TECHNICAL EVALUATION OF OPTIONS FOR LONG-TERM AUGMENTATION OF THE COLORADO RIVER SYSTEM

CONJUNCTIVE USE TECHNICAL MEMORANDUM

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CONJUNCTIVE USE
TECHNICAL MEMORANDUM

EXECUTIVE SUMMARY

Purpose

The Seven Colorado River Basin States (Seven States) have authorized Colorado River Water Consultants (CRWC) to provide a Technical Evaluation of Options for Long-Term Augmentation of the Colorado River System (Project). This Technical Memorandum (TM), one of a series of TMs being prepared as part of the Project, presents results of an evaluation of the Conjunctive Use option.

Scope

The TMs are the second step in an iterative process to develop, screen, and evaluate long-term water supply augmentation options. The TMs build upon and expand White Papers developed during the initial weeks of the evaluation process.

Conjunctive use is a good management tool for addressing drought and emergency conditions and could provide flexibility under conditions of climate change. The conjunctive use option currently defined in preliminary studies carried out on this project is expanded herein to focus on interstate options within the Lower Basin states. The focus is on establishing an interstate water bank (and use of existing water banks) for water that would allow any Lower Basin state to draw upon it. Conjunctive use in the Upper Basin is not considered in the scope of this TM. Only conjunctive use in the Lower Basin will be considered through the Seven States process.

Findings

A summary of the findings relative to this conjunctive use alternative is provided in Table ES-1.

Table ES-1 Summary of Findings Related to Conjunctive Use Option	
Parameter	**Findings**
Location of Supply	Water can come from water rights available from any of the Lower Basin States and it could be stored in Arizona and California groundwater basins.
Quantity of Water Potentially Available	For the examples provided herein, potentially 2,800,000 acre-feet (AF) of water could be stored and recovered over the next 20 to 30 years (annual quantity 8,000 to 40,000 AFY). The ultimate potential is much greater if the scope is expanded beyond the examples given herein.
Water Quality	Water quality is expected to meet the end users' needs based on the planned operations of the conjunctive use projects.
Technical Issues	No major technical issues.
General Reliability of Supply	Once the water is banked, this supply option is reliable. The ability to bank water is dependent on the actual availability of the surface water and the ability to convey the water to the groundwater banking location. This is an efficient way to store surplus water for later use. However, it should be noted that this is not a perpetual water supply.
Environmental Issues	Environmental issues are not expected to be significant, as most of the potential conjunctive use projects are expansions of existing projects, some of which are ready to be implemented immediately
Permitting Issues	Permitting issues are not expected to be significant, as most of the potential conjunctive use projects are expansions of existing projects, some of which are ready to be implemented immediately.
Cost	Detailed capital and annual costs are included in this TM. An independent memorandum calculates the unit cost of these alternatives and compares the findings to other augmentation concepts. The costs herein do not include the cost for water and the operational costs to deliver water, so these costs would be "on top of the normal cost" for water. In addition, all costs are subject to negotiation between those interested parties.

Conclusions

The conclusions drawn from this TM are as follows:

- There is significant potential for conjunctive use in the Lower Basin States

- Conjunctive use, and more specifically interstate water banking, can be implemented relatively soon through expansion of Arizona Interstate Water Banking agreements or acquisition of capacity in the Semitropic Stored Water Recovery Unit. These two alternatives represent a combined storage capacity of over 1.35 million acre feet (MAF) and, based on the possible availability of water over the next 15 years, over 1.8 MAF of water that could be cycled through storage over the next 25 to 30 years.

- Expansion of interstate water banking in California represents significant opportunities to develop reliable supplies at costs expected to be competitive with other potential interstate water banking operations.

- Development of interstate water banking programs in several different locations, using multiple sources of water, would be useful in potentially mitigating the effects of climate change on water supplies

1.0 INTRODUCTION

1.1 Overview

This section describes Project objectives, briefly discusses the program framework within which the evaluation of long-term augmentation options is proceeding, and presents overall Project methodology. Also provided are a brief description of how this TM is organized, a list of abbreviations and acronyms used, and information about the references cited herein.

1.2 Project Rationale (Objectives)

Separate studies and investigations have projected an increase in demands for Colorado River system water and a reduction in long-term runoff of the Colorado River. As part of their proactive response to this scenario, the Seven States have authorized CRWC to provide a technical evaluation of long-term augmentation options. The States will supplement the technical evaluations with legal, administrative, and/or institutional considerations. All phases of the evaluation are being conducted in close coordination with the States and with the two regional offices of the U.S. Bureau of Reclamation (Bureau).

1.3 Other Ongoing Water Management Efforts

The evaluation of long-term options focuses on both previously-identified concepts and applications of new technology or management options. The evaluation was begun in parallel with the Bureau's development of Lower Basin Shortage Guidelines and Coordinated Management Strategies for Lake Powell and Lake Mead under Low Reservoir Conditions. It also should be noted that each of the Seven States has comprehensive water management programs. Concepts being developed under these independent programs will not be evaluated through the Seven States process.

1.4 Methodology

Evaluation of options is an ongoing and iterative process. In the first phase of the evaluation, White Papers were developed for 12 potential long-term augmentation options developed by CRWC in concert with the Seven States. In parallel with White Paper preparation, the CRWC team met with representatives of each State, the Bureau's two regional offices, and other interested parties. A password-protected Project Website was developed, an Expert Panel was convened, and a workshop was held with the Project's Technical Committee. The workshop focus was on the 12 White Paper options and three additional options suggested by the Expert Panel. Grouped by the purpose they achieve and the benefit provided, the initial options were:

- Firm up supply/reduce shortages: Conjunctive use, reservoir evaporation control, vegetation management, weather modification, stormwater storage, and additional storage.

- New supplies. Basin imports/reduction of exports through exchanges, brackish water desalination, coal bed methane produced water, seawater desalination, and water imports using ocean routes.

- Increase water use efficiency/exchange. Reduction of power plant consumptive use, agricultural and urban water reuse, agricultural and urban transfers, and accelerated urban water conservation.

During the workshop with the Technical Committee and a subsequent meeting with the Project Principals, six options were selected for more detailed evaluation at the TM level: brackish water desalination, conjunctive use, ocean water desalination, river imports and exports, stormwater storage, and vegetation management. This TM describes the Conjunctive Use option.

1.5 Technical Memorandum Organization

This TM is organized as follows: Section 1 presents an overview of the Conjunctive Use Alternative and findings relative to this alternative; Section 2 presents a number of conjunctive use projects as examples of projects that could be developed, including potential capacity and costs associated with these projects.

1.6 Abbreviations and Acronyms

The following abbreviations and acronyms are used in this TM.

AF	acre-feet
AFY	acre-feet per year
AMA	Active Management Area
AWBA	Arizona Water Banking Authority
Bureau	U.S. Bureau of Reclamation
CAGRD	Central Arizona Groundwater Replenishment District
CAP	Central Arizona Project
CAVSARP	Central Avra Valley Storage and Recovery Project
CAWCD	Central Arizona Water Conservation District
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CPI	Consumer Price Index
CRWC	Colorado River Water Consultants
CRCN	Colorado River Commission of Nevada
ENR CCI	Engineering News Record Construction Cost Index
GSV	Groundwater Savings Facilities
ICUA	Intentionally Created Unused Apportionment
ISG	Interim Surplus Guidelines
IWBA2001	Interstate Water Banking Agreement dated 2001 Among the Arizona Water Banking Authority, Southern Nevada Water Authority and Colorado River Commission of Nevada

IWBA2005	Amended Interstate Water Banking Agreement dated 2005 Among the Arizona Water Banking Authority, Southern Nevada Water Authority and Colorado River Commission of Nevada
LTSC	Long-Term Storage Credits
MAF	million acre feet
MWD	Metropolitan Water District of Southern California
NEPA	National Environmental Policy Act
OBMP	Optimum Basin Management Plan
O&M	Operations and Maintenance
PEIR	Programmatic Environmental Impact Report
Project	Technical Evaluation of Options for Long Term Augmentation of the Colorado River System
SAVSARP	South Avra Valley Storage and Recovery Project
Secretary	Secretary of the U.S. Department of the Interior
Seven States	Seven Colorado River Basin States
SNWA	Southern Nevada Water Authority
SWSD	Semitropic Water Storage District
SWP	State Water Project
TM	Technical Memorandum
USF	Underground Storage Facility

1.7 References

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2.0 TECHNICAL DISCUSSION

2.1 Overview

This section presents a summary of the White Paper on Conjunctive Use. Conjunctive use is a good water management tool for addressing drought and emergency conditions and could provide flexibility under conditions of climate change. Conjunctive use is the coordinated management of surface water and groundwater in a way that the combined yield and reliability are greater than when they are managed independently. Most commonly, surface water is used during wet periods and groundwater during dry periods, and surplus flows of surface water that would not otherwise be used to satisfy water supply or ecosystem needs are diverted and used to recharge local groundwater basins. This surplus water is then available for later withdrawal to meet peak, emergency, or drought conditions. In effect, the local groundwater basin is used as an additional storage reservoir to increase the overall yield of available surface water supplies. This groundwater storage is a supplement to, not a replacement for, surface water storage throughout the Basin. Water banking is one form of conjunctive use that involves storage of water through direct or in lieu recharge, for retrieval in some future period to meet increased demands or to protect against droughts. Currently, water banking is implemented in all Lower Basin States. Arizona operates an Interstate Water Bank, where water is stored through interstate agreements with Nevada and California. The Metropolitan Water District of Southern California (MWD) and Southern Nevada Water Authority (SNWA) have entered into a Storage and Interstate Release Agreement through which MWD stores water for SNWA.

This TM explores options for developing additional interstate water banking though expansion of uses of existing water banking programs or development of new water banks. Schedule and budget constraints do not allow exploration of all options that are potentially available. This TM focuses on expansion of the Arizona Interstate Water Bank, use of established water banking projects in California, and discussion of the Metropolitan Water District of Southern California Hayfield Groundwater Storage Project, which has been put on indefinite hold because of drought conditions on the Colorado River. This focused look will provide the States a more in-depth look at the potential benefits of conjunctive use and potential costs of implementing this option. In addition, these specific options have been selected for presentation because they could be implemented in a relatively short time frame should there be interest in proceeding with these options.

This TM presents Water Banking alternatives in Arizona and California. All alternatives are evaluated in terms of location of supply, technical issues (quantity of storage available, recharge capacity, extraction capacity, water quality, and reliability), environmental and permitting issues, and costs. This TM builds on the findings of preliminary studies completed earlier in the project. These findings are summarized in Table 2-1.

Table 2-1 Summary of Findings Related to Conjunctive Use Option	
Parameter	**Findings**
Location of Supply	Throughout the area that Colorado River water is delivered, plus potential for water exchanges between entities that obtain imported water from other sources
Quantity of Water Potentially Available	100s of thousands to over 1 million acre feet per year (AFY).
Water Quality	Expected to meet water quality requirements of end uses
Technical Issues	Site-specific but no fatal flaws
General Reliability of Supply	Highly reliable as this is the purpose of conjunctive use programs.
Environmental Issues	Site-specific depending on specific project implementation and site-specific conditions. May provide significant environmental benefits.
Permitting Issues	Variable by State and locality
Cost	Highly variable, ranging from $10's per AF to over $1,500 per AF depending on the specific circumstances. Expected range is from $400 per AF to $700 per AF.

During October 2006, the White Paper was reviewed by the Expert Panel, the Technical Committee, and the Project Principals. This TM reflects the review comments by focusing on Interstate Water Banking opportunities in Arizona and California, and presenting project costs for example programs.

2.2 Conjunctive Use (Water Banking) Alternatives

Interstate water banking is a proven alternative in the Lower Basin States. The Arizona Water Banking Authority (AWBA) stores water on behalf of SNWA through interstate water banking agreements. This TM explores the potential for expanding this water banking program. Intrastate water banking is implemented in California as described in the White Paper on conjunctive use. A number of successful water banks exist and many additional water banks are under development. This TM focuses on two water banks that are marketing water banking capacity and a water bank that was under development by MWD, referred as the Hayfield Groundwater Storage Project. Discussion of water banks in California will provide a foundation for further discussions should the States be interested in pursuing this option further.

Figure 2-1 shows the general location of water banking projects in the Lower Basin States addressed in this TM. Water banking in Arizona is widely distributed across the Maricopa-Pinal-Pima county area, so this entire tri-county area is identified in Figure 2-1.

Explanation

- Semitropic Water Storage District
- Chino Groundwater Basin
- Hayfield Groundwater Storage Project
- **2** Phoenix Active Management Area
- **3** Pinal Active Management Area
- **4** Tucson Active Management Area

Location of Potential Interstate Conjunctive Use Water Banking Programs in the Lower Basin States

The Seven Colorado River Basin States

Figure 2-1

2.2.1 Arizona Interstate Water Bank Expansion.

This alternative involves expansion of interstate water banking in Arizona in order to create additional supplies to Colorado River Basin States. Arizona has an allocation of 2.8 million acre-feet per year (AFY) of Colorado River water in normal years under the 1964 decree in Arizona v. California. Arizona was not using its full allocation of Colorado River water, and the unused portion was being utilized by California. Water demand projections indicated that Arizona would not begin using its full allocation until about 2030. The AWBA was created in 1996 to store unused Arizona Colorado River water to meet future needs. Interstate water banking was authorized, among other purposes, to assist Arizona in paying for storage of its unused Colorado River allocation (AWBA, 2006a).

2.2.1.1 Summary of Existing Arizona Interstate Water Banking Programs.

Nevada, specifically the Southern Nevada Water Authority (SNWA), stores Colorado River water in Arizona through Agreements with the AWBA.

2.2.1.1.1 MWD Water Banking Program.

MWD entered into a Demonstration Agreement with the Central Arizona Water Conservation District (CAWCD) in 1992, which was amended in 1994 and approved by the Secretary of the Department of the Interior of the United States of America (Secretary). This agreement was for demonstrating the feasibility of CAWCD storing Colorado River water in central Arizona for the benefit of an entity outside of Arizona (note that the AWBA was not created until 1996, which is now the Arizona entity responsible for interstate water banking agreements). CAWCD created 80,909 AF of long-term storage credits (LTSC) that may be recovered for MWD from 89,000 AF of Colorado River water received by CAWCD. The Demonstration Agreement calls for Arizona to create unused apportionment that would be made available to MWD under its Colorado River water delivery contract. In December 2006, MWD requested the recovery of 15,000 AF of LTSC for calendar year 2007 and outlined a process for recovery of the remainder of the LTSC, which was agreed to by the CAWCD and AWBA (MWD, 2006). The AWBA presented its recovery plan for the 15,000 AF and creation of Intentionally Created Unused Apportionment (ICUA) in 2007 as a part of its 2007 Annual Plan of Operation (AWBA, 2006c). CAWCD has made arrangements with irrigation districts to pump stored water from existing agricultural irrigation wells in Pinal County, which will deliver banked water for use by the farmers instead of direct-delivered Colorado River water and free up Colorado River water for delivery and use by MWD (Dozier, 2007). Also, a credit exchange with the Central Arizona Groundwater Replenishment District (CAGRD) at the Tonopah Desert Recharge Project will make Colorado River water available for delivery and use by MWD.

2.2.1.1.2 SNWA Water Banking Program.

On July 3, 2001, the Agreement for Interstate Water Banking (IWBA2001) was executed among the AWBA, SNWA and the Colorado River Commission of Nevada (CRCN).

The IWBA2001 required the AWBA to use its best efforts to store water in Arizona sufficient to develop an aggregate total of 1.25 MAF of long-term storage credits. These storage credits would later be recovered to develop ICUA for Nevada as a temporary water supply, while Nevada developed more long-term permanent water sources. Nevada would pay the cost of water delivery and storage in addition to all costs associated with recovery of the LTSC (AWBA, 2006c).

The IWBA2001 was negotiated recognizing the surplus provisions of the Interim Surplus Guidelines (ISG) published by the United States Department of the Interior, which controlled the operation of the Lower Colorado River system through 2016. Nevada anticipated that its water needs would be met through 2016 by surplus water made available through the ISG and after 2016, it would call on its LTSC in Arizona. In 2004, surpluses under the ISG were not available because of drought conditions on the Colorado River system and projected storage in Lake Mead was below the critical threshold elevation established in the ISG. Nevada amended the IWBA2001 with the AWBA in 2005 (referred to herein as IWBA2005) to assure access to 1.25 MAF of LTSC. The amendments included that Nevada would make a $100 million payment to Arizona above the cost of actual water delivery, storage and recovery, to ensure that Arizona could acquire additional water resources, if conditions warranted, $230,000,000 will be paid in ten payments of $23,000,000 beginning in 2009 through 2018 to pay for costs for water delivery and storage (note that these payments are not the full extent of payments, as Nevada is responsible for actual costs), that water other than Colorado River water could be the source of credits, a set schedule for recovery of LTSC, and sufficient supply would be recovered to allow Nevada to use 340,000 AF during a declared shortage on the Colorado River (AWBA, 2006). AWBA has stored 386,000 AF under the IWBA2005 at an actual cost to date of $71.8 million, for an average cost of $186/AF (AWBA, 2006c). This cost did not include costs for recovery of the stored water, as described below.

2.2.1.2 Expansion of Arizona Interstate Water Banking Programs.

There is potential to expand Arizona's interstate water banking program for the mutual benefit of Arizona and the States (Henley, 2007). Arizona has substantial storage capacity available in its overdrafted groundwater basins, is projected to have water demands less than its full Colorado River allocation of 2.8 MAF, have delivery capacity available to deliver water to storage, and have recharge capacity available to put Colorado River water into storage. Assessment of recovery capacity has begun by the CAWCD, but recovery is not expected to be a constraint. However, to date, recovery costs have not been developed by the AWBA (or entities that potentially will provide recovery to facilitate creation of ICUA).

Millions of acre feet of groundwater have been removed from storage in Maricopa, Pinal, and Pima counties, in which the Phoenix, Pinal, and Tucson AMA's are located. Estimates of available dewatered storage exceeds, by millions of acre-feet the storage capacity that is needed to meet Arizona's intrastate groundwater basin storage requirements. Therefore, interstate water banking programs consisting of several million acre-feet of storage above projected storage requirements (including the SNWA interstate water banking program) are feasible (Henley, 2007).

The AWBA develops a 10-year operating plan as mandated by Arizona statute. The AWBA projects Colorado River water uses (Central Arizona Project, CAP demands), average year supply, and water available for conjunctive use/water banking purposes. Table 2-2 shows projected Colorado River water supplies available to the AWBA.

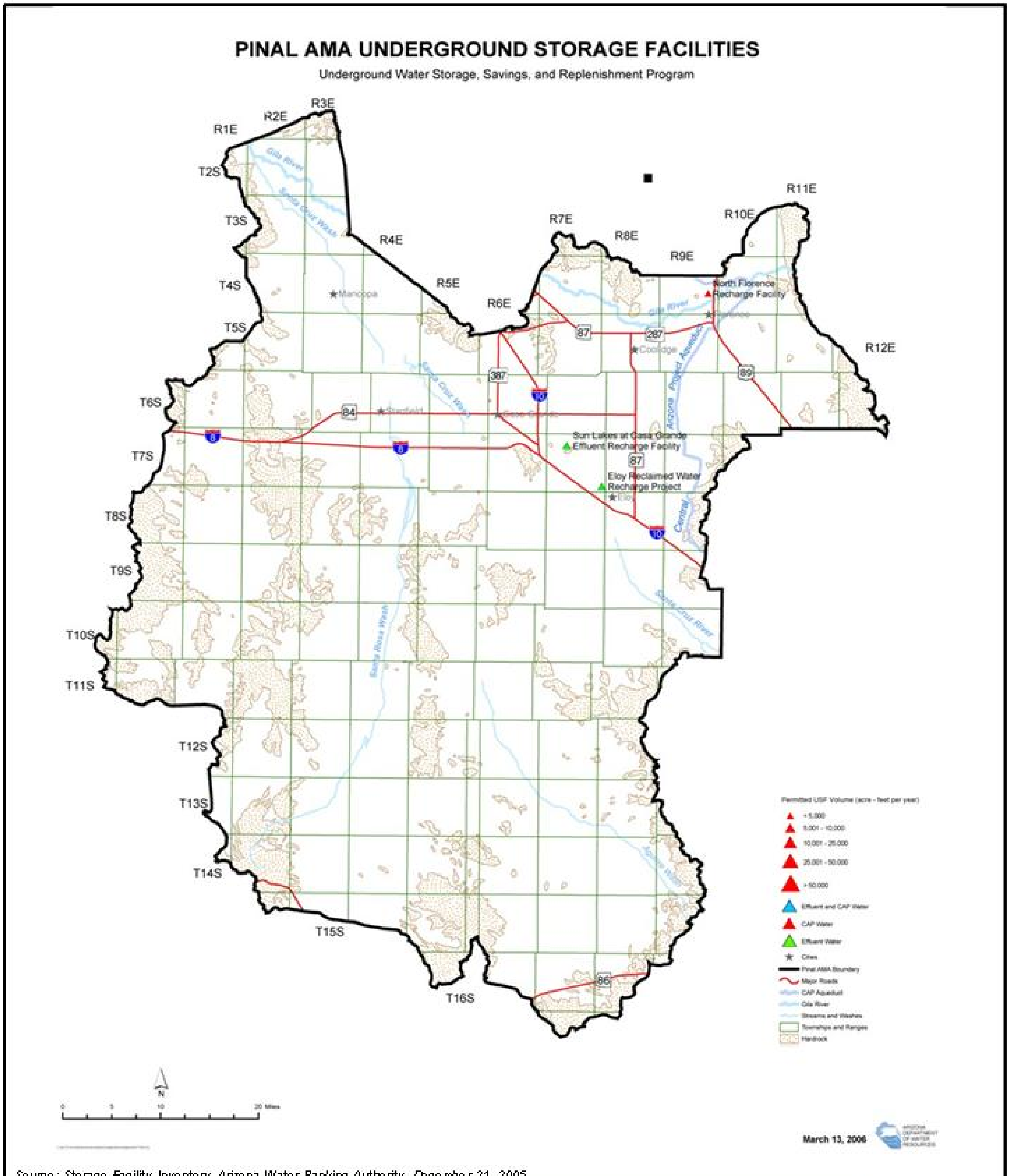
Table 2-2
Water Supplies Available to AWBA
CAP DELIVERY SCHEDULE
(Acre-feet)

Year	**CAP Demands**				**Average Year Supply** [5]	**Available for AWBA** [6]
	M&I[1]	Indian[2]	Ag[3]	Total[4]		
2007	385,951	102,300	400,000	903,251	1,525,000	621,749
2008	368,835	106,800	400,000	890,635	1,525,000	634,365
2009	374,836	121,800	400,000	911,636	1,525,000	613,364
2010	422,937	142,328	400,000	980,265	1,525,000	544,735
2011	434,384	161,928	400,000	1,011,312	1,525,000	513,688
2012	420,625	179,393	400,000	1,015,018	1,525,000	509,982
2013	433,652	204,493	400,000	1,053,145	1,525,000	471,855
2014	461,834	204,493	400,000	1,081,327	1,525,000	443,673
2015	471,086	204,493	400,000	1,090,579	1,525,000	434,421
2016	483,215	204,493	400,000	1,102,708	1,525,000	422,292

(1) Includes M&I, CAGRD, CAGRD replenishment reserve, Indian M&I lease and M&I incentive water.
(2) From settlement discussions.
(3) Based on current agricultural pool policy, includes 32,537 for Harquahala.
(4) Includes secondary excess uses of 15,000 AF per annum 2007 through 2016.
(5) Based on average year delivery of 1,600,000 AF per year minus losses.
(6) Average year supply minus CAP demands; AWBA last priority for intrastate use.
Source: AWBA 2005 Annual Report, dated July 1, 2006, Appendix B

The AWBA also projects the quantity of Colorado River water available for interstate banking. CAP water available to AWBA is first allocated to meet intrastate water banking priorities by individual CAP contractors, subcontractors and the AWBA. These other requirements include replenishment obligations within Arizona Active Management Areas, individual entitlement holders that desire to bank water in order to firm their water supplies, and AWBA intrastate banking activities. The AWBA projects CAP supplies available for banking beyond Arizona's intrastate requirements. Table 2-3, Column 2, summarizes AWBA's projections of available CAP supplies through 2016.

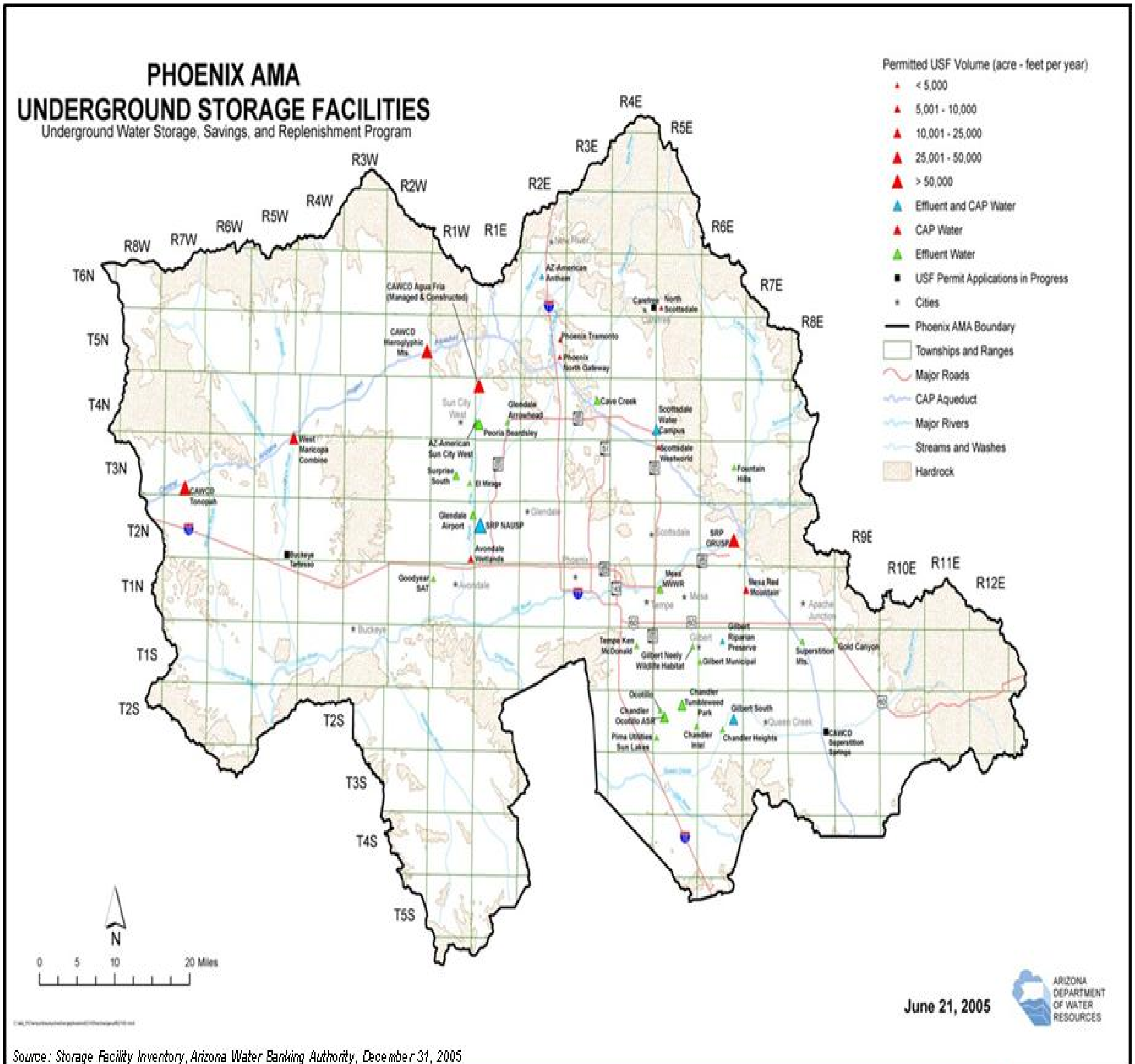
The AWBA also coordinates with operators of Underground Storage Facilities (USF) and Groundwater Savings Facilities (GSF, see White Paper on Conjunctive Use to get more detailed descriptions of these recharge options) to project the available capacity to put water into LTSC accounts. Figures 2-2 through 2-4 show locations of USFs and GSFs in the three AMAs.



Underground Storage Facilities in Pinal AMA

The Seven Colorado River Basin States

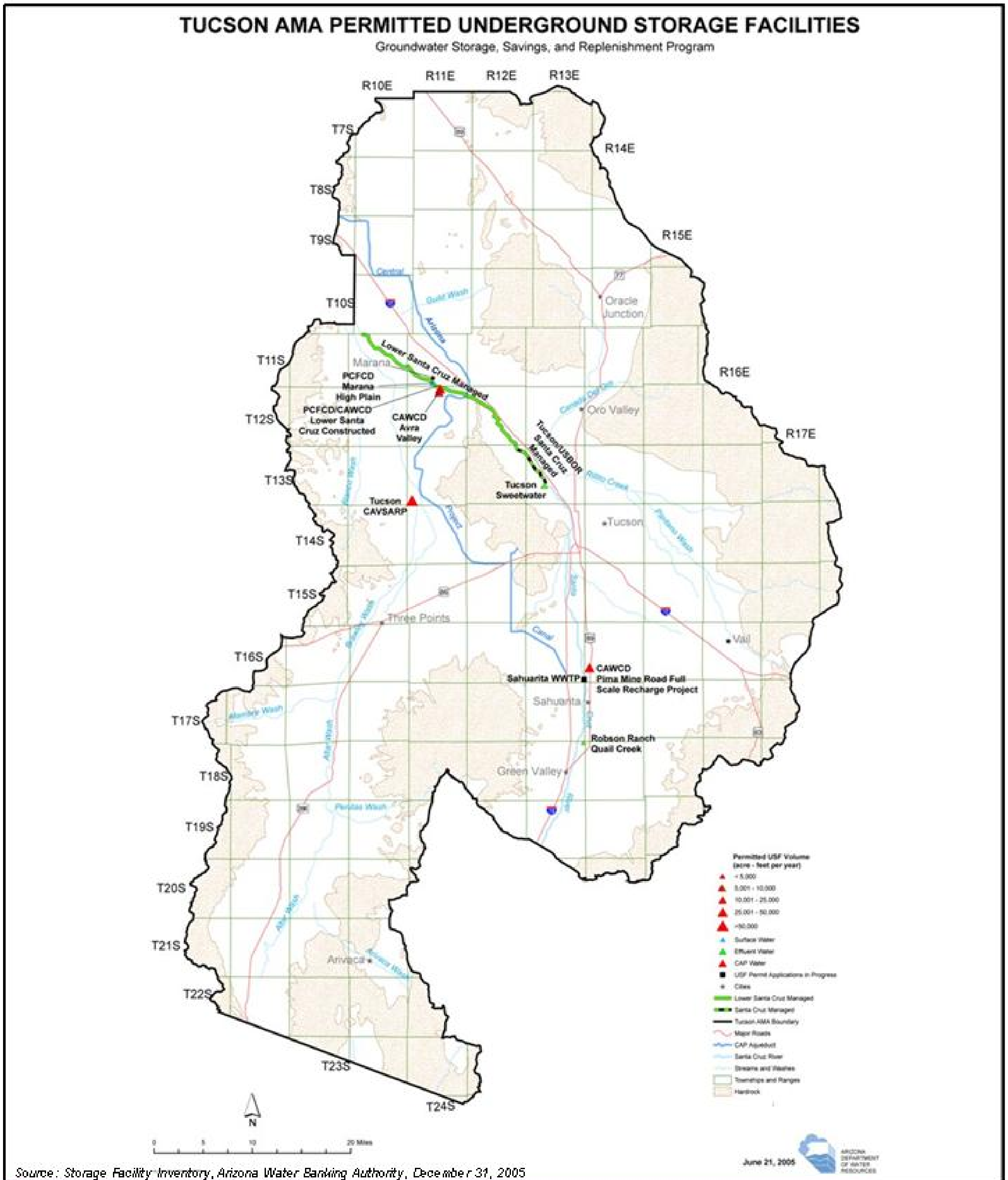
Figure 2-2



Underground Storage Facilities in Phoenix AMA

The Seven Colorado River Basin States

Figure 2-3



Underground Storage Facilities in Tucson AMA

The Seven Colorado River Basin States

Figure 2-4

Table 2-3, Column 3 shows the projected recharge capacity available to the AWBA. The capacity shown is slightly less than the available water supplies for storage; however, new USF facilities are under construction or planned, so this shortage of capacity is not expected to be difficult to resolve. Column 4 shows the potential Colorado River water supplies that could be used to expand interstate water banking in Arizona.

Table 2-3
Potential CAP Water Supply Available for Expanded Interstate Water Banking

Potential Credits Developed for Interstate Water Banking[1]
(Acre-feet)

Year	Available CAP Supplies[2]	Available AWBA Recharge Capacity[3]	Remaining Supply[4] Available to Expand Interstate Water Banking	Interstate Credits[5]
Pre-plan[6]				423,019
2007	305,591	257,352	160,977	136,428
2008	274,470	221,710	132,001	134,405
2009	258,765	226,495	122,079	128,950
2010	181,036	208,898	37,365	135,539
2011	261,248	326,863	121,567	131,775
2012	111,929	184,593	403	105,213
2013	142,178	238,429	84,226	54,671
2014	71,426	199,518	71,426	0
2015	125,682	261,434	125,682	0
2016	156,758	305,580	156,758	0
Total			1,012,484	1,250,000

Footnotes:
(1) The AWBA has an obligation to have 1,250,000 acre-feet of credits for the SNWA.
(2) Water available for Interstate Banking is calculated by subtracting the water delivered and stored by individual subcontractors, contractors, and the AWBA for intrastate water banking from the Total Available Supply (see Appendix B).
(3) Reflects the unused capacity available to the AWBA at USFs and GSFs in the Phoenix, Pinal, and Tucson AMAs as well as capacity available from other storage facilities permitted by the AWBA outside of the AMAs. Additional capacity may be available at individual facilities based on the utilization by individual water storage permit holders.
(4) Remaining supplies after subtracting the water delivered and stored by individual subcontractors, contractors, and the AWBA for intrastate water banking and water delivered for interstate water banking.
(5) Based on the Available Supplies or the Available AWBA Capacity, whichever is less, resulting stored water multiplied by an average 6% cut and loss factor.
(6) Cumulative totals for 1997-2006; 2006 credits estimated based on projected deliveries.

Source: AWBA 2005 Annual Report, dated July 1, 2006, Appendix G

The CAP has delivery capacity to deliver 1.6 MAF annually into Central Arizona, with about 3,000 cubic feet per second delivery capacity, where most of the groundwater storage capacity is available to the AWBA (Henley, 2007). This delivery capacity is largely constrained by the CAP tunnel, so any delivery capacity above 3,000 cfs would require substantial investments and likely substantially increase the cost of water banking should this become necessary.

Recovery of water banked for interstate purposes has not been addressed directly, except in the MWD Demonstration Agreement as described above. AWBA and the CAWCD, in coordination with the Arizona Department of Water Resources, are in the process of developing a recovery plan and costs of recovery. Recovery options are wide ranging. For example, in the Tucson AMA, the City of Tucson does not take direct delivery of CAP water. The City recharges all of its entitlement and extracts the stored water for delivery to its residents and customers. Therefore, the City could make its extraction wells available to the interstate water bank at the cost of capital recovery (e.g., a short term lease), plus cost of operations and maintenance (O&M), and energy costs. So, instead of the City pumping its own water, in a year that there is a call for recovery of water stored under an interstate banking agreement, the City would recover banked water and leave its own water in the ground for recovery in "normal" years. In the Phoenix AMA, the City of Phoenix takes delivery of its CAP water, treats it and delivers this treated water to its residents and customers. So, in the Phoenix AMA, a new wellfield would likely be necessary to provide for recovery of any water stored under an interstate water banking agreement. Pinal County is not expected to have significant excess extraction capacity for recovery of water stored under an interstate water banking program, so a new wellfield(s) would be needed to recovery banked water. SNWA has about 80 percent of its water stored in the Pinal AMA and 20 percent stored in the Tucson AMA. SNWA will be responsible for costs associated with recovery of water stored on its behalf under one of these or some similar recovery alternative (Henley, 2007).

The cost to expand interstate water banking in Arizona would be subject to negotiation. The following assumptions are made for purposes of estimating costs of an expanded interstate water banking program: 1) no new facilities are required to divert and deliver CAP water to USFs in Central Arizona, 2) CAWCD charges for interstate water banking would apply for delivery of CAP water to USFs, 3) CAWCD charges apply for underground water storage capital and underground storage O&M, 4) estimates for recovery costs (including new wells, O&M, and energy), and 5) administrative charges to administer the program, which will be assumed to equal those charges currently paid by SNWA to the AWBA, which is about $23,000 per year (Henley, 2007). Estimates of cost components 1, 2, 3, and 4 are readily available through 2012 through the CAWCD's published rate schedule and unpublished projections through 2016 as well as AWBA's administrative fee. Tables 2-4 and 2-5 show the projected costs for banking the water. Table 2-6 presents the costs for recovering the water.

Table 2-4 Projected Costs of Delivery, Recharge and Storage of CAP Water Under An Expanded Arizona Interstate Water Banking Program ($/Acre-Foot)										
Cost Component	**Year $/Acre-Foot**									
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Delivery Rate for AWBA Interstate Recharge	210	217	233	217	154	162	164	171	182	191
Underground Water Storage Capital Charge										
Phoenix AMA	15	15	15	15	15	15	15	15	15	15
Tucson AMA	9	9	9	9	9	9	9	9	9	9
Underground Water Storage O&M Charge										
Phoenix AMA	8	8	9	10	11	13	15	17	19	21
Tucson AMA	13	15	17	19	21	23	25	27	29	31
AWBA Administrative Fees										
Annual total, not per acre-foot	23,000	23,000	23,000	23,000	23,000	23,000	23,000	23,000	23,000	23,000

Notes:
1. All rates, except AWBA Administrative fees, through 2012 come from CAP 2007 web site. CAP fees from 2013 through 2016 are from Dozier, 2007.
2. AWBA administrative fees are from Henley, 2007.

Table 2-3 indicates that potentially 1,012,484 AF of Colorado River water are available for an expanded interstate banking program. The cost components given in Table 2-4 are used to estimate the costs of delivering and storing this water under an expanded interstate water banking program. Table 2-5 summarizes this cost estimate. The net LTSC created after losses, including transmission and "cut to the aquifer," as required by State statute is 931,485 AF.

Table 2-5 Estimated Delivery and Storage Cost for Expanded Interstate Water Bank In Arizona				
Year	Colorado River Water Diverted (Acre-Feet)1	Annual Cost[2]	Adjusted LTSC (Acre-Feet)[3]	Cumulative Total Credits (Acre-Feet)
2007	160,977	$ 37,450,153	148,098.84	148,098.84
2008	132,001	$ 31,769,241	121,440.92	269,539.76
2009	122,079	$ 31,519,382	112,312.68	381,852.44
2010	37,365	$ 9,121,378	34,375.80	416,228.24
2011	121,567	$ 22,148,194	111,841.64	528,069.88
2012	403	$ 100,376	370.76	528,440.64
2013	84,226	$ 16,531,296	77,487.92	605,928.56
2014	71,426	$ 14,665,330	65,711.92	671,640.48
2015	125,682	$ 27,421,676	115,627.44	787,267.92
2016	156,758	$ 35,920,582	144,217.36	931,485.28
Total	1,012,484	$ 226,647,607	931,485	

Notes:
1 Quantities are from Table 2-3
2 Annual cost based on delivery and storage cost components given in Table 2-4. Assumes that half of the water will be stored in the Tucson AMA and half in the Phoenix AMA. CAWCD fees are projected to remain the same from 2012 to 2016. AWBA administrative fee of $23,000/year is assumed to remain constant through the period. The present worth costs are calculated to be $178,082,595 based on a 4% escalation of the AWBA administrative fee and a 5% discount rate
3 Adjusted LTSC is the quantity of delivered and stored water reduced by 8%, which is the estimated transmission losses of 3% and “cut to aquifer loss” of 5%.

The AWBA has not yet recovered water from the water bank; however, the MWD has notified the CAWCD that it wishes to recover its banked water under their Demonstration Agreement (MWD 2006). CAWCD has made arrangements with irrigation districts in Pinal County to recover this water by using excess well capacity and refurbishing wells that are offline and bringing them online for purposes of recovering the banked water (Dozier, 2007).

CAWCD has not developed a recovery fee for banked water under the Interstate Banking Agreement with SNWA. CAWCD expects to develop additional recovery programs with irrigation districts, similar to the one developed to recover MWD's banked water under the Demonstration Agreement. CAWCD may install their own well fields or partner with other cities and agencies for purposes of recovering banked water. CAWCD expects that its recovery rate will be comparable to its CAP delivery rate for Municipal and Industrial Long Term Subcontracts, which is $87 per AF in 2007, projected to be $125 per AF in 2017, and escalate by about $5 per year thereafter (Dozier, 2007). These rates will be based on actual capital costs of facilities, operations and maintenance, and power, and subject to negotiation. For purposes of this TM, recovery costs of an expanded Arizona Interstate Water Banking program have been estimated based on CAWCD preliminary projections of recovery costs.

Table 2-6
Estimated Recovery Cost for Expanded Interstate Water Bank In Arizona

Year	Colorado River Water Recovered (Acre-Feet)[1]	Annual Recovery Cost[2]	Cumulative Total Credits (Acre-Feet)
2017	100,000	$ 12,523,000	831,485
2018	100,000	$ 13,023,000	731,485
2019	100,000	$ 13,523,000	631,485
2020	100,000	$ 14,023,000	531,485
2021	100,000	$ 14,523,000	431,485
2022	100,000	$ 15,023,000	331,485
2023	100,000	$ 15,523,000	231,485
2024	100,000	$ 16,023,000	131,485
2025	100,000	$ 16,523,000	31,485
Total	900,000	$ 130,707,000	

Notes:
1 Recovery quantities are assumed recovery capacity
2 Annual recovery cost based on recovery costs anticipated by CAWCD projected to start at around $125/AF in 2017 and escalate by $5 per year. AWBA administrative fee of $23,000/year is assumed to remain constant through the period. Cost by party to receive ICUA is not accounted for in these costs. The present worth costs are estimated to be $62,749,040 assuming that AWBA administrative fee escalates 4.5% per year and a discount rate of 5% is used over the period.

The total present worth cost value of an expanded Arizona interstate water bank, as described in the preceding tables is $240,831,636 over the next 20 years. The average cost per acre-foot of water cycled through the water bank (900,000 AF) is approximately $268 per AF based on the present worth costs within approximately a 20-year period. However, it should be noted that this cost is on top of all normal costs associated with taking delivery of Colorado River water once the ICUA is created.

It is expected that expansion of interstate water banking in Arizona can be implemented in a very short period of time. A number of Arizona agencies are considering their options for participating in interstate banking as a way of offsetting their costs of using their full CAP allocations. For example, the City of Tucson is open to partnering with the AWBA on interstate banking (Tucson Water, 2007). The following discussion provides potential opportunities for expanding interstate banking with the City of Tucson as a participant.

Tucson's total allocation of CAP water (including a recent reallocation increase of 8,606 AF) is now at 144,172 AFY. Their community is situated at the southern end of the CAP aqueduct, which traverses central Arizona, with virtually all of the other AZ allottees in between them and the Colorado River. Tucson has built their water supply infrastructure with a large amount of flexibility allowing them the options of delivering local groundwater, recovered recharged water from CAP, or direct treatment of CAP surface water to its customers. Tucson has an aggressive program of constructing infiltration basins and recovery facilities for the recharge of CAP water in the western Avra Valley within 22,000 acres of farmland the City owned for water rights purposes. Ultimately, this allows them the potential for "running the aqueduct backwards" with the prospect of implementing water banking strategies in the Tucson area which may afford others upstream to divert surface water at certain times to meet their needs. This strategy could also be extended to other Colorado River water users in the lower basin including other Colorado River water users outside of Arizona.

There are three primary options, although these are not all of them, that could present water resource banking strategies for Colorado River users. These are summarized as follows:

1. The City of Tucson is not yet at full use of its allocation but is ramping up according to a plan that will get it to full CAP use by the year 2011 or 2012. Local recharge facilities will be implemented to the point where Tucson can take its full allocation as early as 2008. Therefore, there may be an opportunity to partner with the City and assist it in calling up its full allocation by purchasing as much as 50,000 AF of total available water before Tucson gets up to full use of its allocation by 2012. This 50,000 AF could be stored in the Tucson basins as banked water.

2. The existing Central Avra Valley Storage and Recovery Project (CAVSARP) -- the current turnout for CAVSARP is constructed with a capacity of 80,000 AFY. If an entity was interested in investing approximately $5 million to $6 million up front to upsize the turnout to 100,000 AFY, there is the ability to bank an extra

20,000 AFY. Further, Tucson feels that there is also the potential to expand the turnout to an approximate capacity of 120,000 AFY with another $5 million to $6 million up front dollars (i.e. for an investment of approximately $12 million, about 40,000 AFY of additional water could be banked). Tucson anticipates extracting approximately 70,000 AFY for its uses under normal planning circumstances, so there does not appear to be any basic hydrologic issues or concerns for up to 10 or 20 years. According to Tucson, the cost of recharge in CAVSARP is approximately $13.17 per AF of recharge (to put water into storage). This includes all capital/administrative costs, etc. The cost of recovery is in a range of approximately $140 to $180/AF.

3. The Southern Avra Valley Storage and Recovery Project (SAVSARP) currently under construction -- The diversion at SAVSARP is sized at 140,000 AFY at the canal inlet. The first phase of basins, however, will be designed at 45,000 AFY but permitted at 60,000 AFY. Roughly 200 feet from the CAP facilities, the intake piping bifurcates with one outlet that will deliver the 60,000 AF and the other is set up with a blind flange. There would be capital costs up front to connect to the inlet piping and a need to build more basins. The cost of recharge is $13 to $18 per AF. The cost of recovery is also estimated to be $140 to $190/AF.

It should be noted that the cost for putting water into storage and recovering water are slightly higher than the CAWCD projected costs for interstate banking. So, the cost per AF for interstate banking would increase a few dollars above the average present worth costs presented earlier, based on Tucson's current cost projections for recharge, storage, and recovery.

In summary, there is immediate opportunity to expand interstate banking in Arizona, with potential of banking nearly 1,000,000 AF over the next nine to ten years. Environmental documentation or permitting issues are not anticipated as most project components are in place or available for immediate expansion. Water quality is not expected to be an issue because operation of facilities is consistent with current operations. Although water recovery plans appear feasible, these plans are not currently well defined and require further investigation.

2.2.1.3 Expansion of Arizona Interstate Water Banking Programs With A Guarantee

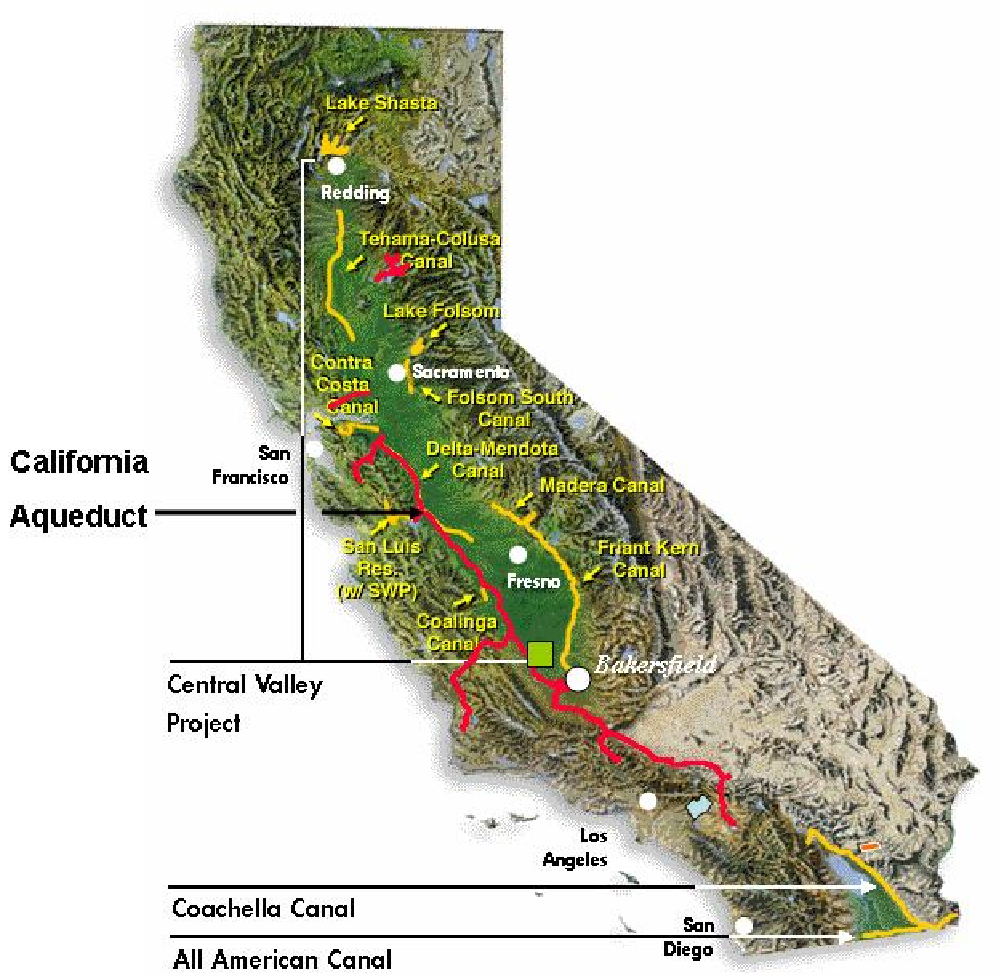
As described in Section 2.3.1.1, SNWA negotiated an arrangement with the AWBA to guarantee that 1.2 MAF of water would be available to SNWA in the event of shortages of Colorado River water. SNWA paid the AWBA $100 million for this guarantee. By agreement, if there is a Colorado River shortage and 1.2 MAF can not be banked by the time SNWA needs the water, then the AWBA would acquire water resources to meet its obligations to SNWA. The AWBA could acquire the water from any source, but the likely source would be native groundwater. The AWBA could negotiate a sale of water from entities with groundwater rights, such as agricultural land owners, etc. So, far the AWBA has put over 400,000 AF of water into storage on behalf of SNWA, so the quantity of water for which it is at risk is shrinking every year. This option of guaranteeing a water supply could be added to the interstate water banking expansion option as a way of insuring a future water supply. This option would be subject to negotiation.

2.2.2 California Interstate Water Bank Alternatives.

Three alternative water banking projects have been selected to provide examples of water banking alternatives in California: Semitropic Water Storage District (SWSD) Groundwater Banking Project ("Semitropic"), Chino Basin Water Storage Program ("Chino Basin") and MWD Hayfield Groundwater Storage Project ("Hayfield"). The Semitropic and Chino Basin projects are existing water banking projects and currently are being marketed for use. The Hayfield project is a project that MWD was implementing to store surplus Colorado River water, which was put on indefinite hold in 2004 as a result of the recent Colorado River Basin drought. MWD has completed various engineering and environmental studies and was proceeding to design and construction prior to putting the project on hold. These projects represent a small sample of the potential conjunctive use projects in California. These projects were selected because they represent real opportunities, can be implemented in a relatively short time period, identify the issues of developing an interstate water banking program in California, and are expected to provide a representative cost of this alternative.

2.2.2.1 Semitropic Water Storage District Groundwater Banking Project.

The Semitropic Water Storage District is located in the Central Valley of California, near Bakersfield, California (Figure 2-5). The SWSD developed its banking project in the mid-1990s in response to substantial groundwater overdraft and increased pumping lifts in a southern Central Valley groundwater basin. Initially, a water bank with one MAF of storage capacity was established in 1994. The SWSD established partnerships with six separate private and public entities to assist in paying for facilities to deliver, recharge water, and recover water from the water bank. The six entities and their storage allocations in AF include, MWD (350,000) Santa Clara Valley Water District (350,000), Alameda County Water District (150,000), Zone 7 Water Agency (65,000), Newhall Land and Farming Company (55,000), and Vidler Water Company (35,000). The water bank has been expanded and is open to new partners, private and public, to participate (Boschman, 2006).



Explanation

- Semitropic Water Storage District
- Chino Groundwater Basin
- Hayfield Groundwater Storage Project
- Central Valley Project
- State Water Project

Source: Presentation by Will Boschman, General Manager, Semitropic Water Storage District; ACWA Fall Conference, December 6, 2006

Location of Semitropic Water Storage District, Chino Basin, and Hayfield Groundwater Storage Projects

The Seven Colorado River Basin States

Figure 2-5

Groundwater banking is accomplished two ways: through in-lieu and direct recharge. In-lieu recharge is storing water by utilizing surface water "in-lieu" of pumping groundwater, thereby storing an equal amount in the groundwater basin. Direct recharge is storing water by allowing it to percolate directly to storage in the groundwater basin. At Semitropic, wet year and surplus water is stored in the groundwater basin primarily through in-lieu recharge. SWSD delivers surface water to farmers for irrigation in-lieu (or instead of) pumping groundwater. To a lesser extent, Semitropic also stores water through direct recharge. Throughout the SWSD service area, there are a number of recharge basins where water percolates to the groundwater basin. Whenever necessary, the "banked" water is returned to the State Water Project (SWP) to deliver to banking partners by a release of Semitropic contract entitlement or, in some cases, through "pumpback" to the California Aqueduct at 300 cubic feet per second (Boschman, 2006).

Semitropic has permitted and is ready to implement an additional 650,000 AF of storage capacity. It is actively marketing 450,000 AF of this storage capacity (200,000 AF are reserved for banking partners). This new unit is referred to as the Stored Water Recovery Unit. In addition to increasing the storage capacity, recovery capacity will be increased by 200,000 AFY for a total guaranteed pump-back capacity of 290,000 AFY. SWSD will be capable of delivering up to 423,000 AFY of dry-year yield when it adds in its entitlement exchange capacity of 133,000 AFY (Boschman, 2006).

This 450,000 AF is being sold as 150,000 shares. Each share includes 1 AFY recovery capacity, plus Lower Priority capacity on a when available basis, 3 AF of storage, plus Lower Priority capacity on a when available basis, and 0.33 AFY recharge, plus Lower Priority capacity on a when available basis. So, acquisition of all 150,000 shares would provide 450,000 AF of storage, 50,000 AFY of recharge capacity, and 150,000 AFY of recovery capacity and access to additional recharge and recovery capacity on a lower priority basis (Boschman, 2006).

The financial terms to participate in the Stored Water Recovery Unit is as follows: capital payment of $1,200/share for the first 14,999 shares and $950/share for 15,000 to 150,000 shares, a $5/share per year management fee, an $8/share per year maintenance fee, a put fee of $40/AF, a take fee of $40/AF and reimbursement for actual power costs, which is expected to range from $40/AF to $60/AF. Costs are escalated according to the Engineering News Record Construction Cost Index (ENR CCI) for the share costs and the Consumer Price Index (CPI) for the management fee, maintenance fee, and put and take fees. All costs are to be recovered, so in addition to these cost escalators, actual expenditures will be reviewed periodically that may result in adjustments to these fees to allow for recovery of all actual costs to operate the water bank (SWSD, 2004). Table 2-7 shows the annual cost of a 25-year program of put and take based on these charges. This provides for two cycles of 450,000 AF of storage for total water cycling "in and out" of 900,000 AF over the period. The 2004 costs for 150,000 shares (450,000 of storage capacity) escalated to present is $162,384,995 based on the December 2006 ENR CCI. The present worth cost of cycling 900,000 AF in and out of the bank is estimated to be $328,056,028, for a total present worth cost of $490,441,023 or $545/AF of water cycled through the water bank.

Table 2-7 Semitropic Stored Water Recovery Unit Annual Costs for a 450,000 Capacity Water Bank, Cycling 900,000 AF Over a 25-Year Period							
	Put/Take (Acre-Feet)		Annual Costs				
Year	**Put**	**Take**	**Power Cost**	**O&M Fees**	**Recharge/Recovery Fees**	**Total Cost**	**Present Worth Cost**
1	50,000		$0	$1,950,000	$2,000,000	$3,950,000	$3,761,905
2	50,000		$0	$2,037,750	$2,090,000	$4,127,750	$3,743,991
3	50,000		$0	$2,129,449	$2,184,050	$4,313,499	$3,726,162
4	50,000		$0	$2,225,274	$2,282,332	$4,507,606	$3,708,419
5	50,000		$0	$2,325,411	$2,385,037	$4,710,448	$3,690,760
6	50,000		$0	$2,430,055	$2,492,364	$4,922,419	$3,673,185
7	50,000		$0	$2,539,407	$2,604,520	$5,143,927	$3,655,693
8	50,000		$0	$2,653,681	$2,721,724	$5,375,404	$3,638,285
9	50,000		$0	$2,773,096	$2,844,201	$5,617,297	$3,620,960
10		150,000	$13,374,856	$2,897,886	$8,916,571	$25,189,313	$15,464,053
11		150,000	$13,976,725	$3,028,290	$9,317,817	$26,322,832	$15,390,415
12		150,000	$14,605,677	$3,164,563	$9,737,118	$27,507,359	$15,317,127
13	50,000		$0	$3,306,969	$3,391,763	$6,698,732	$3,552,480
14	50,000		$0	$3,455,782	$3,544,392	$7,000,175	$3,535,564
15	50,000		$0	$3,611,293	$3,703,890	$7,315,182	$3,518,728
16	50,000		$0	$3,773,801	$3,870,565	$7,644,366	$3,501,972
17	50,000		$0	$3,943,622	$4,044,740	$7,988,362	$3,485,296
18	50,000		$0	$4,121,085	$4,226,754	$8,347,838	$3,468,699
19	50,000		$0	$4,306,534	$4,416,958	$8,723,491	$3,452,182
20	50,000		$0	$4,500,328	$4,615,721	$9,116,048	$3,435,743
21	50,000		$0	$4,702,842	$4,823,428	$9,526,270	$3,419,382

	Put/Take (Acre-Feet)		Annual Costs				
Year	Put	Take	Power Cost	O&M Fees	Recharge/Recovery Fees	Total Cost	Present Worth Cost
22		150,000	$22,682,170	$4,914,470	$15,121,447	$42,718,088	$14,603,173
23		150,000	$23,702,868	$5,135,621	$15,801,912	$44,640,402	$14,533,634
24		150,000	$24,769,497	$5,366,724	$16,512,998	$46,649,220	$14,464,426
25			$0	$0	$0	$0	$0
Total	900,000	900,000	$113,111,794	$81,293,933	$133,650,301	$328,056,028	$154,362,232

Notes:
1. Assumes an amortization rate of 5%
2. An initial power cost of $60/AF in 2007
3. An escalation rate of 4.5% for annual costs, including power
4. Does not include any administrative costs beyond SWSD costs

In order to create ICUA on the Colorado River, this program would have to be operated through exchange agreements with MWD. The Semitropic project would store surplus SWP water. When there is a Colorado River shortage, MWD would call for water from the SWSD water bank. This water would be used instead of MWD's Colorado River water allocation, creating an ICUA that could be transferred to one of the other parties which use Colorado River water. Costs and priorities for use of MWD supplies and capacity in the SWP would have to be negotiated. In addition, any return of Semitropic groundwater to the California Aqueduct would need to comply with the California Department of Water Resources' Pump In Policy which seeks to protect the quality of SWP supplies.

There is a pumping cost differential between SWP and Colorado River water that would have to be recovered in the operation of this type of program. In addition, there could be scheduling conflicts between delivery of Colorado River water and SWP water, so these potential conflicts would need to be addressed in any agreements.

2.2.2.2 Chino Basin Groundwater Banking Project.

The Chino Basin is overlain by portions of Los Angeles, Riverside, and San Bernardino Counties in Southern California (Figure 2-5). The area is approximately 220 square miles and contains about 5.9 MAF in storage. All groundwater rights and access to and use of groundwater storage are controlled through a court adjudication initially entered in 1978. The judgment enjoined all unauthorized pumping, established an initial safe yield of 140,000 AFY and empowered a comprehensive management regime. A governance structure is in place that collectively represents a broad spectrum of stakeholders and the public interest (Slater, 2007a).

In June of 2000, the parties to the Judgment executed the Peace Agreement that in turn launched an Optimum Basin Management Plan ("OBMP") designed to facilitate the Watermaster's efficient management of Chino Basin resources. Storage and Recovery (conjunctive use) was considered an extremely important element of the OBMP as there was a desire to obtain third party contributions and financing to support the efforts being undertaken by Watermaster. A Programmatic Environmental Impact Report (PEIR) was prepared for the Storage and Recovery of water by third parties. The OBMP and the PEIR contemplate that storage of supplemental water may be conducted within Chino Basin without causing any injury to the Basin or the various producers. While the parties expressed some optimism that more than 500,000 acre-feet could be prudently stored within Chino Basin, an agreed upon "Safe Harbor" quantity of 500,000 acre-feet total storage was all that was evaluated within the OBMP. For several years Watermaster has explored arrangements whereby available storage capacity within the Basin might be made available to parties to the Judgment and third parties (Slater 2007a).

Recently, Watermaster approved a 100,000 acre-foot storage agreement among the Inland Empire Utilities Agency, Three Valleys Municipal Water District, Watermaster, and MWD. With this agreement, Watermaster has presently committed approximately 350,000 AF of groundwater capacity to some form of storage. Thus, about 150,000 AF remains available within the initial Safe Harbor quantity. An additional 50,000 AF of storage capacity would be available, if the third party elected to purchase water already within a Chino Basin storage account (Slater 2007a).

Recent successes and stakeholder feedback led Watermaster to believe that 150,000 AF groundwater capacity could be made available to third parties. Watermaster is presently negotiating with three separate agencies regarding the use of some or all of the available capacity. Watermaster remains open to any and all proposals to take advantage of its unique location and stable and secure management environment (Slater 2007a).

Watermaster has provided a range of estimates for partnering with it in the Chino Groundwater Storage Bank. Following are the cost components and range of costs to participate in the water bank (Slater, 2007b).

Storage Right. The participant would pay Watermaster an annual fee for the right to maintain storage capacity in Chino Basin. The fee would be paid regardless of the quantity of water actually held in storage from year to year. The annual fee would be paid directly to Watermaster to cover all of the following: (1) Watermaster costs in administering the program; (2) an incentive payment to in-basin producers to encourage their participation in the program; and (3) compensation in lieu of a losses or "leave behind.

- Assuming a 50,000 acre-foot Storage Right, the annual fee would be $20 per AF of reserved capacity. $1,000,000 per year.

Recharge and Recovery Capital. The participant desiring to augment existing recharge and recovery capacity to meet its respective take schedule would pay the actual cost of the capital required to augment existing facilities to meet the requested put and take cycles.

- Assuming independently dedicated facilities, the capital costs will likely range between $20 million and $30 million and depend largely upon the participant's request.
- Assuming a 50,000 acre-foot capacity, the capital facilities cost would be between $400 and $600 per AF of capacity.

Operations and Maintenance (O&M). The participant will pay the actual increased incremental costs of producing groundwater in lieu of taking a surface delivery incurred by the producers to make water available in accordance with the requested schedule.

- Assuming traditional groundwater extraction and distribution, the incremental costs will likely range between $100 and $200 per AF produced.

Table 2-8 shows the annual cost of a 25-year program of put and take based on these charges. This provides for two cycles of 100,000 AF of storage for a total water cycling "in and out" of 200,000 AF over the period. The 2007 costs for 100,000 AF of storage capacity is estimated to be $50,000,000, using the midpoint of the range of the capital cost estimates. The present worth cost of cycling 200,000 AF in and out of the bank is estimated to be $69,777,820 using the midpoint of operational costs, for a total present worth cost of $119,777,820 or $599 per AF of water cycled through the water bank.

In order to create ICUA on the Colorado River, this program would have to be operated through exchange agreements with MWD. The Chino Basin project would store surplus SWP water. When there is a Colorado River water shortage. MWD would call for water from the Chino Basin storage program. This water would be used instead of MWD's Colorado River water allocation, creating an ICUA that could be transferred to one of the other parties using Colorado River water. Costs and priority for use of MWD supplies and capacity would have to be negotiated.

The Chino Basin Groundwater Storage Project is operating today. However, project-specific facilities may need to be constructed to allow the project to be implemented in accordance with project-specific agreements. Additional California Environmental Quality Act (CEQA) and permitting efforts will be required to implement these project-specific improvements. These additional CEQA and permitting efforts are not expected to be lengthy or costly efforts.

Table 2-8 Chino Basin Groundwater Storage Program Annual Costs for a 100,000 AF Capacity Water Bank, Cycling 200,000 AF Over a 25-Year Period						
	Put/Take (Acre-Feet)		Annual Costs			Present Worth Cost
Year	Put	Take	Program Fees/Power Cost[2]	O&M Fees	Total Cost	
1	11,111		$0	$2,000,000	$2,000,000	$1,904,762
2	11,111		$0	$2,090,000	$2,090,000	$1,895,692
3	11,111		$0	$2,184,050	$2,184,050	$1,886,665
4	11,111		$0	$2,282,332	$2,282,332	$1,877,680
5	11,111		$0	$2,385,037	$2,385,037	$1,868,739
6	11,111		$0	$2,492,364	$2,492,364	$1,859,840
7	11,111		$0	$2,604,520	$2,604,520	$1,850,984
8	11,111		$0	$2,721,724	$2,721,724	$1,842,170
9	11,111		$0	$2,844,201	$2,844,201	$1,833,397
10		33,333	$7,430,476	$2,972,190	$10,402,666	$6,386,335
11		33,333	$7,764,847	$3,105,939	$10,870,786	$6,355,923
12		33,333	$8,114,265	$3,245,706	$11,359,971	$6,325,657
13	11,111		$0	$3,391,763	$3,391,763	$1,798,724
14	11,111		$0	$3,544,392	$3,544,392	$1,790,159
15	11,111		$0	$3,703,890	$3,703,890	$1,781,634
16	11,111		$0	$3,870,565	$3,870,565	$1,773,150
17	11,111		$0	$4,044,740	$4,044,740	$1,764,707
18	11,111		$0	$4,226,754	$4,226,754	$1,756,303
19	11,111		$0	$4,416,958	$4,416,958	$1,747,940
20	11,111		$0	$4,615,721	$4,615,721	$1,739,617

	Put/Take (Acre-Feet)		Annual Costs			Present Worth Cost
Year	Put	Take	Program Fees/Power Cost[2]	O&M Fees	Total Cost	
21	11,111		$0	$4,823,428	$4,823,428	$1,731,333
22		33,333	$12,601,206	$5,040,482	$17,641,688	$6,030,809
23		33,333	$13,168,260	$5,267,304	$18,435,564	$6,002,091
24		33,333	$13,760,832	$5,504,333	$19,265,164	$5,973,509
25			$0		$0	$0
Total	200,000	200,000	$62,839,886	$83,378,393	$146,218,278	$69,777,820

Notes:
1 Assumes an amortization rate of 5%
2 An initial program fee/power cost of $150/AF in 2007
3 An escalation rate of 4.5% for annual costs, including power
4 Does not include any administrative costs beyond Watermaster costs

2.2.2.3 MWD Hayfield Groundwater Storage Project.

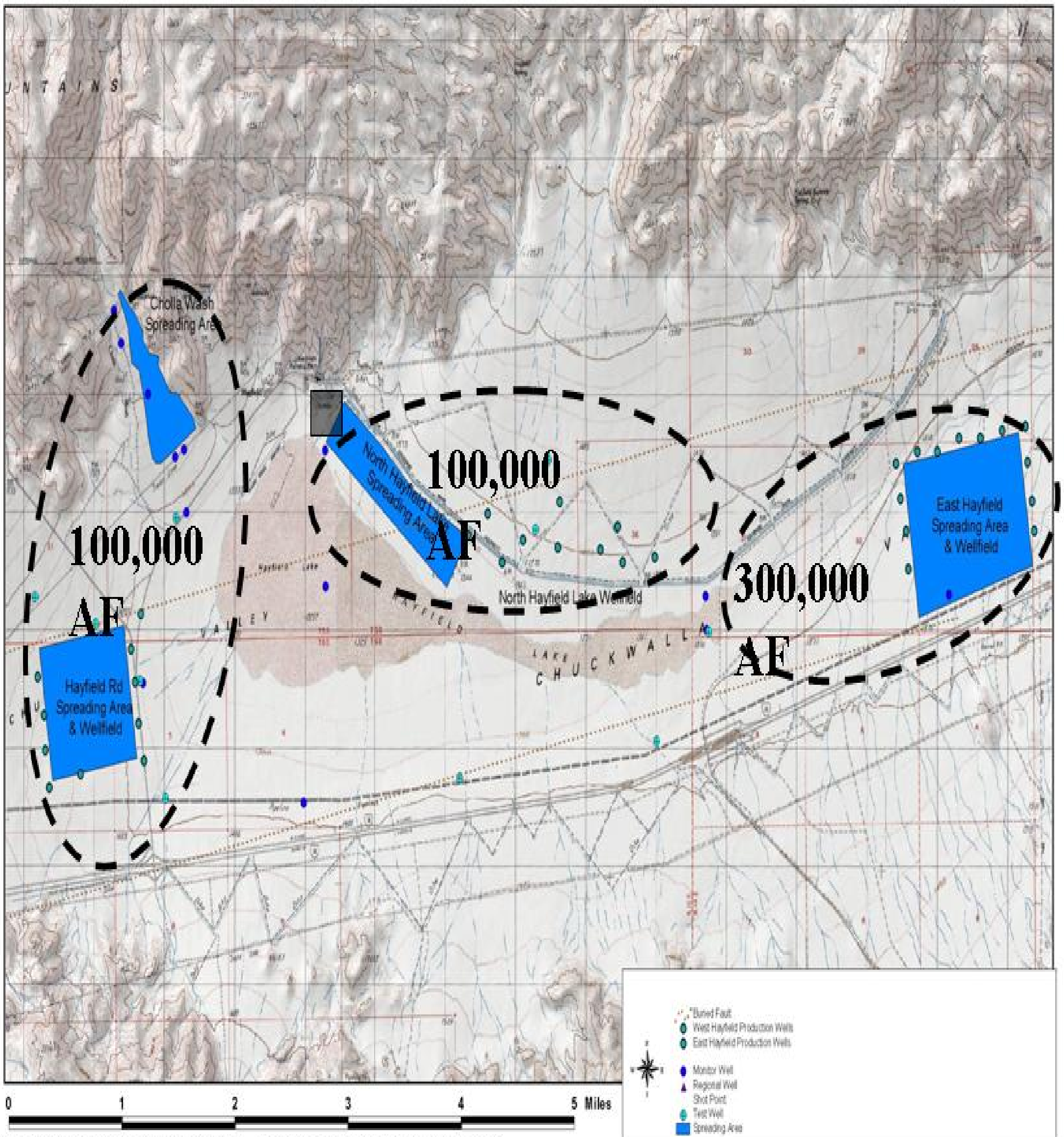
MWD has made significant progress towards developing the Hayfield project. The Hayfield project is located in Riverside County, California, east of Palm Springs, California (Figure 2-5). The Colorado River Aqueduct traverses the land above the Hayfield groundwater basin, making this location ideal for conjunctive use of Colorado River water. MWD put the Hayfield project on indefinite hold in 2004 as a result of the Colorado River Basin drought and uncertainty of obtaining surplus water within the foreseeable future (Folsom, 2007).

MWD has completed a number of technical feasibility studies (e.g., recharge and extraction capacity and water quality evaluations), completed environmental documentation, and purchased land. MWD has estimated a total storage capacity of 400,000 to 500,000 AF for the Hayfield project, with a recharge or “put” capacity of 80,000 to 100,000 AFY and an extraction or “take” capacity of 80,000 to 100,000 AFY. Table 2- 9 presents MWD’s estimated range for the total program cost to develop 400,000 AF of storage (MWD, 2004).

Table 2-9 Estimated Capital Cost to Develop the Hayfield Groundwater Storage Project, November 2004		
Cost Component	**Low End of Cost Range**	**High End of Cost Range**
Costs to date (Studies, Land, Owner Costs)	$10,000,000	$10,000,000
Owner, Land, Design, Project Management, Additional Studies	$25,283,000	$28,602,000
Construction	$70,655,000	$87,251,000
Remaining Budget	$15,981,000	$18,878,000
Total	$121,829,000	$144,731,000
Source: MWD November 2004 Board presentation		

MWD developed conceptual layouts shown in Figure 2-6 and operational scenarios for storage and recovery of Colorado River water. Estimates for operational cost include power costs for operating wells and booster pumps to lift water to the Colorado River Aqueduct, labor costs, and equipment replacement and material costs. These estimated costs for a 30-year period of operation, using a MWD hypothetical operational scenario are summarized in Table 2-10.

The 2007 costs for 400,000 AF of storage capacity is estimated to be $151,878,400, using the midpoint of the range of the capital cost estimates escalated to present. The present worth cost of cycling 800,000 AF in and out of the bank is estimated to be $42,646,376 using the midpoint of operational costs, for a total present worth cost of $194,524,776 or $243/AF of water cycled through the water bank.



Source: Metropolitan Water District of Southern California, Board of Directors Meeting, November 9, 2004

Conceptual Layout of Hayfield Groundwater Storage Project

The Seven Colorado River Basin States

Figure 2-6

Table 2-10 Hayfield Groundwater Storage Program Annual Costs For a 400,000 AF Capacity Water Bank, Cycling 800,000 AF Over a 30-Year Period								
Year	Put/Take (Acre-Feet)		Annual Costs					Present Worth Cost
	Put	Take	Well Pumping Power Cost	Booster Pump Power Cost	Labor Costs	Equipment/Material Replacement	Total Annual Cost	
1	100,000		$0	$0	$356,720	$759,392	$1,116,112	$1,062,964
2	100,000		$0	$0	$372,772	$793,565	$1,166,337	$1,057,902
3	100,000		$0	$0	$389,547	$829,275	$1,218,822	$1,052,864
4	100,000		$0	$0	$407,077	$866,592	$1,273,669	$1,047,851
5			$0	$0	$0	$905,589	$905,589	$709,553
6			$0	$0	$0	$946,341	$946,341	$706,174
7			$0	$0	$0	$988,926	$988,926	$702,811
8			$0	$0	$0	$1,033,428	$1,033,428	$699,464
9			$0	$0	$0	$1,079,932	$1,079,932	$696,134
10			$0	$0	$0	$1,128,529	$1,128,529	$692,819
11			$0	$0	$0	$1,179,313	$1,179,313	$689,520
12		100,000	$3,614,905	$365,142	$578,904	$1,232,382	$5,791,333	$3,224,831
13		100,000	$3,777,576	$381,573	$604,955	$1,287,839	$6,051,943	$3,209,475
14		100,000	$3,947,567	$398,744	$632,178	$1,345,792	$6,324,280	$3,194,191
15		100,000	$4,125,207	$416,688	$660,626	$1,406,352	$6,608,873	$3,178,981
16	100,000		$0	$0	$690,354	$1,469,638	$2,159,992	$989,517
17	100,000		$0	$0	$721,420	$1,535,772	$2,257,192	$984,805
18	100,000		$0	$0	$753,884	$1,604,881	$2,358,765	$980,116
19	100,000		$0	$0	$787,809	$1,677,101	$2,464,910	$975,448
20			$0	$0	$823,260	$1,752,571	$2,575,831	$970,803

Year	Put/Take (Acre-Feet)		Annual Costs					Present Worth Cost
	Put	Take	Well Pumping Power Cost	Booster Pump Power Cost	Labor Costs	Equipment/Material Replacement	Total Annual Cost	
21			$0	$0	$0	$1,831,436	$1,831,436	$657,380
22			$0	$0	$0	$1,913,851	$1,913,851	$654,250
23			$0	$0	$0	$1,999,974	$1,999,974	$651,134
24			$0	$0	$0	$2,089,973	$2,089,973	$648,034
25			$0	$0	$0	$2,184,022	$2,184,022	$644,948
26			$0	$0	$0	$2,282,303	$2,282,303	$641,877
27		100,000	$6,995,862	$706,653	$1,120,343	$2,385,007	$11,207,865	$3,002,008
28		100,000	$7,310,676	$738,452	$1,170,758	$2,492,332	$11,712,219	$2,987,712
29		100,000	$7,639,657	$771,682	$1,223,443	$2,604,487	$12,239,269	$2,973,485
30		100,000	$7,983,441	$806,408	$1,278,497	$2,721,689	$12,790,036	$2,959,326
Total	800,000	800,000	$45,394,892	$4,585,343	$12,572,547	$46,328,281	$108,881,062	$42,646,376

Notes:
1. Assumes an amortization rate of 5%
2. An initial power cost of $0.045/Kilowatt-hour in 2007
3. An escalation rate of 4.5% for annual costs, including power
4. Does not include any administrative costs beyond MWD costs
5. Includes storage in the West and East Basins only and assumes that treatment will not be required for recovered water from these storage areas

MWD would need to complete environmental documentation, including National Environmental Policy Act (NEPA) and CEQA certifications, for the Hayfield Project.

It is anticipated that the Hayfield project could be implemented as an interstate bank similar to the implementation of the Arizona interstate bank. The agreements specified in Section 2.2.4 would need to be put in place:

2.2.2.4 Overview of Potential Issues With Interstate Banking in California.

NEPA and CEQA documentation may need to be completed to allow a new interstate banking project to move forward. The following agreements would need to be put in place for banking by MWD:

- Storage and Interstate Release Agreement – an agreement among the Secretary, the receiving contractor, and MWD. This agreement would provide for and establish the terms for the Secretary to release any unused apportionment to a contractor for use in another Lower Colorado River Basin state.

- Operational Agreement – an agreement between the receiving contractor and MWD providing additional terms and conditions, consistent with the Storage and Interstate Release Agreement, governing operational and financial matters relating to the storage of Colorado River water and the creation of Intentionally Created Unused Apportionment.

3.0 COSTS

For comparison of the economic costs of each option, a cost normalization analysis was completed in a separate TM. The cost normalization analysis used the same methodology as this TM except that some of the economic parameters were different. A summary of the differences between the two analyses is given in Table 3-1.

The different economic parameters between the TMs which will change the calculated unit cost of water. Using the economic parameters from the Cost Normalization TM, the unit costs of water produced are as follows:

- Arizona Interstate Banking - $420/AF
- Semitropic - $420/AF
- Chino - $670/AF
- Hayfield - $470/AF

These unit costs can be used to compare the Conjunctive Use options against other unit costs.

Table 3-1
Differences in Economic Parameters Used in Cost Analysis

Characteristic	Value in Conjunctive Use TM	Value in Cost Normalization TM
Escalation (Inflation)	4.0-4.5%	5.0%
Period	25 years	30 years
Power	$0.045	$0.08