Lavaca Regional Water Plan

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EXECUTIVE SUMMARY
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INTRODUCTION

Senate Bill 1 (SB 1), passed by the 75th Texas Legislature, established a new approach in state water planning that includes a local consensus of planning groups. The 1997 State legislature, through SB 1, determined that the Texas State Water Plan for the 2000-2050 planning period would be developed through a regional approach. To accomplish this task, the Texas Water Development Board (TWDB) divided the state into 16 regional water planning areas and appointed representational Regional Water Planning Groups (RWPG) to guide the development of each region's plan. The 16 regional plans will then be combined to form the next State Water Plan.

SCOPE OF WORK

Task 1

In order to develop the information required to prepare a comprehensive water supply plan, the project was divided into manageable tasks that, when complied, would be the Lavaca Regional Water Plan. The first task was to provide a physical, social, and economic description of the Lavaca Regional Water Planning Area (LRWPA). The geographical boundaries of the LRWPA, originally designated as Region P, are shown in *Figure 1-1*.

Task 2

The second task was to present the population and water demand data for the Region. The Task 2 interim report summarizes this data and discusses the procedures used to obtain revised population and demand projections. These revised projections were then submitted to TWDB in a formal request to be accepted for use in the State Water Plan. TWDB accepted the revised projections on July 14, 1999. The total demands for each county or portion of a county are shown in *Table A* below.

Table A – Total Demands in acre-feet/year

Counties	2000	2010	2020	2030	2040	2050
Jackson	112,506	113,228	113,240	113,502	113,765	114,100
Lavaca	21,665	21,651	21,599	21,713	21,844	22,054
Wharton (partial)	105,287	105,789	106,347	107,003	107,748	108,604
Lavaca Region Total	239,458	240,668	241,186	242,218	243,357	244,758

Note: 1 acre-foot = 43,560 cubic feet
1 acre-foot = 325,851 gallons
1 acre-foot/year = 893 gallons per minute
1 mgd = 1,120 acre-feet/year

Task 3

The third task was to identify the availability of groundwater and surface water resources within the region and the extent of coverage of these resources. Much of the description of the region's water sources are found in the interim Task 1 report. Additional analysis for groundwater supply and availability was completed by LBG-Guyton Associates for the interim Task 3 report. The region has only one major water provider, the Lavaca-Navidad River Authority (LNRA), that supplies only a small portion of its available water to uses within the region. Supplies of groundwater available to the region were based on the consensus of the Regional Water Planning Group, limited to the average sustainable yield of the aquifers.

Task 4

The fourth task was to compare available water supplies identified in Task 3 with the demands developed in Task 2. The interim report illustrated the difference between the supply available to major water providers and the demand on the major water providers. As a result of the supply and demand comparison developed in this plan, four water user groups (WUG) with shortages were identified. These WUGs include Jackson County Livestock, Jackson County Irrigation, Lavaca County Livestock and Wharton County Irrigation. Shortage amounts by decade for each WUG are shown in *Table B* below. Also shown in *Table B* are surplus supplies available, where applicable.

Table B – Surpluses and Shortages in acre-feet/year

County	WUG	Basin*	2000	2010	2020	2030	2040	2050
Jackson	Manufacturing	15	833	35	200	200	200	200
Jackson	Manufacturing	16	507	1,527	1,206	885	559	233
Jackson	Irrigation	15	-22,731	-22,734	-22,732	-22,743	-22,755	-22,782
Jackson	Irrigation	16	-1,504	-2,476	-2,334	-2,260	-2,182	-2,156
Jackson	Irrigation	17	2,354	2,383	2,383	2,378	2,375	2,366
Jackson	Livestock	17	-148	-148	-148	-148	-148	-148
Lavaca	Irrigation	16	262	262	263	263	262	263
Lavaca	Livestock	16	-1,620	-1,620	-1,620	-1,620	-1,620	-1,620
Wharton	Irrigation	15	-3,172	-3,248	-3,332	-3,422	-3,519	-3,625
Wharton	Irrigation	16	-18,668	-19,093	-19,568	-20,130	-20,773	-21,514
Region Surpluses			3,956	4,207	4,052	3,726	3,396	3,062
Region Shortages			-47,843	-49,319	-49,734	-50,323	-50,997	-51,845
Net Results			-43,887	-45,112	-45,682	-46,597	-47,601	-48,783

*Basin 15 is the Colorado-Lavaca Coastal Basin
*Basin 16 is the Lavaca River Basin
*Basin 17 is the Lavaca-Guadalupe Coastal Basin

Task 5

In the fifth task of the planning process, potential alternative supply strategies to address the shortages calculated in Task 4 were identified based on a list developed by the TWDB for consideration. A process for the evaluation of feasibility of strategy implementation was also developed. These alternative strategies were presented in a form so that all potential alternatives were identified and evaluated in accordance with local desires and needs. In addition to an interim report, public information materials were developed to inform the public of information collected. Three public meetings were held specifically to discuss and receive public input on water management strategies. Additionally, other public meetings and regular planning group meetings were held to discuss the progress of the work and solicit comment from the general public and from specific interest groups.

Additional stream modeling was performed to confirm the availability of flows for environmental needs, and all of the potential management strategies considered included consideration of the impacts of the strategy on environmental needs and on other water resources of the state.

The management strategy that was selected to meet the needs of the region was the use of additional quantities of groundwater during drought of record conditions by taking this amount of water from storage within the aquifer. This strategy provided the additional 47,843 acre-feet of water needed in 2000 to the approximately 52,716 acre-feet of water needed annually in 2050 during the drought of record conditions with no discernible environmental effect, since agricultural acreage could be maintained and return flows would not be reduced. This strategy required no additional capital expenditures, and the costs were spread equitably among all of the groundwater users in the region.

Task 6

The Lavaca Regional Water Planning Group designated the Palmetto Bend Phase II reservoir site on the Lavaca River as a Unique Reservoir Site. No designation of unique stream segments was made, as the Group desired to have additional information on the potential impacts of such designation. Ten proposed policy issues were developed and adopted by the LRWPG concerning regulatory and legislative issues. These recommendations include –

- Environmental Issues
- Ongoing RWPG Activities
- Conservation Policy
- Sustainable Yield of the Gulf Coast Aquifer
- Support of the Rule of Capture
- Junior Water Rights

- Single County Groundwater Management Areas
- Establishment of Fees for Groundwater Export
- Limits for Groundwater Conservation Districts
- Full-Scale Desalinization Process Support

Legislation concerning the formation of groundwater management or conservation districts in the past legislative session was followed and updates provided to the LRWPG throughout the session. The bills to form groundwater management districts for two of the three counties in the planning area were withdrawn after unfavorable amendments to the powers and duties were added during the session. A summary of the rules and financing methods of 35 groundwater management districts statewide was prepared for consideration by the LRWPG.

A separate strategy was developed as a means of reducing the threat to movement of groundwater out of the planning area to meet the growing needs of adjacent water short regions, such as Region L (South Central Texas Regional Water Planning Area). The plan includes the **desalination** of 100,000 acre-feet of Lavaca Bay water, the collection and treatment of 100,000 acre-feet of existing supply in the Colorado and Guadalupe River basins, transmission of the 200,000 acre-feet generated by the project to San Antonio, and improving the San Antonio Water System distribution system to accommodate this additional supply. In essence, this can be considered a new found water source. The project costs were estimated using the unit costs and cost methodology developed for estimating costs for all other Region L alternatives. The estimated costs for the blended water were similar to the costs for water obtained from new reservoir construction in Region L.

Task 7

Public participation has been encouraged through the efforts of the Planning Group members as they take information back to the Water User Groups they represent. This has been the most effective method of informing the public of the progress of the Plan. All of the members have been active in meeting with various interest groups and making presentations. Public meetings have been held at the inception of the project, to review the population and water demand data, to review the supply, surpluses and shortages and management strategies, and a public hearing will be held to receive comments on the draft plan. The municipal and manufacturing use in the region is less than 4 percent of the total, and the agricultural demands have been maintained at present levels or slightly higher throughout the planning period, so there has been little controversy. The discussion of groundwater management districts dominated most of the public meetings on the plan, and no substantive comments were received in opposition to any of the plan alternatives. Monthly meetings of the Planning Group have been well attended by the members and non-voting members, but participation by the general public has been limited.

TWDB prepared a guidance document, entitled "*Exhibit B Data and Format Guidelines for SB1 Regional Water Plan—Technical Reports*," to facilitate the compilation of the 16 regional water plans. This document presents tabular formats with specific data fields required for submittal by the RWPG's to the TWDB. These formats will provide consistency among the data presented by all the RWPGs, and will eventually aid in the inclusion of this data in the 2001 State Water Plan. All of these TWDB tables, and their methodologies, can be found at the conclusion of the text. Additionally, all regional water planning information received by TWDB is posted to a website sponsored by the Board. The address is www.twdb.state.tx.us. Another source of information is http://lnra.org. This website is sponsored by LNRA.

Task I. Description of the Lavaca Regional Water Planning Area

Foreword

This document is a compilation of information drawn from existing reports, periodicals, publications and web pages of organizations listed. References that were frequently used include the Texas Almanac, 1998-99, and 1982-83 editions, the web pages of the Lavaca-Navidad River Authority, the Golden Crescent Regional Planning Commission, and the Handbook of Texas On-Line. Complete references to these services are contained in *Task 1 – Appendix A – References*.

I.1. Background-Regional Water Planning in Texas

The increased demand for water, along with several serious droughts, has increased awareness of water supply concerns in Texas. Since 1930, the State's population has tripled, and water demand has increased by more than five times the 1930 usage. Presently, approximately 80 percent of the State's water supplies are developed, and much of that 80 percent has already been committed for use.

Water resource planning and management in Texas is a shared responsibility of local utilities, regional special purpose districts, and state agencies. Local and regional water development agencies have primary responsibility for financing and building new facilities. The State's role has been limited to providing overall guidance, insight into regulatory issues, and financial assistance.

Senate Bill 1 (SB 1), passed by the 75th Texas Legislature, established a new approach in state water planning that includes a local consensus of planning groups. The 1997 State legislature, through SB 1, determined that the Texas State Water Plan for the 2000-2050 timeframe would be developed through a regional water planning approach. To accomplish this task, the Texas Water Development Board (TWDB) divided the state into 16 regional water planning areas and appointed representational Regional Water Planning Groups (RWPG) to guide the development of each region's plan. The 16 regional plans will be combined to form the next State Water Plan.

Scope of Work

The scope of work for the Regional Water Planning project includes the development of the regional water supply plan and performance of the work activities required to develop the plan. Work activities include the preparation of a detailed characterization of the region; the identification and assessment of current and future water supply needs; evaluation of available surface and groundwater resources; identification and evaluation of alternatives for addressing water supply needs; and evaluation of key issues affecting water resources management for the Lavaca Regional Water Planning Group (LRWPG).

The project also involves assisting the LRWPG in the design and implementation of a public involvement process that includes public meetings, the review of public comments, and the development of educational materials on regional water planning issues to be presented to technical and non-technical audiences in the Lavaca Region.

The purpose of this task is to provide a physical, social, and economic description of the Lavaca Regional Water Planning Area (LRWPA). LRWPA, originally designated as Region P of the 16 regions in the State Water Plan, is shown in *Figure 1-1*.

History of Water Planning in the Lavaca Region

The Lavaca-Navidad River Authority (LNRA) and TWDB have enjoyed a long, cooperative water planning history in this region. LNRA was created in 1959 by article 16, section 59 of the Texas Constitution, codified in *Vernon's Annotated Civil Statutes* "for the purpose of controlling, storing, preserving, and distributing the storm and flood waters, and the waters of the rivers and streams of Jackson County, and their tributaries, for all useful and beneficial purposes, but more specifically for the purpose of sponsorship of the Palmetto Bend Dam and Reservoir Project" (LNRA webpage, 1998).

In 1968, the Palmetto Bend Reclamation Project was authorized by the federal government, and the state sponsors named the reservoir Lake Texana. LNRA and TWBD, state sponsors and partners for the Lake Texana/Palmetto Bend project, guaranteed repayment to the federal government of the costs of constructing the project. The Lake Texana/Palmetto Bend project was declared substantially complete by the Bureau of Reclamation in 1985, and has a firm yield of 79,000 acre-feet. The reservoir was built to provide a dependable water supply to meet water requirements inherent with industrial and urban growth for the Jackson-Calhoun County area (U.S. Department of the Interior Bureau of Reclamation, 1974). "The TWDB funded cooperative studies that made planning a reality through implementation of the Trans-Texas water planning process," and further funded the project through the TWDB Storage Acquisition Program to build the project to its potential (presentation by Jack Nelson, General Manager of LNRA). The LNRA and the TWDB jointly hold the water rights permits for the 74,500 acre-feet of available yield that are currently provided to municipal and industrial water users. The remaining 4,500 acre-feet are reserved for required releases for the bays and estuaries.

Approximately 42,000 acre-feet of Lake Texana's yield is contracted for municipal use to Corpus Christi's 10-county service area and the City of Point Comfort. Approximately 32,500 acre-feet is contracted for industrial use to Formosa Plastic Corp., Inteplast Corp., Central Power and Light Co., and Calhoun County Navigational District. Prior to the water being contracted, "the taxpayers of Jackson County contributed $9 million for operating and maintenance expenses" (Nelson, 1999).

The LNRA operates and maintains the entire Lake Texana/Palmetto Bend project, both the federal and state portions. In addition, LNRA has financed, constructed, and currently owns $32 million in facilities, including the East Delivery System, consisting of 36 and 54-inch pipelines that service the Point Comfort industrial area; and the West Delivery intake System pumping plant that delivers water through 102 miles of 64-inch pipeline to the Corpus Christi service area.

"LNRA has developed management strategies that provide guidance for the development, operation, and maintenance of project land and water resources," (Nelson, 1999). These strategies include a Water Quality Management Plan for non-point source pollution, developed in cooperation with Texas State Soil and Water Conservation Board; a Land and Water Management Plan, on file with Texas Natural Resource Conservation Commission (TNRCC), that was developed to guide long-term objectives; and a Recreation Master Plan to provide guidance for public use areas. In addition, a Bay and Estuary Inflow Requirements Study was prepared for Matagorda Bay, in cooperation with Texas Parks and Wildlife Department (TPWD), TNRCC, TWDB, and the Lower Colorado River Authority (LCRA), that will impact future water availability.

In 1992, an agreement was made between the Lone Star Chapter of the Sierra Club, TPWD, TNRCC, TWDB, and LNRA to work cooperatively toward achieving and maintaining the environmental health of the downstream bays and estuaries of the Lavaca River Basin. Currently, releases are made every week based on flows to the reservoir and the permit requirements of TNRCC. Lake Texana was designed to capture flood flows.

Currently, the LNRA is working toward a buyout of the federal portion of the project to reduce redundancy between federal and state requirements. Title Transfer bills have been introduced by U.S. Senator Kay Bailey Hutchison and U.S. Congressman Ron Paul to provide economic benefits for both the federal and the state interests. At the same time, the bills are designed to protect "the project's purposes, which include M&I Water Supply and the cultural and natural resources of the project," (Nelson, 1999). The Federal Buyout and Title Transfer required that an environmental assessment be performed for the planning area. The findings of the environmental assessment included only three issues: "to maintain the current project purposes, to develop a Memorandum of Understanding with the Texas Historical Commission (THC) to protect cultural resources, and to develop a Memorandum of Understanding with TPWD to protect natural resources," (Nelson, 1999).

I.2. Description of the Lavaca Regional Water Planning Area

Physical Description of Planning Region

The LRWPA is located along the southeastern Texas coast, and consists of all of Lavaca and Jackson counties, as well as Precinct 3 of Wharton County and the entire city of El Campo, as shown in *Figure 1-1*. The eastern portion of Wharton County is included in the Region K planning area.

The LRWPA is bounded by Victoria and DeWitt counties to the southeast; Gonzales and Fayette counties to the northwest; Colorado County to the northeast; Matagorda County and the remainder of Wharton County to the east; and Calhoun County to the south. LRWPA is located in the Lavaca, Lavaca-Guadalupe Coastal, and the Colorado-Lavaca Coastal River Basins, as shown in *Figure 2-1*.

LRWPA is located in the Gulf Coastal Plains region of Texas and contains both Gulf Coast Prairies and Marshes and Blackland Prairies. The Gulf Coast Prairies and Marshes encompass the majority of the region. They contain marsh and saltwater grasses in tidal areas, and bluestems and tall grasses inland. Hardwoods grow in limited amounts in the bottomlands. The upland soils consist of clays, clay loams, sandy loams, and black soils. The natural grasses make the region ideal for cattle grazing, and the productive soils and typically flat topography support the farming of rice, sorghums, corn, cotton, wheat, and hay.

The Blackland Prairies are mainly shrink-swell clays that form cracks in dry weather. A large amount of timber grows along the streams, and even though it was originally grasslands, most of the area has been cultivated with productive grasses. The land is used as croplands and grasslands. The main crops supported by the Blackland Prairies are cotton, grain, sorghums, corn, wheat, oats, and hay. The grasslands are used as pastures.

The counties have hot and humid summers which are occasionally relieved by thunderstorms. The average growing seasons are 290 days in Jackson County, 280 days in Lavaca County, and 266 days in Wharton County. The mean rainfall is approximately 40.8 inches annually for the region. Average temperatures for the region vary, from lows of 41°F in January to highs of 94°F in July. Jackson County encompasses 829.5 square miles; Lavaca County encompasses 970 square miles; and Wharton County encompasses 1,090.2 square miles, of which approximately half is in the LRWPA.

Regulators and Political Subdivisions

The primary governmental entities in the region are municipal and county governments. Jackson and Lavaca counties are also included on the Golden Crescent Regional Planning Commission, which was established in 1968. This commission also includes the counties of Calhoun, DeWitt, Goliad, Gonzales, and Victoria. Member cities from Jackson and Lavaca counties include Edna, Ganado, Hallettsville, Moulton, Shiner, and Yoakum. The Jackson County Soil and Water Conservation District, Jackson County Hospital District, Lavaca County Soil and Water Conservation District, and the LNRA are all the special districts created under the Texas Law. The commission assists in developing opportunities for intergovernmental coordination to increase economic opportunities for the region (Golden Crescent Regional Planning Commission, 1999). Wharton County is included in the Houston-Galveston Area Council of Governments (H-GAC). H-GAC was established in 1966, and includes 12 other counties located to the east and north of Wharton County. H-GAC is focused on economic development for the region, as well as on environmental issues such as evaporation and air quality, solid waste, geographic information systems and demographic information, and social and nutrition services to senior citizens. El Campo is also a member of the H-GAC.

In addition to these entities, there are several regulatory authorities that influence long- range water planning. The territory of the South Texas Water Master has been recently expanded to include the Lavaca Basin, in order to monitor regional water uses. The Water Master plays a role in allocation of water supplies by user in the event of drought conditions. The field investigations also play a role in locating illegal diversions of water. With regard to the state, TWDB, TNRCC, and TPWD are responsible for gathering information on water supply and quality. LNRA manages the surface water supplies in the LRWPA. There are also soil and water conservation districts in the region, as noted previously in connection with H-GAC.

Social Description of Lavaca Regional Planning Area

The LRWPA is typically a rural area with small urban centers. The ethnic breakdown is approximately 69 percent white, 15 percent Hispanic, 9.4 percent black, 0.15 percent Asian, 0.13 percent American Indian, and 6.32 percent other. The LRWPA had an estimated 1998 population of 49,689, based on information from the Texas State Data Center. Cities in the LRWPA include Hallettsville, Moulton, Shiner, and Yoakum in Lavaca County (total county population 19,985 in 1997); Edna and Ganado in Jackson County (total county population 14,500 in 1997); and El Campo, the largest city in the region (total city population 10,798 in 1997), in Wharton County. The 1995 median household income was approximately $28,986 for Jackson County, $25,649 for Lavaca County, and $29,075 for all of Wharton County. The Texas 1995 median household income was approximately $31,488. Jackson County has three school districts with approximately 3,400 students total; Lavaca County has six with approximately 2,200 students; and Wharton County has two in the region, with approximately 4,200 students. Some of the social activities enjoyed in Jackson County are the county fair, a rodeo in October, and a bicycle event in November. In Lavaca County, there are numerous church-sponsored events, a fiddlers' frolic, a domino tournament, the Kolache Fest in September, and the Land of Leather celebration in February, and the City of Shiner hosts Bocktoberfest every year. The section of Wharton County in the Lavaca Region enjoys the Texas Polka Music Awards in April (*Texas Almanac*, 1998-1999; U.S. Census Bureau, *Model-Based Income and Poverty Estimates for Texas in 1995*).

Economic Description of Lavaca Regional Planning Area

The regional planning area is described below on a county-by-county basis.

The economy of Jackson County includes petroleum production and operation, metal fabrication and tooling, sheet-metal works, plastics manufacturing, agribusinesses, and lake recreation. The major agricultural interests in Jackson County include corn, cotton, rice, grain sorghums, soybeans, and beef cattle. These agricultural products had a market value of approximately $43.4 million in 1998.

The economy of Lavaca County includes varied manufacturing, leather goods center, agribusinesses, oil and gas production, and tourism. The major agricultural interests in Lavaca County include livestock (especially beef cattle), eggs, poultry, hay, rice, corn, and sorghum, with a market value of approximately $38.1 million in 1998.

The economy of Wharton County includes oil, sulfur, other minerals, agribusiness, hunting leases, and varied manufacturing. The major agricultural interests in Wharton County include rice, sorghum, cotton, corn, eggs, turfgrass, beef cattle, hay, and soybeans, with a market value of approximately $113.4 million for the entire county in 1998 (the county is only partially contained in the Lavaca Region).

The distribution of personal income generated from each of the employment sectors for the period 1993-1997 is as follows.

Table I.2. Magnitude of Personal Income in the Lavaca Region for 1993-1997

Income Sources	Jackson County % of Total County Earnings	Lavaca County % of Total County Earnings	Wharton County % of Total County Earnings
Farm Earnings	9.29%	0.91%	15.41%
Ag. Service, Forestry, Fishing, etc.	1.91%	0.76%	2.61%
Mining-Metal, Coal, Oil and Gas, Minerals	6.18%	1.51%	4.78%
Construction	7.20%	5.43%	3.84%
Manufacturing	28.90%	27.05%	11.28%
Transportation and Public Utilities	8.21%	4.79%	5.22%
Wholesale Trade	3.38%	6.32%	5.07%
Retail Trade	8.03%	13.29%	10.05%
Finance, Insurance, and Real Estate	2.32%	3.63%	3.74%
Services (Health, Business, Recreation, etc.)	9.14%	21.24%	21.63%
Government and Government Enterprises	15.44%	15.07%	16.37%

Source: Texas Regional Economic Information webpages

The magnitudes of personal incomes for each county were based on an average of the data from 1993-1997. For Jackson County, the farm earnings dropped off significantly, from about 16 percent in 1995 to 4 percent in 1996, continuing to drop to about 3 percent in 1997. For Lavaca County from 1993 to 1994, the farm earnings were cut in half, and then in 1995 and 1996, the farm earnings were approximately -1 percent and -2 percent. For Wharton County, the farm earnings dropped about 4 percent between 1995 and 1996. The decrease in farm earnings can be associated with the droughts during the 1993 to 1997 span. Without the droughts, earnings are generally higher.

Unemployment in 1998 was approximately 3.6 percent in Jackson County, 2.9 percent in Lavaca County, and 6.3 percent in Wharton County (*Texas Almanac*, 1998-1999).

Table I.3 compares the market value of specific crops in LRWPA for 1992 and 1997.

Table I.3. Market Value of Agricultural Products Sold in Jackson, Lavaca, and Wharton Counties in 1992 and 1997 (in $1,000)

County	Jackson		Lavaca		Wharton	
Year	1992	1997	1992	1997	1992	1997
Corn for Grain	$7,088	$8,055	$547	$804	$8,943	$5,862
Soybeans	N/A	N/A	N/A	$66	$1,131	$3,432
Sorghum for Grain	$4,449	$7,050	$146	$118	$9,976	$12,333
Other Grains (Rice)	$13,278	$10,736	$1,953	$1,327	$31,796	$37,970
Cotton and Cottonseed	$7,886	$9,604	$52	N/A	$13,550	$18,179

N/A- Not Available

Source: United States Department of Agriculture and the National Agricultural Statistics Service, *1997 Census of Agriculture for Texas-County Data*

Census sales information for manufacturing in the LRWPA was inconsistent or incomplete, since information was withheld when only one entity exists in a county, to avoid disclosing data tied to a specific company.

The value of properties within the Lavaca Region has increased substantially over the last fifteen years, as shown in *Table I.1*.

Table I.1. Property Value by County

County	1982-1983 Property Value	1998-1999 Property Value
Jackson	$190,844,420	$979,338,841
Lavaca	$71,360,673	$1,178,160,082
Wharton	$284,138,090	$1,824,622,440

Source: *Texas Almanac*, 1998-1999 and 1982-1983

Recreational and Environmental Information

Lake Texana is the main recreational area in the LRWPA. There are 10 public boat ramps, the 250-acre Mustang Wilderness Campground for primitive camping, a marina, picnic sites, Brackenridge Plantation Park and Campground, Lake Texana State Park, and an international sailing course. Brackenridge Plantation Park and Lake Texana State Park are located across Highway 111 from each other, on the western side of the Highway 111 bridge, across the lake. Some of the recreational activities enjoyed at these parks are camping, boating, fishing, and picnicking. The area has good nature-viewing opportunities, including birding, and sometimes alligators can be found in park coves. Hunting and fishing are very popular recreational activities throughout the entire Lavaca region. Deer and waterfowl hunting are the most common.

The Gulf Coastal Plains support a wide variety of animal species. Identified threatened and endangered species include:

Threatened

Peregrine Falcon, Arctic	*Falco peregrinus tundrius*
Reddish Egret	*Egretta rufescens*
White-faced Ibis	*Plegadis chihi*
White-tailed Hawk	*Buteo albicaudatus*
Wood Stork	*Mycteria americana*
Texas Horned Lizard	*Phrynosoma cornutum*
Indigo Snake	*Drymarchon corais erebennus*
Reticulated Collared Lizard	*Crotaphytus reticulatus*
Sheep Frog	*Hypopachus variolosus*
Plains Spotted Skunk	*Spilogale putorius interrupta*

Endangered

Bald Eagle	*Haliaeetus leucocephalus*
Brown Pelican	*Pelecanus occidentalis*
Peregrine Falcon, American	*Falco peregrinus anatum*
Whooping Crane	*Grus americana*
Red Wolf	*Canis rufus*
Black-spotted newt	*Notophthalmus meridionalis*
Rio Grande Lesser Siren	S*iren intermedia texana*

LNRA operates Lake Texana to provide freshwater inflows for the bay and estuary, in order to reduce high salinity events in Lavaca Bay and to protect coastal habitats.

Agricultural and Natural Resources

The LRWPG has numerous agricultural and natural resources. The natural resources within the Lavaca region include oil and natural gas, minerals, water resources, and numerous animal species. The mining industry can be divided into metal mining, coal mining, oil and gas extraction, and nonmetallic metals (except fuel). In Jackson, Lavaca, and Wharton counties, the majority of earnings in the mining industry came from oil and gas extraction. The water resources are addressed in the following sections, and the different animal species were discussed in the environmental section above.

The Lavaca region is of major significance to the State's rice production, and Texas is one of the largest rice producers in the nation: "The United States produces only a small portion of the world's total rice, but it is one of the leading exporters. American rice is popular abroad and is exported to more than 100 foreign countries," (*Texas Almanac*, 1998-1999).

"Rice, which is grown in about 20 counties on the Coastal Prairie of Texas, ranked third in value among Texas crops for a number of years. Texas farmers grow long- and medium-grain rice only. The Texas rice industry, which has grown from 110 acres in 1850 to a high of 642,000 acres in 1954, has been marked by significant yield increases and improved varieties. Record production occurred in 1981, with 27,239,000 hundredweights harvested. The highest yield was 6,250 pounds per acre in 1986," (*Texas Almanac*, 1998-1999). In 1995, Jackson County had 27,560 acres of rice planted, amounting to 9 percent of the State's total (see *Task 1 – Appendix B Table B.1* for more detail). Wharton County had 61,118 acres of rice planted, amounting to 19 percent of the State's total; however, only a part of Wharton County is in the Lavaca Regional Water Planning Area. Lavaca County had only 3, 572 acres of rice planted, accounting for approximately 1 percent of the State's total rice acres.

Table B.1, in *Task 1 – Appendix B*, shows the rice acreage for the past eight years for the rice-producing counties in Texas. *Tables B.2, B.3*, and *B.4* show the rice, cotton, corn, milo, and soybean acreages for Jackson, Lavaca, and Wharton counties, respectively. The acreage for Wharton County is not split for the Texas Agricultural Statistics Service (TASS) reports into the Lavaca region area only. *Table B.5* shows the Farm Services Agency (FSA) acreages, and includes only those acreages that are located in the Lavaca region portion of Wharton County. See *Task 1 – Appendix B, Tables B-6, B-7*, and *B-8* for agricultural per-acre information for the LRWPA. This information was developed through a consensus process that included discussion with the Texas Farm Bureau, Farm Services Agency, Soil and Water Conservation Districts in the counties, Texas A&M Agricultural Extension agents, and representatives of related agricultural or warehousing facilities. Mr. L.G. Raun, Jr., a member of the LRWPG, led this effort and made a significant contribution of time in gathering, reviewing, and presenting this data.

I.3. Lavaca Regional Water Supply Sources

The available water supply within the region includes both groundwater and surface water. Groundwater is provided from the Carrizo-Wilcox and Gulf Coast aquifers. Primary surface water sources are the Navidad and Lavaca rivers and Lake Texana.

Groundwater Sources

Groundwater supplies most of the water currently used in the region. Of the 230,972 acre-feet of total 1996 water demand, almost 90 percent, or 206,740 acre-feet, was supplied by groundwater. This trend is expected to continue due to the current relatively low demand for water in the region and anticipated low growth in demand.

There are two major aquifers in the Lavaca Region. These are the Carrizo-Wilcox and Gulf Coast aquifers. The Gulf Coast Aquifer is the predominant supply source, serving more than 90 percent of the total supply. The Carrizo-Wilcox Aquifer is only available in the northwestern corner of Lavaca County; it is not found in Jackson or Wharton counties.

Two components of the Gulf Coast Aquifer, the Chicot and Evangeline aquifers, provide large amounts of fresh groundwater to Wharton County. Within the Lavaca Region in Wharton County, the aquifers contain fresh water to depths that range from about 1,400 to 1,700 feet, based on data contained in Texas Department of Water Resources Report 270, *Groundwater Resources of Colorado, Lavaca, and Wharton Counties, Texas*. "The aquifers are composed of interbedded layers of sand, silt, and clay, with, in some locations, minor amounts of small gravel. The aquifers have been providing water to Wharton County for over 100 years, with the principal water use being irrigation of agriculture crops," (John Siefert, 1999).

Water-level monitoring data was collected and analyzed by LBG-Guyton. "The pumpage, static water-level, and groundwater chemistry data show that the aquifers of the Lavaca region within Wharton County have provided in the past, and can continue to provide, large quantities of good quality water for varied uses within the region," (John Siefert, 1999). The total groundwater pumpage has averaged 81,600 acre-feet per year over the past 15 years, with increases in 1968 through 1980. The pumpage over the last 15 years has not caused additional static-water level decline, and some wells show a slight recovery. See *Figures C-1, C-2,* and *C-3,* attached in *Task 1 – Appendix C,* for more detail.

As in Wharton County large amounts of groundwater are available in Jackson County. The TWDB in the1997 Texas State Water Plan estimates the groundwater availability of Jackson County at 87,876 acre-feet per year. Average groundwater pumpage for Jackson County from 1984 to 1997 was 75,000 acre-feet while static-water levels in heavily irrigated areas of northeast Jackson County have risen 5 to 10 feet in the 1990's as shown on Figure C-4 of Appendix C. Based on estimates from the TWDB in the 1997 Texas State Water Plan availability of groundwater in Lavaca County is about 38,123 acre-feet per year. The water in Jackson and Lavaca counties is available from the Gulf Coast aquifer system.

Surface Water Sources

The Lavaca and the Navidad rivers are located within the LRWPA. The main river basins in the area are the Lavaca, the Colorado-Lavaca, and the Lavaca-Gualdalupe. These basins include the Arenosa, Big Rocky, Brushy, Chicolete, Clarks, Coxs, East Carancahua, Huisache, Mixon, Pinoak, Rocky, Sandy, West Carancahua, and West Mustang creeks. Approximately 90 percent of the LRWPA is within the Lavaca River Basin, which has a total drainage area of 2,309 square miles. *Figure 2-1* shows the location of the Lavaca and adjacent basins. There are no major springs in the LRWPA.

In 1996, 24,232 acre-feet of the total demand in the Lavaca region was supplied by surface water. The only reservoir in the Lavaca Regional Planning Area is Lake Texana. The available firm yield of Lake Texana is 74,500 acre-feet. The Lavaca and Navidad rivers also supply some run-of-river water to the region, primarily for irrigation purposes. Unfortunately, a current completed water availability model does not exist; therefore, the firm yields of these rivers will be determined as a part of the planning process.

Major Water Providers

A major water provider is an entity that delivers and sells a significant amount of raw or treated water for municipal and/or manufacturing use on a wholesale and/or retail basis (TWDB, March 1999). The Lavaca Region has one major water provider, the LNRA.

The LNRA operates and maintains Lake Texana. Water transfers outside the Lavaca Region account for most of the water sales from Lake Texana. Of the 74,500 acre-feet of available firm yield, 72,668 acre-feet are dedicated for water uses outside the region. 178 acre-feet annually are contracted to the City of Point Comfort, in Calhoun County, 41,840 acre-feet annually are contracted to the City of Corpus Christi and surrounding areas, 30,000 acre-feet annually are contracted to Formosa Plastics in Calhoun County, 594 acre-feet annually are contracted to the Calhoun County Navigation Disctrict, and 56 acre-feet annually are contracted to Central Power and Light in Calhoun County. 10,400 acre-feet of the annual contract amount to the City of Corpus Christi can be recalled for use in Jackson County when needed.

I.4. Current Water Use

The total water used in the region in 1996 was 230,972 acre-feet. About 222,501 acre-feet of that total were used for agricultural purposes. Water transfers outside of the region were about 72,668 acre-feet, or 97.5 percent of the firm yield of Lake Texana.

Agricultural Water Use

Agricultural water use accounted for approximately 96 percent of the total usage in the region in 1996. The LRWPA has a large irrigation water demand associated with the region's agriculture. Of the total water usage in 1996, approximately 219,738 acre-feet, or 95.1 percent, was for irrigation (see *Table I.13*), of which rice irrigation accounts for approximately 86 percent. The most prominent crops cultivated are rice, cotton, and corn. Various livestock are also raised. *Figure 3-1* shows the irrigated fields in the Lavaca region, based on information received from the Texas Natural Resources Information System (TNRIS).

Rice production involves both a spring planting and a potential second, or ratoon, crop, grown from the stubble after the first harvest. The amount of ratoon cropping varies with the strength of the initial stand, the time of year that the first planting is completed, the current and expected price of rice, and other factors. In addition, the rice industry status is such that rice can only be planted once in every three years for each field because of disease and yield problems. As a result of these factors, per-acre water usage for rice can be misleading, since the ratoon crop acreage fluctuates significantly. The LRWPA's irrigation water use for 1997 was 2.16 acre-feet per acre for Jackson County, 2.92 acre-feet per acre for Lavaca County, and 3.88 acre-feet per acre for all of Wharton County. These numbers compare to 2.42, 2.70, and 3.36 acre-feet per acre for Jackson, Lavaca, and Wharton Counties, respectively, in 1987 (TWDB, 1999, *Region P Irrigation*).

Industrial Water Use

In 1996, industrial water usage in the LRWPA accounted for 1,152 acre-feet, or 0.5 percent, of the total usage, of which 538 acre-feet were surface water. *Figure 4-1* shows the industrial users in the region.

LNRA also sells water from Lake Texana to industrial users outside the region. Alcoa pumps groundwater from the Lavaca region and exports it to serve water needs outside the region. *Table I.5* shows the industrial water transferred outside the region.

Table I.5. Industrial Users Outside of Region

Industry	1996 Water Usage (acre-feet)
Formosa Plastics Corp USA	17,379.70
Alcoa	1,448.61

Sources: LNRA and John Mayfield of Alcoa

Those industries that used more than 10 acre-feet in 1996 are listed in *Table I.6* by county.

Table I.6. Industrial Users of More Than 10 acre-feet in the Region

County	Industry	1996 Water Usage (acre-feet)	Source of Water
Jackson	IntePlast Corp.	537.96 45.61	Surface Water Groundwater
	Koch Gateway Pipeline	15.34	Groundwater
Lavaca	Better Beverages, Inc.	96.65	Groundwater
	Eddy Packing Co., Inc.	17.97	Groundwater
	Kaspar Electroplating Corp.	55.10	Groundwater
	PanEnergy Field Services, Inc.	40.19	Groundwater
	Spoetzl Brewery, Inc.	134.12	Groundwater
Wharton	Bon L. Campo, LP	116.13	Groundwater
	A.C. Humko Rice Specialties	67.25	Groundwater

Source: TWDB, 1999

(Survey of Ground and Surface Water Use: Industrial Water Use Reports)

Municipal Water Use

Municipal water usage in 1996 was largely concentrated in seven cities within the region. The service areas for these cities are generally coincident with the city limits. *Tables I.7*, *I.8*, and *I.9* show the 1996 municipal water use for each county, by city or county-other. *Figure 5-1* shows the 1996 per capita water use for the seven cities. Approximately 57 percent of the 1996 municipal water usage in Jackson County was in the cities of Edna and Ganado. In Lavaca County, approximately 58 percent of the municipal water use was in the cities of Hallettsville, Moulton, Shiner, and Yoakum. In the portion of Wharton County within the region, approximately 83 percent of the total municipal use was in the City of El Campo. The remaining municipal usage in the three counties represents use by the county-other category. The county-other category represents smaller communities (with a population of less than 500 people), parks, campgrounds, and municipal utility districts.

Table I.7. Jackson County Municipal Water Use in 1996 by City

City Usage	Water Use (acre-feet)	Water Use (%)
Edna	780	43.9
Ganado	236	13.3
County-Other	762	42.8
Total	1,778	100.0

Source: TWDB, 1999 (Historical Summary of City Water Use)

Table I.8. Lavaca County Municipal Water Use in 1996 by City

City Usage	Water Use (acre-feet)	Water Use (%)
Hallettsville	895	26.8
Moulton	178	5.3
Shiner	627	18.8
Yoakum	1,082	32.5
County-Other	552	16.6
Total	3,334	100.0

Source: TWDB, 1999 (Historical Summary of City Water Use)

Table I.9. Wharton County Municipal Water Use in 1996 by City

City Usage	Water Use (acre-feet)	Water Use (%)
El Campo	1,834	83.1
County-Other	373	16.9
Total	2,207	100.0

Source: TWDB, 1999 (Historical Summary of City Water Use)

Major Water Demand Centers

As previously stated, the largest water use category is agricultural, accounting for about 96 percent of the total usage in the region. Since this use is spread over a three-county area, each county is considered a demand center, as shown in *Table I.10*.

Table I.10. Agricultural Water Use For Irrigation and Livestock

County	1996 Water Use (acre-feet)	Percent of Total Ag Use in Region
Jackson	87,036	39.1
Lavaca	21,443	9.6
Wharton	114,022	51.3
Total	222,501	100.0

Source: TWDB, 1999 (1996 Water Use Data)

The remaining water demand centers are all outside the Lavaca region. These water transfers, all from Lake Texana, are significant to planning for the Lavaca region (see *Table I.6*). Lake Texana has a TNRCC- permitted firm yield of 79,000 acre-feet per year. The permit certificate requires a release to the bay and estuary system, which limits the firm yield to 74,500 acre-feet per year. A summary of TNRCC-permitted water diversions as of December 1996 is provided in *Table I.11* below. These are all long-term firm yield contracts with LNRA.

In addition to the firm yield permits noted above, LNRA also has an additional permit to divert 4,500 acre-feet of water annually, when such water is available in the system. This water is known as “interruptible water” or water that is not available under drought of record conditions.

Table I.11. Permitted Water Diversions from Lake Texana

No.	1996 Water Contracts (acre-feet/year)	Percent of Total
1)	Formosa Plastics.......... Calhoun County....................... 30,000 ac-ft/yr.	40.2
2)	Inteplast....................... Jackson County......................... 1,832 ac-ft/yr.	2.5
3)	Point Comfort.............. Calhoun County............................ 178 ac-ft/yr.	0.2
4)	Corpus Christi.............. 8 County Service Area .... 41,840 ac-ft/yr.	56.2
5)	Calhoun County Navigation District...... Calhoun County .. 594 ac-ft/yr.	0.8
6)	Central Power and Light........ Calhoun County..................... 56 ac-ft/yr.	0.1
	Total.. 74,500 ac-ft/yr.	100.0

Source: LNRA webpage

Of the Lake Texana contract holders, only Inteplast is located in the Lavaca region. Inteplast’s 1996 usage represents 2.5 percent of Lake Texana’s firm yield.

Summary of Water Use Characteristics for the LRWPA

According to the TWDB data, water consumed in 1996 within the LRWPA is presented by county in *Table I.12*.

Table I.12. LRWPA 1996 Water Use by County

County	Water Use (acre-feet)	Water Use (%)
Jackson	89,513	38.8
Lavaca	25,161	10.9
Wharton	116,298	50.3
Total	230,972	100.0

Source: TWDB, 1999 (1996 Water Use Data)

Table I.13 shows the total 1996 water use for Lavaca Region, by category of use.

Table I.13. LRWPA 1996 Water Usage by Use Category

Usage Category	Water Use (acre-feet)	Water Use (%)
Municipal	7,319	3.2
Manufacturing	965	0.4
Power	0	0.0
Mining	187	0.1
Irrigation	219,738	95.1
Livestock	2,763	1.2
Total	230,972	100.0

Source: TWDB, 1999 (1996 Water Use Data)

Table I.14 shows the water use in 1996, by county and usage category, for the three counties. *Table I.14* also summarizes the total water transfers outside the Lavaca region for 1996. The industrial use category represents the sum of water usage for manufacturing, steam-electric power, and mining. The water use characteristics for Jackson and Wharton counties are similar to the regional trends. The agricultural usage in 1996 represented 97.23 percent of the total water demand for Jackson County, and 98.04 percent for Wharton County. For Lavaca County, the agricultural usage represented 85.22 percent of the total water demand.

Table I.14. Water Use Summary for 1996, TWDB Data

Category	County	1996 Water Usage acre-feet	% of Totals	
			Lavaca Regional Only	Total Including Transfers
Agricultural Use	Jackson	87,036		
	Lavaca	21,443		
	Wharton	114,022		
	Total	222,501	96.3	
Municipal Use	Jackson	1,778		
	Lavaca	3,334		
	Wharton	2,207		
	Total	7,319	3.2	
Industrial Use	Jackson	699		
	Lavaca	384		
	Wharton	69		
	Total	1,152	0.5	
Water Transfers Outside Lavaca Region	Jackson	72,668		23.9
Total Water Use	Lavaca Region	230,972	100.0	76.1
	Total Usage	303,640	-	100.0

Source: TWDB, 1999 (1996 Water Use Data)

I.5. Water Planning Information in Lavaca Regional Planning Area

A table of state, local, and regional planning information reports and data compiled for the LRWPA study is attached in *Task 1 – Appendix A*. A summary of some of this information follows.

Water Quality and Quantity Problems

No major threats to the agricultural and natural resources in the region as a result of water quality or quantity problems have been identified. The quantity of water supply is adequate for the region throughout the 2050 planning period, and very little growth in demand is expected.

The Lavaca River Basin has sustained adequate water quality for aquatic life, as well as for municipal, industrial, and recreational users. The historical concerns associated with elevated nutrients, dissolved solids, and fecal coliform have been or are currently being addressed by improvements to wastewater treatment plants, elimination of tidal disposal of oil field brine, and implementation of Best Management Practices in the agricultural sector.

Two segments in the Lavaca Basin have been added to TNRCC's 303(d) water quality impaired list, the upper half of Lake Texana and a portion of the Lavaca River. The upper half of Lake Texana is listed as impaired due to low dissolved oxygen levels, and a 25-mile portion of the Lavaca River above tidal is impaired due to thermal modifications (this information was obtained from the TNRCC website).

"An increasing trend of TSS was detected in the upper reaches of the reservoir (Lake Texana), as well as a slight increasing trend in orthophosphate, but the levels of these parameters are not high enough to warrant management concerns.

"The tributary stations in the upper basin on the Lavaca and Navidad do not evidence critical water-quality problems. Phosphorus and coliforms are elevated in both tributaries. For the Lavaca, this may be partially due to the municipal discharge from Hallettsville. For the Navidad, this may be influenced by the municipal discharge of Schulenberg. However, it is noteworthy that the last occurrence of coliforms exceeding 400 cfu/100ml was measured in August of 1992 in the Navidad, and in June of 1993 for the Upper Lavaca.

"On the Navidad, a declining trend in DO was discovered, statistically significant at the 5% level. While DO's are presently healthy, this trend needs to be monitored to determine whether management actions may be necessitated for the future. High concentrations of TSS and VSS seem to be associated with high flow events on the Navidad, probably due to mobilization of sediments on the watershed and from the streambed under storm conditions.

"Both of the eastern tributaries, Sandy and West Mustang Creek, are generally healthy in water quality. However, potentially degenerative trends were disclosed by the Step 5 analysis. On Sandy Creek, both ammonia and BOD are increasing, as well as chlorides, which may be due to oil-field activity. On West Mustang, there is a significant increase in phosphorus and a decline in DO. Continued monitoring of water quality in these tributaries is advised.

"The lower Lavaca is hydrologically unregulated, and exhibits good water quality, with the exception of elevated phosphorus and coliforms. The lower Lavaca was found to have a statistically significant declining trend in dissolved oxygen, for no apparent reason. Though DO's are presently at healthy levels, continued monitoring is advised, and special studies may be warranted at some point in the future." (Regional Assessment of Water Quality, Lavaca Basin of Texas, 1996)

The 1996 Texas Water Quality River Basin Assessments by the Texas Clean Rivers Program and TNRCC established the condition of each river and stream segment in the state and identified possible water quality concerns. The report found that, in the Upper Lavaca River, higher total suspended solids could be expected due to stormwater runoff and minor streambed erosion. There was reasonable concern that elevated phosphorus and fecal coliform bacteria might be present; therefore, contact recreation was not supported. In the Upper Navidad River, there was reasonable concern that fecal coliform originating from non-point sources might be present. There was also reasonable concern that phosphorus might be present in Lake Texana. Since 1996, numerous improvements to wastewater treatment facilities have been planned and implemented for the Lavaca River, and have contributed to improved water quality.

Non-point source pollution is still being evaluated along the Upper Navidad River, and the 1999 assessment is scheduled for revision in early 2000. Based on data gathered and provided by LBG Guyton, there are no concerns of poor water quality in the groundwater supplies used in this region.

The 1997 State water plan, *Water for Texas*, summarizes the water quantity issues for LRWPA. The State water plan is summarized in a following section.

Current Drought Preparation

The LNRA developed a Water Conservation and Drought Management Plan in 1995 which was updated in January 2000, in accordance with the TNRCC guidance for the Lavaca River Basin, including Lake Texana. The goals of the Water Conservation Plan are to reduce the quantity of water required through implementation of efficient water supply and water use practices, without eliminating any use. The Drought Management Plan provides procedures for both voluntary and mandatory actions to temporarily reduce water usage during a water shortage crisis.

Local Water Plans

LNRA has published a Land and Water Resource Management Plan for Lake Texana and Associated Project Lands. This plan was developed in accordance with Texas Water Code Section 11.173(b). In addition, each of LNRA's major water customers has a TNRCC-approved water conservation and emergency demand management plan, see *Task 1 - Appendix A*. LNRA, TNRCC, and the U.S. Geologic Survey (USGS)/LNRA cooperative program has routinely collected water quality monitoring data in Lake Texana since 1988. The USGS/LNRA, through a cooperative program, has been collecting annual pesticide monitoring data since 1992 at stations on Lake Texana. The Texas State Soil and Water Conservation Board (TSSWCB) has a water quality management plan on file for LNRA, and TSSWCB has developed management plans and studies to control non-point source pollution from agriculture and silviculture. (LNRA, 1997)

"Lake Texana has excellent water quality. The LNRA intends to maintain the present condition of the lake and has instituted management practices designed to monitor and protect current water quality and wildlife diversity. Streamflows will continue to be monitored by LNRA and the U.S. Geological Survey (USGS) at various locations in the Lavaca-Navidad Basin. Lavaca River streamflows are monitored near Hallettsville and Edna, while upstream of Lake Texana, flow monitoring stations are maintained near Hallettsville, Speaks, Morales, and Strane Park on the Navidad mainstem, and on its three major tributaries, Sandy, West Mustand, and East Mustang Creeks.

"LNRA's water quality monitoring program includes contracts with the USGS and the Guadalupe-Blanco River Authority, which provides laboratory analyses of water samples. This program was developed under the auspices of the Clean Rivers Program, a statewide effort administered by the TNRCC to encourage the assumption of responsibility for water quality monitoring by local entities already managing water supplies, and the management of water quality on a river basin basis, rather than by political subdivisions whose interests may cut across multiple river basins, or be restricted to portions of basins. Locations, parameters, and details of sample collection, handling, and analytical methodologies for all the studies mentioned below are detailed in the Quality Assurance Project Plan prepared by LNRA, which has been filed with, and approved by, TNRCC.

"Temperature, pH, dissolved oxygen, salinity, redox, conductivity and secchi depth are monitored monthly at nine locations below Palmetto Bend Dam, seven locations on Lake Texana, and at five USGS/LNRA stream gaging stations, including four on the three main tributaries to the Lake. Streamflows at the six gaging stations (Lavaca River near Edna, Sandy Creek near Louise, West Mustang Creek near Ganado, East Mustang Creek near Louise, Navidad River near Morales, and Strane Park) are monitored directly by radio telemetry into LNRA's computer based hydrologic data collection system.

"Quarterly monitoring of 78 parameters, including physical properties, major inorganic constituents, nutrients, metals, and pesticides is conducted at the USGS/LNRA gaging stations. Fecal coliform and BOD samples are collected at road crossings on the major tributaries to the lake as directed by water quality concerns. LNRA has designated a Clean River Steering Committee as the entity for monitoring activities within the basin and advising LNRA on water quality issues. The Clean Rivers Steering Committee is responsible for defining the circumstances that would require "…immediate action and/or cleanup at sources of pollution when identified…", and for developing the appropriate response strategies for those events.

"A land use map/database has been developed and is currently maintained on paper map/overlay and computer database files. LNRA is working toward maintaining these databases on a Geographic Information System. Information on residential development, industrial facilities, intensive agricultural activity such as fertilized and pesticide treated cropland or improved pasture, rice acreage, or concentrated feeding/aquaculture facilities discharges, point sources, and other activities having potential water quality impacts are regularly collected and entered in the database and locations mapped out.

"The database and map are updated on a quarterly schedule to ensure that the information is current. Information is collected by regularly querying the following sources:

- County commissioners;
- City managers and utility directors from Edna, Ganado, Hallettsville, and other communities in the basin;
- Texas Department of Transportation district office;
- Texas State Soil and Water Conservation Board regional office in Wharton;
- County health department files for on site waste disposal applications;
- County records of subdivision plat applications;
- Water supply (including irrigation) districts and corporations; and
- Local and regional newspapers.

"LNRA is notified of TNRCC discharge permit applications, and EPA NPDES applications for point source discharges and industrial stormwater runoff permits. These are reviewed by LNRA and appropriate actions taken (i.e., submission of written comments, negotiation with applicants, requests for hearings and party status) to assure protection of Lake Texana water quality." (Land and Water Resource Management Plan for Lake Texana and Associated Project Lands, 1997)

Master plan information is not available for the cities in the Lavaca region. These cities are relatively small, there is relatively low municipal usage, and there is very little expected growth in municipal usage.

State Water Plan

The TWDB has developed past versions of the State water plan. The 1997 State water plan represents a consensus effort among the TWDB, the TPWD, and TNRCC. In *Water for Texas*, the 1997 State water plan, Jackson, Lavaca, Wharton, and ten other counties are contained in the Mid-Coast region. The expected issues related to water supply for the entire Mid-Coast region are agricultural water supply shortages by 2000 that would continue through 2050 without alternative water supplies, and concern for salt-water intrusion as pumping from the Gulf Coast Aquifer increases. The Lavaca River Basin, which is contained within the Mid-Coast region, is projected to have a slight decline in total water use from 2000 to 2050. The recommendations for LNRA state that excess supplies should be used to meet future demands in the Corpus Christi area or in the San Antonio area. Overall, *Water for Texas* states that LNRA should have adequate resources to meet the area's needs through 2050.

Regional Water Plans

A study of the Corpus Christi area was performed in 1995 for the Trans-Texas Water Program. In the study, possible sources of supply for the Corpus Christi Service Area, including Lake Texana and other sources in the LRWPA area, were identified. Environmental issues were also identified, and each source was studied to compare the advantages and disadvantages of each. Some of the areas studied included Lake Texana, the Navidad River downstream of Lake Texana, the Lavaca-

Colorado Estuary, the location of the proposed pipeline between Lake Texana and Corpus Christi Right of Way, and the proposed construction site of Phase II of Palmetto Bend.

In 1997, the City of Corpus Christi began construction of the Lake Texana Corpus Christi pipeline project to meet the needs brought on by drought conditions in the South. The project was completed in September of 1998. This facility conveys water from Lake Texana to Corpus Christi as well as other users in the Corpus Christi area.

Future projects might include extension of this system to convey additional supplies that the City of Corpus Christi has purchased from the Colorado River water holdings of the Garwood Imigation Company

I.6. Maps

The following maps of the region are included in this report:

Figure 1-1	General Location Map
Figure 2-1	Major Surface Water Sources
Figure 3-1	Irrigated Lands
Figure 4-1	Industrial Users and Utility Service Areas
Figure 5-1	1996 Per Capita Water Use

Palmetto Bend Phase II appears on Figures 1-1, 3-1, 4-1, and 5-1 as the reservoir has already been permitted and studied by the Bureau of Reclamation and is currently awaiting need and funding to begin construction. The reservoir does not appear in Figure 2-1 because it is not a current major surface water source for the LRWPA.

TASK 2 – SECTION I - INTRODUCTION

IA. Scope of Work

The Project scope consists of completing a regional water supplies plan for the Lavaca Regional Water Planning Area (LRWPA), Texas Water Development Board (TWDB), Region P. The Lavaca Region is one of 16 state water resources planning regions defined by the TWDB, and is shown in *Figure 1-1*. As part of a new consensus-based planning effort to more effectively include local concerns in the statewide planning effort, the 16 individual regional water plans will be combined into a comprehensive state water plan.

This report summarizes the procedures and results of Task 2, "Presentation of Population and Water Demands Data for the Region," in the scope of work. The information in this report was used in a formal request to the TWDB to revise population and water demand projections in the TWDB's 1997 state water plan. The revised populations and water demand numbers were approved by TWDB on July 14, 1999; they are attached in *Task 2 - Appendix A*.

IB. Background

The increased demand for water, combined with recent droughts, has increased awareness of water supply issues in Texas. Water resource planning and management in Texas is a shared responsibility of local utilities, regional special purpose districts, and state agencies. Local and regional water development agencies have had primary responsibility for financing and building new water resources projects. The state's role has been to provide overall guidance, including preparation of the State's Water Plan; regulatory insight; and limited financial assistance.

Senate Bill 1 (SB 1), 75th Texas Legislature, established a new approach to state water planning involving local consensus on regional plans first. The Lavaca Regional Water Planning Group (LRWPG) is responsible for completing a consensus-based regional water supply plan for submittal to the TWDB by September 1, 2000. This plan, along with similar plans from the other 15 regions, will be compiled by the TWDB into the State's Water Plan.

1C. Description of the Region

The Lavaca Region consists of Jackson and Lavaca counties, and Precinct No. 3 of Wharton County, including the entire city of El Campo, as shown in the location map on *Figure 1-1*. The region is mostly agricultural, with some small industries. The region had a 1998 population of 49,689. Most of the water demand in the Lavaca Region is associated with agricultural irrigation. *Task 2 - Appendix B* contains detailed crop acreages and agricultural projections for the Lavaca Region.

1D. TWDB Deliverables

In order to facilitate the revision of the Regional Water Planning Groups (RWPGs) deliverables, TWDB prepared a guidance document, entitled "Exhibit B Data and Format

Guidelines for SB1 Regional Water Plan—Technical Reports." This document presents tabular formats with specific data fields required for submittal by the RWPG's to the TWDB. These formats will provide consistency among the data presented by all the RWPGs, and will eventually aid in the inclusion of this data in the 2001 State Water Plan.

The three tables required for Task 2 are *Table 1*, *Table 2*, and *Table 3*. All of these are located in *Task 2 - Appendix C,* along with each table's methodology. *Table 1* presents the current (1996) and projected population (2000-2050) for cities and rural unincorporated areas of each county and river basin, or portion of a county/basin in the Lavaca Region. *Table 2*, provides current (1996) and projected (2000-2050) water demands for the water user cities and categories for each county and basin or portion of a county/basin in the Lavaca Region. *Table 3* lists the demands that will be imposed on the Major Water Providers (MWP) designated in the Lavaca Region in each decade during the 50-year planning period.

TASK 2 – SECTION II - GUIDELINES AND METHODOLOGY

IIA. General

A critical task in the preparation of the water plan for the Lavaca Region is to determine current and future water demands within the region. Projections of future water demand must be compared with estimates of currently available water supply to identify future water shortages. SB 1 and associated rules of the Texas Water Development Board (TWDB) require the use of projections from the current state water plan. Specifically, Section 357.5 of the TWDB rules for regional water planning rules state:

"In developing regional water plans, regional water planning groups shall use:

(1) state population and water demand projections contained in the state water plan or adopted by the board after consultation with the Texas Natural Resource Conservation Commission and the Texas Parks and Wildlife Department in preparation of revision of the state water plan; or

(2) in lieu of paragraph (1) of this subsection, population and water demand projection revisions that have been adopted by the board, after coordination with the Texas Natural Resource Conservation Commission and the Texas Parks and Wildlife Department, based on changed conditions and availability of new information."

In essence, TWDB rules require that the state's projections be used as the "default" for regional water planning, unless there are substantiated reasons to revise those projections.

TWDB rules require that the analysis of current and future water demands be performed for all "water user groups" or, WUGs, within the Lavaca Region. Within the municipal category, all cities with a population of 500 or more are considered a WUG, and all smaller communities and rural areas, aggregated at the county level, are considered a WUG. For each county, manufacturing, irrigation, steam-electric power generation, mining, and livestock water use are each considered water user groups.

This report addresses population and water demand projections for each water user group within the Lavaca Region, as adopted by the TWDB.

Throughout this report, language excerpted directly from the TWDB published guidelines for changes to the 1997 Consensus Water Plan Projections is in italics. Sections in boldface type are the applicable sections cited as a part of the justification for changes to the TWDB numbers.

IIB. TWDB Guidelines for Revisions to Population and Water Demand Projections

The TWDB has established criteria and data requirements that are to be used in developing revisions to the state consensus-based population and water demand projections. The criteria applied in developing revisions to the state's projections for the Lavaca Region are displayed in boldface type below and described in detail.

1) Population Projections

Combined with estimates of per capita water use and water conservation assumptions, population is the principal impetus for projections of future municipal water demand. As such, emphasis has been placed on evaluating the state's population projections and then on developing revisions in accordance with the following criteria.

Criteria: *One or more of the following criteria must be verified by the Regional Water Planning Group and the Executive Administrator of the TWDB for consideration of revising the consensus-based population projections.*

a) The current population estimate of a county or city is greater than or equal to the year 2000 population projection for that respective county or city which was used in the preparation of the 1997 State Water Plan.

b) The population growth rate for a county or city over the latest period of record, beginning in year 1990, is greater than the 1997 State Water Plan projected growth rate for that county or city over the period 1990 to year 2000.

c) If the Regional Water Planning Group disagrees with the long-term population projections (2000-2050) for a county or city that was used in preparation of the 1997 State Water Plan, historical growth rates will be used for comparison purposes and possible verification of changes to the population projections. Historical growth rates for cities must be calculated for the last 30 years of reported population data and for the last 40 years of reported population data for counties. Specifically, historical growth rates will be calculated for each 10-year period in excess of the 30- and 40-year periods.

d) Areas are identified that have been recently annexed by a city within the regional water planning area.

e) Other criteria include items that the Regional Water Planning Group believes are important for consideration of revisions to the State Water Plan population projections.

Data Requirements: *The Regional Water Planning Group must provide to the Executive Administrator of the Water Development Board the following data associated with the identified criteria for justifying revisions of the* *consensus-based population projections used in the preparation of the 1997 State Water Plan.*

a) ***Population estimates for counties and cities developed and published by the State Data Center will be used for verifying criteria (a) and (b).***

b) *If an entity disagrees with the State Data Center's most current population estimate for that entity, the Regional Water Planning Group must provide one or more of the following data sets along with the analysis and documentation used in estimating the entity's current population:*

1) *School enrollment information*

2) *Building permits information*

3) *Active residential water service information*

4) *Appraisal district information*

5) *Other information or current population estimates that the Regional Water Planning Group believes are appropriate and important*

c) *Census counts for cities and counties published by the U.S. Bureau of the Census will be used for verifying historical long-term population growth rates for cities and counties.*

d) *The population of an area that has been annexed by a city will be used as a criteria.*

e) *Other data that the Regional Water Planning Group believes are important to justify any changes to the consensus-based population projections used in preparation of the State Water Plan will be used as criteria.*

2) ***Municipal Water Use***

As indicated above, per capita water use rates and assumptions regarding water conservation are additional variables in municipal water demand projections. Accordingly, the following criteria were applied in the evaluation of the state's municipal water demand projections and in the development of revisions to those projections:

Criteria: *One or more of the following criteria must be verified by the Regional Water Planning Group and the Executive Administrator of the Texas Water Development Board for consideration of revising the consensus-based municipal water use projections that were used in the preparation of the 1997 State Water Plan.*

a) Any changes to the population projections for an entity will require revisions to the municipal water use projections.

b) Criteria will include errors identified in the reporting of annual municipal water use for an entity.

c) Criteria will include differences identified between the Board's calculated per capita water use for a city and the per capita water use calculated by the respective city.

d) The consensus-based municipal water use projections include both the expected case and advanced case conservation savings for any specific municipality. Any requests for changing the conservation savings scenarios (expected or advanced) must be accompanied with complete documentation justifying the request.

e) Criteria will include trends indicating that per capita water use for a city or a rural area of a county have increased over the latest period of record, beginning in 1980.

f) Other criteria that the Regional Water Planning Group believes are important for consideration of revisions to the State Water Plan municipal water use projections will be included.

3) Other User Groups

The state's consensus-based water demand projections were used for other categories of water users (e.g., manufacturing, irrigation, steam-electric power generation, mining, and livestock), except for those cases where more current or better data was provided. Revisions to the projections for these WUGs are described in *Section III* of this report.

IIC. Description of Projection Methods

The population and water demand projections presented in this report were developed using the following three methods.

- Use of the consensus-based default projections from the 1997 State Water Plan without revision

- Application of a "standard" method (referred to as the TC&B - SDC Methodology) for revision of population and municipal water demand projections (described in detail in *Section IID below)*

- Other methodology that was applied on a case-by-case basis (described by WUG for each county in *Section III*)

IID. Methodology

This section describes the methodology used to develop revisions to state projections for population and for municipal, manufacturing, irrigation, steam-electric power generation, mining, and livestock water demand.

1) Population Projection Methodology

The focus of the analysis was on municipal WUGs that include cities of 500 population or greater and smaller cities and rural areas (county other). Municipal water demand projections are the product of three variables, including current and projected population, per capita water use rates, and assumptions regarding the effects of certain water conservation measures. The general methodology that was applied to all cities and county-other areas addresses each of these variables.

The following describes the procedures followed in the analysis of TWDB population projections and for the development of revised population projections:

a) **Identify the baseline projection:** The baseline population projection for SB 1 regional water planning is the TWDB's "most-likely" scenario for each county, each city of 500 population and greater, and cities of less than 500 population and rural areas (county-other). These projections are presented by decade from 1990 (actual reported from census) to 2050. The TWDB projections represent default values that are to be used unless revisions are justified per TWDB guidelines.

b) **Evaluate recent population growth trends:** As indicated in *Section IIA*, TWDB guidelines allow for adjustments of population projections if there is evidence that growth trends during the 1990s have been greater than projected by the TWDB. Using the 1990 census and a January 1998 population estimate provided by the State Data Center, the growth rate for this period was calculated and the trend extrapolated to the year 2000. This extrapolated year 2000 population estimate was then used as the starting point for the development of a TC&B-SDC revised population projection through 2050, using the growth rates in TWDB's projections for each decade. For those cities and county-other areas where the modified year 2000 population estimate is greater than the TWDB year 2000 projection, the effect of the modification is to adjust the TWDB's projection upward for the planning period.

c) **Compare to the best available information:** In cases where better, more current information is available, that information is presented as the revised projection. Other methodologies were not used to develop revised population projections.

d) **Select a population projection:** Revised population projections were determined after the TWDB, the TC&B-SDC modified, and the other available projections were compared. The higher of the TWDB and the TC&B-SDC modified projection was selected as the revised projection, except in cases where better information was available. The revised population projections are presented by county in *Task 2 - Appendix A*, and in *Table 1* of *Task 2 - Appendix C* in TWDB's standardized format.

2) Municipal Water Demand Projection Methodology

Per Capita Water Use

The second critical variable in the TWDB's municipal water demand projections is per capita use, expressed as gallons of water used per person per day. TWDB estimates of per capita water use is derived from data provided by water suppliers annually, and is simply the total annual municipal water use divided by total estimated population and then divided by 365 (days in a year). The starting point in TWDB's default projections is a per capita use estimate for a year with below-normal rainfall, when water use is typically high. These per capita use values were taken from data from the 1982 to 1991 period.

TWDB guidelines for revisions to municipal water demand projections provide that adjustments in per capita use rates can be proposed if more recent data indicates that per capita use has increased. The guidelines also provide for the modification of TWDB conservation assumptions where justified. Given these guidelines (presented in *Section IIB* above), the following procedure was used to develop per capita water use rates:

a) **Identify TWDB projected per capita use rate:** Estimated per capita water use for the year 2000 under a "below-normal-rainfall" and a "no-conservation" scenario was identified.

b) **Identify reported 1996 per capita water use rate:** Using data provided by the TWDB, per capita water use for 1996 was calculated. This value was selected as a more recent measure of per capita use under below-normal-rainfall conditions, as drought conditions affected the entire region for much of 1996.

c) **Select per capita use rate:** Individual municipal WUGs were contacted and given information about the TWDB per capita usage rates. The WUGs were asked to provide alternative data if appropriate. No alternative data was provided, so all of the municipal calculations were based on information supplied by TWDB. In order to provide a conservative starting point for revised municipal water demand projections, the greater of the 1996 reported per capita use and the TWDB projected per capita use was selected.

d) **TWDB water conservation assumptions:** TWDB's baseline, or default, projections of municipal water demand include a set of water conservation assumptions described as the most-likely scenario. This includes the effects of state and federal plumbing fixture efficiency standards, reductions in seasonal water use (e.g., landscape irrigation), and savings in other uses (e.g., public education). These assumptions are applied in the state's projections in such a manner as to result in each city having a unique projection of water savings.

Municipal Water Demand

The final procedural step in the development of municipal water demand projections is described below.

a) **Identify the baseline projection:** As previously indicated, the baseline or default water demand projections to be used for SB 1 regional planning are the TWDB most-likely scenario projections. These projections are presented by decade from 1990 to 2050, and are presented for each county, cities with a population of 500 persons or more, and county-other (i.e. smaller communities and rural areas).

b) **Determine municipal water demand projections:** The municipal water demand projections are the product of the revised population projections and the per capita usage projections described above. These projections are presented for each municipal WUG, by county, and by decade in *Task 2 - Appendix A* and in *Table 1* of *Task 2 - Appendix C* in TWDB's standardized format.

3) Manufacturing Water Demand Projection Methodology

For SB 1 regional water planning purposes, manufacturing water use is considered to be the cumulative water demand by county for all industries within specified standard industrial classifications (SICs) determined by the TWDB. The manufacturing water use projections that were developed by the TWDB and used in the 1997 State Water Plan were used as the default projections, since no alternative manufacturing demand data or calculations were proposed for consideration by the group.

4) Irrigation Water Demand Projection Methodology

The irrigation water use projections developed by the TWDB and used in the 1997 State Water Plan were not adopted by the RWPG for use in this study. The TWDB projections were determined with assistance from Texas A&M, and assume expected case water conservation practices and no reduction in federal farm program subsidies. Irrigation estimates were based on rice prices that have not followed the projected trends. Texas A&M is currently revising its previous estimates; this information is presented in *Section IV*. Revisions to the TWDB projections were made for Jackson, Lavaca, and Wharton counties as a result of the submission of better, more current projection information. These revisions are described in *Section III*. Data on per acre usages for agriculture were provided by L.G. Raun, Jr., a rice farmer and member of the regional planning group, and by Dr. Garry McCauley, with Texas A&M University's Agricultural Extension Service. *Task 2 - Appendix B* contains charts of the agricultural pumpage data and per acre usage for the Lavaca Region.

5) Steam-Electric Water Demand Projection Methodology

The steam-electric water use projections that were developed by the TWDB and used in the 1997 State Water Plan were used as the default projections.

6) Mining Water Demand Projection Methodology

The TWDB mining water use projections that were used in the 1997 State Water Plan were developed based on projected future production levels by mineral category and expected water use rates. These production projections were derived from state and national historic rates, and were constrained by accessible mineral reserves in each region. The TWDB 1997 State Water Plan mining water demand projections were used as the default projections.

7) Livestock Water Demand Projection Methodology

The total livestock water use projections developed by the TWDB and used in the 1997 State Water Plan were used as the default projections. These projections were developed using Texas Agricultural Statistics Service projections of number of livestock by type and county, and Texas Agricultural Extension Service estimates of water use rates by type of livestock. Based on information developed by L.G. Raun and others, however, the total for Wharton County was adjusted slightly upward and the total for Lavaca County was decreased by the same amount to maintain the TWDB projected regional total.

TASK 2 – SECTION III – POPULATION AND WATER DEMAND PROJECTIONS

This section discusses the projections for population and for municipal, manufacturing, irrigation, mining, livestock, and steam-electric water demands for each of the three counties in the Lavaca Region. These projections were developed using the general methodology described in *Section II* with any exceptions described by water user group for each county in *Sections IIIB, IIIC,* and *IIID* below.

IIIA. Regional Summary by Category

Population

The revised population projections indicate that the Lavaca Region's population will grow from 50,366 in 2000 to 60,124 in the year 2050. These projections represent an increase in the state default population projections by 2.0 percent, or 1,166 persons in the year 2050. The revised population projections by county and decade, as well as a comparison to the TWDB and TSDC projections, are presented in *Task 2 - Appendix A* and in *Table 1* of *Task 2 - Appendix C* in the TWDB standard format.

Figures III-1, III-2, III-3, and *III-4* compare the adopted projections and the TWDB projections for the region and for each county. *Figure III-1* also includes a comparison to the TSDC projections for the region.

The projections were presented at the LRWPA meeting held on February 22, 1999. The consensus at this meeting was that the TWDB's projections were lower than expected locally.

Municipal Water Demand Projections

Municipal water demand projections are the product of the revised population projections and the per capita usage projections. These projections are presented for each municipal WUG, by county and by decade, in *Task 2 - Appendix A* and in *Table 2* of *Task 2 - Appendix C* in the TWDB standard format. *Figure III-5* presents the comparison of the revised municipal water demand estimates versus the TWDB default estimates. These municipal water demand projections for the Lavaca Region show an increase in projected demand from 8,556 to 8,614 acre-feet per year in the year 2050. The projections exceed the default TWDB projections by 2.4 percent in 2000 and by 2.2 percent in the year 2050. The projections for each municipal WUG by county are provided in *Task 2 - Appendix A* and in *Table 2* of *Task 2 - Appendix C* in the TWDB standard format.

Manufacturing

Manufacturing water use is considered to be the cumulative water demand by county for all industries within specific standard industrial classification, determined by the TWDB. Manufacturing water demands used for the Lavaca Region are the default projections included in the TWDB 1997 State Water Plan. The manufacturing water demand for the Lavaca Region is projected to increase from 1,393 to 3,259 acre-feet per year between 2000 and 2050. The projections are presented in *Task 2 - Appendix A* and in *Table 2* of *Task 2 - Appendix C* in the TWDB standard format.

Steam-Electric Power

The steam-electric water demands used for the Lavaca Region are the default TWDB projections included in the 1997 State Water Plan. There are no steam-electric power generation facilities in the region and none planned, so the water demand for the Lavaca Region is zero during the period from 2000 to 2050.

Mining

TWDB mining water use estimates developed in the 1997 State Water Plan considered the projected future production levels, by mineral category and expected water use rates. Production levels were determined based on the availability of the mineral reserves in each region. Mining water demands used for the Lavaca Region are the TWDB default projections. The mining water demand by decade for the Lavaca Region is 155 acre-feet per year in the year 2000 and 21 acre-feet per year in 2050. The projections by decade and county are presented in *Task 2 - Appendix A* and in *Table 2* of *Task 2 - Appendix C* in the TWDB standard format.

Irrigation Water Demand Projections

The main crop for the Lavaca Region is rice. The TWDB default estimate shows a decline over the planning period for rice irrigation. The LRWPG prepared a revised rice irrigation projection based on the most current information available. L.G.Raun, Jr., a group member, developed projections for rice irrigation based on collected information from the local rice growers, agricultural businesses, Texas A&M University (TAMU) Agriculture Specialists, and the local County Extension Agent for Wharton County. The irrigation projections are summarized in *Task 2 - Appendix A* and in *Table 2* of *Task 2 - Appendix C* in TWDB standard format. This projection shows a slight increase in irrigation over the current demand. *Figure III-6* illustrates a comparison between the TWDB projections versus the revised projections. The irrigation estimate was later negotiated with the TWDB to reach an agreed projection. The final agreed-upon projections were reached based on changes to assumed canal losses and elimination of the aquaculture values. These estimates are shown in *Task 2 - Appendix B* and the estimates are rolled up into the summary in *Task 2 - Appendix A*. Total irrigation is projected to increase from 226,008 to 229,518 acre-feet per year between 2000 and 2050. The default TWDB estimate is 179,897 acre-feet per year for year 2000, and 143,810 acre-feet per year for year 2050.

Livestock Water Demand Projections

The TWDB projections developed for the total livestock demand for the region in the 1997 State Water Plan were adopted; however, the split between counties was adjusted. The Texas Agricultural Statistics Service projections of livestock, by type and county, and the Texas Agricultural Extension Service estimates of water use rates, by type of livestock, were checked. L.G.Raun, Jr., and others found that the total for Wharton County needed to be adjusted slightly upward, and that the total for Lavaca County needed to be decreased by the same amount in order to maintain the overall TWDB total. These adjustments were made as a result of more accurate counts of farm animals in the region. The projections by decade and county are presented in *Task 2 - Appendix A* and in *Table 2* of *Task 2 - Appendix C* in the TWDB standard format.

IIIB. Projections for Jackson County

1. Population

   The population projection methodology described in *Section II.1* was used to develop initial population projections for the cities and county-other area in Jackson County.

2. Water Demand

   The projections for population, municipal, manufacturing, irrigation, mining, livestock, and steam-electric water demand for Jackson County are presented in *Task 2 - Appendix A* and in *Tables 1* and *2* of *Task 2 - Appendix C* in the TWDB standard format. Irrigation is the major change to the TWDB Water Demand Projections. The methodology used to develop the revised irrigation projections is described in detail in *Section IV*.

IIIC. Projections for Lavaca County

1. Population

   The population projection methodology described in *Section II.1* was used to develop initial population projections for the cities and county-other area in Lavaca County.

2. Water Demand

   The projections for population, municipal, manufacturing, irrigation, mining, livestock, and steam-electric water demand for Lavaca County are presented in *Task 2 - Appendix A* and in *Tables 1* and *2* of *Task 2 - Appendix C* in the TWDB standard format. Irrigation is the major change to the TWDB water demand projects. The methodology used to develop the revised irrigation projections is described in detail in *Section IV*.

IIID. Projections for Wharton County (partial)

1. Population

   The population projection methodology described in *Section II.1* was used to develop initial population projections for the cities and county-other area in Wharton County.

2. Water Demand

The projections for population, municipal, manufacturing, irrigation, mining, livestock, and steam-electric water demands for the portion of Wharton County within the Lavaca Region are presented in *Task 2 - Appendix A* and in *Tables 1* and *2* of *Task 2 - Appendix C* in the TWDB standard format. Irrigation is the major change to the TWDB water demand projections. The methodology used to develop the irrigation projections is described in detail in *Section IV*.

*Figure III-*7 presents the regional water demand estimates, considering all of the categories of use. *Table III-1* is a reference table that indicates which approach was used for each water demand category for each WUG in each county within the Lavaca Region.

Table III-1. Summary of Methodology Used for Projections

	Category	*TC&B - SDC Methodology*	*TWDB Default*	*Other*	*Notes*
Jackson	Municipal	X			
	Livestock		X		
	Irrigation			X	Irrigation demand based on revised projections developed by L.G. Raun, Jr., and others, and adopted by the LRWPG on 1/13/99. See *Section IV*.
	Manufacturing		X		
	Mining		X		
	Steam-Electric		X		
Lavaca	Municipal	X			
	Livestock			X	Livestock demand in Lavaca County adjusted slightly downward as a result of more recent animal numbers developed. Total livestock demand for the region did not change.
	Irrigation			X	Irrigation demand based on revised projections developed by L.G. Raun, Jr., and others, and adopted by the LRWPG on 1/13/99. See *Section IV*.
	Manufacturing		X		
	Mining		X		
	Steam-Electric		X		
Wharton	Municipal	X			
	Livestock			X	Livestock demands were adjusted slightly upward as a result of more recent animal counts developed during this plan. Total livestock demands for the region did not change.
	Irrigation			X	Irrigation demand based on revised projections developed by L.G. Raun, Jr., and others, and adopted by the LRWPG on 1/13/99. See *Section IV*.
	Manufacturing		X		
	Mining		X		
	Steam-Electric		X		

SECTION IV - AGRICULTURAL IRRIGATION WATER DEMAND

IVA. Basis for Revision

The basis for requesting a revision to the agricultural irrigation water demands is described in detail herein.

Criteria: *One or more of the following criteria must be verified by the Regional Water Planning Group and the Executive Administrator of the Texas Water Development Board for consideration of revising the State Water Plan irrigation water demand projections:*

a. Based on the production period of record (last 20 years), regional irrigated acreage for crops grown in the region has increased at a faster rate or declined at a slower rate than the State Water Plan projected regional irrigated crop acreage for the period 1990 to the year 2000.

b. Based on the production period of record (last 20 years), regional irrigation water use has increased at a faster rate or declined at a slower rate than the consensus-based projected regional irrigation water use for the period 1990 to the year 2000.

c. Differences identified between the Board's annual irrigation water use estimates for a region or county and estimates provided by the Regional Water Planning Group must be considered.

d. Other criteria that the Regional Water Planning Group believes are important must be considered in revisions to the State Water Plan projections.

Data Requirements*: The Regional Water Planning Group must provide the Executive Administrator of the Texas Water Development Board the following* ***data*** *associated with the identified criteria for justifying any revisions to the consensus-based State Water Plan irrigation water demand projections:*

1. Historical irrigated acreage data for major crops grown in a region as published by the Texas Agricultural Statistics Service, the Texas Agricultural Extension Service, or the Farm Service Agency (USDA) certified acreage

2. Historical annual estimated quantities of water used for irrigation purposes in a region or a county

3. Historical irrigation application rates per acre for crops grown in a region

4. Other data that the Regional Water Planning Group believes are important to justify revisions to the State Water Plan projections

IVB. Supporting Data

The Lavaca Regional Water Planning Group has expressed concern about the decline in irrigation predicted by the Texas Water Development Board since the inception of the water planning process. As a result, one of the members of the Group, L.G. Raun, Jr., has taken the lead in developing data on irrigation of crops of many types that are commonly grown in the Lavaca Regional Planning Area. Mr. Raun contacted local farmers; Mr. John Cosper, Wharton County Agricultural Extension Agent; the Texas Farm Bureau; and other organizations and individuals to assemble information on acreages and estimated usages of water in the Lavaca Regional Planning Area. Mr. Raun then developed a series of tables of acreages from the Texas Agricultural Statistics Service (TASS), and from the Farm Services Agency (FSA) (which he represents for Wharton County) that represents certified acreages for the various crops for the area. The numbers reported represent a consensus effort on the part of Mr. Raun and the other participants. The irrigation projections by L.G. Raun, Jr., are contained in *Task 2 - Appendix B*. *Table B.1* shows the rice acreage for the past eight years for the rice-producing counties in Texas. *Tables B.2, B.3,* and *B.4* show the acreages for Jackson, Lavaca, and Wharton counties, respectively. The acreage for Wharton County is not split for the TASS reports into the Lavaca Region area only, and *Table B.5* is attached showing the FSA acreages. This table includes only those acreages in the portion of Wharton County within the Lavaca Region.

With the acreages shown, the participants then developed estimated quantities of water that are used in irrigation of the crops shown. For rice, the area has both surface water and groundwater irrigation, with groundwater irrigation predominant. *Tables B.6, B.7, B.8,* and *B.9* show the estimated usage on the farm for both surface and groundwater rice irrigation, as well as the total acreages and percent irrigated for other crops such as cotton, corn, milo, soybeans, and turfgrass in each of the counties or partial counties of the region. At this time, the Region does not have any interest in sugar cane. Acreages used for these calculations are the three-year averages as shown on the bottom of *Tables B.2, B.3, B.4,* and *B.5*. These tables also include factors for conveyance losses, and accumulate the water usage by using the per-acre quantities times the acreage planted. The second crop for rice is handled as a percentage of the first crop use, with a resultant calculation of acre-feet of water total. *Table B.5* shows the total usages for the Lavaca Region. All of the water use estimates and percent of crop irrigated for the other crops are from the consensus values developed during the meetings with the farmers and farm organizations referenced above.

4C. Regional Concerns

The first concern is the TWDB year 2000 irrigation projection for the Lavaca Region. This projection shows approximately 180,000 acre-feet of agricultural use. The 1990 recorded irrigation use is shown as 193,159 acre-feet. The rate of decline that is calculated from those numbers is approximately 7 percent for the 10-year period overall. The year 2000 demand estimated from the consensus numbers (compiled by L.G. Raun, Jr.) presented in the tables above for irrigation is 226,008 acre-feet, which is based on acreages and usages from the 1996, 1997, and 1998 time-periods. Several possible explanations exist for this difference, one of which is the split of demand between the Lavaca Region and Region K. It appears that some of the demand that should have been allocated to the Lavaca Region may have been allocated to Region K, instead. The Lavaca Regional Planning Group feels that the numbers generated by the local farmers and farm organizations are more accurate because they are tied to specific tracts of land by individuals who are familiar with those lands and their operations.

The second concern is the TWDB projection of a long-term decline in irrigation demands throughout the 50-year planning horizon. This decline was projected based on information developed by Texas A&M University through the Agricultural and Food Policy Center (AFPC), and information from the Food and Agricultural Products Research Institute (FAPRI).

The declines were based on a number of factors that pertained to the profitability of rice production in the Texas Gulf Coast area. Costs of production in this area were relatively high, based, at least in part, on the high cost for water, and particularly for surface water. The cost of surface water was expected to increase throughout the planning period as competition intensifies for scarce resources. In addition, the AFPC's December 1995 baseline report, published in February 1996, predicted certain impacts of the modifications contained in the 1996 Farm Bill. These impacts were that landowners who leased land to tenant farmers would be able to collect support payments for rice without growing rice and taking any of the normal risks associated with farming. It was assumed that many of these landowners would opt for the payments and would not farm. This report predicted loss in real equity for Texas farms, as rice prices were predicted to be low, and the high costs of production in this area would continue. It should be noted, however, that even under this scenario, the moderate-sized Texas farm was projected to experience a small increase (under 10 percent) in real earned equity.

A review of the prices projected for rice for 1996, 1997, and 1998 versus the prices paid to Wharton County farmers is shown in *Table IV.1* below:

TABLE IV.1 COMPARISONS OF ACTUAL AND PROJECTED PRICES FOR RICE

Year	*AFPC Projection $/cwt.*	*Actual Price on Farm $/cwt.*	*Percent Difference*
1996	$7.29	$10.58	45
1997	$7.23	$10.82	50
1998	$7.30	$9.69	33

Prices paid to farmers were reported by L.G. Raun, Jr., and represent an average for the year. These averages are in line with those reported by the agricultural statistics services for the rice-producing counties of the Gulf Coast.

As a result of the higher-than-anticipated prices and experience following the implementation of the 1996 Farm Bill, a January 1997 baseline update of the FAPRI study was done to look at the Representative Farms Economic Outlook. This study, entitled *AFPC Working Paper 97-1*, again ranked the farms in the various states (*Task 2 - Appendix D*). In this study, the moderate Texas rice farm was predicted to experience a real equity gain of 53 percent over the 1996 to 2002 planning horizon. The following statement is excerpted from the report. "Average cash expenses as a percent of receipts range from 74 percent on the moderate Texas Farm (TXR2118) to 91 percent for the moderate Missouri operation (MOR1900)." This statement indicates that the Texas operations are not at a disadvantage in comparison to rice farms in California, Arkansas, Louisiana, and Missouri. The analysis also states that all of the rice farms would see a net decrease in real equity if net cash farm income as a percent of receipts were to decline by as much as 10 percent. A review of the FAPRI 1999 Briefing Book shows that rice prices are expected to dip slightly during the next three years, but will remain within 90 percent of the 98 price for all but one year of the next five years. Beginning in 2003, prices are expected to be above $9.00 per cwt. through the remainder of the study period, which ends in 2009.

In addition to the improved economic picture presented by the information above, members of TAMU have provided additional information on the long-term viability of the rice industry in Texas. Their information is not fully developed at this time, but major points that were made at a meeting on April 1, 1999, at Bear Creek Park in Houston further reinforced the economic viability of the rice industry. To summarize, TAMU extension personnel believe that there are significant advances in rice varieties and disease resistance that will significantly reduce costs of production. At the same time, there is a growing segment of the population in Texas that is either of Asian or Hispanic ethnicity. Both of these ethnic groups are rice users, and the long-term prediction is for the per capita consumption of rice in Texas to increase as these two population groups increase. The FAPRI 1999 Briefing Book similarly shows exports decreasing as a greater proportion of U.S. grown rice is consumed domestically. Projected harvested area for the entire U.S. increases slightly, returns to just below the 1999 level by 2005, and declines after that.

As a result of the predicted increase in production and the increasing demand for rice in Texas, TAMU presented a draft table recommending that water be set aside for irrigation of rice acreage at levels equal to the highest historical levels of past operations. Further, TAMU recommended that the ratoon, or second crop, acreage be held at 80 percent of the first crop acreage. Acreage and water demand for such a scenario for rice irrigation only are shown in *Table IV.2* below.

TABLE IV.2 TEXAS A&M WATER DEMAND ESTIMATES 2050 (RICE ONLY)

		WATER DEMANDS ACRE-FEET/YEAR		
County	*Highest Historical Acres*	*First Crop at 2.4 ac.ft./acre*	*Second Crop at 1.44 ac.ft/acre * First Crop [acres * .8]*	*TOTAL WATER DEMAND*
Jackson	46,700	112,080	53,798	165,878
Lavaca	7,900	18,960	9,100	28,060
Wharton (P)	44,000	105,600	50,688	156,288
Total Demand	**98,600**	**236,640**	**113,586**	**350,226**

This demand for rice irrigation only is approximately 48 percent larger than the total estimated year 2000 irrigation demand, based on the average of the past three years' FSA acreages for each county or county portion.

In lieu of the resulting increased demands shown in the table above, the Lavaca RWPG is requesting only that irrigation demands for rice and other row crops be held steady throughout the planning period. The Lavaca RWPG also looked at three categories of demand that may or may not have been included in the TWDB estimates. These categories are turf grasses, aquaculture, and wildlife habitat. For each of these categories, there is no long-term data available from which to calculate a growth rate. In addition, turf grass farms are being displaced closer to the municipalities as municipal development progresses and the turf farms are converted to subdivisions. When this occurs, turf farms relocate in their entirety, and the increase is incremental rather than gradual. In the absence of any reliable data, the Lavaca RWPG requested that the turf grass and aquaculture categories be increased by one percent per year.

The Lavaca Regional Water Planning Group asked for and was granted revisions to the Texas Water Development Board's water demand estimates for irrigation based on the following reasons.

1. Favorable economic conditions exist; rice prices have remained higher than previously projected.

2. The Lavaca Region uses predominantly groundwater for irrigation, and, unlike the situation in most other regions, water supply is not an obvious limiting factor. In addition, the size of rice farms in the region may allow for conversion from surface water to groundwater if surface water becomes too costly.

3. The competition for other land use (subdivisions, commercial, etc.) does not exist in the Lavaca Region. Population growth of only 10,000 persons is expected during the 50-year planning horizon. Assuming one home per acre and three persons per home, this represents less than 3,500 total acres converted to homes.

4. The division of the Wharton County Irrigation demands between Regions K and the Lavaca Region may have overestimated the Region K demands and underestimated the Lavaca Region demands.

TASK 3 – ANALYSIS OF CURRENT WATER SUPPLIES

Introduction

The available water supply within the region includes both groundwater and surface water. Groundwater is provided from the Carrizo-Wilcox and Gulf Coast aquifers. Primary surface water sources are the Navidad and Lavaca rivers and Lake Texana.

Much of the regional water demand is supplied by groundwater. Of the total 1996 water demand, almost 90 percent, or 206,740 acre-feet, was supplied by groundwater. The Gulf Coast aquifer is the predominant supply source. The Carrizo-Wilcox aquifer is available as a supply source only in a small portion of the northwestern corner of Lavaca County. The Carrizo-Wilcox is not a supply source in Jackson or Wharton counties.

Surface water supplies are obtained from Lake Texana and run-of-river flows from the Lavaca and Navidad rivers, and some smaller creeks. The majority of the Lavaca Regional Water Planning Area (LRWPA) is located in the Lavaca River basin. Surface water supplies accounted for approximately 10 percent of the total 1996 water demand. The only reservoir in the Lavaca Region is Lake Texana and there are no major springs in the LRWPA.

As a part of Task 3, the Texas Water Development Board (TWDB) requires the presentation of *Tables 4, 5,* and *6* for Task 3. *Table 4* indicates the maximum amount of water supply that could be obtained during drought of record conditions from each unique supply source. *Table 5* evaluates the current water supplies available to the LRWPA for cities and categories of water users for each county/basin, or portion of a county/basin, in the regional water planning area. *Table 6* evaluates the current water supplies available to the LRWPA for major providers of municipal and manufacturing water for each county/basin, or portion of a county/basin, in the regional water planning area. The planning group has designated the Lavaca-Navidad River Authority (LNRA) as the sole major water provider within the region. See *Task 3 - Appendix A* for the tables and the detailed methodology associated with compiling the tables.

A great deal of the information contained within this report was based on information published in the *Task 1 – Description of the Region*, Lavaca Regional Water Planning Group. For a complete and detailed list of sources, see *Task 3 - Appendix A – References* in the Task 1 report.

Groundwater Supply Overview[1]

Major Aquifers

The major aquifer in the Lavaca Region is the Gulf Coast aquifer. This aquifer accounts for essentially all of the groundwater supply to the Region.

1. The information in this section of the Task 3 report was provided by LBG-Guyton Associates.

The Gulf Coast aquifer consists of four general water-producing units. The shallowest is the Chicot Aquifer, followed by the Evangeline and Jasper aquifers and then the Catahoula formation. These formations are composed of interbedded layers of sand, silt, and clay, with minor amounts of small gravel in some locations. At deeper depths, below the base of the Evangeline aquifer, shale can occur. These aquifer beds vary in thickness, composition and are normally discontinuous over extended distances.

The Chicot and Evangeline aquifers provide large amounts of fresh water. The aquifers contain freshwater to depths that range from 1,400 to 1,700 feet, in the portion of Wharton County in the LRWPA, based on findings of Texas Department of Water Resources (TDWR) Report 270 – "A Ground-Water Resources of Colorado, Lavaca and Wharton Counties, Texas," (July 1982).

Recharge to the aquifers is principally from the infiltration of precipitation and stream flow. Average annual rainfall in the region ranges from about 32 to 42 inches per year. The eastern portion of the region experiences the upper end of the average annual rainfall amounts.

The outcrop area of the Gulf Coast aquifer within the Lavaca Region is shown in *Exhibit 1*. The outcrop area includes the Jasper, Evangeline and Chicot aquifer outcrops. The outcrop parallels the coast and is at times 40 miles wide. The outcrop area extends outside the region to the northeast and southwest.

The Jackson group, a minor aquifer, is located in the northwest portion of Lavaca County. The aquifer provides small amounts of water to domestic and stock wells in the very northwest reaches of the region. A small part of the Jackson group outcrop occurs in the very northwest part of Lavaca County northwest of the town of Moulton.

There are no minor aquifers present in Jackson or Wharton counties for which estimates of groundwater availability have previously been provided as groundwater in the two counties is pumped from the Gulf Coast aquifer system. Data and text from Texas Water Development Board and United States Geological Survey reports for Wharton and Jackson counties do not reference minor aquifers in these two counties.

Groundwater Levels

Static (non-pumping) water levels have been measured in wells in Wharton and adjoining counties for decades to help monitor the response of the aquifer to pumpage. The locations of observation wells within Wharton County and in the east part of Jackson County are circled on *Exhibit 2*. The wells screen the Chicot and/or Evangeline aquifers. *Figure 1* is a graph showing static water levels in wells located in the western part of Wharton County. The data show a gradual decline in water levels in the 1960s and into the 1970s as pumpage generally increased within the region. Since about 1983, while pumpage has averaged about 81,600 ac-ft/yr in the part of LRWPA in the county, the water levels have fluctuated, but show essentially no net static water-level decline except Well 66-52-207 which had about 5 feet of water-level decline during the period. *Figure 2* shows static water levels in wells located in the central Wharton County area with some static water-level measurements extending as far back as 1934. The water-level data show some water-level decline occurring in the 1960s and 1970s as pumpage in the region increased. From about 1983 through 1998 the data show essentially no net static water-level decline, indicating that the aquifers are providing water at a rate that is not causing water levels to decline and that the aquifers can continue to sustain the rate of pumping.

Static water levels have been measured in wells outside the LRWPA and data for some of the wells are shown on *Figure 3*. Again, the water-level data are showing that water levels have stabilized in the last 15 years and in some wells, the water levels actually have risen about 10 to 15 feet through the period. The data show that the stabilization of static water levels in Wharton County is not confined to the part of the county within LRWPA.

Water levels are also shown on *Figure 4* for wells located in the east part of Jackson County. The data from the four wells show that static water levels fluctuated some in the 1980s and have risen about 5 to 10 feet in the 1990s. From 1984 to 1997, pumpage in Jackson County averaged about 75,100 ac-ft/yr based on data provided by the TWDB.

Groundwater Availability

Total groundwater availability has been estimated by the TWDB, for the Lavaca region, as 177,233 acre-feet per year, with the Gulf Coast Aquifer being the most productive. Of this estimated amount, 87,876 acre-feet are expected to be available to Jackson County, with Lavaca and Wharton counties projected available amounts being 38,123 and 51,234 acre-feet, respectively. Groundwater pumpage within the part of Wharton County in the Lavaca Region has significantly exceeded the estimate of groundwater availability within that part of the county.

LRWPG investigated the static water levels and the pumpage of the regional wells and found adequate data to support an increase in the TWDB number for western Wharton County. This portion of Wharton County is estimated to have an available aquifer supply of 81,600 acre-feet annually, increased from TWDB projections of 51,234 acre-feet. This determination is based primarily on the history of pumpage at levels similar to this amount without increasing the static water level.

As stated previously, groundwater pumpage in the Lavaca Region has resulted in acceptable amounts of static water level decline and the recovery of static water levels in years when pumpage decreases occurred in various parts of the region. Groundwater availability in the region is the amount of withdrawal that can be sustained by the aquifers on a long term basis and is about equal to the long term average recharge, plus probably a small amount of intercepted discharge.

There are millions of acre feet of water in storage in sand layers of the aquifers. Water in storage fills the aquifer pore space and helps maintain the aquifers artesian pressure which helps limit subsidence. The aquifers are a flow system with recharge infiltrating into the aquifers and water slowly flowing in the large aquifer storage volume from areas of recharge to areas or points (wells) of discharge.

Groundwater Quality

Water samples have been collected from wells for water chemistry analysis for over 40 years within the area. Water chemistry results obtained from the TWDB are given in *Table B-1* in *Task 3 - Appendix B*. Data in the table show that the groundwater in Wharton County is of good quality, particularly within LRWPA and that the quality has not changed significantly throughout the years. Total dissolved solids generally range from about 300 to 700 milligrams per liter (mg/L) with the principal constituents being calcium and bicarbonate with smaller amounts of sodium, chloride and sulfate. The water has been used principally for irrigation, domestic, municipal, manufacturing, and livestock supplies.

Aquifer Conditions

Groundwater conditions have been favorable and should continue to be favorable within the Lavaca Region for the pumping of substantial quantities of good quality water.

The Gulf Coast Aquifer was deposited in a manner that resulted in substantial thicknesses of sand that contain fresh (good quality) groundwater. The Gulf Coast aquifer has about 200 to 450 feet of sand that contains fresh water in Lavaca County. Sand thickness tends to be greater in the southeast portion of the county. In Jackson and Wharton counties, within LRWPA, the Gulf Coast aquifer contains about 300 to 700 feet of freshwater sands in most of the area. In the southern part of Jackson County, north of Lavaca Bay, a limited area of the aquifer has 0 to 200 feet of sand that contains freshwater of less than 1,000 mg/l total dissolved solids.

The estimated transmissivity for the Gulf Coast Aquifer, including the Chicot and Evangeline aquifers, ranges from about 6,000-24,000 gallons per day per foot (gpd/ft); indicating an aquifer that is capable of transmitting large quantities of water. This information is contained in the Texas Department of Water Resources Report 289 - "Digital Models for Simulation of Groundwater Hydrology of the Chicot and Evangeline Aquifers Along the Gulf Coast of Texas," (May 1985).

The development of large quantities of groundwater within the LRWPA has resulted in potentiometric head decline in the Gulf Coast Aquifer. Data in Report 289 (TDWR, 1985), combined with water level changes since about 1970, indicate that the potentiometric head in the Chicot aquifer has declined about 20 to possibly 80 or 120 feet since 1900 as a result of the pumping that has occurred in the area. For the Evangeline aquifer, about 20 to possibly 100 feet of potentiometric head decline has occurred since 1900 as the result of the withdrawals of groundwater. The depths interval screened by the large capacity wells in the Lavaca Region normally range from about 300 to 600 feet, with some well screening depths as deep as 1,200 to 1,400 feet. Static water levels measured in the wells normally range from about 50 to 120 feet. This illustrates that there is a substantial amount of available drawdown in the wells that will continue to sustain the overall pumpage in the region.

Subsidence Effects

Data show that small amounts of land surface subsidence have resulted from the withdrawal of groundwater that helps to support the economic viability of the Lavaca Region. Land surface subsidence is best described by: the artesian pressure in an artesian aquifer provides a buoyant effect that helps support the aquifer. When the water pressure is reduced, the buoyant effect is reduced and an additional load is transferred to the skeleton of the aquifer. The pressure difference between the sands and clays causes water to move from the clays to the sands resulting in a small amount of compaction of the clays. This in turn results in a small amount of subsidence of the land surface.

Land surface subsidence simulations given in Report 289 (TDWR, 1985), estimate a maximum of about 0.75 feet of subsidence in the southwest part of Wharton County and the very east part of central Jackson County for the period from 1900 to 1975. Lesser amounts down to 0.25 feet and less are estimated to have occurred in the north part of Jackson and Wharton counties for the same time period. Data contained in Report 270, (TDWR, 1982) show that about 0.2 feet of subsidence occurred in the town of Halletsville for the period from 1900 to 1973. Measured subsidence also shows a small area in the very southeast part of Jackson County where about 1.5 feet of subsidence occurred from 1900-1975 based on data contained in Report 289, (TDWR, 1985).

Very limited releveling to quantify the amounts of subsidence that have occurred since 1970 has been performed within the Lavaca Region. Water level hydrographs show that the static water levels in wells are similar to the levels measured in the mid 1970's and in some instances the static water levels are slightly higher. Pumpage within the LRWPA has decreased some since about 1980-1985 when it averaged about 209,300 acre feet per year. For the period from 1994-1997 pumpage averaged about 172,800 acre-feet per year based on data available from the TWDB. As discussed previously, the stabilization and slight rise in water levels in wells within the region is reflective of the stability and slight reduction in pumpage that has occurred within the last 15 years. With the combination of stable to reduced pumpages and stability or a slight rise in static water levels, it is estimated that subsidence within the region has been very small since the mid 1970's, although releveling data have not been collected to verify this. Releveling data from conventional surveying, or GPS surveying, should be developed to evaluate any land surface elevation changes in the Lavaca Region.

Groundwater Uses

Groundwater in the region is pumped for domestic, agricultural, municipal and industrial uses. In 1996, the Lavaca Region pumped approximately 206,744 acre-feet of groundwater for these purposes. Agricultural irrigation accounts for approximately 95 percent of the groundwater pumped in the region. Wells used for agricultural irrigation tend to be deeper than the more shallow wells used for pumping water for livestock purposes. Municipal and public usage, which includes usage for cities, communities, parks, campgrounds, and water districts, represents approximately 3.5 percent of the groundwater pumped. Less than 1 percent of groundwater pumped in the region is for industrial needs, including manufacturing and other industrial uses.

Public Groundwater Usage

The Lavaca Region relies on groundwater to provide all of the municipal water supply. This accounts for approximately 3.5 percent, or 7,319 acre-feet, of the groundwater used in the region in 1996. Within the region, Jackson County accounts for approximately 24.3 percent, or 1,778 acre-feet of the regions municipal groundwater usage; Lavaca County accounting for 45.6 percent, or 3,334 acre-feet; and Wharton County accounting for 30.1 percent, or 2,207 acre-feet. There are ten major municipal users scattered throughout the region. The major municipal users in Jackson County are the towns of Edna and Ganado and the County-Other category with approximately 43 percent, 13 percent and 44 percent of the county's municipal groundwater usage, respectively. The major municipal users in Lavaca County are Hallettsville, Moulton, Shiner, Yoakum and County-Other with approximately 24 percent, 6 percent, 14 percent, 19 percent and 37 percent of the county's municipal groundwater usage, respectively. The major municipal users in Wharton County are El Campo and County-Other with approximately 79 percent and 21 percent of the county's municipal groundwater usage. Municipal users represent cities and communities with a population over 500, while County-Other represents cities or communities with a population less than 500, parks, campgrounds and any water districts.

Agricultural Groundwater Usage

Data concerning groundwater pumpage in the LWRPA within Wharton County were obtained from the TWDB. A graph of pumpage beginning in 1950 for LWRPA within Wharton County is attached as *Figure 5*. Pumpage within LWRPA has averaged more than 80,000 acre-feet per year (ac-ft/yr) since 1967. From 1984 through 1997 pumpage within the region averaged about 81,600 ac-ft/yr with the principal usage being the irrigation of rice. The pumpage for rice irrigation is distributed throughout the region within Wharton County. The location of the region boundary in Wharton County is shown in *Exhibit 2*. This exhibit also shows the eastern portion of Jackson County which immediately joins Wharton County to the southwest.

In 1996, groundwater pumped for agricultural practices, principally irrigation, accounted for approximately 96 percent, or 198,811 acre-feet, of the groundwater pumped in the Lavaca Region. Groundwater was pumped to irrigate approximately 66,738 acres in the region in 1996. Of those 66,738 acres, 4,720 acres were in Lavaca County, 28,160 acres were in Jackson County and 33,858 acres were in Wharton County. In terms of the regions total agricultural groundwater pumpage, Jackson County accounted for about 40 percent, Lavaca County 10 percent, and Wharton County 50 percent of the groundwater pumped. Agricultural pumpage represents water that is used for livestock purposes and irrigation of crops. Groundwater used for irrigation represented approximately 99 percent of the groundwater pumped for agriculture in the region. The main crop is rice with small acreages of cotton, grain sorghum, soybeans, and corn also irrigated.

The regions agricultural irrigated areas are scattered throughout Wharton and Jackson counties and are concentrated in the southeast part of Lavaca County. Groundwater pumpage accounted for about 89 percent of the water supplied for irrigated agriculture. The remainder of the water was provided by surface water from creeks and rivers. Surface water was used in combination with ground water to irrigate some areas in south and west Jackson County and surface water from the Colorado River was used to irrigate about 1,500 acres in the northwest part of Wharton County.

Groundwater Summary

Groundwater accounts for approximately 90 percent of water supply in the LRWPA, providing water for all major usage categories – irrigation, domestic, municipal, manufacturing and livestock. Groundwater is obtained from the Jackson Group and Gulf Coast aquifer with very small amounts pumped from the Jackson Group. Water levels have fluctuated in the Gulf Coast aquifer, but show essentially no net static water level decline over the past 15 years. Although the region is heavily dependent on groundwater, few subsidence issues have occurred. Water from the aquifers continues to be of good water quality, a characteristic that has remained virtually constant over the last 40 years. The groundwater portions of *Tables 4* and *5* illustrate the abundance of groundwater in relation to surface water supplies and demonstrates that the region will continue to be heavily dependent on groundwater supplies.

Surface Water Supply

The LRWPA is located in the Lavaca, Colorado-Lavaca, and Lavaca-Guadalupe River Basins. Approximately 90 percent of the LRWPA is located in the Lavaca River Basin. A portion of the surface water supply is obtained from run-of-river water out of the Lavaca and Navidad rivers. These are the two main rivers in the region. The remaining surface water is obtained from Lake Texana. Lake Texana is the only reservoir in the region.

Run-of-river water from the Lavaca and Navidad rivers is used primarily for irrigation purposes. No surface water is currently being used within the region for municipal purposes and only a small amount is used for industrial purposes. *Table 1.1* shows firm yield amounts as calculated by the Lavaca Regional Water Planning Group (LRWPG). *Table 1.2* demonstrates the water right appropriations of rivers and creeks in the LRWPA. To see a further breakdown of the run-of-river supplies available to the Lavaca Region, refer to *Tables 4* and *5* in *Task 3 - Appendix A*.

Table 1.1: Firm Yields of LRWPA Rivers and Streams

Stream	**Permitted Authorization ac-ft/yr**	**DOR Amount (Firm Yield) ac-ft/yr**
Lavaca River	4,579.6	2,046.9
Navidad River	2,049.8	983.1
West Mustang	4,273.3	1,125.4
East Mustang	3,863.0	0
Sandy Creek	8,523.0	629.4
Pinoak Creek	6,061.2	1,638.70
Goldenrod Creek	3,241.0	0
Sutherland Branch	400	118
McFarland	3	0
Middle Creek	4.2	3.9
Porters Creek	2,985.8	0
Total	**35,989.9**	**6,545.4**

Lake Texana is the only reservoir in the LRWPA. It was developed as part of the Palmetto Bend Reclamation Project in 1968. Lake Texana has a firm yield of 79,000 acre-feet. Approximately 42,000 acre feet of this water is contracted for municipal use to Corpus Christi and its surrounding service area. Another 32,500 acre-feet is contracted for industrial use to Formosa Plastic Corp., Inteplast Corp., Central Power and Light Co., and Calhoun County Navigational District. Water rights which make these contracts possible are held by the Lavaca-Navidad River Authority (LNRA) and TWDB. The remaining 4,500 acre-feet of water is reserved for required releases for the bays and estuaries.

Water demand projections show that communities and entities within the LRWPA do not need additional surface water supplies. However, there are communities and entities outside of the Lavaca region that are experiencing supply needs that can be satisfied by the development of the Palmetto Bend Reservoir. To that end, the LRWPG has designated Palmetto Bend Stage II reservoir site as a unique reservoir site. *Exhibit 3* shows the location of the proposed Palmetto Bend Stage II site.

Surface Water Quality

The Lavaca River basin has sustained good water quality for aquatic life, as well as for municipal, industrial, and recreational users. The historical concerns associated with elevated nutrients, dissolved solids, and fecal coliforms have been or are currently being addressed by improvements to wastewater treatment plants, elimination of tidal disposal of oil field brine, and implementation of best management practices in the agricultural sector. Although the potential for eutrophic conditions exists, the Lavaca Basin has not experienced major concerns and has maintained acceptable dissolved oxygen levels. From the Regional Assessment of Water Quality, Lavaca Basin (1996), Lake Texana water quality is excellent. In the upper reaches of the reservoir, an increase in TSS was detected, as well as a slight increase of orthophosphate, but neither level was high enough to warrant management concerns.

Naturalized Flows and Water Availability Modeling

As part of the original Task 3 scope, it was proposed that the existing Lavaca River Water Availability Model would be executed and evaluated using naturalized flow information received from Texas A&M University (TAMU).

The intent of the Senate Bill 1 planning efforts was to use existing information to the greatest possible extent and, at the time the scope was written, it was expected that TAMU would provide naturalized flows for the Lavaca watershed area. It was also understood that there was a model of the watershed developed using an updated water availability modeling software package known as the Water Rights Analysis Package (WRAP) model developed by Dr. Ralph Wurbs with TAMU. The Lavaca model had been developed using WRAP by a TNRCC staff member working in Austin, and it was assumed that the model was operable and contained some updated data.

In addition to the information noted above, the LNRA also had a reservoir operations model which was developed to provide information to the LNRA on the delivery schedule for the water being transmitted to Corpus Christi. This model was developed by Don Rauschuber. It was the original intent of the scope of services to compare the input files of the Rauschuber model with the TNRCC WRAP model, to determine if there were major changes in the naturalized flows as developed by TAMU; and to discuss the effects those changes might have on the availability of firm yield water as well as interruptible water.

However, the contract to determine naturalized flows in the Lavaca Basin was not in place at the start of the study, and in fact was only recently let to the Bureau of Reclamation, instead of TAMU, to perform the analysis of the naturalized flows as well as to develop a model of the basin in the WRAP format. Also, the TNRCC WRAP based model could not be executed. It was also an older version of the software that did not account for environmental flows and did not include existing restrictions on some of the agricultural diverters.

As a result of the above limitations on the usability of the existing data, the actual Task 3 effort included the development of updated models in WRAP Version 3 and a subsequent update to Version 4. Several sources within the TNRCC and the TWDB were contacted and all indicated that the naturalized flow data in the TNRCC model had been taken from a previous TNRCC or TWDB model and that it was the best available dataset to use. The main drawback to the use of this data, however, is that the data was for a time period prior to the construction of Lake Texana.

A Fortran compiler was used to reconcile the revised models and as a result, the WRAP 4 model was successfully executed. The results of the modeling effort showed that Lake Texana is capable of meeting the firm yield supplies shown in it's permit and assigned under contract to a number of municipal and manufacturing entities.

The Bureau of Reclamation has produced a draft of the new naturalized flows for the basin and provided that information to the TNRCC who in turn provided it to the TWDB for transmittal as draft information to the LRWPG. However, the new naturalized flows are not allocated to the diversion points in the current model and a significant additional effort will be required to provide that breakdown. In addition, the flows were compared to the flows in the existing model and the variances appeared to be minor. As a result of this comparison, and the need to complete the LRWPA water plan within the time limits established by the regional planning process, the work on the interruptible flows available from the Lavaca watershed will continue using the existing naturalized flows that are currently in the model. If Bureau of Reclamation personnel provide additional naturalized flow information prior to the end of the regional planning process, that information will be incorporated into the surface water availability results if possible. If not, then the process will continue with the best available information.

As a result of the above situation, Task 3 is being submitted with the firm yield numbers shown by the initial modeling results.

Task 4 – Comparison of Demand and Supply to Determine Needs

4.1 Introduction

As a part of Task 4, the Texas Water Development Board (TWDB) requires the presentation of *Tables 7* and *8*. *Table 7* is a comparison of the current available supplies in *Table 5* (Task 3 Report) as allocated to a specific Water User Group (WUG), versus the established demands of those WUGs represented in *Table 2* (Task 2 Report). *Table 8* is the difference between *Table 6* (Task 3 Report), supply available to major water providers, and *Table 3* (Task 2 Report), the demand on the major water providers. *Table 8* also will show the amount of water that can be recalled to Jackson County from the City of Corpus Christi contract with Lavaca-Navidad River Authority (LNRA). *Tables 7, 8, 9* and *10* appear in *Task 4 - Appendix A*.

A significant portion of the information contained within this report was based on information published in the *Task 1 – Description of the Region*, Lavaca Regional Water Planning Group (LRWPG). For a complete and detailed list of sources, see *Task 1 - Appendix A – References*.

4.2 Surface Water Quality

Surface water supplies are available to the region from Lake Texana, the Lavaca and Navidad Rivers, and other small streams and creeks. There are no major springs in the region. The majority of the Lavaca Regional Water Planning Area (LRWPA) is located within the Lavaca River Basin. Lake Texana is the only reservoir in the planning area.

Waters in the Lavaca River basin have consistently been of good water quality. These waters maintain water quality standards to be used as municipal, industrial, and recreational waters. Additionally, the water quality is such that aquatic life is not threatened.

Historical water quality concerns have centered around elevated nutrient levels, dissolved solid levels, and fecal coliform counts. These issues have been, or are currently being addressed, by implementation of Best Management Practices (BMPs) in the agricultural sector. Improvements to wastewater treatment plants and the elimination of tidal disposal of oil field brine will also alleviate some of the water quality problems experienced in the past. Continued monitoring of dissolved oxygen (DO) levels in the upper reaches of the Lavaca and Navidad basins is advised to help document improvements in water quality.

The 1996 Texas Water Quality River Basin Assessments by the Texas Clean Rivers Program and Texas Natural Resource Conservation Commission (TNRCC) established the condition of each river and stream segment in the state and identified possible water quality concerns. The report found that, in the Upper Lavaca River, higher total suspended solids could be expected due to stormwater runoff and minor streambed erosion. There was reasonable concern that elevated phosphorus and fecal coliform bacteria might be present; therefore, contact recreation was not supported. In the Upper Navidad River, there was reasonable concern that fecal coliform originating from non-point sources might be present. There was also reasonable concern that phosphorus might be present in Lake Texana. Since 1996, numerous improvements to wastewater treatment facilities have been planned and implemented for the Lavaca River, and have contributed to improved water quality.

Non-point source pollution is still being evaluated along the Upper Navidad River, and the 1999 assessment is scheduled for revision in early 2000. Based on data gathered and provided by LBG Guyton, there are no concerns of poor water quality in the groundwater supplies used in this region.

4.3 Interruptible Flows

In addition to the firm yield flows that are available during the drought of record, reservoirs have larger quantities of water available during non-drought of record years. Since the additional quantities are not 100 percent reliable, these amounts are termed "interruptible flows." An analysis of interruptible flows, that are potentially available during wetter years, to current customers is currently being performed to identify potential additional surface water supply. This supply could be made available to neighboring regions so that existing groundwater supplies in the LRWPA could be preserved for use within the region.

An existing data set developed by TNRCC that was partially completed in a previous version of the Water Rights Analysis Package (WRAP) model was used as a starting point for this modeling effort. This model was updated to the current WRAP IV version using the naturalized flows that were in the original model. The data set developed by the TNRCC includes naturalized stream flows and evaporation data from 1940 to 1979, water right permits (permitted amount, type of permit, and priority dates) at various control-points, and Lake Texan elevation capacity information. The model data set covers 57 control points and 61 water right holders. While there was no documentation on how the naturalized flows in the model were computed, they were the best information available until Bureau of Reclamation completes the new naturalized flow analysis under contract to TNRCC. Bureau of Reclamation completed a draft computation of naturalized stream flows for the USGS stream gauging location in Lavaca-Navindad watershed and the Coastal Basin. This computation covers only three USGS stream gauging station in Lavaca-Navindad watershed. In order for these data to be used in WRAP model, the naturalized stream flow values at the gauging locations need to be distributed to the ungauged location of the remaining control points. Comparison of the new naturalized flows that have been developed by Bureau of Reclamation with the naturalized flows in the existing model at three common gauging points seem to indicate that the flows at the three common locations are similar. Because of the time constraints, it was not possible to wait until the Bureau of Reclamation completes the distribution of the naturalized flows to the ungauged locations, which are 54 control points. At the early stages of the modeling period, a meeting consensus was reached among the agencies involved (TWDB, TNRCC, LNRA, BuRec, TC&B and R.J. Brandes) to proceed with the modeling effort using the naturalized flows developed by TNRCC. However, the data set was updated to reflect the current water right permit conditions.

The revised data set includes the updated flow for bays and estuaries, as well as the permit conditions for a number of irrigators upstream of Lake Texana. When Lake Texana is above 43 feet elevation, these irrigators have permits to divert water upstream of the reservoir after some stream flow restrictions are met. The model has a capability to handle restrictions based on a triggered elevation, but it does not let a junior water right holder divert the permitted amount all the time based on a downstream reservoir triggered elevation that has a senior water right permit. Because of the model's limitation the upstream diversions of the junior irrigators could not be modeled as intended. For modeling purposes only, to get around this problem the priority dates for the upstream irrigators were altered to make them senior to Lake Texana. The modeling effort consists of two scenarios to compare the effects of the altered priority dates on the legally senior permit holders that divert water from the streams regardless of Lake Texana's storage level. The two scenarios are simulations using the legally permitted dates and the altered dates. Examination of the model output (before and after altered priority dates) of simulated diversions revealed that the change in priority dates did not have significant impacts on the diversion of the legally senior permit holders. Six water right holders in the simulation year 1942 in the months of March, April and May were affected. The effect varies and is a reduced diversion of 6 to 50 acre-feet per year for the six water right holders on the months of March, April, and May in 1942. However, the number of months that diversion occurred for the altered water right holders were improved by 10 to 35 percent during the simulation period. The average diversion amounts of the altered date water rights were also improved without affecting the end of reservoir content. *Table 1* summaries the results of simulated diversion of the junior water right holders that divert water upstream of Lake Texana before and after the priority dates were altered.

Table 1: Comparison of upstream diversions before and after the altered water right permits dates.

	Actual Water Right Dates			Water Right Dates Altered to Make it Senior to Lake Texana		
Water Right Holder	DIV	NODIV	CHECK	DIV	NODIV	CHECK
FEAPPL	21%	42%	37%	34%	42%	24%
BRANDL	21%	42%	37%	34%	42%	24%
EAWEIN2	21%	42%	37%	37%	42%	21%
GOFF	22%	42%	36%	58%	42%	0%
HANCO	22%	42%	36%	52%	42%	6%
TRRAUN	22%	42%	36%	46%	42%	12%
VANDI	23%	42%	35%	57%	42%	1%

DIV = Reservoir was above the 43 feet cut-off level and upstream diversion occurred
NODIV = Reservoir was below 43 feet cut-off level and no upstream diversion occurred
CHECK = Reservoir was above 43-feet cut-off level and no upstream diversion occurred

Table 1 is compiled by comparing the beginning of month simulated diversions with pervious month end-of-month reservoir content. From *Table 1*, for instance the months of upstream diversion of water right *FEAPPL* was improved by 13 percent, when the reservoir was above elevation 43-feet during the simulated period, when the priority date is altered to make the right senior to Lake Texana. By the same token, the number of months where upstream diversion could not take place, when the reservoir is above elevation 43-feet, was reduced from 37 to 24 percent. Insufficient naturalized stream flow and regulated stream flow requirements may be the main reason why the diversion could not take place all the time when the reservoir is above elevation 43 feet. The none-diversion months, when the reservoir was below 43 feet, were unchanged and remained at 42 percent of the time.

Interruptible Flow

In this modeling effort, an interruptible flow is defined as the amount of water that can be supplied from Lake Texana on interruptible basis. An analysis of interruptible flows was performed to look at potential supplies of water that could be used for a variety of purposes. The primary purpose of this analysis is to provide all possible assistance to neighboring regions to preserve existing groundwater supplies in the LRWPA.

The interruptible flow analysis also consists of two scenarios. On of the modeling effort looked at the amount of interruptible flow using the legally permitted dates of the upstream irrigators and the second scenario with the permit date altered to make the upstream divertors one day senior to Lake Texana. The results of these analyses are summarized in *Tables 2 and 3*. Both scenarios were performed based on the assumption that an additional foot of water could be stored in Lake Texana above the current maximum elevation of 44 feet. Given the approximately 10,589 surface acres of the lake when the elevation is 45 feet, this represents additional 10,589 acre-feet of water. In addition, this also allows the development of additional supplies during the summer months, when the need is greater.

To determine Lake Texana interruptible yields an additional most junior water right (Dummy water right - CORPUS2) and reservoir cut-off levels associated for this water right were coded in the input data set. The yearly amount is divided equally for each month by the use factor record. The model supplies water to the added junior water right after all required bay and estuary flows and senior water rights that take water from Lake Texana have been satisfied. The existing water rights and environmental flow-through requirements from Lake Texana are:

City of Corpus Christi	41,840 ac-ft/year
Other municipalities	772 ac-ft/year
Industries	31,888 ac-ft/year
Total	**74,500 ac-ft/year**

Environmental flow through requirement 343,212 ac-ft/year when the reservoir capacity is above 78.18% and 5 cfs or 3,260 ac-ft/year when the reservoir capacity is below 78.18%.

After every simulation the output was checked to confirm there are no shortages for the existing water rights and environmental flows. If there are shortages, the reservoir cut-off level associated with the dummy water right is adjusted accordingly to optimize interruptible supply. *Table 2, Table 3* and *Figure 1* summarize the results of the analyses. The reliabilities, standard deviations, and the confidence intervals in *Table 2* and *Table 3* are calculated from the actual diversions of the simulated period. From these analyses, the interruptible yield of Lake Texana is dependent on the associated reliability. For instance, from *Table 2*, in any give year of any given month of the simulated period, 872 acre-feet per month (10,464 acre-feet/year) could be expected at a reliability of approximately 83 percent. Higher interruptible yield has a lower reliability and vise-versa, *Figure 1*. The interruptible yield of approximately 12,000 acre-feet per year with an approximately reliability of 80% is a reasonable amount that may warrant development of a delivery system. This amount includes the existing 4,500 acre-feet per year already permitted to LNRA on an interruptible basis and can be supplied with some shortages. The analysis of the model output from the altered dates did not significantly affect the reliabilities of the interruptible yield, *Table 3*.

The conclusions that were reached from this effort are that the interruptible water documented by this process is not 100 percent reliable, and cannot be expected to relieve any shortages in the LRWPA without adding storage. Since economics is the main driver for the agriculture industry, addition of storage to firm up this yield and the development of pipelines to distribute the yield to the points of need are cost prohibitive. However, piping this water to a remote demand center such as Corpus Christi, is feasible during high demand periods, particularly if the water can be stored in the reservoir for up to 45 days.

Figure 1: Interruptible yield of Lake Texana and associated reliabilities using the legal priority dates.

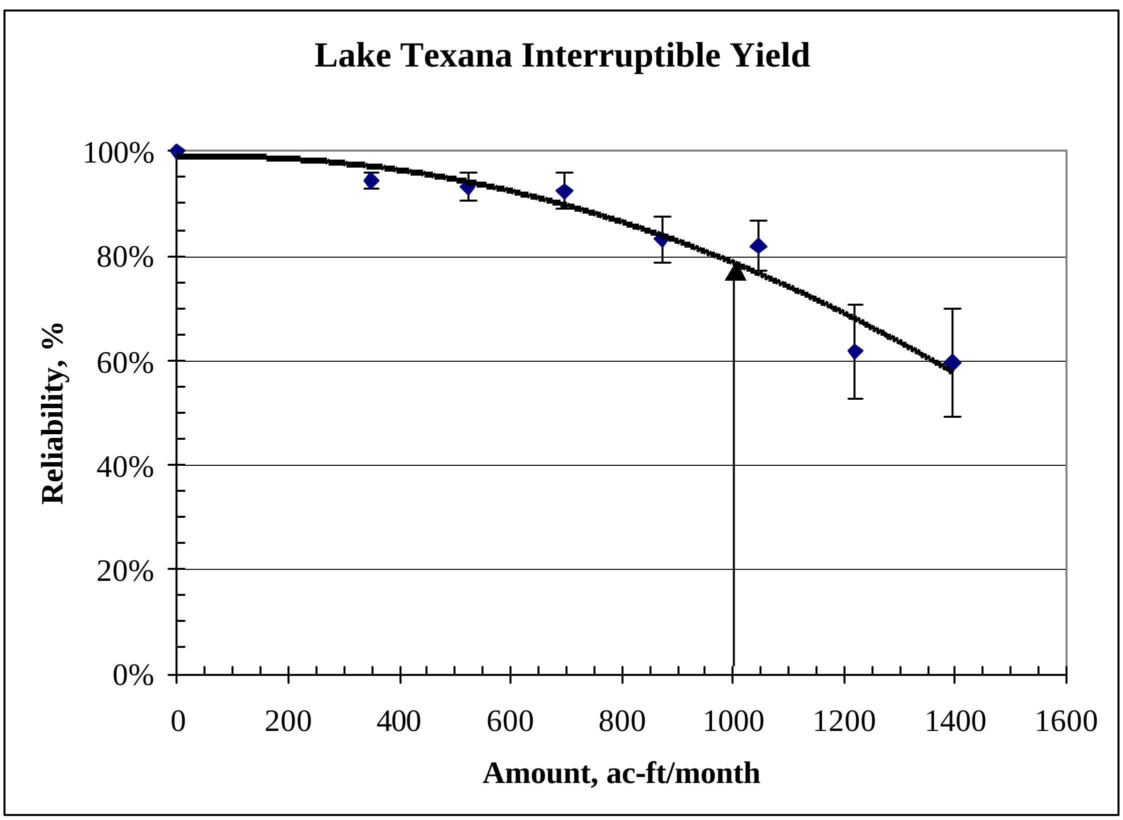

Table 2: Interruptible supply and the associated reliability of Lake Texana using the permitted priority dates of the upstream irrigators.

Reservoir cut-off level					
Storage, ac-ft	Elevation, ft	Amount ac-ft/month	Reliability	Standard Deviation	90% confidence interval
NA	NA	0	100.00%	0.00%	0.00%
88,000	36.00	349	94.38%	1.55%	1.16%
92,000	36.57	523	93.13%	2.64%	1.96%
93,000	36.71	697	92.29%	3.45%	2.56%
113,000	39.32	872	83.13%	4.28%	3.18%
115,000	39.56	1046	81.88%	4.66%	3.47%
138,000	42.20	1220	61.67%	9.13%	6.79%
140,000	42.41	1395	59.58%	10.27%	7.64%

Table 3: Interruptible supply and the associated reliability of Lake Texana using the altered dates of the upstream irrigators.

Reservoir cut-off level					
Storage, ac-ft	Elevation, ft	Amount ac-ft/month	Reliability	Standard Deviation	90% confidence interval
NA	NA	0	100.00%	0.00%	0.00%
88,000	36.00	349	94.17%	1.95%	1.45%
92,000	36.57	523	93.13%	2.64%	1.96%
93,000	36.71	697	92.08%	3.34%	2.49%
113,000	39.32	872	82.92%	4.37%	3.25%
115,000	39.56	1046	81.67%	4.44%	3.30%
138,000	42.20	1220	61.46%	9.38%	6.98%
140,000	42.41	1395	59.38%	10.51%	7.81%

Palmetto Bend Stage II Reservoir Firm Yield

Several simulations were carried out to determine the firm yield of the proposed Palmetto Bend Stage II Reservoir on the Lavaca River. The storage capacity curves for Palmetto Bend Phase II were added to the existing model referenced above, and demands were assigned to determine what level of demand caused the reservoir to become nearly empty during the drought of record. Based on this preliminary analysis the firm yield of the reservoir is approximately 50,000 acre-feet per year without considering any storage loss due to sediment accumulation. This estimate is consistent with the other studies reviewed. In 1965, the Bureau of Reclamation calculated a yield of 30,000 acre-feet per year after 100 years of sediment accumulation, which was estimated at 22,000 acre-feet. In 1991 HDR revised the firm yield of the reservoir to 48,171 acre-feet per year for initial conditions and 43,355 acre-feet per year after 40 years of sediment accumulation.

4.4 Significant Environmental Water Needs

There are significant environmental needs within the region. These water needs are required in order to maintain natural habitats for the numerous threatened and endangered species indigenous to the area. Specific threatened and endangered species, with their Latin names, are listed in *Task 1 – Description of the Lavaca Regional Water Planning Area*.

LNRA operates Lake Texana to provide freshwater inflows for the bay and estuary, in order to reduce high salinity events in Lavaca Bay and to protect coastal habitats. Approximately 4,500 acre-feet per year of the firm yield of Lake Texana is reserved to cover the mandated releases for bays and estuaries during low streamflow conditions. LNRA has a total annual target release of 346,346 acre-feet per year for bays and estuary releases.

In addition, the extensive areas of rice production produce large areas of habitat for waterfowl during the annual waterfowl migrations, as well as populations of non-migratory species. Nineteen different species of birds have been observed in flooded rice fields, and 20 species observed in flooded irrigation canals. Altogether, the rice prairies in the coastal bend region support more than two million wintering waterfowl, including many species of migratory shore and water birds, birds of prey, and native sparrows

4.5 Significant Threats to Agriculture and Natural Resources

The most significant current threat to agriculture is the economic viability of the industry. Rice production is currently facing a difficult situation with regard to the price of the product and the ability of the rice producers to keep up with changes in the technology while at the same time being able to stay in the business. Production of rice requires significant expenditures in equipment and field preparation and significant quantities of water. With the very narrow margin currently available given the recent prices paid for rice, any increase in the cost of water could impact the ability of the rice farmers to continue production. As mergers and restructuring of the milling and manufacturing industry continues, any reduction in quantities of rice produced places increased pressure on these companies to continue to reevaluate the profitability of their locations. If a rice mill in a local area is closed, then it costs the farmer more to get his product to a mill, and further increases the cost.

In contrast to the current situation, there is the prospect of significant improvement in the rice industry situation through the use of improved varieties of rice, the short term expansion of the ratoon crop acreage, and the increased disease resistance of the improved seed stock which will potentially allow a reduction in the time between rice plantings. Currently, rice is planted in a three year rotation. If the time between planting rice in a particular field can be reduced to two years, this represents a 50 percent increase in acreage which could be planted. At the same time, there are advances in water conservation which can be implemented to stretch existing supplies further. As noted above, increasing the number of acres or rice will have the added benefit of producing additional area for wildlife habitat. The primary challenge will be to hold on to as much of the rice acreage as possible under the current economic situation to prevent further significant losses of milling capacity and related transportation issues that will make it harder to take advantage of the improvements in varieties and yield when they are available.

Threats to natural resources are less well defined. However, if the rice industry is severely reduced, the habitat for the waterfowl and other birds mentioned previously will be similarly reduced. The region is not facing rapid population growth, or the competition for natural resources that accompanies such growth, as the total municipal water demand is approximately 2 percent of the regional total. However, continued economic pressure on the rice industry to reduce water use will have a potential carryover effect on streamflow through reduced irrigation return flows.

4.6 Impacts of Water Quality on Utilization of Water Supplies

There are currently no water quality issues that limit the usability of water throughout the planning area. As the aquifer dips toward the coast, there are some quality issues and some quantity issues in the southern part of Jackson County. There are also wells in the region that serve the Alcoa plant outside the region that are affected by heavy pumpage to the extent that they produce increasingly salty water during extended dry weather conditions. For the rest of the region, however, all municipal supplies are of good quality and the water produced is high quality irrigation water. The water in Lake Texana, while subject to higher turbidity loadings because of the predominance of clay particles in the watershed, is low in dissolved solids and is highly desirable for industrial customers seeking low solids boiler feedwater and process water. Further details on quality of the various sources are contained in water quality sections of the Task 3 report for both surface and groundwater.

4.7 Subsidence Conditions*

Data collected and analyzed by LGB-Guyton Associates show that small amounts of land surface subsidence have resulted from the withdrawal of groundwater in the Lavaca Region. Land surface subsidence simulations given in Report 289 (TDWR, 1985), estimate a maximum of about 0.75 feet of subsidence in the southwest part of Wharton County and the very east part of central Jackson County for the period from 1900 to 1975. Lesser amounts down to 0.25 feet and less are estimated to have occurred in the north part of Jackson and Wharton counties for the same period. Data contained in Report 270, (TDWR, 1982) show that about 0.2 feet of subsidence occurred in the town of Halletsville for the period from 1900 to 1973. Measured subsidence also shows a small area in the very southeast part of Jackson County where about 1.5 feet of subsidence occurred from 1900-1975 based on data contained in Report 289, (TDWR, 1985).

Very limited releveling has been performed within the Lavaca Region to quantify the amounts of subsidence that have occurred since 1970. Water level hydrographs show that the static water levels in wells are similar to the levels measured in the mid 1970's and in some instances the static water levels are slightly higher. Pumpage within the LRWPA has decreased some since about 1980-1985 when it averaged about 209,300 acre feet per year. For the period from 1994-1997 pumpage averaged about 172,800 acre-feet per year based on data available from the TWDB. As discussed previously, the stabilization and slight rise in water levels in wells within the region is reflective of the stability and slight reduction in pumpage that has occurred within the last 15 years. With the combination of stable to reduced pumpage and stability and a slight rise in static water levels, it is estimated that subsidence within the region has been very small since the mid 1970's, although releveling data have not been collected to verify this. Releveling data from conventional surveying, or GPS surveying, should be developed to evaluate any land surface elevation changes in the Lavaca Region.

Given the discussion presented above, and the action taken by the LRWPG to limit the amount of water taken from the aquifer under normal conditions to sustainable annual yield, it does not appear that further pumpage limitations are warranted. In addition, there is currently no mechanism for limiting the pumpage in the area until or unless groundwater management district(s) is or are formed. If such districts are formed, it is anticipated that one of their goals would be to limit the withdrawal to the sustainable flow, which will further help to stabilize the aquifer. As a result, it does not appear that additional controls are currently warranted for the prevention of subsidence

4.8 Surpluses and Shortages in the LRWPA

Surpluses and shortages for the LRWPA are shown in *Tables 7* and *8*. The region has 5 water user groups with shortages. These shortages include a manufacturing shortage in one basin that is adjacent to a basin with in the region with a surplus of manufacturing water, and the remaining shortages are either in livestock watering or irrigation. The primary reason for the both the livestock and irrigation shortages is that the analysis required the development of all the demands, but included only the firm yield supplies available to the area. Determination of firm yield requires a watershed and storage capacity analysis that is far beyond the scope of any farm pond or stock tank analysis. In addition, a number of the permits in tributaries to the Navidad River contain limitation that prohibit diversions when the level of water in Lake Texana reaches elevation 43. As a result, the demands of these entities are seen as shortages. This does not mean that there is any less water than there has been in the past, or that any water has been taken away from anyone. It means only that some WUGs are relying on supplies that will not be available under drought of record conditions.

4.9 Socio-Economic impacts of Not Meeting Water Needs.

Upon request from the LRWPG, TWDB staff completed an analysis of the social and economic impacts of not meeting the water needs as identified in *Table 7*. *Tables 9* and *10* were prepared by TWDB and are located in *Task 4 - Appendix A*. The report, in its entirety is located in *Task 4 - Appendix B – Socio-Economic Report*. [Note: Per TWDB, these totals were revised to reflect changes in *Table 7* as a result of the final analysis of supplies and shortages in the region. The original analysis by the Board uses numbers presented in the IPP. While the text of the Board's report remains unchanged, *Tables 9* and *10* have been revised.]

The current level of shortages result in a total impact on employment of 999 fewer jobs than unrestricted development would provide in 2010. By 2030, the gap in job growth widens to 1006 and by 2050, reaches 1017.

With limited job potential in the region, the population growth will be restricted, and migration from the region can be expected. By 2010, the region could expect 1,800 fewer people, 2,000 fewer in 2030, and 2,200 in 2050. By 2050, the expected population would be 3 percent lower than projected in the region's most likely growth forecast.

The potential loss of economic development in the region amounts to less than 2 percent less income to people in the region over the planning period than is currently projected assuming no water restrictions.

A summary of the cost impacts per acre foot is shown below.

Table 1: Socio-Economic Cost Impacts Summary ($/acre-foot)

Shortage:	Impact on:	2000	2010	2020	2030	2040	2050
Jackson Manufacturing Basin 15	Business	-	-	606,557	606,154	606,050	606,084
	Income	-	-	152,459	152,923	152,941	152,928
Jackson Irrigation Basin 15	Business	251	251	251	251	250	250
	Income	70	70	70	70	70	70
Jackson Irrigation Basin 16	Business	266	242	257	265	229	146
	Income	66	81	86	88	46	46
Jackson Livestock Basin 17	Business	13,514	13,514	13,514	13,514	13,514	13,514
	Income	4,730	4,730	4,730	4,730	4,730	4,730
Lavaca Livestock Basin 16	Business	13,580	13,580	13,580	13,580	13,580	13,580
	Income	4,691	4,691	4,691	4,691	4,691	4,691
Wharton Irrigation Basin 15	Business	252	246	240	263	256	248
	Income	63	62	60	58	57	55
Wharton Irrigation Basin 16	Business	252	251	250	253	250	251
	Income	70	68	66	70	67	70

4.10 Conclusions

The surplus and shortages analysis for the LRWPA shows that supplies of water available are of good quality for their intended uses and that shortages do occur in some areas, none of which is in the municipal category. The primary challenge of the management strategies will be to find supplies of reasonably priced water to replace non-reliable supplies that are currently being used.

TASK 5 – IDENTIFICATION AND EVALUATION OF WATER MANAGEMENT STRATEGIES

Introduction

The Lavaca Regional Water Planning Area (LRWPA) is small geographically, and has a municipal water demand that is less than 3 percent of the total water usage. The predominant water usage in the region is for agricultural uses, with approximately 96 percent of the total usage dedicated to irrigation and livestock consumption. Of the agricultural usages, the predominant use is for rice irrigation.

Public Participation

As a result of the small geographic area and the relatively small population, the Lavaca Regional Water Planning Group (LRWPG) members are highly visible and well known representatives of the interests of water users in the region. The individual group members provided a liaison with identified associations, such as the Soil and Water Conservation Districts, the Farm Service Agencies in the counties, the Farm Bureau, and similar organizations. In addition, individual group members, staff members of the Lavaca Navidad River Authority (LNRA), and members of the consultant team made numerous presentations to other regional planning groups, and to civic organizations such as the Lion's Clubs, Kiwanis Clubs, Rotary Clubs, and Chambers of Commerce throughout the regional planning area and in neighboring regional planning areas where LNRA customers were located. Initial contacts were made by several group members with school districts within the area, but no specific programs were developed as a result of these contacts. Copies of graphical presentations were made available to the audience showing the information developed in the planning process to facilitate public interaction. In addition, in order to provide opportunity for input by the general public into the process prior to the selection of the management strategies, three public meetings were held, one in each of the counties. A fourth meeting was held at the regular LRWPG meeting time with special invitations given to all of the municipal water user groups (WUGs) in the area to elicit input concerning the assessment of the surpluses and shortages. Presentation materials tailored to the particular interest groups were prepared for each of the events noted above.

Description of Surpluses and Shortages

The evaluation of the surpluses and shortages revealed that there are four shortages in the planning area. The water management strategies considered for meeting the four shortages identified are included in *Table 11* in *Task 5 - Appendix A – TWDB Tables*. All of the shortages were for either irrigation or livestock consumption.

The group members were polled concerning the criteria posted by the Texas Water Development Board in the planning guidance memorandums and in *Exhibit B*. However, the consensus of the group is that while all of the criteria listed were important, the overriding criteria for agricultural shortages had to be cost. These was no perceived benefit in outlining additional alternatives which provided social or environmental benefits if the cost made the water unaffordable for agricultural use. This is particularly true for the Lavaca Regional

Water Planning Area, since there are no municipal shortages, and therefore there is no need for municipalities in the area to pay for on-farm conservation practices in exchange for the water conserved. As a result, the management strategies presented included a narrative discussion of environmental pros and cons, but if the water was beyond the ability of the agricultural community to purchase and use, then no attempts were made to further refine the costs for those alternatives.

Management Strategies

The planning group and their consultants identified the existence of significant quantities of groundwater stored in the Gulf Coast aquifer within the limits of the region. Because of the sensitivity of agricultural producers to the price of the water, additional attention was paid to the issue of sustainable use to prevent the drawdown of the water table to the point that the water would be unavailable to agriculture from a pumping cost standpoint. The converse of this assumption, however, is that the groundwater is available in the area, and that municipal and industrial users had the necessary funding to drill their wells deeper and pay the increased costs of electricity for pumping from greater depths. As a result, it was assumed that the municipalities and the industrial WUGs had the assurance that they would have sufficient supply. Furthermore, since the municipal and manufacturing usages within the planning region comprised less than 4 percent of the total usage, this assumption would not cause the increased drawdown of the static and pumping water levels to the point that the remaining water would be unavailable for agricultural uses.

The primary evaluation criteria established by the LRWPG was cost and the minimization of capital expenditures for water provided, since there is no readily available source of capital for agricultural water procurement, and limited ability of agricultural operations to repay loans if loans were available. The Group concurred that the price of the water obtained had to be the overriding criteria. In this instance, if the cost of a project was beyond the ability of agriculture to pay for, either through the need for environmental mitigation or the capital cost necessary to provide infrastructure, no further analysis was appropriate.

The management strategies considered for meeting the specific needs included overpumping the aquifer during times of shortages of interruptible surface water supplies, coupled with recovery of the aquifer levels during periods when sufficient surface water is available; reuse of municipal wastewater treatment plant effluent for irrigation purposes; conservation of water by reconstruction of canals to eliminate or reduce seepage and evaporation, leveling of rice fields, and other techniques for on-farm water use reduction; conversion of two of the larger cities in the region to surface water; and provision of alternative supplies to water short neighboring regions.

Specific strategies evaluated included pumping additional groundwater, using wastewater effluent from Edna, Ganado, and El Campo for irrigation, converting Edna and Ganado to surface water, building Palmetto Bend Phase II and constructing a line from the lake to the irrigation areas in northern Jackson and western Wharton counties, and building a desalination facility and a surface water treatment plant to supply neighboring region's needs to reduce the potential for movement of in-region groundwater supplies. The individual strategies and their costs and environmental impacts are contained in *Task 5 - Appendix B – Management Strategies and Impacts*.

The selected strategy as shown in *Table 12* (*Task 5 - Appendix A*) is the pumping of additional amounts of groundwater to meet agricultural needs during dry years and using surface water when it is available to let the aquifer recover. There were no shortages for the LNRA as the major water provider, so *Table 13* is not included.

Pumping of additional groundwater beyond the sustainable yield was the lowest cost alternative. Since there are no springs in the area with the higher water demands, this option also maintains the current status with regard to the environment by allowing the flooding of rice fields to continue and return flows to continue without diminishing. In addition, the area has seen static water levels in earlier years that are as low or lower than the levels predicted to occur if dry years coincide with maximum rice production. As a result of the lowering of many of the irrigation wells pumps during that earlier period, it was assumed that no capital costs would be incurred since the wells have already been modified to meet the lower water table conditions. This is an important factor, since there are no municipal or manufacturing WUGs with shortages which would be a source of capital investment to make farm irrigated field water saving modifications in return for conserved water.

Because of the extreme sensitivity of agricultural users to the cost of water, there are no additional strategies that were developed. Agricultural users cannot afford the cost of water from new reservoirs for firm yield, although the development of new reservoirs would result in some additional interruptible water that could potentially be used for agricultural purposes if it could be provided economically. For much of the region, groundwater is used as the primary source of irrigation water, so large scale canal systems do not exist. The cost of building canals or pipelines would make widespread distribution of any interruptible water uneconomical. The planning group identified groundwater shortages in two of the three counties, and a small groundwater surplus in Lavaca County.

It should be noted that the analysis of demand and supply was done assuming certain acreages were in agricultural production during the drought of record conditions. The overpumping will occur only if peak agricultural production is combined with drought of record hydrological conditions. It is possible that the acreages of rice grown would be reduced during record drought conditions to the extent that pumping of the aquifer beyond the sustainable yield amounts would not occur. As a result, even the costs for pumping at greater lifts for the water used would not materialize. For planning purposes, however, it is prudent to assume that these costs would be incurred during the drought of record conditions.

An analysis of the interruptible flows from Lake Texana was conducted as a part of this process. This analysis determined that there are approximately 12,000 acre-feet of interruptible flows in Lake Texana at least 80 percent of the time. This amount includes the existing 4,500 acre feet of interruptible water already permitted to the LNRA. This water could potentially be provided to a neighboring entity with a shortage. However, this water could only provide firm yield if storage is provided by the potential user prior to the point of use.

Planning level costs were estimated for the conversion of both Edna and Ganado to surface water to meet the municipal demand. Unit costs were based on information contained in the South Central Texas Region Water Supply Options report produced by HDR Engineering. On a planning level, the probable cost for the conversion to surface water is approximately $738 per acre-foot per year. This estimate includes a intake structure, lift station pumping, conveyance lines, a Level 3 (conventional treatment) plant, ground storage, yearly operation and maintenance cost, energy costs, possible studies (feasibility, environmental, etc.), and engineering contingencies. The assumption was also made that the available water from Lake Texana would be the municipal portion allocated currently to the City of Corpus Christi, but recallable by Jackson County and made available to the regional treatment plant at the same cost that Corpus Christi is currently paying for the water. The proposed plant would be located at a suitable site south of Hwy 59 and west of Lake Texana. It is assumed that only major conveyance lines would be needed to tie into the existing distribution systems of the two cities. By converting the municipal water demand to surface water, groundwater currently being used to meet this demand can be utilized for other demands. Since the conversion efforts noted above will result in only 2,000 acre feet annually of groundwater reduction, the effects on groundwater pumpage, aquifer drawdown, and subsidence are expected to be negligible.

Interbasin Transfer Evaluation

The selected management alternative of pumping additional groundwater during drought conditions does not contemplate the movement of water from one basin to another. This alternative is used to meet all of the needs of the basins within the Lavaca Regional Water Planning Area. The desalination facility, proposed to serve the needs of Region L, was developed as a means of protecting the Lavaca Region groundwater. This alternative is not a management strategy for serving needs in the Lavaca Region; hence, no interbasin transfer is needed to meet the Lavaca Region's needs. If the desalination project is developed further and becomes a part of the Region L plan, the needs of the basin of origin will have to be considered at that time. Based on the 50 year needs test, the Lavaca Regional Planning Area has an overall shortage of water and there is no water available to meet the needs of any basin outside the regional planning area.

Selected Strategy

Based on the analysis, the only management strategy that was acceptable to the agricultural community was to pump additional quantities of groundwater above the sustainable yield during drought conditions, and to use interruptible surface water supplies whenever such supplies were available, to allow the aquifers to recover and minimize the cost impacts of additional drawdown. This strategy met the requirement that capital expenditures be minimized, and it provided additional water throughout the area at a cost that was not greatly in excess of the cost of groundwater production from current wells. In addition, this strategy is appropriate for both the short term and the long term needs, as the additional experience gained throughout each planning cycle will better define the accuracy of the agricultural demands and whether or not the current level of demands continue to be felt in the Region.

Groundwater Management Districts

The powers and duties of 35 groundwater management districts were summarized in a table showing financing methods, district powers, regulated well spacings, and amount of allowable groundwater pumpage. It was estimated that a single county groundwater management district could be operated with a full time manager, a secretary, and office space for approximately $150,000 per year. However, savings are anticipated if several counties join together either under common management or as contractors with a single entity providing the contract services.

A review of the information provided by the groundwater management districts indicated that those districts with pumping limitations based them on pumpage in the region prior to the district formation. If per acre allocations were less than the amount of water that was needed for rice irrigation, for example, then those limitations would effectively eliminate rice production in the area. As a result, the per acre pumping limitation, if based on rice production, would not reduce the amount of water pumped if all property owners exercised their rights.

The formation of a groundwater management district or districts may not prevent the export of water outside the regional planning area boundaries. However, the imposition of well spacing requirements and the application of a pumping duty per acre would significantly increase costs of any entity trying to export water outside the region, and could make that alternative less attractive to a water short area.

Local contractors were contacted and the types of wells that they customarily drill were discussed. Cost for drilling and equipping an irrigation well, including pump, motor, and necessary equipment was estimated at $150,000. Output from this type of well is approximately 2,000 gallons per minute, and the well is estimated to be approximately 800 to 1,000 feet deep. Average costs for municipal wells of approximately 1,000 to 1,500 gpm of capacity is $350,000 and can go up to $500,000 depending on the drilling depth.

Drought Contingency Plans and Water Master Program Impacts

The Lavaca-Navidad River Authority is the sole major water provider in the Lavaca Regional Water Planning Area, and the Authority and all of its customers, including Formosa Plastics Corporation, the Inteplast Group, Point Comfort, and the City of Corpus Christi all have current drought contingency plans. Of the Authority's customers, only the Inteplast Group is located within the Lavaca Regional Water Planning Area.

The only existing basinwide drought contingency plan is that prepared and used by the Lavaca Navidad River Authority for its municipal and industrial customers. The plan was revised by the LNRA to include the required trigger levels and a copy is provided in *Task 5 - Appendix C – LNRA Drought Contingency Plan*.

The current Water Master program, for surface water supplies was discussed in detail with the planning group members. The consensus of the group was that the Water Master Program has had a beneficial effect by monitoring that water which is being diverted by those with a legal right to that water. This maximizes reliability for existing rights holders in the regional planning area.

Groundwater Drought Contingencies

Municipal users within the Lavaca Region are essentially all obtaining water from the Gulf Coast Aquifer. However, as noted previously, the amount of municipal usage represents only 2 percent of the total regional water usage. The municipal users in Wharton and Jackson Counties have previously experienced water levels that are significantly lower than they currently are and were in the same range as the water level declines predicted under full irrigation usage during drought of record conditions. As a result, the municipal wells already have pumps set to withdraw water from lower pumping levels as needed. For this reason, the recommended management strategy for the municipal users is to monitor water levels and compare to the year 2000 water levels in at least one well per city or town. When the static water levels in the early part of spring each year in the wells being monitored decline on average more than 40 feet below levels measured in the spring of 2000 then the municipality or water supplier should consider drought contingency measures. The amount of static water level decline required to trigger consideration of drought contingency measures should be subject to revision depending on the growth of a city and whether it begins to provide water to unincorporated areas outside the municipality. Most all of the wells providing water to municipalities are 600 to 900 feet deep with static water levels in the range of 80 to 150 feet showing that there is a large amount of available drawdown from the present static water level to the top of the well screened intervals.

A second trigger mechanism should be developed based on the capacities of the wells, transmission lines, pumping equipment and distribution systems. When the required capacity of any one component exceeds 80 percent of the available capacity of that component, drought contingency measures should be triggered.

For either trigger, the drought contingency measures that should be considered include the following components:

1. Initial Stages
    a. Reduction in outdoor watering uses by city personnel, including vehicle and equipment washing, except for necessary repairs
    b. Elimination of any washing of driveways or vehicle containment areas
    c. Reduction in outdoor watering of City landscapes.

   d. Reduction in water for sprinkling roadways and/or roadway construction
   e. Requests for voluntary reductions in outdoor watering and washing of vehicles at individual residences by the general public
2. Moderate stage – when static water levels fall an additional 10 feet, or total capacity of any one component exceeds 85 percent usage
   a. Prohibition of outdoor washdown of slabs, vehicles, for city workers and residents
   b. Mandatory outdoor watering restrictions for no more than two days per week with watering to occur outside peak system demand hours.
   c. Request voluntary conservation by public in both indoor and outdoor uses
   d. Institution of increasing step rate structure to discourage consumption
3. Severe Stage – static water levels drop an additional 10 feet, or capacity of one or more system components reaches 90 percent of total capacity
   a. Prohibition on outdoor watering
   b. Closing of public swimming pools
   c. Prohibition on filling private swimming pools
   d. Institution of penalties for consuming over fixed percentage of average of three past years monthly usage for the same month.

The above listing is a suggested approach only and is not intended to be an exhaustive listing of all of the potential strategies.

For manufacturing users, the same approach can be taken to monitor water levels in one or more wells, and then to begin reducing water uses not directly related to manufacturing output, instituting water saving measures in the plant processes, and scaling back or curtailing operations during a severe drought.

It was noted previously that the economics of using groundwater for irrigation is such that drawdown in excess of the 40 feet mentioned in the municipal contingency requirements will cause marginal producers to reconsider planting rice, as well as to forego the ratoon (second) crop. For this reason, the irrigation usage is self limiting, and as the primary usage declines it is anticipated that the level of decline in the water tables will slow or stop altogether.
It should also be noted here that the effects of the drought contingency plan to limit the usage of water will also potentially reduce the amount of irrigation return flow and wastewater effluent reaching the area streams during the time when those flows are needed most. While it is necessary to ensure that the systems maintain adequate supplies to get through a drought, the environmental consequences should not be totally ignored, particularly when the area does have the groundwater that is available to it.

Water Conservation

As noted in Task 4, there are no municipal WUGs with shortages. In addition, while water conservation by municipalities is encouraged, the significance of even a 20 percent reduction in municipal use, when applied to the 3 percent of total usage that municipal usage comprises, results in a 0.6 percent savings overall. Further, most of the municipalities have standby well capacities so that they can provide the maximum daily demand with the largest well out of service. Since the anticipated growth in total population is only 10,000 persons, it is not anticipated that conservation savings will result in significant savings over the 50 year planning horizon.

On the agricultural side, conservation savings would not result in a reduction of capital expenditures, but a forced expenditure of funding to garner any savings. As noted previously by several of the group members, there is a finite upper limit to the amount of money that can be spent to conserve agricultural water, and still be supported by on-farm income. There are no municipalities within the planning area that are in need of additional supplies that cannot be supported by groundwater. Neighboring regions with needs tend to have much larger needs than could be supported by savings in groundwater for irrigation purposes. As an example, if 20 percent of the total irrigation water used in Jackson County could be conserved by the canal and on-farm conservation practices outlined in the management strategies, the net effect is that the usage would be reduced to the sustainable yield of the aquifer and there would still not be any surplus to be marketed under the drought of record conditions. With total usage of approximately 100,000 acre-feet annually, the savings would only result in 20,000 acre-feet of available water annually even under the best of conditions. The needs of neighboring basins are such that much larger projects are needed to provide economical costs for new supplies.

Increased conservation in agricultural irrigation would have a potentially negative impact on streamflows in the area. However, the impact of increasing conservation would not effect streamflow as much as the decisions of individual farmers to plant or not to plant rice in a particular year. The more efficient usage of available supply may reduce habitat if canals with current plant growth and wildlife harborage are converted to pipelines, or are lined to reduce seepage and plant growth. However, the high cost of conservation and the lack of funds to pay for it makes large scale conservation projects unlikely. If it occurs, some mitigation could be required. However, current practice allows a farmer to fully utilize all of his irrigation allocation without regard to return flows. Return flows are required only if there is not a specific use for the water. As long as all of the water is beneficially used, the farmer is not required to return it, and it is difficult to determine what form mitigation would take if it is required.

Bay and Estuary Flow and the Environment

Use of the WRAP IV water availability model prepared for this project estimated that the yield of Palmetto Bend Phase II is approximately 50,000 acre-feet per year without consideration for sediment storage. In addition, the recent recalculation of bays and estuary flows indicate that the flows currently being released from Lake Texana will be sufficient to provide the necessary bay and estuary releases, so the 50,000 acre feet of available yield from Phase II is not reduced further for environmental flows. Updating the most recent cost estimates for Phase II to second quarter 1999 costs results in an estimated cost of raw water from the reservoir at approximately $400 per acre foot. As noted previously, only those alternatives that provided a cost of water of $150 per acre foot or less were given serious consideration as management strategies for in-region usage.

The Gulf Coastal Plains support a wide variety of animal species. The following is a list of identified threatened and endangered species potential found in the region.

<u>Threatened</u>	
Peregrine Falcon, Arctic	*Falco peregrinus tundrius*
Reddish Egret	*Egretta rufescens*
White-faced Ibis	*Plegadis chihi*
White-tailed Hawk	*Buteo albicaudatus*
Wood Stork	*Mycteria americana*
Texas Horned Lizard	*Phrynosoma cornutum*
Indigo Snake	*Drymarchon corais erebennus*
Reticulated Collared Lizard	*Crotaphytus reticulatus*
Sheep Frog	*Hypopachus variolosus*
Plains Spotted Skunk	*Spilogale putorius interrupta*
<u>Endangered</u>	
Bald Eagle	*Haliaeetus leucocephalus*
Brown Pelican	*Pelecanus occidentalis*
Peregrine Falcon, American	*Falco peregrinus anatum*
Whooping Crane	*Grus americana*
Red Wolf	*Canis rufus*
Black-spotted newt	*Notophthalmus meridionalis*
Rio Grande Lesser Siren	*siren intermedia texana*

Inflow needs for the Matagorda Bay system are estimated at 346,200 acre-feet per year to maintain fisheries and 27,100 acre-feet per year to maintain minimum salinity requirements from the Lavaca River Basin. For the Lavaca-Tres Palacios Estuary, 418,800 acre-feet per year are required to maintain salinity requirements and 797,900 acre-feet per year to sustain fisheries from freshwater inflows of the Lavaca River Basin.

Acceptability of Projects Not Specifically Mentioned in the LRW Plan

The Lavaca Regional Water Planning Group recognizes that there may be projects that are not mentioned specifically in the plan but that are not in opposition to any of the planning efforts made. Per the request of the TWDB, the Group is including the following statement in the adopted regional plan:

Water supply projects that do not involve the development of or connection to a new water source are consistent with the regional water plan even though not specifically recommended in the plan.

In the same regard, the Group is including the following statement for the TNRCC as well:

Surface water uses that will not have a significant impact on the region's water supply are consistent with the regional water plan even though not specifically recommended in the plan.

TASK 6: RECOMMENDATIONS

Introduction

The Lavaca Regional Water Planning Group (LRWPG) has made the following recommendations regarding unique ecological stream segments and unique reservoir sites. Additionally, the group has considered the creation of regulatory entities in accordance with legislative and regional water policy issues.

Unique Stream Segments and Reservoir Sites

The LRWPG designated the Palmetto Bend Phase II reservoir site on the Lavaca River as a Unique Reservoir Site. This site is currently permitted and awaiting the development of sufficient funding and a purchaser for the water created in order to move forward. It was evaluated as one of the management strategies for the region's agricultural shortages. No designation of unique stream segments was made as the LRWPG desired to have additional information on the potential impacts of such designation. Group members are still considering this designation process.

Creation of Regulatory Entities

The shortages that were noted in the region were primarily agricultural shortages that were spread throughout the region. Development of the management strategies demonstrated that even if a new source of water were made available, the cost of transporting that water to the point of use makes the cost marginal for agricultural usage. For the Palmetto Bend Phase II option, the cost of transporting the water to the farms in northern and eastern Jackson County and western Wharton County was approximately $108/acre-foot. As a result, the type of management authority that could be created to most positively impact the shortages is a groundwater management district which would conserve the existing groundwater.

Information on 35 existing groundwater management districts was collected and placed into a spreadsheet to summarize the features of the districts, including their method of fee or tax assessment, well spacings, pumpage limitations, and other features. A copy of this spreadsheet is contained in *Task 6 – Appendix A – Conservation District Information*. The LRWPG voted in favor of a resolution to support the creation of groundwater management districts to protect and conserve the available groundwater supplies.

Comments were made in the public meetings concerning the need for management of the groundwater resources. Many of the commenters were concerned that there would not be enough water to meet the needs of the Lavaca area and that attempts would be made to locate water in the basin for export to neighboring regions with shortages. Concerns were also expressed regarding the differentiation between the water in the major aquifers and the shallower water sands that are used by many rural residents for private wells. The shallower sands areal coverage varies widely and limited data exists to identify the sands. It was impressed upon the planning group that there is concern that these supplies be protected as well.

There is a significant diversity of opinion within the region concerning groundwater management districts and their application in the area. A participant at one of the public meetings expressed the concern that the groundwater management districts were being formed for the express purpose of developing plans to market groundwater outside the LRWPA. The LRWPG members reiterated that the intent of the resolution, in support of groundwater management districts, was to protect and conserve groundwater resources in the region and in no way was it intended to support the movement of groundwater out of the region.

Desalination of Lavaca Bay Water for a Neighboring Region

In an effort to protect groundwater resources in the Lavaca Region, the LRWPG in conjunction with the TWDB, Texas Parks and Wildlife Department, the Texas Natural Resource Conservation Commission, Texas General Land Office, and the Texas Department of Agriculture funded the *Investigation of the Joslin Steam Electric Station for Co-Location of a Desalination Facility*. This study conducted by Turner Collie & Braden Inc., U.S. Filter, Dr. George Ward, Attorney Doug Caroom and HDR Engineering Inc., with assistance from Central Power and Lighting personnel, assessed the technical and economic feasibly of desalination of Lavaca Bay waters to create a new and viable water resource. This study in its entirety is located in *Task 6 – Appendix B – Desalination Report*.

Regulatory Entities and the LNRA

The LNRA was created under Article 16, Section 59 of the Texas Constitution. It is a conservation and reclamation district of the State of Texas, and it was created in August 1959. The authorizing legislation is codified in Vernon's Annotated Texas Civil Statutes as Article 8280-131. The boundaries of the Authority area are the same as those of Jackson County, and the Authority's purpose is to control, store, preserve, and distribute storm and flood waters, and the waters of the rivers and streams of Jackson County, and their tributaries, for all useful and beneficial purposes. The Authority does not have the specific power to develop and manage groundwater in the area under Chapter 36 of the Texas Water Code. However, the Authority does have the ability to contract for the management responsibilities of legally constituted groundwater management districts in Jackson and nearby counties.

Discussion of a groundwater management district has received mixed reaction from the public in the LRWPA. The LRWPG has gone on record supporting the creation of groundwater management districts. These districts would be created for the purpose of conserving and protecting the groundwater resources within the LRWPA. As previously stated, there is concern from the public that these districts are being considered in order to develop and market groundwater resources outside of the LRWPA.

Related Legislation

Members of the LRWPG and the consultant team monitored water related legislation, and particularly the legislation related to groundwater management districts during the 1999 legislative session. Periodic updates on water related legislation were provided to group members. Bills containing the groundwater management district legislation for two of the three counties in the planning area were withdrawn during the session because of changes to the bills that were unacceptable to the individual counties. Efforts to reintroduce these bills during the upcoming legislative session in January 2001 are continuing.

Proposed Regulatory Changes or Resolutions

The primary concern of the LRWPG has been the protection of existing groundwater sources to maintain the agricultural production in the area because of its direct economic impact to the area. The LRWPG considered and approved nine policy resolutions as a result of the experiences of the planning process. These policy recommendations and rationales for the proposals are located in *Task 6 – Appendix C – Policy Recommendations*. The nine policies supported by the LRWPG are:

- Environmental Issues – the continuing investigation, evaluation and research to mitigate or minimize potential impacts to the environment in conjunction with the desalination of Lavaca Bay water and the development of the Palmetto Bend Phase II to address demands for freshwater.
- Ongoing RWPG Activities – a recommendation to the Texas Legislature to continue funding and the existence of the regional water planning groups through the TWDB.
- Conservation – the support of existing and continued efforts of agricultural producers to practice good stewardship of surface and groundwater resources of the State.
- Sustainable Yield – sustainable yield of the Gulf Coast Aquifer should be included in the State Water Plan as the amount of available water. It should be noted however, that the Lavaca Regional Water Plan allows for short-term overpumping during period of drought conditions, with supply to be replenished through diminished pumping during normal rainfall periods.
- Rule of Capture – supports the Rule of Capture for groundwater in the State of Texas, with the understanding that local control can be exercised through the formation of groundwater conservation districts.
- Junior Water Rights – supports the "Junior Water Right" provisions in Senate Bill 1 (1997) and opposes any modification or elimination thereof.
- Groundwater Management – introduced early in the planning process, supports the efforts of the area to develop groundwater management districts. Groundwater management districts represent the only currently available means to protect and conserve groundwater resources.

- Groundwater Export Fees – establishment of an export fee to help offset the in region impacts of transferring water out of the region.
- Limits for Groundwater Conservation Districts – sustainable yield of the Gulf Coast Aquifer should be used by all groundwater conservation districts in the region as the upper limit of groundwater available for all uses.
- Desalinization Project – to counter demands for groundwater, the LRWPG recommends the state help finance a full-scale desalinization project to meet growing municipal demands in neighboring regions.

Task 7: Public Involvement

Public Involvement in Developing the Lavaca Regional Water Plan

The Lavaca Regional Water Planning Groups (LRWPG) approach to public involvement has been to secure early participation of interested parties so that concerns could be addressed as the plan is being developed. From its initial deliberations, the LRWPG has made a commitment to an open planning process and has actively solicited public input and involvement in developing the elements of the regional water plan. This has been accomplished by pursuing several avenues to gain public involvement.

The first line of public involvement occurs through the membership of the LRWPG. As a result of the small geographic area and the relatively small population, the Lavaca Regional Water Planning Group (LRWPG) members are highly visible and well known representatives of the interests of water users in the region. The individual group members provided a liaison with identified associations, such as the Soil and Water Conservation Districts, the Farm Service Agencies in the counties, the Farm Bureau, and similar organizations. In addition, individual group members, staff members of the Lavaca Navidad River Authority (LNRA), and members of the consultant team made numerous presentations to other regional planning groups, and to civic organizations such as the Lion's Clubs, Kiwanis Clubs, Rotary Clubs, and Chambers of Commerce throughout the regional planning area and in neighboring regional planning areas where LNRA customers were located. Initial contacts were made by several group members with school districts within the area, but no specific programs were developed as a result of these contacts. Copies of graphical presentations were made available to the audience showing the information developed in the planning process to facilitate public interaction. In addition, in order to provide opportunity for input by the general public into the process prior to the selection of the management strategies, three public meetings were held, one in each of the counties. A fourth meeting was held at the regular LRWPG meeting time with special invitations given to all of the municipal water user groups (WUGs) in the area to elicit input concerning the assessment of the surpluses and shortages. Presentation materials tailored to the particular interest groups were prepared for each of the events noted above.

Members of the LRWPG and personnel from the Lavaca-Navidad River Authority (LNRA) attended various other regional planning meetings and meetings of community and civic organizations to present findings and decisions made by the group.

Public Meetings

A public meeting was held on June 23, 1998 to introduce the concept of this regional planning effort and to discuss the scope of services. A questionnaire was circulated in the region prior to this first meeting, asking for input on problem areas related to water supply. The majority response was that the area had good quality water and they wanted to protect and preserve their rights to continue to enjoy their supply. These responses set the theme for most of the subsequent deliberations by the RWPG and has been adhered to by them throughout the process. A round of meetings was held to discuss population and water demand determinations prior to submitting the revised population and demand numbers to the TWDB requesting approval of the changes. In conjunction with public input and planning group findings, revised population and demand projections were submitted to the Texas Water Development Board. These revisions were accepted by TWDB in July 1999. A second, more recent round of public meetings was held in July of 2000 to present the evaluation of surpluses and shortages, present the list of proposed management strategies to be evaluated and to gather input from the constituents of the Lavaca Regional Planning Area. Three public meetings were scheduled so that each portion of the region had the opportunity to attend a meeting at a convenient location. Meetings were held in El Campo, Edna, and Hallettsville. Copies of the meeting minutes from each location are included in *Task 7 – Appendix A – Meeting Minutes*.

Public Information Sources

TWDB hosts a website that contains information provided to them, as well as the listing of the LRWPG members. The address for that website is www.twdb.state.tx.us. Additionally, the LNRA also maintains a website that contains the names and telephone numbers of all of the LRWPG members. That website address is http://lnra.org.