WATER USE ASSESSMENT

of the

IMPERIAL IRRIGATION DISTRICT

FINAL REPORT

22 August 1995

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SPECIAL REPORT

PREPARED FOR THE
U.S. BUREAU OF RECLAMATION
Boulder City, Nevada

by

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In Cooperation with
the

Water Management and Conservation Team
U.S. Bureau of Reclamation, Boulder City, Nevada

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EXECUTIVE SUMMARY

California water users have recently approached or exceeded the water allocated from Colorado River because of increasing demands for water and the completion of the Central Arizona Project (CAP). In a recent agreement between the Imperial Irrigation District (IID) and the Metropolitan Water District (MWD) of southern California (IID and MWD, 1989), MWD agreed to finance a conservation program in the IID, particularly improving water storage and delivery systems. In return, IID agreed to reduce its requests for Colorado Water in an amount equal to the quantity of water conserved by the Program. The IID has also implemented other water conservation measures. However, diversions in 1994 were essentially the same as in 1990.

The purpose of this study was to assess the use of Colorado River water by IID to determine why diversions have not decreased as conservation measures have been implemented. A secondary purpose was to identify alternative mechanisms for Reclamation and IID to consider in implementing more effective conservation measures. Another objective was to develop procedures for use by Reclamation in taking a more proactive role in estimating diversions required for beneficial use of water in the IID.

The largest potential for reducing diversion to the IID and reducing inflow to the Salton Sea from the IID with no change in irrigated crop acreages is to improve on-farm irrigation systems and practices. With surface irrigation systems on fine-textured soils, surface runoff, or tail water, is the main component affecting irrigation efficiency. Pump-back and surface runoff capture systems for redistributing surface runoff are commonplace in many irrigated areas where water supplies are limited or expensive. They are not generally used in the IID. On-farm irrigation management also involves scheduling irrigations to replace soil water used in evapotranspiration (ET) before soil water stress affects crop growth. Estimates of ET and soil water depletion to schedule irrigations and limit water application amounts to that which can be retained or infiltrated in the soil can reduce surface runoff and/or deep percolation.

The net water supply to the Imperial Irrigation District increased from 1991 to 1994. The irrigated crop acreage increased slightly in 1994, and trends indicate further increases of some crops in 1995. During this period, the water level of the Salton Sea has risen. Sea elevations in January 1994 and 1995 were the highest since 1987. The trend in the sea level versus cumulative net drainage from IID was downward from 1988 to 1991. Since 1991, the trend has been upward. Water levels of the Sea are affected by rainfall on the sea, runoff from adjacent areas, and evaporative demand as indicated by reference evapotranspiration measurements (CIMIS ETo). However, the main variable affecting the sea level is net drainage from the IID. Since 1991, the ratios of drainage to water delivered to farms, or drainage to net water supply, have increased indicating a reduction in irrigation efficiencies when conservation measures and improved water management practices should have increased overall irrigation efficiencies. Basically, net water supply to the Imperial Irrigation District increased more than evaporation and evapotranspiration from 1992 to 1994. As a result, the ratio of beneficial uses of water to supply have decreased indicating an immediate need to implement improved on-farm systems and practices including more effective irrigation scheduling.

A spreadsheet model was developed for estimating mean monthly crop ET in the IID using mean measured evaporative demand, or CIMIS ETo, for the years 1990-1994 and crop coefficients for major field, garden and permanent crops. Estimated monthly diversion requirements with the spreadsheet program compared with actual monthly diversions for 1991-1994 indicated that the estimates based on CIMIS ETo and crop and water surface coefficients agree well with actual diversions except for months of December through March when monthly rainfall amounts are more variable. Water orders are sensitive to rainfall events.

The spreadsheet program results indicate that the program estimates E, ET and net drainage reasonably well. The results also support the data which showed that net supply increased more than that required for crop ET and other consumptive water uses. The spreadsheet program was designed to be used to estimate, or predict, diversion requirements. It can also be used with real-time climate and cropping data to evaluate diversions during the year by replacing mean climate data for past months with actual data and updating actual diversions.

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ACRONYMS

CAP	Central Arizona Project
CD	Calendar Day
CIMIS	California Irrigation Management Information System
CU	Consumptive Use
CUc	Consumptive Use Coefficient, CUc = ET/Water Delivered
CVWD	Coachella Valley Water District
ET	Evapotranspiration
ETo	Short Grass Reference Evapotranspiration, CIMIS ETo
IID	Imperial Irrigation District
K_c	Crop coefficient, K_c = ET/ETo
MWD	Metropolitan Water District
USBR	U.S. Bureau of Reclamation
WMCT	USBR Water Management and Conservation Team
WMCTL	USBR Water Management and Conservation Team Leader

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Marvin E. Jensen [1]

1.0. INTRODUCTION

Water supplies for agriculture and other uses in southern California and Arizona are mainly from the Colorado River. In recent years, California water users have approached or exceeded the water allocated from Colorado River because of increasing demands for water and the completion of the Central Arizona Project (CAP). Completion of the CAP enabled Arizona to begin using more of her share of the Colorado River supply. In a recent agreement between the Imperial Irrigation District (IID) and the Metropolitan Water District (MWD) of southern California (IID and MWD, 1989), MWD agreed to finance a conservation program in the IID, particularly improving water storage and delivery systems. In return, IID agreed to reduce its requests for Colorado Water in an amount equal to the quantity of water conserved by the Program. In normal circumstances, IID will reduce its diversions by 106,100 acre-feet annually (NRC, 1992), an amount that is only slightly larger than open channel flow measurement accuracy. The IID has also implemented other water conservation measures. However, diversions in 1994 were essentially the same as in 1990.

The largest potential for reducing diversion to the IID and reducing inflow to the Salton Sea from the IID with no change in irrigated crop acreages is to improve on-farm irrigation systems and practices. Significant improvements have been made in on-farm irrigation technology over the past few decades in addition to advances in open channel water control and distribution systems. These improvements include both on-farm water distribution systems and irrigation management practices. With surface irrigation systems on fine-textured soils, surface runoff, or tail water, is the main component affecting irrigation efficiency. Pump-back and surface runoff capture systems for redistributing surface runoff are commonplace in many irrigated areas where water supplies are limited or expensive. On-farm irrigation management involves scheduling irrigations to replace soil water used in evapotranspiration (ET) before soil water stress affects crop growth. Measurements of daily evaporative demand known as reference ET, or ETo, for irrigation scheduling was started in the IID prior to 1987 by the California Irrigation Management Information System (CIMIS) with one station operating all year in 1987. CIMIS has had at least three stations operating in the IID since 1989. Daily reference ET, or ETo, representing the rate of ET from a well-watered short grass surface is used with coefficients that relate ETo to ET from a crop at each stage of growth. Estimates of ET and soil water depletion to schedule irrigations and limit water application amounts to that which can be retained or infiltrated in the soil can reduce surface runoff and/or deep percolation.

The purpose of this study was to assess the use of Colorado River water by IID to determine why diversions have not decreased as conservation measures have been implemented. A secondary purpose was to

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identify alternative mechanisms for Reclamation and IID to consider in implementing more effective conservation measures. Another purpose was to develop procedures for use by Reclamation in taking a more proactive role in estimating diversions required for beneficial use of water in the IID.

2.0 BACKGROUND

The three lower states of the Lower Colorado River Basin are allocated 7.5 million acre-feet (maf) of Colorado River water per year under the Colorado River Compact. California is entitled to 4.4 maf of this allocation. Within California, pursuant to water delivery agreements with the Secretary of the Interior, highest priority is given to diversions of 3.85 maf to irrigate Palo Verde Irrigation District, the Reservation District of the Yuma Project, the Imperial Irrigation District (IID), and the Coachella Valley Water District (CVWD). When these diversions exceed 3.85 maf and the Lower Basin diversions exceed 7.5 maf, the Secretary has the authority to require compensation for use of excess water.

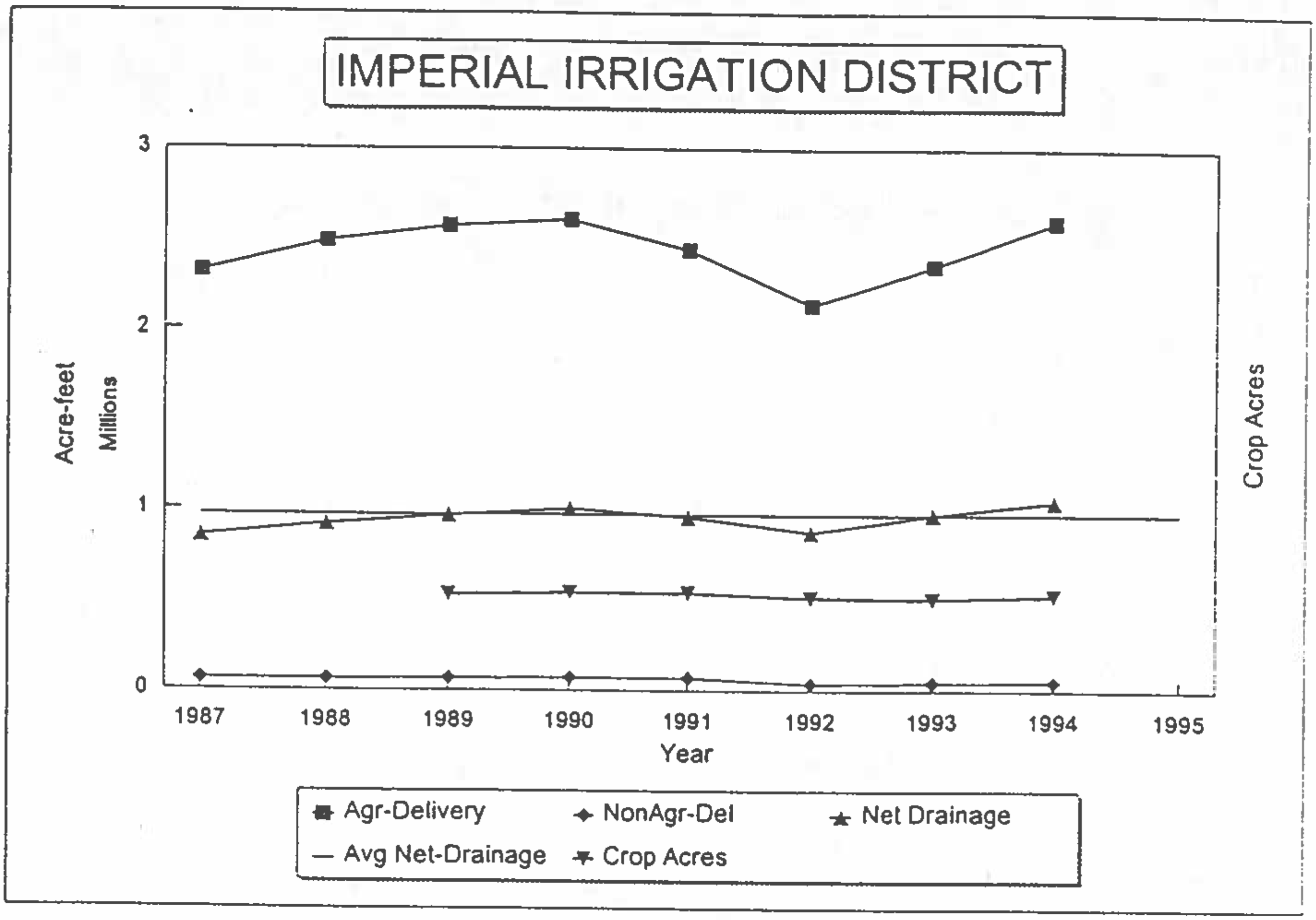
Diversions exceeded 3.85 maf in 1990, and appears to have exceeded 3.85 maf in 1994 pending final decree accounting. Indications are that diversions may exceed 3.85 maf in 1995. Districts were given credit for estimated water savings due to conservation activities within districts, but diversions actually increased during the same periods due to increased demands within districts. Actual water savings must be measurable as reduced diversions and/or reduced loss of water to nonrecoverable locations such as the Salton Sea.

Federal Regulations (Part 417 of Title 43, Code of Federal Regulations) obligate Reclamation to ensure that "*... deliveries of Colorado River water to each Contractor will not exceed those reasonably required for beneficial use.*" (Section 417.2, Appendix A). Each year, Reclamation works with districts in estimating monthly diversions from the Colorado River. Recent trends in diversions indicate that Reclamation must take a more proactive role to ensure that diversions will not exceed those required for beneficial use and that estimated water savings from conservation programs translate into actual reductions in diversions or nonrecoverable return flows.

Diversions to IID are of particular concern because they represent nearly 70 percent of California's allotment, and there are no return flows to the Colorado River to offset any excess diversions. Return flows from irrigated areas in the IID flow to the Salton Sea. The trends of diversions to IID, crop acreages, and the level of the Salton Sea, which is due mainly to return flows from IID, all indicate that the effects of conservation programs are not reflected in reduced diversions of Colorado River water to IID.

2.1 Trends in Diversions, Crop Acreages and Salton Sea Levels

Consumptive Use diversions to IID (diversions minus return flow to the Colorado River) during the period 1987 to 1994, crop acreages, deliveries to agricultural and nonagricultural users, and net drainage (total drainage less inflow from Mexico) to the Salton Sea are shown in Fig. 2.1. These data indicate that diversions have increased while irrigated crop acreages remained essentially constant. At the same time, the water level of the Salton Sea has risen. Diversions decreased in 1991 and 1992 when rainfall was above average, but increased again in 1993 and 1994. Net drainage from the IID to the Salton Sea provides about 60 percent of inflow that evaporates annually from the Sea. Net drainage, which is related to diversions (Fig. 2.1), also began to increase in 1993 and was higher in 1994 than during the previous six-year period. Sea elevations in January 1994 and 1995 were the highest since 1987. Trend in the sea level versus cumulative net drainage from IID was downward from 1988 to 1991. Since 1991, the trend is upward (Fig. 2.2). Determination of reasonable beneficial use must take into account benefits and damages resulting from net drainage from irrigated areas.



31-May-95

Figure 2.1 - Water delivered to farms and nonagricultural users in the Imperial Irrigation District, and net drainage to the Salton Sea from 1987 to 1994.

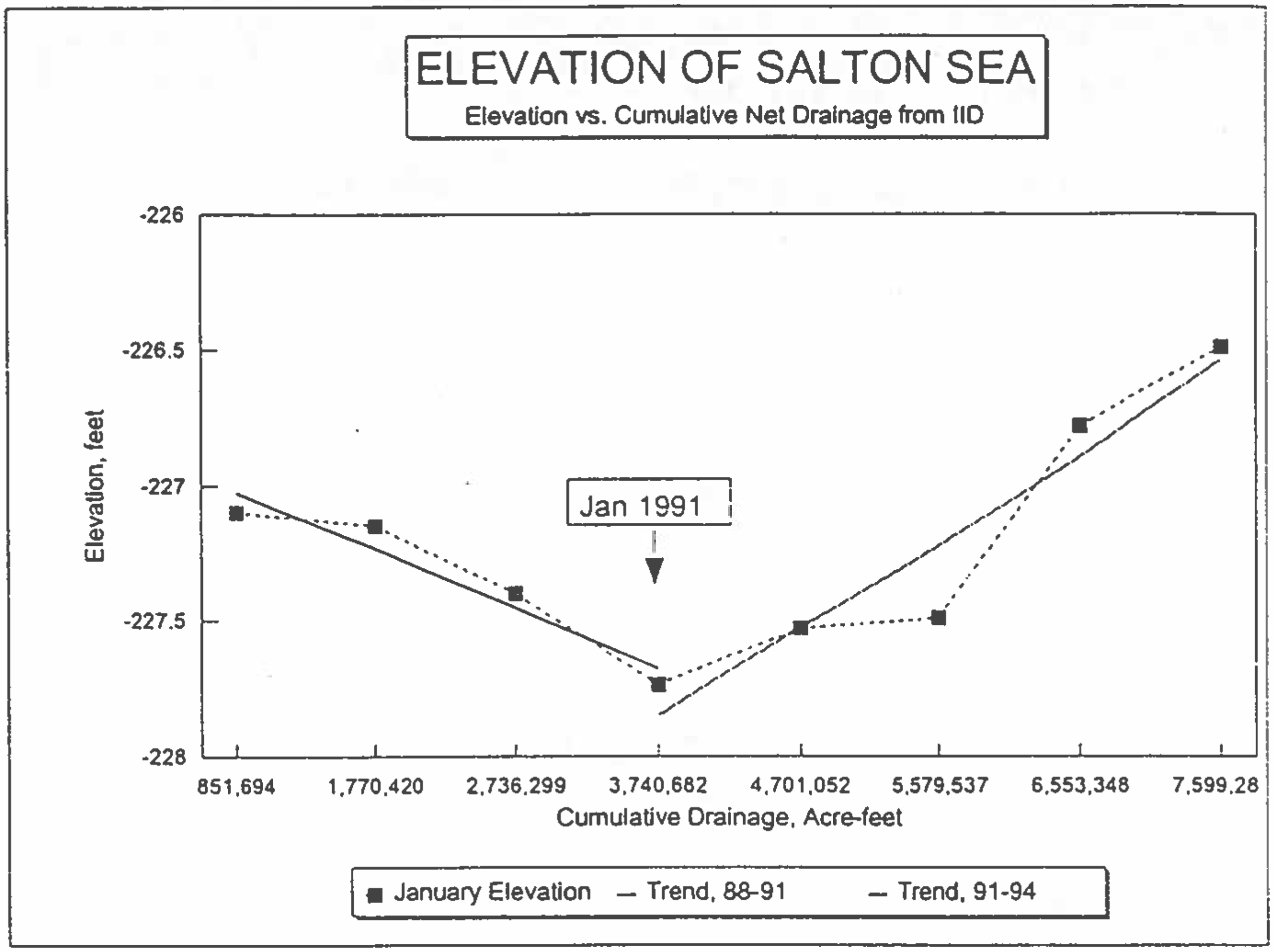


Figure 2.2 - January elevations of the Salton Sea versus cumulative net drainage from the Imperial Irrigation District from 1987 to 1994.

4.0 ASSESSMENT PLAN

4.1 Study Plan

The study will address the objectives in Section 3.0, and will be thoroughly documented in a written report. The computer spreadsheets are to be easy for Reclamation employees to use in evaluating diversions and estimated water requirements. Some training will be provided to users of the spreadsheet programs.

This study will be managed by the Water Management and Conservation Team Leader (WMCTL). Technical aspects will be reviewed by the Water Management and Conservation Team (WMCT) and others identified by the WMCT. The report shall be defendable to IID's review and comments.

4.2 Study Approach

4.2.1. Data Collection and Analyses. The data collection and analyses approach to be used in this study will involve the following:

- Gather Information and Data. Reclamation will facilitate the gathering of known data and reports pertinent to the assessment. This includes acquiring data from the California Irrigation Management Information System (CIMIS) and data from the Imperial Irrigation District. The contractor will be responsible for developing the correspondence needed by Reclamation in requesting data from IID.

- Evaluate Existing Data. The contractor will assess the quality of the data for the needs of the IID water use assessment.

- Determine Additional Data Needs. The contractor will identify what additional data will be required and recommend how these data can be obtained to complete the assessment.

- Data Analysis. The contractor will outline the procedures that will be used to analyze the data to accomplish the objectives of the study.

4.2.2. Technical Oversight, Documentation and Dissemination of Results. Technical oversight will be provided by the WMCT. Documentation will be prepared by the Contractor. Dissemination may require participation by the Contractor. These items will involve the following:

- Review Process. The contractor is to make available the results of the study as they are obtained, and the WMCT is to respond quickly with its concerns to the Contractor. The Contractor will address the concerns and make necessary changes. The Contractor shall implement an internal review process for review of the findings as they are developed. The review process will enable the Contractor and the WMCT the opportunity to communicate all concerns in unedited form.

- Documentation. The assessment report will be prepared by the contractor to document the results of the study. It will involve the assessment of the adequacy/correctness of existing data, identification of additional data needs, and address the items listed under the Purpose of Assessment. The report will be developed professionally upon completion of the data collection and analyses. Technical oversight and adequacy will be the responsibility of the WMCT.

Water levels of the Sea are also affected by rainfall on the water, runoff from adjacent areas, evaporative demand as indicated by reference evapotranspiration measurements (CIMIS ETo). However, the main variable affecting the sea level is net drainage from the IID. The average net drainage per unit area of cropped land in the IID is about 1.85 ac-ft per acre.

2.2 Cooperative Water Use Assessment

In 1993, Reclamation initiated a cooperative study of water use with both IID and CVWD. A five-member, independent study team prepared a draft first phase report, but it was not finalized. The second phase, which was intended to determine what constituted "reasonable use" of Colorado River water under current economic conditions, was not implemented because IID chose not to allow the team to independently gather data in the IID. Only data provided by IID or generated by the Team was allowed.

This year, and in the future, Reclamation will be working more closely with IID to estimate and predict diversion requirements for beneficial use. Future studies will address reasonable use of water diverted. Reclamation will be using data provided by IID and data generated independently to estimate monthly diversion requirements for beneficial use of Colorado River water.

2.3 Water Conservation Programs

The IID's conservation programs since 1989 have focused on canal lining, constructing regulating reservoirs to capture operational waste at the ends of canals, improved system water control structures, replacement of wooden check gates with non-leak gates, improved water measurement, automation and remote control of flows and improved management practices. Management programs have involved opportunity for 12-hour water deliveries vs. the previous 24-hour practice, delivery of small flows to complete irrigations, cutoff of delivery during the last four hours if canal capacity exists, remote control and automation to increase flexibility of water deliveries to the water users, conversion to electronic recording of data by ditch riders along with increased computerized data processing, and demonstration of pump-back systems (Silva, 1990).

3.0 PURPOSE OF ASSESSMENT

The purpose of this assessment of IID's water use will be to address the following objectives:

1. Update the water budget for 1993 and 1994 following the format used in the "*Water Use Assessment at CVWD and IID*" January 31, 1994 Phase I Report.

2. Develop water budgets and projections of water use for the years 1995 and 1996.

3. Formulate recommendations relating to water conservation measures and operating practices as required in Section 417.2 and discussed in 417.3 of Title 43 (Code of Federal Regulations, 1993).

4. Develop statements to assist Reclamation in responding to the trends in water use by IID.

5. Develop a working spreadsheet program for use by Reclamation in updating IID's annual water budget with associated confidence intervals.

6. Develop a working spreadsheet program for use by Reclamation to evaluate water use by any district considering but not limited to items listed in Appendix B, and including confidence intervals.

- Dissemination of Results. The results of this study are expected to include an evaluation of the water use by IID for the past five years, estimates for 1995, and projections for 1996. The Contractor may also be requested to assist in meetings and reviews.

4.2.3. Schedule. The proposed schedule for this study is as follows:

- April 28, 1995. Preliminary Assessment Report to Reclamation.
- May 19, 1995. Final Report Due.
- May 31, 1995. Deliver Spreadsheet Programs.

5.0 PROCEDURES

5.1 Climate Data

The five-year period of historical water use selected for study was 1990-1994. Climate data (1987-1992) for three CIMIS stations in the IID (41-Mulberry; 68-Seeley, and 87-Meloland) were available from Phase I of the previous Cooperative Water Use Assessment. These daily data had been screened to eliminate zeros when instrument problems occurred. Data for 1993 and 1994 were obtained directly from CIMIS via telephone and the new computer system being tested by the CIMIS group. They were also screened to eliminate zeros.

5.2 Crop Acreages

Crop acreages for 1987-1991 were obtained from the report by Boyle (1993). Data for 1992-1994 were obtained from the USBR Crop Production and Water Utilization reports. Because of the large number of crops, some crops of small acreages (less than 0.25 percent of the total crop acreage) were grouped to facilitate estimating crop consumptive use. The groupings and acreages are summarized in Table 5.1.

5.3 Planting and Harvest Dates

Planting and harvest dates used to estimate crop water requirements are listed in Table 5.2. These dates may need to be adjusted or refined following discussions with farm advisors or IID staff. It is possible that ditch rider records may contain some data that can be used for this purpose.

5.4 Crop Coefficients

The crop coefficient, as used in this report, is the ratio of evapotranspiration (ET) that occurs from a crop at each growth stage from planting through development to maturity to the concurrent reference ET, or ETo. Crop coefficients, K_c, were based on the coefficients developed during Phase I of the previous Water Use Assessment. Since information on irrigation frequency was not available except for alfalfa, no direct adjustment could be made for increased evaporation that occurs after each irrigation when crop cover is incomplete. Most annual crops are either irrigated for germination and emergence of seedlings, or the fields are irrigated before planting to bring the soil to field capacity or to assure sufficient soil water for germination and seedling emergence. The evaporation during this 5-10 day period was assumed to be equal to ETo, or $K_c = 1.0$. Coefficients for major crops grown in the IID are presented in the spreadsheet program (Appendix C).

The mean crop coefficient curve for alfalfa was based on nine cuttings of hay. The estimated potential ET for well-watered alfalfa cut for hay with complete plant stands unaffected by soil salinity was based on these coefficients and ETo. Actual estimated alfalfa ET was based on both estimates of potential ET and on reported crop yields for Imperial County and a yield-ET relationship developed from measured yield and ET data from New Mexico, North Dakota and Israel. These three yield-ET data sets had almost identical linear regressions (Fig. 5.1). The potential alfalfa ET was multiplied by 0.80, the ratio of yield-based ET to potential alfalfa ET. Such reduced estimates were required to achieve water balance with measured water deliveries and net drainage. Such reductions can also be justified for other reasons. Estimates of soil water depletion between cuttings indicated that available soil water probably limits ET prior to cuttings. The low infiltration rate on fine-textured soils in the district also limits the amount of water that can be added during irrigations. In addition, declining plant stands and increasing salinity during alfalfa 5-6 year cycles can reduce ET. The net effect is that alfalfa ET is less than potential alfalfa ET.

The average crop coefficients for each 9-11 day period used for ET estimates is shown by the solid circles in Fig. 5.2. Therefore, most mean 9-11 day coefficients for potential alfalfa ET ranged from 0.7 to 1.2 for use with CIMIS ETo values.

Table 5.1 - *Distribution of major crops and surfaces in the Imperial Irrigation District for 1987-1994.* Source: Boyle (1993) and USBR Crop Production and Water Utilization Data for 1991-1994.

	YEAR								
	1989	1990	1991	1992	1993	1994	Estimate 1995	Estimate 1996	1990-1994 Average
	Acres								
FIELD CROPS:			USBR DATA						
Alfalfa	166,732	190,808	202,145	186,205	182,910	188,309	189,000		190,075
Alfalfa (Seed)	3,070	4,523	17,397	7,099	7,949	6,675	7,000		8,729
Bermuda Grass	4,249	4,498	0	0	0	0	0		900
Bermuda Grass (Seed	3,778	13,410	15,890	19,522	20,929	17,801	17,000		17,510
Cotton	9,568	11,014	9,401	4,227	7,255	6,891	6,400		7,758
Oats & Barley	4,806	2,602	3,895	2,073	1,444	1,778	1,700		2,358
Rye Grass	8,205	8,876	1,380	588	527	519	500		2,378
Sudan Grass	48,792	41,482	73,445	69,518	76,195	96,747	102,000		71,477
Sugar Bee (Fall)	14,582	20,754	20,796	19,852	20,746	17,401	17,500		19,910
Sugar Bee (Spring)	14,582	20,754	20,796	19,852	20,746	17,401	17,500		19,910
Wheat	99,891	56,833	32,552	69,180	59,283	58,247	58,000		55,219
Miscellaneous	1,418	1,988	2,461	2,706	3,712	3,531	3,400		2,880
Total Field Crops	379,672	377,542	400,157	400,821	401,696	415,300	420,000	0	399,103
Percent	71.8%	69.7%	74.7%	77.7%	78.4%	78.3%	78.3%		75.9%
GARDEN CROPS:	1989	1990	1991	1992	1993	1994	1995	1996	
Broccoli	11,343	10,484	9,543	8,899	6,406	6,406	6,400		8,348
Cabbage	846	1,192	1,365	1,011	1,511	1,518	1,500		1,319
Carrots	11,874	12,682	14,635	15,557	16,312	16,312	16,000		15,100
Cauliflower	6,673	7,334	6,087	6,237	3,755	3,755	3,800		5,434
Corn, Ear	1,724	1,822	2,973	3,830	2,879	4,491	4,500		3,199
Lettuce (Fall)	16,031	19,021	15,646	11,480	10,924	11,072	11,000		13,628
Lettuce (Spring)	16,031	19,021	15,646	11,480	10,924	11,072	11,000		13,628
Melons:									
Cantaloupes (Fall)	8,174	10,498	0	0	0	0	0		2,100
Cantaloupes (Spring)	20,684	22,837	21,236	12,304	13,682	14,339	14,500		16,860
Honeydew (Fall)	1,761	2,148	792	232	697	1,545	1,500		1,083
Melons (Mixed, fall)	484	376	0	0	0	0	0		75
Melons(Mixed, spring	640	1,104	0	0	0	0	0		221
Watermelons	3,830	3,234	2,326	2,485	2,596	3,498	3,500		2,828
Onions	8,903	10,125	11,862	10,126	10,767	12,004	12,000		10,977
Onion (Seed)	2,261	3,339	2,540	2,790	2,315	1,929	2,000		2,583
Tomatoes (Spring)	12,640	10,835	6,385	3,483	2,850	3,486	3,500		5,408
Misc Other	6,208	7,262	6,557	5,841	9,136	7,278	7,500		7,215
Total Garden Crops	130,106	143,314	117,593	95,754	94,653	98,704	98,700		110,004
Percent	24.6%	26.5%	22.0%	18.6%	18.5%	18.6%	18.4%		20.9%
PERMANENT CROPS:	1989	1990	1991	1992	1993	1994	1995	1996	
Artichokes	237	442	0	0	0	0	0		88
Asparagas	5,376	6,145	6,445	6,466	6,111	6,136	6,200		6,261
Citrus:	1,761	1,831	3,094	2,717	3,083	3,134	3,200		2,772
Duck Ponds (Feed)	7,819	7,863	7,863	7,863	7,863	7,863	7,900		7,863
Jojoba	2,117	2,117							
Misc	1,763	2,382	395	225	256	216	200		695
Total Permanent Crop	19,073	20,780	17,797	17,271	17,313	17,349	17,500		17,679
Percent	3.6%	3.8%	3.3%	3.3%	3.4%	3.3%	3.3%		3.4%
TOTAL CROPS	528,851	541,636	535,547	513,846	513,662	531,353	536,200	0	526,785
TOTAL CROPS (USBR)			527,975	515,940	512,457	530,342			525,770

Table 5.2 - *Annual Growth Periods for Major Crops Grown in the Imperial Irrigation District.*

Crop	Start or plant Date	Start or plant CD	Full cover Date	Full cover CD	Harvest Date	Harvest CD	Days Plt-FC	Days FC-Harv	Days Plt-Harv
FIELD CROPS:									
Alfalfa, 6/15-7/15 *	15-Jun	166	07-Jul	188	15-Jul	196	22	8	30
Alfalfa Seed **	15-Mar	74	- -	- -	31-Jul	212	- -	- -	139
Bermuda Grass	01-Mar	60	- -	- -	30-Sep	273	- -	- -	214
B. Grass (Seed)	01-Mar	60	- -	- -	30-Sep	273	- -	- -	214
Cotton	01-Apr	91	12-Aug	224	31-Oct	304	133	80	214
Oats	01-Jan	1	05-Mar	64	30-Apr	120	63	56	120
Rye Grass	01-Jan	1	- -	- -	30-Apr	120	- -	120	120
Sudan Grass	01-Apr	91	23-May	143	30-Sep	273	- -	130	183
Sugar Beets (Summer)	01-Jul	182	9 Nov	313	30-Apr	485	131	172	304
Sugar Beets (Winter)	01-Oct	274	10-Feb	406	30-Jun	546	132	140	273
Wheat	01-Dec	335	25-Feb	421	30-Apr	485	86	64	151
Misscellaneous	01-Jan	1	24-Mar	81	31-May	151	80	70	151

* Other cutting dates are: 8/15; 9/15; 11/15; 01/15; 03/15; 04/15; and 05/15.
** Assuming three cuttings for seed, then revert to hay production or other crops.

Crop	Start or plant Date	Start or plant CD	Full cover Date	Full cover CD	Harvest Date	Harvest CD	Days Plt-FC	Days FC-Harv	Days Plt-Harv
GARDEN CROPS:									
Brocolli	10-Sep	253	17-Dec	351	15-Feb	411	98	60	159
Cabbage	01-Nov	305	21-Dec	355	31-Mar	455	50	100	151
Cantaloupe (Fall)	01-Aug	213	12-Oct	285	31-Dec	365	72	80	153
Cantaloupe (Spring)	01-Feb	31	12-Mar	71	31-May	151	40	80	121
Carrots	01-Oct	274	09-Feb	405	30-Apr	485	131	80	212
Cauliflower	01-Oct	274	- -	- -	31-Jan	396	- -	- -	123
Corn, Ear	15-Jan	15	24-Feb	55	15-May	135	40	80	121
Lettuce (Fall)	01-Sep	244	24-Sep	267	02-Jan	367	23	100	124
Lettuce (Spring)	01-Nov	305	21-Dec	355	31-Mar	455	50	100	151
Melons, Honeydew, F	01-Aug	213	12-Oct	285	31-Dec	365	72	80	153
Melons, Mixed (Fall)	01-Aug	213	12-Oct	285	31-Dec	365	72	80	153
Melons, Mixed (Spring)	01-Feb	31	12-Mar	71	31-May	151	40	80	121
Onions	01-Jan	1	20-Feb	51	31-May	151	50	100	151
Onion Seed	01-Jan	1	20-Feb	51	31-May	151	50	100	151
Tomatoes, Spring	01-Feb	32	11-Apr	101	30-Jun	181	69	80	150
Watermelons	01-Jan	1	14-Apr	73	31-May	151	72	78	151
Miscellaneous	01-Feb	32	11-Apr	101	30-Jun	181	69	80	150
PERMANENT CROPS:									
Artichoke	01-May	121	- -	- -	10-Mar	434	- -	- -	314
Asparagus	01-Jan	1	- -	- -	31-Dec	365	- -	- -	365
Citrus	01-Jan	1	- -	- -	31-Dec	365	- -	- -	365
Duck Ponds (Feed)	01-Jan	1	- -	- -	31-Dec	365	- -	- -	365
Jojoba	01-May	121	- -	- -	10-Mar	434	- -	- -	314
Miscellaneous	01-Jan	1	- -	- -	31-Dec	365	- -	- -	365

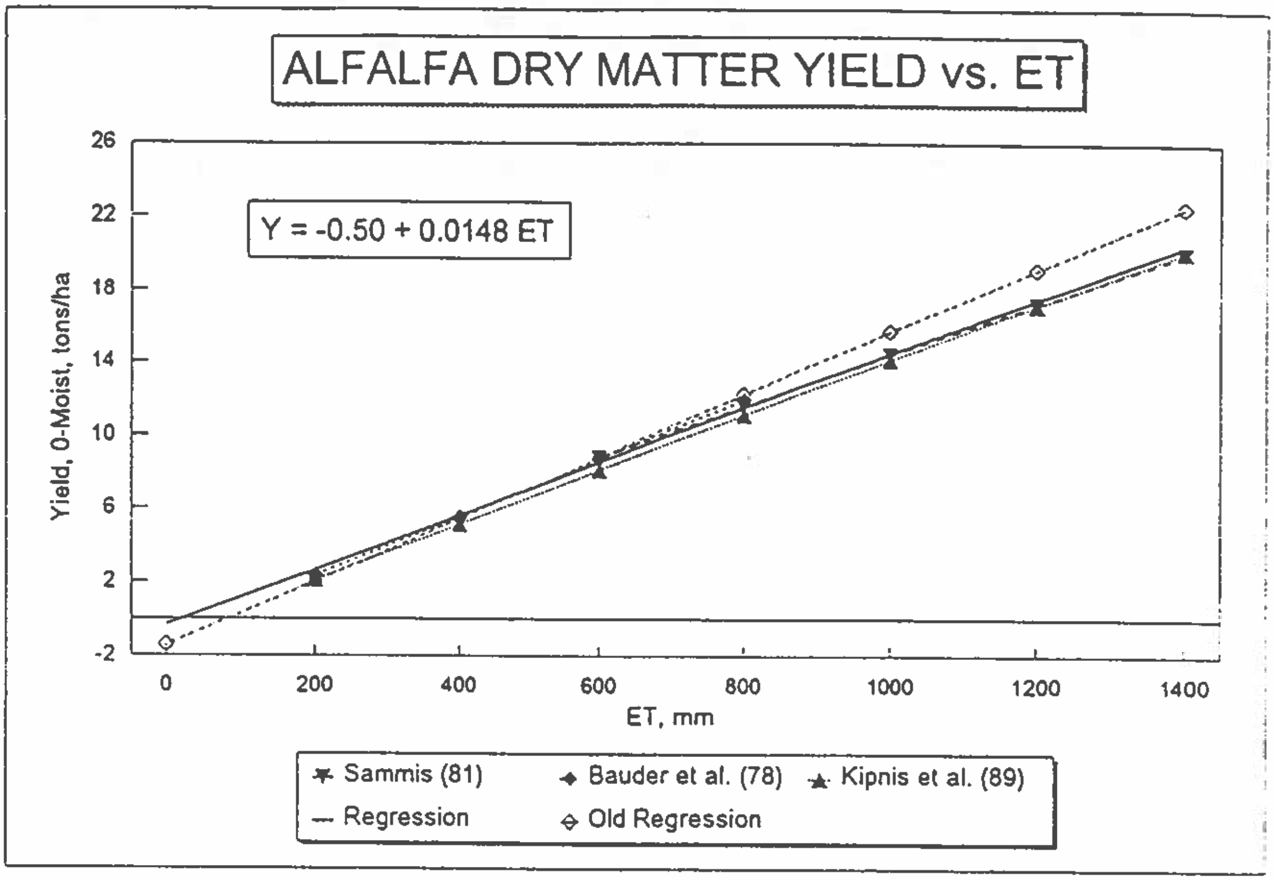


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Figure 5.1 - Yield of dry matter alfalfa hay relative to total annual evapotranspiration in dryland and irrigated areas of north Dakota (Bauder et al., 1978), sprinkler-irrigated studies in New Mexico (Sammis, 1981), and irrigation studies in Israel (Kipnis et al., 1989). Data points are values from regression equations at each of the three locations. New Mexico and Israel are at similar latitudes as IID (about 32 degrees N). The North Dakota site was about 46 degrees N latitude.

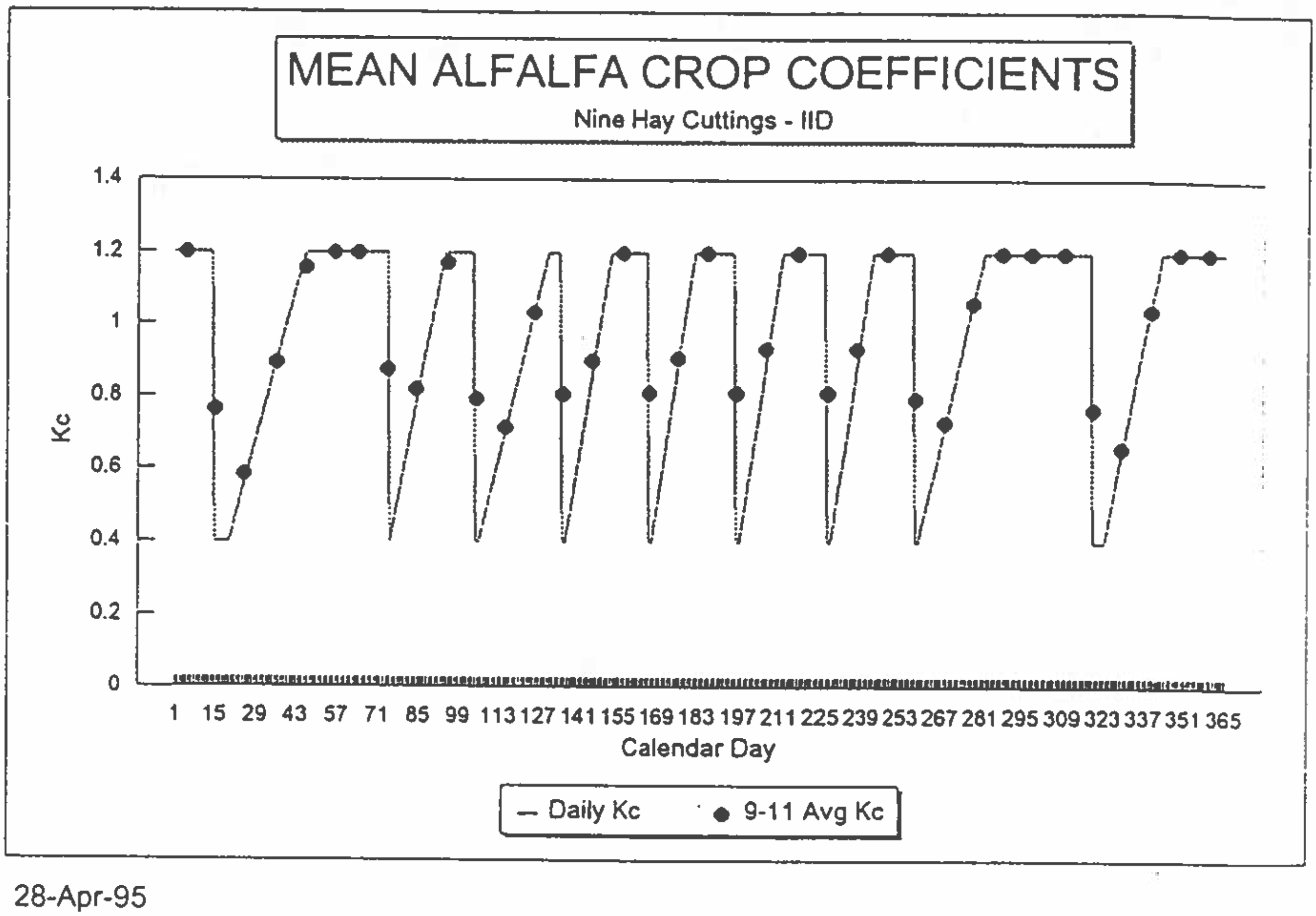


Figure 5.2 Mean daily and 9-11 day crop coefficients for potential alfalfa ET for use with CIMIS ETo.

5.5 Effective Rainfall

Effective monthly rainfall depends on the degree of crop cover when rains occur and the evaporative demand, ETo. Initially, effective rainfall was based on a component of the study conducted during Phase I. As time permits, effective rainfall amounts can be re-evaluated using IID crops and IID rainfall amounts during the five-year study period.

5.6 Evaporation Estimates

Estimates of evaporation from reservoir and flowing water surfaces were made using the Penman-Monteith equation and estimates of net radiation during Phase I of the previous study. These results indicated that estimates of evaporation could be made using the following coefficients:

Reservoirs: evaporation = 1.05 x ETo, and

Flowing water: evaporation = 1.15 x ETo.

Evaporation from flowing water is estimated to be slightly higher than from reservoirs because of an aerodynamically rougher surface and turbulence caused by canal configurations. Rainfall falling on water surfaces was assumed to be 100 percent effective in reducing evaporation of Colorado River water.

5.7 Evapotranspiration from Drainage and River Channels

Evaporation and transpiration from vegetation in drainage and river channels was assumed to be equal to reference ET, ETo. Estimated effective rainfall was used to reduce the use of Colorado River water by drain and river vegetation. These estimates differed slightly from those reported in the IID report by Boyle Engineering, Table 6.34 (Boyle, 1993).

5.8 Areas of Water Surfaces and Drain and River Channels

Areas of water surfaces and drain and river channels were obtained from the report by Boyle (1993). Areas of water surfaces, and drain and river channels for the years 1987-1992 are summarized in Table 5.3. Most of these areas are expected to remain relatively constant during the study period 1990-1994.

5.9 Other Flows and Water Deliveries

Inflow rates to the IID from Mexico were obtained from Boyle (1993) and the USBR. The values were identical since the values were obtained from same source (IID). The rate estimated for 1995 was the average for the 1990-94 period.

Table 5. 3 - *Areas of water surfaces and vegetation in drains and rivers in the Imperial Irrigation District.* Source: Boyle Engineering, Table 6-23.

Water surface or vegetated area	Area, Acres
WATER SURFACES: All American Canal	488
Main Canals	1,256
Concrete Laterals	2,015
Earthen Laterals	1,012
Reservoirs	250
DRAINS AND RIVERS: Drains, vegetative area	11,434
Drains, water surface	2,365

5.10 Spreadsheet for Estimating Future Diversions to IID

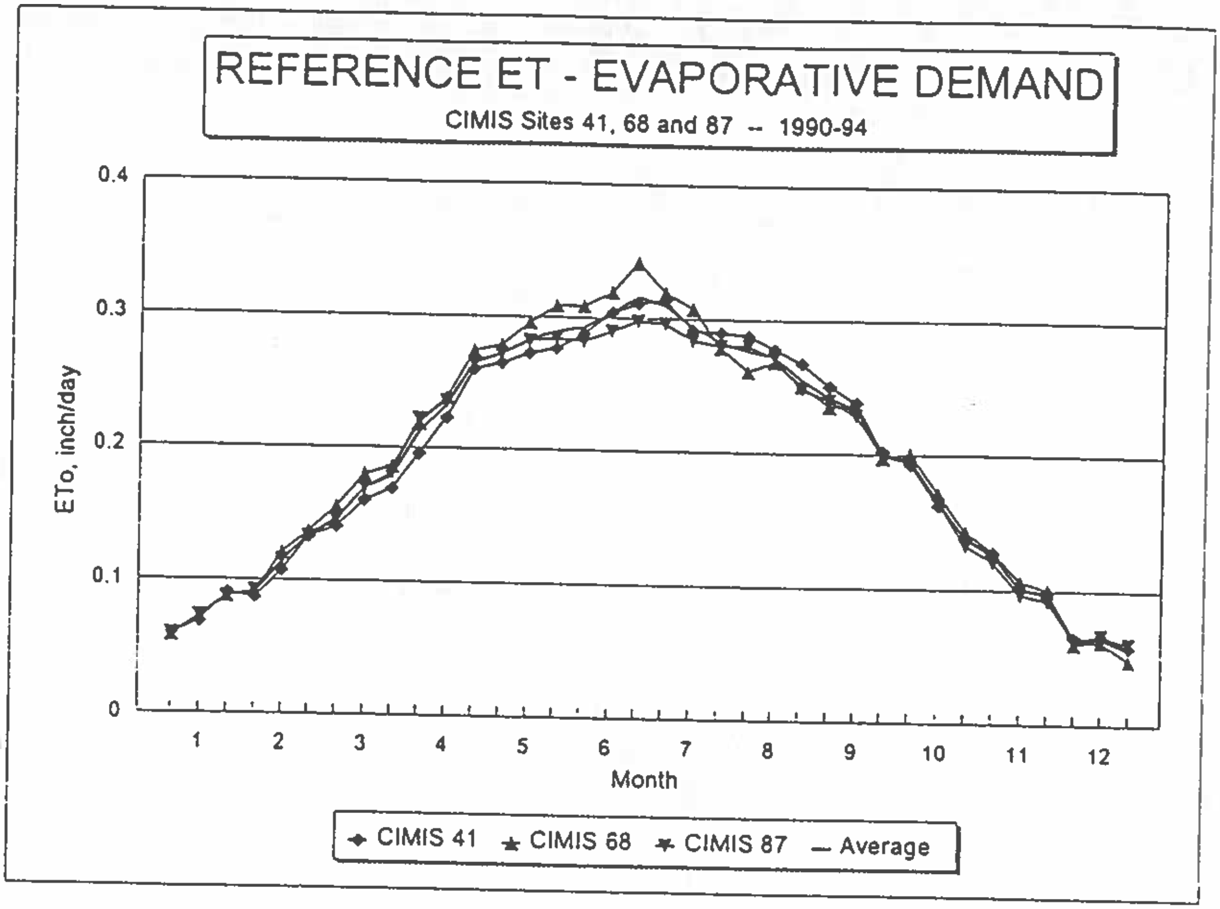
The spreadsheet developed for use by Reclamation in estimating monthly diversions to IID was evaluated using 1991-1994 test years. The initial results showed a need for monthly adjustments to account for mean soil water depletion and replenishment. During midsummer, irrigation of alfalfa apparently does not fully replenish soil water depleted by ET. Depleted soil water is replenished later in the year during lower ET demand months. Similarly, some adjustment was needed to compensate for soil water depletion-replenishment associated with estimated planting and harvest dates for annual crops. The sum of these mean monthly adjustments was zero. The adjustments only compensated for apparent changes in soil water storage. The same adjustments were used each year.

6.0 RESULTS AND DISCUSSION

6.1 Evaporative Demand or Reference ET

Average reference ET for the five-year period, 1990-1994, as represented by CIMIS ETo values are presented in Fig. 6.1. The values in Fig. 6.1 are the 9-11 day averages of ETo values measured at CIMIS stations 41-Mulberry, 68-Seeley, and 87-Meloland. The Meloland station, No. 87, was operational in 1990, the Seeley or western station, No. 68 in 1988, and the Mulberry station, No. 41 in 1987. Data from all three stations were available for the 1990-1994 period.

Annual ETo values for the 1990-94 five-year period are summarized in Table 6.1. As indicated in the Phase I report, annual ETo was less during years of above normal rainfall. With increased rain, dewpoint temperature increased, and solar radiation and wind speed decreased resulting in less evaporative demand. Total annual ETo varied less than ± 5 percent during the 1990-94 period.



Annual ETo, in. =	41 - Mulberry	68 - Seeley	87 - Meloland	Average
	69.5	71.7	69.1	70.1

Figure 6.1 - Average reference ET (CIMIS ETo) for three CIMIS stations in the Imperial Irrigation District.

Table 6.1 - *Total average annual reference evapotranspiration, ETo, and rainfall as measured by CIMIS stations 41, 68 and 87.* Source: CIMIS electronic data files.

	1990	1991	1992	1993	1994	1995*	Avg. **
REFERENCE ET: ETo, inches	74.0	67.0	66.8	71.5	71.3	70.1	70.1
Relative ETo	1.05	0.96	0.95	1.02	1.02	1.00	1.00
RAINFALL: Rain, inches	2.28	5.20	7.57	5.33	3.19	4.71	4.71
Relative Rain	0.48	1.10	1.61	1.13	0.68	1.00	1.00

* Estimated
** Average for 1990-1994

6.2 Total Annual Crop Acreages

Total annual crop acreages by field crops, garden crops and permanent crops are summarized in Table 6.2. Field crops are grown on 3/4 of the IID area receiving Colorado River water. Changes in crop acreages between 1990 and 1991 indicate some difference in methodology used. Therefore, evaluations of consumptive use were made using only the 1991-1994 period.

Table 6.2 - *Total annual crop acreages by major crop categories.* Source: IID Annual Inventory of Areas Receiving Water, 1990, and USBR for 1991-1994.

Major crops	1990	1991	1992	1993	1994	1995*	Avg. *
Field crops	377,542	403,157	400,821	401,696	415,300	420,000	399,100
Garden crops	143,314	117,596	95,754	94,653	98.704	98,700	110,004
Permanent crops	22,597	17,794	17,271	17,313	17,349	17,500	17,690
Total	541,636	525,547	515,846	513,662	531,353	536,200	526,785

* Estimated
** Average for 1991-94

6.3 Annual Diversions and Water Use

Total annual diversions to the Imperial Irrigation District are summarized in Table 6.3. Diversions at Imperial Dam minus return flow to the Colorado River (Use) decreased in 1991 and 1992 during years of above rainfall. Diversion in 1994 increased to almost the same amount as in 1990 before most of the recent conservation programs had been implemented. Gutwein and Lang (1993), in an analysis of factors affecting ordering of water in the IID, showed that rainfall events, though small, greatly affected water orders. A sharp drop in orders for water followed rainfall events. The decrease represented about twice the rainfall amount and may also reflect the decrease in evaporative demand due to increased cloudiness during and following rains as well as rainfall itself. Above normal rainfall in January 1993, for example, resulted in very low diversions that month.

Table 6.3 - *Total annual diversions and use (diversion minus return flow) to the Imperial Irrigation District for 1990-1994.* Source: USBR 1993-94, and Boyle (1993) (nonagricultural users).

	1990	1991	1992	1993	1994	1995	Avg. *
Diversion at ID	3,135,301	2,985,723	2,675,901	2,886,565	3,172,082		2,971,114
Use (Div - RF)	3,054,188	2,898,963	2,572,659	2,772,148	3,048,076		2,869,207
Relative Use	1.06	1.01	0.90	0.97	1.06		1.00
Nonagricultural deliveries	70,287	71,439	72,372	* 73,415	* 74,457		72,394

* Estimated

** Average for 1990-94

6.4 Annual Inflow to the Salton Sea

Total annual inflows to the Salton Sea and sea elevations are summarized in Table 6.4. Total inflow to the Salton Sea is closely related to the diversion to IID minus return flow (Use) at Imperial Dam (Table 6.3). A graph of cumulative drainage versus elevation of the Sea was shown in Fig. 2.2. Those data indicated a general decreasing trend in the sea level from 1988 to 1991, and an increasing trend in the sea level from 1991 through 1994.

The effect of reduced orders in 1992 from IID had a major effect on net flow to Salton Sea from IID. This indicates that orders for water, or improvements in on-farm irrigation practices, may have the largest potential for reducing flow to the Sea and controlling the rise in the sea level. The focus of conservation programs to date appears to have been mainly on structural programs for water distribution and storage. Now, it appears that greater emphasis will be needed on water management and conservation measures on farms. These will include improving on-farm irrigation systems, irrigation scheduling, and practices to reduce surface runoff during normal field irrigations and establishing annual crops.

6.5 Relationship Between Inflow to the Sea and Water Delivered to Farms

The ratio of inflow to the Salton Sea to water delivered to farms by months is shown in Fig. 6.2. The fraction of water delivered to farms is lowest in summer months when ET rates are high. The ratios were lowest from April through August. They begin to increase in August-September reaching a peak in December-January after which they begin to decrease.

The ratios in Fig. 6.3 clearly show that more of the water delivered to farms and the net supply resulted in drainage to the Salton Sea during 1992-1994 than during 1990 and 1991. These trends further show that on-farm water management practices have not improved, but may have actually deteriorated since 1990. The reasons are not apparent, but this trend indicates that a critical assessment of "reasonable" beneficial use may be required as competition for available water from the Colorado River continues to increase and the level of the Salton Sea rises.

Table 6.4 - *Annual inflow in acre-feet to the Salton Sea and sea level elevation in feet on January 1 of each year.* Sources: USBR.

	1990	1991	1992	1993	1994	1995	Avg. *
Total flow to Sea from IID	1,139,464	1,093,096	1,023,372	1,165,910	1,192,940		1,123,535
Inflow from Mexico	135,081	132,736	144,887	191,099	147,004		150,161
Net from IID	1,004,383	960,360	878,485	974,811	1,045,936		972,795
Relative net from IID	1.03	0.99	0.90	1.00	1.08		1.00
Elevation of Salton Sea, feet	-227.40	-227.74	-227.53	-227.49	-226.78	-226.49	-227.24
Change in elevation, feet		-0.34	0.21	0.04	0.71	0.29	0.20

* Average for 1990-94

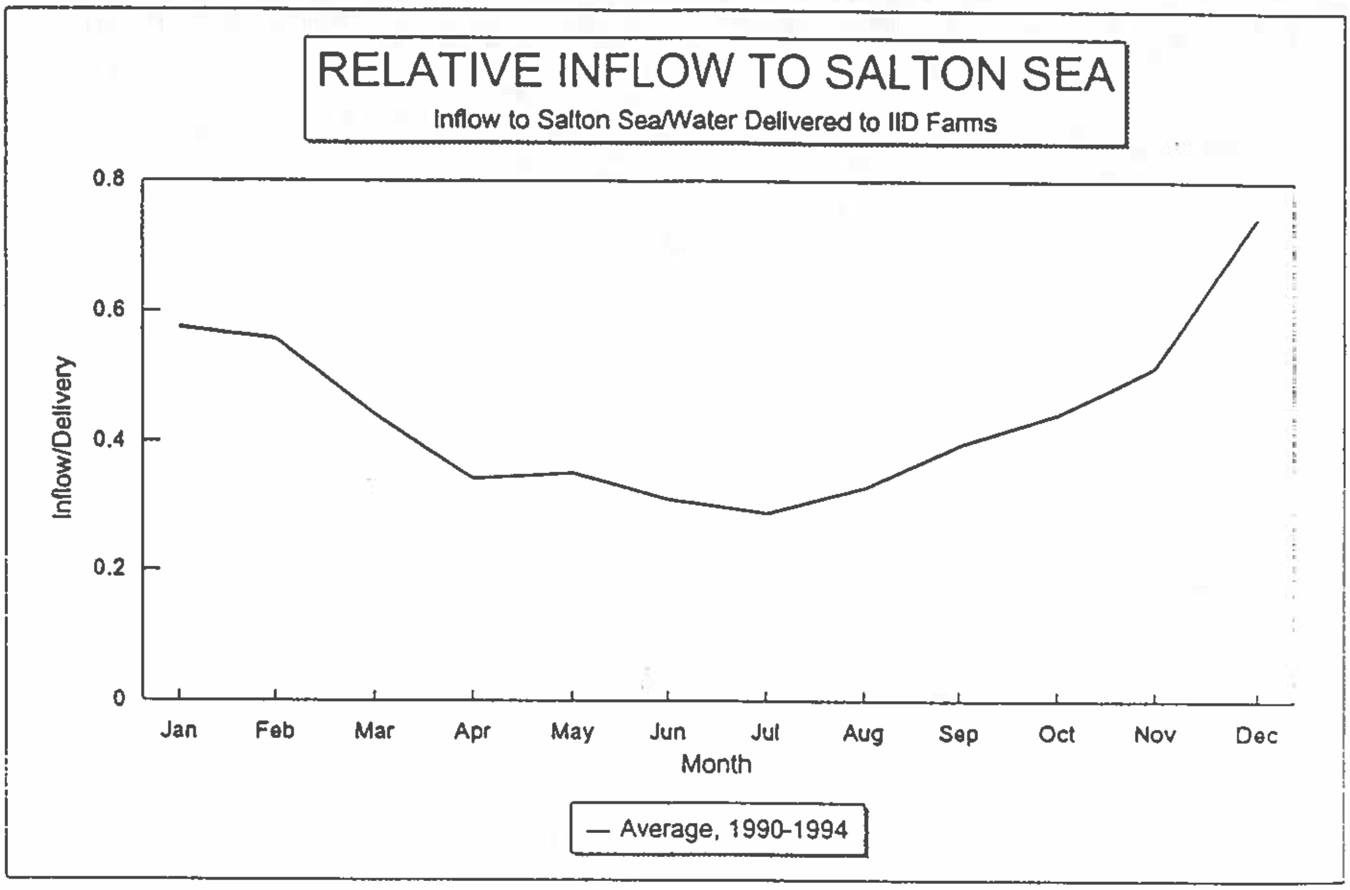


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Figure 6.2 - Average ratio of inflow to the Salton Sea from the Imperial Irrigation District to water delivered to farms by months.

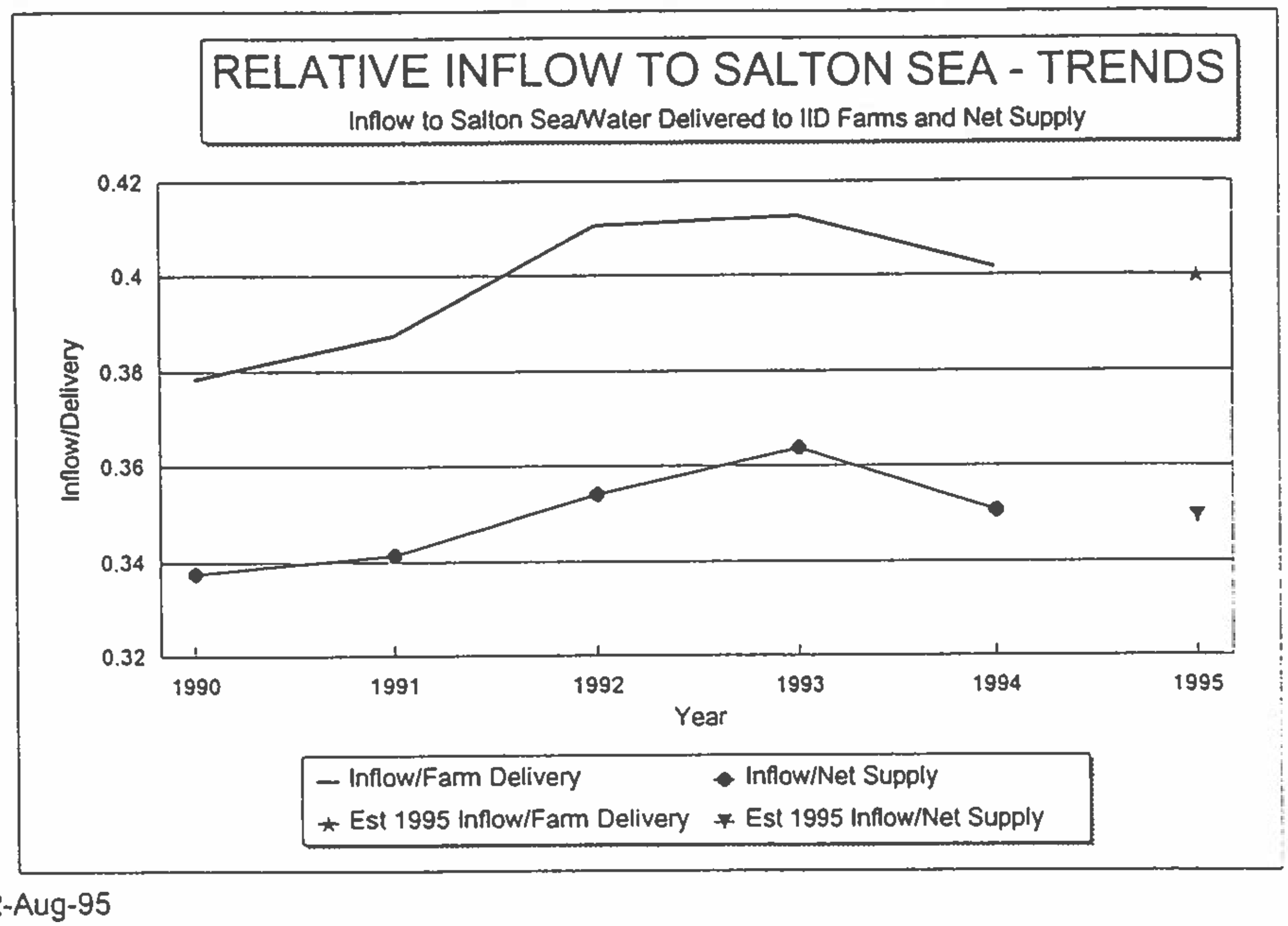

Figure 6.3 - Ratio of inflow to the Salton Sea to water delivered to farms and to net supply in the Imperial Irrigation District from 1990 to 1994.

6.6 Estimates of Crop ET and Evaporation from Water Surfaces

6.5.1 Spreadsheet Model for Estimating Crop ET and Evaporation. A spreadsheet model was developed for estimating mean monthly crop ET using mean measured evaporative demand, or CIMIS ETo, for the years 1990-1994 and crop coefficients for major field, garden and permanent crops. The initial estimates appeared to be high during summer months and low during winter months. A plot of monthly water diversion indicated that diversions were approximately the same as evaporative demand during the summer and much higher during the winter months. It is well-known that because of low intake rates on fine-textured soils, it is difficult to apply sufficient water between cuttings of alfalfa to replace water depleted by ET. Thus, it soon became apparent that alfalfa was likely extracting more soil water than was being replenished during the summer. A decrease in available soil water of 3 inches, or 0.25 foot, over 200,000 acres represents 50,000 acre-feet. As evaporative demand decreased in the fall months, replenishing depleted soil water would have an opposite effect. These effects were taken into account in the spreadsheet model by reducing the estimated diversion requirements during summer months and increasing them by a like amount during winter months. The amount for individual months essentially calibrated the model using the estimated planting and harvest dates shown in Table 5.2. If these crop planting and harvest dates are changed greatly, recalibration may be required.

6.5.2 Total Annual Estimated Evapotranspiration. Total annual estimated crop ET values for 1991 to 1995 are summarized in Table 6.5. ET from field crops represents about 77 percent of the estimated total annual ET. Garden crops account for about 9 percent, permanent crops about 5 percent, evaporation from water surfaces and ET from vegetation along drains and rivers, about 5 percent, and nonagricultural deliveries about 4 percent.

6.5.3 Net Water Supply, Water Delivered to Agriculture, and Net Inflow to Salton Sea. The net water supply to IID, water delivered to agriculture, and net inflow to the Salton Sea, or net drainage from IID is summarized in Table 6.6. Also shown is water delivered to agriculture, estimated evaporation and ET, CUest, the agricultural CUc and (1 - CUc). Estimates of agricultural consumptive use fraction, or coefficient CUc_{ag}, agree closely with the overall consumptive use fraction of water delivered to IID, CUc, except for 1992. The CUc_{ag} for 1992 appears to be unusually high and may be due to low values of monthly water deliveries to farms, or high estimated CU as illustrated (Fig. 6.4). If the estimated CU is adjusted for the ratio of individual years to the 1990-1994 average as shown in Table 6.1, the 1992 results are improved.

A summary of net supply, net drainage, and estimated total CU is shown in Fig. 6.5. These results indicate that the spreadsheet program estimates E, ET and net drainage reasonably well. The results also support the data presented in Fig. 6.3 which showed that net supply increased more than that required for crop ET and other consumptive water uses.

Table 6.5 - *Total estimated annual crop evapotranspiration by field, garden and permanent crops, evaporation and phreatophyte evapotranspiration for 1991-1994. Estimates for 1995 are based on estimated crop acreages.*

Crop & Area	1991	1992	1993	1994	1995	91-94 Avg.
Field Crops	1,433,630	1,354,869	1,371,885	1,413,702	1,432,263	1,393,517
Garden Crops	180,916	146,084	149,298	155,312	155,287	157,903
Permanent Crops	88,866	87,603	87,516	87,516	87,472	87,848
Evaporation & Phreatophyte ET	96,562	96,652	96,652	96,652	96,652	96,652
Deliveries, Non-agr	71,439	71,439	71,439	71,439	71,439	71,439
Total	1,871,412	1,756,558	1,776,571	1,824,530	1,843,023	1,807,268

Table 6.6 - *Annual net water supply to the Imperial Irrigation District, net drainage to the Salton Sea in acre-feet and ratios of water consumed by evaporation and evapotranspiration to net water supply, and water delivered to farms, estimated agricultural consumptive use in acre-feet and ratios of water consumed to water delivered to farms. Estimates for 1995 based on January-June net supply, and 1994 net supply and farm delivery for July-December.*

Item	1991	1992	1993	1994	1995	87-94 Avg
Net Supply, Wn	2,813,019	2,481,845	2,677,597	2,984,067	2,995,010	2,803,069
Net Drainage, Dn	930,370	878,485	973,811	1,045,936	1,045,936	949,911
CUc = (Wn-Dn)/Wn	0.659	0.646	0.636	0.649	0.651	0.661
(1 - CUc)	0.341	0.354	0.349	0.399	0.349	0.339
Water delivered to farms, Wf	2,478,977	2,213,444	2,359,044	2,604,195	2,616,460	2,458,949
Wf/Wn	0.881	0.862	0.881	0.873	0.874	0.877
Est agr CU, CUag (1)	1,703,412	1,588,557	1,608,571	1,656,530	1,675,022	- -
Est agr CUc =CUag/Wf	0.696	0.743	0.682	0.636	0.640	- -
(1 - CUcag)	0.304	0.257	0.318	0.364	0.360	- -

1. Estimate for 1995 based on estimated crop acreage for 1995.

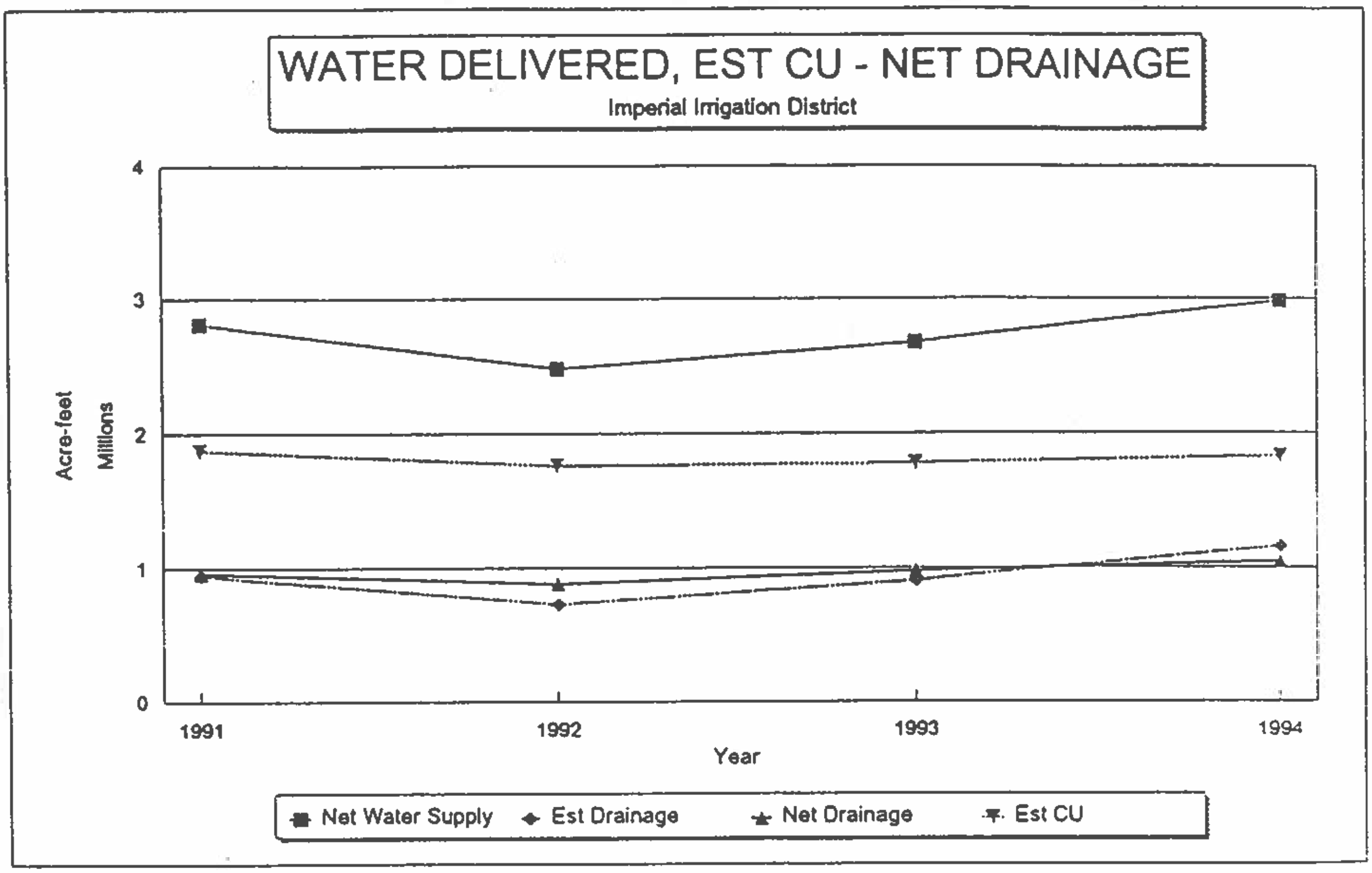

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Figure 6.4 - Net water supply to the Imperial Irrigation District and net drainage from IID, estimated total consumptive use, and estimated drainage using the spreadsheet program.

6.7 Estimated versus Measured Diversions for 1990-94

6.6.1 Evaluation of the Spreadsheet Model. Estimates of mean monthly diversion requirements for crop CU and evaporation from water surfaces and diversion requirements using measured net drainage for 1991-94 are shown in Fig. 6.5 - 6.8. The ET for alfalfa was assumed to be 0.80 of the potential ET for alfalfa based on nine cuttings for hay and soil water not limiting the ET rate. Adjustments for average soil water depletion-storage were made has explained in section 6.5.1. Estimated monthly use diversion requirements were compared with actual monthly diversions for each year. The results indicated that the estimates based on CIMIS ETo and crop and water surface coefficients agree well with actual diversions except for several specific months such as January 1993 when rainfall was much above normal (Fig. 6.10). The differences generally were greatest during December through March when rains occur and may also reflect the effects of assumed planting and harvest dates. Verification of assumed crop planting and harvest dates and updated crop acreages are needed before attempting to refine the spreadsheet model further.

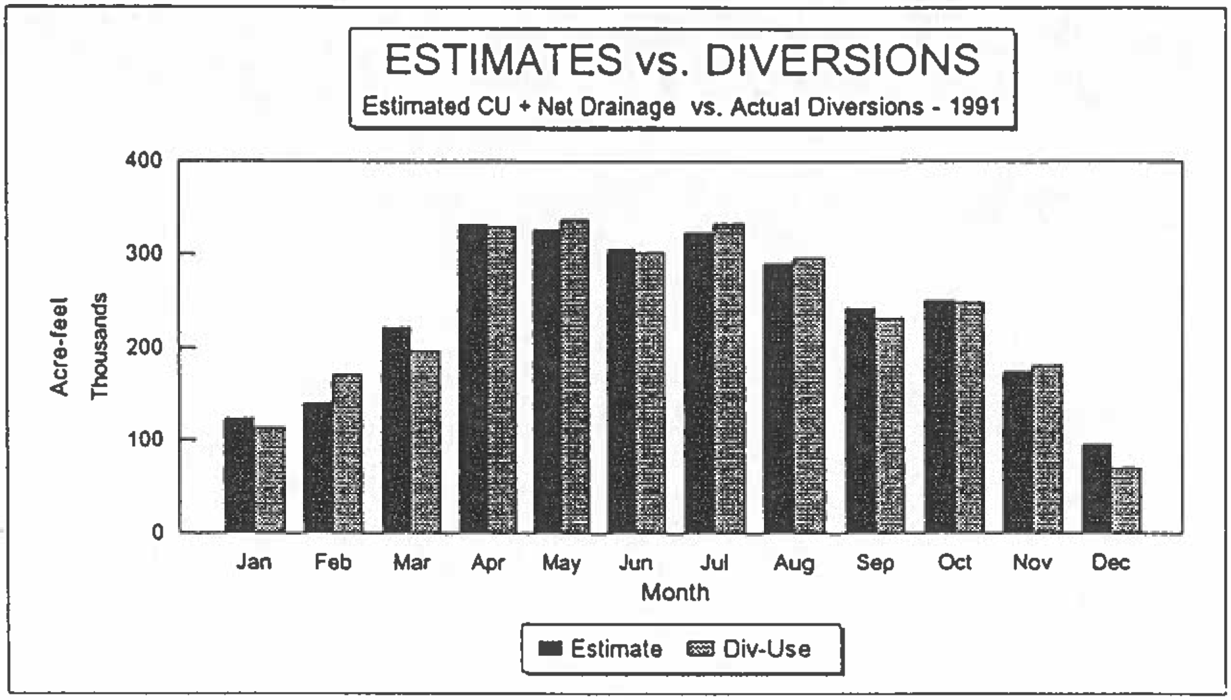
6.5.2 Evaluation of Estimated vs. Measured Diversions for 1991-94. An evaluation of the spreadsheet model for estimating diversions for 1991-1994 was made using the difference between estimated and actual net water delivered. The results are summarized in Table 6.7. They indicate that diversions were higher than the estimates in 1994 when ratio of the inflow to the Salton Sea was high. The diversions were lower than the estimates in 1992 and 1993 when rainfall was above average. The overall standard error (SE) of the difference between monthly estimates and actual diversions for the four years was 23,200 acre-feet with a coefficient of variability (CV) of 10.2 percent. The SE cannot be attributed only to estimates of crop ET and evaporation, but rather must be attributed to both estimates and actual diversions that may be higher or lower than that required

Table 6.7 - *Average difference in estimated versus measured monthly diversions for the Imperial Irrigation District, actual annual net water delivered, the standard error (SE) of the difference for each year, and the overall standard deviation of the difference in acre-feet and coefficient of variability (CV) in percent for the Imperial Irrigation District.*

Month	1991	1992	1993	1994	1995	Average *
Diff., annual total	18,760	153,200	72,790	-113,600		32,790
Net Supply to IID	2,813,020	2,481,845	2,677,600	2,984,070		2,739,130
Difference, percent	0.7	6.2	2.7	-3.8		1.4
Standard error	15,300	14,000	37,000	9,200		23,200**
Overall coefficient of variability, percent	--	--	--	--		10.2**

* 1991-1994

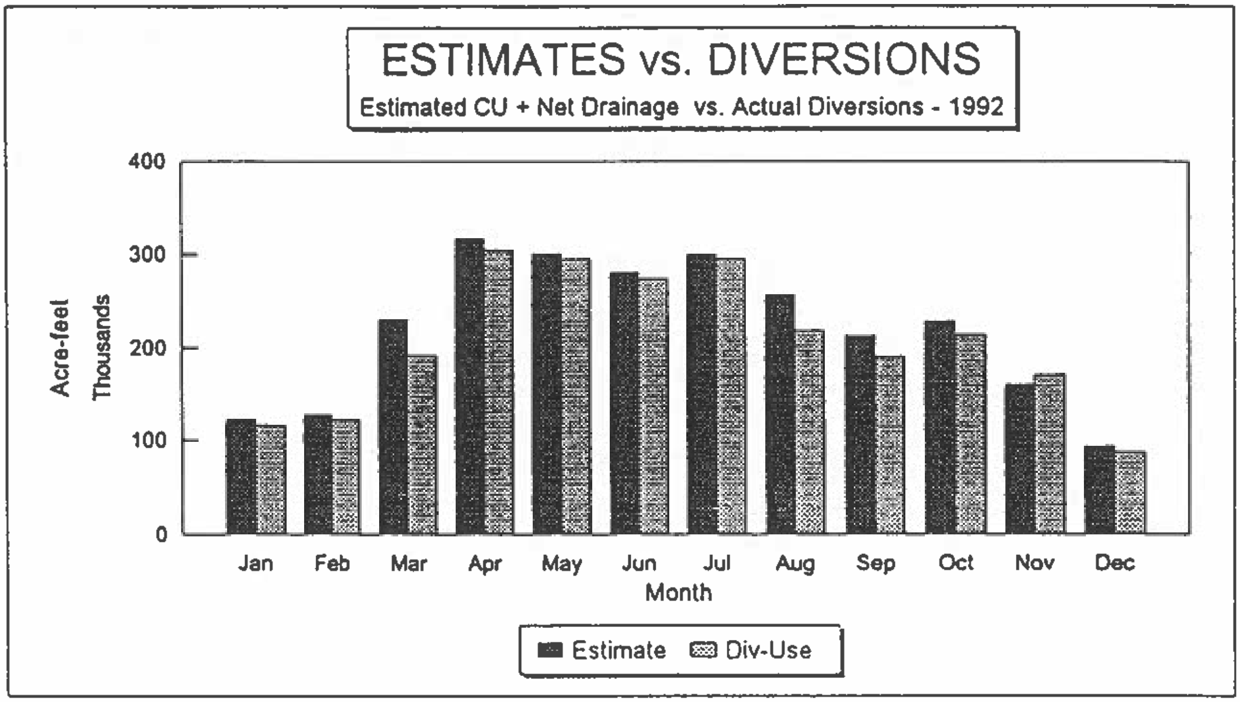
** Overall standard monthly error, ac-ft, and coefficient of variability, percent, for the four-year period.



14-Jun-95 **Alf Adj =** 0.80 **ET Factor** 1.00

SUMMARY: Period	Estimates	Net Supply	Est - Div	Est - Div, %	Per mo Est - Div
Jan-Feb	264,792	285,177	(20,385)	-7.1%	(10,192)
Mar-Apr	554,623	526,280	28,343	5.4%	14,171
May-July	957,076	973,465	(16,389)	-1.7%	(5,463)
Aug-Oct	784,317	777,015	7,302	0.9%	2,434
Nov-Dec	270,974	251,082	19,892	7.9%	9,946
Total	2,831,782	2,813,019	18,763	0.7%	

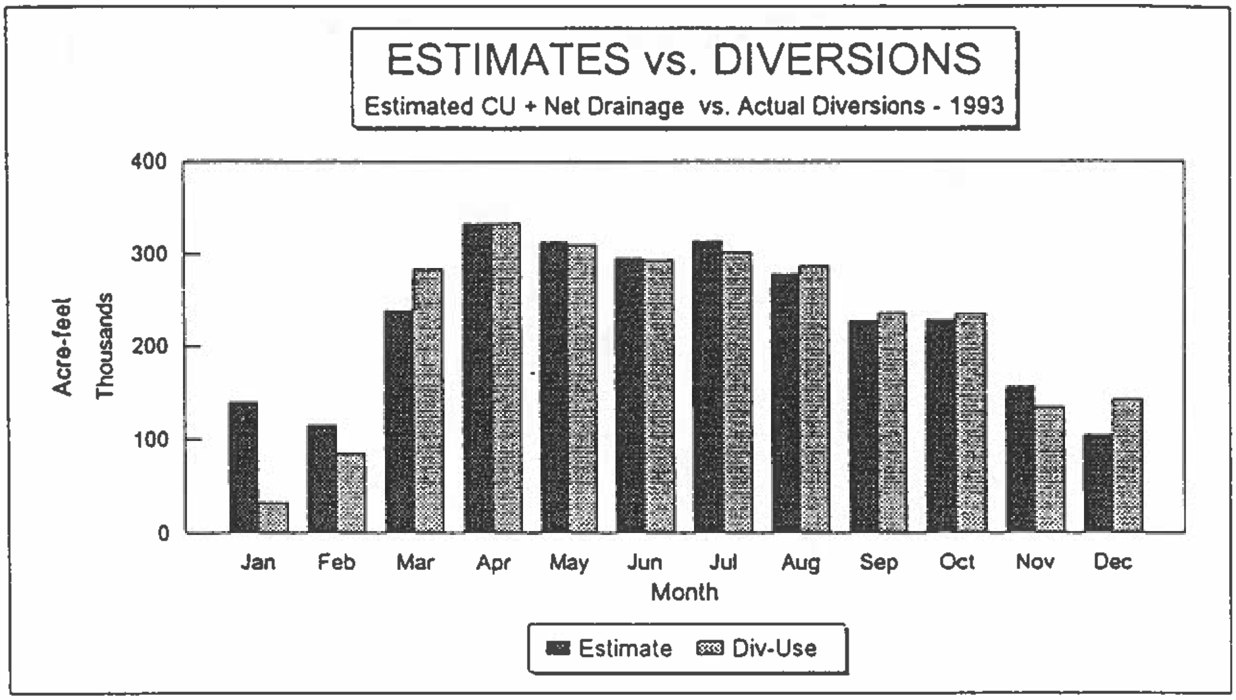
Figure 6.5 - Comparison of monthly diversion requirements for the Imperial Irrigation District with actual diversions for farm delivery in 1991 along with summaries by various periods during the year.



16-Jun-95 Alf Adj = 0.80 ET Factor 1.00

SUMMARY: Period	Estimates	Net Supply	Est - Div	Est - Div, %	Per mo Est - Div
Jan-Feb	249,468	238,056	11,412	4.8%	5,706
Mar-Apr	549,210	497,516	51,694	10.4%	25,847
May-July	884,588	866,580	18,008	2.1%	6,003
Aug-Oct	699,534	622,341	77,193	12.4%	25,731
Nov-Dec	252,242	257,352	(5,110)	-2.0%	(2,555)
Total	2,635,043	2,481,845	153,198	6.2%	

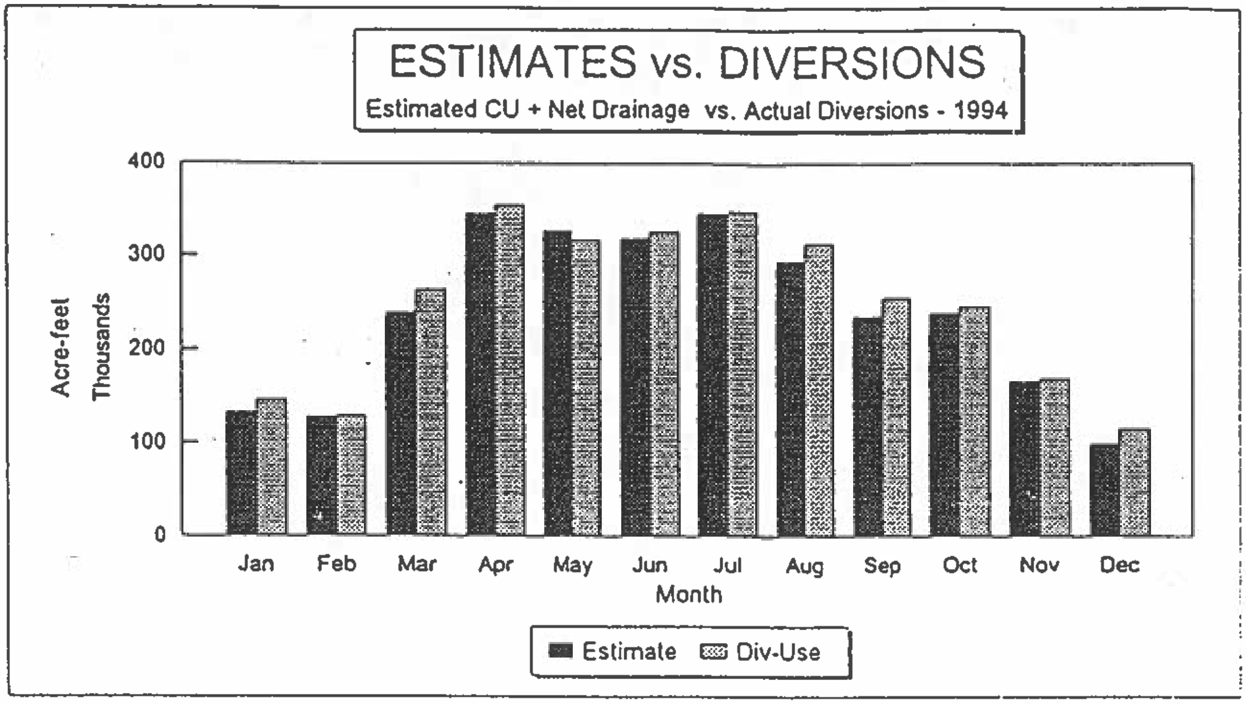
Figure 6.6 - Comparison of monthly diversion requirements for the Imperial Irrigation District with actual diversions for farm delivery in 1992 along with summaries by various periods during the year.



16-Jun-95 Alf Adj = 0.80 ET Factor 1.00

SUMMARY: Period	Estimates	Net Supply	Est - Div	Est - Div, %	Per mo Est - Div
Jan-Feb	255,904	116,942	138,962	118.8%	69,481
Mar-Apr	572,312	617,942	(45,630)	-7.4%	(22,815)
May-July	925,045	908,027	17,018	1.9%	5,673
Aug-Oct	735,074	757,503	(22,429)	-3.0%	(7,476)
Nov-Dec	262,047	277,183	(15,136)	-5.5%	(7,568)
Total	2,750,382	2,677,597	72,785	2.7%	

Figure 6.7 - Comparison of monthly diversion requirements for the Imperial Irrigation District with actual diversions for farm delivery in 1993 along with summaries by various periods during the year.



16-Jun-95 Alf Adj = 0.80 ET Factor 1.00

SUMMARY: Period	Estimates	Net Supply	Est - Div	Est - Div, %	Per mo Est - Div
Jan-Feb	260,323	275,358	(15,035)	-5.5%	(7,517)
Mar-Apr	584,884	619,005	(34,121)	-5.5%	(17,060)
May-July	991,543	990,879	664	0.1%	221
Aug-Oct	768,896	815,082	(46,186)	-5.7%	(15,395)
Nov-Dec	264,819	283,743	(18,924)	-6.7%	(9,462)
Total	2,870,466	2,984,067	(113,601)	-3.8%	

Figure 6.8 - Comparison of monthly diversion requirements for the Imperial Irrigation District with actual diversions for farm delivery in 1994 along with summaries by various periods during the year.

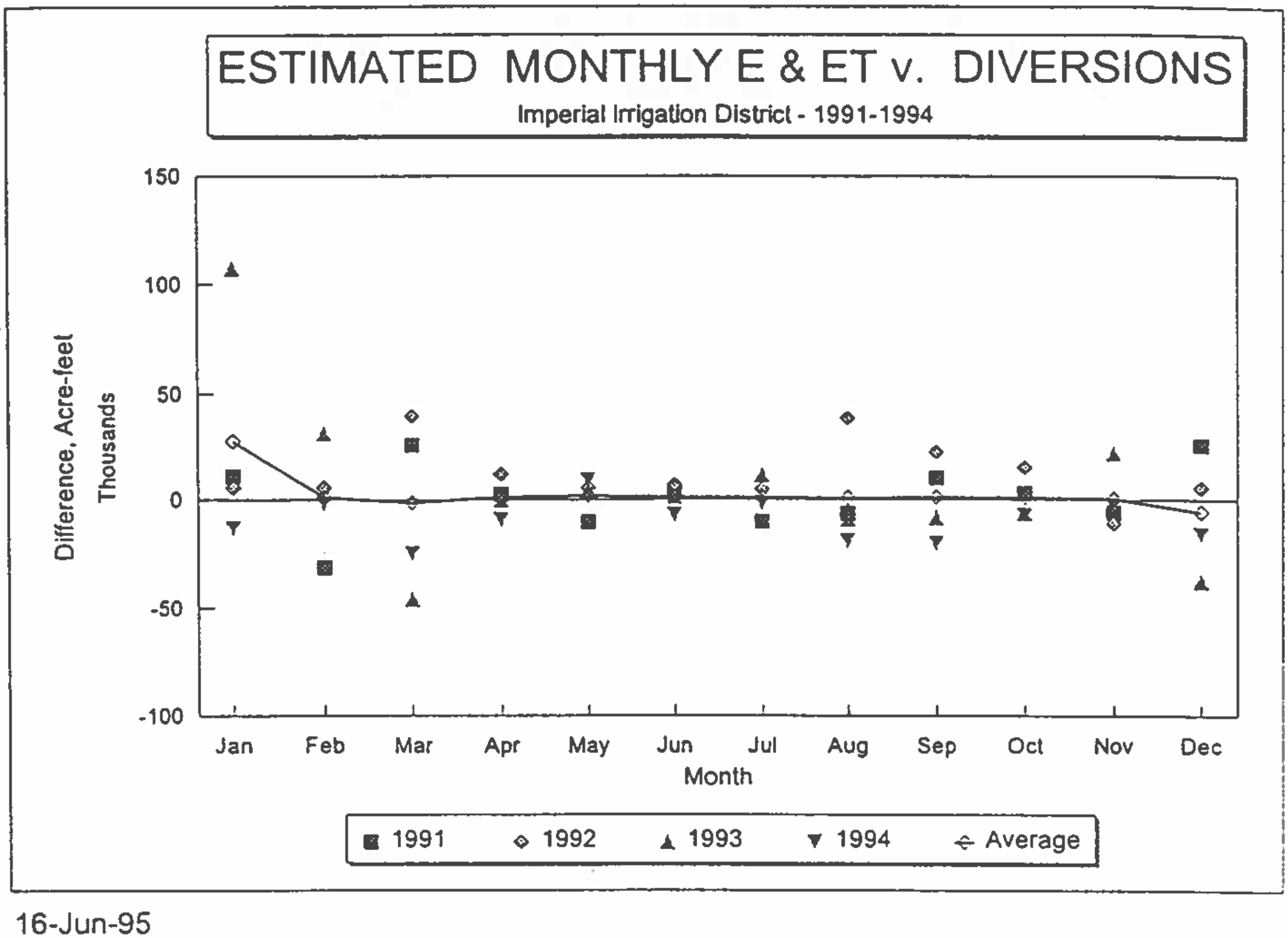


Figure 6.9 - Summary of monthly differences between estimates of total evaporation and evapotranspiration and drainage and net water supply by individual months and the four-year mean.

6.8 Projections of Water Use for 1995-96

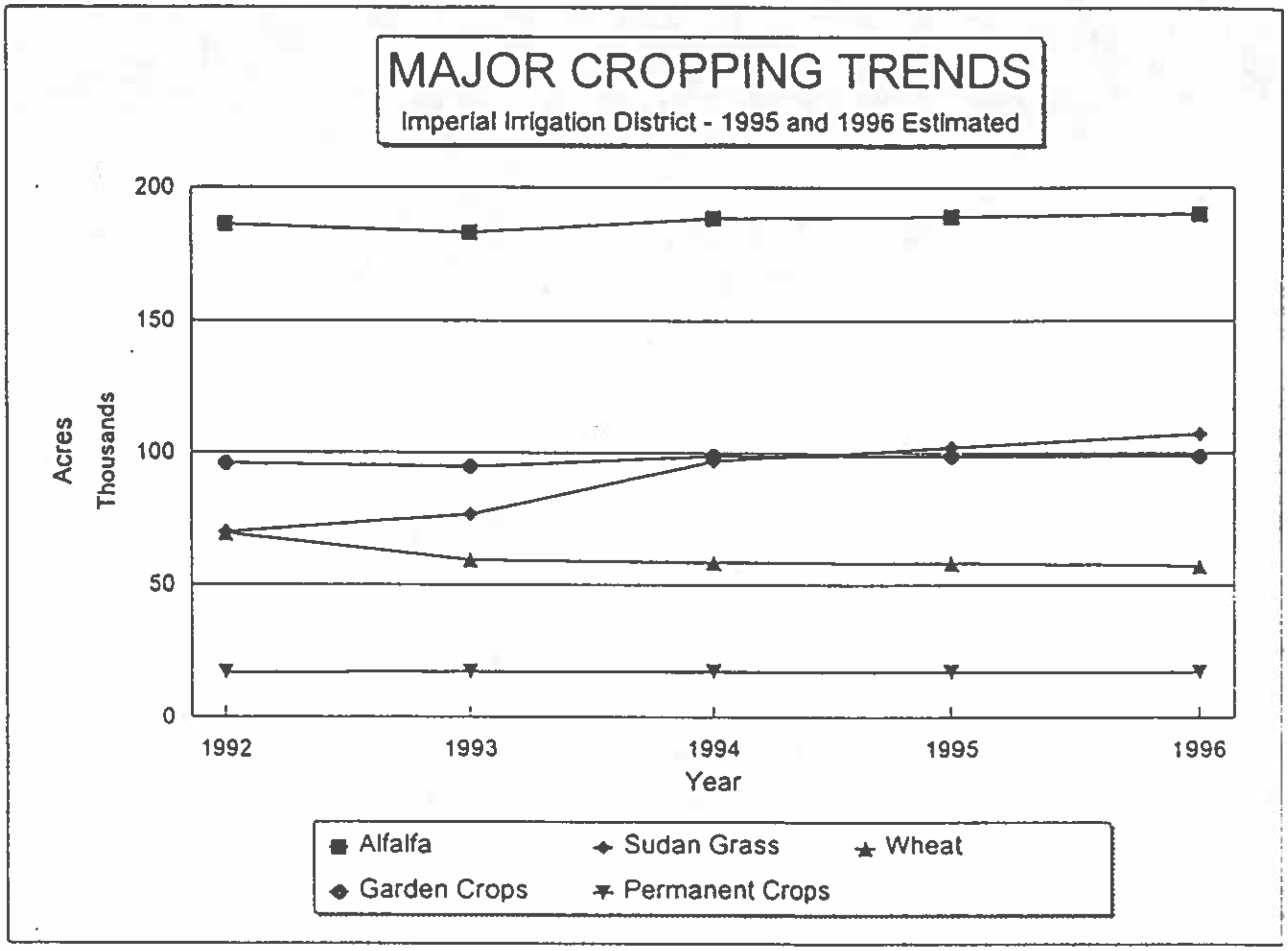
The spreadsheet model was used to estimate water use for 1995 using projected 1995 crop acreages since actual 1995 acreages were not available (Tables 6.2 and 6.5). Trends of 1992-1994 acreages for several major crops were used to estimate 1995 values as shown in Fig. 6.10. Average CIMIS 1990-1994 reference ET data were used although 1995 data are now available for part of the year.

6.9 Estimates and Projections of Beneficial Uses for 1995-96

Estimates of beneficial uses of water were made in the previous 1987-1992 water use assessment were summarized in Table 3 -13 of that draft report. Similar estimates were made for 1993-1995 using the results of the spreadsheet model for estimating crop ET. The results of the two studies are shown in Fig. 6.11. Estimates of beneficial use include the same fraction of ET for the leaching requirement (ET x 0.1235) as was used in the previous study. The estimates of beneficial uses using the spreadsheet model for the two overlapping years were 11 percent higher. However, when adjusting for the difference in other beneficial uses, the difference was 9 percent. In the 1987-1994 study, the study team indicated that estimated crop ET should have been at least 5-7 percent higher if increased evaporation following irrigations and evaporation during preplant or soil preparation were included. In the spreadsheet model, estimates of increased evaporation values following preplant irrigation and crop establishment were included. In addition, the alfalfa yield-ET relationship was slightly modified by including yield-ET data from Israel in the new relationship. Actual alfalfa ET was estimated to be 80 percent of potential alfalfa ET (water never limiting) which was the average ratio of yield-based ET to potential alfalfa ET. The net effect of these procedures were higher ET estimates for alfalfa. The difference between the annual estimated consumptive use and the net water supply and measured inflow to the Salton Sea from the IID generally agreed closely during each of the four test years.

The ratios of inflow to the Salton Sea to net supply and to farm delivery shown in Fig. 6.3 indicated that the ratio of inflow to the Salton Sea from the IID relative to net supply or relative to delivery to farms had increased substantially during 1992-1994 compared with 1990-1991. These data were extended to include 1995 in Fig. 6.12. The monthly net supplies for 1995 were based on 1995 January-June data and 1994 July-December data since the cumulative total for January-June in 1995 was essentially the same as in 1994 (Fig. 6.13). Actual crop acreages should be used for 1996 estimates using similar procedures. The estimated 1995 ratios of inflow to the Salton Sea relative to net supply and to farm deliveries were 0.35 and 0.40, respectively. These values indicate that ratios of inflow to the Salton Sea to net supply or farm delivery in 1995 will be about the same as in 1994 and they will be substantially higher than in 1990 and 1991.

The difference between net supply and beneficial uses during the period 1993-1995 is about 200,000 acre-feet larger than that for 1990-1991. Expressed as the fraction of the water delivery to farms that is used beneficially, or irrigation efficiency, the fraction of water delivered that was used beneficially has decreased from about 78 percent in 1990-91 to 72 percent in 1994-95 as shown in Fig. 6.14. This trend indicates that significant changes are needed in on-farm irrigation systems and water management practices to reduce the spread between net supply and beneficial use and to increase irrigation efficiency to at least back to what was being achieved in 1990-91. Irrigation technology, including irrigation scheduling has improved greatly in recent years. The data presented in this study show that such improvements are not being applied adequately in the IID. Greater effort is needed to improve on-farm systems and practices including the adaption of modern irrigation scheduling technology.



28-Jul-95

Figure 6.10 - Trends in major crop acreages for 1992-94 and projected acreages for 1995 and 1996.

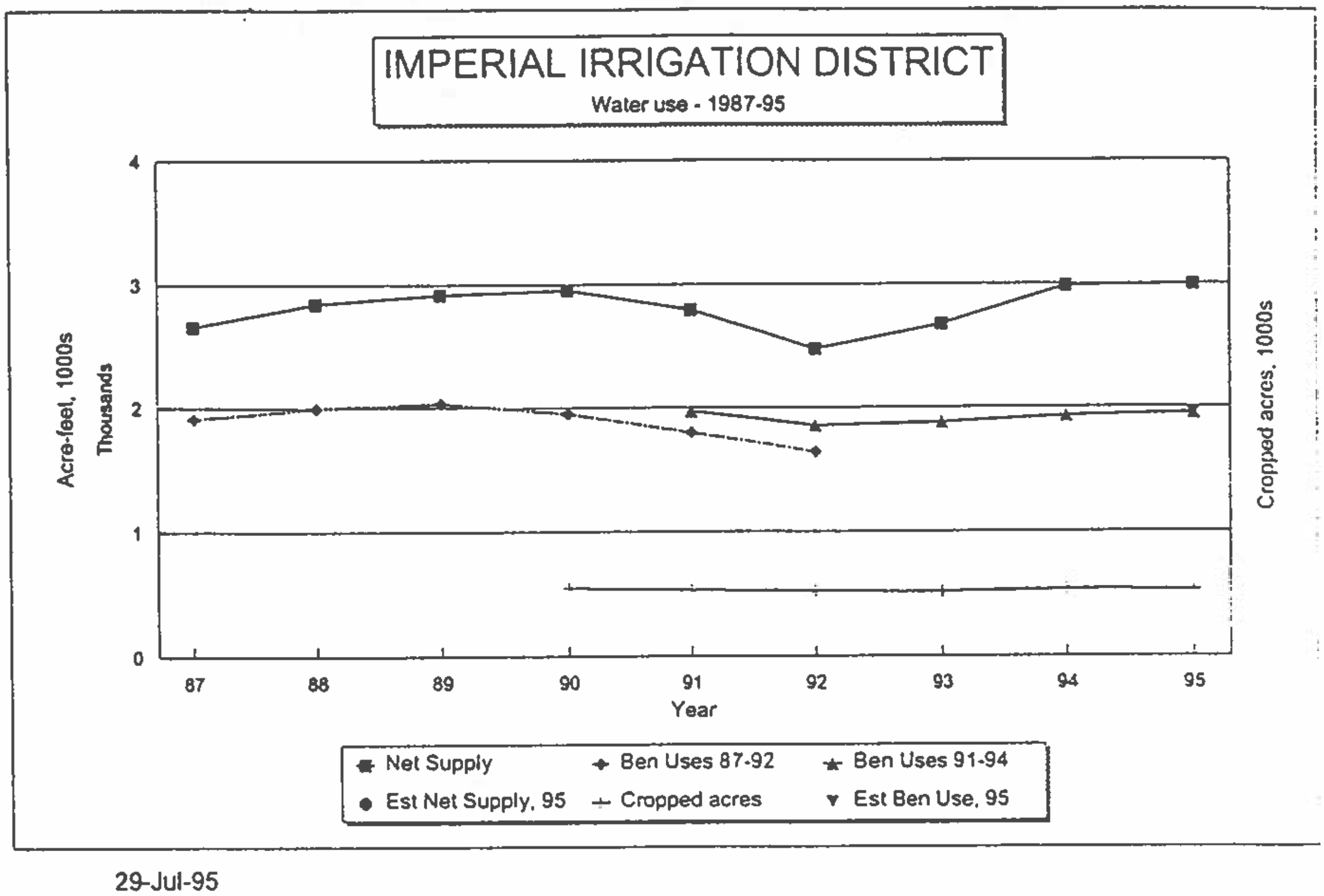


Figure 6.11 - Net water supply, beneficial water uses and crop acreages for the Imperial Irrigation District from 1987 to 1994 and estimated values for 1995.

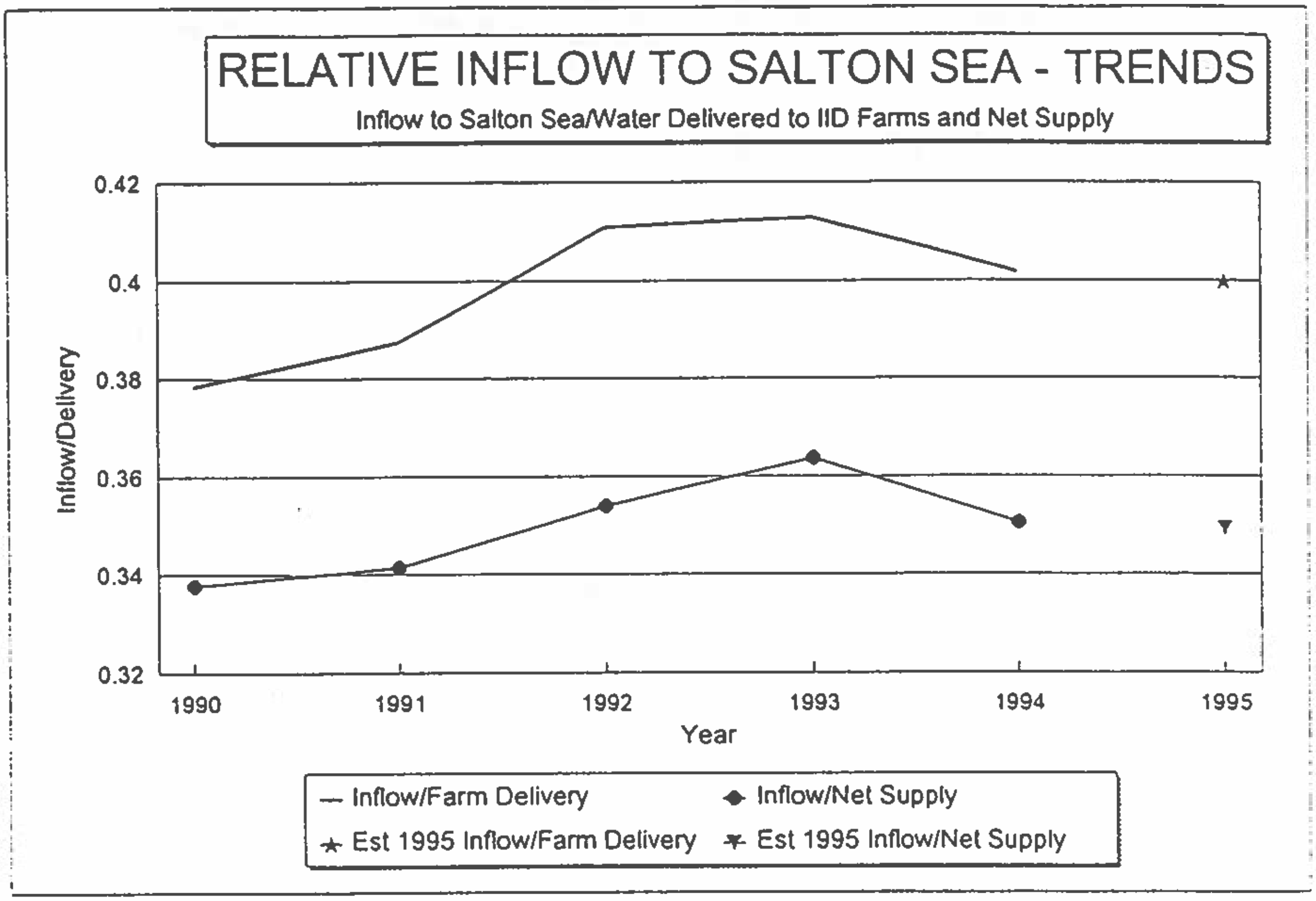
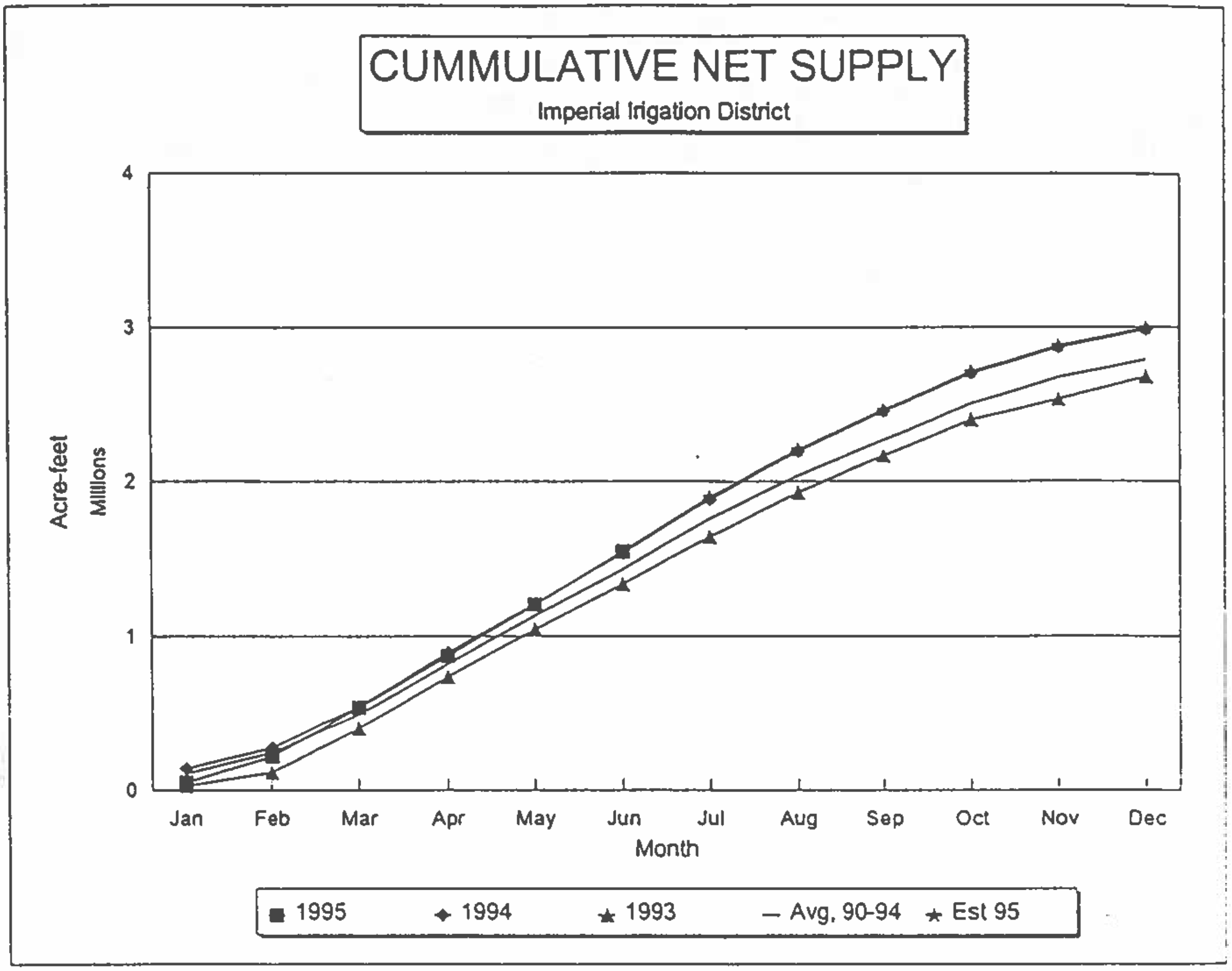


Figure 6.12 - Ratios of inflow to the Salton Sea to water delivered to farms and to net water supply in the Imperial Irrigation District from 1990 to 1994, and estimated ratios for 1995.



28-Jul-95

Figure 6.13 - Cumulative net supply to the Imperial Irrigation district for 1993 and 1994, average net supply for 1990-1994, and estimated net supply for 1995 based on actual data for January-June and 1994 data for July-December.

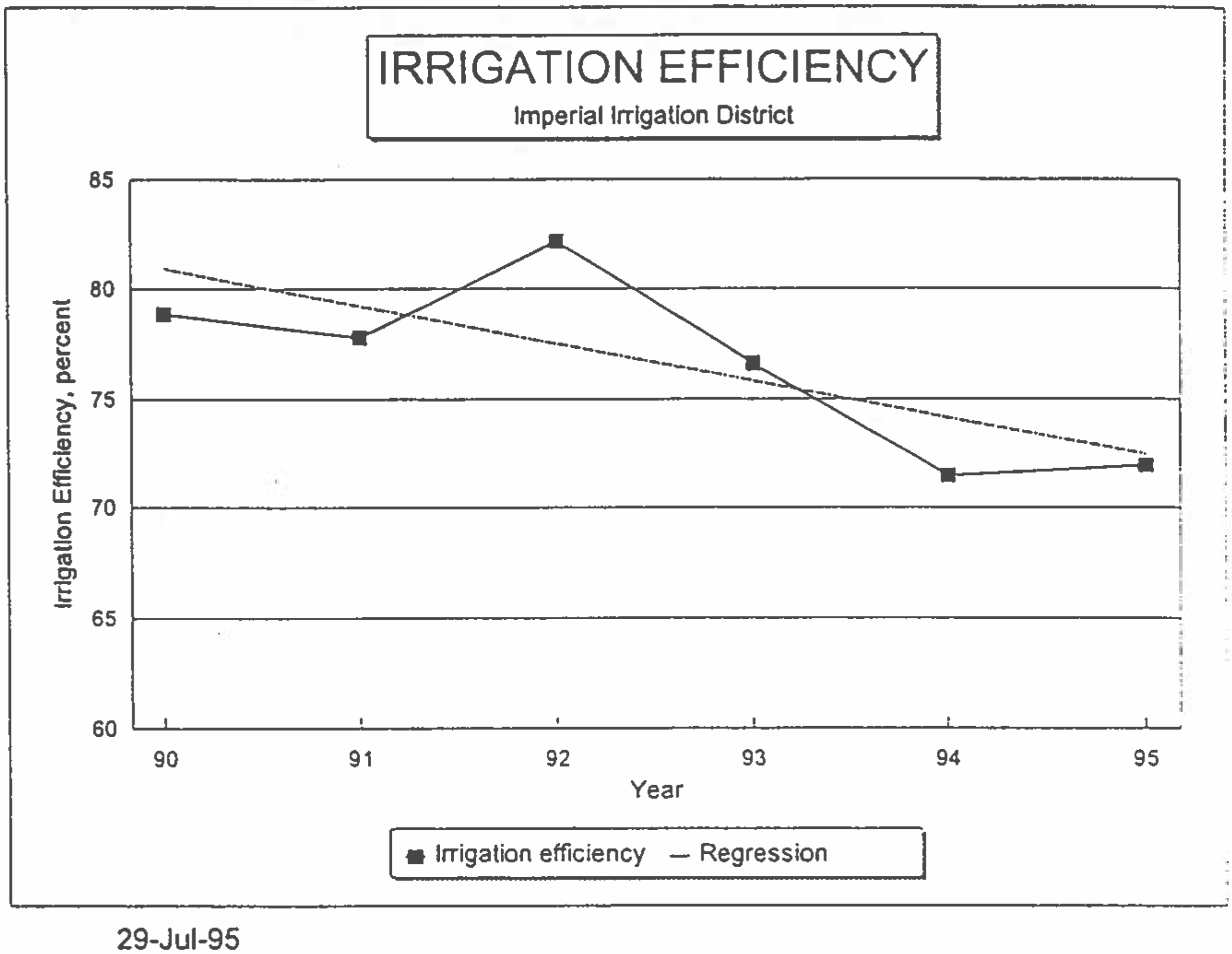


Figure 6.14 - Trend in beneficial uses versus water delivery to farms, or irrigation efficiency, from 1990 to 1995. Values for 1995 were based on estimated cropped acreages and water deliveries.

6.10 Factors Considered, Determinations, and Recommendations for 1995-96

As required by CRF 43, ¶417.3, the following factors are to be considered by the Regional Director in arriving at the determinations and recommendations concerning water deliveries for 1995-1996. These statements were prepared for consideration by the Regional Director.

6.10.1 Climate. The climate of the Imperial Valley is known for its high summer temperatures and low rainfall. The California Irrigation Management Information System (CIMIS) has established automated climate stations throughout California. These stations record a number of climatic variables. The dominant variables that affect the rate of daily evapotranspiration are solar radiation, humidity, temperature, and wind speed. Solar radiation is the primary variable determining reference ET. Solar radiation during summer months remains nearly constant from year to year because of limited cloud cover. Humidity is consistently very low except when rainfall is above normal. Windspeed is generally very low compared to other arid irrigated sites. The parameter that integrates climatic effects on evaporative demand is reference ET, ETo. CIMIS stations calculate ETo hourly and sum the results to obtain daily values. Three CIMIS stations were used in this study to represent average conditions in the IID. The differences between average 9 to 11-day means for these stations are relatively small (Page 2, Appendix B). The average annual ETo for these three stations for the 1990-1994 period deviated from the overall average less than $\pm$ 1.6 inches. The annual average of the three stations deviated from the overall mean by 2 to 5 percent (Table 6.1 and Appendix B, p. 20). These data indicate that the three-station average 9 to 11-day ETo values can be used to estimate evaporative demand for estimating monthly diversions. Rainfall is more variable (Table 6.1 and Appendix B, p. 2). The fraction of summer rainfall that is effective is almost zero due to increased evaporation from soils and plants following rains.

6.10.2 Location. The Imperial Irrigation District's location is unique in several ways. First, the district is located at a large distance below water storage reservoirs. Water orders must be anticipated and estimated in advance since travel time from reservoirs to the district is about one week. Second, return flows from irrigated land do not return to the Colorado River. Instead, surface and subsurface drainage flows to the Salton Sea and is no longer available for any traditional beneficial water uses. Thus, any improvement in conveyance, distribution, and on-farm irrigation efficiency translates directly to potential reductions in diversion requirements.

6.10.3 Land Classification. The topography of the IID is well-suited for surface irrigation. However, much of the soils are fine-textured (clay) and have shallow water tables. The soils crack when dry, but generally have very low infiltration rates that make it difficult to apply sufficient water to replace water used in ET during summer months. Surface runoff from border strip or furrow irrigation that enters drains compromises the bulk of the inflow to the Salton Sea. Return flow, or pump-back, systems generally are not used although some demonstration systems have been constructed and are being monitored. Use of return flow systems is commonly practiced by farmers who pump water because it reduces pumping costs. In the high plains of Texas, irrigation runoff from irrigated land is not permitted by the ground water conservation district even though most soils are fine textured. In that area, return flow systems have become almost mandatory or farmers have converted to sprinkler irrigation. As competition for limited water continues to increase, and the value of water for other uses increases, the amount of water that is reasonably used for beneficial purposes must also reflect alternative beneficial uses and values.

6.10.4 Kinds of Crops. Many speciality, high-value crops are grown in the IID, Table 5.1. About 76 percent of the crops irrigated are field crops, 21 percent are garden or specialty crops, and 3 percent are permanent crops. Of the field crops, about 65 percent are alfalfa and Sudan grass.

6.10.5 Cropping Practices. The acreage of speciality crops varies with market potentials. The acreage of alfalfa and Sudan grass has been increasing. Alfalfa, once established, is cropped for 5-6 years during which time the plant stand deteriorates in the later years due to increasing soil salinity and other pest problems. Soil salinity increases on alfalfa because of the difficulty in applying sufficient water between cuttings. Alfalfa is harvested for hay about nine times per year. Much of the alfalfa hay is chopped and dehydrated, but alfalfa hay is also baled for shipment to cattle feeding locations. Fewer cuttings are made when alfalfa is harvesting for seed.

6.10.6 Systems Used. Almost all of the lands are irrigated with surface or gravity systems. These systems generally consist of sloping border strips and furrows. Some level systems, which have no surface runoff, have been tried, but are not considered suitable by most farmers. Level systems on fine textured soils require careful management to avoid scalding of plants during the hot part of the season. Sprinkler systems are used primarily to germinate and establish stands of crops that have very small seeds. After establishment, the solid set sprinkler systems are removed and the fields are irrigated by furrows or border strips. Drip irrigation systems, including some subsurface drip systems, are being tested in demonstration fields. Drip systems could be used on high-value crops to both germinate and establish stands and to provide irrigation water the balance of the cropping season. There should be no surface runoff with drip systems.

6.10.7 Carriage System. Many improvements have been made in the carriage systems and in regulating reservoirs since the IID agreement with the Metropolitan Water District. In addition to lining canals, improved flow control and flow measurement structures have been installed. Flow rates at many structures are monitored remotely, and flow rates at many structures can now be controlled remotely.

6.10.8 Water Orders and Records. During the past several years, the IID has been modernizing its system of recording water orders by using electronic data recorders that can be downloaded directly into the computer system. These same systems can be used by ditch riders to record the type of crop being grown on individual fields. The effects or impacts of the new system on water orders and monitoring of these orders by IID personnel is not known at this time. The system has the capacity to permit IID personnel to monitor all, or to monitor selected fields, to determine if water orders agree with estimated crop water requirements.

6.10.9 Orders Rejected. Records of water orders, monitoring practices, and orders rejected are not available to this consultant at this time. The increase in water orders in 1993, 1994 and in 1995 indicate that little or no monitoring may be occurring, or water ordering policies are not being implemented or are ineffective.

6.10.10 General Operating Practices. The trends in data presented in Fig. 6.10-6.14 indicate that general operating practices in the IID need to be reviewed and improved. Project management relative to water orders, records of water orders and crops grown, monitoring of amounts of water delivery appears to have declined in effectiveness since 1990.

6.10.11 Operating Efficiencies. The overall annual operating efficiencies expressed as beneficial uses (evapotranspiration and leaching) divided by water deliveries to farms shown in Fig. 6.14 show a disturbing trend. Operating efficiency in terms of managing water for beneficial uses has been declining rather than increasing as expected with all of the improvements that have been made in recent years. The recent rise in the level of the Salton Sea indicates that more water is being diverted to IID relative to beneficial uses in recent years than in 1990-91.

6.10.12 Irrigation Methods. Most irrigations are being made with surface methods except for germination and establishment of specialty and high value crops. Surface irrigation can be relatively efficient on the fine textured provided attention is given to stream size, timely changing of irrigation sets, and full attention of irrigators during irrigations. Return flow systems and level borders are valid options that must be considered as water supplies become scarce. Irrigation scheduling utilizing reference ET data provided by CIMIS can also reduce excess water applications.

6.10.13 Return Flow. Because of its location and topography, the amount of return flow from the IID to the Colorado River is almost negligible. Some of the seepage from the All-American becomes available to water users in Mexico. Thus, all improvements in water management in IID contribute directly to improvements in irrigation efficiencies because all excess water applied is lost to other beneficial uses of the Colorado River water.

6.10.14 M & I Contracts. Up to date information on water deliveries to M & I users were not available to the consultant at this time. Estimates were based on previous data.

6.10.15 Provisions. The consultant is not aware of pertinent special provisions of the Contractor's Boulder Canyon Act water delivery contract.

7.0 SUMMARY AND CONCLUSIONS

California water users have recently approached or exceeded the water allocated from Colorado River because of increasing demands for water and the completion of the Central Arizona Project (CAP). In a recent agreement between the Imperial Irrigation District (IID) and the Metropolitan Water District (MWD) of southern California (IID and MWD, 1989), MWD agreed to finance a conservation program in the IID, particularly improving water storage and delivery systems. In return, IID agreed to reduce its requests for Colorado Water in an amount equal to the quantity of water conserved by the Program. The IID has also implemented other water conservation measures. However, diversions in 1994 were essentially the same as in 1990. Estimates of beneficial water uses indicate that if the net water supply to the IID and farm deliveries in 1995 continue as they have from January through June, the ratio of beneficial use to net water supply and to water deliveries to farms will be significantly lower than in prior years. The ratios of beneficial use to farm deliveries, or irrigation efficiencies, have been decreasing indicating that major changes are needed in farm irrigation systems and irrigation practices.

The largest potential for reducing diversion to the IID and reducing inflow to the Salton Sea from the IID is to improve on-farm irrigation systems and practices. With surface irrigation systems on fine-textured soils, surface runoff, or tail water, is the main component affecting irrigation efficiency. Total infiltration on these soils during an irrigation does not increase much after runoff begins. Continued irrigation for fixed time periods appears to be a major factor affecting irrigation efficiency. Pump-back and surface runoff capture systems for redistributing surface runoff are commonplace in many irrigated areas where water supplies are limited or expensive, but not in the IID. On-farm irrigation management also involves scheduling irrigations to replace soil water used in evapotranspiration (ET) before soil water stress affects crop growth. Estimates of ET and soil water depletion to schedule irrigations and limit water application amounts to that which can be retained or infiltrated in the soil can reduce surface runoff and/or deep percolation.

The net water supply to the Imperial Irrigation District has increased from 1991 to 1994, and if they continue in 1995, the net supply in 1995 will be about as much as it was in 1994. The irrigated crop acreages increased slightly in 1994 and were estimated to increase for some crops in 1995. During the 1990-94 period, the water level of the Salton Sea has risen. Sea elevations in January 1994 and 1995 were the highest since 1987. The trend in the sea level versus cumulative net drainage from IID was downward from 1988 to 1991. Since 1991, the trend has been upward. Water levels of the Sea are also affected by rainfall on the sea, runoff from adjacent areas, and evaporative demand as indicated by reference evapotranspiration measurements (CIMIS ETo). However, the main variable affecting the sea level is net drainage from the IID. Since 1991, the ratios of drainage to water delivered to farms, or drainage to net water supply, have increased indicating a reduction in irrigation efficiencies. Basically, net water supply to the Imperial Irrigation District increased more than evaporation and evapotranspiration from 1992 to 1994.

A spreadsheet model was developed for estimating mean monthly crop ET in the IID using mean measured evaporative demand, or CIMIS ETo, for the years 1990-1994 and crop coefficients for major field, garden and permanent crops. Estimates of ET indicated that field crops account for about 77 percent of the estimated total annual ET, garden crops about 9 percent, permanent crops about 5 percent, evaporation from water surfaces and ET from vegetation along drains and rivers, about 5 percent, and nonagricultural deliveries about 4 percent.

Estimated monthly use diversion requirements with the spreadsheet program compared with actual monthly diversions for 1991-1994 indicated that the estimates based on CIMIS ETo and crop and water surface coefficients agree well with actual diversions except for months of December through March when monthly rainfall amounts are more variable. The overall standard error (SE) of the difference between monthly estimates and actual diversions for the four years was 23,200 acre-feet with a coefficient of variability of 10 percent. The SE cannot be attributed only to estimates of crop ET and evaporation, but rather must be attributed to both estimates and actual diversions that may be higher or lower than that required. These results indicate that the spreadsheet program estimates E, ET and net drainage reasonably well. The results also support other data which show that net supply has increased more than that required for crop ET and other consumptive water uses.

8.0 REFERENCES

Bauder, J.W., A. Bauer, J.M. Ramirez, and D.K. Cassel. 1978. Alfalfa water use and production on dryland and irrigated sandy loam. *Agron. J.*, 70:95-99.

Boyle Engineering Corporation. 1993. *On-Farm Irrigation Efficiency*. Special Report for the Imperial Irrigation District, August, 100 pp. Plus Appendices A-C.

Code of Federal Regulations. 43 CFR Ch. 1 (10-1-93 Edition). 1993. *Procedural Methods for Implementing Colorado River Water Conservation Measures with Lower Basin Contractors and Others*, pp. 490-493.

Gutwein, B.J., and R.J. Lang. 1993. Regional irrigation demand. *J. Irrig. And Drain. Engr.*, 119:829-847.

Imperial Irrigation District (IID) and Metropolitan Water District of Southern California (MWD). 1989. *Agreement for the Implementation of a Water Conservation Program and Use of Conserved Water.* December.

Kipnis, T., I. Vaisman, and I. Granoth. 1989. Drought stress and alfalfa production in a Mediterranean environment. *Irrig. Sci.*, 10:113-125.

National Research Council Committee on Western Water Management, Water Science and Technology Board. 1992. *Water Transfers in the West*, National Academy Press, Washington, 318 pp.

Sammis, T.W. 1981. Yield of alfalfa and cotton as influenced by irrigation. *Agron. J.*, 73:323-329.

Silva, J.P. 1990. *1990 Water Report*, Imperial Irrigation District, 110 pp.

9.0 APPENDICES

Appendix A - 43 CFR Ch. 1 (1-10-93 Edition) Part 417-Procedural Methods for Implementing Colorado River Water Conservation Measures with Lower Basin States and Others

Appendix B - Water Budget Items

Appendix C - Working Spreadsheet for Estimating and Evaluating Water Use by IID

Appendix D - Working Spreadsheet for Updating IID's Water Balance

APPENDIX A

43 CFR Ch. 1 (1-10-93 Edition)

Part 417

ject to assessment by a district on the same basis as other lands of like character within the operation of the district.

(c) Settlement lands, which the United States is not under contract to sell or exchange at the time a district makes its levy may be assessed by a district to the extent of the construction charge obligation installment required to be levied for the following year on such lands on account of the district's construction cost obligation to the United States. No other levies shall be made by a district against settlement lands in this status.

(d) While settlement lands which the United States has leased for use as irrigated lands and which the United States has not contracted to sell or exchange may not be assessed by a district except as provided in paragraph (c) of this section, lessees shall pay the district the same amounts annually that would be required to be paid for water service if the lands were subject to assessment therefor, in addition to any assessment levied under paragraph (c) of this section.

(e) Assessments made by a district against settlement lands while the United States is under contract to sell or exchange such lands shall be subject to all interest and penalties for delinquency as provided by the laws of Washington, but interest and penalties shall cease to accumulate on the date such contract is terminated or the purchaser's interest therein reacquired by the United States.

(f) No action shall be taken by or for a district to enforce any lien created as permitted under the regulations in this part by assessment foreclosure or other means that would purport to transfer any right in or title to any land or interests therein while title thereto is vested in the United States. Although the United States does not assume any obligation for the payment of such liens, it will in any conveyance of settlement lands covered thereby convey subject to those liens.

§ 413.4 Assessment of other project act lands and rights of way.

(a) A district shall, as to other project act lands and rights of way the title to which passes to the United States on or after January 1 of any year and before the district has levied its assessments for that year, immediately remove the lands from its assessment rolls and shall not thereafter take any proceedings to complete or enforce the assessments. Any such removal from the rolls shall be effective as of January 1 of the year in which title passes to the United States Action so to remove shall be taken promptly after the giving of written notice by the Project Manager to the district as to the lands involved, and the district shall provide the United States with a certificate stating that the lands have not been and will not be assessed so long as title thereto remains in the United States.

(b) There is no authority in law for the assessment of rights of way owned by the United States. Accordingly, a district shall make no assessment thereof while title thereto remains in the United States.

(c) Other project act lands while title thereto remains in the United States shall not be assessed for any district charge so long as they are in the "other project act lands" category.

§ 413.5 Reports on status of settlement lands.

The Project Manager will furnish each district prior to its annual levy every year a list of all the settlement lands owned by the United States for which water is available and which are not under contract of sale or exchange and therefore are not to be assessed by the district, except for construction charge obligation installments under §413.3(c) when such charges are required to be levied.

PART 417—PROCEDURAL METHODS FOR IMPLEMENTING COLORADO RIVER WATER CONSERVATION MEASURES WITH LOWER BASIN CONTRACTORS AND OTHERS

Sec.

AUTHORITY: 45 Stat. 1057, 1060; 43 U.S.C. 617; and Supreme Court Decree in "Arizona v. California," 376 U.S. 340.

SOURCE: 37 FR 18076, Sept. 7, 1972, unless otherwise noted.

§ 417.1 Scope of part.

The procedures established in this part shall apply to every public or private organization (herein termed "Contractor") in Arizona, California, or Nevada which, pursuant to the Boulder Canyon Project Act or to provisions of other Reclamation Laws, has a valid contract for the delivery of Colorado River water, and to Federal establishments other than Indian Reservations enumerated in Article II(D) of the March 9, 1964, Decree of the Supreme Court of the United States in the case of "Arizona v. California et al.", 376 U.S. 340 (for purposes of this part each such Federal establishment is considered as a "Contractor"), except that (a) neither this part nor the term "Contractor" as used herein shall apply to any person or entity which has a contract for the delivery or use of Colorado River water made pursuant to the Warren Act of February 21, 1911 (36 Stat. 925) or the Miscellaneous Purposes Act of February 25, 1920 (41 Stat. 451), (b) Contractors and permittees for small quantities of water, as determined by the Regional Director, Bureau of Reclamation, Boulder City, Nev. (herein termed "Regional Director"), and Contractors for municipal and industrial water may be excluded from the application of these procedures at the discretion of the Regional Director, and (c) procedural methods for implementing Colorado River water conservation measures on Indian Reservations will be in accordance with § 417.5 of this part.

§ 417.2 Consultation with Contractors.

The Regional Director or his representative will, prior to the beginning of each calendar year, arrange for and conduct such consultations with each Contractor as the Regional Director may deem appropriate as to the making by the Regional Director of annual recommendations relating to water conservation measures and operating practices in the diversion, delivery, distribution and use of Colorado River water, and to the making by the Regional Director of annual determinations of each Contractor's estimated water requirements for the ensuing calendar year to the end that deliveries of Colorado River water to each Contractor will not exceed those reasonably required for beneficial use under the respective Boulder Canyon Project Act contract or other authorization for use of Colorado River water.

§ 417.3 Notice of recommendations and determinations.

Following consultation with each Contractor and after consideration of all relevant comments and suggestions advanced by the Contractors in such consultations, the Regional Director will formulate his recommendations and determinations relating to the matters specified in §417.2. The recommendations and determinations shall, with respect to each Contractor, be based upon but not necessarily limited to such factors as the area to be irrigated, climatic conditions, location, land classifications, the kinds of crops raised, cropping practices, the type of irrigation system in use, the condition of water carriage and distribution facilities, record of water orders, and rejections of ordered water, general operating practices, the operating efficiencies and methods of irrigation of the water users, amount and rate of return flows to the river, municipal water requirements and the pertinent provisions of the Contractor's Boulder Canyon Project Act water delivery contract. The Regional Director shall give each Contractor written notice by registered or certified mail, return receipt requested, of his recommendations and determinations. If the recommendations and determinations include a reduction in the amount of water to be delivered, as compared to the calendar year immediately preceding, the notice shall be delivered to the Contractor or timely sent by registered or certified mail, return receipt requested, so that it may reasonably be delivered at least 30 days prior to the first date water delivery would be affected thereby, and shall specify the basis for such reduction including any pertinent factual determinations. The recommendations and determinations of the Regional Director shall be final and conclusive unless, within 30 days of the date of receipt of the notice, the Contractor submits his written comments and objections to the Regional Director and requests further consultation. If, after such further consultation, timely taken, the Regional Director does not modify his recommendations and determinations and so advises the Contractor in writing, or if modifications are made but the Contractor still feels aggrieved thereby after notification in writing of such modified recommendations and determinations, the Contractor may, before 30 days after receipt of said notice, appeal to the Secretary of the Interior. During the pendency of such appeal, and until disposition thereof by the Secretary, the recommendations and determinations formulated by the Regional Director shall be of no force or effect. In the event delivery of water is scheduled prior to the new recommendations and determinations becoming final, said delivery shall be made according to the Contractor's currently proposed schedule or to the schedules approved for the previous calendar year, whichever is less.

§417.4 Changed conditions, emergency, or hardship modifications.

A Contractor may at any time apply in writing to the Regional Director for modification of recommendations or determinations deemed necessary because of changed conditions, emergency, or hardship. Upon receipt of such written application identifying the reason for such requested modification, the Regional Director shall arrange for consultation with the Contractor with the objective of making such modifications as he may deem appropriate under the then existing conditions. The Regional Director may initiate efforts for further consultation with any Contractor on his own motion with the objective of modifying previous recommendations and determinations, but in the event such modifications are made, the Contractor shall have the same opportunity to object and appeal as provided in §417.3 of this part for the initial recommendations and determinations. The Regional Director shall afford the fullest practicable opportunity for consultation with a Contractor when acting under this section. Each modification under this section shall be transmitted to the Contractor by letter.

§417.5 Duties of the Commissioner of Indian Affairs with respect to Indian Reservations.

(a) The Commissioner of Indian Affairs (herein termed "Commissioner") will engage in consultations with various tribes and other water users on the Indian Reservations listed in Article II (D) of said Supreme Court Decree, similar to those engaged in by the Regional Director with regard to Contractors as provided in §417.2 of this part. After consideration of all comments and suggestions advanced by said tribes and other water users on said Indian Reservations concerning water conservation measures and operating practices in the diversion, delivery, distribution and use of Colorado River water, the Commissioner shall, within the limits prescribed in said decree, make a determination as to the estimated amount of water to be diverted for use on each Indian Reservation covered by the above decree. Said determination shall be made prior to the beginning of each calendar year. That determination shall be based upon, but not necessarily limited to, such factors as: The area to be irrigated, climatic conditions, location, land classifications, the kinds of crops raised, cropping practices, the type of irrigation system in use, the condition of water carriage and distribution facilities, record of water orders, and rejections of ordered water, general operating practices, the operating efficiencies and methods of irrigation of the tribes and water users on each reservation, the amount and rate of return flows to the river, municipal water requirements, and other uses on the reservation. The Commissioner of Indian Affairs shall deliver to the Regional Director written notice of the amount of water to be diverted for use upon each Indian Reservation for each year 60 days prior to the beginning of each calendar year and the basis for said determination. The determination of the Commissioner shall be final and conclusive unless within 30 days of the date of receipt of such notice the Regional Director submits his written comments and objections to the Commissioner of Indian Affairs and requests further consultation. If after such further consultation, timely taken, the Commissioner does not modify his determination and so advises the Regional Director in writing or if modifications are made by the Commissioner but the Regional Director still does not agree therewith, the Regional Director may, within 30 days after receipt of the Commissioner's response, appeal to the Secretary of the Interior for a decision on the matter. During the pendency of such appeal and until disposition thereof by the Secretary, water deliveries will be made to the extent legally and physically available according to the Commissioner's determination or according to the Commissioner's determination for the preceding calendar year, whichever is less.

(b) Modifications of said determinations due to changed conditions, emergency or hardship may be made by the Commissioner, subject, however, to the right of the Regional Director to appeal to the Secretary, as provided in the case of an initial determination by the Commissioner. During the pendency of such an appeal, water deliveries will be made on the basis of the initial determination.

§417.6 General regulations.

In addition to the recommendations and determinations formulated according to the procedures set out above, the right is reserved to issue regulations of general applicability to the topics dealt with herein.

PART 418—NEWLANDS RECLAMATION PROJECT, NEVADA; TRUCKEE RIVER STORAGE PROJECT, NEVADA; AND WASHOE RECLAMATION PROJECT, NEVADA-CALIFORNIA (TRUCKEE AND CARSON RIVER BASINS, CALIFORNIA-NEVADA); PYRAMID LAKE INDIAN RESERVATION, NEVADA; STILLWATER AREA, NEVADA

Sec.

AUTHORITY: Sec. 10, 32 Stat. 388, *et seq.*; 43 U.S.C. 373.

SOURCE: 32 FR 3098, Feb. 21, 1967, unless otherwise noted.

§418.1 Statement of considerations leading to the proposed adoption of general operating criteria and principles relating to the captioned stream systems.

(a) Under authority of the Act of Congress approved June 17, 1902 (32 Stat. 388), commonly known as the Reclamation Act, and acts amendatory thereof or supplementary thereto, including the Washoe Project Act of August 1, 1956 (70 Stat. 775), as amended by the Act of August 21, 1958 (72 Stat. 705), and the Federal Water Pollution Control Act of July 9, 1956, as amended (33 U.S.C. 466 *et seq.*) the Secretary of the Interior is charged with responsibility for the management of the water supplies available to the Newlands Project, Nevada, to the Truckee River Storage Project, Nevada, and to the Washoe Project, California-Nevada. He is also required to provide for the construction, operation and maintenance of the authorized fa-

APPENDIX B

WATER BUDGET ITEMS

Appendix "B"
Water Budget Items

A. Water Supplies

a. All surface water supplies, imported and originating within the District.
b. Ground water extracted by the District or its customers.
c. Precipitation.
d. Recycled water.
e. Other supplies.

B. Water Uses

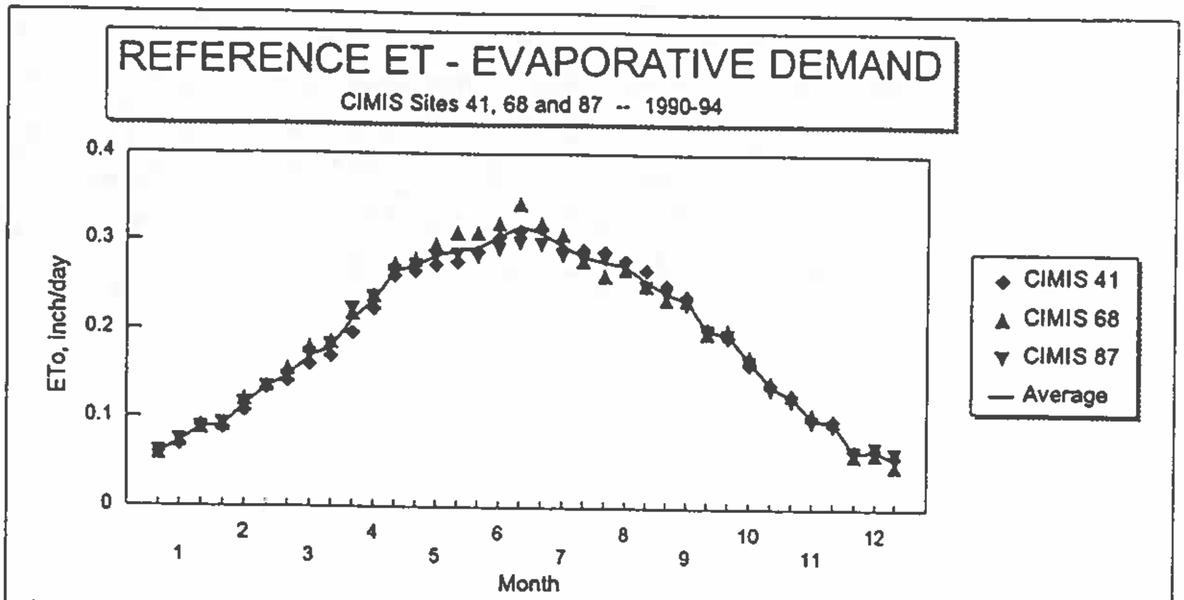
a. Conveyance losses, including seepage, evaporation, operation spills.
b. Consumptive use by riparian vegetation and phreatopytes.
c. Total water delivered to farms
   1. On-farm consumptive use by agricultural crops
   2. Water used for on-farm leaching or other cultural practices (e.g., frost protection, soil reclamation, etc.)
   3. On-farm distribution/application losses
d. Municipal and industrial water use, if any.
e. Water used for environmental purposes.
f. Water used for recreational purposes.
g. Estimated deep percolation, ground water recharge, and flows to perched water table or saline sinks, if any, within the District.
h. Water exchanges or transfers, if any.
i. Waste water treated and discharged, if any.
j. Water leaving the District, if any.
k. Other uses, if any.

APPENDIX C

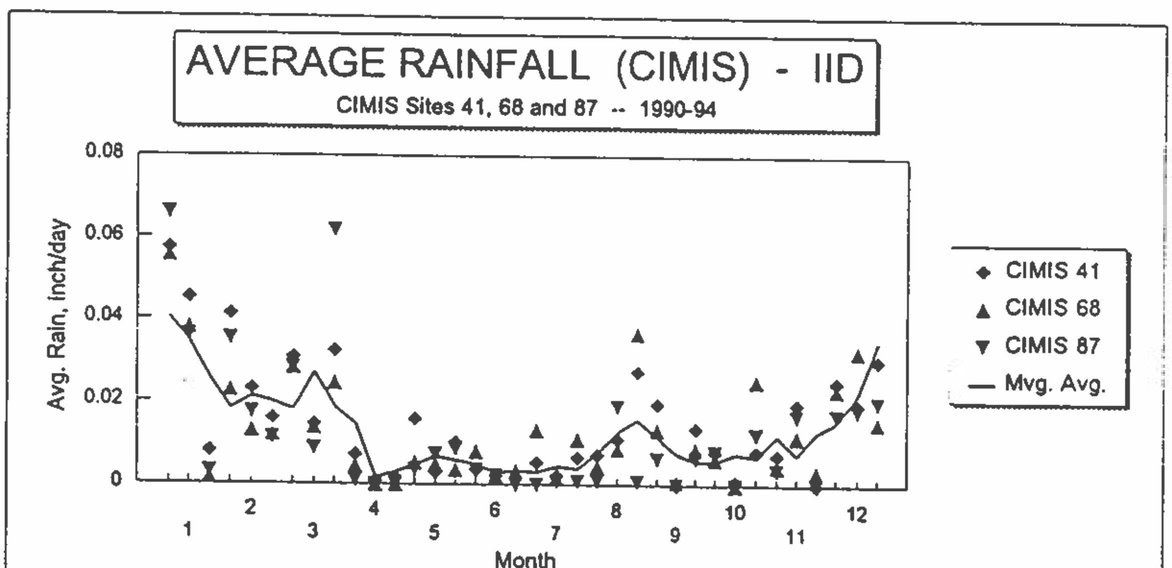
SPREADSHEET PROGRAM

FOR

ESTIMATING WATER USE BY IID



Annual	41 - Mulberry	68 - Seeley	87 - Meloland	Average
ETo, in. =	69.5	71.7	69.1	70.1



Annual	41 - Mulberry	68 - Seeley	87 - Meloland	Average
Rain, In. =	5.2	4.6	4.3	4.7

AVERAGE CROP COEFFICIENTS

Field Crops

Mo	1/3 month	Alfalfa	Alfalfa (Seed)	Bermuda Grass	Bermuda Gr. (Seed)	Cotton	Oats
	5	1.200	0.314				0.636
1	15	0.764	0.349				0.219
	25	0.585	0.413				0.356
	5	0.892	0.493				0.571
2	15	1.158	0.596				0.874
	25	1.200	0.713				1.175
	5	1.200	0.835	0.789	0.789		1.200
3	15	0.875	0.725	0.926	0.926		1.200
	25	0.821	0.301	0.960	0.960	1.000	1.175
	5	1.172	0.312	0.960	0.960	0.545	1.076
4	15	0.794	0.345	0.960	0.960	0.182	0.890
	25	0.717	0.402	0.960	0.960	0.195	0.606
	5	1.033	0.475	0.960	0.960	0.220	
5	15	0.809	0.574	0.960	0.960	0.259	
	25	0.900	0.707	0.960	0.960	0.318	
	5	1.200	0.851	0.960	0.960	0.385	
6	15	0.812	0.669	0.960	0.960	0.465	
	25	0.907	0.301	0.960	0.960	0.564	
	5	1.200	0.312	0.960	0.960	0.666	
7	15	0.812	0.345	0.960	0.960	0.787	
	25	0.933	0.406	0.960	0.960	0.936	
	5	1.200	0.484	0.960	0.960	1.084	
8	15	0.812	0.585	0.960	0.960	1.181	
	25	0.933	0.720	0.960	0.960	1.141	
	5	1.200	0.866	0.960	0.960	1.099	
9	15	0.795	0.696	0.945	0.945	1.020	
	25	0.730	0.730	0.575	0.575	0.897	
	5	1.061	1.061	0.300	0.300	0.758	
10	15	1.200	1.200			0.590	
	25	1.200	1.200			0.381	
	5	1.200	1.200				
11	15	0.767	0.767				
	25	0.660	0.660				
	5	1.040	1.040				
12	15	1.200	1.200				
	25	1.200	1.200				

AVERAGE CROP COEFFICIENTS

Field Crops (continued)

SB - Reduced last 2 mo due to harvest, see --->

Mo	1/3 month	Rye Grass	Sudan Grass	Sugar Bts Summer	Sugar Bts Winter	Wheat	Misc.
	5	0.789		1.128	1.140	0.903	0.724
1	15	0.926		1.092	1.140	1.064	0.425
	25	0.960		1.051	1.140	1.070	0.666
	5	0.960		1.013	1.140	1.070	0.903
2	15	0.960		0.976	1.140	1.070	1.064
	25	0.960		0.941	1.140	1.070	1.070
	5	0.960		0.806	1.132	1.070	1.070
3	15	0.960		0.672	1.095	1.070	1.070
	25	0.960		0.537	1.054	1.055	1.070
	5	0.960	0.637	0.403	1.017	0.854	1.070
4	15	0.930	0.240	0.269	0.980	0.583	1.070
	25	0.525	0.419	0.134	0.941	0.299	1.062
	5		0.688		0.806	0.150	0.881
5	15		1.067		0.672		0.610
	25		1.200		0.537		0.312
	5		1.198		0.403		0.150
6	15		1.196		0.269		
	25		1.187		0.134		
	5		1.140	0.636			
7	15		1.049	0.198			
	25		0.903	0.323			
	5		0.729	0.452			
8	15		0.605	0.582			
	25			0.725			
	5			0.855			
9	15			0.984			
	25			1.113			
	5			1.140	0.636		
10	15			1.140	0.198		
	25			1.140	0.323		
	5			1.140	0.452		
11	15			1.140	0.582		
	25			1.140	0.718		
	5			1.140	0.842	0.656	
12	15			1.140	0.971	0.441	
	25			1.140	1.107	0.689	

APPENDIX D

SPREADSHEET PROGRAM

FOR

IID'S WATER BALANCE

Variable	Source of net ET value	Crop acres	Confidence interval, %	Source of CI
Field Crop ET:				
Alfalfa	Kc x (AvgETo) x 0.85 (1	IID (5)	10%	MEJ estimate
Alfalfa seed	Kc x (AvgETo)	IID (5)	10%	MEJ estimate
Bermuda Grass	Kc x (AvgETo)	IID (5)	10%	MEJ estimate
Bermuda Grass (Seed	Kc x (AvgETo)	IID (5)	10%	MEJ estimate
Cotton	Kc x (AvgETo) (2)	IID (5)	10%	MEJ estimate
Oats	Kc x (AvgETo) (2)	IID (5)	10%	MEJ estimate
Rye Grass	Kc x (AvgETo)	IID (5)	10%	MEJ estimate
Sudan Grass	Kc x (AvgETo)	IID (5)	10%	MEJ estimate
Sugar Beets (Fall)	Kc x (AvgETo) (2)	IID (5)	10%	MEJ estimate
Sugar Beets (Spring)	Kc x (AvgETo) (2)	IID (5)	10%	MEJ estimate
Wheat	Kc x (AvgETo) (2)	IID (5)	10%	MEJ estimate
Miscellaneous	Kc x (AvgETo) (2)	IID (5)	10%	MEJ estimate
Garden Crop ET:				
Broccoli	Kc x (AvgETo) (2)	IID (5)	15%	MEJ estimate
Cabbage	Kc x (AvgETo) (2)	IID (5)	15%	MEJ estimate
Carrots	Kc x (AvgETo) (2)	IID (5)	15%	MEJ estimate
Cauliflower	Kc x (AvgETo) (2)	IID (5)	15%	MEJ estimate
Corn, Ear	Kc x (AvgETo) (2)	IID (5)	15%	MEJ estimate
Lettuce (Fall)	Kc x (AvgETo) (2)	IID (5)	15%	MEJ estimate
Lettuce (Spring)	Kc x (AvgETo) (2)	IID (5)	15%	MEJ estimate
Melons:				
Cantaloupes (Fall)	Kc x (AvgETo) (2)	IID (5)	15%	MEJ estimate
Cantaloupes (Spring)	Kc x (AvgETo) (2)	IID (5)	15%	MEJ estimate
Honeydew (Fall)	Kc x (AvgETo) (2)	IID (5)	15%	MEJ estimate
Melons (Mixed, fall)	Kc x (AvgETo) (2)	IID (5)	15%	MEJ estimate
Melons(Mixed, spring	Kc x (AvgETo) (2)	IID (5)	15%	MEJ estimate
Watermelons	Kc x (AvgETo) (2)	IID (5)	15%	MEJ estimate
Onions	Kc x (AvgETo) (2)	IID (5)	15%	MEJ estimate
Onion (Seed)	Kc x (AvgETo) (2)	IID (5)	15%	MEJ estimate
Tomatoes (Spring)	Kc x (AvgETo) (2)	IID (5)	15%	MEJ estimate
Misc Other	Kc x (AvgETo) (2)	IID (5)	15%	MEJ estimate
Permanent Crop ET:				
Artichokes	Kc x (AvgETo)	IID (5)	10%	MEJ estimate
Asparagas	Kc x (AvgETo)	IID (5)	10%	MEJ estimate
Citrus:	Kc x (AvgETo)	IID (5)	10%	MEJ estimate
Duck Ponds (Feed)	Kc x (AvgETo)	IID (5)	10%	MEJ estimate
Jojoba	Kc x (AvgETo) (3)	IID (5)	10%	MEJ estimate
Misc	Kc x (AvgETo) (4)	IID (5)	10%	MEJ estimate

Continued

Water Surfaces and Phreatophytes:

Canals, flowing water	1.15 x (AvgETo)	Boyle, T6-	10% MEJ estimate
Laterals, flowing water	1.15 x (AvgETo)	Boyle, T6-	10% MEJ estimate
Reservoirs	1.05 x (AvgETo)	Boyle, T6-	10% MEJ estimate
Riv & Drains Phreat	1.0 x (AvgETo)	Boyle, T6-	10% MEJ estimate
Riv & Drains Evap	1.15 x (AvgETo)	Boyle, T6-	10%
Non-Agric Deliveries	Boyle Report	Boyle, T6-	10% MEJ estimate

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Footnotes:

1. Estimated potential alfalfa ET, Kc x (AvgETo), was muliplied by 0.85 based on an updated linear regression of yield vs. ET using data from New Mexico, North Dakota and Israel. Average ETo and rainfall are CIMIS 1990-94 data.
2. Annual crop coefficients were increased to 1.0 for five days during establishment to account for either preplant irrigation, or irrigating for germination.
3. Estimated as the same as artichokes.
4. Estimated the same as asparagas.
5. Imperial Irrigation District Annual Inventory of Crops Receiving Water.

70	16-Jun-95 CONFIDENCE INTERVAL - IID DIVERSION ESTIMATES				\DIV-CI.WK4
71	Variable	Net ET	C.I.	Norm C.V.	C.V.^2
72	Field Crop ET:	ac-ft	%	- -	- -
73	Alfalfa	885,394	10%	0.02325	5.40E-04
74	Alfalfa seed	51,595	10%	0.00135	1.84E-06
75	Bermuda Grass	24,782	10%	0.00065	4.23E-07
76	Bermuda Grass (Seed)	68,177	10%	0.00179	3.20E-06
77	Cotton	29,111	10%	0.00076	5.84E-07
78	Oats	4,755	10%	0.00012	1.56E-08
79	Rye Grass	11,327	10%	0.00030	8.85E-08
80	Sudan Grass	192,041	10%	0.00504	2.54E-05
81	Sugar Beets (Fall)	61,540	10%	0.00162	2.61E-06
82	Sugar Beets (Spring)	58,680	10%	0.00154	2.37E-06
83	Wheat	61,098	10%	0.00160	2.57E-06
84	Miscellaneous	2,939	10%	0.00008	5.96E-09
85	Garden Crops:				
86	Broccoli	8,801	15%	0.00035	1.20E-07
87	Cabbage	1,141	15%	0.00004	2.02E-09
88	Carrots	28,631	15%	0.00113	1.27E-06
89	Cauliflower	3,979	15%	0.00016	2.46E-08
90	Corn, Ear	4,591	15%	0.00018	3.27E-08
91	Lettuce (Fall)	12,557	15%	0.00049	2.45E-07
92	Lettuce (Spring)	20,982	15%	0.00083	6.83E-07
93	Melons:			0.00000	
94	Cantaloupes (Fall)	4,482	15%	0.00018	3.12E-08
95	Cantaloupes (Spring)	29,235	15%	0.00115	1.33E-06
96	Honeydew (Fall)	659	15%	0.00003	6.74E-10
97	Melons (Mixed, fall)	331	15%	0.00001	1.70E-10
98	Melons(Mixed, spring)	1,088	15%	0.00004	1.84E-09
99	Watermelons	3,890	15%	0.00015	2.35E-08
100	Onions	18,813	15%	0.00074	5.49E-07
101	Onion (Seed)	4,028	15%	0.00016	2.52E-08
102	Tomatoes (Spring)	13,214	15%	0.00052	2.71E-07
103	Misc Other	16,770	15%	0.00066	4.36E-07
104	Permanent Crops:				
105	Artichokes	2,691	10%	0.00007	4.99E-09
106	Asparagas	29,038	10%	0.00076	5.81E-07
107	Citrus:	10,799	10%	0.00028	8.04E-08
108	Duck Ponds (Feed)	48,785	10%	0.00128	1.64E-06
109	Jojoba	10,174	10%	0.00027	7.14E-08
110	Misc	10,133	10%	0.00027	7.08E-08
111	Water Surfaces and Phreatophytes:				
112	Canals, flowing water	9,288	10%	0.00024	5.95E-08
113	Laterals, flowing water	7,425	10%	0.00019	3.80E-08
114	Reservoirs	1,363	10%	0.00004	1.28E-09
115	Rivers and Drains Phreat ET	65,594	10%	0.00172	2.97E-06
116	Rivers and Drains Evaporation	12,892	10%	0.00034	1.15E-07
117	Non-Agric Deliveries	71,439	5%	0.00094	8.80E-07
118	Total	1,904,252	4.9%	0.02431	0.000591

SUMMARY:

	Net ET	C.I.	Low	High
	ac-ft	%	ac-ft	ac-ft
Total net ET (Et minus effective rain	1,904,252	4.9%	1,811,654	1,996,851
Standard error of estimate (SEE)	46,299			

AVERAGE CROP COEFFICIENTS

Garden Crops

Mo	1/3 month	Broccoli	Cabbage	Carrots	Cauli-flower	Corn, Ear	Lettuce Fall
	5	1.189		1.060	1.041		
1	15	1.101		1.060	0.819	0.553	
	25	0.895		1.060	0.465	0.256	
	5	0.609		1.054		0.527	
2	15	0.332		1.020		0.985	
	25			0.985		1.140	
	5			0.954		1.140	
3	15			0.918		1.139	
	25			0.878		1.118	
	5			0.841		1.057	
4	15			0.805		0.954	
	25			0.766		0.804	
	5					0.629	
5	15					0.465	
	25						
	5						
6	15						
	25						
	5						
7	15						
	25						
	5						
8	15						
	25						
	5		0.689				1.000
9	15	0.925	0.170				0.752
	25	0.188	0.245	1.000	1.000		1.073
	5	0.231	0.440	0.683	0.545		1.068
10	15	0.325	0.647	0.430	0.204		1.068
	25	0.483	0.875	0.440	0.282		1.068
	5	0.675	1.020	0.533	0.403		1.068
11	15	0.917	1.020	0.648	0.573		1.068
	25	1.171	1.011	0.768	0.802		1.068
	5	1.200	0.893	0.877	1.055		1.068
12	15	1.200	0.735	0.991	1.200		1.068
	25	1.200	0.561	1.060	1.200		1.068

AVERAGE CROP COEFFICIENTS

Garden Crops (continued)

Mo	1/3 month	Lettuce Spring	Cantaloupes Fall	Cantaloupes Spring	Honeydew Fall	Melons (Other) Fall	Melons (Other) Spring
	5	1.068					
1	15	1.068					
	25	1.068					
	5	1.068		0.642			0.642
2	15	1.068		0.294			0.294
	25	1.068		0.531			0.531
	5	1.068		0.865			0.865
3	15	1.068		1.080			1.080
	25	1.068		1.080			1.080
	5	1.068		1.066			1.066
4	15			1.022			1.022
	25			0.943			0.943
	5			0.842			0.842
5	15			0.704			0.704
	25			0.517			0.517
	5						
6	15						
	25						
	5						
7	15						
	25						
	5		1.000		1.000	1.000	
8	15		0.276		0.273	0.276	
	25		0.276		0.270	0.276	
	5		0.391		0.384	0.391	
9	15		0.553		0.546	0.553	
	25		0.772		0.766	0.772	
	5		1.006		1.004	1.006	
10	15		1.080		1.080	1.080	
	25		1.080		1.080	1.080	
	5	1.000	1.076		1.064	1.076	
11	15	0.720	1.043		1.013	1.043	
	25	0.889	0.970		0.922	0.970	
	5	1.072	0.871		0.805	0.871	
12	15	1.080	0.730		0.646	0.730	
	25	1.070	0.534		0.430	0.534	

AVERAGE CROP COEFFICIENTS

Garden Crops (continued)

Mo	1/3 month	Water-melons	Onions	Onion (Seed)	Tomatoes (Spring)	Misc
	5	1.000	0.889	0.889		
1	15	0.274	0.750	0.750		
	25	0.277	0.750	0.750		
	5	0.398	0.750	0.750	1.000	1.000
2	15	0.570	0.761	0.761	0.284	0.284
	25	0.779	0.813	0.813	0.291	0.291
	5	0.999	0.863	0.863	0.412	0.412
3	15	1.080	0.923	0.923	0.611	0.611
	25	1.080	0.988	0.988	0.900	0.900
	5	1.064	1.024	1.024	1.172	1.172
4	15	1.013	0.909	0.909	1.200	1.200
	25	0.922	0.751	0.751	1.200	1.200
	5	0.805	0.607	0.607	1.133	1.133
5	15	0.646	0.457	0.457	0.965	0.965
	25	0.430	0.291	0.291	0.780	0.780
	5		0.200	0.200	0.612	0.612
6	15				0.444	
	25				0.268	
	5					
7	15					
	25					
	5					
8	15					
	25					
	5					
9	15					
	25					
	5					
10	15					
	25					
	5					
11	15					
	25					
	5					
12	15					
	25					

AVERAGE CROP COEFFICIENTS

Permanent Crops

Mo	1/3 month	Artichokes	Asparagas	Citrus	Duck Ponds	Jojoba	Misc
	5	1.100		0.705	1.050	1.100	
1	15	1.100		0.696	1.050	1.100	
	25	1.100		0.686	1.050	1.100	
	5	1.095		0.677	1.050	1.095	
2	15	1.055		0.668	1.050	1.055	
	25	1.012		0.660	1.050	1.012	
	5	0.974		0.652	1.050	0.974	
3	15	0.952	0.601	0.643	1.050	0.952	0.601
	25		0.234	0.633	1.050		0.234
	5		0.318	0.624	1.050		0.318
4	15		0.456	0.615	1.050		0.456
	25		0.655	0.605	1.050		0.655
	5	0.694	0.879	0.596	1.050	0.694	0.879
5	15	0.354	0.950	0.587	1.050	0.354	0.950
	25	0.467	0.950	0.577	1.050	0.467	0.950
	5	0.624	0.950	0.570	1.050	0.624	0.950
6	15	0.836	0.950	0.570	1.050	0.836	0.950
	25	1.070	0.950	0.570	1.050	1.070	0.950
	5	1.100	0.950	0.570	1.050	1.100	0.950
7	15	1.100	0.950	0.570	1.050	1.100	0.950
	25	1.100	0.950	0.570	1.050	1.100	0.950
	5	1.100	0.950	0.570	1.050	1.100	0.950
8	15	1.100	0.950	0.570	1.050	1.100	0.950
	25	1.100	0.950	0.570	1.050	1.100	0.950
	5	1.100	0.950	0.570	1.050	1.100	0.950
9	15	1.100	0.950	0.581	1.050	1.100	0.950
	25	1.100	0.950	0.596	1.050	1.100	0.950
	5	1.100	0.950	0.609	1.050	1.100	0.950
10	15	1.100	0.950	0.623	1.050	1.100	0.950
	25	1.100	0.950	0.639	1.050	1.100	0.950
	5	1.100	0.950	0.653	1.050	1.100	0.950
11	15	1.100	0.950	0.667	1.050	1.100	0.950
	25	1.100	0.950	0.681	1.050	1.100	0.950
	5	1.100	0.942	0.695	1.050	1.100	0.942
12	15	1.100	0.891	0.709	1.050	1.100	0.891
	25	1.100	0.779	0.724	1.050	1.100	0.779

AVERAGE COEFFICIENTS

Water Surface & Other Coefficients

Mo	1/3 month	Canals	Reservoirs	Drains & Rivers Phreat.
	5	1.15	1.05	1.00
1	15	1.15	1.05	1.00
	25	1.15	1.05	1.00
	5	1.15	1.05	1.00
2	15	1.15	1.05	1.00
	25	1.15	1.05	1.00
	5	1.15	1.05	1.00
3	15	1.15	1.05	1.00
	25	1.15	1.05	1.00
	5	1.15	1.05	1.00
4	15	1.15	1.05	1.00
	25	1.15	1.05	1.00
	5	1.15	1.05	1.00
5	15	1.15	1.05	1.00
	25	1.15	1.05	1.00
	5	1.15	1.05	1.00
6	15	1.15	1.05	1.00
	25	1.15	1.05	1.00
	5	1.15	1.05	1.00
7	15	1.15	1.05	1.00
	25	1.15	1.05	1.00
	5	1.15	1.05	1.00
8	15	1.15	1.05	1.00
	25	1.15	1.05	1.00
	5	1.15	1.05	1.00
9	15	1.15	1.05	1.00
	25	1.15	1.05	1.00
	5	1.15	1.05	1.00
10	15	1.15	1.05	1.00
	25	1.15	1.05	1.00
	5	1.15	1.05	1.00
11	15	1.15	1.05	1.00
	25	1.15	1.05	1.00
	5	1.15	1.05	1.00
12	15	1.15	1.05	1.00
	25	1.15	1.05	1.00

CROP ACREAGES AND OTHER AREAS

Year: 1995 ***INPUT VALUES IN SHADED AREAS***

FIELD CROPS:

	Alfalfa	Alfalfa (Seed)	Bermuda Grass	Bermuda Gr. (Seed)	Cotton	Oats
Acres	190,075	8,729	900	17,510	7,758	2,358

	Rye Grass	Sudan Grass	Sugar Bts Summer	Sugar Bts Winter	Wheat	Misc.
Acres	2,378	71,477	19,910	19,910	55,219	2,880

GARDEN CROPS:

Year: 1995	Broccoli	Cabbage	Carrots	Cauli-flower	Corn, Ear	Lettuce Fall
Acres	8,348	1,319	15,100	5,434	3,199	13,628

		Cantaloupes			Melons (Other)	
	Lettuce Spring	Fall	Spring	Honeydew Fall	Fall	Spring
Acres	13,628	2,100	16,860	1,083	75	221

	Water-melons	Onions	Onion (Seed)	Tomatoes (Spring)	Misc	
Acres	2,828	10,977	2,583	5,408	7,215	

PERMANENT CROPS:

Year: 1995	Artichokes	Asparagas	Citrus	Duck Ponds	Jojoba	Misc
Acres	88	6,261	2,772	7,863		695

WATER SURFACES:

Year: 1995	Canals	Laterals	Reservoirs	Drains & Phreat.	Rivers & Water	
Acres	1,704	3,027	250	11,434	2,365	

TOTALS:

Year: 1995	Field Crops	Garden Crops	Permanent Crops			Total
Acres	399,104	110,006	17,679			526,789
Percent	75.8%	20.9%	3.4%			

ESTIMATED CONSUMPTIVE USE

			Field Crops				
	Acres =	190,075	8,729	900	17,510	7,758	2,358
Mo	1/3 month	Potential Alfalfa	Alfalfa (Seed)	Bermuda Grass	Bermuda Gr. (Seed)	Cotton	Oats
	5	6,175	74	0	0	0	41
1	15	7,513	158	0	0	0	27
	25	8,908	289	0	0	0	67
	5	9,849	250	0	0	0	78
2	15	21,648	512	0	0	0	203
	25	19,635	536	0	0	0	238
	5	24,183	773	75	1,465	0	300
3	15	25,570	973	128	2,494	0	435
	25	24,507	413	136	2,640	1,218	435
	5	35,341	432	137	2,667	671	402
4	15	32,150	641	184	3,581	301	447
	25	30,171	778	191	3,723	335	316
	5	40,046	846	176	3,427	348	0
5	15	39,937	1,301	224	4,365	522	0
	25	45,420	1,639	229	4,463	654	0
	5	50,076	1,630	190	3,690	655	0
6	15	43,133	1,633	241	4,697	1,009	0
	25	45,564	695	228	4,444	1,158	0
	5	53,061	633	201	3,910	1,203	0
7	15	41,665	812	233	4,537	1,649	0
	25	45,991	919	224	4,358	1,882	0
	5	47,316	877	179	3,487	1,745	0
8	15	38,569	1,276	216	4,200	2,288	0
	25	41,572	1,474	202	3,939	2,075	0
	5	41,414	1,373	157	3,052	1,548	0
9	15	32,436	1,303	182	3,549	1,698	0
	25	23,107	1,061	86	1,676	1,158	0
	5	29,221	1,342	39	761	853	0
10	15	34,673	1,592	0	0	695	0
	25	27,716	1,273	0	0	359	0
	5	21,228	975	0	0	0	0
11	15	12,773	587	0	0	0	0
	25	10,145	466	0	0	0	0
	5	8,104	372	0	0	0	0
12	15	11,846	544	0	0	0	0
	25	9,997	459	0	0	0	0
Total		1,040,659	30,907	3,861	75,128	24,023	2,990

ESTIMATED CONSUMPTIVE USE

Field Crops (continued)

Mo	1/3 month	Rye Grass	Sudan Grass	Sugar Bts Summer	Sugar Bts Winter	Wheat	Misc.
	Acres =	2,378	71,477	19,910	19,910	55,219	2,880
	5	51	0	608	615	1,351	56
1	15	114	0	1,125	1,175	3,040	63
	25	183	0	1,677	1,820	4,737	154
	5	133	0	1,171	1,318	3,431	151
2	15	225	0	1,911	2,232	5,811	301
	25	197	0	1,612	1,954	5,086	265
	5	242	0	1,702	2,389	6,264	327
3	15	351	0	2,057	3,354	9,087	474
	25	358	0	1,680	3,296	9,150	484
	5	362	7,226	1,273	3,212	7,478	489
4	15	471	3,654	1,140	4,155	6,858	657
	25	277	6,625	592	4,147	3,655	677
	5	0	10,030	0	3,273	1,689	517
5	15	0	19,801	0	3,473	0	456
	25	0	22,774	0	2,841	0	239
	5	0	18,802	0	1,762	0	95
6	15	0	23,889	0	1,495	0	0
	25	0	22,429	0	707	0	0
	5	0	18,951	2,944	0	0	0
7	15	0	20,242	1,062	0	0	0
	25	0	16,740	1,666	0	0	0
	5	0	10,804	1,869	0	0	0
8	15	0	10,805	2,896	0	0	0
	25	0	0	3,382	0	0	0
	5	0	0	3,089	0	0	0
9	15	0	0	4,205	0	0	0
	25	0	0	3,687	0	0	0
	5	0	0	3,289	1,834	0	0
10	15	0	0	3,450	598	0	0
	25	0	0	2,758	781	0	0
	5	0	0	2,112	838	0	0
11	15	0	0	1,988	1,015	0	0
	25	0	0	1,836	1,157	0	0
	5	0	0	930	687	1,484	0
12	15	0	0	1,179	1,004	1,263	0
	25	0	0	995	966	1,668	0
Total		2,963	212,771	59,887	52,099	72,052	5,406

ESTIMATED CONSUMPTIVE USE

				Garden Crops			
	Acres =	8,348	1,319	15,100	5,434	3,199	13,628
	1/3				Cauli-	Corn,	Lettuce
Mo	month	Broccoli	Cabbage	Carrots	flower	Ear	Fall
	5	269	0	433	153	0	0
1	15	476	0	828	230	92	0
	25	599	0	1,283	203	66	0
	5	295	0	924	0	98	0
2	15	272	0	1,515	0	310	0
	25	0	0	1,281	0	314	0
	5	0	0	1,528	0	387	0
3	15	0	0	2,131	0	561	0
	25	0	0	2,081	0	561	0
	5	0	0	2,015	0	536	0
4	15	0	0	2,589	0	650	0
	25	0	0	2,563	0	569	0
	5	0	0	0	0	410	0
5	15	0	0	0	0	386	0
	25	0	0	0	0	0	0
	5	0	0	0	0	0	0
6	15	0	0	0	0	0	0
	25	0	0	0	0	0	0
	5	0	0	0	0	0	0
7	15	0	0	0	0	0	0
	25	0	0	0	0	0	0
	5	0	0	0	0	0	0
8	15	0	0	0	0	0	0
	25	0	0	0	0	0	0
	5	0	165	0	0	0	2,474
9	15	1,658	48	0	0	0	2,200
	25	261	54	2,513	904	0	2,433
	5	280	84	1,495	429	0	2,109
10	15	412	130	987	168	0	2,213
	25	489	140	808	186	0	1,769
	5	525	125	749	204	0	1,355
11	15	671	118	856	273	0	1,275
	25	790	108	938	353	0	1,177
	5	411	48	543	235	0	597
12	15	520	50	777	339	0	756
	25	439	32	702	286	0	638
Total		8,367	1,103	29,540	3,963	4,940	18,995

ESTIMATED CONSUMPTIVE USE

Garden Crops (continued)

	Acres =	13,628	2,100	16,860	1,083	75	221
	1/3	Lettuce	Cantaloupes		Honeydew	Melons (Other)	
Mo	month	Spring	Fall	Spring	Fall	Fall	Spring
	5	394	0	0	0	0	0
1	15	753	0	0	0	0	0
	25	1,167	0	0	0	0	0
	5	845	0	629	0	0	8
2	15	1,431	0	488	0	0	6
	25	1,253	0	771	0	0	10
	5	1,543	0	1,546	0	0	20
3	15	2,239	0	2,801	0	0	37
	25	2,286	0	2,858	0	0	37
	5	2,309	0	2,852	0	0	37
4	15	0	0	3,671	0	0	48
	25	0	0	3,521	0	0	46
	5	0	0	2,893	0	0	38
5	15	0	0	3,082	0	0	40
	25	0	0	2,314	0	0	30
	5	0	0	0	0	0	0
6	15	0	0	0	0	0	0
	25	0	0	0	0	0	0
	5	0	0	0	0	0	0
7	15	0	0	0	0	0	0
	25	0	0	0	0	0	0
	5	0	436	0	225	16	0
8	15	0	145	0	74	5	0
	25	0	136	0	68	5	0
	5	0	149	0	75	5	0
9	15	0	249	0	127	9	0
	25	0	270	0	138	10	0
	5	0	306	0	158	11	0
10	15	0	345	0	178	12	0
	25	0	276	0	142	10	0
	5	1,268	210	0	107	8	0
11	15	859	192	0	96	7	0
	25	980	165	0	81	6	0
	5	599	75	0	36	3	0
12	15	764	80	0	36	3	0
	25	639	49	0	20	2	0
Total		19,330	3,081	27,426	1,561	110	360

ESTIMATED CONSUMPTIVE USE

Garden Crops (continued)

Mo	Acres = 1/3 month	2,828 Water-melons	10,977 Onions	2,583 Onion (Seed)	5,408 Tomatoes (Spring)	7,215 Misc	
	5	77	264	62	0	0	
1	15	40	426	100	0	0	
	25	63	660	155	0	0	
	5	65	478	112	314	419	
2	15	159	822	193	151	202	
	25	190	768	181	135	181	
	5	300	1,005	236	236	315	
3	15	470	1,558	367	508	678	
	25	479	1,704	401	764	1,020	
	5	477	1,784	420	1,006	1,342	
4	15	610	2,126	500	1,383	1,845	
	25	577	1,825	430	1,437	1,918	
	5	464	1,360	320	1,249	1,666	
5	15	474	1,301	306	1,355	1,808	
	25	323	847	199	1,120	1,494	
	5	0	482	113	727	969	
6	15	0	0	0	671	0	
	25	0	0	0	383	0	
	5	0	0	0	0	0	
7	15	0	0	0	0	0	
	25	0	0	0	0	0	
	5	0	0	0	0	0	
8	15	0	0	0	0	0	
	25	0	0	0	0	0	
	5	0	0	0	0	0	
9	15	0	0	0	0	0	
	25	0	0	0	0	0	
	5	0	0	0	0	0	
10	15	0	0	0	0	0	
	25	0	0	0	0	0	
	5	0	0	0	0	0	
11	15	0	0	0	0	0	
	25	0	0	0	0	0	
	5	0	0	0	0	0	
12	15	0	0	0	0	0	
	25	0	0	0	0	0	
Total		4,769	17,410	4,097	11,439	13,856	0

ESTIMATED CONSUMPTIVE USE

Permanent Crops

Mo	1/3 month	Artichokes	Asparagas	Citrus	Duck Ponds	Jojoba	Misc
	Acres =	88	6,261	2,772	7,863	0	695
	5	3	0	53	224	0	0
1	15	5	0	100	427	0	0
	25	8	0	153	662	0	0
	5	6	0	109	479	0	0
2	15	9	0	182	812	0	0
	25	8	0	157	711	0	0
	5	9	0	192	875	0	0
3	15	13	579	274	1,270	0	64
	25	0	231	275	1,296	0	26
	5	0	316	274	1,310	0	35
4	15	0	608	363	1,759	0	67
	25	0	909	371	1,829	0	101
	5	12	1,122	337	1,683	0	125
5	15	8	1,545	423	2,144	0	171
	25	11	1,579	425	2,192	0	175
	5	12	1,306	347	1,813	0	145
6	15	21	1,662	441	2,307	0	184
	25	25	1,573	418	2,183	0	175
	5	23	1,384	368	1,921	0	154
7	15	26	1,605	426	2,228	0	178
	25	25	1,542	410	2,140	0	171
	5	20	1,234	328	1,713	0	137
8	15	24	1,486	395	2,063	0	165
	25	23	1,394	370	1,935	0	155
	5	18	1,080	287	1,499	0	120
9	15	21	1,276	346	1,772	0	142
	25	16	990	275	1,374	0	110
	5	14	862	245	1,196	0	96
10	15	15	904	263	1,255	0	100
	25	12	723	215	1,003	0	80
	5	9	554	168	768	0	61
11	15	8	521	162	723	0	58
	25	8	481	153	668	0	53
	5	4	242	79	338	0	27
12	15	5	290	102	429	0	32
	25	4	214	88	362	0	24
Total		423	28,209	9,573	47,363	0	3,131

ESTIMATED CONSUMPTIVE USE

		Water Surface & Other Coefficients			Drains and Rivers		Non-Agr
	Acres =	1,704	3,027	250	11,434	2,365	
	Use, % =	100%	45%	100%	100%	100%	1995
Mo	Day	Canals	Laterals	Reservoirs	Phreat. ET	Evap	Deliveries
	5	0	0	0	310	1	
1	15	51	41	7	592	71	5,953
	25	133	106	19	917	184	
	5	74	59	11	664	102	
2	15	151	121	22	1,125	209	5,953
	25	138	110	20	984	191	
	5	151	121	22	1,212	209	
3	15	247	197	36	1,759	342	5,953
	25	218	174	32	1,796	303	
	5	266	213	39	1,814	369	
4	15	363	290	53	2,436	503	5,953
	25	377	301	55	2,533	523	
	5	337	269	49	2,331	468	
5	15	435	347	64	2,969	603	5,953
	25	441	352	65	3,036	612	
	5	368	294	54	2,510	510	
6	15	473	378	69	3,195	656	5,953
	25	448	358	66	3,023	622	
	5	389	311	57	2,660	539	
7	15	458	366	67	3,086	635	5,953
	25	432	346	63	2,964	600	
	5	348	278	51	2,372	483	
8	15	406	324	60	2,857	563	5,953
	25	366	292	54	2,679	508	
	5	293	234	43	2,076	406	
9	15	365	292	54	2,454	507	5,953
	25	270	216	40	1,903	375	
	5	241	193	35	1,657	335	
10	15	259	207	38	1,738	359	5,953
	25	193	154	28	1,389	268	
	5	155	124	23	1,064	215	
11	15	134	107	20	1,001	187	5,953
	25	137	109	20	925	190	
	5	53	43	8	469	74	
12	15	67	53	10	594	93	5,953
	25	54	43	8	501	75	
Total		9,288	7,425	1,363	65,594	12,892	71,439

SUMMARY - DISTRIBUTION OF ESTIMATED CONSUMPTIVE

Alf Adj = 0.80 See J1085

Mo	1/3 month	Field Cropsw ac-ft	Field Crops Adj Alfalfa ac-ft	Garden Crops ac-ft	Permanent Crops ac-ft	Evap & Phreat ET ac-ft	Boyle,T6-15 Non-agr Deliveries ac-ft
	5	8,971	7,736	1,652	279	311	
1	15	13,214	11,711	2,946	532	762	5,953
	25	17,834	16,053	4,195	822	1,359	
	5	16,381	14,411	4,188	594	909	
2	15	32,842	28,512	5,549	1,003	1,628	5,953
	25	29,523	25,596	5,083	876	1,444	
	5	37,720	32,883	7,115	1,076	1,715	
3	15	44,924	39,810	11,349	2,200	2,581	5,953
	25	44,317	39,416	12,192	1,828	2,523	
	5	59,690	52,622	12,779	1,935	2,701	
4	15	54,239	47,809	13,423	2,797	3,645	5,953
	25	51,490	45,455	12,888	3,210	3,788	
	5	60,352	52,343	8,400	3,280	3,455	
5	15	70,080	62,093	8,753	4,291	4,418	5,953
	25	78,259	69,175	6,327	4,382	4,506	
	5	76,900	66,885	2,291	3,622	3,736	
6	15	76,097	67,471	671	4,615	4,771	5,953
	25	75,226	66,113	383	4,373	4,518	
	5	80,903	70,291	0	3,848	3,955	
7	15	70,201	61,868	0	4,465	4,612	5,953
	25	71,778	62,580	0	4,288	4,406	
	5	66,276	56,813	676	3,431	3,533	
8	15	60,249	52,535	224	4,133	4,210	5,953
	25	52,643	44,329	209	3,876	3,899	
	5	50,633	42,350	2,869	3,004	3,052	
9	15	43,374	36,887	4,291	3,556	3,671	5,953
	25	30,775	26,154	6,583	2,765	2,803	
	5	37,338	31,494	4,872	2,413	2,461	
10	15	41,010	34,075	4,445	2,537	2,601	5,953
	25	32,887	27,344	3,820	2,033	2,033	
	5	25,154	20,908	4,551	1,561	1,580	
11	15	16,362	13,808	4,347	1,472	1,450	5,953
	25	13,603	11,574	4,597	1,363	1,381	
	5	11,577	9,956	2,546	690	646	
12	15	15,837	13,468	3,326	858	816	5,953
	25	14,085	12,085	2,807	691	682	
Totals		1,582,745	1,374,613	170,346	88,699	96,562	71,439
(Check)		1,582,745	1,374,613	170,346	88,699	96,562	71,439
TOTAL							1,801,660

ESTIMATED DISTRIBUTION OF WATER CONSUMPTION

Mo	(Adj alf) Field Crops	Garden Crops	Permanent Crops	Evap & Phreat ET	Non-agr Deliveries	Total	Total
	Acre-feet						Percent
1	35,500	8,794	1,634	2,432	5,953	54,313	3.0%
2	68,520	14,820	2,473	3,981	5,953	95,748	5.3%
3	112,110	30,656	5,104	6,820	5,953	160,643	8.9%
4	145,886	39,090	7,942	10,135	5,953	209,005	11.6%
5	183,610	23,481	11,953	12,378	5,953	237,376	13.2%
6	200,468	3,345	12,611	13,025	5,953	235,402	13.1%
7	194,738	0	12,601	12,973	5,953	226,265	12.6%
8	153,677	1,108	11,440	11,641	5,953	183,820	10.2%
9	105,391	13,743	9,325	9,527	5,953	143,938	8.0%
10	92,913	13,137	6,983	7,095	5,953	126,081	7.0%
11	46,290	13,494	4,396	4,411	5,953	74,543	4.1%
12	35,510	8,679	2,239	2,145	5,953	54,525	3.0%
Total	1,374,613	170,346	88,699	96,562	71,439	1,801,660	100.0%
Percent	76.3%	9.5%	4.9%	5.4%	4.0%	100.0%	

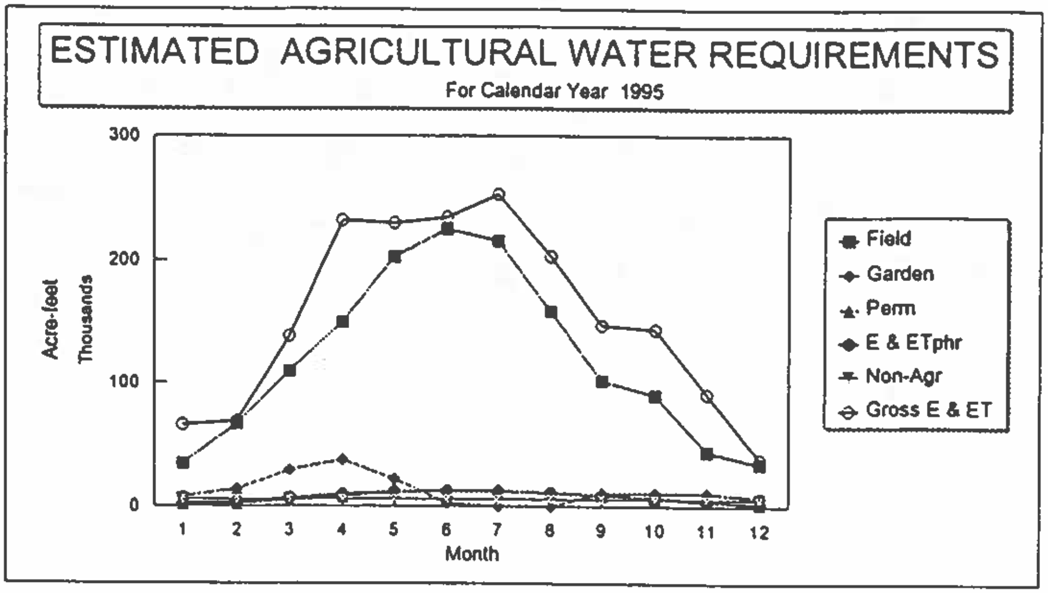
TOTAL ESTIMATED CONSUMPTIVE USE AND NON-AGR DELIVERIES:

Mo	Previous years 1993	1994	Average	This year 1995	Change	Change, %	Soil water Depl-Repl
	Acre-feet					%	Acre-feet
1	66,508	65,868	66,188	67,313	1,125	1.7%	13,000
2	69,013	68,682	68,847	70,748	1,900	2.8%	(25,000)
3	139,851	138,726	139,288	142,643	3,355	2.4%	(18,000)
4	226,578	230,474	228,526	229,005	479	0.2%	20,000
5	211,567	225,628	218,598	212,376	(6,222)	-2.8%	(25,000)
6	211,159	229,371	220,265	210,402	(9,863)	-4.5%	(25,000)
7	233,005	248,489	240,747	232,265	(8,482)	-3.5%	6,000
8	196,580	201,725	199,153	198,820	(332)	-0.2%	15,000
9	149,140	147,025	148,083	153,938	5,855	4.0%	10,000
10	143,781	141,113	142,447	149,081	6,635	4.7%	23,000
11	90,798	89,804	90,301	94,543	4,242	4.7%	20,000
12	38,591	37,625	38,108	40,525	2,417	6.3%	(14,000)
Total	1,776,571	1,824,530	1,800,551	1,801,660	1,109	0.1%	0

WATER BALANCE COMPUTATIONS

850	WATER BALANCE COMPUTATIONS								
851									
852				Summary of average (CIMIS 41, 68, and 87) annual ETo					
853		1987	1988	1989	1990	1991	1992	1993	1994
854		81.67	80.05	79.74	73.95	67.04	66.82	71.47	71.32
855	Average, 1990-1994:								70.12
856	Relative to 1990-94 avg:			1.14	1.05	0.96	0.95	1.02	1.02
857									
858									
859	TOTAL DELIVERIES TO AGRICULTURAL WATER USERS:						USBR		
860			Previous years			This year			
861			1993	1994	Average	1995	Change	Change, %	
862			----------	----------	----------	----------	----------	----------	
863			2,359,044	2,604,195	2,481,620	2,444,000	(37,620)	-1.5%	
864						1987-94 avg			
865									
866	ESTIMATED TOTAL AGRICULTURAL CONSUMPTIVE USE AND CUcoefficient:								
867									
868			1993	1994	Average	1995	Change	Change, %	
869	Agr CU		1,608,571	1,656,530	1,632,550	1,633,659	1,109	0.1%	
870	Avg 1990-94 ETo					70.1	inches		
871				CUcoef		0.668			
872	ESTIMATED DRAINAGE FROM AGRICULTURAL LANDS:						Estimates from Boyle,		
873							T 6-9, 25, 28, 30, 32, 33		
874			1993	1994	Average	1995	Change	Change, %	
875	Del - Est CU		739,113	947,665	843,389	810,341	(33,048)	-3.9%	
876	Alamo R, in		144,887	147,004	145,946	132,726	(13,220)	-9.1%	
877	Rn RO to Dr		45,780	45,780	45,780	30,886	(14,894)	-32.5%	
878	Non-Agr RF		16,697	16,697	16,697	16,084	(613)	-3.7%	
879	Storm Inflow		5,400	5,400	5,400	5,400	0	0.0%	
880	Ext Flo to Dr		20,000	20,000	20,000	20,000	0	0.0%	
881						----------	----------	----------	
882	Potential		971,877	1,182,546	1,077,212	1,015,437	(61,775)	-5.7%	
883	Drain Flow	(Averages from Boyle (93) used for R876-878. More recent data may beavailable.)							
884									
885	Measured		965,878	1,004,383	985,131	972,600	(12,531)	-1.3%	
886	Drain Flow					90-94 Avg			
887	Difference, est. flow minus measured drain flow					42,837	Comment: If > 0, reduce diversions		
888	Difference, est. flow minus measured drain flow,%					4.4%	Cell F863, & drainage, Cell G915		

For: Bob McCullough



SUMMARY OF GROSS DELIVERY ESTIMATES -- IID

Year: 1995 Drainage Fact 1.00 *Date of Estimate:* 22-Aug-95 VALUES F 1995

See J1086 1.00

Month	Total ET	Confidence Interval Low	High	90-94 Avg Net Drain	Total Avg Est Div	IID Water Orders	Difference Order-Est	Total Avg Est Div
	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft
Jan	65,869	62,575	69,162	63,022	128,891	113,553	(15,338)	130,335
Feb	68,764	65,326	72,202	60,356	129,120	171,624	42,504	131,104
Mar	138,504	131,579	145,430	93,005	231,510	196,140	(35,370)	235,649
Apr	231,568	219,989	243,146	103,986	335,553	330,140	(5,413)	332,991
May	229,593	218,113	241,072	101,455	331,048	337,548	6,500	313,831
Jun	233,993	222,294	245,693	83,102	317,095	302,623	(14,472)	293,504
Jul	252,239	239,627	264,851	83,899	336,137	333,294	(2,843)	316,164
Aug	202,925	192,778	213,071	81,758	284,682	296,851	12,169	280,578
Sep	147,338	139,972	154,705	78,601	225,939	231,675	5,736	232,539
Oct	143,549	136,372	150,727	90,390	233,939	248,489	14,550	239,471
Nov	90,456	85,933	94,979	72,138	162,594	181,197	18,603	166,681
Dec	38,225	36,314	40,136	60,885	99,110	69,885	(29,225)	101,411
	1,843,023	1,750,872	1,935,175	972,597	2,815,620	2,813,019	(2,601)	2,774,257

COMPARISON OF ESTIMATED WITH ACTUAL DIVERSIONS

Year:	1995		1995				
ET Factor =	1.00		USBR		Difference	Difference	90-94 Avg
Month	Total	Distrib	87-94 Avg	Distrib	Est-Div	Est-Div	Net Drain
	ac-ft		ac-ft		ac-ft	Percent	ac-ft
Jan	130,335	4.7%	118,317	4.2%	12,018	10%	63,022
Feb	131,104	4.7%	147,608	5.3%	(16,504)	-11%	60,356
Mar	235,649	8.5%	253,004	9.0%	(17,356)	-7%	93,005
Apr	332,991	12.0%	324,572	11.6%	8,419	3%	103,986
May	313,831	11.3%	314,053	11.2%	(222)	-0%	101,455
Jun	293,504	10.6%	290,559	10.4%	2,945	1%	83,102
Jul	316,164	11.4%	317,800	11.3%	(1,636)	-1%	83,899
Aug	280,578	10.1%	283,566	10.1%	(2,988)	-1%	81,758
Sep	232,539	8.4%	236,686	8.4%	(4,147)	-2%	78,601
Oct	239,471	8.6%	228,484	8.2%	10,987	5%	90,390
Nov	166,681	6.0%	164,181	5.9%	2,501	2%	72,138
Dec	101,411	3.7%	124,239	4.4%	(22,828)	-18%	60,885
	2,774,257	100.0%	2,803,069	100.0%	(28,812)	-1.0%	972,597

TOTAL DISTRICT CONSUMPTIVE USE AND CU COEFFICIENT, CUc:

				87-94 Avg		
	1993	1994	Average	1995	Change	Change, %
Pilot Knob	3,376,801	3,419,700	3,398,251	3,230,260	(167,991)	-4.9%
Seepage	94,200	94,200	94,200	94,200	0	0.0%
Evaporation	7,458	6,995	7,227	6,476	(751)	-10.4%
CVWD Del	351,264	359,402	355,333	307,826	(47,507)	-13.4%
DelU/SEHL	5,140	5,140	5,140	5,140	0	0.0%
IID Del	2,918,739	2,953,963	2,936,351	2,816,618	(119,733)	-4.1%

Total estimated CU & non-agricultural deliveries	1,801,660	
Fraction of total water consumed within IID	0.640	If less <0.65, Drainage coefficient should be reduced (Cells F915)
Estimated water delivered to agricultural users	2,444,000	1987-1994 average = 2,458,950
Estimated agricultural consumptive use	1,633,659	
Fraction of delivered water consumed by agric	0.668	Should be 0.67 or greater
Fraction of delivered agr water not consumed	0.332	

SUMMARY OF CROP AND OTHER EVAP & ET

Avg ETo: 1990-1994 *Stations:*41, 68, & 8

FIELD CROPS:	Alf reduction 0.80 Alfalfa	Alfalfa (Seed)	Bermuda Grass	Bermuda Gr. (Seed)	Cotton	Oats
Acre-feet	832,527	30,907	3,861	75,128	24,023	2,990
	Rye Grass	Sudan Grass	Sugar Bts Summer	Sugar Bts Winter	Wheat	Misc.
Acre-feet	2,963	212,771	59,887	52,099	72,052	5,406

GARDEN CROPS:	Broccoli	Cabbage	Carrots	Cauli-flower	Corn, Ear	Lettuce Fall
Acre-feet	8,367	1,103	29,540	3,963	4,940	18,995
		Cantaloupes		Honeydew	Melons (Other)	
	Lettuce Spring	Fall	Spring	Fall	Fall	Spring
Acre-feet	19,330	3,081	27,426	1,561	110	360
	Water-melons	Onions	Onion (Seed)	Tomatoes (Spring)	Misc	
Acre-feet	4,769	17,410	4,097	11,439	13,856	

PERMANENT CROPS:	Artichokes	Asparagas	Citrus	Duck Ponds	Jojoba	Misc
Acre-feet	423	28,209	9,573	47,363	0	3,131

WATER SURFACES:	Canals	Laterals	Reservoirs	Riv & Drain Phreat. ET	Riv & Drain Evap	Non-Agr Deliveries
Acre-feet	9,288	7,425	1,363	65,594	12,892	71,439

TOTALS:	Field Crops	Garden Crops	Permanent Crops	Wtr Surf Evap	Drains, Phreat ET	Non-Agr Deliveries
Acre-feet	1,374,613	170,346	88,699	30,968	65,594	71,439
Percent	76.3%	9.5%	4.9%	1.7%	3.6%	4.0%
GRAND TOTAL, Acre-feet						1,801,660

1020	SUMMARY FOR TRANSFER TO OTHER FILES			
1021			VALUE	NOTE: These must be
1022		From above	FOR TRANSFER	updated
1023	Field Crop ET:	ac-ft	ac-ft	manually
1024	Alfalfa	832,527	832,527	after each
1025	Alfalfa seed	30,907	30,907	calculation
1026	Bermuda Grass	3,861	3,861	update
1027	Bermuda Grass (Seed)	75,128	75,128	R1024-107
1028	Cotton	24,023	24,023	
1029	Oats	2,990	2,990	
1030	Rye Grass	2,963	2,963	
1031	Sudan Grass	212,771	212,771	
1032	Sugar Beets (Fall)	59,887	59,887	
1033	Sugar Beets (Spring)	52,099	52,099	
1034	Wheat	72,052	72,052	
1035	Miscellaneous	5,406	5,406	
1036	Garden Crops:			
1037	Broccoli	8,367	8,367	
1038	Cabbage	1,103	1,103	
1039	Carrots	29,540	29,540	
1040	Cauliflower	3,963	3,963	
1041	Corn, Ear	4,940	4,940	
1042	Lettuce (Fall)	18,995	18,995	
1043	Lettuce (Spring)	19,330	19,330	
1044	Melons:			
1045	Cantaloupes (Fall)	3,081	3,081	
1046	Cantaloupes (Spring)	27,426	27,426	
1047	Honeydew (Fall)	1,561	1,561	
1048	Melons (Mixed, fall)	110	110	
1049	Melons(Mixed, spring)	360	360	
1050	Watermelons	4,769	4,769	
1051	Onions	17,410	17,410	
1052	Onion (Seed)	4,097	4,097	
1053	Tomatoes (Spring)	11,439	11,439	
1054	Misc Other	13,856	13,856	
1055	Permanent Crops:			
1056	Artichokes	423	423	
1057	Asparagas	28,209	28,209	
1058	Citrus:	9,573	9,573	
1059	Duck Ponds (Feed)	47,363	47,363	
1060	Jojoba	0	0	
1061	Misc	3,131	3,131	
1062	Continued on next page			

Water Surfaces and Phreatophytes:		
Canals, flowing water	9,288	9,288
Laterals, flowing water	7,425	7,425
Reservoirs	1,363	1,363
Rivers and Drains Phreat ET	65,594	65,594
Rivers and Drains Evaporation	12,892	12,892
Non-Agric Deliveries	71,439	71,439
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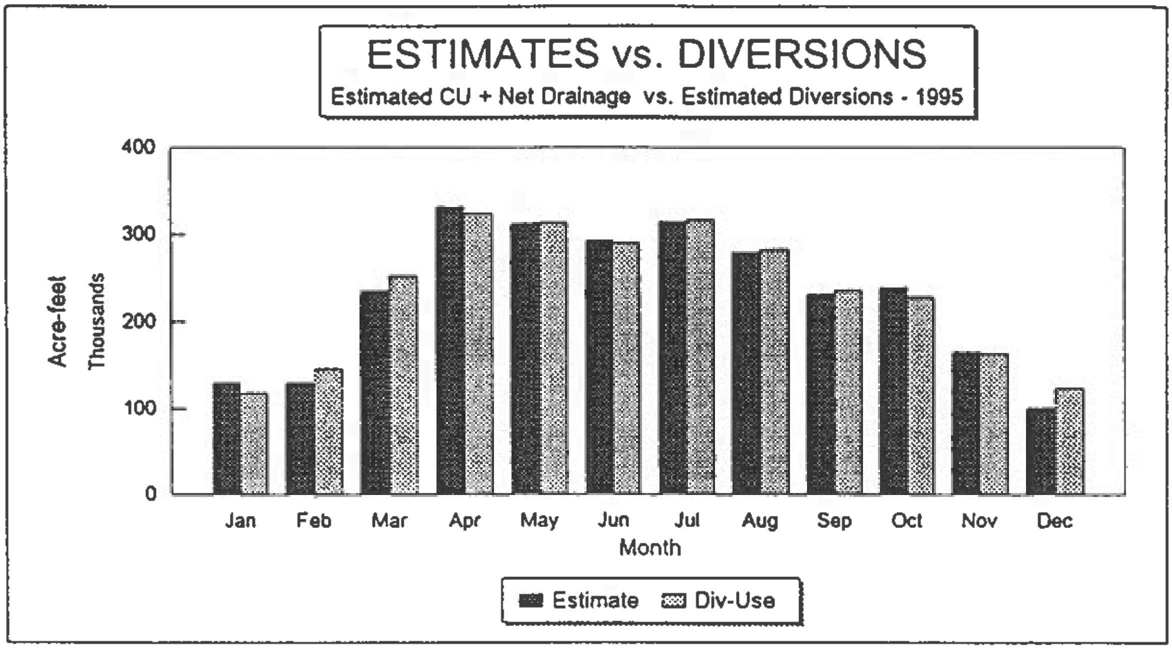
GRAND TOTAL	1,801,660	1,801,660 These must agree
Check	1,801,660	1,801,660 before making transfer
		to other data files



15-Jun-95 Alf Adj = 0.80 ET Factor 1.00 Drain Ftr 1.00

SUMMARY: Period	Estimates	Net Supply	Est - Div	Est - Div, %	Per mo Est - Div
Jan-Feb	261,439	265,925	(4,486)	-1.7%	(2,243)
Mar-Apr	568,639	577,576	(8,937)	-1.5%	(4,468)
May-July	923,499	922,412	1,087	0.1%	362
Aug-Oct	752,588	748,736	3,852	0.5%	1,284
Nov-Dec	268,092	288,419	(20,327)	-7.0%	(10,164)
Total	2,774,257	2,803,069	(28,812)	-1.0%	