

## **Appendix F Groundwater Banking Volume and Availability**

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## DRAFT TECHNICAL MEMORANDUM

Date: September 1, 2009  
To: Matt Zidar  
From: Natural Resources Consulting Engineers, Inc.  
RE: IID Groundwater Banking Opportunities

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### Introduction

Imperial Irrigation District (IID) has a fixed annual consumptive use allocation from the Colorado River based on the Quantification Settlement Agreement (QSA) and the United States Bureau of Reclamation (USBR) Colorado River Decree accounting<sup>1</sup>. Most of IID's demands are based on agricultural irrigation which tends to vary from year to year.

On an annual basis this results in overruns (diversions<sup>2</sup> in excess of consumptive use right) or underruns (diversions that are less than consumptive use rights). These inadvertent overruns must be paid back by extraordinary water conservation in future years. USBR has developed the Inadvertent Overrun and Payback Policy (IOPP) that provides accounting for overruns and manner of payback<sup>3</sup>.

Underruns are allocated to other California Colorado River water users and are not available for future IID diversions. Storage at locations other than the Colorado River can provide water for IID that is currently unavailable. Metropolitan Water District of Southern California (MWD) utilizes both surface and groundwater storage to bank available water supplies. Southern Nevada Water Agency (SNWA) banks unused Colorado River allocation in Arizona, California, and local groundwater basins.

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<sup>1</sup> For details, see Colorado River Water Delivery Agreement: Federal QSA, Exhibit B, October 2003  
<http://www.usbr.gov/lc/region/g4000/crwda/crwda.pdf>.

<sup>2</sup> For purposes of this memorandum IID diversions and consumptive use are equivalent.

<sup>3</sup> Quantifications and Transfers, Record of Decision - Colorado River Water Delivery Agreement – Implementation Agreement, Inadvertent Overrun and Payback Policy, and Related Federal Actions Final Environmental Impact Statement, October 10 2003, Gale A. Norton, Secretary of the Department of the Interior.

Groundwater banking is the most feasible storage option for IID. Groundwater banking is recognized as a beneficial use of Colorado River water.

The purpose of an IID groundwater bank would be to store IID's unused Colorado River water (underruns) such that there is water available in future years for beneficial uses and/or inadvertent overrun paybacks. Beneficial use includes municipal, commercial, and industrial water supply.

Another opportunity to increase available water supplies for banking is to limit overruns through demand management. Limiting overruns decreases payback requirement, thus increasing the amount of water available for use or retained in storage in future years.

IID has had underruns in 3 of the 5 full years (2004, 2005 and 2006) since the QSA was signed in Oct. 2003, and it is expected that an underrun will occur in 2009<sup>4</sup> (see Figure 1). The total of these three underruns is almost 370,000 AF. This is water that could have been ordered and stored if adequate groundwater banking facilities had been available. This is the entire period of accounting under the QSA operating regulations and may not reflect future diversions.

A set of demand data was developed for the QSA environmental impact analysis based on weather data from 1925-1999 and crop patterns from 1987-1998<sup>5</sup>. A groundwater banking model was created to evaluate multiple groundwater banking scenarios and to quantify water available for banking and pumping based on these data. The model is adapted from a spreadsheet provided by Dr. John Eckhardt containing formulae relating inadvertent overrun, underruns, payback, diversion, groundwater banking yield, and groundwater storage capacity.

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<sup>4</sup> U.S. Bureau of Reclamation Lower Colorado Region Provisional CY2009, July 14, 2009  
<http://www.usbr.gov/lc/region/g4000/hourly/forecast09.pdf>.

<sup>5</sup> From TABLE 6-4, Draft Imperial Irrigation Decision Support System, November 2001, prepared by CH2MHill et al.

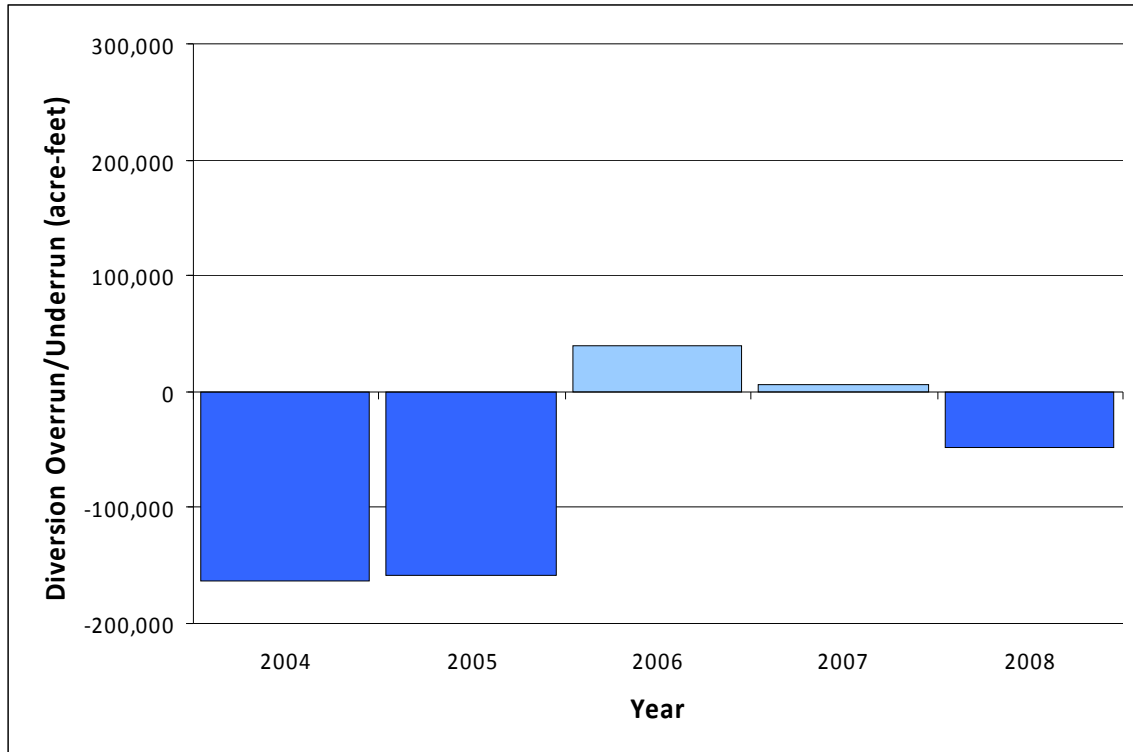


Figure 1 – Post-QSA IID diversion overrun and underrun based on USBR Colorado River Decree Accounting.

### Potential Sites

Potential groundwater storage sites must be economically and physically feasible. Consideration was given to available storage capacity, recharge and withdrawal capacity, initial water storage, existing groundwater water quality, and land ownership. Two general areas under consideration are the Coachella Valley and East Mesa. The two areas require different modeling input due to the differences in their initial volumetric storage and the associated water quality.

#### Coachella Valley

Coachella Valley has a large potential storage volume but little water at present. The area has wells and pumps in place since groundwater is a source of water supply for Coachella Valley Water District (CVWD). Due to land ownership and location, use of the area would require cooperation with CVWD. Groundwater quality in the Coachella Valley site is suitable for irrigation use without treatment and requires treatments similar to Colorado River water for municipal, commercial, and industrial uses. The groundwater aquifer has been depleted so that water could be banked as soon as facilities are in place.

The Coachella Valley site would require a water exchange with CVWD. IID would take deliveries from the Colorado River while CVWD would pump an equivalent amount of IID stored groundwater in lieu of Colorado River deliveries. For example, if IID took delivery of 50,000 AF from CVWD's Colorado River water allocation then CVWD would pump 50,000 AF from groundwater that was previously banked by IID. The water exchange agreement would require an accounting method incorporating stored water, exchanged water, and banking losses.

#### East Mesa

The East Mesa site is located to the east of the IID irrigated area. The aquifer is full but the poor quality of the existing water supplies will likely require desalinization before use. The desalinization process produces a brine stream for disposal and, therefore, a portion of the extracted water would be unavailable for beneficial use. The area does not currently have groundwater recharge or extraction facilities. Utilizing this site would require extensive capital investment for recharge, pumping, distribution, and water treatment facilities. A benefit of the East Mesa site is its location and land ownership; IID could own and independently operate recharge, extraction, and desalting facilities.

### **Groundwater Banking Scenarios**

Groundwater storage and banking can be used to meet increasing municipal, commercial, and industrial (MCI) water demands and/or reduce extraordinary conservation measures required to pay back inadvertent overruns.

MCI Management Option: Groundwater storage is used solely to meet increasing MCI demands, and IID orders water specifically for groundwater banking during years in which an underrun could occur. The USBR currently forecasts underruns and overruns during the year based on deliveries. The forecast or other methodology developed by IID could be used to operate the groundwater bank. If inadvertent overruns occur, extraordinary conservation measures will be required to pay back overruns as per USBR policy. This scenario allows maximum MCI supply.

MCI and Agricultural Management Option: Groundwater banking water is for both the agricultural and MCI sectors. This option allows payment of inadvertent overruns from groundwater storage and creates additional supplies for MCI demands. Under this option inadvertent overruns need to be limited so that banked water is available for overrun payback and MCI needs. Payment of inadvertent overruns is accomplished by leaving additional water supplies in the Colorado River and taking diversions from banked groundwater. Any remaining banked groundwater would be available to meet additional MCI demands. In this management option, extraordinary conservation obligations are

reduced as paybacks are supplemented by groundwater resources. This option leaves less water for MCI use because a portion of the banked groundwater is used for payback of inadvertent overruns.

Based on projected IID diversions from the Draft Imperial Irrigation Decision Support System, there would be little additional water available if the inadvertent overruns are not limited or the banked groundwater is used for payback. In late 2007, IID adopted an Equitable Distribution Plan and implemented regulations, together referred to as the Equitable Distribution Program, that are designed to limit overruns and to provide to provide guidelines for distribution of water in any year when demand for water is likely to exceed supply.<sup>6</sup>

### **Groundwater Banking Model**

The groundwater banking model calculates available water supplies based on aquifer storage, recharge and extraction capacity, and an assumed overrun management value. This available water supply can be allocated according to the chosen management option. The model provides new water yield first from underruns and then from banked water. Only underruns in excess of new water yields are banked.

The model has a managed overrun variable that can be adjusted based on anticipated overrun limitations. Site specific assumptions include maximum available storage, maximum recharge rate, maximum pumping rate, initial groundwater storage, and losses due to inefficiencies and/or treatment of extracted water supplies.

#### *Limitations*

As configured the model allows calculation of a single maximum yield for the user-defined scenario. Therefore, if the initial storage is small and there are few years or little volume of underruns at the beginning of the operation, the resulting yield will be small even though there may be a significant surplus of water later in operation of the site.

Diversion data in the model are based on 75 years of historical weather data from 1925 to 1999 and IID crop pattern data from 1987 to 1999. The scenarios represented in the model are based on the assumption that the USBR declares water supply conditions that would affect IID's allocation (i.e., no surplus declaration).

### **Modeling Results and Findings**

The presented modeling results are limited to 32 examples that cover a range of probable management options. Additional scenarios can be analyzed by adjusting recharge

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<sup>6</sup> See IID website: Equitable Distribution <http://www.iid.com/Water/EquitableDistribution>

capacity, withdrawal capacity, initial and maximum groundwater storage, and system operation efficiency.

Annual yields from groundwater banking range from 19,000 AF per year (AFY) to 55,000 AFY based on the scenarios described in Table 1. These scenarios assume that groundwater pumping is not used for repayment of inadvertent overruns. If the banked groundwater is used to pay back uncapped inadvertent overruns, no additional water resources are available; because the quantity of overruns is approximately equal to the underruns in the 75 year record. However, by limiting inadvertent overruns additional water supplies are available.

Table 1 – Estimated Yields from Various Groundwater Banking Management Options.

Analysis Scenario		Yield with Managed Overrun(Cap), AFY			
		No Overrun	50,000	100,000	200,000
100,000 AFY Aquifer Contribution Limit	Original random data order, no initial storage	23,000	19,000	19,000	19,000
	Original random data order, adequate initial storage	45,000	39,000	34,000	31,000
	Initial underrun period, no initial storage	39,000	33,000	29,000	26,000
	Initial underrun period, adequate initial storage	45,000	39,000	34,000	31,000
200,000 AFY Aquifer Contribution Limit	Original random data order, no initial storage	23,000	19,000	19,000	19,000
	Original random data order, adequate initial storage	55,000	50,000	44,000	40,000
	Initial underrun period, no initial storage	50,000	43,000	38,000	35,000
	Initial underrun period, adequate initial storage	55,000	49,000	43,000	40,000

Table Notes:

- Losses are estimated to be 5% of recharge.
- Total aquifer storage capacity is estimated to be 1,000,000 AF.
- All scenarios result in either no change in groundwater storage or greater groundwater storage at end of the 75-year record (no negative net change).
- Adequate initial storage scenarios allow utilization of groundwater prior to banking of underruns. Initial storage ranges from 230,000 AF for the 100,000 AFY aquifer contribution limit and 200,000 AFY overrun limit yielding 31,000 AFY yield to 650,000 AF for the 200,000 AFY aquifer contribution limit and no overrun yielding 55,000 AFY yield. In these scenarios the initial and ending storage are the same.
- Original random data order has an early period with limited underruns.
- Scenario with initial underruns re-configures the original random data into the following order: 1982-1999, 1925-1981.

## Appendix A

### Data Used in the Groundwater Banking Water Supply Model.

<b>Model Year</b>	<b>Calendar Year</b>	<b>Mapped Year</b>	<b>IID Diversion (acre-feet)</b>
1	1925	1988	3,019,153
2	1926	1994	3,168,264
3	1927	1990	3,144,347
4	1928	1989	3,084,705
5	1929	1988	3,019,153
6	1930	1988	3,019,153
7	1931	1993	2,892,079
8	1932	1994	3,168,264
9	1933	1988	3,019,153
10	1934	1989	3,084,705
11	1935	1993	2,892,079
12	1936	1996	3,297,693
13	1937	1996	3,297,693
14	1938	1995	3,201,984
15	1939	1991	2,993,896
16	1940	1995	3,201,984
17	1941	1991	2,993,896
18	1942	1996	3,297,693
19	1943	1988	3,019,153
20	1944	1997	3,312,800
21	1945	1993	2,892,079
22	1946	1994	3,168,264
23	1947	1989	3,084,705
24	1948	1996	3,297,693
25	1949	1995	3,201,984
26	1950	1989	3,084,705
27	1951	1990	3,144,347
28	1952	1995	3,201,984
29	1953	1989	3,084,705
30	1954	1989	3,084,705
31	1955	1997	3,312,800
32	1956	1989	3,084,705
33	1957	1993	2,892,079
34	1958	1995	3,201,984
35	1959	1995	3,201,984
36	1960	1988	3,019,153
37	1961	1995	3,201,984
38	1962	1995	3,201,984
39	1963	1997	3,312,800
40	1964	1994	3,168,264
41	1965	1993	2,892,079
42	1966	1987	2,836,008

<b>Model Year</b>	<b>Calendar Year</b>	<b>Mapped Year</b>	<b>IID Diversion (acre-feet)</b>
43	1967	1991	2,993,896
44	1968	1990	3,144,347
45	1969	1993	2,892,079
46	1970	1990	3,144,347
47	1971	1994	3,168,264
48	1972	1994	3,168,264
49	1973	1995	3,201,984
50	1974	1995	3,201,984
51	1975	1987	2,836,008
52	1976	1991	2,993,896
53	1977	1998	3,253,978
54	1978	1993	2,892,079
55	1979	1994	3,168,264
56	1980	1993	2,892,079
57	1981	1995	3,201,984
58	1982	1991	2,993,896
59	1983	1991	2,993,896
60	1984	1993	2,892,079
61	1985	1997	3,312,800
62	1986	1990	3,144,347
63	1987	1987	2,836,008
64	1988	1988	3,019,153
65	1989	1989	3,084,705
66	1990	1990	3,144,347
67	1991	1991	2,993,896
68	1992	1992	2,677,183
69	1993	1993	2,892,079
70	1994	1994	3,168,264
71	1995	1995	3,201,984
72	1996	1996	3,297,693
73	1997	1997	3,312,800
74	1998	1998	3,253,978
75	1999	1990	3,144,347

Table Notes:

1. From Table 6-4, Draft Imperial Irrigation Decision Support System, November 2001, prepared by CH2MHill et al.
2. Climate data is from calendar year.
3. Mapped year is cropping data is from randomized cropping pattern for the listed year.