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RIO SALADO DRAFT EVALUATION REPORT PART V - WATER

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RIO SALADO DRAFT EVALUATION REPORT PART V - WATER

Prepared for

CARR, LYNCH ASSOCIATES, INC.

and the

RIO SALADO DEVELOPMENT DISTRICT

November 17, 1982

EXECUTIVE SUMMARY

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The goals of this study were to evaluate the potential options and constraints associated with the water Availability and Flood Management Plans for the Rio Salado Project. Reccomendations are made as to which options are most feasible.

Water Availability

Numerous potential water sources were analyzed to determine their feasibility as a source for Rio Salado. Each was evaluated for the following characteristics:

1) Quantity
2) Quality
3) Location
4) Cost
5) Means of Acquisition
6) Availability
7) Physical Limitations

The major findings are as follows:

1) Two classes of water use exist within the Project. First, there will be a need for potable domestic supplies to accomodate residential and commercial development. Second, water will be needed for aesthetic and recreational uses.

2) The most likely source for the domestic water would be to obtain a CAP allotment if it becomes available. A second option would be to obtain water rights, both surface and groundwater, from lands within the District. In either case, the water would be turned over to the cities, in return for service to the District.

3) The most likely source for aesthetic and recreational water would be from poor quality groundwater obtained through acquisition of a Special Use permit. It is anticipated that this source will diminish with time, but can be replaced with available effluent as needed.

4) Major results of this investigation are best summarized in the following items:

a) "Water Availability Source Priority" list which appears in part II, Section I, Water Availability.

b) "Water Availability Rating Matrix" which summarizes the evaluation for each source and is located immediately after the executive summary.

c) "Water Availability Maps" which identify the locations of both potential surface and groundwater sources. These maps are not included in this report but are kept at the Rio Salado District's Office.

Flood Management

1. The basis for the Flood Management Plan involved two scenarios. These were:

a) assuming no upstream flood control, an existing conditions, 100 year peak discharge of 200,000 cfs.

b) assuming upstream flood control, a design condition, 100 year peak discharge of 55,000 cfs.

2. Use of lands within the District boundary can occur outside of the 200,000 cfs flood contour for existing conditions.

3. If no upstream flood control is implemented, all construction should be limited to "flood proof" facilities or expendable features with a limited life. No streambotton lakes are suitable for this alternative.

4. Reclamation of large land areas can occur by limited levee and channel construction along the 100 year floodplain.

5. If upstream flood control is implemented, and the peak discharge is reduced to 55,000 cfs or less, construction within the floodplain is feasible and desirable.

6. With a maximum peak discharge of 55,000 cfs or less, four alternatives were considered suitable for floodway development. These are described as follows.

a) A Brownbelt floodway consisting of an earthern channel 2000 to 2500 feet wide, drop structures every 3000 to 4000 feet of channel length, maximum velocities of 4 1/2 fps, and small localized lake systems.

b) A Greenbelt Floodway consisting of a constant width grass lined channel 1100 to 1200 feet wide, approximately ten drop structures to limit the maximum slope to 0.002 ft/ft, maximum velocities of 8 fps, restricted sediment inflow and light, moderate or intense lake system development.

c) A Greenbelt floodway consisting of a varying width (1100 to 5000 foot maximum), grass lines channel, approximately ten drop structures, up to five sediment basins and light, moderate or intense lake system development.

d) A floodway that combines the above Brownbelt/Greenbelt concepts in part or as a whole, as local development conditions warrant.

7. Maps directing the various options were prepared and are kept at the Rio Salado District's office.

WATER AVAILABILITY RATING MATRIX

SOURCE	DESIRABILITY FACTORS					CONSTRAINTS			COMMENTS
	ANNUAL QUANTITY af/yr	QUALITY[4]	LOCATION[5]	ADDITIONAL COSTS[6]	TOTAL	PHYSICAL & OTHER LIMITATIONS POLITICAL[7]	PHYSICAL[8]	AQUISITIONS[9]	
CAP/domestic use	5,000	Fair/4	Very good/5	5	14	2	1	1	
CAP/support use	5,000	Fair/4	Very good/5	5	14	2	1	1	
CAP/CAWCS Plan 7	30,000	Fair/4	Very good/5	5	14	2	1	1	
CAP from Cities:									
Mesa	7,063	Fair/4	Very good/5	5	14	2	1	2	
Tempe	1,112	Fair/4	Very good/5	5	14	2	1	2	
Scottsdale	7,050	Fair/4	Very good/5	5	14	2	1	2	
Phoenix	54,454	Fair/4	Very good/5	5	14	2	1	2	
SRP Class A	11,500	Good/5	Very good/5	3	13	2	3	5	
SRP Class B	3,080	Good/5	Very good/5	3	13	2	3	5	
SRP From Cities	7,000	Good/5	Very good/5	3	13	2	2	3	
Salt River Indian Reservation Class A	4,300	Good/5	Good/4	4	13	2	2	2	
Salt River Indian Reservation Class B	3,000	Good/5	Good/4	4	13	2	2	2	
Irrigation Districts									
New State	4,569	Fair/4	Poor/1	3	8	0	2	2	
St. Johns	5,136	Good/5	Poor/1	3	9	0	2	2	
Penninsula	5,658	Good/5	Poor/1	3	9	0	2	2	
Maricopa Gardens	3,774	Good/5	Poor/1	3	9	0	2	2	
Lakin Cattle Co.	480	Good/5	Poor/1	3	9	0	2	2	
Storm Runoff	9,000	Poor/3	Fair/3	3	9	0	3	4	
Grandfathered Groundwater	76,000	Fair/4	Very good/5	1	10	0	3	5	
Grandfathered Groundwater/Vacant	24,000	Fair/4	Fair/3	1	8	0	3	5	
Existing Wells	49,000[1]	Fair/4	Good/4	2	10	2	2	2	
Exempt Wells	56/well	Fair/4	Very good/5	1	10	0	3	3	
Poor Quality Water									
Leachate	11,250+	Poor/3	Good/4	1	8	0	2	3	
High TDS	10,000+	Poor/3	Very good/5	1	8	0	2	3	
Wastewater Effluent:									
91st Ave. WWTP	71,000[2]	Very poor/1	Very poor/1	2	4	0	2	1	
23rd Ave. WWTP	34,000[3]	Very poor/1	Poor/2	2	5	0	2	1	
Existing Mesa/Dobson Rd.	3,360	Very poor/1	Good/3	2	6	0	2	1	
Proposed Mesa/Dobson Rd.	11,200	Very poor/1	Good/3	2	6	0	1	1	
Proposed Falcon Field	6,720	Very poor/1	Fair/3	2	6	0	1	1	
Proposed 48th Street		Very poor/1	Good/4	2	7	0	1	1	
Other Medium Plants	11,000	Very poor/1	Good/4	2	7	0	1	1	
Oth. Small Plants	2,240	Very poor/1	Good/4	2	7	0	1	1	
Industrial Waste:									
Ocotillo	236	Poor/3	Fair/3	5	11	0	2	4	
Motorola	2,200	Very poor/2	Poor/2	2	6	0	2	4	

(1) This represents less than half of the existing wells within the District's boundary. The remaining yields were not available.

(2) This quantity is the available, less the percent committed, which could come from the 91st Ave. Plant.

(3) This quantity is the available, less the percent committed, which could come from the 23rd Ave. Plant.

(4) Quality rating is based upon the following criteria: Good/5 - highest quality available, Fair/4 - slightly lower but acceptable, Poor/3 - may need some treatment, Very Poor/2 - requires at least secondary treatment, Very Poor/1 - requires tertiary treatment.

(5) Location rating is based upon the following criteria: Very good/5 - many possible delivery locations near Salt River, Good/4 - several possible delivery locations near Salt River, Fair/3 - limited delivery locations, but near Salt River, Poor/2 - single delivery removed from development area, Very poor/1 - single delivery location far removed from development area.

(6) Cost rating is based on the following criteria: 5 - cost of transport, plus negotiated benefit, plus land, pumping facilities and capital costs. 4 - cost of transport 3 - cost of transport 2 - cost of treatment or existing 1 - cost of pumping plus

(7) Physical limitations are based on the following criteria: a designation of zero is given if any of the following are required - new facility construction, upstream pumping, construction of delivery systems, construction of other structures, placement of new groundwater pumps. Otherwise it will receive a 2.

(8) Political limitations ratings are based on the following:
0 if it is of political nature
2 if it is a mildly political and
3 if it is a non political

(9) Aquisitional ratings are based on the following:
1 if political
2 if negotiation is required
3 if a permit is required
4 if limited negotiation is required
5 if it is routine

SECTION I

WATER AVAILABILITY

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WATER AVAILABILITY

I. INTRODUCTION

Water is available from several sources for potential Rio Salado Project uses. These sources are described in varying degrees of detail, depending on their relative value to the Project and the problems involved.

In general, there will be two classes of water use within the Project boundaries, First, there will be residential and commercial development for which potable domestic supplies will be needed. The second general category will be for water for greenbelt uses, including grass, trees, lakes, fountains and minor artificial waterways within the area.

A logical solution would be to obtain a CAP allotment, if it becomes available when reallocations are made, for the necessary potable supplies. Such allotment would be turned over to the cities in exchange for services to the Project area. A second option for potable water would be to obtain irrigation rights, both surface and underground, from lands in the District, turn those rights over to the cities in exchange for domestic water service.

The second general catagory of water use is that of aesthetic and recreational purposes. It is likely that water for these purposes can be obtained in suffecient quantities to meet a substantial demand from extraction of contaminated water and other poor quality groundwater through industrial type permits. It is anticipated that these sources will diminish with time, but can be replaced with growing availability of effluent sources.

Presentation of the various sources of water supplies and the problems associated with their aquisition are assembled in section II.

II. WATER AVAILABILITY SOURCE PRIORITY

A tentative source, priority list has been prepared, and appears in this table. Although the list is subject to further discussion and thought, we believe that the first six sources on the list will not change, except that poor quality leachate and CAP (for domestic use only) might share the first priority. Some of the lower items could move up the list if the conversion of irrigated lands to urban uses should take a long period of time.

Table 1. Water Source Priority

1. Leachate
2. High TDS
3. Effluent
4. Exempt wells
5. CAP (cities)
6. CAP (domestic)
7. Grandfathered Groundwater Rights
8. Class A SRP
9. Class A SRIR
10. Class B SRP
11. Class B SRIR
12. Other SRP
13. Vacant Groundwater
14. CAP (support)
15. Irrigation Districts (other than SRP)
16. Storm Runoff
17. Motorola
18. Ocotillo

III. Surface Water

A. Central Arizona Project

The Central Arizona Project (CAP) is expected to deliver some 1.1 to 1.6 million acre-feet per year of Colorado River water to Arizona. Initial delivery is scheduled for 1985, although funding problems may alter this date.

1. CAP Allocations

The Arizona Department of Water Resources (DWR) has the responsibility of recommending to the Secretary of the Interior, the allocation of CAP water among competing applicants. The Secretary of the Interior will subsequently make the allocations which may or may not conform with the DWR recommendations. The Central Arizona Water Conservation District (CAWCD) will then modify and validate its master contract for delivery of the water and for the repayment of CAP costs. Each successful applicant will then enter into individual subcontracts to receive the allocated water and repay their appropriate share of the costs.

On January 18, 1982, DWR sent to the Secretary of the Interior the latest allocation recommendation. DWR recommends that 640,000 acre-feet of CAP supply be allocated to non-Indian municipal and industrial uses, with specific amounts recommended for each applicant. Rio Salado Development District had requested an allocation of 21,000 acre-feet. DWR recommended no allocation to Rio Salado. In denying the request, DWR recognized "the desirability of the Rio Salado Project", but did not include an allocation because "that allocation would have to come from the already short supplies identified for cities".

The Department further stated that, "while the request for an allocation is valid for the Rio Salado Project, a portion of the CAP water allocated to cities involved in this project can provide the needed water supply in the early years with effluent taking over in later years as the cities need their full CAP entitlements to meet municipal needs".

It should be noted that one of the final eight alternative Central Arizona Water Control Study (CAWCS) plans for regulatory storage and flood control would provide a source of water for Rio Salado. Plan 7, which is structurally identical to the selected Plan 6, would be operated to "emphasize opportunities for

environmental enhancement". Enough water would be made available to provide "minimum flows in the Salt and Verde Rivers and to provide the potential for recreation and fish and wildlife enhancement in the Salt River through Phoenix". As a means of achieving this, "30,000 acre-feet of water could be made available to Rio Salado". Thus, a decision to amend the choice of Plan 6 to include this provision could provide a source of CAP water to Rio Salado. Such a decison could be made as a result of the environmental impact assessment of Plan 6 which is currently underway.

2. Rio Salado Use of CAP Water

The use of CAP water by Rio Salado is most likely under one or more of the following four scenarios:

a. An allocation would be made to Rio Salado of a portion of any surplus water that resulted from the inability of any successful applicant to contract for the water. DWR estimated that at least 50,000 acre-feet of the initial M & I allocation will not be placed under contract and will be available for reallocation.

1) There are two different uses, for which separate requests should be sought by the Rio Salado District for CAP water under this reallocation. First, and of greatest priority is 5,000 acre-feet of water per year for domestic use. This request is substantiated by the fact that the Rio Salado development will attract a core population with a potential magnitude in excess of 25,000 people, creating a demand for water for domestic use. The needs of these fixed and transient populations using the facilities within the Rio Salado boundary demonstrates a definite ability to beneficially use the CAP water.

2) The second use for which a separate allocation should be sought is for population support systems. This would include recreation, green strip irrigation, improvement of the Salt River environment throughout Rio Salado and any other supportive water needs.

b. The Secretary of Interior would approve an allocation for Rio Salado, either as a direct change in DWR's recommendation or through the modification of Plan 6 to include the environmental enhancement provisions of Plan 7.

c. The cities would assign a portion of their CAP allocations for Rio Salado uses. Some cities have recently emphasized that they may be willing to

contract with Rio Salado for all or part of their CAP allocation. This provides a potential opportunity for Rio Salado to use CAP water during the early years of the project with a transition to waste effluent usage as the cities' water demands grow and they need their CAP allocations. Table 2 lists the CAP allocations for several cities. The entire allocation is considered as the potential maximum available.

Table 2. CAP Allocations

Municipality	1985	2005	2034
Mesa	7063	14500	20129
Tempe	1112	3376	4315
Scottsdale	7050	13070	19702
Maricopa County	97512	18802	279566
Total	112,737	49748	323712

The City of Tempe in particular, has shown an interest in this plan. Discussions with Tempe and other cities, should be pursued in order to further quantify this potential source.

d. Rio Salado water developments could be used as groundwater recharge facilities for the storage of CAP water. Such a system would provide a means of banking the state's entitlement of CAP water during the early years, when other storage and delivery facilities were unavailable or before contracts had been executed for the entire amount.

3. Costs of CAP Water

The latest projections of the cost of CAP water for M & I purposes is $82.50 per acre-foot at the canal. This figure includes a capital cost of $32.50 plus $50.00 for operation, maintenance and replacement. Transportation costs to the location of use would be additional. The cost of 30,000 acre-feet would be $2,475,000 per year plus transportations costs.

B. Kent Decree Water Rights

In 1910 the Kent Decree established the water rights in a large portion of the Salt River Valley. It identified three classes of land, each possessing a different right. Class A lands have the highest right.

It pertains to those lands which were under continuous cultivation beginning in 1869 and subsequent years and continuing through 1909.

Class B lands have a lesser right. It pertains to those lands that were irrigated intermittently during this same period of 1869-1909. The irrigation of these lands began during times of good water supply and was suspended during times of scarcity of flow in the river. The failure to continuously irrigate was the result of a lack of dependable water supply rather than a desire to terminate the use of the land. Class C pertains to irrigatable lands under the canals for which no appropriation of water from the river had been made at the time of the decree.

The majority of the land affected by the Kent Decree, is within the Salt River Project (SRP)*. The remainder is located and controlled by the Salt River Indian Reservation (SRR).

*The term "Salt River Project" refers strictly to the Project authorized by the Congress and built by the U.S. Bureau of Reclamation. The term is used loosely throughout the region to include the operating entity established under Arizona law having the name "Salt River Valley Water Users Association", (SRVWUA). For convenience, and conforming to general usage, Salt River Project (SRP) is used in this report to mean the operating entity SRVWUA.

1. Rio Salado Use of SRP Water

The use by Rio Salado of water delivered through the SRP system would be contingent upon the purchase of land within the Project area. The right to the water would beacquired with the land. The extent of the water rights would depend upon which lands were acquired. As development occurs it is suggested that the assessments for the water could be picked up by the District and the rights turned over to the cities in exchange for water service. This exchange could involve effluent as well as other sources. Treatment cost of water related to Rio Salado would be paid by the District.

For the purpose of quantifying these rights, an allocation of 3 acre-feet per acre per year has been assumed for both Class A and Class B lands. Due to the poor water rights and small percentage of Class C lands within the Rio Salado boundary, they were neglected. Table 3 lists the location , area, quantity of water and other pertinent data for each section of land within both the Rio Salado boundary and the Salt River

Table 3. Kent Decree Surface Water Rights Within the Rio Salado Development District.

Location Township	Range	Section	Administrator	Class	Area (acre)	Quantity (ac-ft/yr)	Political Affiliation
T2N	R6E	30	Salt River Project	A	6	18	Maricopa Co.
		31	"	A	425	1275	Mesa
T1N	R5E	1	"	A	210	630	Mesa
		2	"	A	486	1458	Mesa
		3	"	A	188	564	Mesa
		8	"	A	98	294	Maricopa Co.
		9	"	A	139	417	Mesa
		10	"	A	83	249	Mesa
		11	"	A	47	141	Mesa
		17	"	A	233	699	Mesa
		18	"	A	224	672	Mesa
T1N	R3E	14	"	A	113	339	Phoenix
		18	"	A	52	156	Phoenix
		19	"	A	42	126	Phoenix
		21	"	A	80	240	Phoenix

Table 3. Continued

Location Township	Range	Section	Administrator	Class	Area (acre)	Quantity (ac-ft/yr)	Political Affiliation
T1N	R3E	22	Salt River Project	A	96	288	Phoenix
		28	"	A	64	192	Phoenix
T1N	R2E	13	"	A	127	381	Phoenix
		19	"	A	320	960	Maricopa Co.
		20	"	A	240	720	Maricopa Co.
		21	"	A	230	690	Maricopa Co.
		22	"	A	288	864	Phoenix
		23	"	A	30	90	Phoenix
T1N	R1E	25	"	A	22	66	Maricopa Co.
			Total Class	A	3841	11522	
T2N	R6E	28	Salt River Project	B	20	60	Mesa
		29	"	B	75	224	Mesa
		31	"	B	22	66	Mesa
		32	"	B	265	795	Maricopa Co.
T1N	R2E	19	"	B	200	600	Maricopa Co.
		20	"	B	320	960	Maricopa Co.
		30	"	B	125	375	Maricopa Co.
			Total Class	B	1027	3081	

Project boundary. Maps 1 & 2 show these boundaries, along with the lands with Kent Decree water rights.

It is important to realize, that for this analysis, three acre-feet per acre per year has been assumed to be the quantity available for use including both groundwater and surface water. In other words, the total quantity of water which may be realized from both groundwater and surface water rights for any given parcel of land is three acre-feet per acre per year.

Some of the best rights are attached to lands close to the Salt River. A portion of these are urbanized or otherwise retired from cultivation. Purchase of such lands could provide premium water rights as well as potential for development. However, the lands must be within the Project area. Water derived from rights on Project land cannot be used on lands outside the Project area. Thus, it is unlikely that water derived from lands close to the river could be used within the channel, since most of the channel is off-Project.

2. Rio Salado Use of SRR Water

The use of Salt River Indian Reservation Kent Decree water would be contingent upon successful negotiations with the appropriate reservation authorities. The amount of land and corresponding available water which lies within the Rio Salado District boundary is tabulated by location, and class of water right in Table 4. Here again a combined surface and groundwater assessment of three acre-feet per acre per year is used.

The location of these lands, shown on Maps 1 & 2, are in the upstream reaches of the Rio Salado District, and border the Salt River.

3. Rio Salado Use of Other SRP Water

Another potential source for obtaining SRP water is through the direct purchase of water from cities which possess Kent Decree rights for their jurisdictional areas. The City of Mesa, for example, had a surplus of approximately 7,000 acre feet of SRP water last year, for which they paid assessments. In order to lessen the financial burden of paying for water not used, the City may decide to sell this water in the future. Due to the nature of this situation, action may be taken by the City of Mesa to alleviate the burden within a year, thus requiring the prompt attention of the Rio Salado Development District.

Table 4. Kent Decree Surface Water Rights within the Rio Salado Development District.

Location Township	Range	Section	Administrator	Class	Area (acre)	Quantity (ac-ft/yr)	Political Affiliation
T2N	R5E	27	Salt River Indian Reserv.	A	320	960	Salt River Indian Reserv.
		35	"	A	475	1425	"
		36	"	A	640	1920	"
			Total	Class A	1435	4305	
T1N	R5E	4	Salt River Indian Reserv.	B	200	600	Salt River Indian Reserv.
		5	"	B	400	1200	"
		6	"	B	200	600	"
		7	"	B	200	600	"
			Total	Class B	1000	3000	

Another potential source for this type of water is the City of Tempe. They have estimated that they have a maximum of 5.42 acre-feet per acre per year of ground and surface water available to them and a maximum historic use of approximately three acre-feet per acre per year. This indicates that there may be an excess of 2.42 acre-feet feet per acre per year available for purchase by Rio Salado. These and other potential city-sources should be throughly investigated.

4. Cost of SRP Water

The right to the water is acquired with the purchase of the land. the only additional cost is the assessment to cover the expense of delivering the water. The current assessment is $13.50 per acre, which entitles the owner to three acre-feet of water. Thus the current cost of the assessment water is $4.50 per acre-foot. The SRP Board of Governors has also allotted an additional acre-foot of stored and developed water for $6.75.

C. Other Irrigation Districts and Agricultural Sources

In addition to the Salt River Project, several smaller irrigation districts are located along the Salt River. These include the New State Irrigation and Drainage District, St. Johns Irrigation and Drainage District, the Peninsula (Horowitz) Ditch Company, Maricopa Garden and Lakin Cattle Company.

The New State Irrigation and Drainage District originally had water rights adjudicated under the Benson-Allison Decree (1917). Since that time the New State District has entered into a permanent contract with the Salt River Valley Water Users' Association to furnish the District lands with a supply of water equal in quantity to the amount allocated to project lands, acre for acre. This water has been supplied from wells and thus, the District has not maintained its diversion from the River.

St. Johns District and the Peninsula Ditch Company also have rights adjudicated under the Benson-Allison Decree. They also have contracts to buy water from the Salt River Project.

Maricopa Garden Farms has water delivered by the SRP. The lands are "Class C" lands as described in the Kent Decree of 1910.

The Lakin Cattle Company has waste water delivered by the Salt River Valley Water Users Association in lieu of the ordered gravity water due to them by authority of the Benson-Allison Decree.

These entities are all located along the downstream end of the Rio Salado District. The necessity to convey pump water upstream may eliminate them as a main source of water. It is a potential source for local use in the lower end of the District. Table 5 lists the land areas and the potential water available to Rio Salado. As with the SRP water, this water would be aquired by purchasing the land. These potential sources are located on Map 2.

D. Rio Salado Use of Municipal Storm Runoff

In the Phoenix area it has been estimated that the average annual storm runoff yield is 38 acre-feet per square mile. Based on an urban area of 325 square miles, this represents a total runoff of approximately 12000 acre-feet per year. Because of variables, climate and others, this is not a reliable source of water. Due to storm water detention structures, dry wells and other abstractions, not all thestorm water reaches the river. It is assumed that three quarters of the total, or an average of 9000 acre-feet per year, may be reaching the River. This water discharges into the River, at 25 major storm discharge points. These are identified on Maps 3 and 4.

Another discharge source is the Tempe Ditch Number 2, shown on Map 1. This drainage ditch is reported to flow at a moderate level periodically, and have a continual flow of nuisance water.

Although these sources represent a significant amount of water anually, the nature of the source makes it difficult and expensive to fully utilize. Since the majority of rainfall occurs during the two rainy seasons, storage will be required. Storm runoff generally contains a variety of pollutants, making treatment a potential necessity.

Table 5. Other Irrigation Districts with Water Rights

Peninsula (Horowitz) Ditch Company

Location Township	Range	Section	Administrator	Class	Area (acre)	Quantity (ac-ft/yr)	Political Affiliation
1N	2E	32	Peninsula (Horowitz) Ditch Company		240	720	Phoenix
		31	"		480	1440	Phoenix
1N	1E	36	"		602	1806	Phoenix
		35	"		152	456	Phoenix
1S	2E	6	"		119	357	Phoenix
1S	1E	1	"		293	879	Maricopa Co.
				Total	1886	5658	
1N	1E	25	New State Irr. & Drainage Company		211	633	Maricopa Co.
		26	"		520	1560	Maricopa Co.
		27	"		341	1023	Maricopa Co.
		28	"		451	1353	Maricopa Co.
				Total	1523	4569	

Table 5. Other Irrigation Districts with Water Rights (Cont.)

St. Johns Irrigation & Drainage Company

Location Township	Range	Section	Administrator	Class	Area (acre)	Quantity (ac-ft/yr)	Politic Affiliation
1N	1E	29	St. Johns Irrig. & Drainage Co.		154	462	Maricopa Co.
		30	"		154	462	Maricopa Co.
1N	1E	25	"		160	480	Maricopa Co.
		26	"		158	474	Maricopa Co.
		27	"		80	240	Maricopa Co.
1N	1E	32	"		239	717	Maricopa Co.
		31	"		289	867	Maricopa Co.
1N	1W	36	"		193	579	Maricopa Co.
		35	"		203	609	Maricopa Co.
1N	1W	34	"		82	246	Maricopa Co.
				Total	1712	5136	
Maricopa Garden Farms					1258	3774	
Lakin Cattle Co.					160	480	

IV. GROUNDWATER

A. Groundwater Management Act

The State of Arizona has an estimated dependable supply of surface and groundwater of 2.6 million acre-feet per year. Once CAP water delivery begins, the dependable supply will increase to 3.8 million acre-feet per year. The current consumption rate is 4.8 million acre-feet per year, resulting in a current overdraft of 2.2 million acre-feet and a future overdraft of 1.0 million acre-feet annually.

This critical groundwater situation in Arizona led to the passage of the Groundwater Management Act in the year 1980. The potential use of groundwater by the Rio Salado Project will be governed by this very complex act. The law is intended to institute comprehensive groundwater conservation and management in Arizona. Prior to its passage, few controls existed on the use of groundwater. Under the new Act, the amount of water that may be withdrawn will be subject to strict conservation requirements.

A major provision of the law mandates the designation of groundwater basins as Active Management Areas (AMA's). Groundwater withdrawals in AMA's will be managed pursuant to management plans to be prepared by the State Director of Water Resources. The Phoenix AMA includes the entire Rio Salado Development District, but is divided between two sub-basins. Thus, any use of groundwater by Rio Salado will be controlled by the statute, with specifics provided by the Phoenix AMA Management Plan. The management goal of the Phoenix AMA is the maintenance by 2025, of a long-term balance between groundwater withdrawals and natural and artificial groundwater recharge.

Within a sub-basin of a designated Active Management Areas, water may be withdrawan under only two conditions - either pursuant to a "grandfathered right" or a permit from the Department of Water Resources. A grandfathered right enables an existing legal use of groundwater to continue.

Three catagories of grandfathered rights exist; (1) Irrigation Grandfathered Rights are attached to land that was irrigated at some time between January 1, 1975 and January 1, 1980, (2) Type 1 Non-Irrigation Grandfathered rights are created when an Irrigation Grandfathered Right is converted to a non-irrigation use, (3) Type 2 Non-Irrigation Grandfathered Rights include all existing non-irrigation withdrawals of groundwater that are not based on the retirement of irrigated land.

In addition to grandfathered rights, groundwater may be withdrawan pursuant to a permit from DWR. These permits may only be issued for designated purposes and under specified condtitions.

The use of groundwater by Rio Salado could occur under any of the three approaches named above. However, groundwater derived from one designated sub-basin cannot be transported and used in another sub-basin.

B. Rio Salado Use of Grandfathered Water Rights

The first approach would be for the Rio Salado Development District or another suitable entity, to purchase irrigated farm land that has a certified Irrigation Grandfathered Water Right. The farm land would then be retired from cultivation and the right converted to a Type 1 Non-Irrigation Grandfathered Right.

The second approach would be for the Rio Salado Development District, or another suitable entity, to purchase land that has an existing Type 2 Non-Irrigation Grandfather Right. The existing right would then be used to supply water for Rio Salado purposes. The amount of the Type 2 right is the maximum amount legally withdrawn in any one of the five years preceding the designation of the AMA. Thus, the amount of water available to Rio Salado would depend upon the previous use of the land.

Areas within the Rio Salado district boundary which have a potential Grandfathered Right have been designated on Map 3. These include both irrigated areas which would qualify for a Type 1 permit and non-irrigated areas which would qualify for a Type 2 permit. The location, areas, quantity of water and political subdivision in which each area is located is given in Table 6. Quantities have been based on an allocation of three acre-feet per acre annually.

There are several parcels of of land within the Rio Salado which have a potential Grandfathered Right but are currently vacant or underdeveloped. These parcels would be easily acquired and a good source of groundwater. They have been separately distinguished on Map 3. In order to secure the Grandfather Rights for these parcels, action would be required before an allotted time period elapses and they lose their Grandfather potential.

Table 6. Lands with Potential Grandfather Rights

Township	Range	Sec.	Area (ac.) Irri.	Non-Irri.	AF/yr. Quantity	Political Subdivision
T2N	R6E	28	60	--	180	Salt River Ind. Res./Maricopa Co.
		29	90	50	420	" "
		30	40	50	270	" "
		31	595	--	1785	Mesa/Maricopa County
		32	400	--	1200	Maricopa County
		33	320	--	960	Mesa/Maricopa County
T1N	R6E	06	30	--	90	Mesa
T2N	R5E	23	460	--	1380	Salt River Ind. Res.
		26	116	--	348	"
		27	545	--	1635	"
		33	400	--	1200	"
		34	70	120	570	"
		35	500	--	1500	"
		36	640	--	1920	"
T1N	R5E	01	220	--	660	Mesa
		02	500	--	1500	"
		03	320	120	1320	Salt River Ind. Res./Mesa
		04	97	60	471	Salt River Ind. Res./Maricopa Co.
		05	490	3	1479	Salt River Ind. Res.
		06	638	--	1914	Salt River Ind. Res.
		07	220	--	660	Salt River Ind. Res.
		08	120	135	765	Salt River Ind. Res./Maricopa Co.
		09	210	48	774	Mesa/ Maricopa County
		10	260	--	780	Mesa

Table 6. Lands with Potential Grandfather Rights
(Continued)

Township	Range	Sec.	Area (ac.) Irri.	Non-Irri.	AF/yr. Quantity	Political Subdivision
T1N	R5E	11	120	--	360	Mesa
		17	24	--	72	Mesa
		18	36	130	498	Tempe/Mesa
T1N	R4E	08	180	--	540	Phoenix/Tempe/Maricopa Co.
		09	75	--	225	" " "
		12	530	--	1590	Salt River Indian Reservation
		13	--	165	495	Tempe/Maricopa County
		14	--	70	210	" "
		17	--	48	144	Tempe
T1N	R3E	13	--	125	375	Phoenix
		14	140	--	420	"
		15	--	20	60	"
		16	--	5	15	"
		18	65	--	195	"
		19	30	38	204	"
		20	--	140	420	"
		21	80	23	309	"
		22	84	100	552	"
		23	--	50	150	"
		24	--	16	48	"
		28	70	--	210	"
		30	125	--	375	"

Table 6. Lands with Potential Grandfather Rights (Continued)

Township	Range	Sec.	Area (ac.) Irri.	Non-Irri.	AF/yr. Quantity	Political Subdivision
T1N	R2E	13	130	--	390	Phoenix
		16	10	--	30	Maricopa County
		17	15	--	45	"
		18	25	--	75	"
		19	640	--	1920	"
		20	620	--	1860	"
		21	330	--	990	"
		22	240	100	1020	Phoenix
		23	20	140	480	Phoenix
		24	--	40	120	Phoenix
		25	290	--	870	Maricopa County
		26	510	--	1530	"
		27	240	--	720	"
		28	510	--	1530	"
		29	260	95	1065	"
		30	135	60	585	"
		31	480	--	1440	"
		32	600	--	1800	"
		33	480	--	1440	"
T1S	R2E	04	280	--	840	"
		05	240	--	720	"
		06	300	--	900	"

Table 6. Lands with Potential Grandfather Rights
(Continued)

Township	Range	Sec.	Area (ac.) Irri.	Non-Irri.	AF/yr. Quantity	Political Subdivision
T1N	R1E	22	40	--	120	Maricopa County
		23	80	--	240	"
		24	80	--	240	"
		25	350	25	1125	"
		26	530	--	1590	"
		27	300	--	900	"
		28	640	--	1920	"
		29	470	--	1410	"
		30	410	--	1230	"
		31	280	--	840	"
		32	210	--	630	"
		33	130	--	390	"
		34	110	--	330	"
		35	190	--	570	"
		36	600	--	1800	"
T1S	R1E	01	300	--	900	"
		02	30	--	90	"
		03	600	--	1800	"
		04	420	--	1260	"
		05	20	--	60	"
T1N	R1W	23	110	--	330	"
		24	120	--	360	"
		25	640	--	1920	"
		26	575	--	1725	"
		27	360	--	1080	"
		34	115	--	345	"
		35	210	--	630	"
		36	200	--	600	"
	Totals		23375	1976	76053	

C. Indian Reservation Lands

As with the surface water rights the Reservation lands also have potential groundwater Grandfathered Rights. The use of this water would be sought through negotiation with Reservation officials.

D. Rio Salado Use of Special Permits

Special permits may be granted by DWR for five catagories of use, two of which are applicable to Rio Salado. First would be the "General Industrial Use" permit which includes, all non-irrigation uses except mineral processing and subdivisions. Included could be such uses as commercial centers, landscaping, parks, golf courses, fish and wildlife, recreation and industry.

The issuance of general industrial use permits is subject to restricting conditions, which generally could limit the District's ability to obtain such a permit. Rio Salado is most likely to be granted this type of permit when poor quality water is withdrawn. Using the available assessments of groundwater quality as a guide, zones could be delineated, wherein permits could be readily issued to applicants who could make use of poor quality water. Limits on amounts of water that could be so withdrawn could be set to develop flow patterns that would allow use of the poor quality water without unreasonably impacting other users or interfering with the local AMA's management goal.

The second special use permit, and the most promising, would be for the withdrawal of contaminated water. Permits could be issued where the groundwater quality was impaired through pollution. Such a permit would allow extraction where the intention was to control and eventually eliminate the migration of the contaminated water.

E. Groundwater Contamination Along the Salt River

As the Salt River flows through the greater Pheonix Metropolitan area it occupies the lowest point in the Valley. This results in a natural sink where both surface and groundwaters tend to migrate. Thus, contaminants concentrate along this strip, resulting in a poor quality of groundwater. The continual downstream increase in the concentration of dissolved salts due to multiple reuse of water, adds to the poorer quality of groundwater in the vicinity of the river channel area.

The U.S. Public Health Service recommends that water containing a Total Dissolved Solids (TDS) concentration greater than 500 mg/l not be used for public supplies. The TDS concentrations have been identified by the U.S. Geological Survey in the Phoenix valley. From approximately Granite Reef Dam to Rural/Scottsdale Road, the concentrations of TDS range from 500 to 1000 mg/l and from Rural/Scottsdale Road down to the confluence of the Salt River and the Agua Fria River, the concentrations range from 1000 to 3000 mg/l. These zones have been delineated on maps 3 and 4.

Another source which results in contaminated groundwater in localized areas is sanitary landfills located along the banks of the Salt River. At various locations between Gilbert Road and 43rd Avenue, there are 17 landfills for the disposal of domestic waste and 9 for the disposal of either hazardous waste or sludge. These sites are shown on Map 3. Not all of these sites are presently in active use, but they still have a high potential for groundwater contamination .

The major problem exists at the domestic waste landfills. During periods of high groundwater level, such as floods or near intensive recharge locations, the water table moves up through the bottom of the landfill, saturating the decomposing material and creating a leachate which follows the groundwater as levels recede. These saturated landfills probably continue to drain leachate into the groundwater for extended periods of time. If not controlled, the plume of leachate will move into, and contaminate larger areas of higher quality groundwater.

Each landfill has been prioritized based on the degree to which they contribute to the pollution of the groundwater. Nine of the municipal landfills and three hazardous waste disposal sites have received the highest priority and should be the first to receive corrective attention. The remainder of sites received a moderate or low priority as outlined in Table 7. Each site is located on maps 3 and 4.

F. Rio Salado Use of Contaminated Groundwater

Use of poor quality groundwater, both high TDS and leachate, presents the Rio Salado District with an excellent opportunity to meet its non-potable water needs, as well as assist in cleaning up a pollution source which is a detriment to the entire Valley.

Table 7. Landfill Sites and Information

Site	Priority	Operator	Status	Assumed Production Wells Needed	Total Pumpage gpm
40th Street	High	Phoenix	Inactive/ Munic. Waste	2	1000
Estes	High	Phoenix	"	2	1000
16th Street	High	Phoenix	"	2	1000
Del Rio	High	Phoenix	"	2	1000
7th Avenue	High	Phoenix	"	2	1000
N. 19th Avenue	High	Phoenix	Active/ Munic. Waste	2	1000
S. 19th Avenue	High	Phoenix	"	2	1000
27th Avenue	High	Phoenix	"	2	1000
40th Avenue	High	Unknown	Inactive/ Munic. Waste	2	1000
Tempe Shops	High	Unknown	Inactive/ Hazardous Waste	1	250
Resource Recovery Conservation Assoc.	High	Private	Active/ Hazardous Waste	Unknown	250
Wayne Oxygen Inc.	High	WOI	Inactive/ Hazardous Waste	1	250
Feedlot	Moderate	Unknown	Inactive/Feedlot	1	250
Phnx. Sludge Disposal	Moderate	Phoenix	Inactive/ Sludge Disposal	1	250
Sctsdle. Sludge Disposal	Moderate	Scottsdale	"	1	250
Mesa WWTP	Moderate	Mesa	Active/Sludge	1	250
Phoenix WWTP (23rd Ave.)	Moderate	Phoenix	"	1	250
Phoenix WWTP (91st Ave.)	Moderate	Phoenix	"	1	250
Tri-City	Low	Unknown	Inactive/Munic. & Construction	1	250
SRP Mesa Drive	Low	SRP	Active/Munic. & Construction	1	250
Mesa	Low	Mesa	"	1	250
SRR	Low	SRR	Inactive/Munic. & Construction	1	250
Country Club Dr.	Low	Unknown	"	1	250
SRP McClintock Rd.	Low	SRP	Active/Munic. & Construction	1	250
Ariz. State Univ.	Low	ASU	Inactive/Munic. & Construction	1	250
SRP (56th St.)	Low	SRP	Active/Munic. & Construction	1	250
Central	Low	Union Rock	"	1	250

To withdraw poor quality groundwater the District would need to apply to DWR for a "General Industrial" or a "Poor Water Quality" permit. Withdrawal could continue throughout the duration of the permit or as long as the water quality remained poor. Based on the findings of a comprehensive hydrogeologic investigation, which would need to be performed to determine the feasibility and impact by this type of withdrawal a permit might be issued for as long as 35 years and then renewed if conditions allowed.

Practically, pumping at landfill locations would also draw a higher quality of water from surrounding areas. This water would dilute the leachate, resulting in a mixture which would probably be acceptable for use on parks, golf courses and in water developments.

Preliminary calculations show that a properly placed well field downstream of a typical landfill could considerably reduce and control the size of a contaminant plume. At each site the pumping requirements might be about 1000 gallons per minute (gpm). If such a plan was implemented at each of the 17 domestic landfill sites, a total of 24,000 acre-feet of water could be pumped annually. Because of a variable demand, the practical limit would probably be approximately 15,000 acre-feet per year. If more water were needed as conditions changed, additional industrial permit wells, could be placed along the river at various locations to pump poor quality groundwater at points removed from the landfills.

G. Cost of Groundwater

The cost of groundwater includes expenses associated with the following items; land acquisition (when applicable), well drilling, installing pump equipment, distribution facilities, where necessary, and the continued operation of the system. Numerous wells already exist in the area. The need for new wells would depend upon which land was aquired. It can be expected that each well could produce up to 3,000 acre-feet per year. Thus, the production of 30,000 acre-feet would require a minimum of ten to fifteen wells. Each new well could cost about $250,000. Pumping costs are estimated to be $30.00 to $50.00 per acre foot.

H. Rio Salado Use of Existing Wells

Within the Rio Salado boundary there are numerous wells which might be used to deliver water to the District. These wells are located on Maps 3 and 4. Table 8 summarizes the important data for each well.

Table.8 Tabulation of Wells by Location

Location				Yield	DWR
Qdt.	Twp.-Rng.	Sec.	1q2q3q	(gpm)	No.
(A - 1 - 1)		25	a b a		9
(A - 1 - 1)		25	d a a	300	10
(A - 1 - 1)		25	d c c		11
(A - 1 - 1)		25	d d a		12
(A - 1 - 1)		25	d d a	8	13
(A - 1 - 1)		25	d d d	30	14
(A - 1 - 1)		26	a a	2500	15
(A - 1 - 1)		26	b b b		16
(A - 1 - 1)		27	b d a	1500	18
(A - 1 - 1)		27	d d d		20
(A - 1 - 1)		28	b a a		1
(A - 1 - 1)		28	b c b		21
(A - 1 - 1)		28	d a a		23
(A - 1 - 1)		31	b c c	35	24
(A - 1 - 1)		32	b a a		26
(A - 1 - 1)		32	b c c	40	27
(A - 1 - 1)		33	b b a	20	31
(A - 1 - 1)		33	b b a	20	32
(A - 1 - 1)		35	a a d	20	34
(A - 1 - 1)		35	a c d		2
(A - 1 - 1)		35	a d d	1000	35
(A - 1 - 1)		35	a d d	8	36
(A - 1 - 1)		35	a d d	1500	37
(A - 1 - 1)		35	b d a		38
(A - 1 - 1)		35	b d d		39
(A - 1 - 1)		36	a b b		42
(A - 1 - 1)		36	b a b		43
(A - 1 - 1)		36	b b c		44
(A - 1 - 1)		36	d d	2400	45
(A - 1 - 2)		19	a a b	24	53
(A - 1 - 2)		19	b a a		54
(A - 1 - 2)		19	c a d	1300	56
(A - 1 - 2)		19	c c b	10	57
(A - 1 - 2)		19	c c c	15	58
(A - 1 - 2)		19	c d c		59
(A - 1 - 2)		21	a d d		60
(A - 1 - 2)		21	b b a		61
(A - 1 - 2)		21	b a		62
(A - 1 - 2)		21	b c b		63
(A - 1 - 2)		21	b c c		64
(A - 1 - 2)		22	b c d		65
(A - 1 - 2)		22	d a a		66
(A - 1 - 2)		24	d a b		70
(A - 1 - 2)		25	d d d	3000	72
(A - 1 - 2)		26	a a a		73
(A - 1 - 2)		26	d c d		74
(A - 1 - 2)		26	d d b	450	75
(A - 1 - 2)		26	d d d		76
(A - 1 - 2)		27	a d a		77

Table 8. Tabulation of Wells by Location
(Continued)

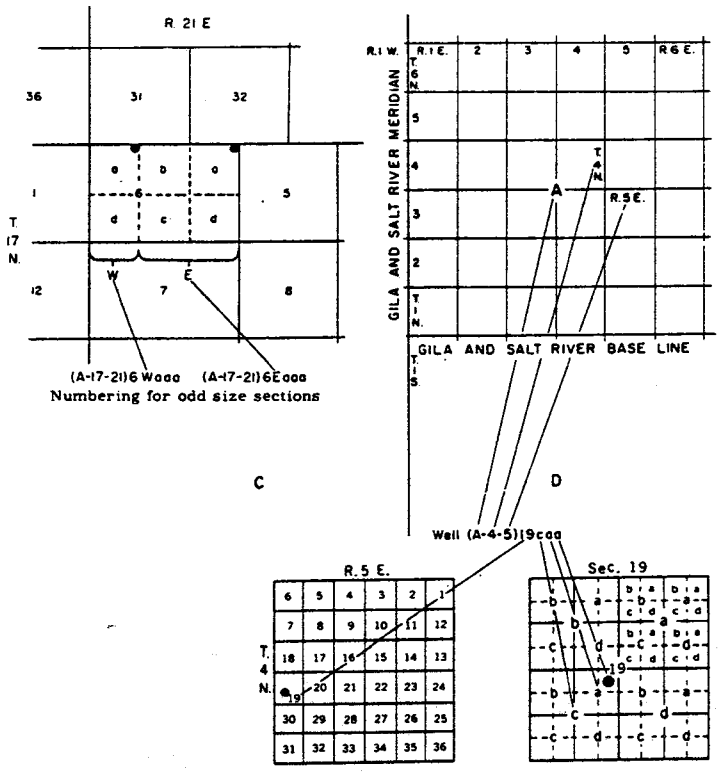
Location				Yield	DWR
Qdt.	Twp.-Rng.	Sec.	1q2q3q	(gpm)	No.
	(A - 1 - 2)	27	d a a		78
	(A - 1 - 2)	28	a d c		80
	(A - 1 - 2)	28	b d b		81
	(A - 1 - 2)	28	c a a		4
	(A - 1 - 2)	28	c a a	1500	82
	(A - 1 - 2)	29	d d a	2800	83
	(A - 1 - 2)	30	a a a	1200	84
	(A - 1 - 2)	30	d c d	3250	85
	(A - 1 - 2)	31	c b b		88
	(A - 1 - 2)	31	d b b	183	90
	(A - 1 - 2)	32	b a a		93
	(A - 1 - 2)	32	b b	3500	94
	(A - 1 - 2)	32	d d d	600	95
	(A - 1 - 3)	14	c c c		96
	(A - 1 - 3)	19	c c c		99
	(A - 1 - 4)	2	d d b	1052	112
	(A - 1 - 4)	11	a a a		113
*	(A - 1 - 4)	11	a b	2014	T-1
	(A - 1 - 4)	11	a c	2200	114
	(A - 1 - 4)	11	d c a		118
	(A - 1 - 4)	13	a d c	400	119
	(A - 1 - 4)	13	a d d		120
	(A - 1 - 4)	13	b a c		6
	(A - 1 - 4)	13	c d a	600	121
	(A - 1 - 4)	15			123
	(A - 1 - 4)	17	b c d	150	125
	(A - 1 - 4)	18	c a d		126
	(A - 1 - 4)	18	d a d		127
	(A - 1 - 4)	19	d a a	2000	129
*	(A - 1 - 4)	22	c b		T-2
*	(A - 1 - 4)	23	b b		T-3
*	(A - 1 - 4)	24	ba		T-4
	(A - 1 - 5)	8	b a d	3200	144
	(A - 1 - 5)	9	b b b	770	145
	(A - 1 - 5)	10	d b c	280	148
	(A - 1 - 5)	10	d b d	280	149
*	(A - 1 - 5)	14	b c		M-1
*	(A - 1 - 5)	15	a c		M-2
*	(A - 1 - 5)	15	d c		M-3
	(A - 1 - 5)	18	a a a		152
	(A - 1 - 5)	18	b a d		153
	(A - 1 - 5)	18	d b a		156
	(A - 1 - 5)	19	b b		T-5
*	(A - 1 - 6)	3	a a		M-4
	(A - 2 - 5)	34	c c a	1200	159
	(A - 2 - 6)	27	c a a	2244	163
	(A - 2 - 6)	29	c d a		167

Table 8. Tabulation of Wells by Location
(Continued)

Location				Yield	DWR
Qdt.	Twp.-Rng.	Sec.	1q2q3q	(gpm)	No.
(A	- 2 - 6)	29	d d d		7
(A	- 2 - 6)	33	c b a		178
(A	- 2 - 6)	33	d b d		8
(B	- 1 - 1)	33	c b b	460	185
(B	- 1 - 1)	34	d c d	2690	186
(B	- 1 - 1)	36	c a	300	187
(B	- 1 - 1)	36	c a b		188
(B	- 1 - 1)	36	d b b		189
(C	- 1 - 1)	2	b d a	750	
(C	- 1 - 1)	3	a a d		
(C	- 1 - 1)	3	c c a	1200	
(C	- 1 - 1)	3	d b c		
(C	- 1 - 1)	3	d c a	3	
(C	- 1 - 1)	3	d c d		
(C	- 1 - 1)	4	a a d		
(C	- 1 - 1)	4	d d a		

* Not DWR Number

WELL-NUMBERING SYSTEM IN ARIZONA



I. Exempt Wells

A limited source that could be used without a permit, is small exempt wells which the law limits to a pumping rate of not more than 35 gpm for domestic purposes,including the non-commercial irrigation of less than two acres of land. These wells might be used for localized commercial development or for limited public use such as a small park area.

V. WASTEWATER EFFLUENT

The reuse of wastewater effluent as a means of augmenting available water resources is presently receiving increased attention. As other sources become scarcer and more expensive, this source becomes more attractive. Although this situation will cause competition for the available effluent, it represents a significant potential for Rio Salado.

The information in this section was quoted directly (with the exception of Table 8) from "Potential Water Sources for Rio Salado", a preliminary report compiled by the Rio Salado Development District. This portion of the report was well researched. Nothing significant was found in our research that would change this presentation.

A. Existing System and Plans

The existing system for the management of wastewater in the Phoenix urban area is evolving to meet the demands of an expanding population. Recently, the Maricopa Association of Governments (MAG) revised their Water Quality Management Plan that outlined the facilities and procedures needed to treat and manage the area's wastewater.

This plan calls for the continued use and expansion of the two major existing treatment plants at 91st Avenue and 23rd Avenue. The 91st Avenue plant is presently being expanded from a capacity of 90 million gallons per day (mgd) to 120 mgd. The revised plan provides for another 30 mgd expansion to a total capacity of 150 mgd by 1985-87. The 23rd Avenue plant needs to be expanded initially from its present 37.2 mgd to 42.5 mgd, with an eventual expansion to 50 mgd.

A significant feature of the new plan is the option for the individual communities to construct selected small plants to provide a portion of the needed treatment capacity instead of sending all wastewater to the two large plants.

While providing some excess treatment capacity, this provision will allow greater flexibility in planning and operation of the total system. It will especially increase the potential for the reuse of treated effluent. It will allow the treatment of wastewater at locations upstream from Rio Salado facilities, thus increasing the possibilities for its use in the project. The smaller plants could be in either of two catagories.

First, satellite plants could be built by the indiviual communities. Plants with a capacity larger than two mgd would have to be named specifically in the MAG Plan. Second, plants smaller that two mgd could be built after receiving approval through a specified review process. These smaller plants could be designed to provide treated effluent for reuse in a particular development.

B. Projected Flows and Reuse

Critical to the use of treated effluent by Rio Salado is the amount of wastewater that will be generated and the existing obligations for its reuse. A major question is whether there will be sufficient future effluent to serve the needs of Rio Salado.

Four agreements for the use of treated effluent now exist. These agreements represent committments that would need to be satisfied before wastewater would be available to Rio Salado. They are as follows:

1. A contract between the cities of Glendale, Mesa, Phoenix, Scottsdale, Tempe and Youngtown, and APS/SRP to provide water for electrical generation. The intended use is for cooling at the Palo Verde Nuclear Generating Station, although it is not limited to this facility. The contract calls for a maximum of 125 mgd (140,000 acre-feet per year) to be delivered from the 91st Avenue plant, and if necessary, from the 23rd Avenue plant. However, the maximum need for the three units of the PVNGS that will be completed is estimated to be 58 mgd (65,000 acre-feet per year). Also, the current contract is subject to renegotiation.

2. A contract between the City of Phoenix and the Buckeye Irrigation District to provide 26.8 mgd (30,000 acre-feet per year) until 2011.

3. A contract between the city of Phoenix and the Roosevelt Irrigation District for 17.9 mgd (20,000 acre-feet per year) from the 23rd Avenue plant until 2000. This agreement has never been implemented because of a difference between the quality of the needed water and that of the effluent produced by the plant.

4. An informal agreement between the City of Phoenix and the Arizona Game and Fish Department for 6.5 mgd (7,280 acre-feet per year). The Department claims a right to this amount based on historical effluent flow in the Salt River bed. This claim may be subject to challenge.

The total amount of effluent now committed under contract is therefore 176.2 mgd (about 197,280 feet per year). However, if only actual use is considered, the total is about 91.3 mgd (about 102,280 acre-feet per year).

Projections of future effluent availability have been made by MAG. These projections have been compared to the contractual obligations. The analysis concluded that the two treatment plants would be able to meet their contracts by 1995. If only the actual use is considered, sufficient effluent is available at all times. In fact, under this assumption, the 91st Avenue plant alone could supply the contracted amounts and still have a surplus.

If satellite plants are built in East Mesa and the Northeast area, the situation is only slightly changed. Contract obligations could then be met by 2000. Again, if only the actual use is considered, the need can be met at all times even from the reduced flow of the 91st Avenue plant.

The attached Tables 9 and 10 are from the MAG plan and provide the details. As can be seen from these tables, the excess production, assuming only actual use, ranges from 97.2 mgd in 1980 to 199.5 mgd in 2020. If the committed amounts are assumed, the surplus ranges from 0.4 mgd in 1995 to 132.5 mgd in 2020. The assumed average annual need for Rio Salado is 26.2 mgd, with a peak monthly demand of 56.2 mgd. Thus, it can be concluded that there will be a surplus of effluent. This surplus is more than enough to meet the assumed Rio Salado need. Under the current contractural obligations for the effluent, the surplus would begin to be available in 1995. However, if only actual use is considered, the surplus is available immediately.

C. Wastewater Quality

The quality of wastewater to be reused is obviously very important. Quality standards vary depending on the use to which the effluent will be put. In general, three aspects must be considered in determining these standards. First, the public health must be protected. Strict standards are required where the water will be used for unrestricted irrigation of playgrounds, parks and recreational water bodies. Contamination of existing groundwater supplies must also be avoided. Second, the water must not contain substances that will have an adverse effect on the use itself. For example, water in recreational lakes must meet certain standards

Table 9. Effluent Availability With Majority of Flow to 91st Ave.

Year	23rd Ave.	91st Ave.	Total	Committed Effluent/Effluent Actually Used (1) AGEF	(2) BIC	(3) ANPP	(4) RID	Total	Available Effluent Less Committed Effluent (mgd)	Available Effluent Less Effluent Actually Used(mgd)
1980	42.6	87.9	130.5	6.5/6.5	26.8/26.8	125/0	17.9/0	175.9/33.3	130.5-175.9=(45.4)	130.5-33.3=97.2
1985	42.4	105.6	148.0	6.5/6.5	26.8/26.8	125/38.7	17.9/0	175.9/72.0	148.0-175.9=(27.9)	148.0-72.0=76.0
1990	42.5	119.1	161.6	6.5/6.5	26.8/26.8	125/58	17.9/0	175.9/91.3	161.6-175.9=(14.3)	161.6-91.3=70.3
1995	42.5	133.8	176.3	6.5/6.5	26.8/26.8	125/58	17.9/0	175.9/91.3	176.3-175.9=0.4	176.3-91.3=85.0
2000	43.6	152.21	195.8	6.5/6.5	26.8/26.8	125/58	17.9/0	175.9/91.3	195.8-175.9=19.9	195.8-91.3=104.5
2010	46.5	186.2	232.7	6.5/6.5	26.8/26.8	125/58	--	158.3/91.3	232.7-158.2=74.4	232.7-91.3=141.4
2020	48.3	215.7	264.0	6.5/6.5	---	125/58	--	131.5/64.5	264.0-131.5=132.5	264.0-64.5=199.5

(1) Verbal Agreement for 6.5 mgd between City of Phoenix and Arizona Game & Fish Department.

(2) Buckeye Irrigation company had contracted for 30,000 acre-feet per year (26.8 mgd).

(3) 125 mgd from 91st Avenue and/or the 23rd Avenue plants to Arizona Public Service/Salt River Project.

(4) Roosevelt Irrigation District has contract for 17.9 mgd from 23rd Avenue plant until 2000 (requires additional treatment before implementation).

Table 10. Effluent Availability With Satellite Plants.

Year	23rd Ave.	91st Ave.	Total	Committed Effluent/Effluent Actually Used (1) AGEF	(2) BIC	(3) ANPP	(4) RID	Total	Available Effluent Less Committed Effluent (mgd)	Available Effluent Less Effluent Actually Used (mgd)
1980	42.6	87.9	130.5	6.5/6.5	26.8/26.8	125/0	17.9/0	175.9/33.3	130.5-175.9=(45.4)	130.5-33.3=97.2
1985	42.4	96.2	138.6	6.5/6.5	26.8/26.8	125/38.7	17.9/0	175.9/72.0	138.6-175.9=(37.3)	138.6-72.0=66.6
1990	42.5	107.2	149.7	6.5/6.5	26.8/26.8	125/58	17.9/0	175.9/91.3	149.7-175.9=(26.2)	149.7-91.3=58.4
1995	42.5	120.3	162.8	6.5/6.5	26.8/26.8	125/58	17.9/0	175.9/91.3	102.8-175.9=(13.1)	162.8-91.3=71.5
2000	43.6	134.3	177.9	6.5/6.5	26.8/26.8	125/58	17.9/0	175.9/91.3	177.9-175.9=2.0	177.9-91.3=86.6
2010	46.5	163.5	210.0	6.5/6.5	26.8/26.8	125/58	---	158.3/91.3	210.0-158.3=51.7	210.0-91.3=118.7
2020	48.3	188.0	236.3	6.5/6.5	---	125/58	---	131.5/64.5	236.3-131.5=104.8	236.3-64.5=171.8

in order to minimize the growth of algae. Third, the water must be treated so that it is aesthetically acceptable for unrestricted irrigation and recreation.

Treatment of sewage is done in stages, referred to as primary, secondary and tertiary. The primary stage removes solids. Biological action in the secondary stage begins the purification process. Tertiary treatment achieves higher standards.

Effluent from the existing treatment plants has received secondary treatment. A review of existing standards indicates that this level of treatment is insufficient for the uses contemplated by Rio Salado. Thus, any effluent used from existing treatment plants will require additional treatment. Any new facility that might be constructed to provide wastewater for Rio Salado would have to be designed for a higher level of treatment.

One method of producing the higher quality water would be the construction of plants capable of tertiary treatment. While technically possible, such facilities would be extremely expensive for the large capacities needed.

An alternative method of achieving the needed wastewater quality has been developed by Dr. Herman Bouwer, Director of the U.S. Water Conservation Laboratory, U.S. Department of Agriculture. In this system the effluent from the treatment plant is subjected to a land treatment process. The effluent is placed into infiltration basins and allowed to seep into the ground. The soil, sand and gravel layers act as a natural filter that purifies the water as it percolates into the groundwater. It can then be pumped from wells and used for unrestricted irrigation and recreation purposes.

Experiments using the Bouwer process have been conducted at both the 91st Avenue and the 23rd Avenue plant. In these cases, effluent that had received secondary treatment was utilized. Results of these experiments indicated that such a system can indeed yield renovated water of sufficient quality for unrestricted irrigation and recreation. Chlorination of the water may also be indicated in order to completely eliminate the possibility of adverse effects. The Bouwer process can also be applied to effluent that has received only primary treatment, thus eliminating the need for secondary plants.

Costs of operating the infiltration systems can be substantially less than conventional treatment plants. However, a major need is land. Such a system can be

designed to produce approximately 200 acre-feet per year for each acre of land. Thus, the production of the assumed 30,000 acre-feet for Rio Salado would require 150 acres of land.

D. Methods for Wastewater Use

Given the general availability of wastewater, the next question relates to the means by which it could be used in Rio Salado. Several possibilities exist.

1. Effluent From Current System

Under the existing system, treated wastewater would be available from the 23rd Avenue and 91st Avenue plants. As noted above, additional treatment would be required. This source presents problems of transporting the water to the point of its use. While the exact location of Rio Salado water facilities is not yet known, it is very likely that most, if not all, of the initial sites will be upstream from these two plants. The use of this water directly would involve the exchange of effluent for other water that could be more easily delivered. For example, the effluent could be provided to SRP or another irrigation district for use downstream in exchange for water that has its origin upstream from the desired Rio Salado use. Details of this type of possibility are being studied by the District. Location and effluent flows for existing and proposed plants are given in Table 11. Each is also located on Map 3, where applicable.

2. Package Treatment Plants

One method of producing the treated water at locations upstream from the described sites would be the construction of small treatment plants at or near the point of use. The Salt River Outfall (SRO), which collects and delivers sewage to the large treatment plants, passes through the length of the Rio Salado area. Raw sewage could be taken directly from this line and treated in package plants of one to three mgd capacity. Solids would be returned to the SRO for transportation to the large plants. The package plants would provide tertiary treatment and would supply high quality water for use on the site. Such water could provide the source for lake evaporation and irrigation of adjoining landscaped areas. This type of facility could be repeated several times along the length of the project. Such a technique is now being implemented in Scottsdale for the Gainey Ranch development. The City of Phoenix is also beginning a feasibility study for such a project in north Phoenix.

Table 11. Waste Water Treatment Plants

Plant	Existing	Proposed	Location	Effluent Flow	Remarks
91st Avenue	X		91st Ave.	87.9 mgd	Expansion being planned
23rd Avenue	X		23rd Ave.	37.2 mgd	Expansion being planned
Mesa/Dobson Rd.	X		Dobson & 8th St.	3 mgd	
Mesa/Dobson Rd.		X	Dobson & 8th St.	10-15 mgd	Expansion
Leisure World/ Turner Ranch		X	6312 E. Baseline	6 mgd	may be too far away
Salt River/ Falcon Field		X	north of Falcon Fld.	6 mgd	
Tempe/48th St.		X	48th St. No. of Salt	--	remote chance
Gainey Ranch		X	Glendale & Sctsdle Rd.	--	
N. Scottsdale		X	Bell Rd. & Sctsdle Rd.	.5 mgd	

3. Satellite Treatment Plants

Another method would be the construction or expansion of medium-sized satellite treatment plants by the cities at upstream locations. The existing Mesa plant, at Dobson Road and 8th Street, could be retained and expanded. In Tempe, the proposed plant location at 48th Street could be used. These actions would be consistent with the flexibility of the updated MAG plan. The treated water would then be upstream from the location of use and could be transported by gravity flow.

Two Mesa locations, Falcon field and the existing Dobson Plant, offer a particularly good opportunity. Sufficient land exists at the sites to enable the use of the Bouwer process. The city could expand the present plant, perhaps adding only primary treatment facilities, in conjunction with the construction of infiltration basins needed for the Bouwer process. Renovated water could then be delivered to Rio Salado. As much as 10,000 annual acre-feet, one-third of the needed supply, could come from such a facility. The City of Mesa would then have a guaranteed market for the water, thus enabling the reduction of its treatment costs.

The Falcon field site is currently planned to treat 6 mgd (6700 acre-feet per year). This is approximately 22% of the District's proposed use. The potential supply from these two Mesa plants may ultimately provide up to 60% of the district's requirements. In other words, this source could supply a Greenbelt with water for evaporation and irrigation from Granite Reef to the 23rd Avenue treatment plant.

3. Costs of Treated Wastewater

Experience at the larger treatment plants indicates that the total cost of secondary treatment is approximately $150 to $170 per acre foot. Of this amount, costs of operation, maintenance and replacement are about $60 to $70 per acre foot. The remainder is for capital costs and debt service. The capital cost of the Bouwer process includes the acquisition of the land and the construction of the filtration basins.

Operating costs are essentially the costs of pumping, which are estimated to be about $30.00 per acre-foot. Thus, the operating costs of a system that included secondary treatment plus the Bouwer process (equivalent to tertiary treatment) could approach $100 per acre foot. The inclusion of capital costs could double this figure. The cost would be less if only primary

treatment plus the Bouwer process was used. It is unlikely that the Rio Salado project would have to sustain the total treatment costs. The wastewater must be treated in any case. The cities will incur these costs whether or not the treated water is reused. Thus, an agreement could be reached that will provide water to Rio Salado at a reasonable cost while partially off-setting the expenses of the cities.

The most expensive treated wastewater would likely be associated with the small package plants. It is estimated that the capital cost of three mgd tertiary treatment facility would be about $8,000,000. Operating costs should approximate $135.00 per acre foot. One such plant would produce about 3400 acre-feet per year or slightly more than one-tenth of the assumed need for Rio Salado water.

E. Industrial Effluent

Another secondary source of potential effluent available to Rio Salado is from local industries with large water consumptions. Each industrial site could be directly tapped and effluent treated at small local treatmnt plants according to its need.

Two possible sources include the Arizona Public Service Ocotillo Power Plant, which discharges 236 acre feet per year, and the Motorola Plant at 52nd Street and McDowell Road, which discharges 2 million gallons per day.

The Ocotillo Power Plant discharges water at temperatures slightly greater than ambient river water temperatures. This would need cooling but no other treatment. The Motorola plant effluent would require secondary treatment before use. Industrial sites are located on Map 3.

SECTION II

FLOOD MANAGEMENT

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FLOOD MANAGEMENT

I. INTRODUCTION

The Salt River bed throughout the Phoenix metropolitan area is generally barren and isolated. It is used as a dumping ground for trash and debris. Pollution is commonplace and many buildings and structures are either abandoned or poorly maintained. The only productive use of the river consists of uncontrolled sand and gravel mining operations. In these areas, the river is a natural resource that has been abused and misused for many years.

The Rio Salado concept presents an opportunity to reclaim this wasteland, to turn it into a productive environment, enhancing rather than polluting. This can be accomplished, in part, by proper and systematic Flood Management.*

Flood Management for the Rio Salado Master Plan addresses the existing conditions of potential flooding in the Salt River, as well as several development scenarios. These scenarios include brownbelt, greenbelt and limited greenbelt concepts.

The Salt River within the Rio Salado Development District boundary extends from the Granite Reef Dam to approximately three miles beyond its confluence with the Gila River to approximately the confluence of the Agua Fria River and the Gila River. The length of this reach is approximately 40 miles.

The Salt River drainage basin is comprised of 13,700 square miles, from the headwaters to its confluence with the Gila River. The major tributary is the Verde River which has approximately 6,600 square miles of drainage area.

*The term Flood Management refers to the manipulation of excess runoff by modifying the geometric and hydraulic characteristics of the channel and floodplain, as opposed to Flood Control, which refers to control of flood water through storage and flood damage prevention by rigid channelization.

The elevations of these drainage basins range from more than 12,000 feet at the San Francisco Peaks in the Verde River Basin to approximately 900 feet near the mouth of the Agua Fria river. The area is extremely irregular and rugged, and the soils and vegetative types are widely varied.

Thirteen major floods have occured in recent history between 1891 and 1980. The peak discharges from these floods range from 47,000 cfs to 271,000 cfs. The Salt River is regulated by four major reservoirs. These are Roosevelt, Horse Mesa, Morman Flat and Stewart Mountain. The Verde River is regulated by Horseshoe and Bartlett reservoirs.

Waters impounded in these reservoirs are used for irrigation, municipal and industrial purposes in the Salt River Valley. As a result, the river through the Rio Salado Development District is generally dry. During flood periods, when the reservoir capacity is exceeded, releases from the reservoirs can cause flood stages in the Salt River.

The Central Arizona Water Control Study (CAWCS), proposes two additional dams to assist in regulating these unusual flooding events. These structures are the new Cliff Dam on the Verde River and a new or modified Roosevelt Dam on the Salt River. With these structures in place, the estimated 100 year peak discharge in the Salt River through the Rio Salado District will be reduced from 200,000 cfs to 55,000 cfs.

Flood Management Plan addresses alternatives that would provide opportunities for development and encroachment into the historic floodway.

Four major items were analyzed during this undertaking and are presented in detail. These items are:

1. Basic Criteria

2. Existing Conditions

3. Conceptual Designs

4. General Conclusions

II. BASIC CRITERIA

A. Data Availability

The sources of data and information used to establish the flood contours for existing flow conditions in the Salt River (assuming no additonal upstream flood control) included the following:

1. Rio Salado Development District

2. U.S. Army Corps of Engineers

3. Arizona Department of Transportation

4. City of Phoenix

5. Flood Control District of Maricopa County

6. Maricopa County Highway Department

7. Various consulting firms who have performed engineering studies and evaluations on portions of the Salt River from 51st Avenue to Gilbert Road.

B. Type of Data Acquired

The primary data acquired for the study include comprehensive and detailed hydraulic analyses and bridge designs, concept finalization reports, channelization plans and construction documents. Specific aspects of the engineering plans and reports were verified through oral communications from key individuals.

Secondary data, were from two reports, 1) "Salt and Gila River Hydraulic Analysis for Central Arizona Water Control Study", prepared by the U.S. Army Corps of Engineers, Los Angeles District (USCE) and 2) "Stage II Structural Design and Cost Memorandum-Channelization Elements", prepared by Camp, Dresser and McKee, Inc., for the Central Arizona Water Control Study (CAWCS), through the U.S. Army Corps of Engineers, Los Angeles District.

Included in the USCE Reports are two sets of floodplain delineation plans. One set shows the floodplain delineation for discharges of 50,000 cfs, 100,000 cfs, 150,000 cfs and 200,000 cfs in the Salt River from the western boundary of the Rio Salado District to Granite Reef Diversion Dam. The second set of plans defines the limit of flooding for the same reach of the Salt and Gila rivers for the 1978, 1979 and 1980 floods.

The CDM Report provided profiles showing the most recent invert profile of the Salt River and the associated water surface elevations for a 300,000 cfs flood.

These data were supplemented by USCE computer model profiles, for the 50,000 cfs, 100,000 cfs and 200,000 cfs floods.

1. Bridge Plans

Additional information was gathered from consulting engineers' reports, preliminary designs and plans for bridges, some of which are existing, and others that are under construction or in the final phases of design for the following locations:

a. 51st Avenue
b. 35th Avenue
c. 19th Avenue
d. Central Avenue
e. 7th Street
f. 16th Street
g. 24th Street
h. I-10 Freeway
i. Scottsdale Road
j. Hayden Road
k. Pima/Price Road
l. Alma School Road
m. Country Club Drive
n. Gilbert Road

2. Channelization Plans

Channelization plans, reports and construction documents were available for various reaches of the Salt River as follows:

a. 35th Avenue to 27th Avenue
b. 19th Avenue to Central Avenue
c. 7th Street to 16th Street
d. I-10 Freeway to Princes Drive,
e. Channelization projects proposed in conjunction with the aforementioned bridges, not yet authorized.

Additional channelization projects that are in the conceptual stage were not used as a primary source of information, but are noted on the drawing (Figs. 1 and 2) accompanying this report.

C. Use of Data

1. Mapping

The original plan was to delineate new water surface elevations for 55,000, 100,000 and 200,000 cfs based on the current topographic mapping. Depths of flow would be taken from the stage vs. discharge relationships in the previously mentioned reports. The depths for the three discharges then would have been extrapolated to a topographic contour map.

This concept had to be abandoned when no single source of topography was available for the study. Many independent (site specific) topographic maps had been completed, but there was no data to tie the independent sites together. Variations in data made calibration of the consultants' plans impractical due to a significant increase in cost.

The method of delineation selected for this study, consisted of taking the Corps' computer generated contours for 50,000, 100,000 and 200,000 cfs and calibrating them with the known flooding limits of the 1978, 1979 and 1980 floods. The contour lines, inverts and water surface profiles were adjusted where new data showed significant changes had occured, such as, at all the new bridge sites.

If neither new engineering, or the Corps' delineations were available, the 1977 F.I.A. Floodplain Delineation was used to establish the contours.

Differences encountered were primarily due to the age of the data and design considerations. Data provided by the Corps of Engineers were based on 1976 aerial topography, which does not reflect the conditions of the channel after the 1978, 1979 and 1980 floods.

The results of this investigation are shown on the accompanying plans. Figures 1 and 3 show the delineations of the various events, and their profiles, respectively.

In the reach between Granite Reef and the Gilbert Road Project, the invert profile was taken from the U.S. Geological Survey 7 1/2 minute quadrangle sheets, 1977.

2. Selection of Events and Criteria

a) Maximum peak discharge is 200,000 cfs at Central Avenue. This is the Corps of Engineers latest 100 year flood event. Although attenuation causes this figure to vary, it is reasonable to use it for the entire reach within the District boundary.

b) Upstream flood control (CAWCS Plan #6) 55,000 cfs is used as the 100 year flood event.

c) Maximum average velocity for 55,000 cfs is 8 fps for grass lined channels.

d) The maximum and minimum invert slopes for 55,000 cfs are 0.002 ft/ft and 0.001 ft/ft, respectively.

e) The maximum slope for a stabilized earth bottom brownbelt (invert treated with desert landscaping and decomposed granite) is 0.0005 ft/ft.

f) Criteria governing sediment control is discussed in section VI.

D. Missing Data

Currently water surface profiles were not available or are nonexistant for the following areas:

1. Granite Reef Dam to Gilbert Road Bridge and Channelization Project

2. 115th Avenue to the Rio Salado Development District's western boundary.

3. Information has not been received from the USCE which shows the water surface profiles and velocities for the 200,000 cfs flood in the reach between 35th Avenue and the western border of the Rio Salado District.

E. Quality of Available Data

With the exception of the most current consultants' bridge and channelization projects, the Corps' data is of a reconnaissance level and was only used as a planning tool.

F. Additional Investigations

Specific planning and detail design should not be implemented based on the available information. Any detail designs should be preceded by in-depth hydraulic, sedimentation and groundwater investigations. Unified topographic mapping, based on the most recent aerialphotogrammetry for the entire reach of the master planning area, will be required.

It is our understanding that the Arizona Department of Transportation is currently mapping the river upstream, between Central Avenue to approximately Country Club Road, and that the Rio Salado District and the Maricopa County Flood Control District are entering negotiations to map the river from Central Avenue downstream to the Rio Salado District's boundary.

G. Hydraulics

Upon completion of the new topographic mapping, detailed water surface profiles should be computed and flooding limits redelineated using the new topography.

A detailed hydraulic analysis using a computer model, will provide the District a basis, from which initial refinements of the Master Plan and early construction projects can be implemented.

H. Sedimentation Study

The District should undertake a detailed sediment study, in conjunction with the hydraulic analysis. The study should consist of field work, lab analysis, sampling, calculations, designs and physical model testing of sediment conditions and control features. The results of a detailed investigation should establish the quantity of expected sedimentation, equilibrium slopes and other design parameters relative to major features in the Master Plan.

III. GENERAL HYDRAULIC CHARACTERISTICS OF THE CHANNEL

The general characteristics of the Salt and Gila river channels for existing conditions were determined using available data. They are as follows:

A. Varying width ranging from 550 feet to 5,000 feet.

B. Depth of water for the 200,000 cfs flood ranges from between 7 feet to almost 27 feet and 4 feet to 15 feet for 55,000 cfs.

C. Invert slopes range from nearly level to 0.5% (0.005 ft/ft) with the average slope for the entire reach from Agua Fria to Granite Reef of approximately 0.2% (0.002 ft/ft).

D. The size of the bed material ranges from clays to large cobbles.

E. The median size material has an approximate D_{50} of 8 mm or 0.026 ft.

F. Major bridge crossing and channelization works have altered portions of the Salt River from its natural state to more defined and rigid, sides and inverts.

G. Excavations for sand and gravel mining operations alter localized areas on a continual basis.

H. Old abandoned landfills, trash dumps and general misuse of the dry river bed are apparent throughout its reach.

IV. DEVELOPMENT POTENTIAL AND CONSTRAINTS

A. Developable Areas Without Upstream Flood Control

1. The Corps of Engineers has determined the discharge of the 100 year flood as being 230,000 cfs at Gilbert Road, 200,000 cfs at Central Avenue and 185,000 cfs at the confluence with the Gila River which is approximately 115th Avenue. For the purpose of this study 200,000 cfs was considered to be the discharge of the 100 year flood throughout the study area.

Currently there are areas within the District boundary that can be developed outside the 200,000 cfs floodplain limit. These areas can be developed without upstream flood control or alteration to the existing river channel. They are are shown in green on Figure 1.

2. There are areas that can potentially be reclaimed from within the 200,000 cfs floodplain boundary by a minimal amount of levee construction and/or excavation within the channel. These areas are designated "reclaimed lands" and shown under the cross-hatched green areas on Figure 1. Figure 1 also identifies both areas where currently proposed channelization or levee work has been authorized and areas where work has not been authorized by the local authorities, but would serve to reclaim additional land for the District's use. On Figure 1 this work is shown as a black line. The red lines show proposed locations of levee and channelization work that may aid in reclaiming lands. These locations need further analysis when detailed topography is available.

3. The criteria used for determining developable areas are as follows:

a) Encroachment may occur within the flood plain as long as the water surface elevation for the 100 year event is not raised by more than one foot.

b) Construction within the flood plain shall not cause flooding, on the developed property, beyond that which would occur without that construction.

c) The Levee and/or channelization construction should not require major structures and earth moving.

d) The property being developed must be protected against the 100 year event.

B. Flood Peaks With Upstream Flood Control

With flood control structures in place, the peak discharge during the 100 year event, will be 80,000 cfs at the Granite Reef Dam and 55,000 cfs in the area of Sky Harbor International Airport. Additional inflow from the 1100 square mile drainage area below the dams comes from uncontrolled drainage basins, such as Sycamore Creek and Indian Bend Wash, which peak earlier than the floods from the Salt and Verde, do not contribute significantly to the peak discharge. Therefore, 55,000 cfs was adopted as the maximum design flood.

C. Alternative Development Concepts

Four separate development concepts were selected for investigation, these are as follows:

1. Brownbelt

2. Constant section greenbelt

3. Greenbelt widened for park and lake development.

4. Several localized limited length Greenbelts/Brownbelts (Less than 40 miles).

Each of the four concepts has individual sets of characteristics and parameters, and the total developable area varies with the concept.

A fifth concept is the do nothing concept. This should only be given consideration if no reliable plans can be justified.

D. Floodplain Delineation With Upstream Flood Control

The floodplain must be redelineated for the 100 year peak discharge of 55,000 cfs. The existing condition delineation for both plan and profile will conform closely to the existing 50,000 cfs delineation contour shown on Figures 1 and 3.

E. Areas of Development Lying Outside Redefined Floodplain Limits

For each of the concepts, the area lying outside the redelineated floodplain will be developable with a minimum of effort. The suggested criteria for

development will state that those areas lying outside the floodplain boundary need only to be elevated or protected from the 100 year water surface elevation. This criteria is consistent with current Federal and local standards.

F. Development Areas Lying Within the Redefined Floodway

Those areas lying within the defined floodway will have limited development capabilities. This development will be in the form of lakes, parks, roadways, ramadas, parking lots, ball parks, open air theaters, concert pavillions, etc.

The use of the areas must be evaluated relative to the potential damage risks associated with the various degrees of flooding. The relative degree of flooding is based on the various alternatvies and are discussed later.

G. Limitation to Development

Limitations and deletions to the suggested concepts and land uses may occur within the Rio Salado District if the upstream flood control is not implemented. The Arizona Revised Statutes, (ARS 45-2913) states in general, that without Orme Dam or a suitable alternative there will be no state monies available for construction of a Rio Salado development.

H. Implementation and Variations of the CAWCS Plan

Step planning is not inherent in the CAWCS Plan. Portions of the proposed CAWCS Plan 6 which affect flow in the Salt River includes two new dam sites, Cliff Dam on the Verde River and a new or enlarged Roosevelt Dam, on the Salt River. Conversations with local Corps of Engineers personnel indicate that construction of both dams should occur within no more than a ten year period, after funding. The Corps of Engineers has estimated that each of the dams should take no longer than five years to complete. The ten year period would occur if funding was authorized for the first dam initially and funding for the second dam was contingent upon completion of the first dam.

I. Potential Phasing for the CAWCS Plan #6

The Corps of Engineers has provided preliminary 100 and 200 year flood discharge figures based on the construction of either Cliff Dam or Roosevelt Dam as a single feature.

1. Construct New Roosevelt Only

The first scenario considers the construction of Roosevelt dam without Cliff Dam. The results of this study show the peak discharge at Granite Reef to be approximately 150,000 cfs for the 100 year event, and 190,000 cfs for the 200 year flood event. These results are based on a planned release from Roosevelt, of 25,000 cfs for approximately 10 days.

2. Construct Cliff Dam Only

The same approach was applied to the Cliff Dam with the exception that the Corps' study assumed a planned release from Cliff Dam of 45,000 cfs which is 20,000 cfs greater than its' release under CAWCS Plan #6. The 100 year discharge for this scenario at Granite Reef is 150,000 cfs and 160,000 cfs for the 200 year flood event.

Based upon these findings, it was concluded that flows resulting from a gradual or optional implementation concept exceeded the design parameters to such a magnitude that further investigation was unwarranted.

3. Operation of Flood Control Structures

During interviews, Corps of Engineers personnel indicated that several flood discharge operational alternatives may be available which could reduce the flow from the new Roosevelt and Cliff Dams. Corps personnel stated that there is the possibility of reducing the current planned release of 55,000 cfs to 30,000 cfs, 20,000 cfs or less. By changing the operational parameters, a peak reduction of this magnitude will be significant. Any reduction in peak discharge would increase the duration of flow, but this should not be a significant problem and could be resolved early in the planning phase.

This option certainly merits further investigation and should be pursued during the development of the Master Plan. Generally, any reduction in the peak discharge should enhance the feasibility of a Rio Salado development.

V. POTENTIAL FOR LAKES

Lakes, streams and water features are very desirable for any open space development of this type. They are aesthetic features that attract both commercial and recreational activities. When lakes and water features are constructed, property values increase dramatically. Water features can be integrated into flood management plans if basic criteria are followed. These issues are addressed in this section.

A. Basic Criteria

1. Velocities must be maintained so that destructive erosion will not occur, and lake systems can be constructed economically.

2. Sediment from flooding must be controlled so that minimal deposition occurs over the expected life of a lake.

3. Seepage should be controlled to minimize waste. This is accomplished through the use of liners. Economics should be a prime factor in selecting a lake lining material.

4. Water surface areas should be minimized to reduce losses from evaporation. This is accomplished by maximizing the shoreline, resulting is a series of streams and "finger" type lakes.

B. Flood Discharge Constraints

Lake systems have been used to attenuate peak discharges and reduce velocities and associated erosive energies. The use of the Salt River bed for storm retention and peak attenuation is impractical due to the high volumes of releases that would occur. Flows must be accomodated as they occur for the upstream releases. For this study, two conditions have been considered, the 100 year event without upstream flood control and the 100 year event with flood control. They are discussed as follows:

1. No upstream control - (200,000 cfs-100 year event)

Velocities vary from 8 ft/sec to 20 ft/sec, depths vary from 7 ft to 27 ft and localized scour and erosion are occuring. Lakes constructed in the stream bottom would need protection against high erosive velocities. They would be susceptible to potentially high sediment depositions.

Lakes outside the 100 year floodplain would be highly desirable and development potential would be limited to available water supply, land acquisition and constructions costs.

2. With upstream control (55,000 cfs- 100 year event)

Velocities vary from 4 to 8 ft/sec, with depths from 5 to 17 feet, erosion and deposition are occuring at a controllable levels. Lakes constructed in the stream bottom need minimal protection from velocities and sediment. The potential for lake development in the stream bottom is excellent.

Development of lakes outside the 100 year floodplain should be evaluated on a site by site basis, since lake systems are an integral part of the floodway.

VI. CHANNEL CONFIGURATIONS AND CRITERIA FOR FOUR CONCEPTS

A. The Brownbelt Concept

A Brownbelt concept would consist of a uniform earthen channel approximately 2,400 feet wide. Such a channel could be continuous throughout the project or might form interconnecting links between the various concepts. A cross section of the brownbelt is shown on Plate 1. In addition to the width criteria, the following conditions should be imposed to allow this concept to function properly during a design flood of 55,000 cfs:

1. Hydraulic Criteria

a) The maximum velocity should 4.5 feet per second.

b) The design slope should be 0.03%, with a maximum slope of 0.05% allowed for special conditions.

c) The maximum depth of water during the design flood should range from between four feet and six feet.

2. Sediment Criteria

a) The implementation of this concept will require drop structures to be located at intervals of approximately three thousand feet. If this concept is carried throughout the 21 mile core area, approximately 35 drop structures would be required, depending on the slope used.

b) Sedimentation basins might be required at each of the local inflow sites such as Indian Bend Wash, and at the upstream end of the project. Additional detailed analysis should confirm this.

3. Lake Potential

A few isolated lakes above the 4 to 6 foot depth could be integrated into the channel. These lakes should be above the expected depth of flow in order to restrict sediment inflow. Inflows from approximately 25 major storm inlets must also be accomodated.

4. Conclusions

A Brownbelt is suitable if the hydraulic and sediment criteria are met. The invert should be stabilized before any desert landscaping is considered. The minimum width is approximately 2400 feet.

B. Constant Section Greenbelt Floodway

This concept consists of a greenbelt floodway with a constant cross section from Granite Reef to the Agua Fria River. The cross section and associated hydraulic characteristics are shown on Plate 2. The floodway consists of an 1100 feet wide, grass lined channel. Incised into one side is a low flow or "nuisance flow" channel with a base width of 200 feet. The floodway is capable of having streambottom lakes placed in both the low flow channel and the "benched" portion of the floodway.

1. Hydraulic Criteria

a. The average velocity should not exceed 8 feet/second.

b) The slope is to remain as nearly constant as is practical with a minimum slope of 0.1% (0.001 ft/ft) and a maximum slope of 0.2% (0.002 ft/ft).

c) The design flow should be restricted to an upper limit of 55,000 cfs.

d) Depth of flooding during the 55,000 cfs event will be:

1) 15 to 17 feet, measured in the 200 foot wide low flow channel.

2) 5 to 7 feet measured in the benched area of the floodway.

e) Low flow channel

1) base width - 200'

2) capacity - 20,000 cfs

3) maximum velocity at 20,000 cfs - 8.5 ft/sec

f. Main channel

1) base width- 800 feet

2) capacity-55,000 cfs

3) maximum average velocity at 55,000 cfs - 8 ft/sec.

g) Approximately 10 drop structures will be required at locations where the existing invert slopes exceed 0.2% (0.002) ft/ft.

2. Sediment Criteria

a. Sediment basins should be constructed at the confluence of local washes in the river to keep new sediment out.

b. A sediment basin should be constructed as close as possible to Granite Reef.

c. Equilibrium slopes should be maintained so that a minimum of suspended sediments are deposited in the main floodway.

d. The Salt River Project currently dredges sediment from behind Granite Reef and puts it in the dry river below the dam. This practice should be abandoned. Opportunities might include sale of the dredged materials to nearby sand and gravel companies.

3. Lake Potential

Stream bottom lakes are suitable and desirable in both the low flow channel and in the main floodway. Lake density can either be minimal or high, neither one of which would create significant design problems. Some of the parameters considered are as follows:

a) A minimum water surface density should consist of 2 to 5% of the total Greenbelt/Floodway area, or 3 to 7 acres of water surface per mile.

b) A moderate water surface density should consist of 8 to 12% of the total Greenbelt/Floodway area, or 10 to 16 acres of water surface per mile.

c) The maximum density of water surfaces should not exceed 25% of the total Greenbelt/Floodway area, or 33 acres of water surface per mile.

d) Deposition of sediment should not create a significant problem if equilibrium slopes are maintained and no new sediment is introduced into the floodway.

e) A maximum flow of 55,000 cfs should be adopted.

f) Inflows from approximately 25 major storm inlets must be accomodated in the design of the low flow channel.

g) Flows of 200,000 cfs will have excessive velocities and sediments.

4. Conclusions

a) A Greenbelt Floodway with stream bottom lakes is suitable and desirable if hydraulic and sediment criteria are met. The minimum width of the proposed Greenbelt is 1100 feet. It has less than 50% of the width, only 33% of the required drop structures and is aesthetically superior to a Brownbelt.

b) It is concluded that the original concept, consisting of two to three mile-long lakes in Phoenix, Tempe and Mesa, should be abandoned. Such a plan is not practical from an engineering, economic or water availability perspective. Costs of design and construction alone would be staggering.

c) Lake design should be limited to small and moderate "systems" that optimize shoreline and minimize surface area.

C. Varying Section Greenbelt Floodway

This concept consists of a Greenbelt Floodway with a variable width cross-section. The minimum width of the floodway would be 1100 feet and the maximum width would be approximately 4000 feet. The Greenbelt Floodway planning area is shown in Figure 2.

This concept allows large recreational areas to be integrated into the 100 year floodway. Parameters and criteria associated with this concept are as follows:

1. The depth and velocity would vary greatly between the cross sections.

2. The upper limits of the hydraulic criteria would remain the same as for Alternative B, that is, a maximum velocity of 8 ft/sec for a maximum peak discharge of 55,000 cfs.

3. A 1100 foot primary channel may be integrated into wider regions if required.

4. 55,000 cfs remains the maximum flow due to constricted areas throughout the study area.

5. Stream bottom lakes are suitable and desirable, although the relative percentages of lake area to grass area may be smaller than the fixed section (Alternate B).

6. Due to the large variations in velocities, sediment transport equilibrium may be difficult to achieve. Therefore, potential sediment basin-sites have been identified and are shown on Figure 2. The feasibility of these basins should be investigated in greater detail once the actual sediment load had been established.

The optimum design situation is to locate only one basin as far upstream as possible. A feasible location is upstream from Gilbert Road. Additional basins may prove practical if design conditions warrant. An example would be the situation at Country Club Drive where sand and gravel operations might be integrated into the sediment basin concept.

The general design parameters for sediment basin are as follows:

a) Design discharge - 55,000 cfs for 10 days

b) Estimated sediment supply - 9×10^6 ft^3/day or 600,000 tons/day.*

c) Basins are to be symmetrical with velocities ranging from one to two ft/sec.

d) Depth of the basins (below crests) to be a minimum of 14 feet.

*This is a general estimate based upon limited data and simplified methods. It should be used only to give a general idea of the potential sediment transport capabilities of the Salt River. The following major assumptions were made: 1) Supply of sediment is equal to the calculated transport capacity, 2) The majority of sediment is transported as bed load, 3) The available sediment size distribution is typical, 4) The channel slope is 0.4% (0.004 ft/ft).

7. All other criteria established in Alternate B is to remain the same.

D. Partial Development and Combined Floodways

In the initial stages of development, it may not be practical to construct a floodway the entire 40 miles (or even from central Phoenix to Granite Reef). Several prime areas exist where construction could begin if upstream flood control is in place. This may require the modification or combination of parts of the first two alternatives presented herein. Two principal locations are as follows:

1) Phoenix - Central Avenue to Priest Drive.

2) Tempe - Priest Drive to Hayden Road.

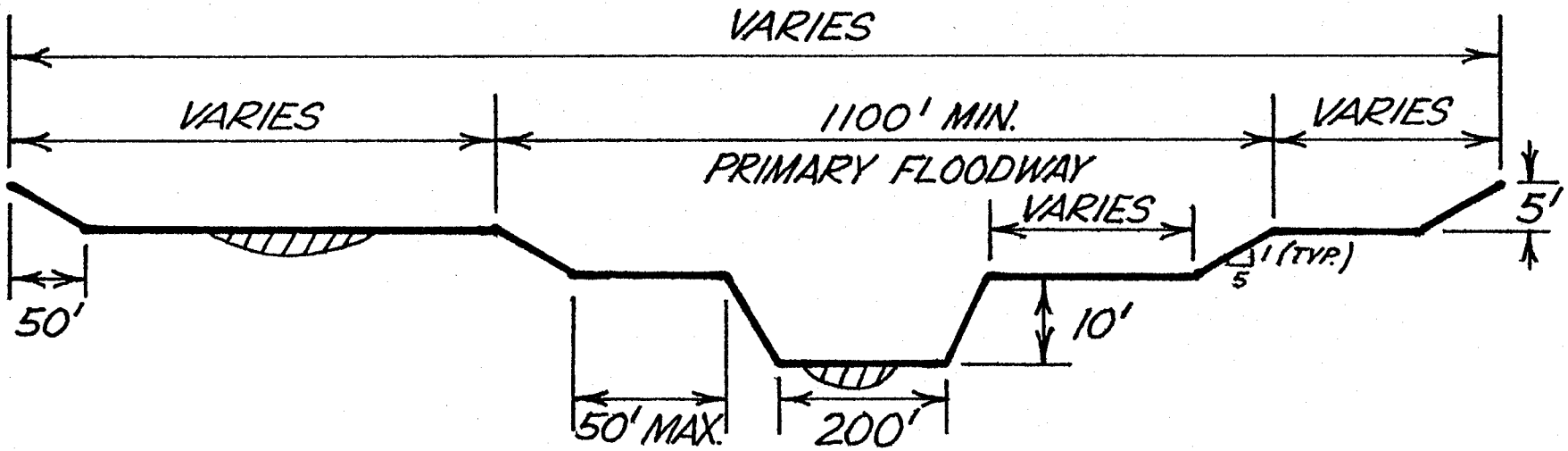
Both sites would require upstream flood protection and the installation of interim sedimentation basins.

Table 1

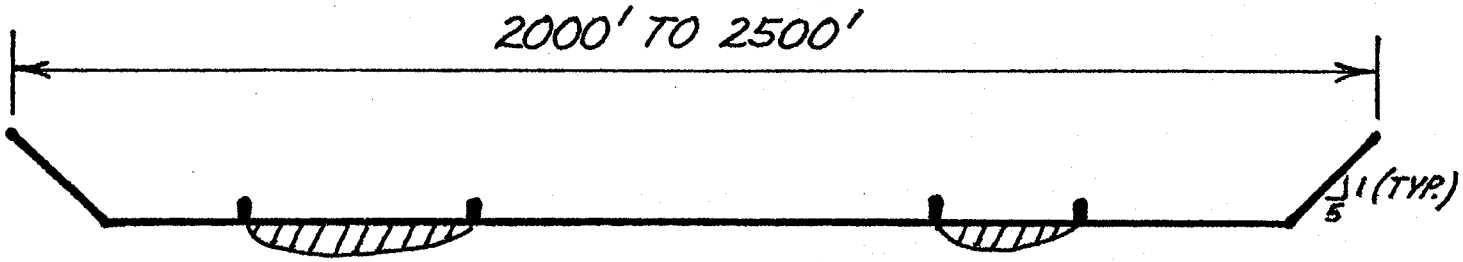
Table of Preliminary
Hydraulic Elements

Condition or Concept	100 Year Design Discharge (cfs)	Geometric Shape	Range of Width (ft)	Avg. Width (ft)	Depth of Flow (ft)	Velocity (fps)	Slope (%)	Approx Mean Dia. of Material Transported (ft)	Number of Drop Structures
Existing	200,000	Natural	550 to 5,000	3500	17 to 25	4 to 15	nearly level to 0.5	0.02-0.40	None
Brownbelt	55,000	Modified Trapezoid	2,000 to 2,500	2400	4 to 6	to 4 1/2 max.	.03 to .05	0.17	1 Approx. Every 3,000 ft.
Greenbelt W/Constant Section	55,000	Modified Trapezoid	1,100	1100	14 1/2 to 16 1/2	6 1/2 to 8 1/2	0.1 to 0.2	0.17 to 0.35	10
Greenbelt W/Widened Areas	55,000	Variable	1,100 to 4,000		(Worst condition, see Greenbelt w/Constant Section)				10
Sediment Basins	55,000	Modified Trapezoid	2,000 to 5,000		14+	approx. 1	nearly level	.004 to .007	As Needed

GREENBELT



BROWNBELT



DROP STRUCTURE EVERY
3000' TO 4000'

CONCEPT SECTIONS

PLATE 1