TECHNICAL REPORT

The 1997 Irrigation Suspension Program for the Edwards Aquifer: Evaluation and Alternatives

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The 1997 Irrigation Suspension Program for the Edwards Aquifer: Evaluation and Alternatives

Early in 1997, the Edwards Aquifer Authority (EAA) implemented a pilot Irrigation Suspension Program (ISP) for the Edwards Aquifer (Aquifer) region in Texas that paid a group of farmers not to irrigate for the 1997 cropping season. The program was designed to raise aquifer levels, increase springflow, and provide municipalities with relief in critical drought periods. This report describes that program and analyzes its potential impacts: 1) providing background leading up to the decision to implement an ISP, 2) documents details of the pilot ISP, 3) estimates the effects of the program in terms of decreased pumping by irrigators; changes in crop mix, aquifer elevation, springflow and return flow; and impacts on the local economy, under prevailing and potential weather conditions, 4) presents results from a survey of ISP irrigators, and 5) briefly evaluates some alternative approaches.

Background

The Edwards Aquifer (Aquifer) is a tremendous resource for the economy of south central Texas. It supplies virtually all the municipal and industrial water supply for the greater San Antonio region (the 10th largest city in the United States). West of San Antonio, the Aquifer supports a thriving irrigated agricultural economy, while supplying springflow to two large springs northeast of San Antonio. In turn, these springs are a significant source of recharge to the Guadalupe and Blanco rivers, where the water can be utilized for agricultural, municipal, and industrial uses. The springs and rivers also support a recreation industry, are attractions in their own right, and support a unique biological community. Five Aquifer species are currently listed as threatened or endangered by the United States Fish and Wildlife Service (USFWS).

Springflow is highly correlated with Aquifer elevation, especially for Comal Springs, the larger of the two springs. Aquifer elevation is a function of both Aquifer recharge and Aquifer pumping. A study by Keplinger and McCarl (1995b) indicates that a one foot increase in Aquifer elevation at the J17 index well in San Antonio at the beginning of the year increases Comal springflow by about 2,650 acre-feet over the course of a year or 3.66 cfs, on average. The same study suggests that one acre-foot of recharge (which occurs mainly in the west) increases Comal springflow by .08 acre-feet during the year of recharge, while one acre-foot of pumping in the eastern portion of the aquifer reduces Comal springflow by about .28 acre-feet during the year water was pumped. Although the relationships over time and space are quite complex, examination of annual Aquifer recharge, pumping, and springflow, as depicted in Figure 1 reveals the positive correlation between recharge and springflow, and the inverse relationship between pumping and springflow. Increasing withdrawals from the Aquifer over the years by agricultural, municipal, and industrial interests have led to declining springflow, particularly during dry years.

Until recently, withdrawals from the Edwards Aquifer were largely unregulated, and the Aquifer suffered from misallocation due to common property ownership in the face of scarcity. In

addition, withdrawals from the aquifer imposed negative externalities on springflow and downstream interests and there was no legal mechanism whereby these interests could secure additional springflow or even protect existing levels of springflow. This situation led to challenges of the prevailing modus operandi under various legal mechanisms. A suit filed in 1991 seeking springflow protection under the Endangered Species Act (Sierra Club v. Babbitt) was upheld in federal court in 1993. That suit was as a major factor promoting the introduction, passage, and ultimate implementation of Senate Bill 1477 (SB 1477). This bill was designed to improve Aquifer management by creating an Edwards Aquifer Authority (EAA) which was given strong powers to set overall pumping limits; adjudicate, define, and monitor individual pumping rights; collect fees, and engage in water marketing.[1]

Although SB 1477 initially passed the Texas legislature in 1993, legal challenges upheld its full implementation until June 28, 1996, when the Texas Supreme Court ruled that the legislation was not prima facie unconstitutional. Although the EAA commenced operations in accordance with SB 1477, it faced the inevitably long and tedious process of requesting and validating permit applications, adjudicating and defining water rights, issuing pumping permits, collecting fees, etc. Current estimates are that it will take from three to five years to establish a functioning permit system.

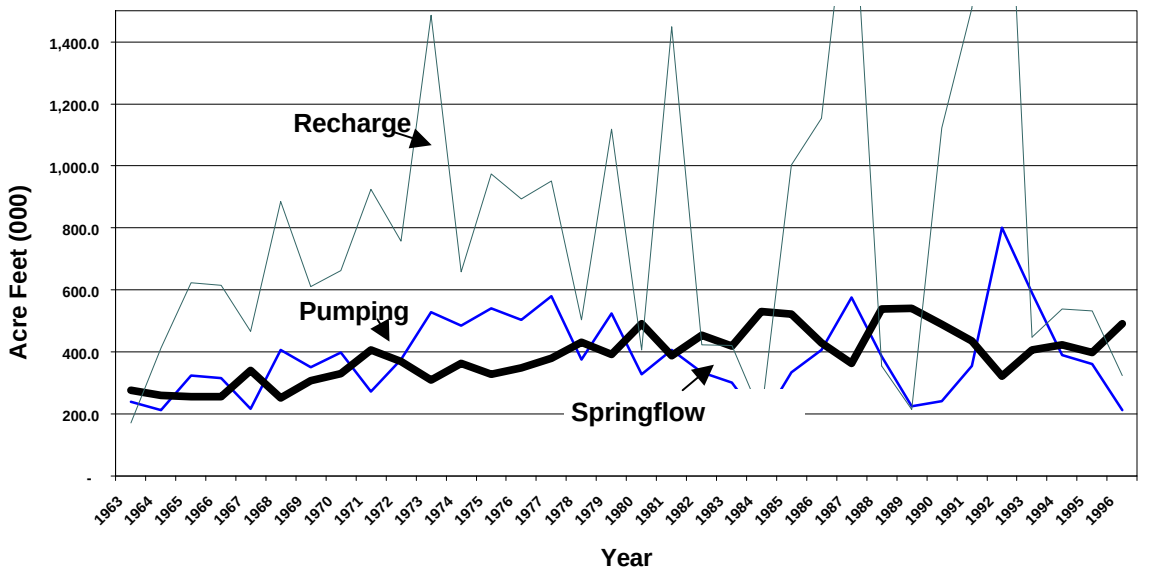


Figure 1. Total Recharge, Pumping, and Springflow, Edwards Aquifer, 1963-1996.

During 1996, the region experienced one of its worst droughts in recent history. Comal Springs dropped to its lowest level since 1990 at 79 cubic feet per second (cfs).[2] The absence of established water rights limited the ability of the EAA, its predecessor organization (the Edwards

[1] Longley and Jordan elaborate on how the Endangered Species Act influenced events in the region.

[2] The USFWS determined minimum springflow at Comal Springs needed to protect the Fountain darter to be 200 cs to prevent takes, and 150 cfs to prevent jeopardy (USFWS).

Underground Water District, EUWD), and area water purveyors to limit overall aquifer pumping, although various drought management plans were implemented. These plans, however, were insufficient in achieving springflow objectives.

Another idea to augment declining springflow that emerged in this weak regulatory environment was to pay farmers not to irrigate, a concept referred to as a dry year option or irrigation suspension program (DYO/ISP). Approximately 80,000 acres of cropland are situated over the Edwards Aquifer, almost all of which are irrigated using Aquifer water. Between 1982 and 1996, irrigation from the Aquifer is estimated to have averaged 127,000 acre-feet (USGS).

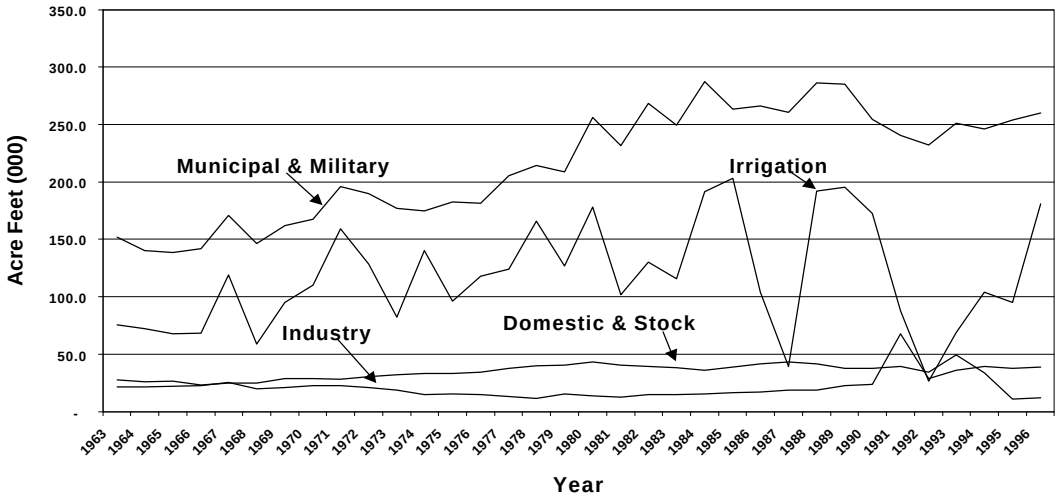


Figure 2. Edwards Aquifer Pumping by Type of Use, 1963-1996

Agricultural water use, however, is sensitive to weather conditions as Figure 2 suggests. For six of these fifteen years, agricultural water use topped 170,000 acre-feet. Irrigation use is estimated to have been 180,800 acre-feet in 1996. These figures suggest that considerable amounts of irrigation water pumped from the Aquifer potentially could be diverted to other uses, especially during dry years, when water is scarcer.

The DYO/ISP concept that emerged in the Aquifer region late in 1996 involved voluntary contracts between irrigators and a purchasing entity. Because water rights were not established nor were most pumps metered, payment was to be based on the number of acres withdrawn from irrigation, rather than a transfer or lease of water rights, per se.[3]

Recent Events

[3] Additional background material is provided in Keplinger and The Water Strategist. A detailed description of the aquifer and region is provided in Grubb. Legal issues are discussed in Shenkkan.

In 1996, the EUWD and the Texas Water Development Board (TWDB) organized an investigation into the issues and opportunities of initiating a DYO/ISP program for 1996. A report was prepared by G.E. Rothe Company, Inc. that outlined elements of a pilot DYO/ISP in sufficient detail for legal counsel to draft an option contract that could be executed by buyers and farmers. This report was not completed until well into the 1996 growing season. A funding entity for the 1996 program did not emerge and the program was not implemented.
The 1996 drought as well as legal pressure to relieve low springflow continued throughout the remainder of the year. In August, a Court Order by Judge Bunton (Bunton) delineated an emergency plan as relief to plaintiffs in the ongoing Sierra Club v. Babbitt suit. A key element of the plan involved restricting irrigation water use in 1997 and a DYO/ISP was recommended as a possible solution. In September, the San Antonio Water System's (SAWs) board voted to allocate $500,000 of surcharge fees collected on high water volume customers in the summer of 1996 to a DYO/ISP program. In October, the EAA expressed interest in developing a DYO/ISP for the 1997 season based on long-range weather forecasts that predicted similar drought conditions in 1997 to those of 1996. After substantial deliberation, the EAA merged the DYO/ISP into its Interim Critical Period Management (CPM) Rules,[4] providing incentives for local water agencies to fund the program. In November, permanent members of EAA board of directors were elected in the general election and assumed office on December 1. At a December 19 board meeting, the newly elected EAA board adopted the amended CPM Rules and approved a DYO/ISP for implementation. Events moved very rapidly from this point forward in order to implement the program for the 1997 cropping season.

First notice of the ISP was published in regional newspapers on December 29. On January 2, the EAA held a meeting for interested irrigators in Castroville to explain the program and how to apply. Despite the short lead-time, this meeting drew a standing room only crowd of approximately 140 persons. Deadline for submission of offers by irrigators was set at January 9.

Offers were evaluated and acres were selected between January 10 and January 13. Contracts between the EAA and Program Irrigators were executed on January 15. On February 7, the first installment of payments to irrigators was made. Signed pledges by funding sources were initially due by January 15, however, the final deadline was extended until March 1. A schedule of Program Activities is provided in Appendix A.

The 1997 Pilot Irrigation Suspension Program

[4] The Interim CPM Rules defines Critical Period Stages (I-IV) in the eastern and western regions of the Aquifer triggered by head levels at the J-17 index well and a well in Medina county respectively. Maximum Allowable Usages corresponding to Critical Period Stages are designated and are the product of base usage (the average monthly total usage for the three lowest months between November 1995 and February of 1996) times a "reduction multiplier" assigned to each reduction stage. Reduction multipliers range from 1.8 for Stage I to 1.2 for Stage IV.

Description

The three key entities involved in the 1997 DYO/ISP were: 1) participating irrigators, 2) funding agencies, and 3) the EAA; which correspond to sellers, buyers, and administrators of the program, respectively.

A major challenge facing the EAA was the acquisition of sufficient funds soon enough to implement a DYO/ISP program for the 1997 cropping season. The newly established and cash strapped EAA, charged with protecting springflow in its enabling legislation, lacked sufficient funds of its own. Regional water purveyors were reluctant or legally prevented from committing funds to the program unless their customers received benefits in return. Thus, the EAA revised the CPM Rules to provide benefits to funding agencies. "Participants" in the program were defined as Aquifer beneficiaries who would pay program fees to the EAA and finance the cost of the ISP. Although participation in the ISP by municipal water suppliers was voluntary, participants were given more favorable treatment under the CPM rules.[5] Because this concept differed from that of the original DYO, the name Irrigation Suspension Program (ISP) was used.

The objectives of the 1997 Pilot ISP were: "(1) to increase the water levels in the Aquifer; (2) to help prevent or delay cessation of springflow in the Comal Springs and the San Marcos Springs; and (3) to obtain useful data relating to the effect [of] partial suspension of irrigation withdrawals on the Aquifer" (EAA, Appendix B). The goal of the program was "to cause suspension of irrigation with Edwards Aquifer water of at least 10,000 acres in 1997" (EAA, Appendix B).

Eligible irrigators were designated as "Owners" and were required to have irrigated acreage within the boundaries of the EAA for both 1995 and 1996. The Contract provided payment to irrigators in three installments: 1) at the beginning of the program year (February 7, 1997), 2) at the end of the Spring crop growing season (July 15, 1997), and 3) at the end of the Program year (December 31, 1997). Additional details of the ISP are presented in Appendix B.

Documents

A number of legal and informational documents were prepared by the EAA to secure legal implementation of the 1997 ISP. They included the following:

1. Participation Agreement (Appendix C). An agreement between the EAA and regional water associations (mainly municipal water suppliers) that outlined the conditions under which that agency would provide funding to the ISP; the EAA's commitment to compensate irrigators and administer the Program; and the benefits for water delivering agencies.
2. Invitations For Offers. An invitation to irrigators to bid (published in regional

[5] In the event the EAA implemented an ISP, participants were allowed to pump up to 1.4 time base usage in Stage IV of a critical period, whereas non-participants would be allowed to pump only 1.3 times base usage. Maximum allowable usage in Stage 4 would have been 1.2 time base usage if the EAA *did not* implement an ISP.

newspapers).

3. Instructions To Offerors (Appendix D). A set of instructions on how to bid.
4. Offer (Appendix E). A document indicating the undersigned offers to suspend irrigation on defined acres and has submitted the required documents.[6]
5. Information Sheet (Appendix F). An instrument used to appraise bids containing contact information, whether the farm unit is leased, crop mixes for the 1995 and 1996 cropping seasons, and type of irrigation equipment used.
6. Irrigation Suspension Contract (Appendix G). The formal contract between participating irrigators and the EAA specifying terms of the agreement including per acre payments to irrigators.

Selection Criteria

Eligible irrigators were invited to submit sealed per acre bids to the EAA, although selection was based on four other criteria in addition to bids. A score from one to ten was assigned for each criteria, ten being the most favorable.[7] Three of these other four criteria were aimed at tilting the selection in favor of those irrigators whose suspension of pumping would have the greatest per acre impact in producing springflow at Comal Springs. Thus, scores were assigned for: 1) location of well, based on strength of the hydrologic connection between pumping location and Comal Springs, 2) type of crops produced in 1995 and 1996, and 3) type of irrigation equipment used on the proposed acres. Exact point assignments are detailed in Appendix H. Criteria 2 and 3 were designed to favor irrigators who were likely to have applied more water, e.g., more points were assigned for irrigators with less efficient irrigation systems.

The fourth score was assigned based on whether or not the irrigator would make a commitment to plant a nonirrigated crop on the proposed acres. This criterion was included to help protect agriculture-dependent industries and community interests. Scores of the four criteria were summed; each irrigator's bid was then divided by total score. The resulting final score was used to select participating irrigators.

Participation

Irrigators

The EAA received 125 offers made by January 9; of these, 120 were found to meet the requirements of the program. Within that set, per acre bids ranged from $116 to $750, with the median bid at about $300. There was relatively little variation in the points assigned by the selection criteria (based on location, crop mix, irrigation equipment, and willingness to plant dryland crops). Eighty-two percent of bidders had total point scores ranging from 32 to 38. Thus, final scores were determined largely by the bidders' per acre prices. Final scores were ordered from lowest to highest and farm units with the lowest bids were selected for participation

[6] Required document are a) the signed Offer, b) a completed Information Sheet, c) an executed Irrigation Suspension Contract with price term stated, and d) a Location Map and Property Description.

[7] In a few cases, score greater than 10 were assigned based on more favorable impact on springflow.

until the amount of program acreage reached the 10,000 acre goal. This led the EAA to accept offers on 39 farm units with 10,067 irrigatable acres, owned by 37 individuals. Subsequent verification of enrolled acreage reduced the number of eligible acres to 9,669.

Participating farm size ranged from 45.3 to 1,269 acres. Per acre bids of accepted offers ranged from $116 to $300, and total amount of bid (per acre bid times participating acres) ranged from $12,495 to $304,560. Median values for farm size, bids, and total amount of bid for successful bidders were 183 acres, $240, and $45,617 respectively. Payments to farmers totaled $2,295,132.

Funding Agencies

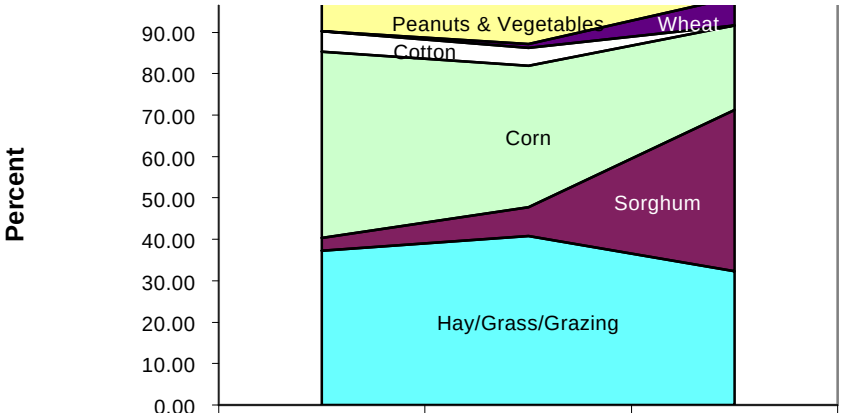
The EAA sought the participation of water agencies and other large pumpers to fund the 1997 ISP by offering Participants benefits under CPM Rules, as described earlier. Year 1995 pumping by major pumpers in Bexar, Comal, and Hays Counties was used as a basis for determining how much each pumper should contribute. A "fair share" list of 32 area water purveyor and pumpers was developed by determining each Participant's percentage of the sum of all their pumping and multiplying this fraction by the amount needed to fund the program. A small amount (about 3% of payments to farmers) was added to cover administrative expenses. The EAA was successful in soliciting pledges of approximately $2,350,000. With very few exceptions, each pumper pledged the amount on the "fair share" list.

Participant pledges were dominated by SAWS, which accounted for 77% of 1995 water use. Other large users were the Bexar Metropolitan Water District, which accounted for about 10% of use, and the City of Universal accounted for about 1%. All other Participants pumped less than 1% of the total. Participants agreed to make three equal payments to the EAA corresponding to the dates the EAA agreed to pay irrigators. To date, two of the three payments have been collected from all Participants.

Estimated Effects Of The 1997 Irrigation Suspension Program

Impacts of the 1997 ISP are estimated in terms of: 1) changes in crop mix, 2) decreased pumping by irrigators, 3) increased aquifer elevation, 4) increased springflow, 5) changes in return flow, and 6) effects on the local economy. Because Spring1997 weather conditions were very favorable in the Aquifer region, we also estimate anticipated effects for typical dry, average, and wet conditions.

To assist in ISP evaluation and in estimating its effects, a questionnaire was administered to participating ISP irrigators. The questionnaire included questions on how the ISP might have changed irrigators' crop mixes and purchases, and their general opinions regarding administration of the program and the adjudication of pumping rights in the Aquifer region. Fourteen of the 39 program irrigators participated in the survey. Results are presented in Appendix I.



	1995	1996	1997
Other	2.64	3.15	1.56
Peanuts & Vegetables	7.13	9.67	0.00
Wheat	0.00	0.96	6.82
Cotton	5.00	4.24	0.00
Corn	44.93	34.20	20.43
Sorghum	2.99	7.06	38.85
Hay/Grass/Grazing	37.32	40.72	32.34

Figure 3. Crop Mix for ISP Participants, 1995 - 1997

Changes in Crop Mix

Changes in crop mix were determined from information on program irrigators' information sheet (Appendix F), verifications of 1997 cropping activities by the EAA, and by interviews with irrigators. Comments by irrigators (Appendix I) indicate that there were changes in the 1997 crop mix by participating irrigators made as a direct result of ISP participation, or due to the fact that some irrigators anticipated an ISP. Comments reflect a shift away from corn and peanuts in favor of sorghum and wheat. Figure 3 displays ISP irrigator crop mixes for the years 1995 to 1997.[8] It reveals substantial increases in sorghum and wheat acreage, a substantial decline in corn acreage, and the elimination of peanuts, vegetables, and cotton.

Corn acreage decreased from an average of 40 percent of the crop mix for the 1995 and 1996 cropping seasons to about 20 percent of the crop mix in 1997. Peanut and vegetable farming, which averaged 8.4 percent of the crop mix, was eliminated in 1997 for ISP participants and cotton acreage, which averaged around five percent, was virtually eliminated.[9] On the other hand, sorghum acreage increased from an average of five percent to almost 39 percent, while wheat acreage increased from an average of less than one half percent to almost seven percent.

These changes are consistent with expectations since peanut and vegetable production are very irrigation dependent in the Aquifer region and dryland corn produces a good crop only in relatively wet years, while sorghum and wheat are more drought resistant. Coastal hay tends to be grown perennially, which may account for the relatively small year-to-year movement of the

[8] Figure 3 is based only on those farm units for which crop mix information is complete for all three years (28 of the 41 farm units). The "Other" category in Figure 3 includes oat grain, soybean, and pecan acerage.

[9] A small amount of cotton acreage was reported in 1997 by a farm unit, but data were incomplete for this unit and consequently, it does not show up in Figure 3.

hay / grass / grazing category.

Reduction in Irrigation

Two questions can be asked regarding reduced irrigation resulting from ISP implementation: 1) what reduction might we expect based on the probability of experiencing wet, normal, or dry years and 2) what was the actual reduction of irrigation as a result of the 1997 pilot ISP implementation?

Addressing the first question, application of water for irrigation is highly dependent on weather conditions during and to some extent before the cropping season. Table 1 reports estimated water use reductions for wet, average, and dry years, as well as for the year 1997, as a result of suspending irrigation on 9,669 acres in the eastern region of the Aquifer. Table 1 is based on an analysis of the past fifteen years of irrigation activity in the Aquifer region that indicates that an average of 2.4 acre-feet were applied during the five driest years, an average application of .8 acre-feet were made for the wettest five years, while an average of 1.6 acre-feet were applied during the remaining (average) five years. The third column of Table 1, "Pumping Reduction", is developed by multiplying average per acre usage by the number of acres suspended (9,669) to produce an estimate for the amount of reduction for the three weather scenarios.

Table 1. Estimated Effects of Implementing an Irrigation Suspension Program on 9,669 Acres.

Scenario	Prob.	Average Application (af)	Pumping Reduction (af)	Increased Comal Springflow (af)	Increased August Comal Springflow (cfs)	Increased Eastern Aquifer Elevation (feet)	Cost of Additional Water ($/af)
Wet Year	0.33	0.8	7,735	2,166	5.9	1.3	297
Average Year	0.33	1.6	15,470	4,332	11.8	2.5	148
Dry Year	0.33	2.4	23,206	6,498	17.7	3.8	99
1997		0.4	3,868	1,083	2.9	0.6	593

Now we turn to the question of the actual amount of reduced irrigation in 1997. By all accounts, the Aquifer region experienced very favorable weather condition for dryland cropping in Spring 1997. Rains were of near ideal spacing and intensity.[10] The weather turned very dry starting in July, however, by then most crops had received sufficient moisture. Reportedly, many irrigators

[10] In 1996, a very dry year, corn averaged about 100 bushels per acre with intense irrigation, while corn harvests averaged around 140 bushels per acre in 1997 with little or no irrigation (Peña). Some farmers reported their best yields ever.

not enrolled in the ISP did not need to irrigate. Estimates are that only one in ten acres of corn in the region required only one four-inch irrigation application (Peña). Most corn acreage usually receives four or five applications. Because the weather turned dry in July, cotton acreage may have received up to three applications, although it usually requires four or five, and Coastal hay may have been watered up to four or five times, while it is usually watered about twice this amount. Some late summer and fall irrigation usually occurs for winter wheat and pecan orchards, although this amount is quite small compared to Spring irrigation.

Based on the forgoing assessment, we estimate that irrigators in the region not enrolled in the ISP irrigated only .4 acre-feet, on average, for the 1997 cropping season. Corroborating this estimate, irrigation applications for the two wettest of the past 15 years averaged only .4 acre-feet according to USGA discharge estimates.[11]

Springflow Effect

Regression coefficients developed in Keplinger and McCarl (1995b) were used to estimate increased springflow at Comal Springs as a result of the ISP in terms of: 1) total amount of additional springflow produced for the program year, and 2) increased flow at Comal springs during the month of August (a month when Comal Springs has historically exhibited lowest annual flow levels). The amount of additional springflow for the program year, presented in Table 1, is estimated to be 28 percent of the amount of reduced irrigation. The remaining 72 percent of reduced pumping contributes to Aquifer elevation, which increases springflow in subsequent years, increases flows in other springs (particularly San Marcos Springs) and may leak to other aquifers.

Comal Springflow estimates for the month of August suggests that an ISP of the magnitude initiated in 1997 would increase Comal springflow by 17.7 cfs in dry years, 11.8 cfs in average years, and 5.9 cfs in wet years (Table 1). Estimated effects of larger ISPs can be estimated by multiplying these values by the ratio of the amount of acreage in a larger ISP to 9,669, the number of acres in the 1997 pilot ISP. Thus, an ISP on 30,000 acres in the eastern region of the Aquifer would be estimated to increase August Comal springflow by 17.7 x (30,000 / 9,669) = 54.9 cfs for an average dry year. This represents a considerable portion of total springflow at Comal Springs when Aquifer levels are low.[12]

Springflow effects for very wet years, and particularly the estimated increase on Comal springflow as a result of 1997 ISP implementation, are low. The 1997 ISP is estimated to have increased Comal springflow by only 2.9 cfs due to low irrigation applications associated with very favorable weather conditions and the relatively small amount of acreage enrolled. It should be noted, however, that increased springflow is not critical during wet years when flows are already adequate, but is critical during dry years, when increased springflow as a result of ISP

[11] Average of 1987 and 1992 total irrigation discharge for the Aquifer (USGS) was divided by total irrigated acres (NRCS).

[12] On August 18, 1996, for instance, comal springflow reached a low of 83 cfs, and flow was less than 100 cfs for the entire months of July and August. An additional 54.9 cfs of springflow during this period would have increased springflow to above or near the USFWS determined jeopardy level (150 cfs) for the fountain darter.

implementation is greater. If the region had experienced a repeat of 1996 weather conditions, ISP implementation would have made a significant contribution to springflow, contributing almost 20 percent above the 1996 low of 79 cfs.

Effect on Aquifer Elevation

Table 1 also presents estimated increases for year-end eastern Aquifer levels as a result of implementing an ISP on 9,669 acres. Results indicate Aquifer elevation is increased 3.8 feet in dry years, 2.5 feet in average years and 1.3 feet in wet years. For the very wet 1997 scenario, Aquifer elevation is estimated to have increased by 0.6 feet by year-end as a result of the ISP. Again, the effect of larger ISP implementations on Aquifer elevation is roughly in proportion to the number of acres enrolled.

Increased Aquifer levels are not the major goal of an ISP, however, they benefit all pumpers by reducing lift and increasing springflows in future years.

Effects on Return Flow and Recharge to Other Aquifers

Due to inefficiencies in irrigation technology, a portion of irrigation water is not taken up by crops, but either evaporates, percolates past plant roots and becomes groundwater, or enters river systems. Since most irrigatable land in the Aquifer region is not over the Aquifer's recharge zone, most water that is not transpired or evaporated feeds other area aquifers or rivers that overlie the Edwards formation. These shallower aquifers include the Austin Chalk, Uvalde Gravels, and Leona Gravels.

Thousands of wells were drilled into these shallower aquifers before Edwards water become more widely available (Bader). Until the 1980's many of these wells served as rural residential water supply. Domestic wells tapping these shallower aquifers, however, have largely been abandoned as rural water companies have provided community wells and distribution networks that pump higher quality Edwards water.[13] Many of these shallower wells, however, are still used for stock and crop irrigation. Some of the wells are very productive.[14] Many are quite shallow, being only 15 to 20 feet below the surface, thus they are inexpensive to drill and pump from as opposed to most wells tapping Edwards water.

Table 2 quantifies potential loss of recharge to shallower area aquifers and surface water as the result of implementing an ISP on 9,669 acres under average dry year condition, when irrigation application is expected to average 2.4 acre-feet per acre. As part of the requirements for ISP participation, irrigators were required to indicate how many acres of their farm unit were irrigated by what type of irrigation. Column 1 of Table 2 indicates that ISP participants recorded that over one half of enrolled acreage employed relatively inefficient furrow irrigation without surge valves. Column 3 of Table 2 indicates the efficiency of this type of irrigation is estimated at

[13] Water from Leona gravel is high in Nitrates, posing health concerns, especially for infants (Bader).

[14] A few wells recently dug into Leona Gravel in the Hondo area produce from 600 to 1200 gallons per minute (Bader).

60%, while the weighted average irrigation efficiency by all ISP participants is estimated at 67%.

Table 2. Estimated Irrigation Loss for ISP Irrigators Under Dry Year Conditions.

Type of Irrigation	Percent of Total[a]	Acres[a]	Estimated Average Efficiency[b]	Estimated Application[c] (af/acre)	Estimated Loss[d] (af/acre)	Estimated Loss (af)
Pivot Low Pressure	13.2	1,274	0.88	1.79	0.22	274
Pivot High Pressure	4.7	452	0.75	2.10	0.53	238
Furrow w/ Surge	13.4	1,296	0.65	2.43	0.85	1,101
Furrow w/o Surge	52.2	5,043	0.60	2.63	1.05	5,306
Furrow Other	2.8	268	0.60	2.63	1.05	282
Sprinkler - Side	3.9	376	0.83	1.90	0.32	122
Sprinkler - Other	5.4	527	0.83	1.90	0.32	170
Flood	4.5	433	0.60	2.63	1.05	455
Total	100.0	9,669				7,948
Weighted Average			0.67	2.40	0.82	

[a] Developed from information in ISP applicants' Information Sheet.

[b] Jose Peña, Texas Agricultural Experiment Station, Uvalde.

[c] Estimated Application assumes water intake by crops of 1.58 acre feet for all types of irrigation.

[d] Estimated Loss (af/acre) = Estimated Application - 1.58.

Estimates of applications for each type of irrigation were developed by assuming water intake by crops averages 1.58 acre-feet across all types of irrigation.[15] Loss is estimated by subtracting 1.58 from estimated application. For furrow irrigation without surge, loss is estimated to average 1.05 acre-feet of the 2.63 acre-feet applied to an acre of land. On average, we estimate an average loss of .82 acre-feet for an average application of 2.4 acre-feet for dry years. Thus, we estimate that approximately 7,948 acre-feet of water on the 9,669 acres of ISP participants' farm units would not be taken up by crops for an average dry year. Much of this "return flow" therefore, would be lost to the Edwards but would recharge other shallow regional aquifers or augment flows in area river basins.

[15] Irrigation application was estimated using the formula $A_I=2.4/(e_{ii}(p_i/e_i))$, where A_i is water application in acre-feet per acre, e_i is irrigation efficiency for irrigation type i, and p_i is the percentage of irrigation using irrigation type i. This formulation assumes a constant crop water intake equal to A_ie_i.

Effects on the Local Economy

There is little evidence to conclude that changes in crop mix had or will have a significant impact on the local economy. A Frito Lay plant in the San Antonio area, for instance, does not contract with producers in the Edwards Aquifer region. Its contracts for corn are made with a corn supplier in the Texas panhandle area, while other contracts (potatoes) are made with suppliers in Kansas and Colorado (Diaz).

There is theoretic and empirical evidence to suggest that converting to dryland during an ISP reduces purchases of supplies by irrigators. Question 9 of Survey Results (Appendix I) reports that 9 of the 14 irrigators surveyed indicated that they purchased less inputs from suppliers. Comments to Question 9 reveal that reduced inputs resulted from planting dryland crops less densely (less seed) and reduced fertilization. In addition, diesel or electricity was not needed to operate pumps. One participant indicated hiring one less person to apply fertilizer. While regional agricultural suppliers would experience a modest reduction in sales as a result of a widespread ISP, the intermittent nature of ISP implementation mitigates against a noticeable restructuring of the agricultural economy west of San Antonio.

During the regional 1996 drought, it was reported that landscaping and swimming pool businesses in the San Antonio metropolitan area were suffering reduced sales and loss of employment as the result of drought management restrictions on water use. To the extent an ISP would ease municipal pumping restrictions, its implementation might benefit these impacted industries.

There are also economic benefits derived from increased springflow. If implementation of an ISP resulted in significantly higher springflow, commercial benefits to recreation - based businesses in New Braunfels might accrue. Downstream agricultural, municipal, and industrial interests would also benefit. There are also non-market valuations associated with springflow and endangered species that accrue to a broader environmental community as well as area residents. Techniques such as contingent valuation have been developed to measure these less revealed valuations, however, we are not aware of any studies measuring willingness to pay for Comal springflow.

Evaluation

It is important to evaluate the 1997 ISP in terms of its purpose and the limitations inherent in such a program. First, implementation of an ISP is triggered by low Aquifer elevation, not by past or current dry years, per se. Although a prediction of a coming dry year would (and did) add to the attractiveness of implementing an ISP, it is understood that long range weather forecasts are not totally reliable. This being the case, an ISP implemented early in the year should be thought of as insurance against a dry year following a low beginning Aquifer elevation. Such an ISP would make its largest contribution to springflow during dry years, when springflow is most needed; a moderate contribution in average years, when additional springflow is less critical; and little contribution to springflow during wet years, when additional springflow has little value.

Thus funding agencies can expect to "cash in" on their "insurance policy" only about a third of the time, but may need to "buy the policy" whenever aquifer elevation is low in order to avoid the dire circumstances associated with a dry year following low Aquifer elevation.[16]

Administration

Judging by survey responses (Questions 6 and 7, Appendix I), participants were quite pleased with the administration of the 1997 ISP. Most also had favorable comments on the EAA's administration of the program. Thirteen of the 14 respondents indicated they would participate in another ISP if one is offered within the next three to five years (Question 8).

Timing

Administrators of the 1997 program also deserve credit for rapid implementation of the program once the commitment had been made. As noted earlier, the EAA was not established until June 28 and the permanent elected board did not take office until December 1. Yet first notice of the program was published on December 29 and by January 15, 1997, contracts between the EAA and irrigators were executed.

The late start of the program may have added to the cost of the program. However, only three of 14 respondents (Question 2) indicated that this was the case. Yet, when participants were asked when they would like to know about an ISP to avoid making commitment that would make it harder or more expensive for them to participate (Question 3), the majority answered October or November. Thus, sooner notification of a January 1st ISP is recommended.
A motivation for having an ISP starting earlier than January 1 is to start the program before irrigators have made commitments that would make it more expensive for them to participate. When asked how an ISP starting in March or April would have impacted their bid (Question 4), four of 14 respondents answered that it would be "too late", two indicated it would be more difficult, and one indicated he would have bid more. However, two respondents indicated it would make no difference, one indicated he would have bid less, and three answered "don't know."

Most irrigation in the Aquifer region occurs in April, May, and June, however a January 1 ISP is implemented before weather for the heavy irrigation months is revealed. A more conventional option contract might involve contracts between the EAA and irrigators around the first of the year, where the EAA would purchase the option to have the irrigator suspend pumping on April 1 or May 1. Upon exercise of the option, the EAA would make an additional payment(s) to irrigators according to specifics of the contract. It is likely that irrigators would adjust their cropping mix and practices to mitigate against a potential exercise of the option, thereby reducing expected cost of option exercise.

A more conventional option contract might lower cost to the EAA since they would

[16] These include stringent Critical Period Management rules, possible suits filed by springflow interests, reduced springflow, and harm to endangered species.

exercise their option only for dry years. By April 1 or May 1, weather for the remainder of the year should be more predictable. Thus, even if the cost to the EAA was considerably more during years when they exercised their option, expected cost may well be less, since we might expect the EAA to exercise the option in only one out of three years.[17] For the 1997 cropping year, for instance, it is unlikely that the EAA would have exercised an option to cut irrigation in April or May, given the favorable weather outlook and rebounding Aquifer levels in early Spring. Specifying an Aquifer elevation at which the EAA would or might exercise their option would provide irrigators with information with which they could judge the probability of option exercise. Less probable exercise of the option would be expected to lower the cost of option exercise.

An ISP starting in April or May (without an option payment) is also a possibility but would most likely increase irrigators bids and program costs when exercised, as irrigators would be facing a certain cutoff. It is also likely that measures irrigators might take to protect against an April or May cutoff (e.g. planting thinner or more drought tolerant crops) would be less than if they had signed an option contract, thereby raising anticipated bids.

Selection Criteria

The ranking method for selection into the 1997 ISP, referred to earlier, can be represented as:

(1) Ranking = Per Acre Bid / Score, where

(2) Score = Loc + Crop + Equip + Dryland,
where Loc = location score, Crop = crop score, Equip = equipment score, and Dryland = dryland score, as described in Appendix H.
It is possible that the incentive in the ranking structure (Equations 1 and 2) for irrigators to plant dryland crops could have increased the cost of the ISP. If bidders based their bids on recovering from a worst case scenario, i.e., a total loss of dryland crops, then their bid would reflect all the costs of dryland production. It is very likely that most irrigators would have planted dryland without any incentive in the ranking structure.[18]
A conceptual formulation that would rank bids in terms of cost for an additional unit of springflow, and therefore has the potential minimize the cost of additional springflow would be:

(3) Ranking = Bid ($) / Springflow Effect (af),
where Bid is an irrigator's bid and Springflow Effect is the amount of additional water produced (acre-feet) at Comal Springs over the course of the program year as the result of suspending irrigation on the farm unit. Springflow effect is a function of both the amount that pumping is reduced and the location of the irrigation well, and can be estimated as:

(4) Springflow Effect = Reduced Irrigation (af) * Per Acre-foot Springflow Effect.

[17] This question amount to, " Is the expected value of information attained by waiting until April 1 or May1 greater than the increase in expected cost incurred by the delay?"

[18] Only six of 118 bidders indicated that they would not plant dryland crops.

Per Acre-foot Springflow Effect can be estimated by one of the Edwards Aquifer simulation programs.[19] In the absence of a pumping log or other good pumping estimates, reduced irrigation as a result of an ISP can be estimated by collecting information on crop mix and irrigation equipment according to the formula:

(5) Reduced Irrigation (af) = S_{Crop} ($Acres_{Crop}$ * $(Irrigation\ Demand)_{Crop}$) / (Irrigation Efficiency), where $Acres_{Crop}$ is the number of acres devoted to each crop for the previous year, $(Irrigation\ Demand)_{Crop}$, is the amount of irrigation water required for each crop for a dry year[20] (assuming 100 percent irrigation efficiency), and Irrigation Efficiency is the irrigation efficiency of irrigation equipment used. Thus,

(6) Springflow Effect (af) = (Irrigation Demand For a Given Crop Mix) / (Irrigation Efficiency)* (Per Acre-foot Springflow Effect).

Three elements in Equation 2 (Crop, Equip, and Loc) were designed to capture the three elements in Equation 6. In the conceptual formulation (Equation 6), however, we see that the total springflow effect due to suspension of pumping is a multiplicative function of the three elements, whereas it is an additive function or summation in Equation 2. Moreover, the Loc score in Equation 2 ranged from 6 to 11, whereas the relative impact on springflow from pumping in various regions of the aquifer varies considerably more.[21] Thus, while the score developed in Equation 2 takes into account many factors that affect the differential impact of pumping on springflow, it does not give enough weight to farm units with the greatest ability to impact springflow. A more conceptual approach, as derived in Equations 3-6, would enable the EAA to buy more current year springflow for the same cost. Another desirable feature of the conceptual approach is that Equation 2 produces rankings which represent bids in terms of the cost of producing one additional acre-foot of springflow at Comal Springs.

Bidding Process and Price Determination

A goal of the 1997 ISP was to generate as much additional springflow as possible for the least cost to funding agencies. A sealed bid arrangement was used to solicit offers from farmers with features reminiscent of an early implementation of the Conservation Reserve Program (CRP). Beginning in 1986, USDA held periodic sign-ups during which farmers offered acres for enrollment for annual per acre rental rates they were willing to accept (US GAO). USDA set rental rates ceilings that, in many cases, were far higher than local cash rental rates, and for a time, accepted all bids falling under the rental rate ceilings. A GAO report (US GAO) estimates that this process resulted in CRP rates as much as 200 to 300 percent higher than local cash rental rates.

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[19] Available models include GWSIM-IV, developed at the Texas Water Development Board (Thorkildsen and McElhaney), which has also been ported to the PC Windows environment (Masch, Armstrong, and Hammond). A simplified lumped parameter model has been developed at Southwest State University (Wanakule and Anaya).

[20] A dry year is assumed here because the effects of an ISP are most pronounced and needed when the ISP program year is dry.

[21] For example, Keplinger and McCarl (1995b) found that the effect of pumping on current year springflow averaged approximately seven time greater for pumping from the eastern region of the aquifer, as opposed to the western region.

Like the early CRP, the 1997 ISP elicited bids from farmers reflecting per acre payments that they were willing to accept. Unlike the early CRP, however, the 1997 ISP did not accept all bids below a certain rate, thus irrigators were competing with one another to qualify for a target amount of acreage rather than trying to bid just at or under predetermined rate ceilings.[22] Nonetheless, evidence suggests that irrigators selected for the program were paid substantially higher than local cash rental rates for irrigated land. Annual rental (lease) rates for irrigated farmland in the Edwards Aquifer region can vary considerably, based on soil type, type of irrigation equipment installed, cost of pumping, etc. County offices of USDA's Farm Service Agency indicate that annual lease rates of irrigated land range from $40 to $65 in Bexar County, $90 to $100 in Medina County, and from $40 to $60 in Uvalde County.[23]

An analysis by Rothe suggests that farmers may use costs and/or expected revenues as a basis for price determination and predicts that farmer would bid in the $300-$600 per acre range for corn acreage. This method has theoretical merit if all costs have been incurred, as they largely would be in a mid-year ISP as was contemplated in 1996, and if participation would result in a complete loss of revenue. In theory, for a beginning-of-the-year ISP, maximizing expected profit under a competitive bidding arrangement should result in bids equal to the difference of expected profit using irrigation and expected profit for dryland cropping. An economic analysis by Keplinger et al. suggests that over 90 percent of irrigated acreage in Medina County would accept an offer of $50 per acre, far less than the lowest bid actually received.

There may be a number of reasons why bids were substantially higher than land rental rates and theory would suggest. First, irrigators may have included their expected returns to labor as well as their returns to land in their bids. In other words, they may have bid their average profit margin per acre of land, or even their profit margin for a good year. Some irrigators claimed to have made their bid according to this criterion. Second, there is some evidence that some irrigators may have believed that the payment they received for the ISP might determine the price at which they might be able to sell water for in the future. Third, there is evidence to suggest that there was collusion among some bidders to all offer a set rate. Fourth, the late start of the ISP may have caused some irrigators to bid higher than they otherwise would have due to the short decision-making timeframe and/or to the fact that some irrigators may have made commitments making it more difficult for them to participate (see Question 9 of Appendix I). Fifth, lack of experience with an ISP may have caused some irrigators to bid higher. The 1997 program was the first of its kind offered to Aquifer irrigators. Finally, leasing arrangements of irrigators may have caused higher bids than otherwise would have occurred. Only ten percent of selected participates were leasees, whereas 44 percent of rejected bids were made by irrigators who rented all or part of the farm unit. Sharing arrangements of ISP payments between owners and leasees in such cases may have increased bids for leased farm units.

The question arises, Would a different bidding arrangement have resulted in lower overall

[22] Bids on 26,880 acres were submitted to the EAA, whereas the EAA accepted bids on somewhat less than 10,000 acres. These represented the lower bids as adjusted by a total score as described earlier.

[23] Because of low turnover of land in the region, we could not determine land prices based on sales. Anecdotally, land is worth between $1500 and $2000 per acre in the region. At seven percent interest, annual financing cost would fall between $105 and $140 per acre.

cost to the EAA? The CRP method of price determination was changed so that the CRP rental rate ceiling was set at prevailing local rental rates. It is not clear if the desired level of participating land could have been attained by setting a maximum bid at or near reported land rental rates since this is an empirical question. Since reported land rental rates for irrigated land in the Aquifer region are substantially below most irrigators' bids, and existing lease arrangements are often of long term duration, it seems unlikely desired levels of land could be attained at or near reported lease rates. Experience with the 1997 program, and announcement of an ISP in the fall before the cropping season, however, may lower per acre bids on future ISPs.

Comparison with Other Irrigation Water Use Reduction Options

The dry year option, irrigation suspension program (ISP) is not the only way one could achieve regional agricultural water use reductions. In particular, three alternatives are possible:

1) Stimulate adoption of improved irrigation technology
2) Purchase irrigated agricultural land and then lease if for farm use, but not always for irrigated farming. In particular, it would be leased for dryland uses when the water is needed elsewhere.
3) Purchase water rights.

We will evaluate the first two alternatives along with an ISP since water rights purchases require fully established water rights and that it is not yet the case. We will define the alternatives then outline our methodological approach before presenting results.

Assumptions used in defining Alternatives

Investigation of the ISP, improved irrigation technology, and land purchase program (LPP) alternatives required the development of data on program cost, water savings and frequency of program implementation. The assumptions pertinent to each of these systems appear below.

Irrigation Suspension Program (ISP)

As discussed above there are reasons to feel that the ISP was more expensive than it might need to be in the long run. Evaluation of the ISP over a long time period also requires an assumption on the frequency with which it would be implemented. The specific assumptions made relative to the ISP are:

Cost of Program – The 1997 ISP cost about $234 per acre. This may be more expensive than is required for reasons given. One can also infer potential ISP payments by looking at land rental rates. According to statistics gathered by the USDA NRCS, Medina county dry land now rents for between $16 and $25 per acre while irrigated land rents for between $90 and $100. Subtracting the dryland rate from the irrigated rate, an average rate for the value of irrigation is $75 per acre, which is another estimate of how much it should cost to get farmers to suspend irrigation. This compares with average ISP payments of $234 per acre and Keplinger et al's budgeting based estimates that the cost should end up at $90 or less. Consequently, we evaluated

future ISPs at three payment levels $75, $150 and the current $234.

Water Usage Reduction – The ISP only reduces agricultural water use when it is implemented. The amount of water use reduction differs based on the rainfall during the year. We assumed that the ISP would reduce agricultural water use to zero on all participating acres when implemented. Thus the water use savings when the ISP is implemented are the water use data given in Table 1.

ISP Implementation Frequency - The ISP is effective only when implemented. We ran program cost assumptions under an ISP implemented one year out of ten, one out of four, one out of three and one out of two.

Improved Irrigation Technology - LEPA

During the course of this study we examined a number of alternative irrigation systems. Based on cost and water use data, we concluded that we would limit our attention to the use of Low Energy Precision Application (LEPA) systems. Further we discussed the costs of conversion with equipment dealers and agriculturists (Pena, Amosson) arriving at the following assumptions.

Per acre Cost of LEPA – the region now has a mixture of irrigation systems. We assumed

a) High and low pressure center pivots would convert to LEPA for $80 per acre.
b) Furrow and flood systems would also convert, with one half of the acreage going to center pivots at $500 per acre and the other half going to a sideroll form of LEPA at $550 per acre (Mainly because of parcel size)
c) Side roll systems would convert to a side roll LEPA form at $400 per acre.
d) The distribution of irrigated acres by system type is that given in Table 1.

Conversion to LEPA also alters farm labor use, hired labor costs, pumping energy bills, and water distribution costs. Considering all of these factors results in an average total cost of conversion to LEPA of $442 per acre. Finance theory shows us that the annuity equivalent is that number times the discount rate. Using 7% we get a cost of $30.90 per acre per year for LEPA conversion.

Water usage savings – LEPA saves water because it applies water more precisely to the crop. The amount saved depends on the system being replaced and rainfall. Taking an average across all systems, assuming they populate the region in the proportions inherent in Table 2, leads to an average irrigation efficiency for the existing systems of 71%. We assume that when these systems are replaced by LEPA systems that irrigation efficiency will rise to 95%. In turn, we assume that conversion to LEPA would save 30% of the water that would have been applied without conversion under all states of nature. Thus, the calculated savings are 30% of the water usage figures in Table 1.

Frequency of Water Savings - the LEPA conversion must be put in place and paid for in each

year. The water will accrue in each year varying only with rainfall. Consequently, the cost is assumed for all years regardless of whether the ISP would be implemented or not.

Land Purchase Program (LPP)

Under our conception of a land purchase program, a party like the EAA would acquire irrigated agricultural lands and rent them back to tenant farmers. However, we assume the land would be rented back for irrigated or dryland farming depending on water needs. The specific assumptions made relative to these points are:

Cost of Land Purchase – An informal survey revealed a range of land prices for larger parcels from $1500 an irrigated acre to $2000 an acre. We will consider both extremes. This however is total cost and we need an annualized cost. Finance theory shows that the annuity equivalent is the purchase price times the discount rate. Using 7% we get a cost of $105 to $140 per acre. The program cost will be offset by land rentals. We assume the land will be leased land back to farmers at the rental rates consistent with those discussed under the ISP section above, namely $20 an acre for dryland farming when the water is needed elsewhere and $95 an acre if the tenant farmer gets to irrigate.

Water usage savings – The land purchase only saves water when the land is rented back to farmers as dryland. We assumed that dryland rental would save 100% of the water that an irrigated usage would apply. The water savings when the LPP is implemented are the total water use data in Table 1 and exactly the same as the savings under ISP.

LPP Program Frequency - The LPP program costs money in all years, but the cost is offset by land rental income. The offset is less when dryland rental is implemented but water savings are realized in that case. We evaluated the LPP under a dryland rental implemented one year out of ten, one out of four, one out of three and one out of two just as under the ISP.

Combined Strategies

Also, to fully consider the situation we will consider using LEPA independently and in conjunction with exercising the dry year option or buying the land.

Methodology Employed

The study was done using a spreadsheet-based approach building on the data in Table 1. Three levels of recharge events are considered along with an assumption of whether of not the ISP buyout /LPP rental for dryland farming option is triggered. In doing this analysis we make further assumptions about when water really counts and the land base considered. Then we compute the cost of several classes of water under the program and under different assumed ISP implementation frequencies.

When is water scarce and what water counts

An important question to address in comparing these strategies is when is water scarce and valuable. In the analysis above, the recharge and crop water use was broken into three states of nature. We assume that water use reductions are valuable when the aquifer is low and not valuable when the aquifer is high. As a consequence we make the following assumptions.

1) The most valuable water use reductions are those when the aquifer is low enough that the ISP/LPP is exercised and the rainfall/recharge is low.
2) Another source of valuable water occurs either in: a) a year when the aquifer is low enough that the ISP/LPP is exercised and we get average recharge, or b) a year when the ISP/LPP is not exercised but we get the driest recharge possibility. We will assume when the ISP/LPP is exercised and we get the highest recharge that water is not worth anything. We also assume that when the ISP/LPP is not invoked and we get average or high recharge that water is not a valuable item.
3) The water under item 2 is only half as valuable as the water yielded when the ISP is needed and a dry year occurred. This leads us to tabulate the amount of water diverted and the amount of springflow saved under three conditions:
   a) Under the ISP/LPP implemented dry recharge condition for the most critical water;
   b) Under average recharge occurs when ISP/LPP is active or under dry recharge when the ISP/LPP is inactive; and
   c) Under average conditions.

We will also compute a composite water availability, which is the amount under the driest conditions (1 above) plus ½ under the next condition (2 above).

LAND AREA

The comparisons were all done for a land area of 9,669 acres which is the number of acres enrolled in the ISP program in 1997.

Table Item Definitions

A number of items appear in the results in tables 3-6. These include:

a) total program cost which is the cost of the program over the entire 9,669 acres.
b) The average increase in Eastern aquifer elevation in feet which gives the amount that each of the programs is estimated to increase the elevation in the aquifer based on the regression equations developed in Keplinger.
c) Credit for elevation increase. This is the amount of money the elevation

increase is worth when figured at $60,000 a foot value which is the marginal value derived from the EDSIM model during a recent pumping limit study (McCarl, et. al.) under a 400,000 af pumping limit.

d) Elevation adjusted cost, this is the cost of the program less the credit for elevation aquifer.

e) Water savings, here we table the amount of water that is saved in terms of reduced irrigation pumping in
   - i) the driest years when the ISP/LPP is implemented.
   - ii) the second next driest year cases as explained above
   - iii) on an adjusted basis where the driest year plus half the next driest year total is added hereafter called "adjusted dry" water and,
   - iv) average years.

f) The year long Comal springflow increases as projected by the regression equations in Keplinger for the four water classes discussed above.

g) Comal springs August springflow in cubic feet per second for each of the four water classes as discussed above.

h) Water savings, which is the program cost divided by dry year water, the adjusted dry year water, and the average year water.

i) Cost of annual Comal springflow program cost divided by the springflow augmentation estimates for the three water classes.

j) Cost of August Comal springflow program cost is divided by the amount of additional springflow estimated in August under each of the three water conditions.

Results

Tables 3-6 give the results under the alternative programs on program cost and water cost. If the ISP program is implemented with a frequency of 10% (1 year out of 10), it only cost an average of $200,000 and generates roughly 6 times as much water under dry conditions than does LEPA. This occurs since LEPA improves irrigation efficiency from 71-95%, but adds a cost of roughly $31 per acre. Spread across the 9,669 acres this amounts to $300,000 per year, perpetually. Comparison of all these options appears in Table 3. Tables 4, 5 and 6 provide the same information for 25%, 33%, and 50% frequency, respectively.

Several general conclusions can be reached from data in these tables. First, for infrequent ISP/LPP implementation, the ISP or LPP programs are the cheapest source of critical year water. This occurs for three reasons.

a) Since the ISP is implemented only infrequently, then it only is costly when implemented and yields the greatest amount of critical year water.

b) The LPP has the same water yield characteristics as the ISP, but requires a more costly purchase and then subsequent leasing of the land. However, it may be cost effective if the land purchase price is low enough.

c) The LEPA program requires investment whether the aquifer is low or not and returns lower water savings. Thus, it costs more for critical water.

The cost advantage of the ISP and LPP programs is reduced when one considers "adjusted dry" water and vanishes when one considers average water. In particular, the ISP at $234 per acre is a cheaper source of conserved water as long as the program is implemented less than 1 year out of 4 as compared to LEPA. However, if one can drop the ISP cost down to $75, it is more cost effective than LEPA, in 19 out of 20 years.

However, when considering average water, LEPA is always cheaper. But average water savings are perhaps not a realistic goal to strive for, particularly since the Edwards discharges relatively quickly through natural springflow during years of extremely high recharge. Thus, it appears critical year water management is more desirable.

Finally, discussion of water yield effectiveness is in order. Notice that from Table 3, LEPA generates the least amount of water under the dryer conditions. ISP and LPP programs generate the next largest amount of water, while the most water is generated by the combined programs. Under an infrequent anticipated ISP/LPP program, one would ordinarily either buy land or use the ISP program as the first option and then expand them with LEPA as the second option, generating more costly water, but a larger supply. Table 7 presents break even probabilities between the LEPA option and the various suspension programs. It shows for example that the current ISP is a cheaper source of critical water as long as program implementation occurs less than 38% of the time and of adjusted dry for frequencies of 27% or less.

These basic conclusions emerge from these analyses. First, an ISP/LPP program is the most effective source of water under critical conditions. Second, LEPA should probably not be pursued until after the ISP program is pursued as LEPA costs substantially more for critical water. Third, LEPA is an attractive option for average water savings. Hence, LEPA would be attractive if there were a practical way to store most of the unused water from year to year so that it could be available for use under dryer conditions but it now is released as springflow.

Table 3 Program characteristics when water use suspended 1 year out of 10

ITEMS	----------Irrigation Suspension Program---------						LEPA	----------Buy Land ----------			
	Current	at $75/ac	at $150/ac	with LEPA current	With LEPA at $75/ac	with LEPA at $150/ac		Land at $1500/ac	Land at $2000/ac	LEPA + Land $1500/ac	LEPA + Land $2000/ac
Annualized Program Cost											
Total Program Cost ($)	$229,513	$72,518	$145,035	$528,285	$371,290	$443,807	$298,772	$169,208	$507,623	467,980	806,395
Avg. Increase in east. Aquifer elevation (ft)	0.38	0.38	0.38	1.37	1.37	1.37	1.1	0.38	0.38	1.37	1.37
Credit for Elev. Increase ($)	$22,800	22,800	22,800	82,200	82,200	82,200	66,000	22,800	22,800	82,200	82,200
Elevation Adjusted Cost	$206,713	49,718	122,235	446,085	289,090	361,607	232,772	146,408	484,823	385,780	724,195
Water Savings (AF)											
Dry Years	23,206	23,206	23,206	23,206	23,206	23,206	6,865	23,206	23,206	23,206	23,206
Next Driest years	15,470	15,470	15,470	22,335	22,335	22,335	11,409	15,470	15,470	22,335	22,335
Adjusted Dry	30,941	30,941	30,941	34,374	34,374	34,374	12,570	30,941	30,941	34,374	34,374
Average Year	1,547	1,547	1,547	5,666	5,666	5,666	4,577	1,547	1,547	5,666	5,666
Yearlong Springflow increase(AF)											
Dry Years	9,395	9,395	9,395	9,395	9,395	9,395	2,779	9,395	9,395	9,395	9,395
Next Driest years	6,264	6,264	6,264	9,043	9,043	9,043	4,619	6,264	6,264	9,043	9,043
Adjusted Dry	12,527	12,527	12,527	13,917	13,917	13,917	5,089	12,527	12,527	13,917	13,917
Average Year	626	626	626	2,294	2,294	2,294	1,853	626	626	2,294	2,294
August Springflow(CFS)											
Dry Years	17.7	17.7	17.7	17.7	17.7	17.7	5.2	17.7	17.7	17.7	17.7
Next Driest years	11.8	11.8	11.8	17.0	17.0	17.0	8.7	11.8	11.8	17.0	17.0
Adjusted Dry	23.5	23.5	23.5	26.1	26.1	26.1	9.6	23.5	23.5	26.1	26.1
Average Year	1.2	1.2	1.2	4.3	4.3	4.3	3.5	1.2	1.2	4.3	4.3
Cost of Total Water Saving ($/AF)											
Dry Years after elev. Credit	$8.91	$2.14	$5.27	$19.22	$12.46	$15.58	$33.91	$6.31	$20.89	$16.62	$31.21
Next Driest years	$6.68	$1.61	$3.95	$12.98	$8.41	$10.52	$18.52	$4.73	$15.67	$11.22	$21.07
Average Year	$133.62	$32.14	$79.01	$78.73	$51.02	$63.82	$50.86	$94.64	$313.39	$68.09	$127.81
Cost Of Annual Comal Springflow ($/AF)											
Dry Years after elev. Credit	$22.00	$5.29	$13.01	$47.48	$30.77	$38.49	$83.75	$15.58	$51.60	$41.06	$77.08
Next Driest years	$16.50	$3.97	$9.76	$32.05	$20.77	$25.98	$45.74	$11.69	$38.70	$27.72	$52.04
Average Year	$330.03	$79.38	$195.15	$194.46	$126.02	$157.63	$125.62	$233.75	$774.04	$168.17	$315.69
Cost of August Comal Springflow ($/CFS)											
Dry Years after elev. Credit	$11,710	$2,816	$6,925	$25,270	$16,377	$20,485	$44,574	$8,294	$27,465	$21,854	$41,025
Next Driest years	$8,783	$2,112	$5,193	$17,060	$11,056	$13,829	$24,344	$6,220	$20,599	$14,754	$27,696
Average Year	$175,652	$42,247	$103,868	$103,496	$67,072	$83,897	$66,860	$124,408	$411,972	$89,505	$168,021

Table 4 Program characteristics when water use suspended 1 year out of 5

ITEMS	----------Irrigation Suspension Program---------						LEPA	----------Buy Land ----------			
	Current	at $75/ac	at $150/ac	with LEPA current	With LEPA at $75/ac	with LEPA at $150/ac		Land at $1500/ac	Land at $2000/ac	LEPA + Land $1500/ac	LEPA + Land $2000/ac
Annualized Program Cost											
Total Program Cost ($)	$459,026	$145,035	$290,070	$757,799	$443,807	$588,842	$298,772	$241,725	$580,140	$540,497	$878,912
Avg. Increase in east. Aquifer elevation (ft)	0.76	0.76	0.76	1.64	1.64	1.64	1.1	0.76	0.76	1.64	1.64
Credit for Elev. Increase ($)	$45,600	45,600	45,600	98,400	98,400	98,400	66,000	45,600	45,600	98,400	98,400
Elevation Adjusted Cost ($)	$413,426	99,435	244,470	659,399	345,407	490,442	232,772	196,125	534,540	442,097	780,512
Water Savings (AF)											
Dry Years	23,206	23,206	23,206	23,206	23,206	23,206	6,865	23,206	23,206	23,206	23,206
Next Driest years	15,470	15,470	15,470	22,335	22,335	22,335	11,409	15,470	15,470	22,335	22,335
Adjusted Dry	30,941	30,941	30,941	34,374	34,374	34,374	12,570	30,941	30,941	34,374	34,374
Average Year	3,094	3,094	3,094	6,755	6,755	6,755	4,577	3,094	3,094	6,755	6,755
Yearlong Springflow increase(AF)											
Dry Years	9,395	9,395	9,395	9,395	9,395	9,395	2,779	9,395	9,395	9,395	9,395
Next Driest years	6,264	6,264	6,264	9,043	9,043	9,043	4,619	6,264	6,264	9,043	9,043
Adjusted Dry	12,527	12,527	12,527	13,917	13,917	13,917	5,089	12,527	12,527	13,917	13,917
Average Year	1,253	1,253	1,253	2,735	2,735	2,735	1,853	1,253	1,253	2,735	2,735
August Springflow(CFS)											
Dry Years	17.7	17.7	17.7	17.7	17.7	17.7	5.2	17.7	17.7	17.7	17.7
Next Driest years	11.8	11.8	11.8	17.0	17.0	17.0	8.7	11.8	11.8	17.0	17.0
Adjusted Dry	23.5	23.5	23.5	26.1	26.1	26.1	9.6	23.5	23.5	26.1	26.1
Average Year	2.4	2.4	2.4	5.1	5.1	5.1	3.5	2.4	2.4	5.1	5.1
Cost of Total Water Saving ($/AF)											
Dry Years after elev. Credit	$17.82	$4.28	$10.53	$28.42	$14.88	$21.13	$33.91	$8.45	$23.03	$19.05	$33.63
Next Driest years	$13.36	$3.21	$7.90	$19.18	$10.05	$14.27	$18.52	$6.34	$17.28	$12.86	$22.71
Average Year	$133.62	$32.14	$79.01	$97.61	$51.13	$72.60	$50.86	$63.39	$172.76	$65.44	$115.54
Cost Of Annual Comal Springflow ($/AF)											
Dry Years after elev. Credit	$44.00	$10.58	$26.02	$70.18	$36.76	$52.20	$83.75	$20.87	$56.89	$47.06	$83.07
Next Driest years	$33.00	$7.94	$19.52	$47.38	$24.82	$35.24	$45.74	$15.66	$42.67	$31.77	$56.08
Average Year	$330.03	$79.38	$195.15	$241.09	$126.29	$179.32	$125.62	$156.56	$426.71	$161.64	$285.37
Cost of August Comal Springflow ($/CFS)											
Dry Years after elev. Credit	$23,420	$5,633	$13,849	$37,354	$19,567	$27,783	$44,574	$11,110	$30,281	$25,044	$44,215
Next Driest years	$17,565	$4,225	$10,387	$25,218	$13,210	$18,757	$24,344	$8,333	$22,711	$16,908	$29,850
Average Year	$175,652	$42,247	$103,868	$128,317	$67,215	$95,438	$66,860	$83,327	$227,109	$86,031	$151,88

Table 5 Program characteristics when water use suspended 1 year out of 3

ITEMS	----------Irrigation Suspension Program---------						LEPA	----------Buy Land ----------			
	Current	at $75/ac	at $150/ac	with LEPA current	with LEPA at $75/ac	with LEPA at $150/ac		Land at $1500/ac	Land at $2000/ac	LEPA + Land $1500/ac	LEPA + Land $2000/ac
Annualized Program Cost											
Total Program Cost ($)	$765,043	$241,725	$483,450	$1,063,815	$540,497	$782,222	$298,772	$338,415	$676,830	$637,187	$975,602
Avg. Increase in east. Aquifer elevation (ft)	1.266665	1.26667	1.26667	1.9999991	2	2	1.1	1.266665	1.266665	1.999999	1.999999
Credit for Elev. Increase ($)	$76,000	76,000	76,000	120,000	120,000	120,000	66,000	76,000	76,000	120,000	120,000
Elevation Adjusted Cost ($)	$689,043	165,725	407,450	943,815	420,497	662,222	232,772	262,415	600,830	517,187	855,602
Water Savings (AF)											
Dry Years	23,206	23,206	23,206	23,206	23,206	23,206	6,865	23,206	23,206	23,206	23,206
Next Driest years	15,470	15,470	15,470	22,335	22,335	22,335	11,409	15,470	15,470	22,335	22,335
Adjusted Dry	30,941	30,941	30,941	34,374	34,374	34,374	12,570	30,941	30,941	34,374	34,374
Average Year	5,157	5,157	5,157	8,208	8,208	8,208	4,577	5,157	5,157	8,208	8,208
Yearlong Springflow increase(AF)											
Dry Years	9,395	9,395	9,395	9,395	9,395	9,395	2,779	9,395	9,395	9,395	9,395
Next Driest years	6,264	6,264	6,264	9,043	9,043	9,043	4,619	6,264	6,264	9,043	9,043
Adjusted Dry	12,527	12,527	12,527	13,917	13,917	13,917	5,089	12,527	12,527	13,917	13,917
Average Year	2,088	2,088	2,088	3,323	3,323	3,323	1,853	2,088	2,088	3,323	3,323
August Springflow(CFS)											
Dry Years	17.7	17.7	17.7	17.7	17.7	17.7	5.2	17.7	17.7	17.7	17.7
Next Driest years	11.8	11.8	11.8	17.0	17.0	17.0	8.7	11.8	11.8	17.0	17.0
Adjusted Dry	23.5	23.5	23.5	26.1	26.1	26.1	9.6	23.5	23.5	26.1	26.1
Average Year	3.9	3.9	3.9	6.2	6.2	6.2	3.5	3.9	3.9	6.2	6.2
Cost of Total Water Saving ($/AF)											
Dry Years after elev. Credit	$29.69	$7.14	$17.56	$40.67	$18.12	$28.54	$33.91	$11.31	$25.89	$22.29	$36.87
Next Driest years	$22.27	$5.36	$13.17	$27.46	$12.23	$19.27	$18.52	$8.48	$19.42	$15.05	$24.89
Average Year	$133.62	$32.14	$79.01	$114.99	$51.23	$80.68	$50.86	$50.89	$116.51	$63.01	$104.24
Cost Of Annual Comal Springflow ($/AF)											
Dry Years after elev. Credit	$73.34	$17.64	$43.37	$100.46	$44.76	$70.48	$83.75	$27.93	$63.95	$55.05	$91.07
Next Driest years	$55.00	$13.23	$32.53	$67.82	$30.22	$47.58	$45.74	$20.95	$47.96	$37.16	$61.48
Average Year	$330.03	$79.38	$195.15	$284.01	$126.54	$199.28	$125.62	$125.69	$287.78	$155.63	$257.47
Cost of August Comal Springflow ($/CFS)											
Dry Years after elev. Credit	$39,034	$9,388	$23,082	$53,466	$23,821	$37,514	$44,574	$14,866	$34,037	$29,298	$48,469
Next Driest years	$29,275	$7,041	$17,311	$36,095	$16,082	$25,326	$24,344	$11,149	$25,527	$19,779	$32,722
Average Year	$175,652	$42,247	$103,868	$151,162	$67,347	$106,061	$66,860	$66,895	$153,165	$82,833	$137,033

Table 6 Program characteristics when water use suspended 1 year out of 2

ITEMS	----------Irrigation Suspension Program---------						LEPA	----------Buy Land ----------			
	Current	at $75/ac	at $150/ac	with LEPA current	with LEPA at $75/ac	with LEPA at $150/ac		Land at $1500/ac	Land at $2000/ac	LEPA + Land $1500/ac	LEPA + Land $2000/ac
Annualized Program Cost											
Total Program Cost ($)	$1,147,566	$362,588	$725,175	$1,446,338	$661,360	$1,023,947	$298,772	$459,278	$797,693	$758,050	$1,096,465
Avg. Increase in east. Aquifer elevation (ft)	1.9	1.9	1.9	2.45	2.45	2.45	1.1	1.9	1.9	2.45	2.45
Credit for Elev. Increase ($)	$114,000	114,000	114,000	147,000	147,000	147,000	66,000	114,000	114,000	147,000	147,000
Elevation Adjusted Cost ($)	$1,033,566	248,588	611,175	1,299,338	514,360	876,947	232,772	345,278	683,693	611,050	949,465
Water Savings (AF)											
Dry Years	23,206	23,206	23,206	23,206	23,206	23,206	6,865	23,206	23,206	23,206	23,206
Next Driest years	15,470	15,470	15,470	22,335	22,335	22,335	11,409	15,470	15,470	22,335	22,335
Adjusted Dry	30,941	30,941	30,941	34,374	34,374	34,374	12,570	30,941	30,941	34,374	34,374
Average Year	7,735	7,735	7,735	10,024	10,024	10,024	4,577	7,735	7,735	10,024	10,024
Yearlong Springflow increase(AF)											
Dry Years	9,395	9,395	9,395	9,395	9,395	9,395	2,779	9,395	9,395	9,395	9,395
Next Driest years	6,264	6,264	6,264	9,043	9,043	9,043	4,619	6,264	6,264	9,043	9,043
Adjusted Dry	12,527	12,527	12,527	13,917	13,917	13,917	5,089	12,527	12,527	13,917	13,917
Average Year	3,132	3,132	3,132	4,058	4,058	4,058	1,853	3,132	3,132	4,058	4,058
August Springflow(CFS)											
Dry Years	17.7	17.7	17.7	17.7	17.7	17.7	5.2	17.7	17.7	17.7	17.7
Next Driest years	11.8	11.8	11.8	17.0	17.0	17.0	8.7	11.8	11.8	17.0	17.0
Adjusted Dry	23.5	23.5	23.5	26.1	26.1	26.1	9.6	23.5	23.5	26.1	26.1
Average Year	5.9	5.9	5.9	7.6	7.6	7.6	3.5	5.9	5.9	7.6	7.6
Cost of Total Water Saving ($/AF)											
Dry Years after elev. Credit	$44.54	$10.71	$26.34	$55.99	$22.16	$37.79	$33.91	$14.88	$29.46	$26.33	$40.91
Next Driest years	$33.40	$8.03	$19.75	$37.80	$14.96	$25.51	$18.52	$11.16	$22.10	$17.78	$27.62
Average Year	$133.62	$32.14	$79.01	$129.63	$51.32	$87.49	$50.86	$44.64	$88.39	$60.96	$94.72
Cost Of Annual Comal Springflow ($/AF)											
Dry Years after elev. Credit	$110.01	$26.46	$65.05	$138.30	$54.75	$93.34	$83.75	$36.75	$72.77	$65.04	$101.06
Next Driest years	$82.51	$19.84	$48.79	$93.37	$36.96	$63.01	$45.74	$27.56	$54.58	$43.91	$68.22
Average Year	$330.03	$79.38	$195.15	$320.17	$126.74	$216.09	$125.62	$110.25	$218.31	$150.57	$233.96
Cost of August Comal Springflow											
Dry Years after elev. Credit	$58,551	$14,082	$34,623	$73,606	$29,138	$49,678	$44,574	$19,560	$38,731	$34,615	$53,786
Next Driest years	$43,913	$10,562	$25,967	$49,692	$19,671	$33,538	$24,344	$14,670	$29.048	$23,369	$36,312
Average Year	$175,652	$42,247	$103,868	$170,407	$67,458	$115,011	$66,860	$58,679	$116,192	$80,139	$124,522

Table 7 Breakeven Probability with LEPA

Program	Type of Water Saved		
	Driest	Adjusted	Avg.
ISP – current	38	27	never
ISP $75	none	none	never
ISP $150	64	46	never
Land Purchase @$1500	none	95	never
Land Purchase @$2000	70	27	never
ISP – current & LEPA	25	18	never
ISP $75 & LEPA	98	71	never
ISP $150 & LEPA	44	31	never
Land Purchase @$1500 & LEPA	81	54	never
Land Purchase @$2000 & LEPA	21	10	never

The Future

After water or pumping rights are fully adjudication in the Aquifer region, any variety of sale, lease, or option arrangements might be made between irrigators (sellers) and agencies (buyers) interested in maintaining springflow. These contracts would involve transfers of the right to pump a specified quantity of water rather than cessation of pumping on a specified amount of land. Because of the greater preciseness and flexibility of trading water, we would expect the cost of such transfers to be less expensive than dry year option or irrigation suspension programs based on total suspension of pumping on a given land area.

In the coming decades it is likely that much or most of the irrigated land in the eastern part of the Aquifer will engage in option contracts or leasing arrangements allowing municipalities to pump more during dry years or when aquifer elevations are low, while providing adequate springflow.

Finally, it is unlikely that eventual adjudication of water rights will be detrimental to irrigators. Irrigators expressed a good deal of uncertainty on this issue when asked if adjudication of water rights would effect them positively, negatively, or have little effect (Question 8, Appendix I). Five of 14 respondents replied "negatively," five replied "positively" or "little effect," while four replied "don't know."

Irrigators are guaranteed a minimum of two acre-feet annually by SB 1477. If we assume the most restrictive case, whereby all irrigators would be limited to two acre-feet per year, then irrigators may adjust their crop mix to more drought tolerant crops. During very dry years, perhaps one out of five, many irrigators need to apply more than two acre-feet. On the other hand, the ability to buy, sell, and lease water rights creates new opportunities for irrigators. For the eastern portion of the Aquifer, it is virtually certain that the value of water in dry years, or when Aquifer elevations are low, will be much higher to municipalities and springflow interests than it is for crop production.

Leasing opportunities to irrigators west of the Knippa gap are more uncertain because of the delayed effects of their pumping (Keplinger and McCarl, 1995a). The EAA should manage the Aquifer such that the less direct influence of western pumping on springflow is recognized. Suspending irrigation in the western part of the Aquifer would serve to increase overall Aquifer elevations, but would have little impact on eastern Aquifer elevation or springflow for any given year.

The California Experience

Water shortages in California provide insight into how future water markets might operate in the Aquifer region. California started trading water in 1991 during a severe drought, when municipalities offered irrigators $175 an acre-foot for additional water (Howitt). Response by irrigators was unexpectantly high (at this price), and municipalities accumulated 264,000 af of carryover. Municipalities offered $72 per acre-foot in 1992 and $68 per acre-foot in 1994 to

willing sellers. A recent option contract in California involved paying irrigators $3.50 per acre-foot for the option to purchase water, and a sales price of between $36.50 and $41.50 per acre-foot upon exercise of the option.

Summary and Conclusions

The EAA implemented a pilot irrigation suspension program in 1997 on 9,669 acres mainly in Medina and Uvalde counties with the objective of increasing springflow at Comal Springs, and providing relief to municipalities in meeting Critical Period (drought) Management Rules. The Aquifer region, however, experienced a wet Spring in 1997, so that even irrigators not enrolled in the program applied little or no irrigation water. If conditions were dry in Spring 1997, aquifer simulation results indicate that suspending irrigation on enrolled acreage would have reduced pumping by 23,206 acre-feet and would have augmented Comal springflow by 6,498 acre-feet during the program year and by 17.7 cfs in August. The level of the eastern portion of the Aquifer would have been expect to rise by about 3.8 feet, and the cost per acre-foot of suspended irrigation would have been about $99. Payments to irrigators totaled $2,350,000.

The ISP Program did cause farmer adjustments. Participants in the ISP program planted less corn, cotton, vegetables, and peanuts in favor of more sorghum and wheat. Irrigators who converted to dryland purchased somewhat less fertilizer, seed, and labor, but secondary effects on the local economy appeared to be small.

The price paid per suspended acre was much higher than regional lease rates and average cropping profit margins in many instances. Factors which may have accounted for the high bids include: 1) lack of experience with an ISP, 2) its late start up, 3) the belief that bids might affect future water prices or offers, 4) tendencies to bid high enough to cover costs under a worst case scenario of a total loss of dryland crops, 5) collusion and need to bid high enough to compensate all under current land lease arrangements. Bids in future ISP solicitations might be lower, or might not. Given the substantial difference between local irrigated land rental rates and ISP bids, it seems unlikely that the EAA could attract sufficient acreage by capping bids at rental rates. There may be, however, some latitude for the EAA to set a maximum per acre rate somewhere between local rental rates and the ISP bids. This, combined with announcing the program and executing contracts in October or November, has the possibility of substantially reducing program cost.

The EAA may also want to consider offering an option contract which when implemented would suspend irrigation in April or May. Waiting until April or May would provide the EAA more information on current year weather allowing better information on whether irrigation suspension is really necessary since: 1) more time would have elapsed allowing administrators to know Aquifer elevation at a later date, and 2) information of weather, irrigation use to date and projected irrigation for the remainder of the cropping year is increased this point. The cost of a single implementation of such a program may be substantially higher than a January 1 contract, since irrigators may sustain greater loss. Expected program cost, however, could be lower, since this option would be exercised less frequently, offsetting over higher cost of implementation.

Good alternatives to an ISP are limited. We evaluated the potential of 1) implementing more efficient irrigation technology and 2) buying land and leasing it back during wet or average years. The ISP is a more cost effective source of critical water than is the use of subsidized irrigation efficiency largely because the ISP can put in place only when water is needed. Also, while not considered here, evidence in areas such as the High Plains suggests that irrigator pumping is not reduced by the amount an increase in irrigation efficiency would imply. This is because irrigators may choose to irrigate more water intensive crops and/or irrigate more acreage when efficiency is increased. The high bids experienced in the 1997 program compared to price of land in the Aquifer region suggests that a buy-leaseback arrangement could substantially reduce the cost to the EAA of suspending irrigation. This, of course, would require an alternate set of administrative costs by the EAA and may be less expensive than the ISP. Also the picture may be altered by the adjudication of water rights in the Aquifer which will likely be finished within three to five years. After water rights adjudication, however, buying and leasing back water rights may be a very appropriate and cost effective strategy for the EAA.

In sum, we conclude that the 1997 pilot ISP was a reasonable response to the drought condition experienced in 1996. Fine-tuning the selection criteria, bid arrangement, allowing greater lead time, and/or implementing an ISP or option contract later in the year, holds the potential for reducing the cost of program implementation.

A land-based ISP is an interim arrangement that can be implemented in the absence of a fully functioning permit system. After water rights are adjudicated in the region, ISP and option contracts will take on more conventional forms involving buy, lease, and option contracts for water rights. It is expected that water-based versus land-based arrangements would likely facilitate the transfer of water at lower rates.

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APPENDIX A

EDWARDS AQUIFER AUTHORITY
Document Giving

Irrigation Suspension Program
Schedule of Program Activities

1996 Activities:

	December 19	Authority Board adopts amended CPM Rules with identified benefits for Program Participants show are Aquifer users;
		Authority Board approves Irrigation Suspension Program for implementation
Week of December 29		First notice published in regional newspapers

1997 Activities:

Thursday	January 2 7:00 p.m.	Meeting with Irrigators in Castroville
Week of	January 5	Additional notices published
Thursday	January 9 5:00 p.m.	Deadline for submission of Offers by Irrigators
Thursday	January 9	Consideration by San Antonio City Council
	January 10-13	Offers analyzed and evaluated; Program Acres selected
Monday	January 13	Deadline for signed pledges from Program Participants
Tuesday	January 14	Authority Board meeting to approve numbers
Wednesday	January 15	Contracts with Program Irrigators executed
Friday	January 31	Deadline for receipt of Initial Program Fee from Participants
		Execute any required Addenda
Thursday	February 6	EAA Board meeting to approve or ratify final actions

		pertaining to the Program
Friday	February 7	Payment of First Installment to Program Irrigators

APPENDIX B

EDWARDS AQUIFER AUTHORITY Document Describing

PILOT IRRIGATION SUSPENSION PROGRAM FOR 1997

Section 1. The Program Implementation and Term

The Edwards Aquifer Authority will implement and administer a Pilot Irrigation Suspension Program for 1997 as one-year pilot program. The Program will commence on or about January 15, 1997 and end on December 31, 1997. The Pilot Program will be funded by contributions from Aquifer beneficiaries.

1.1 Program Purpose

The purpose of the Program is to cause suspension of irrigation with Edwards Aquifer water on at least 10,000 acres in 1997. The Program does not have as its purpose or effect the transfer of water rights.

1.2 Program Goals

The goals of the Program are: (1) to increase the water levels in the Aquifer; (2) to help prevent or delay cessation of springflow in the Comal Springs and the San Marcos Springs; and (3) to obtain useful data relation to the effect or partial suspension of irrigation withdrawals on the Aquifer.

1.3 Program Participants

The financial participants ("Participants") in the Program will be Aquifer beneficiaries who will pay Program Fees to the Authority as Program Administrator. The Authority will place the funds received from Participants in a trust account for payment to Program Irrigators who enter into contracts to suspense irrigation. The Authority will retain an amount not to exceed 3% of the total Program Fees to cover the administrative costs of the Program.

1.4 Eligible Irrigators

Program Irrigators must have actually irrigated acreage within the boundaries of the Authority in 1995 and must have timely file Declarations of Historical use and Permit Applications covering the affected acres with the Authority. They will submit to the Authority sealed offers to place defined acres in the Program.

1.5 Selected Criteria

The Authority will apply the following criteria in the selection of Program acres.

(a) Location of well (relative to hydrogeologic connection to known Aquifer flowpaths);
(b) Type of crops produced in 1995 and 1996 on the proposed acres;
(c) Type of irrigation equipment used on the proposed acres;
(d) Commitment by the Owner to plant a nonirrigated crop on the proposed acres;
(e) Offering price per acre.

1.6 Evaluation of Offers

The Authority will develop a scoring system to evaluate the offers. The Participants will be invited to participate in the evaluation. If the Authority determines that in order to place 10,000 acres in the Pilot Program, the total price expectations of offering irrigators exceeds the total initial commitments of the Participants, then the Authority shall request the Participants, then the Authority shall request the Participants to consider increasing their commitments to produce the required total amount. If the total initial commitments are not sufficiently increased within 7 days of the request, then the Authority will cease further implementation and declare the Pilot Program terminated. The Authority will return all Program Fees to the Participants and inform the offering irrigators of the termination of the Pilot Program.

1.7 Payment to Program Irrigators

In the event the Authority determines, after evaluation of the offers, there are sufficient financial commitments from Participants to proceed with the Program, 'Contracts with the Program Irrigators' will be executed. The Contract will provide for payment to Program Irrigators in three installments: (1) at the beginning of the Program year (on or about January17, 1997); and (2) at the end of the spring crop growing season (July 15, 1997); and (3) at the end of the Program year (December 31, 1997). The installments may be equal.

Section 2. Benefits to Region and to Participants through Critical Period Management Rules

2.1 Regional Benefits of the Program

The authority anticipates that there will be region-wide public benefits from the cessation of some irrigation that would otherwise occur. The benefits will be higher Aquifer levels and increased springflow at Comal Springs and San Marcos Springs.

2.2 Benefits to Program Participants

The benefits to Participants who participate in the 1997 Pilot Program will principally be through the CPM Rules of the Authority. In addition to other benefits, the Program Participants will be subject to less severe water use curtailments under CPM Rules. The Authority acknowledges that some Program Participants are publicly owned entities, and must be able to identify a public benefit in order to commit funds. The Authority will adopt or approve for publication and public comments revisions to proposed CPM Rules contemporaneously with, or as soon as possible after the Authority's approval of the implementation of the Pilot Program.

Section 3. Program Administrator

The Edwards Aquifer Authority as Program Administrator will perform the following administrative duties:

(1) Secure Program pledges from prospective Participants, including Aquifer users and downstream beneficiaries;
(2) Encourage participation in the Program from eligible irrigators;
(3) Prepare and finalize Program Documents;
(4) Publish notice of the Program and invitation for sealed offers from eligible irrigators;
(5) Accept and evaluate offers with the participation of Participants;
(6) Enter into ISP Contracts with Program Irrigators;
(7) Accept and hold Participants' payments in a special trust account with the Authority's depository bank;
(8) Disburse payments to Program Irrigators;
(9) Monitor compliance by Program Irrigators;
(10) Coordinate efforts with governmental and other agencies to alleviate the economic impacts on persons affected by the Program;
(11) Collect hydrologic and economic data to verify results of the Program;
(12) Structure and propose future irrigation suspension, dry-year option, or other programs which the Authority may consider for implementation.

Section 4. Program Documents

The Authority will prepare documents to implement the Pilot Program.

4.1 The Participation Agreement between the Authority and each Participant will provide for:

(1) The Participant's commitment to the Program and pledge to pay fees;

(2) The Authority will commit to solicit Irrigators and administer the Program;

(3) The benefit for Participants is defined.

4.2 Offer and Solicitation Documents will include the following:

(1) Invitation for Offers from eligible Irrigators (to be published in regional newspapers);
(2) Instructions for Offers.

4.3 Irrigation Suspension Contract is the Contract between the Authority and the Program Irrigator

(1) The Program Irrigator agrees to suspend irrigation on defined acres in 1997 in consideration of payments from the Authority;
(2) The Authority agrees to make payments to Program Irrigator in three installments.

APPENDIX C
EDWARDS AQUIFER
AUTHORITY DOCUMENT
Pilot Irrigation Suspension Program for 1997
Which is the individual
PARTICIPATION AGREEMENT

This **Program Participation Agreement** is entered into between

_____

of _____, _____ County, Texas, and the EDWARDS AQUIFER AUTHORITY, a conservation and reclamation district and political subdivision of the State of Texas pursuant to Article XVI, Section 59 of the Texas Constitution and the Edwards Aquifer Authority Act, Ch. 626, Laws of the 73rd Texas Legislature, as amended, with jurisdictional boundaries including all of Uvalde, Medina and Bexar Counties and parts of Atascosa, Comal, Guadalupe, Hays, and Caldwell Counties, Texas, and having its principal office in San Antonio, Bexar County, Texas, acting by and through its Board of Directors. (Capitalize terms are defined in Section 1.)

RECITALS

1. The Authority is the Administrator of a Pilot Irrigation Suspension Program for 1997 intended to reduce withdrawals from the Edwards Aquifer during calendar year 1997 when Aquifer levels are expected to be substantially below average levels. The Authority has determined that the suspension of some withdrawals for irrigation of approximately 10,000 acres of historically irrigated acres, along with other Aquifer demand reductions required by the Authority's Critical Period Management Rules, will increase levels in the Aquifer and help prevent or delay cessation of springflow at the Comal and San Marcos Springs.

2. The Authority, as Program Administrator, has identified Aquifer beneficiaries who are willing to participate in the Program as Participants and pay Program Fees to the Authority in order to receive the benefit of protection from certain curtailments required by the CPM Rules, if applicable, as well as the general benefits deriving from increased amounts of water in the Aquifer.

3. The Authority has invited offers from persons who own or control acres within the boundaries of the Authority on which crops have been irrigated with water from the Edwards Aquifer, and who are willing to suspend irrigation for the remainder of the calendar year 1997. The agreement to suspend irrigation is in consideration of the payment of amounts by the Authority on the acres accepted for the Program from funds received by the Authority form the Participants.

4. The undersigned Participant and the Authority desire to enter into this Participation Agreement to provide for the Participant's commitment to make Program payments in consideration of the implementation and administration of the Program by the Authority pursuant

to with the terms herein stated.

AGREEMENT

In consideration of the mutual agreements and covenants herein stated and other good and valuable consideration, the Participant and the Authority agree as follows.

Section 1. Definitions

1.01 In this Agreement, the following terms shall have the respective meaning stated:

"*Act*" means the Edwards Aquifer Authority Act as defined in the first paragraph of this Participation Agreement.

"Administrator" means the Edwards Aquifer Authority as administrator of the Program.

"Aquifer" means that part of the Edwards Aquifer subject to the jurisdiction of the Edwards Aquifer Authority.

"CPM Rules" means the Authority's Critical Period Management rules adopted December 19, 1996.

"Authority" means the Edwards Aquifer Authority.

"Irrigation Suspension Contract" means the contract between Authority and Owners to suspend irrigation in 1997 on defined acres within the Authority's boundaries, the form of which is attached as Attachment A.

"Irrigation Suspension Program" means the Authority's Pilot Irrigation Suspension Program for 1997 described in the Recitals.

"Offer" means the offer by a person who owns or otherwise has the right to irrigate eligible cropland acres to place such acres in the Program in response to the Authority's Invitation for Offers issued on or about December 29, 1996.

"Offeror" means a person who submits and Offer.

"Owners" means persons who enter into Irrigation Suspension Contracts with the Authority pursuant to the Program.

"Participant" means a person who participates in the Program by the payment of Program Fees.

"Participant Agreement" means this Participation Agreement by and between the Authority and the undersigned Participant.

"Pledge" means the commitment and pledge of a Participant to participate in the Program and pay Program Fees as evidenced by the Participant's execution of this Participation Agreement.

"*Program*" means the Pilot Irrigation Suspension Program for 1997 implemented and ad ministered by the Edwards Aquifer Authority.

"*Program Acres*" means acres accepted by the authority for the Program.

"Program Document" means any or all the documents pertaining to the Program.
"Program Fees" means the fees paid to the authority by the Program Participants.

"Program Evaluation Criteria" the criteria provided in Section 3 for selection of Program Acres.

"Program Obligations" means the Authority's administrative obligations, duties and responsibilities with respect to the Program., as described in Section 2.

"Program Payments" means the payments made by the Authority to Owners for suspending irrigation on Program Acres.

Section 2. Administrator's Program Obligations

2.01 The Authority agrees to implement and administer and Irrigation Suspension Program for 1997. The Authority will perform the following Program Obligations.

(1) Secure Program Pledges from prospective Participants, including Aquifer users and downstream beneficiaries, to participate in the Program;

(2) Encourage participation in the Program from eligible irrigators;

(3) Prepare and finalize Program Documents required to implement and administer the Program;

(4) Publish notice of the Program and invite sealed from eligible irrigators;

(5) Accept and evaluate Offers, with the participation of Participants, in accordance with the Evaluation Criteria provided in Section 3;

(6) Enter into Contracts with Owners for suspension of irrigation on Program Acres;

(7) Accept and hold Participants' payments in a special account with the Authority's depository bank;

(8) Disburse payments to Program Irrigators in accordance with the Contracts;

(9) Monitor compliance by Program Irrigators with the Contracts;

(10) Coordinate efforts with governmental and other agencies to alleviate the economic impacts on persons affected by the Program.

(11) Collect hydrologic and economic data to verify results of the Program; and

(12) Structure and propose future irrigation suspension, dry-year option, or other programs which the Authority may consider for implementation.

2.02 Authority further agrees to perform such other administrative duties as may be necessary to facilitate implementation of the Program.

Section 3. Selection and Evaluation of Program Acres

3.01 The Authority agrees to apply the following criteria in the selection of Program acres:

1. Location of well (relative to hydrogeologic connection to known Aquifer flowpaths);

2. Type of crops produced in 1995 and 1996 on the proposed acres (relative to amount of water required);

3. Type of irrigation equipment used on the proposed acres (relative to amount of water used);

4. Offering price per acre

3.02 Using the criteria in Subsection 3.02, the Authority and Participants will develop a scoring system and evaluate the Offers. If the Authority determines that in order to place 10,000 acres in the Pilot Program, the total price expectations of the offering irrigators will exceed the total initial Pledges of Participants, then the Authority shall request Pledges from additional persons and request the Participants to consider increasing their respective initial Pledges to produce the required total amount not later than February 6, 1997. If the adjusted aggregate total of all Pledges, including any additional and increased Pledges, is not sufficient by the close of business on February 6, 1997, then the Authority may either modify the Pilot Program or cease further implementation and terminate the Pilot Program. If the Authority terminates the Program, the Authority will return all Program Fees to the respective Participants from which payments were received and inform the offering irrigators of the termination of the Pilot Program.

Section 4. Program Participant's Pledge and Commitment to Pay

4.01 The Participant pledges and commits to pay the Authority a Program Fee in the total amount of _____ DOLLARS ($_____) in immediately available funds according to the following schedule:

(1) Participant shall pay Authority the first installment payment equal to one-third of such total by January 31, 1997.

(2) Participant shall pay Authority the second installment payment equal to one-third by July 9, 1997.

(3) Participant shall pay the third installment equal to one-third by December 24, 1997.

4.02 Funds paid as the Program Fee, plus any applicable late payment fee required pursuant to Subsection 8.01, will be placed in the Authority's depository account with NationsBank San Antonio solely for use in accordance with this Agreement:

(1) Funds will be withdrawn periodically to make Program Payments to each Program Irrigator who is in compliance with his respective Irrigation Suspension Contract.

(2) The amount of three percent (3%) of the Participant's Payments shall be retained by the Authority for the costs and expenses it incurs in implementing and administrating the Program. The Authority shall account for such costs and expenses, and if the amount is determined to be less than the amount retained, the Authority shall return the excess amount to the Participants pro rata. If the amount is determined to be greater than the amount retained, the Authority shall incur the excess amount as a contribution to the Program.

Section 5. Representatives, Covenants and Conditions of Agreement

5.01 Authority represents that it has duly adopted the CPM Rules with defined benefits for the Program Participants who are Aquifer users.

5.02 Authority and Participant expressly agree that unless the Authority, in the sole discretion, modifies the Program, the aggregate total of pledges from Participants must equal or exceed the amount required to pay Program Irrigators to suspend irrigation on a t least 10,000 acres, plus three percent for projected Program Administrative costs.

5.03 Authority and Participant expressly agree that, unless the Authority, in its sole discretion, modifies the Program, the aggregate total of Program Acres accepted for the1997 Program must equal or exceed 10,000.

5.04 Authority covenants that it shall timely perform all its Program Obligations.

5.05 Participant covenants the Participant will submit timely payments to the Authority in accordance with Section 4.

5.06 Participant expressly represents that it has authorized such payments and identified funds or revenue sources sufficient to pay each installment of the Program Fee as it becomes due, and upon request of the Authority will submit written evidence to the Authority of such authorization and fund identification in form satisfactory to the Authority.

Section 7. Determination not to Proceed.

7.02 If the Authority, in its sole discretion, determines it is not in its interest to proceed with the Program because of lack of interested prospective Participants or shortfall of Pledges to meet price expectations of Offerors or any other reason, then the Authority shall declare the Program terminated and shall promptly notify the Participant. Any amounts paid as an installment of a Program Fee shall be returned.

Section 8. Late Payment and Non-Payment of Program Fees by Participant.

8.01 If the Program Participant fails to pay in full any Program Fee installment when due, the Participant may no longer participate in the Program and will be subject to more restrictive reductions under the CPM Rules until payment is made.

8.02 If any required Program Fee installment is not paid in full within seven (7) days of the due date, Participant shall be obliged to pay, in addition to such installment, penalty interest on the outstanding amount at the rate of ten percent (10%) per annum.

Section 9. Directors, Officers, Employees and Agents Exempt from Personal Liability.

9.01 This Participation Agreement is solely a corporate obligation of the Authority and no recourse under or upon any obligation, covenant or agreement of this Participation Agreement, of for any claim based hereon, shall be asserted against any past, present or future director, officer, employee or agent of the Authority whether by virtue of any law or otherwise. All such liability and claims against such persons are expressly waived as a condition of, and in consideration for, the execution and delivery of this Participation Agreement.

Section 10. General Provisions

10.01 **Notices and Addresses.** All notices required under this Participation Agreement must be in writing and given in person or by certified or registered mail, addressed to the Participant at the address provided in the Pledge and to the Authority as follows:

Edwards Aquifer Authority
P.O. Box 15830
1615 N. St. Mary's
San Antonio, Texas 78212-9030
Attention: General Manager

Either party may change the address to which notices are to be given or sent by sending written notice of the new address to the other party in accordance with the provisions of this section.

10.02 **Parties Bound.** This Participation Agreement binds and inures to the benefit of the parties to this Participation Agreement and their respective heirs, executors, administrators, legal representatives, successors, and assigns when this Participation Agreement permits.

10.03 **Texas Law to Apply; Venue.** This Participation Agreement shall be construed under Texas law, and any suit to enforce this Agreement shall be brought in a court of competent jurisdiction in Bexar County, Texas.

10.04 **Legal Construction; Severability.** If any one or more of the provisions in this Participation Agreement are for any reason held by a court of competent jurisdiction to be invalid, illegal, or unenforceable in any respect, the invalidity, illegality, or unenforceability will not affect any other provision of the Participation Agreement, which will be construed as if it had not included the invalid, illegal, or unenforceable provision.

10.05 **Prior Agreements Superseded.** This Participation Agreement constitutes the parties' sole agreement and supersedes any prior understandings or written or oral agreements between the parties with respect to the subject matter, unless expressly incorporated herein.

10.06 **Amendment.** No amendment, addendum, modification, or alteration of this Participation Agreement is binding unless in writing, dated subsequent to the date of this Participation Agreement, and duly executed by the parties.

10.07 **Rights and Remedies Cumulative.** The rights and remedies provided by this Participation Agreement are cumulative and either party's using any right or remedy will not preclude or waive its right to use any other remedy. These rights and remedies are in addition to any other rights the parties may have by law, statute, ordinance, or otherwise.

10.08 **Attorney's Fees and Costs.** If, as a result of either party's breaching this Participation Agreement, the other party employs an attorney to enforce its rights under this Participation Agreement, the breaching party will pay the other party the reasonable attorney's fees and costs incurred to enforce the Participation Agreement.

10.09 **Force Majeure.** Neither Participant nor Authority is required to perform any term or covenant in this Participation Agreement so long as performance is delayed or prevented by *force majeure* which includes acts of God, strikes, lockouts, material or labor restrictions by any governmental authority, civil riots, floods, and other cause not reasonably within Participant's or Authority's control and that Participant and Authority cannot, by exercising due diligence, prevent or overcome, in whole or part.

10.10 **Time of Essence.** Time is of the essence in payment obligations and all other obligations performable under this Participation Agreement.

Section 11. Authorization.

11.01 Participant expressly states that Participant has full legal power and authorization to enter into this Participation Agreement and to perform the payment and other obligations herein.

11.02 The person executing this Participation Agreement on behalf of the Participant expressly states that such execution had been duly authorized by Participant.

11.03 The person executing this Participation Agreement on behalf of the Authority expressly states that such has been authorized by the Board of Directors of the Authority.

The undersigned Administrator and Participant execute this Participation Agreement on the respective dates written below but is effective for all purposes on the date shown for execution on behalf of the Authority.

Participant

Attest:

_____ _____
(signature)
_____ _____ 1997
(printed name)
(date)

Administrator

Attest: Edwards Aquifer Authority

_____ _____
(signature)
_____
_____1997 (printed name)
(date)

STATE OF TEXAS §
§
COUNTY OF_____ §

This instrument was acknowledged before me on this _____day of _____, 1997, by_____.

_____
Notary Public, State of Texas

STATE OF TEXAS §
§
COUNTY OF_____ §

This instrument was acknowledged before me on this _____day of _____, 1997, by_____.

_____
Notary Public, State of Texas

APPENDIX D
Edwards Aquifer Authority
INSTRUCTION TO OFFERORS
Issued before Bidding

2.1 REQUEST FOR INFORMATION

This Invitation for Offers is being issued by the Edwards Aquifer Authority, San Antonio, Texas, which is the sole point of contact for purposes of information concerning this Invitation. The Authority reserves the right to issue addenda if required. All questions and inquires must be submitted in writing to Rick Illgner, General Manager, by 5:00 p.m. Monday, January 6, 1997. Requests for information received prior to the above stated deadline are to be responded to in writing by the Authority in the form of an addendum addressed to all Offer invitation recipients.

2.2 CONFERENCE

The Authority will conduct a pre - Offer conference with prospective Offerors at 3:00p.m. on Tuesday, January 7, 1997 in the Conference Center of the Authority's office located at 1615 N. St. Mary's Street. Prospective Offerors are encouraged to attend the pre-Offer conference, but attendance is not a requirement for Offer submission nor will it be a factor in considering proposals.

Submission of an Offer shall be considered prima facie evidence that the Offeror is familiar with the terms of the Contract and the administration of the Authority's Pilot Irrigation Suspension Program for 1997, and is prepared to be bound by the terms of the Contract. The Authority will not be responsible for any interpretations or misinterpretations of any oral instructions.

2.3 SUBMISSION REQUIREMENTS

Offerors are required to submit their offers on the attached Offer and Contract. Offerors must submit the completed Information Sheet attached to the Offer and attach all required documents.

Offer envelopes are to be sealed and plainly marked "Offer for Irrigation Suspension Program."

Offers must be received in the Authority offices no later than 5:oo p.m. Thursday, January 9, 1997, addressed to or delivered personally to:

Mr. Rick Illgner
General Manager
Edwards Aquifer Authority
1615 N. St. Mary's Street
P.O. Box 15830
San Antonio, Texas 78212-9030
Telephone (210) 222-2204

NO FACSIMILE OFFERS WILL BE ACCEPTED.

Upon receipt by the Authority, each Offer will be stamped with the date and time received and stored unopened in a secure place until the Offer due date. All Offers become the property of the Authority.

Offers received after the times set for the opening will be declared late and not eligible for opening and consideration. The Authority is not responsible for the nondelivery or late delivery of mail, courier or other methods. Late deliveries will be held unopened. Offeror will be advised that his Offer was late and not accepted and will be allowed to pick up his Offer package.

2.4 OFFER FORMAT

The Authority requires that submitted Offers adhere to the following requirements. Failure to follow the requirements may result in rejection of the Offer. All Offers must be submitted on the enclosed Offer and Contract forms *in duplicate* or photocopies of the forms, with the completed Information Sheet and any other required attachments. Failure to submit a complete package may result in rejection of the Offer.

2.5 OFFERS BINDING

Upon acceptance by the Authority, the Offer price per acre for suspending irrigation shall be binding on the successful Offerors. Offers must provide accurate and complete information as required by this Invitation (including attachments). Negligence on the part of the Offeror in preparing the Offer confers no right of withdrawal after the time fixed for the submission of Offers.

2.6 LATE OFFERS, MODIFICATIONS, OR WITHDRAWALS

Offers received after the date and time indicated will not be considered and will be returned unopened if the Offeror is identified on the envelope.

Offers may be withdrawn or modifies in writing prior to the Offer due date and time.

2.7 OFFEROR SIGNATURE

2.7.1 **Complete Signature**
The offeror must sign the Offer using correct and complete legal names and titles.

2.7.2 **Offer by Lessee**
If the property subject to the Offer is under lease, and the Offer is submitted by the Lessee, then the Owner (or Lessor) must execute the Consent to the Offer and the Contract, and sign the Information Sheet, unless the Lessee can present evidence satisfactory to the Authority that he Lessee has authority to commit to the Contract without executing such Consent and providing such signature.

2.8 **CONTRACT AWARD**

The Authority reserves the right to accept or reject any and all Offers. Unless all Offers are rejected or the Program is canceled, Contracts shall be awarded to Offerors who submit the best and most responsive proposals which meet the criteria set forth in these Instructions and in the Program Documents. No Offer is considered binding upon the Authority until the Contract had been accepted and executed by the Authority. The Authority reserves the right to award Contracts to as many Offeror as it deems appropriate. The Authority reserves the right to request Offerors to submit additional maps or other information about the acreage proposed and to inspect the property and the irrigation system, including the well(s). The Authority further reserves the right to request Offerors to modify and resubmit Offers with different terms if such resubmission is in the interest of the Program.

2.9 **CONTRACT**

It is expressly understood by the Offerors that written notice by the Authority of acceptance of the Offer constitutes a binding contract between the Authority and Offeror.

2.10 **CONTRACTOR SELECTION**

2.10.1 **Selection Process**
The selection process will include the following steps:

1. Receipt of Offers
2. Review and evaluation of Offers submitted (by the Authority and Program Participants).
3. Ranking of Offers (by Authority and Program Participants).
4. Contract Award - The Authority will award Contracts to Offerors whose Offers are the most advantageous to the Program and which will result in the most reasonable Program cost.

2.10.2 **Selection Criteria**
The Offeror must offer to suspend irrigation on an entire Farm Unit, meaning all of the area watered by an irrigation system connected to one or more wells.

Selection will be based on the following criteria

1. Location of well(s) (relative to hydrogeologic connection to known Aquifer flowpaths);
2. Type of crops produced in 1995 and 1996 on the proposed acres (relative to amount of water required);
3. Type of irrigation equipment used on the proposed acres (relative to amount of water used);
4. Commitment by the Owner to plant a nonirrigated crop on the proposed acres; and
5. Offering price per acre

2.11 **CONFIDENTIAL MATERIAL**

Any information or material which the Offeror considers confidential in nature must be clearly marked as such and will be treated as confidential by the Authority to the extent allowable under the Public Information Act.

2.12 **LAWS AND REGULATIONS**

The Authority requires that all Offers and any Contract that may result be in accordance with the laws and regulations of the State of Texas.

2.13 **OFFER ACCEPTANCE PERIOD**

All prices and conditions of the Offer shall remain in effect for 30 days after the date set for the Offer opening. Offers offering less than 30 calendar days from the date set for opening for acceptance by the Authority will be considered nonresponsive and will be rejected.

APPENDIX E

OFFER DOCUMENT

To: Mr. Rick Illgner, General Manager
Edwards Aquifer Authority
1615 N. St. Mary's Street
P.O. Box 15830
San Antonio, Texas 78212

1. **Response to Invitation.** In response to the authority's Invitation for Offers for irrigation suspension pursuant to the Authority's Pilot Irrigation Suspension Program for 1997, the undersigned Offeror submits this Offer to suspend irrigation on defined acres for the remainder of 1997 in exchange for payment from the Authority. The Offeror submits the following required Offer documents.

1.1 This signed and certified Offer;
1.2 The completed Information Sheet;
1.3 The executed Irrigation Suspension Contract, with the price term in Section 401 stated;
1.4 Attachments A and B to the Contract:
Attachment A - Location Map
Attachment B - Property Description

2. **Certification.** I, the undersigned Offeror, hereby certify that all the information provided in the Information Sheet and in the other Offer Documents is true and correct. I submit this Offer to the Authority solely for the purposes and consideration stated in the Contract, and I understand that the terms of the Contract with regard to the suspension or irrigation and related matters are binding upon acceptance of the Contract by the Authority.

_____
SIGNATURE

_____
PRINTED NAME

DATE

STATE OF TEXAS §
§
COUNTY OF _____§

This instrument was acknowledged before me on this _____ day of _____, 1997, by_____.

_____
Notary Public, State of Texas

Seal

3. **Lessor's Consent to Offer by Lessee.** If applicable (to be executed by the Lessor if the acres offered for the Pilot Irrigation Suspension Program for 1997 are farmed pursuant to a lease agreement).

I, the undersigned Owner and Lessor of the real property described in this Offer and attachments thereto hereby consent to the offering of such property for the Edwards Aquifer Authority's Pilot Irrigation Suspension Program for 1997, and I understand that the terms of the Contract with regard to the suspension or irrigation and related matters are binding upon acceptance of the Contract by the Authority.

_____
SIGNATURE

_____
PRINTED NAME

DATE

STATE OF TEXAS §
§
COUNTY OF _____§

This instrument was acknowledged before me on this _____ day of _____, 1997, by_____.

_____
Notary Public, State of Texas

Seal

(To be signed by the Lessor (owner) if Offeror is a Lessee and cannot provide evidence satisfactory to the Authority that the Lessee has the right to offer the Farm Unit for the Program).

The Undersigned Lessor (owner) hereby certifies that he or she is the Lessor (owner) of the acres descried above and that, to the best of such person's knowledge, the information provided is true and correct.

_____
Printed Name

_____ _____
Signature Date

APPENDIX F
Edwards Aquifer Authority
INFORMATION SHEET
Which was to be Attached to Offer for Irrigation Suspension by Bidders

The following information is provided to the Edwards Aquifer Authority in connection with the Offer dated January___, 1997, of acres for the Pilot Irrigation Suspension Program for 1997. The information covers the acres described in the Contract submitted with the Offer. (All capitalized terms have the meaning assigned in the Contract.)

Number of acres in Farm Unit to be placed in the Program: _____ acres.

1. Will Offeror plant a dryland crop on the acres in the Program in 1997? ____yes ____no

2. The Offeror of the Farm Unit is: _____Owner _____Lessee

_____
(name)
_____
(address)
_____
(city) (state)
_____
(telephone)

3. Is the Farm Unit under lease? ___yes ___no

If the Offeror is a Lessee, the Lessor (owner) is

_____
(name)
_____
(address)
_____
(city) (state)
_____
(telephone)

4. If the Lessee is offering the acres in the Farm Unit, attach a copy of the lease agreement or other evidence of Lessee's right to offer the acres in the farm Unit to the Program.

5. If the Lessee does *not* have the right to offer the Farm Unit for the Program, then the Lessor (owner) must also sign this Information Sheet and must execute the Consent to both the Offer and the Contract.

6. Describe the irrigation of the Farm Unit in 1995 and 1996.

	Crops	*Acres*
1995		
	Total Acres	

	Crops	*Acres*
1996		
	Total Acres	

7. Irrigation Equipment Used on Farm Unit:

	Equipment	*Acres*
Pivot	LEPA	
	Low Pressure	
	High Pressure	
Furrow	With surge valves	
	Without surge valves	
Sprinkler	Side row	
	Other	
	Total Acres	

8. The number of wells that provide water for the irrigation equipment indicated in paragraph 8: _____.

(The location of each such well must be shown on the aerial photograph attached to the Contract.)

9. Is the well or wells used for domestic livestock or other uses in addition to irrigation?
____yes _____no
If yes, please specify.

10. Please attach an aerial photograph that shows the location of the irrigated acreage you wish to place into the program and the well(s) that provide water for that acreage.

The undersigned Offeror hereby certifies that he or she has irrigated the acres described above in 1995 and 1996 and that, to the best of such person's knowledge, the information provided above is true and correct.

_____
Printed Name

_____ _____
Signature Date

APPENDIX G
Edwards Aquifer Authority
IRRIGATION SUSPENSION CONTRACT
To be executed with those in Program

This **Irrigation Suspension Contract** is entered into between

_____ _____

an Owner of real property located in _____ County, Texas, and the Edwards Aquifer Authority, a conservation and reclamation district and political subdivision of the State of Texas created by the Texas Legislature pursuant to Section 59 of the Texas Constitution and the Edwards Aquifer Authority Act, Chapter 626, Laws of the 73rd Texas legislature, as amended, with jurisdictional boundaries including all of Uvalde, Medina, and Bexar Counties and parts of Atascosa, Comal, Guadalupe, Hays, and Caldwell Counties, Texas and having its principal office in San Antonio, Bexar County, Texas, acting by and through its Board of Directors. (*Capitalized terms are defined in Section I.*)

RECITALS

1. The Authority is the Administrator of a Pilot Irrigation Suspension Program intended to reduce withdrawals from the Edwards Aquifer during calendar year 1997 when Aquifer levels are expected to be substantially below average levels. The Authority has determined that the suspension of some withdrawals, along with other Aquifer demand reductions required by the Authority's Critical Period Management Rules, will increase levels in the Aquifer and help prevent or delay cessation of springflow at the Comal and San Marcos Springs.

2. The Authority, as Program Administrator, has identified Aquifer beneficiaries who are willing to participate in the Program as Participants and pay amount of money in order to receive the benefit of protection from certain curtailments required by the CPM Rules as well as other benefits. The Participants and the Authority have entered into Participation Agreements pursuant to of which the Participants have agreed to pay fees and the Authority had agreed to administer the Program.

3. The Authority has issued an Invitation for Offers from Owners of acreage within the boundaries of the Authority on which crops have been irrigated with water from the Aquifer during 1995 and 1996 who are willing to suspend irrigation for the remainder of calendar year 1997. Offered acres which meet the criteria established by the Authority for the Program may be accepted as Program Acres.

4. By entering into this Irrigation Suspension Contract, the undersigned Owner agrees that if some or all of the acres described hereinafter are accepted as Program Acres, the Owner will suspend irrigation on the Program Acres pursuant to the terms of this Contract.

CONTRACT TERMS

In consideration of the mutual covenants and agreements to the terms and conditions in this Contract, and other good and valuable consideration, Owner and Authority hereby agree as follows:

Section I. Definitions

101. In this Contract, the following terms shall have the respective meanings stated:

"*Act*" means the Edwards Aquifer Authority Act as defined in the first paragraph of this Participation Agreement.

"Administrator" means the Edwards Aquifer Authority as administrator of the Program.

"Authority" means the Edwards Aquifer Authority.

"Aquifer" means that part of the Edwards Aquifer subject to the jurisdiction of the Edwards Aquifer Authority.

"CPM Rules" means the Authority's Critical Period Management rules adopted December 19, 1996.

"Farm Unit" means all of the area watered by an irrigation system connected to one or more wells.

"Information Sheet" means the information sheet on the proposed Program Acres provided by the Owner with the Offer.

"Invitation" means the invitation described in paragraph 3 of the Recitals.

"Lessee" means a person who leases and farms the Program Acres described in this Contract.

"Lessor" means a person who owns and leases to a Lessee the Program Acres described in this Contract.

"Location Map" means the county highway map attached hereto as Attachment A for the purpose of delineating the acres proposed as Program Acres.

"Offer" means the offer by a person who owns or otherwise has the right to irrigate eligible cropland acres to place such acres in the Program in response to the Authority's Invitation for Offers issued on or about December 29, 1996.

"Owner" means a person who owns or had the right to farm cropland acres within the boundaries of Authority which have been irrigated with water from the Aquifer. If the

person having such farming rights is a Lessee, the Consent of this Contract must be extended by the Lessor, unless the Lessee presents evidence satisfactory to the Authority that the Lessor's consent is not required.

"*Participants*" means persons who are beneficiaries of the Aquifer who have agreed to pay fees to the Authority for the implementation and administration of the Program.

"*Participant Agreement*" means the agreement described in paragraph 2 of the Recitals.

"*Program*" means the Pilot Irrigation Suspension Program for 1997 implemented and ad ministered by the Edwards Aquifer Authority.

"*Program Acres*" means acres accepted by the Authority for the Pilot Irrigation Suspension Program of 1997, and subject to the terms of this Contract.

"*Program Documents*" means the Invitation, the Offers, the Information Sheet, this Contract, the Participation Agreement and all attachments and addenda, if any, to such documents and any other document issued by the Authority in connection with the Program.

"*Program Payments*" means payments described in Section IV paid to the Owner for the suspension of irrigation as required by this Contract.

"*Property Description*" means field notes description of the Program Acres attached hereto as Attachment B.

Section II. Term of Contract

201. The term of this Contract is the approximately eleven month period beginning February 7, 1997, and ending on December 31, 1997, unless terminated sooner as provided in this Contract.

Section III. Agreement to Suspend Irrigation

301. Owner agrees that upon receipt of the first Program Payment, Owner shall suspend and discontinue for the entire term of this Contract all irrigation with Aquifer water on the Program Acres shown on the Location Map attached hereto as Attachment A and further described in the Property Description attached hereto as Attachment B and incorporated herein for all purposes.

Section IV. Program Payments

401. Authority will pay Owner Program Payments in an amount equal to Owner's offering price of _____DOLLARS ($_____) per acre for each Program Acre on which irrigation is suspended

during the term of this Contract.

402. Program Payments will be made in three installments:

(1) The first payment equal to one-third (1/3) of the total payment will be paid on or before February 7, 1997.
(2) The second payment equal to one-third (1/3) will be paid on July 15, 1997.
(3) The third payment equal to one-third (1/3) of the total payment will be paid December 31, 1997.

403. Authority will make Program Payments to the Owner at the address indicated, or such other address as Owner from time to tome may designate by written notice to Authority.

Section V. Permit Application

501. Owner represents that, in compliance with the Act and the rules of the Authority, Owner had timely filed with the Authority a permit application and declaration of historical use for the withdrawal of Aquifer water for the purpose of irrigating the proposed acres. Owner represents that, pending approval of the application, Owner has interim authorization to withdraw the water for irrigation use.

Section VI. Owner's Obligations with Respect to Contract and Program Acres

601. **Approvals**. Owner has obtained required approvals or consents from any co-owner, lender, lienholder, and any other person or any government agency which may be required for execution and performance of this Contract.

602. **Permit Fees, Real Property Taxes, and Assessments.** Owner will pay any and all applicable permit fees or permit application fees, including fees payable to the Authority, with respect to Owner's right to withdraw Aquifer water that but for this Contract would be withdrawn and used by Owner to irrigate the Program Acres. Owner will also pay and fully discharge all real property taxes, special assessments, and governmental charges of any kind imposed on the Program acres during the Contract term.

603. **Recordation.** Owner will cooperate with the filing and recording of a Memorandum of this Contract in the Official Public Records of the County or Counties in which the Program Acres are located.

604. **Use of Program Acres.** During the term of this Contract, unless Authority has expressly waived compliance with this subsection upon Owner's written request, Owner shall protect the Program Acres by planting and producing crops not requiring irrigation.

605. **Economic Impacts.** Upon request by Authority, Owner shall provide information to Authority and other governmental agencies to facilitate efforts to alleviate the economic impacts of the Program on employees and other affected persons.

606. **Limitations of Transferee.** Unless the Authority has expressly waived compliance with this subsection, upon Owner's written request, Owner shall not sell, assign transfer, convey or lease any interest in the Program Acres during the term of this Contract unless the Owner gives ten (10) days prior notice to the Authority, and unless the Owner obtains the written agreement of any transferee, assignee or lessee in form satisfactory to the Authority, to the suspension of irrigation and other terms of this Contract.

Section VII. Right to Inspect

701. Owner shall permit inspection of the Program Acres and the related irrigation system, including any well, by the Authority's representatives at reasonable time upon 4-hour prior notice. Owner hereby grants access to Owner's property to Authority's representatives for such purposes. The notice of intent to inspect may be given in writing, by telephone, or in person, and shall be deemed received whether or not receipt is acknowledged.

Section VIII. Hold Harmless

801. To the extent permitted by law, Authority shall hold Owner harmless against any claims, demands, damages, costs, and expenses, including reasonable attorney's fees for defending any claims and demands arising form any breach on Authority's part of any conditions of this Contract or from any act or negligence of Authority, its agents, contractors, or employees in connection with activities on or about the Program Acres.

Section IX. Default and Remedies

901. **Events of Default.** Any one of the following shall constitute and Event of Default under this Contract:

If the information in Owner's Offer is materially false or overstated;
If the Owner does not completely suspend irrigation on the Program Acres;
If the Owner fails to comply with any agreement or covenant in this Contract or any representation made by Owner in this Contract is determined to be untrue by the Authority;
If, in the absence of a breach by the Owner, the Authority fails to pay Payments when due.

902. **Termination.** Upon the occurrence of an Event of Default by the Owner, the Authority shall immediately send a notice of such Default to Owner and Authority may, at its option, either provide an opportunity for the Owner to cure the default or declare the Contract terminated, and send a notice of termination to Owner.

903. **Liquidated Damages.** The Parties agree that, if Owner breaches this Contract

by failing to suspend any part of the irrigation on the Program Acres during the term of this Contract, or causes any other Event of Default causing the Authority to terminate this Contract, the actual damages sustained by the Authority because of any such Default will be uncertain and difficult of ascertainment. The Owner therefore agrees to pay, as liquidated damages and not as a penalty, an amount equal to all amounts paid to Owner under this Contract through the date of breech plus 10%. Such payment shall be made immediately upon Owner's receipt of notice of breech.

904. **Default by Authority.** If the authority should fail to pay one or more payments within thirty (30) days of the due date, and there has been no breech by Owner, Owner shall be entitled to collect such Payment plus interest in the amount of eight percent (8%) from such date 30 days after the due date.

Section X. General Provisions

1001. Notices and Addresses. Except for the notice of inspection in Section VII, all notices required under this Contract must be in writing and given in person or by certified or registered mail, addresses to the Owner at the address provided in the Information Sheet, and to the Authority as follows:

Edwards Aquifer Authority
P.O. Box 15830
1615 N. St. Mary's
San Antonio, Texas 78212
Attention: General Manager

Either party may change the address to which notices are to be given or sent by sending written notice of the new address to the other party in accordance with the provisions of this section.

1102. **Parties Bound.** This Contract binds and inures to the benefit of the parties to this Contract and their respective heirs, executors, administrators, legal representatives, successors, and assigns when this Contract permits.

1103. **Texas Law to Apply, Venue.** This Contract shall be construed under Texas law, and any reason held by a court of competent jurisdiction to be invalid, illegal, or unenforceable in any respect, the invalidity, illegality, or unenforceability will not affect any other provision of the Contract, which will be construed as if it had not included the invalid, illegal or unenforceable provision.

1105. **Prior Agreements Superseded.** This Contract constitutes the parties' sole agreement and supersedes any prior understandings or written or oral agreements between the

parties with respect to the subject matter, unless expressly incorporated herein.

1106. **Amendment.** No amendment, addendum, modification, or alteration of this Contract is binding unless in writing, dated subsequent to the date of this Contract, and duly executed by the parties.

1107. **Rights and Remedies Cumulative.** The rights and remedies provided by this Contract are cumulative and either party's using any right or remedy will not preclude or waive its right to use any other remedy. These rights and remedies are in addition to any other rights the parties may have by law, statue, ordinance, or otherwise.

1108. **Attorney's Fees and Costs.** If, as a result of either party's breaching this Contract, the other party employs an attorney or attorneys to enforce its rights under this Contract, the breaching party will pay the other party the reasonable attorney's fees and costs incurred to enforce the Contract.

1109. **Force Majeure.** Neither Owner nor Authority is required to perform any term or covenant in this Contract so long as performance is delayed or prevented by *force majeure* which includes acts of God, strikes, lockouts, material or labor restrictions by any governmental authority, civil riots, floods, and other cause not reasonably within the Owner's or Authority's control and that Owner or Authority cannot, by exercising due diligence, prevent or overcome, in whole or part.

1110. **Time of Essence.** Time is of the essence of this Contract.

Section XI. Authorization

1201. The Owner expressly states that Owner has full legal power and authorization to execute this Contract and to suspend irrigation and perform other obligations as may be required herein. If the Owner's execution of this Contract requires the Consent of a Lessor, such Consent has been provided below.

1202. The person signing on behalf of the Authority expressly states that the execution of this Contract has been authorized by the Board of Directors of the Authority.

This Contract is executed by the Owner and on behalf of the Authority on the respective dates written below but is effective for all purposes on the date shown for execution on behalf of the Authority.

Owner

_____
(signature)

_____1997
(printed name) (date)

Authority

Edwards Aquifer Authority

Attest

_____ _____
(signature)

_____ _____1997
(printed name) (date)

STATE OF TEXAS §
§
COUNTY OF _____§

This instrument was acknowledged before me on this _____ day of _____, 1997, by_____.

_____
Notary Public, State of Texas

STATE OF TEXAS §
§
COUNTY OF _____ §

This instrument was acknowledged before me on this _____ day of _____, 1997, by_____, _____ of the Edwards Aquifer Authority, on behalf of said Authority.

_____
Notary Public, State of Texas

Seal

Lessor's Consent to Contract
(Complete if applicable)

I, the undersigned Lessor (owner) of the real property described in this Contract and Attachments hereto consent to the placing of such property in the Edwards Aquifer Authority's Pilot Irrigation Suspension Program for 1997, and I understand that the terms of this Contract with regard to the suspension or irrigation and related matters are binding upon acceptance of this Contract by the Authority.

_____
(signature)

_____1997
(printed name)

(date)

STATE OF TEXAS §
§
COUNTY OF _____§

This instrument was acknowledged before me on this _____ day of _____, 1997, by_____.

_____
Notary Public, State of Texas

Seal

APPENDIX H
Edwards Aquifer Authority
EVALUATION CRITERIA FOR IRRIGATED ACREAGE
Used to score Bids

The following selection criteria were established by the workgroup on December 6, 1996. Criteria are listed, followed by ranking for each. Determine the points to be assigned for each land unit in each criteria, and list on the attached ranking matrix sheet.

1) Location of well relative to hydrogeologic flowpaths in the pilot program area.

Points assigned:
11 = Comal County acreage
10 = Bexar County acreage
9 = Southeast Medina County (South Central flowpath)
8 = Northeast Medina County, south of Haby Crossing/Medina Lake Fault Trend
7 = West Medina County, south of Haby Crossing/Medina Lake Fault Trend.
6 = North Medina County, north of Haby Crossing/Medina Lake Fault Trend.
6 = Uvalde County.

2) Types of crops produced in 1995 and 1996.

10 = Alfafa / Pecans
10 = Coastal Bermuda
8 = Corn
7 = Cotton
6 = Peanuts
5 = Sorghum / Wheat / Hay
4 = Cabbage / Cauliflower / Cantaloupe

Note: For double crop acreage Crop Type value is multiplied by factor of 1.3. Triple crop acreage is multiplied by a factor of 1.6.

3) Type of irrigation equipment used.

10 = Flood
9 = Furrow
8 = Traveling Guns
6 = High Pressure Pivots

5 = Low Pressure Pivots
4 = LEPA Pivots
3 = Drip

4) Commitment to plant nonirrigated crop.

10 =Yes
0 = No

The values for each of these criteria are to be summed. This calculated sum is then divided into the bid price, in order to come up with a number which incorporates price, but weights it by the other criteria.

Example: Irrigator in Northeast Medina County, south of Haby Crossing Fault. He irrigated corn in 1996, using a standard high pressure pivot system. He raised Two crops per year in 1995 and 1996. He will commit to dryland farming in 1997.

1) Loc.- 8 = 8.0
2) Crop - 8 x 1.3 = 10.4
3) Irrig. Equip.- 6 = 6.0
4) Dryland - 10 = 10.0
Total score = 34.4

His bid price = $300 per acre

Ranking = $300 ÷ 34.4 = 8.72

APPENDIX I
SURVEY INTRUMENT USED IN THIS STUDY AND RESPONDENT RESULTS

Q1. Did your crop mix change any as a result of participating in the Irrigation Suspension Program? _____ If so, how did it change?

Response	Frequency
No	9
Yes	5

(Crop mix acreage for a subset of irrigators is reported in Figure 3.)

Comments:

Would usually have planted corn. Wheat good for dry year.
Planted some wheat this year.
Planted the same as always.
Usually plant corn, planted wheat this year.
Would normally plant peanuts as a second crop.
Went from Corn to Sorghum.
Would have grown Sorghum anyway this year, based on rotation.
Did not plant because it was too dry.
Land is leased.

Q2. Because you did not hear about the Irrigation Suspension Program until the very end of last year or early this year, did you make any commitment that made it harder or more expensive for you to participate?

Response	Frequency
No	9
Yes	3
Don't know	1
No Answer	1

Comments:

Heard a lot about it. Planned for it.
Planted wheat in anticipation of the ISP.
Would not have irrigated anyway in 1996

Q3. When do you feel you would need to know about an Irrigation Suspension Program or a Dry Year Option program in order to avoid making commitments which might make it harder or more expensive for you to participate?

Response	Frequency
September	2
October	4
November	4
December	2
No Answer	2

Q4. If you had been asked to participate in an Irrigation Suspension Program in March or April, how would that have impacted your bid?

Response	Frequency
Too Late	4
More Difficult	2
No Difference	2
Would Bid More	1
Would Bid Less	1
Don't Know	3
No Answer	1

Q5. Did your purchases from suppliers change any this year as a result of going dry land? ____
If so, how?

Response	Frequency
No change	4
A little less	8
Less purchases	1
No Answer	1

Comments:

Fertilized a little lighter
Not quite as much fertilizer
Less fertilizer and seed. Same inputs for grain crops.
Not as much fertilizer.
Purchased somewhat less seed.
Less fertilizer

Less diesel and fertizer.
Fertilized twice rather than four times. Hired one less person to apply fertilizer.

Q6. Are you pleased with this year's administration of the Irrigation Suspension Program? _____ If not, why not.

Response	Frequency
Yes	12
No	0
Don't Know	1
No Answer	1

Comments:

Good job. (several)
Not over with yet.

Q7. Do you feel the amount of compensation you received covered your amount of lost profits due to the fact that you did not irrigate? _____

Response	Frequency
Yes	11
No	2
No Answer	1

Q8. Would you participate in another Irrigation Suspension Program or Dry Year Option if another one is offered within the next three to five years? _____

Response	Frequency
Yes	13
No	0
Maybe	1

Q9. Do you feel the adjudication of water rights and issuing of pumping permits by the Edwards Aquifer Authority within the next three to five years will effect you: positively, negatively, or have little effect?

Response	Frequency
Positively	2
Little Effect	3
Negatively	5
Don't Know	4

Comments:

See good and bad in it. Need controls to help Aquifer. Need to recharge, keep it pure. Need regulation, but can be overdone.
Hard to say. Need experience.
There will be some meters. We will have to pay.
Like everyone else. (don't know)
Established water rights is a positive development.
Too early to tell.
They are stealing our rights without compensation, making us pay for pumping.