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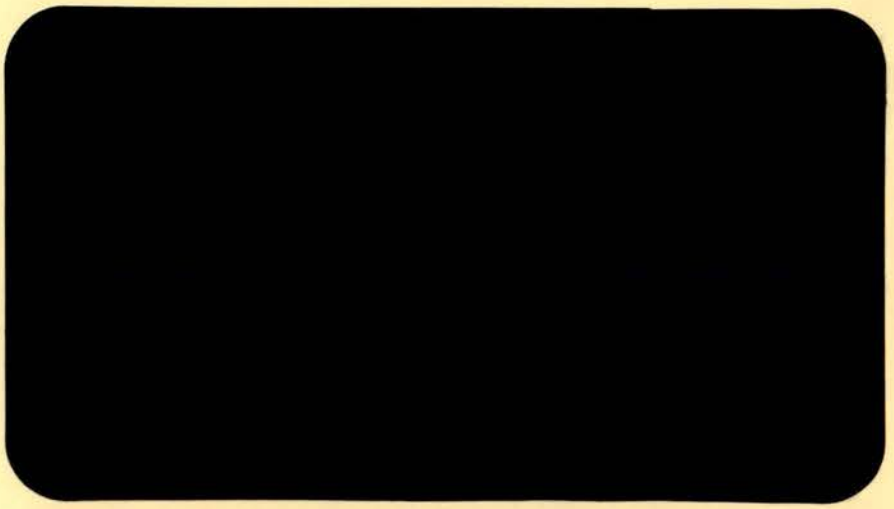

WORKING PAPER SERIES

University of California, Davis
Department of Agricultural Economics

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Benefits and Costs of a Through Delta Facility to Kern County Agriculture

by

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The Problem

Landowners, irrigation district managers, and farm operators in Kern County in the next few years will most likely be required to make a decision to contract or decline to contract for the enlarged Through Delta Facility. They must weigh the benefits of having a higher probability of receiving their full entitlement against a significantly higher cost for that water over the entire 40 year payout period of the project. Using the analogy of an insurance policy, water users must decide how large an insurance premium they will be willing to pay each year over the next 40 years in order to capture the increased probability of receiving their contract entitlement plus any surplus water which might be available.

The following sections contain information that will aid these water users in coming to their decision. First, the costs of an enlarged Through Delta Facility are given. Second, given historic rainfall and runoff patterns, the increased deliveries from the enlarged facility are given. The next section discusses the theory behind calculating the net benefits of the increased deliveries, taking into account the increased costs. The forth section presents the results of the benefit calculations using the costs and deliveries from sections one and two. Finally, given the results, the decision making problem is discussed.

Project Costs

In November, 1983, the California Department of Water Resources proposed several alternatives for transferring additional water to contractors of the State Water Project (SWP). All these proposals involved transfers through the Sacramento-San Joaquin Delta. Unit costs varied from $23.00 to $103.00 per acre foot depending on the configuration and environmental safeguards included.

Project annual and unit costs for the most likely configuration of an enlarged Through Delta Facility have been estimated by an independent financial consultant[1/] as follows:

Construction Costs, 1984:	Pumps	$ 30 million
	North Delta	260 million
	South Delta	40 million
	Total	$333 million

Bond Issue: $370 million including funded interest during construction and insurance costs.

Costs: Incremental cost per acre foot for average annual yield of 560,000 acre feet, $68.00. Increase in average annual cost per acre foot of entitlement, $9.15.

Interest Rate: 9.4% for 40 years.

Note: Cost savings assumed to offset any increase in operation and maintenance in Delta but does not include provision for additional levee maintenance.

It is this $9.15 per acre foot increase in price that is used in the benefits section.

Water Deliveries

The Department of Water Resources has developed a hydrologic simulation model to simulate the effect of operating rules and contractual agreements on deliveries of the SWP. The model utilizes 57 years (1922 to 1978) of historical rainfall and runoff data and can incorporate alternative Delta facilities. This model was used to project possible deliveries of entitlement and surplus water to Kern County agricultural users (Figures 1 and 2) under the assumed demand conditions of 1990 and 2000. There projections are based on the 57 historic years. Both figures plot water deliveries on the vertical axis. On the horizontal axis, the 57 historic years are arranged with the wettest

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1/Mark Eudey, California Municipal Statistics, Inc.

Figure 1

Water Supplies From State Water Project and Groundwater Pumpage Kern County, 1990

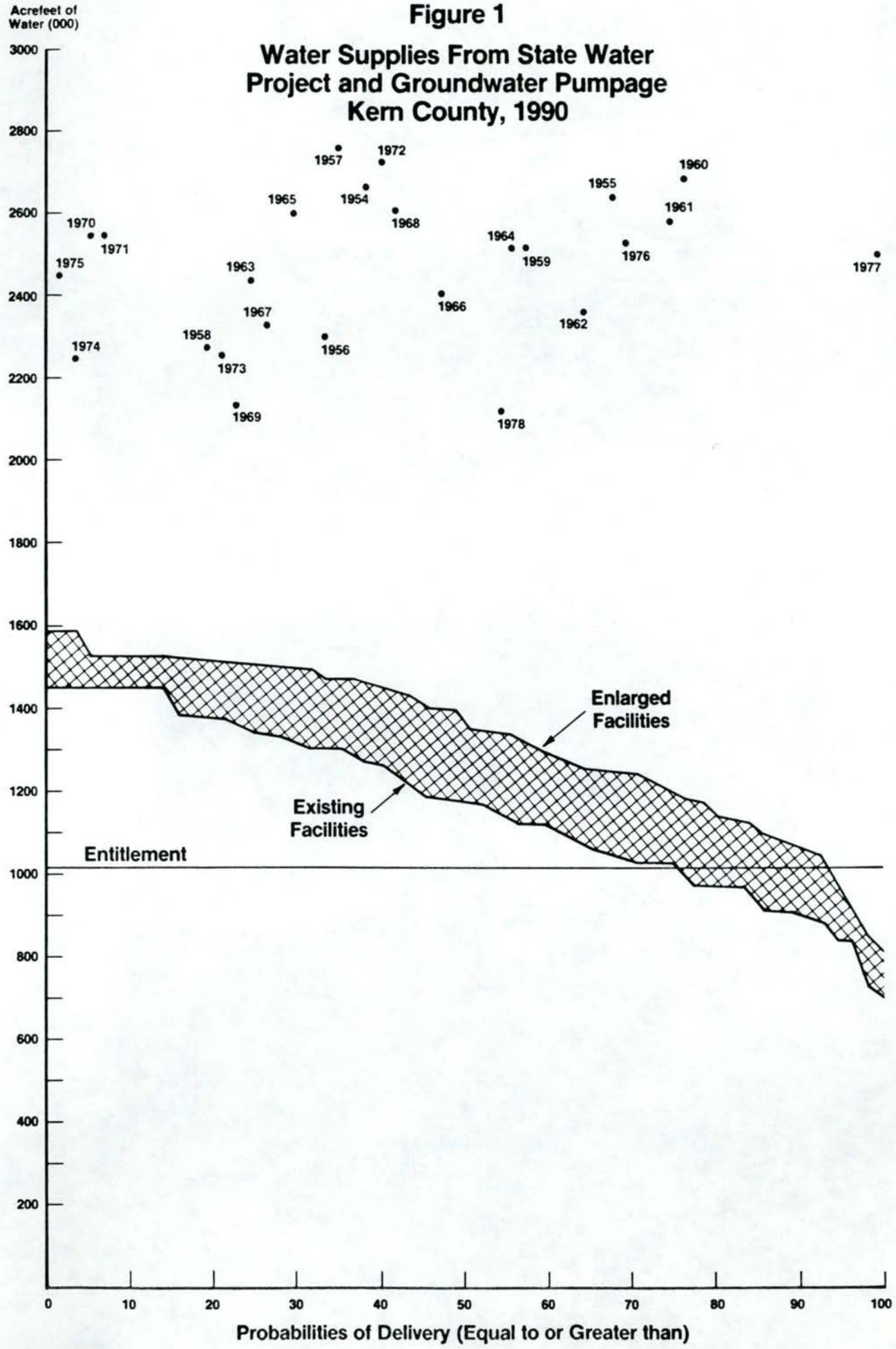
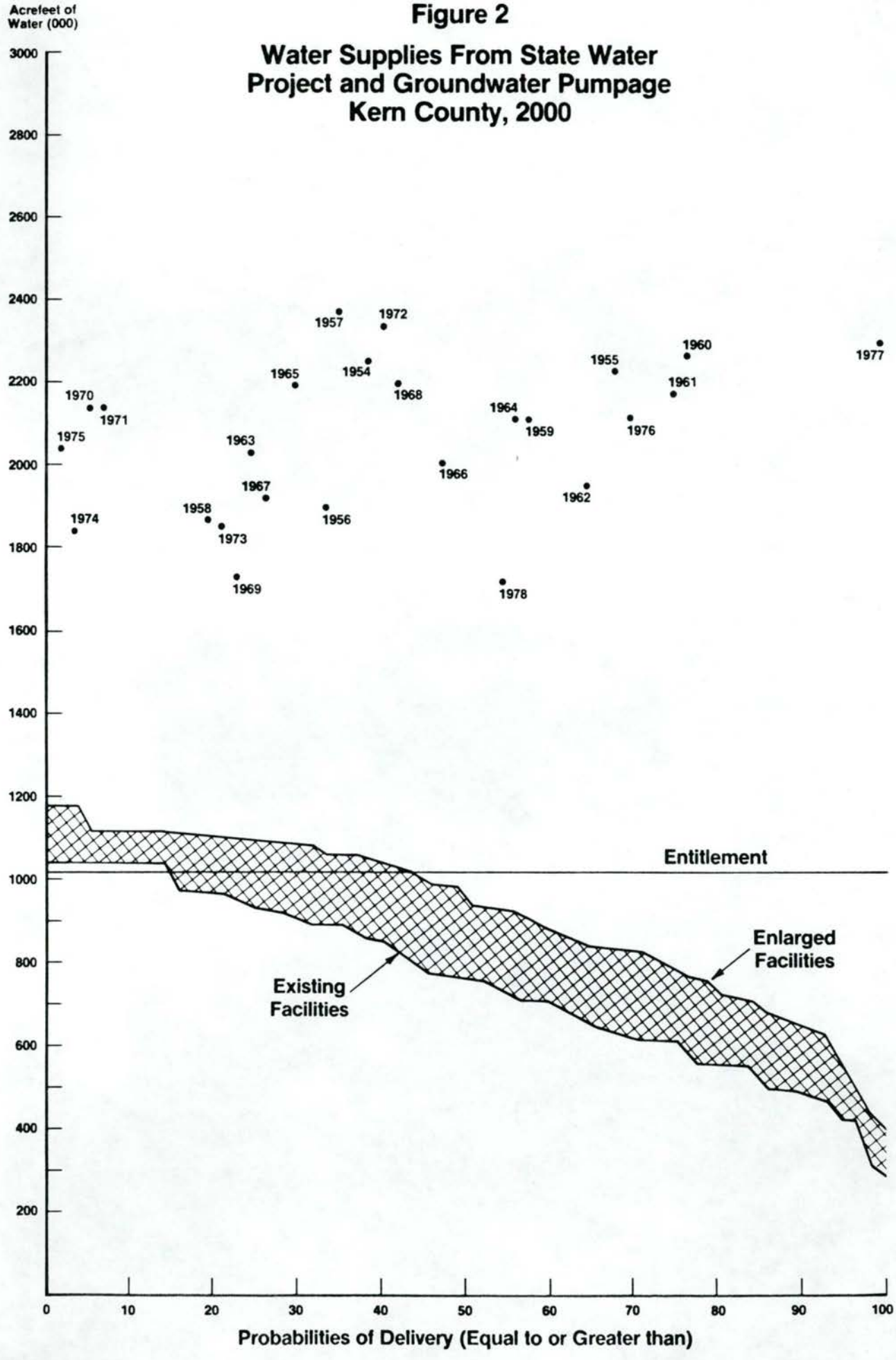


Figure 2

Water Supplies From State Water Project and Groundwater Pumpage Kern County, 2000



year (1953) on the extreme left and progressively drier years are plotted as one moves to the right until the driest year (1934) is reached on the extreme right. The horizontal axis is then divided into 10 equal probability intervals. There is an equal chance (10 percent) of an actual water delivery falling into any one of the 10 intervals.

By 1990, Kern County will have reached its maximum agricultural entitlement of 1,033,800 acre feet, thus, any deliveries greater than the entitlement line is surplus water (Figure 1). The difference between the 1990 deliveries and 2000 deliveries is the assumed increase in demand of 400,000 acre feet by the Metropolitan Water District. Finally, we have in addition plotted total water use (groundwater withdrawals plus SWP deliveries) corresponding to 25 of the 57 historic years (1954 to 1978). In very dry years, areas in Kern County with groundwater potential have apparently increased pumpage to compensate for reduced surface deliveries.

The enlarged Through Delta Facility, including additional pumping plant capacity, can be viewed as an insurance policy against drought. In 1990 there is 75 percent probability of receiving the full agricultural entitlement using existing facilities. However, by investing in the enlarged facility, the probability of receiving a full entitlement increases to about 94 percent (Figure 1). By the year 2000, assuming that Southern California expands utilization of its entitlement, there is only a 15 percent probability of Kern County receiving its agricultural entitlement with existing facilities. With the enlarged facilities the comparable figure is 45 percent probability (Figure 2). It is interesting to note that the increase in deliveries with the enlarged facility is considerably less in extremely dry years similar to 1977 than in an average rainfall year such as 1966 (104,000 acre feet compared to 200,000 acre feet).

Water deliveries in excess of entitlement are important to areas of the county which can use it for groundwater recharge or in lieu of pumping. It is not clear that all of the surplus water assumed to be delivered by the hydrologic simulation model under the 1990 demand conditions could in fact be utilized during very wet years. Primarily, this is due to the fact that local streams would already be in flood or near flood conditions and recharge basins would already be near capacity. Actual utilization would probably be less during these periods than the physical capacity of the SWP to make deliveries. Thus, benefits in this study may be overstated in very wet years for areas with groundwater.

Benefits

To keep the problem manageable, agricultural water users in Kern County were placed in two groups, those with a groundwater supply and those in the northwest portion of the county without a groundwater supply. This distinction is important because water districts without access to groundwater will place little or no value on surplus water deliveries in that they are precluded from contracting for surplus SWP water. Thus, for areas with ground water, it is assumed that approximately the same total amount of water will be used and thus planted acreage will not change (except in very dry years). However, the relative proportion of surface water and ground water will vary depending on availability of surface water.

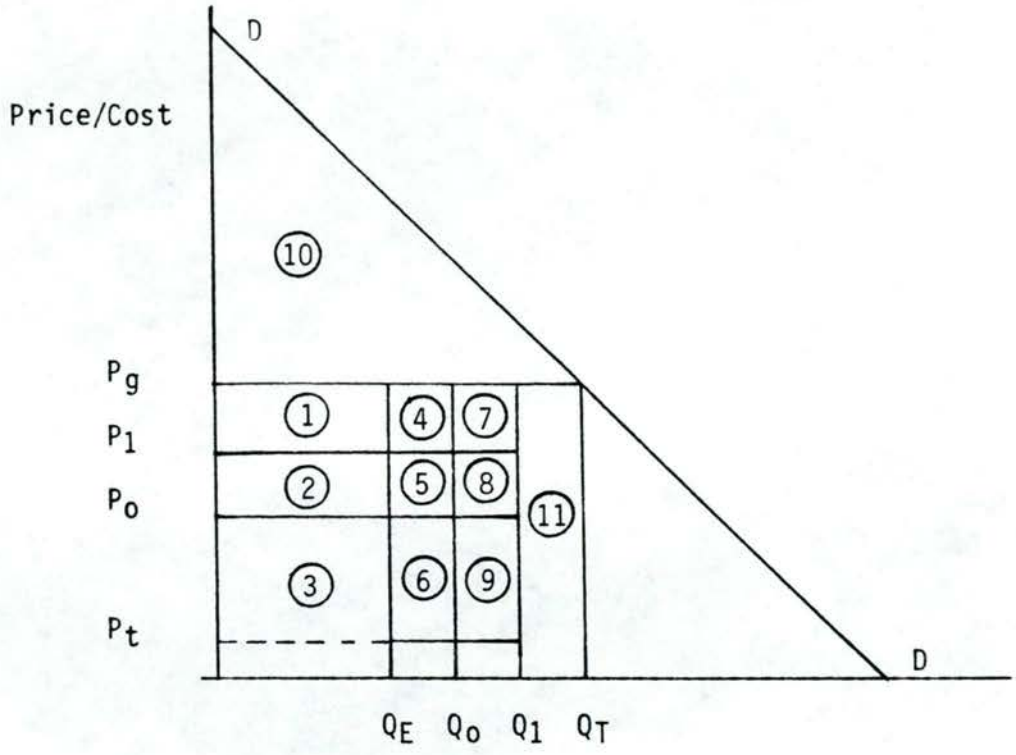
For areas without groundwater, only surface water is available and thus total applied water, and thus planted acreage, can vary from year to year.

For areas with a groundwater supply, economic benefits are based on the savings achieved from not having to pay groundwater pumping costs for the total water used. The procedure for estimating irrigation benefits is as follows for a very wet water year (Figure 3):

1) Determine the benefits of entitlement water (Q_E) with the existing

Figure 3

Benefits and Costs of Water Deliveries to Kern County
(Groundwater Area, Very Wet Year)



P_g : Cost of pumping one acre foot of groundwater

P_1 : Cost of one acre foot of surface water supplied by new facility including transportation cost

P_o : Cost of one acre foot of surface water supplied by existing facility including transportation cost

P_t : Transportation cost for surplus water

Q_T : Total applied water (assumes groundwater water will be used to make up any deficit in surface water).

Q_1 : Surface water supplied by new facility

Q_o : Surface water supplied by existing facility

Q_E : Surface water entitlement

(11) : Groundwater pumpage

facility [the difference between pumping costs (P_g) and the current SWP price (P_o)]: Sum of areas ① + ② .

2) Determine benefits of surplus water ($Q_o - Q_E$) with the existing facility [the difference between P_g and the transportation cost (P_t)]: Sum of areas ④ + ⑤ + ⑥.

3) Determine the benefits of entitlement water with the enlarged facility (the difference between P_g and P_1): Area ① .

4) Determine the benefits of surplus water with the enlarged facillity (the difference between P_g and P_t): Sum of areas ④ + ⑤ + ⑥ + ⑦ + ⑧ + ⑨.

5) Thus, because of the increased quantity, the enlarged facility increases the total value of surplus water by ⑦ + ⑧ + ⑨[the difference between 4) and 2) above], but, because of the cost of the enlarged facility it decreases the value of entitlement water by ② [the difference between 1) and 3) above].

Thus net benefits for districts <u>with</u> groundwater can be calculated as follows:

Benefits from Enlarged Through Delta Facility = ① + ④ + ⑤ + ⑥ + ⑦ + ⑧ + ⑨

Benefits from Existing Facilities = ① + ② + ④ + ⑤ + ⑥

Net benefit of Enlarged Facility = ⑦ + ⑧ + ⑨ - ②

The procedure is somewhat different for areas <u>without</u> groundwater suplies. Economic benefits are based on changes in the area under the economic demand curve for irrigation water in north western Kern County estimated for the

Department of Water Resources by Auslam and Associates, Inc.[1/]. The procedure for a drier than normal year is as follows (Figure 4):

1) Determine the benefits with the existing facility: (a) + (b)
2) Determine the benefits of entitlement water with the enlarged facility: (a) + (c)
3) Thus, because it increases the quantity of water delivered, the enlarged facility increases the benefits from agricultural output by (c), but because of the increased cost of facilities it decreases the value of entitlement water by (b)

Thus net benefits for districts <u>without</u> groundwater can be calculated as follows:

Benefits from Enlarged Facilities = (a) + (c)

Benefits from Existing Facilities = (a) + (b)

Net Benefit of Project = (c) - (d)

Results

For ease of presentation, the benefits from receiving exactly the full entitlement was set equal to 100 percent. Thus, because surplus water has no benefit to districts <u>without</u> groundwater, the maximum benefits for them was 100 percent with the existing facilities and 92 percent with the enlarged facilities due to the higher water costs. (Table 1.)

Water districts <u>with</u> groundwater could receive 100 percent of benefits from a full entitlement plus the value of any surplus deliveries. Thus, in

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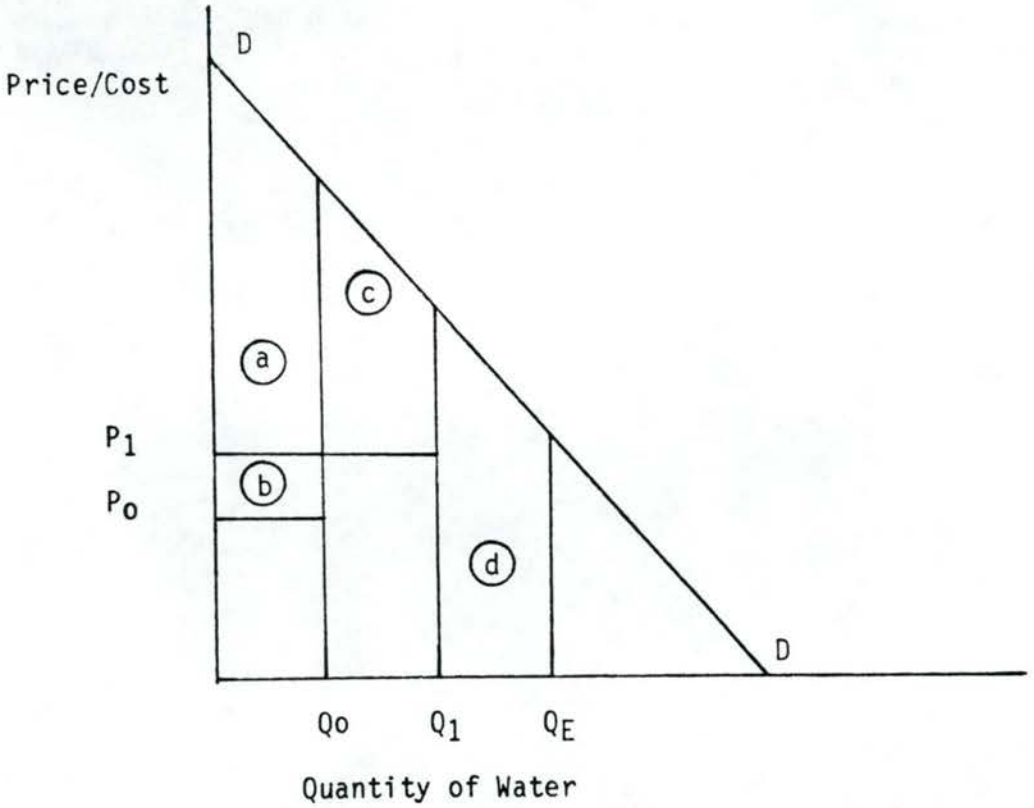
[1/]J.E. Noel and D. McLaughlin. Final Report San Joaquin Valley Hydralogic-Economic Modeling Study. Auslam and Associates, Inc., North Highlands, Calif., October 1982.

Figure 4

Benefits and Costs of Entitlement Water Delivered to
Kern County, Nongroundwater Area--Dry Year



P_1 : Cost of one acre foot of surface water supplied by the enlarged facility including transportation cost

P_o : Cost of one acre foot of surface water supplied by the existing facility including transportation cost

Q_1 : Surface water supplied by new facility

Q_o : Surface water supplied by existing facility

Q_E : Surface water Entitlement

(d) : Is the unfulfilled demand which increases in dry years

Table 1

Net Benefits for Growers Without Groundwater

Kern County

1990

	Existing Facilities		With Through Delta Facility	
	Water Percent	Benefits Index	Water Percent	Benefits Index
Extremely Wet	100*	100*	100*	92
Very Wet	100	100	100	92
Wet	100	100	100	92
Wet	100	100	100	92
Normal	100	100	100	92
Normal	100	100	100	92
Dry	100	100	100	92
Dry	97	100	100	92
Very Dry	91	98	100	92
Extremely Dry	79	93	91	91
Average		99		92

2000

	Existing Facilities		With Through Delta Facility	
	Water Percent	Benefits Index	Water Percent	Benefits Index
Extremely Wet	100*	100**	100*	92
Very Wet	97	100	100	92
Wet	90	98	100	92
Wet	85	96	100	92
Normal	78	92	96	92
Normal	71	88	89	90
Dry	64	83	82	88
Dry	58	78	77	86
Very Dry	51	72	68	81
Extremely Dry	39	59	52	69
Average		87		88

*100% represents full entitlement

**100% represents returns with full entitlement without project

Table 2

Net Benefits for Growers With Groundwater

Kern County

1990

	Existing Facilities		With Through Delta Facility	
	Water Percent	Benefits Index	Water Percent	Benefits Index
Extremely Wet	174*	195*	192*	196**
Very Wet	168	187	186	189
Wet	155	171	183	185
Wet	146	159	179	179
Normal	132	140	169	167
Normal	119	125	153	146
Dry	106	107	140	130
Dry	97	97	130	116
Very Dry	91	91	114	95
Extremely Dry	79	79	91	71
Average		135		147

2000

	Existing Facilities		With Through Delta Facility	
	Water Percent	Benefits Index	Water Percent	Benefits Index
Extremely Wet	101*	100	119	103
Very Wet	97	97	114	96
Wet	90	90	110	91
Wet	85	85	106	85
Normal	78	77	98	76
Normal	71	70	89	69
Dry	64	63	82	64
Dry	58	57	77	60
Very Dry	51	51	68	53
Extremely Dry	39	39	52	40
Average		73		74

*100% represents full entitlement

**100% represents returns with full entitlement without project

the wettest year the index of benefits for 1990 is 195 with the existing facilities and 196 with the enlarged facilities. For 2000 the maximum values are 100 and 103 (Table 2).

Both areas in the county, those with and without groundwater, indicate a decline in total benefits in the year 2000 due to the decline in deliveries (entitlement and surplus) caused by the increased deliveries to Southern California. However, districts with groundwater are more severely effected than without groundwater districts. This is caused by two factors. First, in 1990 the with groundwater agencies can use surplus water to increase benefits above 100%. If these agencies could not use these surpluses, their average benefits would be similar to those found for without groundwater agencies. Second, in 2000, the with groundwater agencies appear to be more severely effected than the without groundwater agencies. This is because of the two different ways in which benefits are calculated for each type of agency (Figures 3 and 4). This difference gives without groundwater agencies a higher base and, thus, a smaller relative change for the same net change in benefits.

For those districts without groundwater, the average index of benefits drops from 99 in 1990 to 87 in 2000 with the existing facilities. The average index of benefits declines from 92 in 1990 to 88 in 2000 with the enlarged facilities. The net benefits of the enlarged facility being only one index number higher than with the existing facilities in 2000 (Table 1).

Water Districts with groundwater show a more dramatic decline in net benefits between the years 1990 and 2000. With only existing facilities, the index of benefits declines from an average of 135 to 73. Even with the enlarged facilities, the index of benefits declines from an average of 147 to 74 (Table 2).

The Decision: To Build or Not to Build

A water manager in this situation is presented with a decision to choose between two uncertain events. The manager is concerned not only with the average supply and benefits but the certainty of these benefits. Since the demands of Southern California are dynamic, changing over time, optimal timing of the investment decision is equally important.

Growers without groundwater and dependent on entitlement water would have to be willing to pay 7 percent of their present benefits as an insurance premium in order to want the enlarged facility built by 1990. However, even the most conservative operator in the no groundwater area would want to have the enlarged facility built by the year 2000 because the expected net benefits with the enlarged facility are slightly higher than with the existing facility by 2000.

Operators with groundwater would in all probability want the project constructed by 1990 assuming that all of the system's capacity to deliver surplus water in very wet years can in fact be utilized for recharge and in lieu of pumping. The case for having the project in operation in the year 2000 is not as clear. The difference in expected net benefits is only one index number, 74 vs. 73.

Given that the payout period for the project is 40 years, growers with groundwater areas must continue to pay the $9.15 per acre foot until well into the third decade of the next century. Until additional hydrology simulation runs are made, it will not be clear whether the stream of net benefits for the groundwater area will continue to decline at the same rate as Southern California water demands continue to grow. Agriculture absorbs all supply shortfalls up to 50 percent, after which shortfalls are shared equally with Southern California.

With only the two observations, 1990 and 2000, the trend in the gains

from constructing an enlarged Through Delta Facility appear to increase over time for the non-groundwater districts and to decline for the groundwater districts. This may make agreement between the two groups more difficult, especially since the Kern County Water Agency represents all SWP contractors in the county, is the signature agency with DWR, and historically has approved all contract modifications for SWP water.

One final note on the uncertainty of water demands: The 400,000 acre foot difference between 1990 and 2000 is approximately the same quantity under discussion in the proposed Imperial Irrigation District-Metropolitan Water Distric water transfer. If a major block of non SWP water was made available to Southern California the level of net benefits attributable to the project in 2000 would be very similar to the benefit level now estimated for 1990.