was based primarily on public land ownership and availability of unused land. These lands also have the better soils conditions in the study area. The recharge basins are upgradient from the Beardsley Canal and pumping is required. Beardsley Canal water is pumped through a pipeline up to the division box where it is diverted to the recharge basins. Major features

of the McMicken Dam recharge site facilities plan are shown on Figure 5 and listed below:

Major Features

Canal Turnout & Pump Station (190 cfs, 50 ft. lift)
Conveyance Pipelines (3,500 ft., 60-inch dia.)
Interbasin & Drain Structures (7)
Division Structures (1)

Recharge Basins

Basin A - 90 acres, 1.9 fpd infiltration rate
Basin B - 110 acres, 1.5 fpd infiltration rate

TOTAL 200 acres, 1.7 fpd average rate

ESTIMATED ANNUAL RECHARGE RATE - 61,000 acre-feet/yr

Project Costs

Estimated costs for capital improvements, land, and operation and maintenance are shown in Table 3. Costs for purchase of the recharge source water are not included.

APPROX. SCALE 1"=500'
DATE OF PHOTOGRAPHY 5/85

T 3 N

R 2 W

TRILBY WASH BASIN

LEVEE

BEARDSLEY CANAL

MWD IRRIGATION LATERAL

BASINS A
90 Acres

BASINS B
110 Acres

DIVISION BOX

TURNOUT, TYP.

BASIN DIKE, TYP.

INTER-BASIN SPILLWAY & DRAIN STRUCTURE, TYP.

1A 1B 2A 2B 3A 3B 4B

PIPELINE

CANAL TURNOUT & PUMP STATION

Proposed Extension of Bell Road

WADDELL RD.

GREENWAY RD.

BELL RD.

16 9 15 10 9 4 10 3

1370 1360 1350 1340 1330 1320 1310 1300

T 3 N

CH2M HILL	DSGN						
	DR						
	CHK						
	APVD	NO.	DATE	REVISION	BY	APVD	

REUSE OF DOCUMENTS

THIS DOCUMENT, AND THE IDEAS AND DESIGNS INCORPORATED HEREIN, AS AN INSTRUMENT OF PROFESSIONAL SERVICE, IS THE PROPERTY OF CH2M HILL AND IS NOT TO BE USED, IN WHOLE OR IN PART, FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF CH2M HILL.

VERIFY SCALES

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

GROUNDWATER RECHARGE FEASIBILITY INVESTIGATION

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FIGURE 5

McMICKEN DAM RECHARGE SITE CONCEPTUAL FACILITIES PLAN

SHEET
DWG NO.
DATE
PROJ NO.

Table 3
PROJECT COSTS - McMICKEN DAM RECHARGE PROJECT

ITEM	CONSTRUCTION COST
Earthwork for Levees & Channels	$476,000
Hydraulic Structures	$113,000
Pipeline	$459,000
Pump Station	$562,000
Monitor Wells	$143,000
Subtotal	$1,753,000
Contingency (30%)	$526,000
Subtotal	$2,279,000
Engineering and Administration (15%)	$342,000
Construction Cost	$2,621,000
TOTAL PROJECT COST	$2,621,000
Annualized Project Cost (8% Revenue Bonds, 20 yr Maturity, 20% Initial Cost)	$320,000
Operation & Maintenance Cost (200 acres @ $600/ac.)	$120,000
Pumping Cost (1500 HP Maximum Demand, 4,462,000 kwhr/yr)	$222,000
Land Lease Cost: 230 acres @ $300/ac.	$69,000
Total Annual Cost	$731,000
Annual Cost Per Acre Foot, For 56,000 ac. ft./yr. Recharge	$12

AGUA FRIA/NEW RIVER RECHARGE PROJECT

The Agua Fria/New River recharge project is located at the confluence of New River and the Agua Fria River between Glendale Avenue and Camelback Road. An advantage of this location is that it allows diversion of floodwaters from both the Agua Fria River and New River watersheds for recharge. This location also has soils with high infiltration rates. Most of the land is publicly owned, and the property is undeveloped.

CAP water would be conveyed via the Salt River Project (SRP) Grand Canal. CAP water could also be conveyed to the project via the SRP Arizona Canal or within the Agua Fria River channel. Floodwaters and spills from Waddell Dam could also be recharged. Additional diversions and upsizing of hydraulic structures within the recharge project are required to accommodate the intermittent floodwater flows.

Analysis of flood recharge potential required estimating flood flows at the proposed site. A computer spreadsheet was used to analyze daily average stream flow data from stream gages at six locations in the Agua Fria River drainage basin over a selected number of years and to estimate the effects of existing flood control facilities. The gage records used to generate flood flows at the site include:

Gage #	Description	Agency[1]	Drainage Area (sq. mil)	Period of Record (Water Year)
09513000	Agua Fria River at Waddell Dam	USGS	1459	1934-87
09513860	Skunk Creek near Phoenix	USGS	64.6	1967-87
Arizona Tail	Arizona Canal Spills	SRP	-	1967-87[2]
09513835	New River at Bell Road, near Peoria	USGS	187	1968-84
Grand Tail	Grand Canal Spills	SRP	-	1967-87[2]
09513970	Agua Fria River at Avondale	USGS	2013	1967-72, 1974-81

[1] USGS: United States Geological Survey.
SRP: Salt River Project
[2] Records prior to 1967 are unknown.

A map of the hydrologic system and gage locations are shown in Figure 6. A study period of October 1966 to September 1981, not including water year 1973, was chosen for analysis (14 years). Water year 1973 was deleted because the Avondale gage was inoperative during that year.

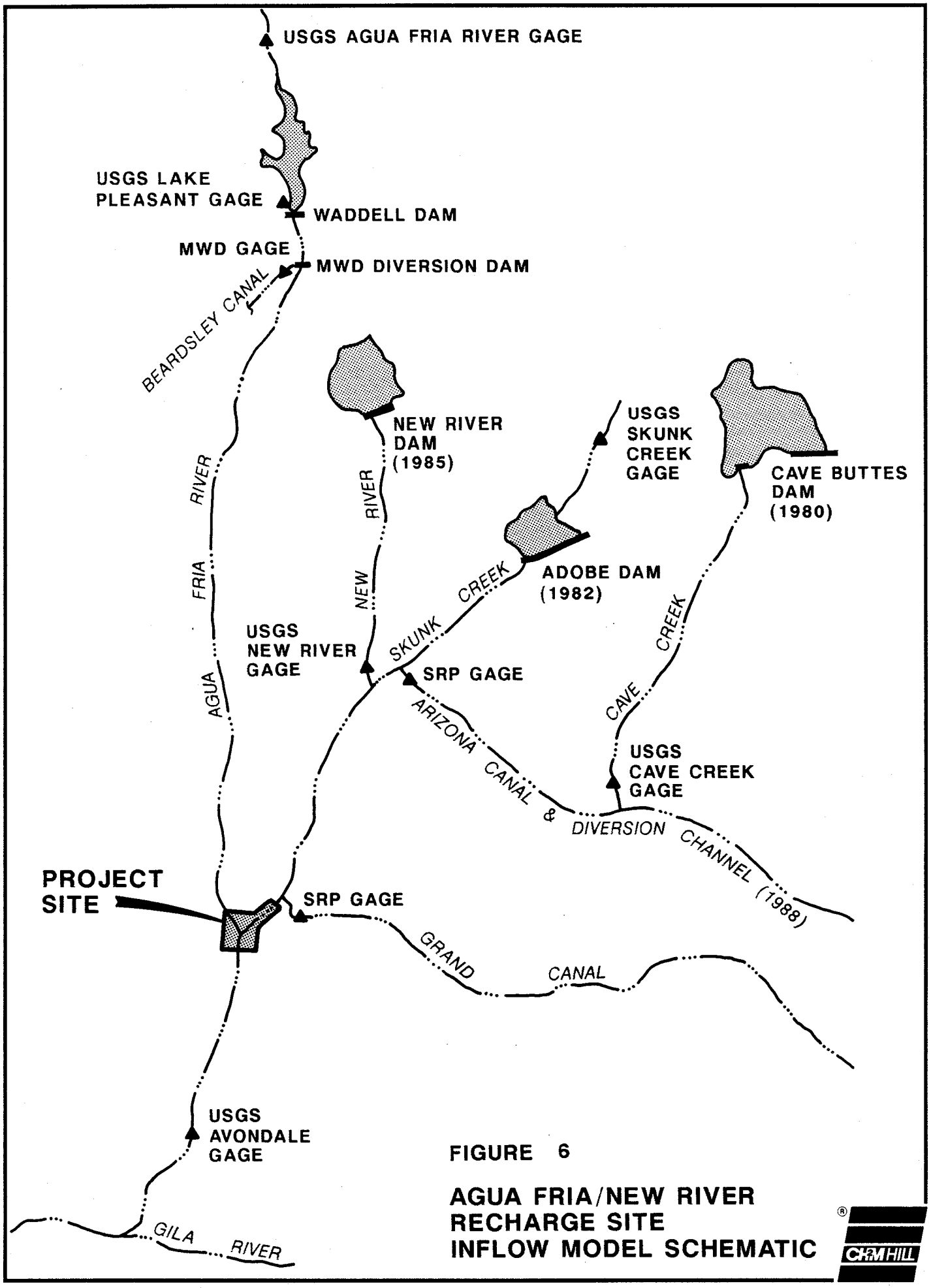


FIGURE 6

AGUA FRIA/NEW RIVER RECHARGE SITE INFLOW MODEL SCHEMATIC

CH2M HILL

Project benefits include underground storage of imported waters and the conservation of floodwaters. An added benefit is that artificially recharging floodwaters at the project site will reduce the amount of natural recharge that occurs downstream which is contributing to high groundwater levels and waterlogging in the Buckeye area.

Conceptual Facilities Plan

Locating the recharge basins for this site plan was based primarily on using publicly owned lands, land with the best soils conditions, and the need to maintain close proximity to the active river channel for recharge of floodwaters. Major features of the Agua Fria/New River recharge site facilities plan are shown on Figure 7 and listed below:

Major Features

Inflatable Dam and Intake Structure (600 cfs)
Conveyance Channel (7600 ft.)
Interbasin & Drain Structures (9)
Diversion and Turnout Structures (3)
Monitor Wells (3)

Recharge Basins

Basin A -	163 acres,	2.0 fpd infiltration rate
Basin B -	73 acres,	2.0 fpd infiltration rate
Basin C -	31 acres,	2.0 fpd infiltration rate
Basin D -	52 acres,	2.0 fpd infiltration rate
TOTAL	318 acres,	2.0 fpd average rate

ESTIMATED ANNUAL RECHARGE RATE - 116,000 acre-feet/yr

An inflatable rubber dam used in New River is used to divert floodwaters and upstream releases of CAP water from the SRP Grand Canal. A conceptual drawing of the New River diversion dam and intake structure is shown on Figure 8. New River flows can be diverted to recharge basins in the Agua Fria River. New River has in-channel levees for recharge and the Agua Fria has both in-channel levees and off-channel basins. The off-channel basins would remain intact except during major floods. In-channel levees may need maintenance and repairs after moderate floods.

CH2M HILL	DSGN						
	DR						
	CHK						
	APVD	NO.	DATE	REVISION	BY	APVD	

REUSE OF DOCUMENTS

THIS DOCUMENT, AND THE IDEAS AND DESIGNS INCORPORATED HEREIN, AS AN INSTRUMENT OF PROFESSIONAL SERVICE, IS THE PROPERTY OF CH2M HILL AND IS NOT TO BE USED, IN WHOLE OR IN PART, FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF CH2M HILL.

©CH2M HILL

VERIFY SCALES

BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

GROUNDWATER RECHARGE FEASIBILITY INVESTIGATION

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FIGURE 7

AGUA FRIA/NEW RIVER RECHARGE SITE CONCEPTUAL FACILITIES PLAN

SHEET	
DWG NO.	
DATE	
PROJ NO.	

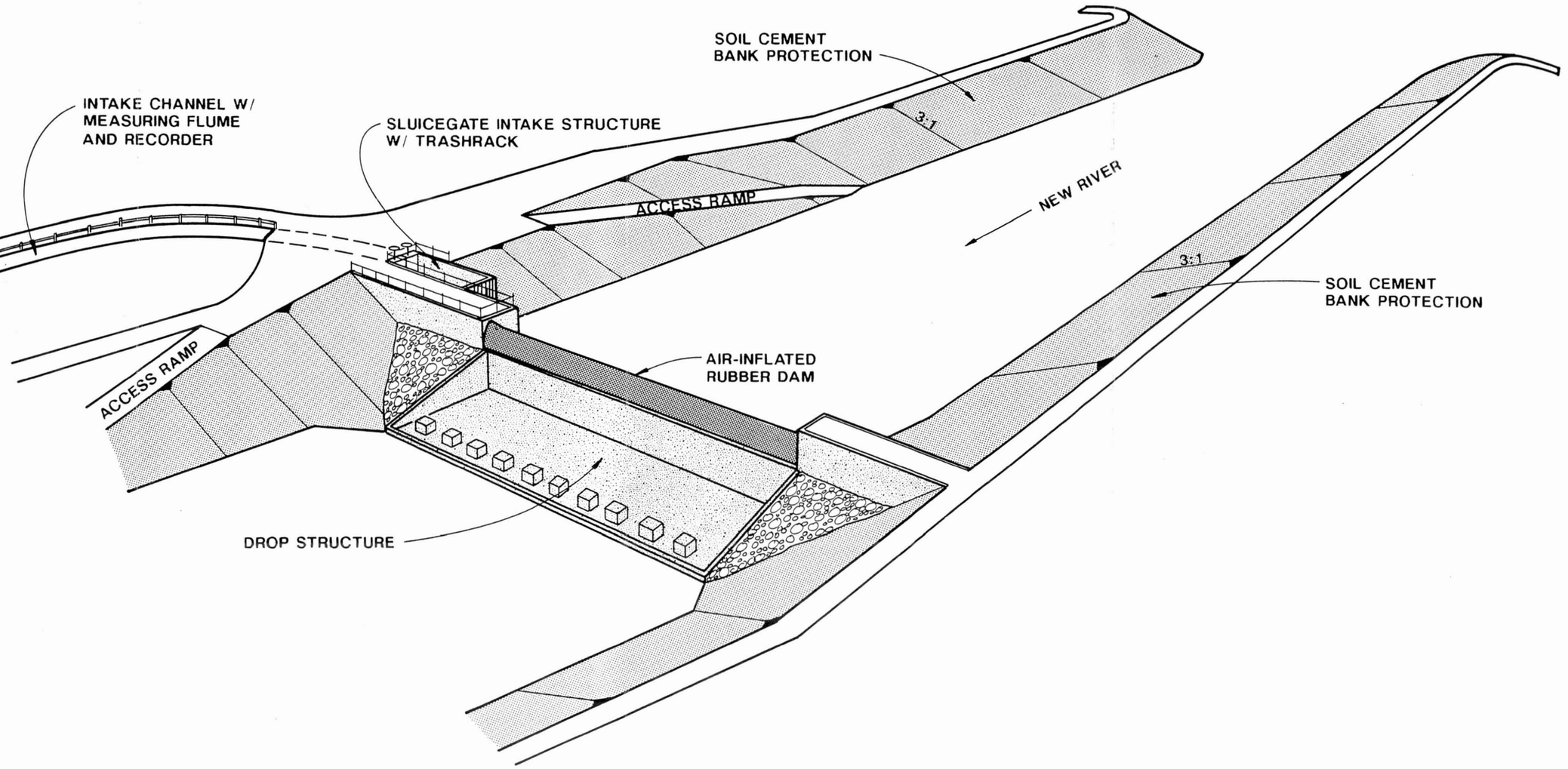


FIGURE 8

NEW RIVER
DIVERSION DAM
AND INTAKE STRUCTURE

Project Costs

Estimated costs for capital improvements, land, and operations and maintenance are shown in Table 4. Costs for purchase of the recharge source water are not included.

Table 4

PROJECT COSTS - AGUA FRIA/NEW RIVER RECHARGE PROJECT

ITEM	CONSTRUCTION COST
Earthwork for Levees & Channels	$336,000
Hydraulic Structures	$152,000
Pump Station	$998,000
Monitor Wells	$80,000
Subtotal	$1,566,000
Contingency (30%)	$470,000
Subtotal	$2,036,000
Engineering and Administration (15%)	$305,000
Construction Cost	$2,341,000
Land Purchase: 190 acres @ $15,000/ac.	$2,850,000
TOTAL PROJECT COST	$5,191,000
Annualized Project Cost (8% Revenue Bonds, 20 yr Maturity, 20% Initial Cost)	$634,000
Operation & Maintenance Cost (320 acres @ $1,000/ac.)	$320,000
Land Lease Cost: 400 acres @ $300/ac.	$120,000
Total Annual Cost	$1,074,000
Annual Cost Per Acre Foot, For 116,000 ac. ft./yr. Recharge	$9

QUEEN CREEK RECHARGE PROJECT

The Queen Creek recharge project is located on both sides of the Queen Creek channel immediately west of the CAP Salt-Gila Aqueduct and adjacent to Queen Creek Road. The location is close to the CAP source water, has favorable soils for recharge, and is mostly on public lands. Much of the stream channel has ongoing sand and gravel operations and most of the off-channel areas are farmed.

The sole recharge source is CAP water. Scarce floodwater flows and existing sand and gravel operations in the stream channel make floodwater recharge impractical. Underground storage of imported water is the major project benefit.

Conceptual Facilities Plan

Recharge basins were located in two principal areas. The largest area is State owned lands adjacent to the CAP aqueduct which are about half undeveloped land and half active farmland. The smaller area is a block of private land located off-channel about one mile downstream on the northside. This recharge basin site has the best soils conditions for off-channel lands in the study area.

Elevations of the lands adjacent to the aqueduct are about 10 feet above the water level in the CAP aqueduct, therefore pumping is required. The aqueduct turnout includes a pump station for the adjacent lands and a gravity turnout into the creek channel for conveyance to the downstream basins. The downstream basins are served by a diversion in the creek channel and a conveyance channel with check structures and turnouts to serve individual pairs of basins.

Major features of the Queen Creek recharge site facilities plan are shown on Figure 9 and listed below:

Major Features

Canal turnout & Pump Station (250 cfs, 20 ft. lift)
Conveyance Pipelines (600 ft., 60-inch dia.)
Conveyance Channels (7,200 ft.lined, 5,800 ft. unlined)
Interbasin & Drain Structures (19)
Other Hydraulic Structures (9)
Monitor Wells (6)

APPROX. SCALE 1"=500'
DATE OF PHOTOGRAPHY 5/85

BASINS A
227 Acres

BASINS B
120 Acres

BASINS C
95 Acres

BASINS D
116 Acres

BASINS E
144 Acres

INTER-BASIN SPILLWAY & DRAIN STRUCTURE TYP.

BASIN DIKE, TYP.

CANAL TURNOUT, TYP.

CONCRETE LINED CANAL

CHECK STRUCTURE TYP.

GRAVEL PIT OPERATIONS

MONITOR WELL, TYP.

DIVERSION STRUCTURE

DIVERSION DIKE

GRAVEL PIT

Queen Creek

NEW MAGNA IRRIGATION DISTRICT CANAL

EARTH LINED CANAL

PIPELINE

EXST. DRAINAGE OVERPASS

PROPOSED AQUEDUCT TURNOUT/PUMP STATION

EXST. AQUEDUCT TURNOUT/PUMP STATION

SALT-GILA AQUEDUCT

LEVEE

TURNOUT, TYP.

DIVISION BOX, TYP.

INTER-BASIN SPILLWAY & DRAIN STRUCTURE, TYP.

MATCHLINE

QUEEN CREEK RD.

COMBS RD.

T 2 S

R 8 E

1500 1510 1520 1530 1540 1550 1560 1570 1580 1590

DSGN							
DR							
CHK							
APVD	NO.	DATE	REVISION	BY	APVD		

REUSE OF DOCUMENTS

THIS DOCUMENT, AND THE IDEAS AND DESIGNS INCORPORATED HEREIN, AS AN INSTRUMENT OF PROFESSIONAL SERVICE, IS THE PROPERTY OF CH2M HILL AND IS NOT TO BE USED, IN WHOLE OR IN PART, FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF CH2M HILL.

VERIFY SCALES

BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

GROUNDWATER RECHARGE FEASIBILITY INVESTIGATION

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FIGURE 9

QUEEN CREEK RECHARGE SITE CONCEPTUAL FACILITIES PLAN

SHEET
DWG NO.
DATE
PROJ NO.

Recharge Basins

Basin A -	227 acres,	1.3 fpd infiltration rate
Basin B -	120 acres,	0.8 fpd infiltration rate
Basin C -	95 acres,	1.3 fpd infiltration rate
Basin D -	116 acres,	0.8 fpd infiltration rate
Basin E -	144 acres,	0.8 fpd infiltration rate
TOTAL	702 acres,	1.0 fpd average rate

ESTIMATED ANNUAL RECHARGE RATE - 128,000 acre-feet/yr

Project Costs

Estimated costs for capital improvements, land, power, and operations and maintenance are shown in Table 5. Costs for purchase of the recharge source water are not included in these costs.

Table 5

PROJECT COSTS - QUEEN CREEK RECHARGE PROJECT

ITEM	CONSTRUCTION COST
Earthwork for Levees and Channels	$1,015,000
Hydraulic Structures	$234,000
Pump Station	$1,437,000
Monitor Wells	$300,000
Subtotal	$2,986,000
Contingency (30%)	$896,000
Subtotal	$3,882,000
Engineering and Administration (15%)	$582,000
Construction Cost	$4,464,000
Land Purchase: 230 acres @ $15,000/ac.	$3,450,000
TOTAL PROJECT COST	$7,914,000
Annualized Project Cost (8% Revenue Bonds, 20 yr Maturity, 20% Initial Cost)	$967,000
Operation & Maintenance Cost: 702 acres @ $500/ac.	$351,000
Pumping Cost (800 HP Maximum Demand, 4,125,000 kwhr/yr)	$221,000
Land Lease Cost: 600 acres @ $300/ac.	$180,000
Total Annual Cost	$1,719,000
Annual Cost Per Acre Foot, for 128,000 ac.ft/yr. Recharge	$13

ADDITIONAL DATA REQUIREMENTS

Appendix C outlines the work tasks needed to fill data gaps or provide additional information to determine recharge project feasibility. The Conceptual facilities plans and cost estimates presented in this report have been prepared using readily available data. In many instances data are sketchy or unavailable, therefore, certain assumptions or tentative criteria have been used which are critical items in project performance and overall feasibility. The additional data requirements described in Appendix C are those needed to reduce uncertainties and provide the basis for a preliminary final design effort.

LEGISLATIVE REQUIREMENTS AND PERMITTING PROCEDURES

INTRODUCTION

Technical Memorandum No. 4, Legislative Requirements and Permitting Procedures for Artificial Groundwater Recharge Projects (Appendix D), summarizes the institutional and permitting aspects of artificial groundwater recharge projects that may be undertaken by Maricopa County Flood Control District. Specific legislation and permitting requirements that must be considered were reviewed, including: (1) federal legislation, (2) state legislation, (3) rules and regulations of cooperating agencies, and (4) planning and permitting activities for a Maricopa County Flood Control District recharge project.

PROCEDURES AND PLANNING FOR A RECHARGE PROJECT

The following procedures must be considered when planning a recharge-related project:

- Scheduling a preapplication conference with ADWR and ADEQ.
- Submitting permits under the Recharge Act and the Environmental Quality Act.
- Obtaining permits for site-specific hydrogeological studies.
- Obtaining permits for monitoring activities.
- Obtaining special permits for water spreading projects.
- Obtaining local zoning permits, land use permits, and interparty agreements.

- Monitoring activities during the Gila River adjudication potentially affecting a recharge project.

The permits and notices of intention for recharge-related activities are summarized in Table 6. The stages for obtaining permits for a recharge project and an underground storage and recovery project are summarized on Figure 10.

PREAPPLICATION MEETINGS

The first step is to arrange a preapplication meeting between Maricopa Flood Control District, cooperating agencies, the Director of the Phoenix AMA, an ADWR hydrologist, a representative from ADEQ, and legal representatives. The purpose of this meeting is to summarize the proposed plans and to discuss impediments. The requisite permits will be reviewed at this meeting.

SUBMISSION OF PERMITS REQUIRED BY THE RECHARGE ACT AND THE ENVIRONMENTAL QUALITY ACT

The second step is to submit permit applications to ADWR for the planned project (i.e., a Recharge Project, including full-scale and demonstration projects, and an Underground Storage and Recovery project). A copy of the hydrological study for the proposed project must be included. This report will be minimal for pilot scale projects and for short term underground storage and recovery projects, whose goals are to obtain hydrological information. Until Aquifer Protection Permits come online, a Groundwater Quality Protection Permit is required from ADEQ. Accordingly, a Notice of Disposal for a Groundwater Quality Protection Permit should be included with the general application. Similarly, a Groundwater Quality Protection Permit is required until the General Permits for pilot scale projects are available.

The Flood Control District and associated agencies must also demonstrate the following:

- The technical and financial capability to construct and operate a recharge project.
- The right to use the water source for a project.
- The goals of the project are consistent with the goals of the AMA.
- The project will not harm others.

Table 6

PERMITS AND NOTICES OF INTENTION FOR RECHARGE PROJECTS

	Associated Legislation	Permit or Notice	Responsible Agency
Federal			
	Clean Water Act	NPDES	ADHS
	Clean Water Act	Dredge and Fill	COE
State			
	Title 45	Appropriation of Public Waters	ADWR
	Groundwater Management Act	Permit to Drill a Well in AMA	ADWR
	GWMA	Permit to Drill a Nonexempt, Nonservice Area Well	ADWR
	GWMA	Hydrologic Testing Permit	ADWR
	GWMA	Notice of Intention to Drill Exploration Well	ADWR
	GWMA	Notice of Intention to Drill Monitor/Piezometer Well	ADWR
	Recharge Act	Recharge Permit	ADWR
	Recharge Act	Storage and Recovery Permit	ADWR
	Recharge Act	Recovery Well Permit	ADWR
	Title 9	Notice of Disposal	ADHS
	Title 9	Groundwater Quality Permit	ADHS
	Environmental Quality Act	Aquifer Protection Permit	ADEQ

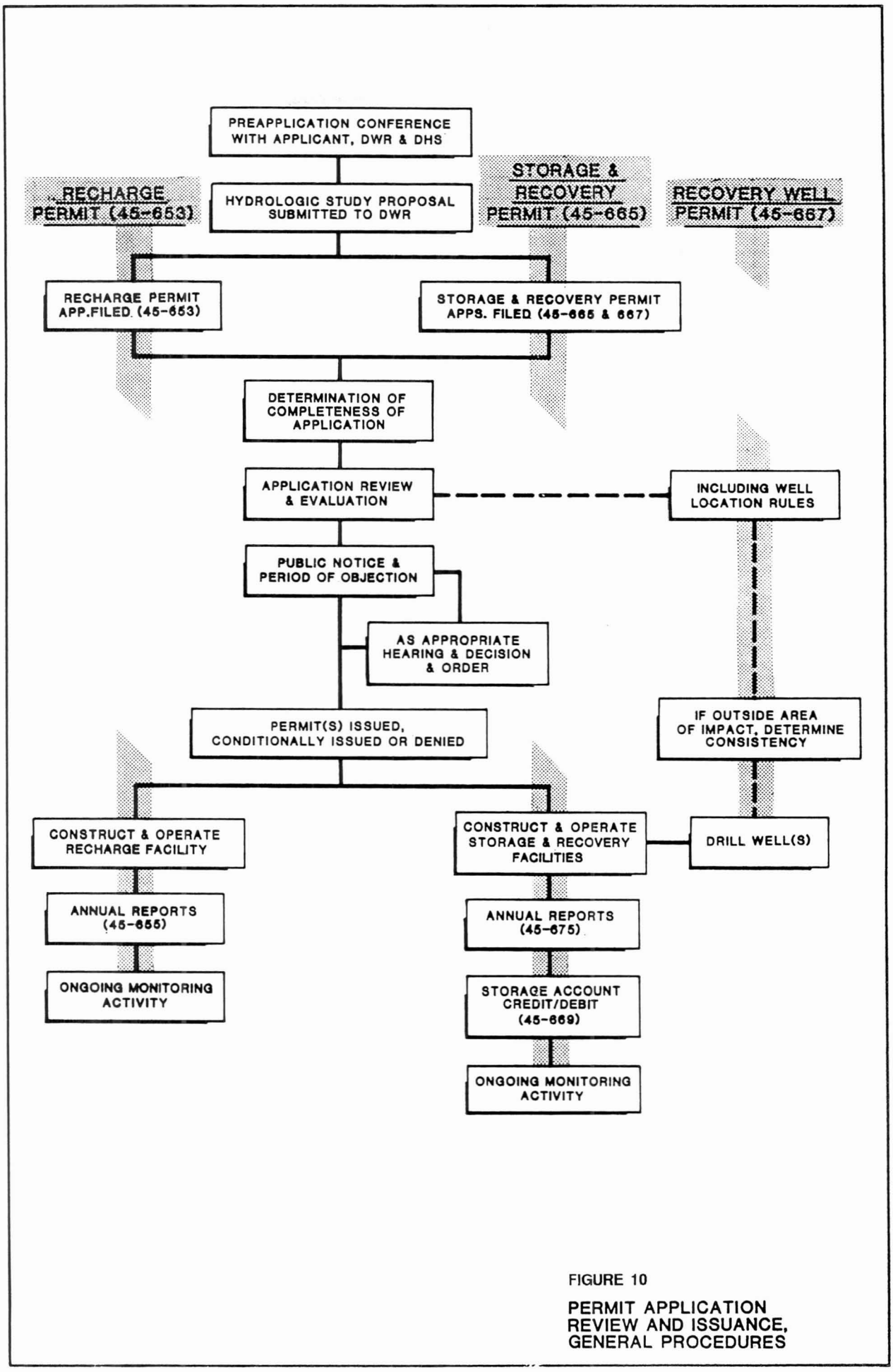


FIGURE 10

PERMIT APPLICATION REVIEW AND ISSUANCE, GENERAL PROCEDURES

Hydrological Testing Permits

The third step is to obtain Hydrological Testing Permits. These permits are required for site-specific hydrogeological studies.

Permits for Monitoring Activities

The fourth step is to use the results of the hydrogeological studies to design a monitoring and recovery well network. The requisite permits and Notices of Intention are as follows:

- Permit to Drill a Service Area Well in an AMA
- Permit to Drill a Nonexempt, Nonservice Area Well
- Notice of Intention to Drill a Monitoring/Piezometer Well
- Notice of Intention to Drill an Exploration Well

Well driller reports and well completion reports are required for each well. A well spacing and well impact study may also be required.

A NPDES permit may be required during hydrological testing if it is deemed that pumped water contains pollutants that may join tributaries of waters of the United States.

Permits for Water Spreading Projects

Additional permits are required for water spreading projects in floodplains, including:

- A NPDES permit, pursuant to Section 402 of the Clean Water Act.
- A Dredge and Fill Permit, pursuant to Section 404 of the Clean Water Act.
- County and City Flood Plain Use Permits.
- An Application for a Permit to Appropriate Water of the State of Arizona, if floodwaters are the intended source.

ZONING PERMITS, LAND USE PERMITS, AND INTERAGENCY AGREEMENTS

The Flood Control District should obtain all necessary zoning permits, land use permits, and interagency agreements before submitting a permit application for a recharge-related project. Land ownership of proposed sites

should be determined. Similarly, the necessary insurance policies should be obtained.

ONGOING ACTIVITIES ASSOCIATED WITH THE GILA RIVER ADJUDICATION

The process of adjudicating both surface water and groundwater rights during the Gila River suit is proving to be highly volatile. Indeed, as the process unfolds, there is a great deal of uncertainty regarding ownership of these water sources. Accordingly, the Maricopa Flood Control District is strongly advised to follow the progress of the Gila River Adjudication to monitor outcome affecting a recharge-related project.

TIME REQUIRED TO OBTAIN PERMITS

The time requirements for obtaining permits are affected by a number of variables too numerous to mention. Typically, the larger, more complex, and projects of longer duration will require the most time for permitting. The completeness of the application and degree of coordination with permitting agencies will also affect the time required. The permits that would be expected to require the most time are those required by the State Recharge Act and the Dredge and Fill Permit required by the Army Corps of Engineers (COE) if stream channel modifications are needed.

Dredge and Fill Permits are now handled at the COE Phoenix branch office. Individual permits generally required 60 to 90 days. The average for the district, which encompasses Southern California and Arizona, is 100 days. This is assuming that the environmental assessment completed by the COE does not turn up any significant impacts. If an Environmental Impact Statement is required than a minimum of one year is usually required.

The permit applications required by ADWR and ADEQ under the Recharge Act are intended to be filed simultaneously and it is anticipated that the individual permits can all be obtained within the same time frame. The following estimates for permitting times are the times required to issue the permit after a completed application is submitted. These are reasonable times assuming that the applications submitted are complete, that requests for additional information and clarification are minimal, and that public comments are minimal with no need for public hearings.

A permit for a demonstration recharge project could be obtained in as little as two months. Storage and recovery permits for a short-term project duration will require four to six months. Long term storage and recovery permits will require six to eight months to obtain.

PROBLEMS EXPERIENCED IN OBTAINING RECHARGE-RELATED PERMITS

According to permitting staff members at ADWR and ADEQ (1987), the major problems in processing recharge-related permits are as follows: (1) submission of incomplete applications, especially those lacking complete hydrogeologic information; (2) failure of applicants to schedule preapplication meetings with ADEQ and ADWR; (3) failure of applicants to coordinate with permitting agencies; and (4) submission of applications before local zoning, land use, and interparty agreements are completed. Recognizing the unique set of circumstances that surround each specific recharge proposal, ADWR and ADEQ staff members emphasized the need for ongoing dialogue during project development.

EVALUATION OF PLANNED AND PROPOSED FLOOD CONTROL PROJECTS

INTRODUCTION

The Flood Control District of Maricopa County (FCD) currently has planned and proposed flood control projects at various stages of development. Certain of these projects have been given a cursory review and potential changes in design and/or operations which could promote incidental, beneficial recharge of groundwater have been identified. The activities, measures, and recommendations for promoting recharge are contained in Technical Memorandum No. 5, Evaluation of Planned and Proposed Flood Control Projects for Potential Recharge Benefits (Appendix E).

FLOODWATER RECHARGE ENHANCEMENT

Natural groundwater recharge generally occurs wherever precipitation and floodwaters have the opportunity to infiltrate permeable soils and stream channel deposits. The amount recharged is a function of the rate of infiltration, the wetted area where infiltration takes place, and the time period when the opportunity for infiltration exists. Thus, natural recharge can be promoted or enhanced by increasing any one of these three factors: 1) rate of infiltration, 2) wetted area, and 3) opportunity time for infiltration. These factors are discussed in detail in Appendix E.

EVALUATION OF SPECIFIC PROJECTS

Certain planned and proposed flood control projects and activities have been reviewed to identify potential changes in design and/or operations which could promote incidental, beneficial recharge of groundwater. These ideas and recommendations have been formulated without regard to many of the technical and institutional considerations that could be addressed. These issues will need additional investigation

to determine whether a recommendation is applicable and/or feasible.

Area Drainage Master Studies and Programs

Area drainage master studies (ADMS) are a tool for integrating the planning for drainage and floodwater management facilities into plans for residential and commercial development of large areas. These facilities include onsite retention, stormwater collection systems, retention basins, drainageways, and floodwater conveyance channels. Guidelines for planning these facilities to promote recharge include:

- Maximize areas where onsite retention is required and increase the use of retention basins.
- Avoid lining channel bottoms where permeabilities are expected to be high.
- Use shallow slopes and maximum widths for drainageways and channels.

Skunk Creek/New River Channelization

A channelization project for Skunk Creek and New River is in various stages of planning and engineering. Plans are being developed to provide an engineered channel with soil cement bank protection constructed on both sides. Several drop structures are also planned. Suggestions for recharge enhancement on this project include:

- Avoid lining the channel bottom.
- Design the drop structures adaptable to the addition of hydraulic control facilities, such as inflatable rubber dams, in the future.

Flowage Easements

Flowage easements are being acquired along some reaches to mitigate potential damage suits due to flooding. In some areas it may be advantageous to include the right for the FCD to construct and operate recharge facilities within the privileges granted by the flowage easement. Perhaps existing easements could be renegotiated to include the rights to conduct recharge.

Open Space Requirements

Certain flood control projects sponsored by the Army Corps of Engineers (COE) have included requirements that set aside areas of open space as an environmental impact mitigation

measure. Perhaps these open space areas could take the form of recharge projects. The open water contained in the spreading basins and the enhanced growth of vegetation at the site could provide ideal habitat for water fowl and other wildlife.

Gaging Stations

The FCD is planning to install stream gaging and precipitation recording stations with telemetry equipment at various locations. The merits of collecting stream flow data for use in planning floodwater recharge projects needs to be factored into the site selection process. The need for continuous recording, especially during low flows, needs to be considered. The idea of using real time monitoring of flow events to operate recharge-related hydraulic control structures could also be considered.

TSR11/007