4C.2 Irrigation Water Conservation (N-2)

4C.2.1 Description of Strategy

Irrigation water use is the use of freshwater that is pumped from aquifers and/or diverted from streams and reservoirs of the planning area and applied directly to grow crops, orchards, and hay and pasture in the study area. Irrigated agriculture accounted for almost 60 percent of approximately 17 million acft of water used in the state in 2000.[1] Approximately 10 million acft of water were used in Texas to grow a variety of crops ranging from food and feed grains to fruits and vegetables to cotton. Of these 10 million acft, groundwater resources provide approximately 80 percent of the water used for irrigation purposes, with surface water supplies accounting for the remaining 20 percent.[2] Although irrigated agriculture accounts for only 30 percent of all harvested cropland acres in Texas, the value of irrigated crops account for nearly 50 percent of the total value of crop production in the State.[3]

In Texas, irrigated acreage development peaked in 1974 with 8.6 million acres of irrigated cropland. In 2000, irrigated acreage had declined statewide by approximately 2.25 million acres, with a corresponding decline in on-farm water use of more than 3.3 million acft, a reduction of 25 percent.[4] There are a number of factors associated with this declining trend, including more acreage being set aside for compliance with federal farm programs, poor economic conditions in the agricultural sector, a decline in the number and size of farms, technological advancements in crop production, advancement and implementation of more water efficient irrigation systems, and better irrigation management practices.

Irrigation water is supplied by groundwater and surface water and is typically applied to land by: (1) flowing or flooding water down the furrows; and (2) with the use of sprinklers. When groundwater is used, irrigation wells are usually located within the fields to be irrigated. For surface water supplies, typically water is diverted from the source and conveyed by canals and pipelines to the fields. In both the use of groundwater and surface water, the conservation objective is to reduce the quantity of water that is lost to deep percolation and evaporation between the originating points (wells in the case of groundwater, and stream diversion points in the case of surface water), and the irrigated crops in the fields. Thus, the focus is upon

[1] Texas Water Development Board (TWDB) database, 2004.
[2] TWDB, "Surveys of Irrigation in Texas," Report 347, August 2001.
[3] 2002 Census of Agriculture.
[4] TWDB, Op. Cit., August 2001.

investments in irrigation application equipment, instruments, and conveyance facility improvements (canal lining and pipelines) to reduce seepage losses, deep percolation, and evaporation of water between the originating points of the water and the destination locations within the irrigated fields, and management of the irrigation processes to improve efficiencies of irrigation water use and reduce the quantities of water needed to accomplish irrigation.

Although the statewide trend in irrigated acreage is downward, irrigated acreage in the Coastal Bend Region does not reflect this trend. Crops grown on irrigated acres in the Coastal Bend Region included cotton, grain sorghum, corn, forage crops, peanuts, pecans, hay-pasture, Irish potatoes, vegetables, and other crops. Data collected for the Region by the TWDB in 1994 indicates that irrigated acreage totaled 10,628 acres. However, 2000 data indicates that irrigated acreage totaled about 25,810 acres, with over 60 percent of the acreage planted for cotton, corn, and hay-pasture.[5] Table 4C.2-1 summarizes the variety of crops grown in the Coastal Bend Region and number of irrigated crops for each county in 2000.

In 1994, the irrigators in the Coastal Bend Region used 10,588 acft of water, of which nearly 90 percent was from groundwater sources. In 2000, the TWDB estimated that the irrigators used 21,971 acft. Due to increased water application efficiencies, the irrigation use rate decreased from 1.00 acft/acre in 1994 to 0.85 acft/acre in 2000.

In the Coastal Bend Region, 10 of the 11 counties (except Nueces County) received a majority of their supply, in many cases full water supply, from groundwater sources. Nueces County irrigators receive most of their water supply from run-of-river water rights from the Nueces River, with water rights exceeding projected water demands.

The TWDB irrigation water demand projections for the Coastal Bend Region show significant decreases in irrigation usage in the future. For example, the TWDB estimate of irrigation water use is projected to decline to 17,077 acft by 2030 and 13,365 acft by 2060, representing a decrease of approximately 61 percent from 2000. Furthermore, each county has projected decreases in water demand over time. The county-wide decline in water use is likely due to expected reductions in irrigated land in the future, however this would imply a reversal of the trend observed in reported irrigated acreage from 1994 to 2000.

In the Coastal Bend Region, Live Oak County is projected to have irrigation needs (shortages) during the 2000 to 2060 planning period, as shown in Table 4C.2-2. Live Oak

[5] Ibid.

Table 4C.2-1.
Irrigated Acres by Crop (2000)
Coastal Bend Region

County	Cotton	Grain Sorghum	Corn	Forage Crops	Peanuts	Pecans	Other Orchard	Hay – Pasture	Irish Potatoes	Vegetables (deep)	All other crops	Total
Aransas	0	0	0	0	0	0	0	0	0	0	0	0
Bee	1,070	1,480	575	0	0	0	0	608	0	0	62	3,795
Brooks	0	0	0	0	0	20	0	0	0	0	0	20
Duval	0	152	682	1,002	250	0	0	154	655	2,760	200	5,855
Jim Wells	73	0	80	458	0	0	93	2,382	135	713	0	3,934
Kenedy	0	0	0	160	0	0	0	0	0	0	0	160
Kleberg	0	0	0	0	0	0	0	428	0	168	0	596
Live Oak	240	240	0	0	0	0	14	1,586	0	4	25	2,109
McMullen	0	0	0	0	0	0	0	0	0	0	0	0
Nueces	470	40	285	0	0	0	305	710	0	0	0	1,810
San Patricio	3,860	735	2,378	0	0	0	0	120	0	0	438	7,531
Total	**5,713**	**2,647**	**4,000**	**1,620**	**250**	**20**	**412**	**5,988**	**790**	**3,645**	**725**	**25,810**
Percent	**22.1**	**10.3**	**15.5**	**6.3**	**1.0**	**0.1**	**1.6**	**23.2**	**3.1**	**14.1**	**2.8**	**100**

Source: TWDB database, 2002. Provided to TWDB by NRCS.

County uses both surface water and groundwater supplies to meet water demands. The shortagedeclines over time from 627 acft in 2010 to 373 acft in 2060. Live Oak County irrigation water supply was based on TWDB water use data for 2000;[6] consisting of 75 percent groundwater and 25 percent surface water. This ratio was maintained through 2060, according to the groundwater supply procedure presented in Section 3. The City of Corpus Christi has irrigation permits in Live Oak County with firm yield of 200 acft.[7] The predominant crop in Live Oak County is hay-pasture; constituting 75 percent of the irrigated acres (Table 4C.2-1).

Table 4C.2-2.
Projected Water Demands, Supplies, and
Water Needs (Shortages) for Irrigation Users
Live Oak County

	Water Projections						
	2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Irrigation Demand	3,539	3,289	3,056	2,840	2,639	2,451	2,277
Irrigation Existing Supply							
Groundwater	2,649	2,462	2,287	2,126	1,975	1,835	1,704
Surface water	200	200	200	200	200	200	200
Total Irrigation Supply	2,849	2,662	2,487	2,326	2,175	2,035	1,904
Shortage	(690)	(627)	(569)	(514)	(464)	(416)	(373)

TWDB Rules for regional water planning require Regional Water Planning Groups to consider water conservation and drought management measures for each water user group with a need (projected water shortage). In addition, the Rules direct water conservation BMPs, as identified by the Water Conservation Implementation Task Force (Task Force), be considered in the development of the water conservation water management strategy.

4C.2.2 Available Yield

In March 2005, the CBRWPG recommended that counties with projected irrigation needs (shortages) reduce their irrigation water demands by 15 percent by 2060 using BMPs identified

[6] TWDB, Op. Cit., August 2001.
[7] Part of TCEQ Water Right #3214.

by the Task Force. A 15 percent reduction in irrigation water demand by 2060, results in a new demand of 1,935 acft for 2060 and maximum savings of 342 acft as shown in Table 4C.2-3.

Table 4C.2-3.
Projected Water Demands and Needs (Shortages) for Irrigation Users after Recommended Irrigation Water Conservation Live Oak County

	Water Projections					
	2010 (acft)	***2020 (acft)***	***2030 (acft)***	***2040 (acft)***	***2050 (acft)***	***2060 (acft)***
New Demand	3,272	3,004	2,737	2,470	2,203	1,935
Expected Savings	17	52	103	169	248	342
New Shortage	(610)	(517)	(411)	(295)	(168)	(31)
Shortage Reduction	3%	9%	20%	36%	60%	92%

The Task Force report lists the following irrigation BMPs that may be used to achieve the recommended water savings:[8]

1. Irrigation Scheduling;
2. Volumetric Measurement of Irrigation Water Use;
3. Crop Residue Management and Conservation Tillage;
4. On-farm Irrigation audit;
5. Furrow Dikes;
6. Land Leveling;
7. Contour Farming;
8. Conservation of Supplemental Irrigated Farmland to Dry-Land Farmland;
9. Brush Control/Management;
10. Lining of On-Farm Irrigation ditches;
11. Replacement of On-/farm Irrigation Ditches with Pipelines;
12. Low Pressure Center Pivot Sprinkler Irrigation Systems;
13. Drip/Micro-Irrigation System;
14. Gated and Flexible Pipe for Field Water Distribution Systems;
15. Surge Flow Irrigation for Field Water Distribution Systems;
16. Linear Move Sprinkler Irrigation Systems;
17. Lining of District Irrigation Canals;

[8] Water Conservation Implementation Task Force, Report to the 79th Legislature, Texas Water Development Board, Special Report, Austin, Texas, November 2004.

18. Replacement of District Irrigation canals and Lateral canals with Pipelines;
19. Tailwater Recovery and Use System; and
20. Nursery Production Systems.

The Task Force report describes the above BMP methods and how they reduce irrigation water use, however information regarding specific water savings and costs to install irrigation water saving systems is generally unavailable. The Task Force report does include water savings and costs for three irrigation water conservation BMPs: (1) furrow dikes; (2) low-pressure sprinklers (LESA); and (3) low-energy precision application systems (LEPA). These major irrigation water conservation techniques applicable in the Coastal Bend Region are described briefly below.

Furrow dikes are small mounds of soil mechanically installed a few feet apart in the furrow. These mounds of soil create small reservoirs that capture precipitation and hold it until it soaks into the soil instead of running down the furrow and out the end of the field. This practice can conserve (capture) as much as 100 percent of rainfall runoff, and furrow dikes are used to prevent irrigation runoff under sprinkler systems. This maintains high irrigation uniformity and increases irrigation application efficiencies. Capturing and holding precipitation that would have drained from the fields replaces required irrigation water on irrigated fields; and furrow dikes have been demonstrated to be useful management tools on both irrigated and non-irrigated cropland. Use of furrow dikes can have water savings up to 12 percent gross quantity of water applied using sprinkler irrigation. According to TWDB estimates of acreage equipped with sprinkler irrigation systems, if Live Oak County irrigators install furrow dikes, the expected water savings could be up to 422 acft/yr, assuming 100 percent participation of irrigated lands with sprinkler systems. Furrow dikes require special tillage equipment and costs $5 to $30 per acre to install.

Low-pressure sprinklers (LESA) with 75 percent application efficiency improve irrigation application efficiency in comparison to conventional furrow irrigation by reducing water requirements per acre by 15 percent. Currently, the application efficiency of sprinkler systems in Live Oak County is estimated at 60 percent.[9] Low-pressure sprinklers spray water into the atmosphere above the crops as the sprinkler systems are moved across the fields. In Live Oak County, conversion to LESA systems would save about 0.34 acft/acre converted and result in a total savings of 704 acft/yr.

[9] TWDB, Op. Cit., August 2001.

LEPA systems involve a sprinkler system that has been modified to discharge water directly into furrows at low pressure, thus reducing evaporation losses. When used in conjunction with furrow dikes, which hold both precipitation and sprinkler applied water behind small mounds of earth within the furrows, LEPA systems can accomplish the irrigation objective with less water than is required for the furrow irrigation and pressurized sprinkler methods. If LEPA is used with furrow dike systems the expected water savings would be approximately 0.62 acft/acre (a total reduction in water use of approximately 37 percent). Use of LEPA and furrow dikes allows irrigation farmers to produce equivalent yields per acre at lower energy and labor costs of irrigation. It has been demonstrated that LEPA systems improve production and profitability of irrigation farming. The barriers to installation are high capital costs; with no assurance (at the present time) that the water saved would be available to the irrigation farmer who incurred the costs.

A comparison of irrigation rates for furrow dikes, LESA, and LEPA systems to irrigation rates before irrigation water conservation are shown in Table 4C.2-4.

Table 4C.2-4.
Region G Irrigated Acreages and Effects of Water Conservation on Irrigation Water Use and Application Rates
Live Oak County

	Acreage Irrigated with Sprinklers (2000)	*Irrigation Water Use (acft)*	*Irrigation Rate (acft/acre)*	*Estimated water savings (acft)*
Before Conservation				
	2,091	3,518	1.68	—
With Conservation				
Furrow Dikes[1]	2,091	3,096	1.48	422
LESA[2]	2,091	2,814	1.35	704
LEPA[3]	2,091	2,638	1.26	879

[1] 12% savings of water applied using sprinkler irrigation.
[2] Assumes application efficiency of 75 percent.
[3] Assumes application efficiency of 80 percent.

4C.2.3 Environmental Issues

The irrigation water conservation methods described above have been developed and tested through public and private sector research, and have been adopted and applied within the Region. Hundreds of LEPA systems have been installed, and are in operation today, and experience has shown that there are not any significant environmental issues associated with this water management strategy. For example, this method improves water use efficiency without making changes to wildlife habitat. This method of application, when coupled with furrow dikes reduces runoff of both applied irrigation water and rainfall. The results are reduced transport of sediment and any fertilizers or other chemicals that have been applied to the crops. Thus, the proposed conservation practices do not have potential adverse effects, and in fact have potentially beneficial environmental effects.

4C.2.4 Engineering and Costing

The CBRPG recommended irrigation water conservation strategy for irrigation users results in a potential water savings of 342 acft. This savings can be accomplished by using any one or a combination of three strategies: furrow diking, LESA or LEPA. Furrow dikes can save up to 422 acft at an average unit cost of $173 per acft (Table 4C.2-5). Installing LESA or LEPA systems would incur a greater capital cost, and therefore higher annual costs, however both achieve a substantially higher water savings potential and therefore have more economical unit cost ($/acft) when compared to furrow dikes. The maximum water conservation potential can be realized by using the LEPA system, as shown in Table 4C.2-4. The capital cost to install LEPA irrigation is approximately $400 per acre.[8] It is estimated that it would take a total investment of $836,400 to equip the estimated 2,091 irrigated acres currently served by sprinkler systems in Live Oak County. This investment, at an annual cost of $60,764 (30 years at 6 percent), would save an estimated 879 acft/yr at an average unit cost of $69 per acft of water saved.

Each of the three irrigation water conservation strategies described (furrow dikes, LESA, and LEPA) have the potential to increase water savings beyond the recommendations of the CBRWPG. For example, installing LEPA or LESA for acreage currently equipped with sprinkler systems could potentially eliminate all shortages. The largest shortage for Live Oak County is 627 acft in 2010. If LEPA was installed on approximately 1,490 acres of 2,091 acres currently irrigated with sprinkler systems, the shortage would be eliminated. In 2060, only 890 acres would need to be equipped with LEPA to eliminate the shortage.

Table 4C.2-5.
Potential Water Savings and Costs
(Total Project, Annual Average, and Unit Costs)
to Implement Irrigation Water Conservation BMPs
Live Oak County

	Maximum Desired Water Savings (acft)	Maximum Amount Saved (acft)	Total Project Cost (average)	Average Annual Cost	Average Cost per acft
Furrow Dikes	342	422	—	$36,593	$173
LESA (90% efficiency)	342	704	$836,400	$60,764	$86
LEPA (95% efficiency)	342	879	$836,400	$60,764	$69

It may not be economically feasible for some agricultural producers to pay for additional water supplies to meet projected irrigation water needs (shortages), even if such supplies were available. For example, in 2004, for irrigated cotton, the estimated income remaining after other production expenses had been paid was about $158 per acre. For cotton farming, although limited in the Coastal Bend Region, it may be practical to install furrow, LESA, or LEPA systems. For other crops, if the cost of water exceeds the estimated income, then it would not be practical to pay for additional water.

4C.2.5 Implementation Issues

The rate of adoption of efficient water-using practices is dependent upon public knowledge of the benefits, information about how to implement water conservation measures, and financing. There is widespread public support for irrigation water conservation and it is being implemented at a steady pace, and as water markets for conserved water expand, this practice will likely reach its maximum potential. A major barrier to implementation of water conservation is financing. The TWDB has irrigation conservation programs that may provide funding to irrigators to implement irrigation BMPs that increase water use efficiency. Future planning efforts should consider the use of detailed studies to fully determine the maximum potential benefits of additional irrigation conservation.

4C.2.6 Evaluation Summary

An evaluation summary of this water management option is provided in Table 4C.2-6.

Table 4C.2-6.
Evaluation Summary of Irrigation Water Conservation

Impact Category	***Comment(s)***
a. Water Supply	
1. Quantity	1. Firm yield: Variable according to BMP selected. Ranges up to 879 acft, depending on BMP and extent of participation.
2. Reliability	2. Highly reliable quantity.
3. Cost of Treated Water	3. Cost: Ranges from $69 to $173 per acft water saved based on BMP selected.
b. Environmental factors	
1. Instream flows	1. None or low impact.
2. Bay and Estuary Inflows	2. None or low impact..
3. Wildlife Habitat	3. No apparent negative impact.
4. Wetlands	4. None.
5. Threatened and Endangered Species	5. None.
6. Cultural Resources	6. No cultural resources affected.
7. Water Quality	7. None or low impact.
a. dissolved solids	
b. salinity	
c. bacteria	
d. chlorides	
e. bromide	
f. sulfate	
g. uranium	
h. arsenic	
i. other water quality constituents	
c. Impacts to State water resources	• No apparent negative impacts on water resources.
d. Threats to agriculture and natural resources in region	• None.
e. Recreational impacts	• None.
f. Equitable Comparison of Strategies	• Standard analyses and methods used.
g. Interbasin transfers	• None.
h. Third party social and economic impacts from voluntary redistribution of water	• None.
i. Efficient use of existing water supplies and regional opportunities	• Improvement over current conditions by reducing rate of decline of local groundwater levels.
j. Effect on navigation	• None.