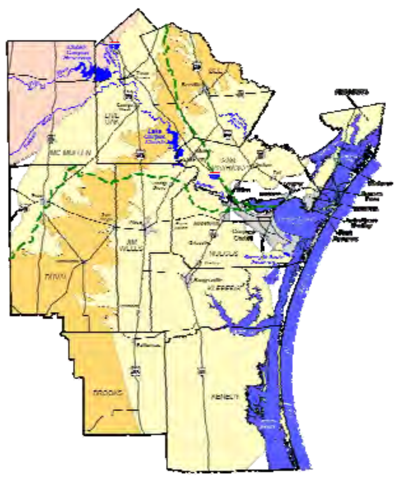
Coastal Bend
Regional Water Planning Area
Region N

Regional Water Plan
Volume I
Executive Summary and Regional Water Plan



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Texas Water Development Board

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September 2010

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Coastal Bend Regional Water Planning Area

2011 Regional Water Plan

Acknowledgements

The thoughtful consideration, input, public service, and direction of the members of the Coastal Bend Regional Water Planning Group is gratefully acknowledged in producing the water plan for this diverse planning area.

Coastal Bend Regional Water Planning Group

Voting Members

Co-Chair	Ms. Carola Serrato, South Texas Water Authority	Water Utilities Representative
Co-Chair	Mr. Scott Bledsoe III, Live Oak UWCD	Water Districts Representative
Interim Secretary	Mr. Bernard Paulson, Port Authority	Other Representative
	Mr. Tom Ballou, Sherwin Alumina	Industry Representative
	Mr. Chuck Burns, Rancher	Agricultural Representative
	Ms. Teresa Carrillo, Coastal Bend Bays Foundation	Environmental Representative
	Mr. Billy Dick, City of Rockport	Municipal Representative
	Mr. Lavoyger J. Durham	Counties Representative
	Mr. Gary Eddins	Electric Generating Utilities Representative
	Dr. Pancho Hubert, Tejas Veterinary Clinic	Small Business Representative
	Mr. Pearson Knolle	Small Business Representative
	Mr. Robert Kunkel, Lyondell Basell	Industry Representative
	Mr. Thomas M. Reding, Jr., Nueces River Authority	River Authorities Representative
	Mr. Charles Ring	Agricultural Representative
	Mr. Mark Scott, City of Corpus Christi Councilmember At Large	Municipal Representative
	Mr. Bill Stockton	Counties Representative
	Ms. Kimberly Stockseth	Public Representative

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Ms. Virginia Sabia	Texas Water Development Board
Mr. George Aguilar	Texas Department of Agriculture
Dr. Jim Tolan	Texas Parks and Wildlife Department
Mr. Tomas Dominguez	USDA – NRCS
Mr. Con Mims, Nueces River Authority	South Central Texas RWPG
Mr. Robert Fulbright	Rio Grande RWPG
Mr. Haskell Simon	Lower Colorado RWPG

The efforts, long hours, and diligence is specially noted and appreciated of these individuals:

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Ms. Frankie Kruckemeyer	Nueces River Authority
Ms. Beth Almaraz	Nueces River Authority
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Coastal Bend Regional Water Planning Area

Regional Water Plan

This Regional Water Plan is released for planning purposes on September 1, 2010 by HDR Engineering, Inc., 8404 Indian Hills Dr., Omaha, NE 68114, Registration No. F-754 and the following individuals presented below.

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List of Acronyms

acft	acre-feet
acft/yr	acre-feet per year
ASR	Aquifer Storage and Recovery
BEG	Bureau of Economic Geology
BMPs	Best Management Practices
CA	Certificate of Adjudication
CaCO3	Calcium Carbonate
CBBEP	Coastal Bend Bays and Estuaries Program
CBRWP	Coastal Bend Regional Water Plan
CBRWPG	Coastal Bend Regional Water Planning Group
CCR/LCC	Choke Canyon Reservoir/Lake Corpus Christi
cfs	cubic feet per second
CGCGAM	Central Gulf Coast Groundwater Availability Model
DFCs	Desired Future Conditions
EPA	U.S. Environmental Protection Agency
IPP	Initially Prepared Plan
GAM	Groundwater Availability Model
GCD	Groundwater Conservation District
GLO	General Land Office
GMA	Groundwater Management Area
gpcd	gallons per capita per day
GPM or gpm	gallons per minute
kW-hr	kilowatts hours
LCC	Lake Corpus Christi
LEPA	Low Energy Precision Application
LESA	Low Elevation Spray Application
LNRA	Lavaca-Navidad River Authority
LOUWCD	Live Oak Underground Water Conservation District
MAG	Managed Available Groundwater
MGD or mgd	million gallons per day
mg/L	milligrams per liter
MSA	Metropolitan Statistical Area
msl	mean sea level
MUD	Municipal Utility District
N/A	not available <u>or</u> not applicable
NEAC	Nueces Estuary Advisory Council
NPDES	National Pollutant Discharge Elimination System
NRA	Nueces River Authority
NTU	Nephelometric Turbidity Units
NUBAY	Lower Nueces River Basin and Estuary Model
NWF	National Wildlife Federation
O&M	Operation and Maintenance
PPD	Pounds per day
psi	pounds per square inch

List of Acronyms (Concluded)

REIS	Regional Economic Information System
RWP	Regional Water Plan
RWPG	Regional Water Planning Group
SB1	Senate Bill 1
SPMWD	San Patricio Municipal Water District
STWA	South Texas Water Authority
TCEQ	Texas Commission on Environmental Quality
TDS	Total Dissolved Solids
TOES	Texas Organization for Endangered Species
TPDES	Texas Pollutant Discharge Elimination System
TPWD	Texas Parks and Wildlife Department
TSSWCB	Texas State Soil and Water Conservation Board
TWDB	Texas Water Development Board
TxDOT	Texas Department of Transportation
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation
USFWS	United States Fish & Wildlife Service
USGS	United States Geological Survey
UWCD	Underground Water Conservation District
WAM	Water Availability Model
WCID	Water Control and Improvement District
WMS	Water Management Strategies
WRAC	Water Resources Advisory Committee
WRAP	Water Rights Analysis Package
WSC	Water Supply Corporation
WTP	Water Treatment Plant
WUG	Water User Group
WWP	Wholesale Water Provider
WWTP	Wastewater Treatment Plant

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Coastal Bend (Region N) Regional Water Plan

Executive Summary

ES.1 Background

Since 1957, the Texas Water Development Board (TWDB) has been charged with preparing a comprehensive and flexible long-term plan for the development, conservation, and management of the State's water resources. The current state water plan, *Water for Texas, January 2007,* was produced by the TWDB and based on approved regional water plans pursuant to requirements of Senate Bill 1 (SB1), enacted in 1997 by the 75th Legislature. As stated in SB1, the purpose of the regional water planning effort is to:

> "Provide for the orderly development, management, and conservation of water resources and preparation for and response to drought conditions in order that sufficient water will be available at a reasonable cost to ensure public health, safety, and welfare; further economic development; and protect the agricultural and natural resources of that particular region."

SB1 also provides that future regulatory and financing decisions of the Texas Commission on Environmental Quality (TCEQ) and the TWDB be consistent with approved regional plans.

The TWDB divided the state into 16 planning regions and appointed members to the regional planning groups. As shown is Figure ES-1, the Coastal Bend Region (Region N) includes 11 counties. The Coastal Bend Regional Water Planning Group (CBRWPG) has a total of 17 voting members. The members represent 11 interests or stakeholders (Public, Counties, Municipalities, Industry, Agriculture, Environmental, Small Business, Electric Generating Utilities, River Authorities, Water Districts, and Water Utilities), serve without pay, and are responsible for the development of the Coastal Bend Regional Water Plan (Table ES-1).

The CBRWPG adopted bylaws to govern its operations and, in accordance with its bylaws, selected the Nueces River Authority to serve as its administrative agency (Qualified Political Subdivision) to: (1) Develop scopes of work; (2) Apply for TWDB planning grants; (3) Contract with the TWDB for the grants; and (4) Manage the development of the Regional Water Plan.

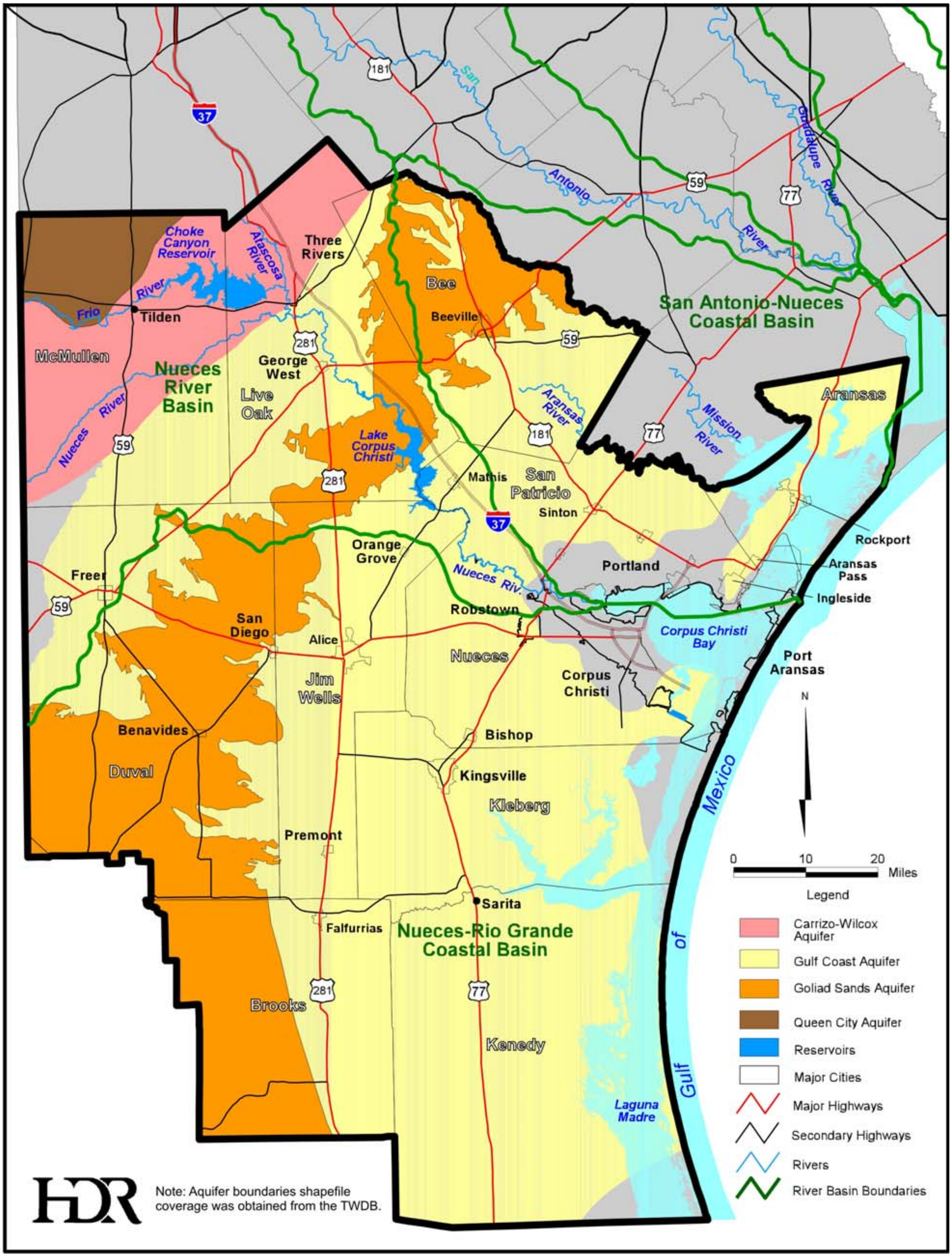

Figure ES-1. Coastal Bend Regional Water Planning Area

Table ES-1.
Coastal Bend RWPG Members
(as of January 2010)

Interest Group	*Name*	*Entity*
Voting Members		
Agriculture	Mr. Charles Ring	
	Mr. Chuck Burns	Rancher
Counties	Mr. Bill Stockton	
	Mr. Lavoyger J. Durham	
Electric Generating Utilities	Mr. Gary Eddins	
Environmental	Ms. Teresa Carrillo	Coastal Bend Bays Foundation
Industry	Mr. Tom Ballou	Sherwin Alumina
	Mr. Robert Kunkel	Lyondell Basell
Municipalities	Mr. Billy Dick	City of Rockport
	Mr. Mark Scott	City of Corpus Christi Councilmember
Other	Mr. Bernard Paulson, Executive Committee	Port Authority
Public	Ms. Kimberly Stockseth	
River Authorities	Mr. Thomas M. Reding, Jr., Executive Committee	Nueces River Authority
Small Business	Dr. Pancho Hubert	
	Mr. Pearson Knolle	
Water Districts	Mr. Scott Bledsoe III, Co-Chair	Live Oak UWCD
Water Utilities	Ms. Carola Serrato, Co-Chair	South Texas Water Authority
Non-Voting Members		
	Ms. Virginia Sabia	Texas Water Development Board
	George Aguilar	Texas Department of Agriculture
	Dr. Jim Tolan	Texas Parks and Wildlife Department
	Mr. Tomas Dominguez	USDA – NRCS
Liaison, South Central Texas RWPG	Mr. Con Mims	Nueces River Authority
Liaison, Rio Grande RWPG	Mr. Robert Fulbright	
Liaison, Lower Colorado RWPG	Mr. Haskell Simon	
Staff	Ms. Rocky Freund	Nueces River Authority

Pursuant to Regional and State Water Planning Guidelines (Texas Administrative Code, Title 31, Part 10, Chapters 357 and 358), the CBRWPG developed the 2001 and 2006 Regional Water Plans, which were then integrated into Water for Texas – 2002 and 2007, respectively, by the TWDB. The 2011 Coastal Bend Regional Water Plan, of which this Executive Summary is a part, represents the second update of a plan as presently required to occur on a five-year cycle. The TWDB will integrate this Regional Water Plan into a State Water Plan to be issued in 2012.

This executive summary and the accompanying *Regional Water Plan* convey water supply planning information, projected needs in the region, proposed water management strategies to meet those needs, and other findings. The report is provided in two volumes. Figure ES-2 shows the contents of each volume.

ES.2 Description of the Region

The area represented by the Coastal Bend Region includes the following counties: Aransas, Bee, Brooks, Duval, Jim Wells, Kenedy, Kleberg, Live Oak, McMullen, Nueces, and San Patricio (Figure ES-1). The Coastal Bend Region has four regional Wholesale Water Providers: the City of Corpus Christi (City), San Patricio Municipal Water District (SPMWD), South Texas Water Authority (STWA), and Nueces County Water Control and Improvement District #3 (Nueces County WCID #3). The City, the largest of the four, sells water to two of the other regional water providers—SPMWD and STWA. The City and the SPMWD distribute water to cities, water districts, and water supply corporations for residential, commercial, and industrial customers. STWA provides water to cities and water supply corporations that supply both residential and commercial customers within the western portion of Nueces County as well as Kleberg County. The smallest regional wholesale water provider, Nueces County WCID #3, provides water to the City of Robstown and other rural municipal entities in the western portion of Nueces County. The major water demand areas are primarily municipal systems in the greater Corpus Christi area, as well as large industrial (manufacturing, steam-electric, and mining) users primarily located along the Corpus Christi and La Quinta Ship Channels. Based on state surveys[1] of industrial water use, industries in the Coastal Bend area are very efficient in their water use. For example, petroleum refineries in the Coastal Bend area use on the average 60 percent less water to produce a barrel of refined crude oil than refineries in the Houston/Beaumont area.

[1] Texas Water Development Board, "Industrial Water Use Efficiency Study," 1993.

Volume I: Executive Summary, Regional Water Plan, and Appendices

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Volume II: Water Management Strategies

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Figure ES-2. Plan Structure

Copies of Volumes I and II are filed at each County Clerk's office and at one public library in each county. Copies of individual sections can be obtained by calling the Nueces River Authority at (361) 653-2110.

In addition to the work contained in the two volumes of the *Regional Water Plan*, other important products produced as part of the Coastal Bend planning effort include the Phase I studies. These included the following reports, which are summarized in Appendix B:

Study 1 – Evaluation of Additional Potential Regional Water Supplies for Delivery through the Mary Rhodes Pipeline, Including Gulf Coast Groundwater and Garwood Project

Study 2 – Optimization and Implementation Studies for Off-Channel Reservoir

Study 3 – Implementation Analysis for Pipeline from CCR to LCC, Including Channel Loss Study Downstream of Choke Canyon Reservoir

Study 4 – Water Quality Modeling of Regional Water Supply System to Enhance Water Quality and Improve Industrial Water Conservation

Study 5 – Region-Specific Water Conservation Best Management Practices (BMPs)

The Coastal Bend Region depends mostly on surface water sources for municipal and industrial water supply use. The two major surface water supply sources include the Choke Canyon Reservoir/Lake Corpus Christi System (CCR/LCC System) in the Nueces River Basin and Lake Texana on the Navidad River in Jackson County. The water quality of these sources is generally good. However, there are some areas of concern, specifically within the Lower Nueces River and the Calallen Pool, where the bulk of the region's water supply intakes are located.

There are some areas in the region that are dependent on groundwater. There are two major aquifers that lie beneath the region—the Carrizo-Wilcox and Gulf Coast Aquifers. The Gulf Coast Aquifer underlies all counties within the Coastal Bend Region and yields moderate to large amounts of both fresh and slightly saline water. The Carrizo-Wilcox Aquifer only underlies parts of McMullen, Live Oak, and Bee Counties and contains moderate to large amounts of either fresh or slightly saline water. The Yegua-Jackson is an official minor aquifer and covers parts of McMullen, Live Oak, and Bee counties within the Coastal Bend Region.

In 2000, the population of the Coastal Bend Region was 541,184 with a regional average per capita income of $19,833, ranging from $14,876 in Brooks County to $26,458 in McMullen County.[2] By 2007, the estimated population for the Coastal Bend Region was 549,686 with a regional average per capita income of $27,518, ranging from $20,887 in Bee County to $33,970 in Nueces County.[3] The Corpus Christi Metropolitan Statistical Area, consisting of Aransas, Nueces, and San Patricio Counties, accounts for 75 percent of the Coastal Bend Region's population and 79 percent of the total personal income. In 2007, the total personal income in the Coastal Bend Region was nearly $17.3 billion.[4,5]

The primary economic activities within the Coastal Bend Region include oil/gas production and refining, petrochemical manufacturing, military installations, retail/trade, agriculture, and service industries including health services, tourism/recreation industries, and governmental agencies. In 2007, these industries employed nearly 311,000 people in the Coastal Bend Region with annual earnings over $11.1 billion.[6] The services sector had the biggest economic impact in 2007, with an economic contribution of $3.8 billion, while employing 48%

[2] U.S. Department of Commerce Bureau of Economic Analysis, REIS Database, 2007.
[3] Ibid
[4] Ibid.
[5] Total personal income includes net earnings, dividends, and personal transfer receipts. Personal transfer receipts are government payments to individuals, including retirement and disability insurance and medical services.
[6] U.S. Department of Commerce Bureau of Economic Analysis, REIS Database, 2007.

of the total workforce within the Region. The petrochemical and refining industries had total compensation to employees of almost $600 million in 2007.

ES.3 Population and Water Demand Projections

For the 2011 Coastal Bend Regional Water Plan, the TWDB did not issue new population or water demand projections due to the lack of new Census data. The Coastal Bend RWPG did request a water demand revision for irrigation in Bee and San Patricio Counties. This is discussed further in Section 2.3.5. In all other cases, the population and water demand projections remained identical to the 2006 Regional Water Plan as developed by the TWDB. Population projections were developed for cities with a population greater than 500, water supply corporations and special utility districts using volumes of 280 acft or more in 2000, and 'county-other' to capture those people living outside the cities or water utility service areas for each county. Water demand projections were developed by type of use: municipal for cities and water supply corporations/special utility districts (along with a 'county-other' for each county), and countywide for manufacturing, steam-electric, mining, irrigation, and livestock.

ES.4 Population Projections

Figure ES-3 illustrates population growth in the entire Coastal Bend Region for 1990 and 2000 and projected growth for 2010, 2020, 2030, 2040, 2050, and 2060. In 2060, the population of the Coastal Bend Regional Water Planning Area is projected to be 885,665.

As can be seen in Figure ES-4, the average annual growth rate of the region over the 50-year planning period is 0.82 percent. San Patricio and Nueces Counties have growth rates higher than the regional average, while the other counties have lower growth rates than the average, and in the case of McMullen County, negative growth rate.

ES.5 Water Demand Projections

Water demand projections have been compiled for six categories of water use: (1) Municipal, (2) Manufacturing, (3) Steam-Electric Cooling, (4) Mining, (5) Irrigation, and (6) Livestock.

Water User Groups

Each of these consumptive water uses is termed a "water user group" according to Senate Bill 1. Incorporated cities and County-Other category are water user groups within the Municipal Use category. County-Other category includes persons residing outside of cities and also outside water utility boundaries. Water demand projections and supplies have been estimated for all water user groups.

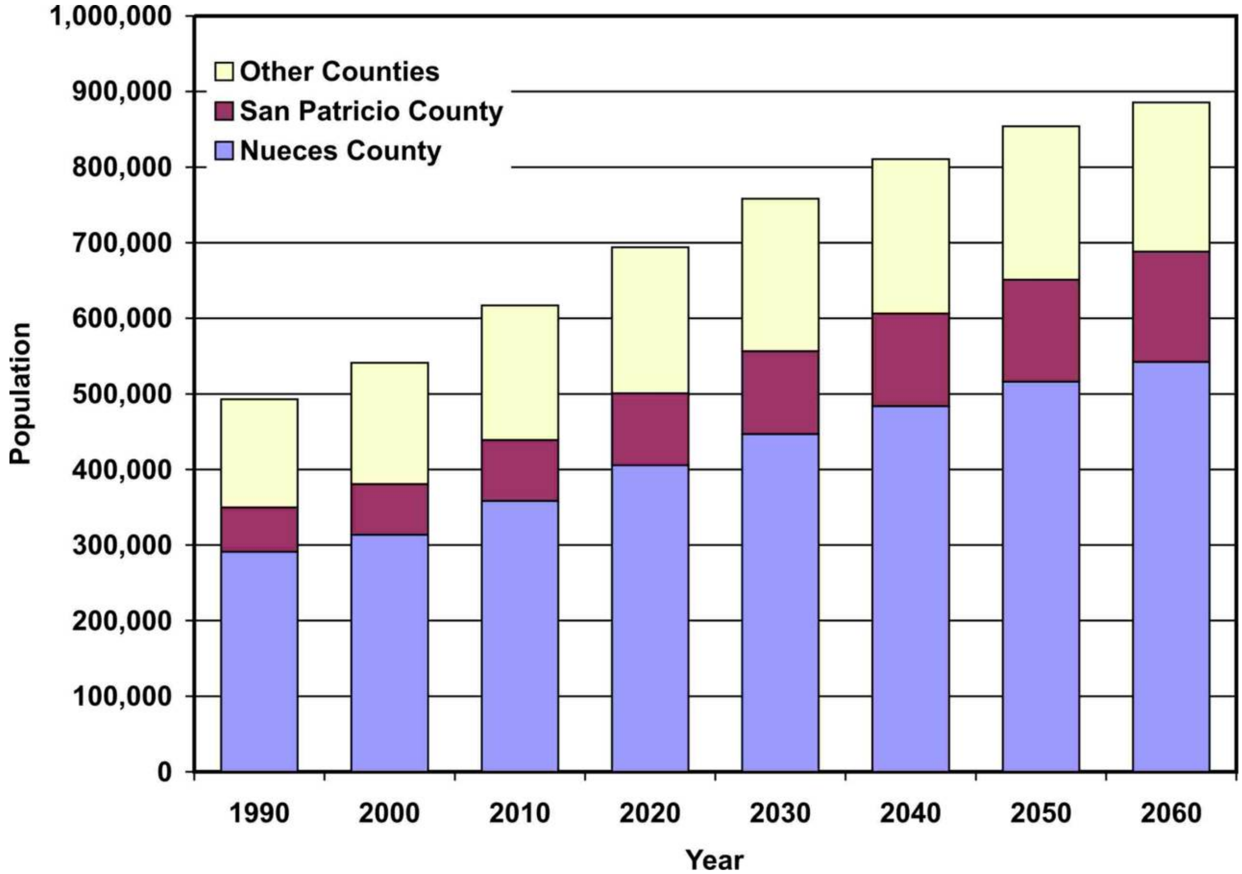


Figure ES-3. Historical and Projected Coastal Bend Regional Water Planning Area Population

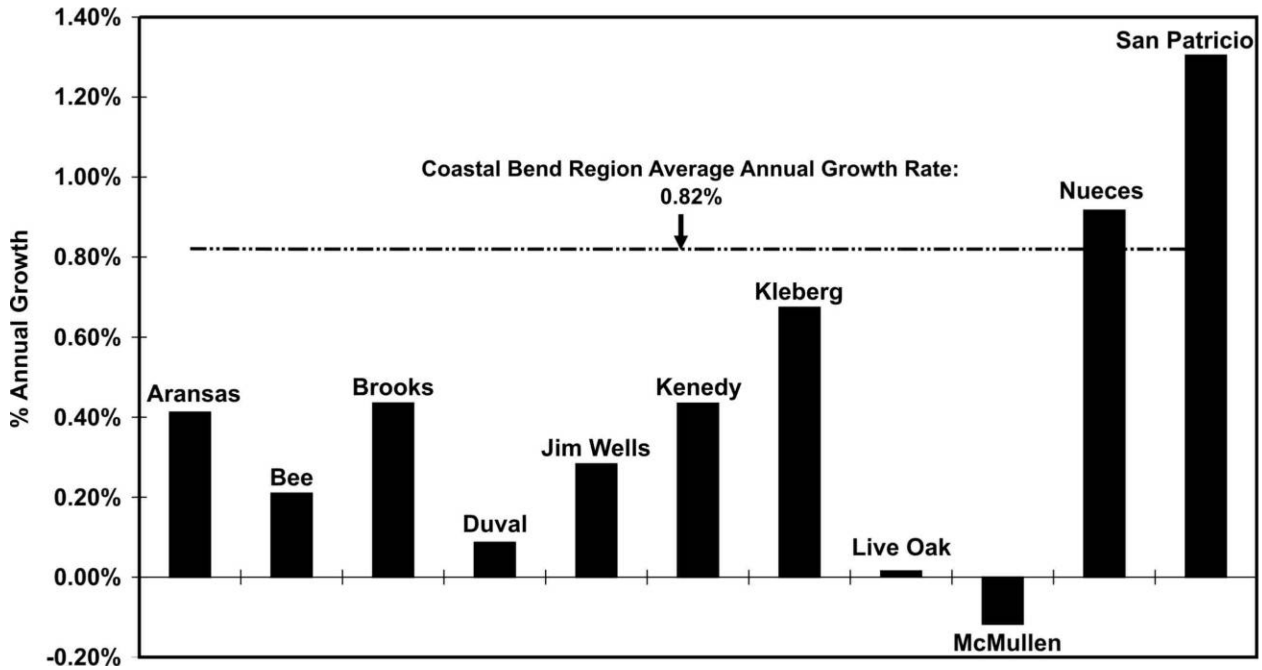


Figure ES-4. Percent Annual Population Growth Rate for 2000 through 2060 by County

Total water use for the region is projected to increase from 205,936 acft in 2000 to 324,938 acft in 2060, a 57.8 percent increase. The trend in total water use is shown in Figure ES-5. The six types of water use and associated demands are shown for 2000 and 2060 in Figure ES-6. Municipal, manufacturing, steam-electric, irrigation, and mining water use are all projected to increase, while livestock use is unchanged.

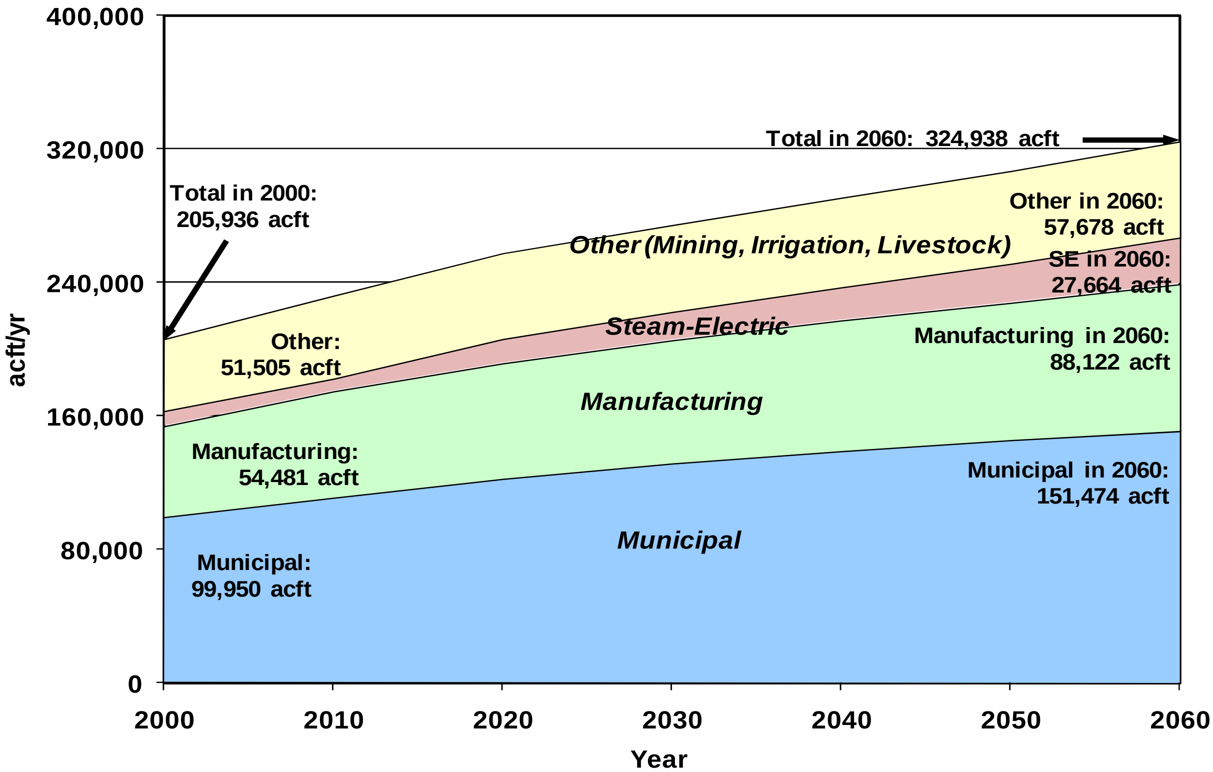


Figure ES-5. Projected Total Water Demand

ES.6 Water Supply

ES.6.1 Surface Water Supplies

Streamflow in the Nueces River and its tributaries, along with reservoirs in the Nueces River Basin and interbasin transfers from Lake Texana, comprise the most significant supply of surface water in the Coastal Bend Region. Water rights associated with major water supply reservoirs are owned by the City of Corpus Christi and the Nueces River Authority. The western and southern parts of the region are heavily dependent on groundwater sources, due to limited access to surface water supplies.

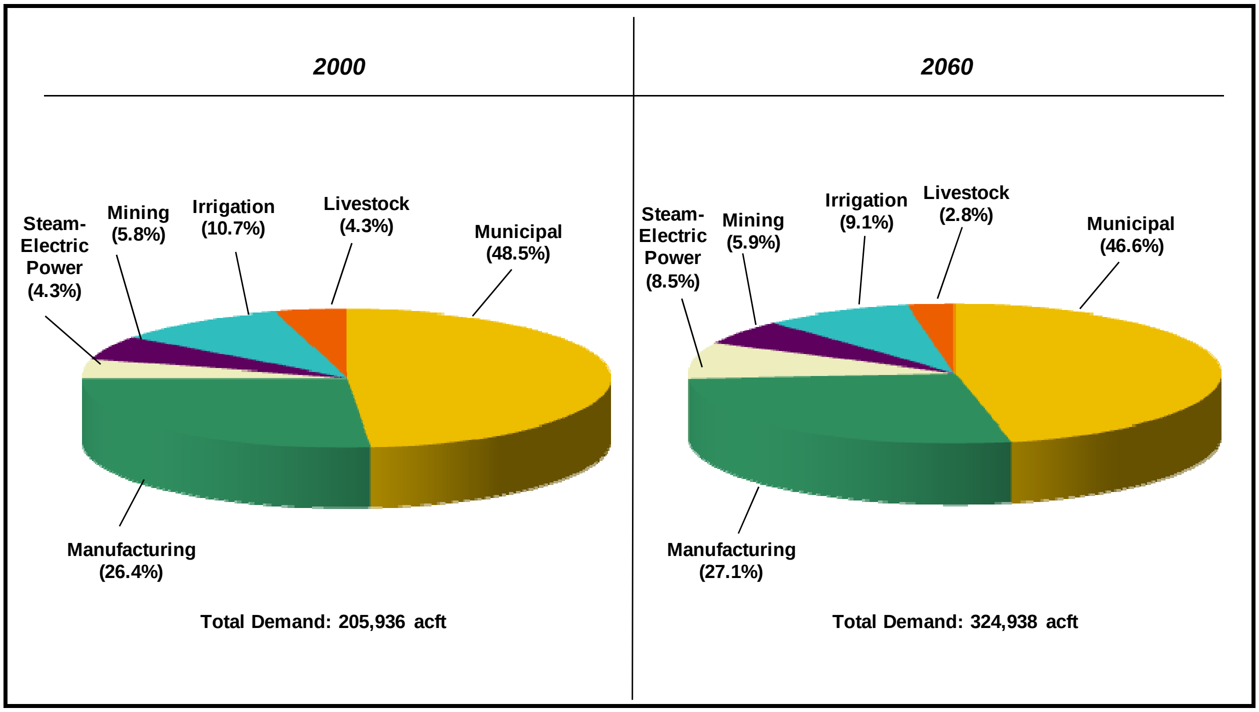


Figure ES-6. Total Water Demand by Type of Use

Municipal Use and Water Conservation

The 51.5 percent projected increase in municipal water demand over the 50-year planning horizon is lower than the projected population increase of 63.6 percent due to expected savings in per capita water use resulting from water conservation. Average per capita municipal water use in 2000 was 165 gallons per capita per day and is projected to decrease to 152 gallons per capita per day by 2060 due to built-in savings for low flow plumbing fixtures. This results in a reduction of 13,313 acft/yr in municipal water demand in 2060.

Many entities within the Coastal Bend Region obtain surface water through water supply contracts. The City is the largest provider of water supply contracts in the Coastal Bend Region with 205,000 acft/yr raw water available from its reservoir system (2010 sediment conditions).[7] Run-of-river and small municipal water rights provide 8,603 acft/yr of reliable water. Other surface water supplies are provided by on-farm local sources and small supplies from adjacent coastal basins.

In addition to raw water supply contracts and/or availability, total surface water supplies are constrained based on existing water treatment plant capacities as discussed in Section 3. As shown in Table ES-2, total surface water from all surface water sources in year 2060 is 198,816 acft/yr, of which 93 percent is provided by the City's supplies.

[7] The City of Corpus Christi holds a contract with the Lavaca-Navidad River Authority to provide a base amount of 41,840 acft/yr and a maximum of 12,000 acft/yr on an interruptible basis from Lake Texana to the City.

Table ES-2.
Total Supply in 2060 from
All Surface Water Sources (acft)

Municipal	133,596
Manufacturing	38,827
Steam-Electric	14,481
Mining	0
Irrigation	4,332
Livestock	7,580
Total	**198,816**

Note: This table considers both treatment plant capacity and raw water constraints.

ES.6.2 Groundwater Supplies

Two major aquifers and two minor aquifers underlie parts of the Coastal Bend Planning Region (Figure ES-1) and have a combined reliable yield of about 109,351 acft/yr and projected 2060 use of 81,426 acft if recommended water management strategies are implemented.[8] The two major aquifers include the Gulf Coast Aquifer, which supplies significant quantities of water throughout the region and the Carrizo-Wilcox Aquifer, which supplies water to the northwest portion of the study area in parts of McMullen, Live Oak, and Bee Counties (Figure ES-1). Groundwater supplies are based on projected groundwater use, well capacities, and drawdown constraints adopted by the Coastal Bend Region. In the northwestern part of the region, the Carrizo-Wilcox is a prolific aquifer with lesser quality water in most areas.

The TWDB is currently working with the Groundwater Management Areas (GMAs) to determine desired future conditions. Once these have been determined, the groundwater models will be used to simulate those conditions to determine aquifer availability for future planning cycles. These values may be different than what has been previously adopted by the CBRWPG.

ES.6.3 Water Quality

Previous studies by the U.S. Geological Survey and others show a significant increase in the concentration of dissolved minerals occurring in the Lower Nueces River between Lake Corpus Christi and the Calallen Saltwater Barrier Dam, where the vast majority of the Region's

[8] Based on TWDB Central Gulf Coast Groundwater Availability Model analyses.

surface water is diverted.[9] Figure ES-7 shows that median chloride concentrations at the Calallen Pool near the City of Corpus Christi's O.N. Stevens Water Treatment Plant intake (155 mg/L) are 2 times the level of chlorides in water released from Lake Corpus Christi (80 mg/L). The results of these studies indicate that on the average about 60 percent of the increase in chlorides occurs upstream of the Calallen Pool and about 40 percent of the increase within the pool.

Potential sources of minerals to the Calallen Pool include saltwater intrusion, groundwater seepage, and upstream sources of contamination from abandoned wells in adjacent oil fields and gravel washing operations. Previous 2001 and 2006 Plans included results of a Nueces River sampling program confirming the increase in mineral concentrations. The results of this sampling program strongly suggested that poor quality groundwater is entering the river and resulting in the increase. The effect of the high dissolved solids concentrations is two-fold and includes an increase in industrial water demands due to accelerated buildup of minerals in industrial cooling facilities, as well as high levels of chlorides and bromides, which sometimes exceed drinking water standards. Since a large portion of the Region's water demands are for industrial use, improvements in water quality will result in reduced levels of water consumption and provide additional water conservation for the region. Reductions in chloride and bromide levels will help ensure Safe Drinking Water Act requirements can be achieved without having to resort to expensive treatment methods.

An assessment was conducted during development of the 2011 Plan to evaluate water quality in Lake Corpus Christi and downstream Lower Nueces River segment to Calallen Pool (Section 4C.3). A water management strategy for potential interconnections to the Mary Rhodes Pipeline was also evaluated to provide water supplies from Lake Texana for industries with intakes located in the Calallen Pool to reduce water quality fluctuations in their water supply as is currently experienced with supplies from the Lower Nueces River (Section 4C.3.6.6).

Groundwater supplies are generally of good water quality. However, some areas in the region have slightly brackish groundwater (TDS ≈ 1,000 to 1,500 mg/L). In previous studies, several small rural utilities have had water quality concerns associated with salinity and other water quality constituents. For these systems, brackish groundwater desalination may be considered in the future.

[9] USGS studies report average chloride concentrations in the Calallen Pool are 2.5 times the level of chlorides in water released from Lake Corpus Christi.

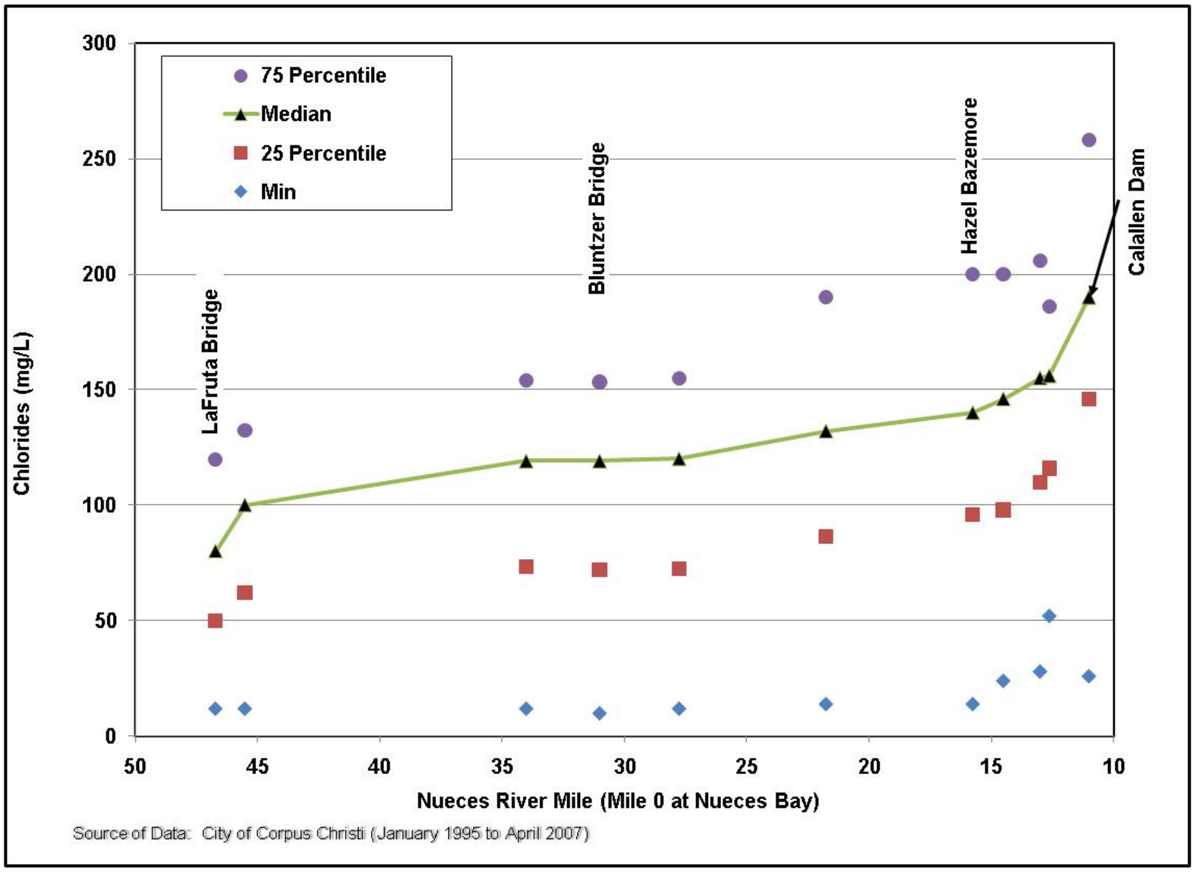


Figure ES-7. Summary of Historical Data — Chloride Content of the Lower Nueces River, Segment 2102

ES.6.4 Supply and Demand Comparison

The CBRWPG identified 18 individual cities and water user groups that showed unmet needs during drought of record supply conditions during the 60-year planning horizon. Figure ES-8 shows these water user groups with shortages for both the 2030 and 2060 timeframes.

Eight of the 11 counties in the region have a projected shortage in at least one of the water user groups in the county. These are Aransas, Bee, Duval, Jim Wells, Kleberg, Live Oak, Nueces and San Patricio. None of the water user groups in Brooks, Kenedy, or McMullen Counties have projected shortages. Table ES-5 is organized by county and information on each municipality and water use category in the county is listed. The tables can be examined for each county to determine which cities and water user groups have projected shortages.

Constraints on Water Supply
Water supplies are also affected by contractual arrangements and infrastructure constraints. Expiring contracts, insufficient well capacity, and water treatment plant capacity - each of these supply constraints was taken into account in estimating water supplies available to municipal water user groups. Consequently, the water supply listed for a given city may be less than the quantity in their water purchase contract or water right.

ES.7 Wholesale Water Providers

There are four wholesale water providers in the Region: the City of Corpus Christi, SPMWD, STWA, and Nueces County WCID #3. In 2000, the City of Corpus Christi supplied about 77 percent of the Region's water demands, and SPMWD (a major customer of the City of Corpus Christi) supplied about 11 percent of the Region's water demands. Both STWA and Nueces County WCID #3 combined provided less than 3 percent of the Region's water demand. Figure ES-9 shows a comparison of water demands to currently available water supplies for each of these providers. The City of Corpus Christi needs additional water treatment plant capacity beginning before 2020 to effectively utilize raw water supplies. SPMWD needs additional supplies beginning around 2035. STWA and Nueces County WCID #3 have sufficient supplies to meet their projected customer demands to 2060.

By 2060, the Corpus Christi Service Area is estimated to need 54,357 acft of additional water supply based on existing treatment plant and raw water supply constraints, and of this amount 39,517 acft is attributed to raw water supply shortages. SPMWD Service Area is estimated to need 7,898 acft of additional water supply based on existing treatment plant and raw water supply constraints, and of this amount 5,742 acft is attributed to raw water supply shortages. Surface water allocation for wholesale water providers is discussed in Section 4A.5.

ES.8 Water Supply Strategies to Meet Needs

Numerous water management strategies were identified by the CBRWPG as potentially feasible to meet water supply shortages. Each strategy was evaluated by the consultant team and compared to criteria adopted by the CBRWPG. The Coastal Bend Regional Water Plan includes recommended water management strategies that emphasize water conservation; maximize utilization of available resources, water rights, and reservoirs; engage the efficiency of conjunctive use of surface and groundwater; and limit depletion of storage in aquifers. There are additional strategies that have significant support within the region, yet require further study regarding quantity of dependable water supply made available during severe drought, feasibility,

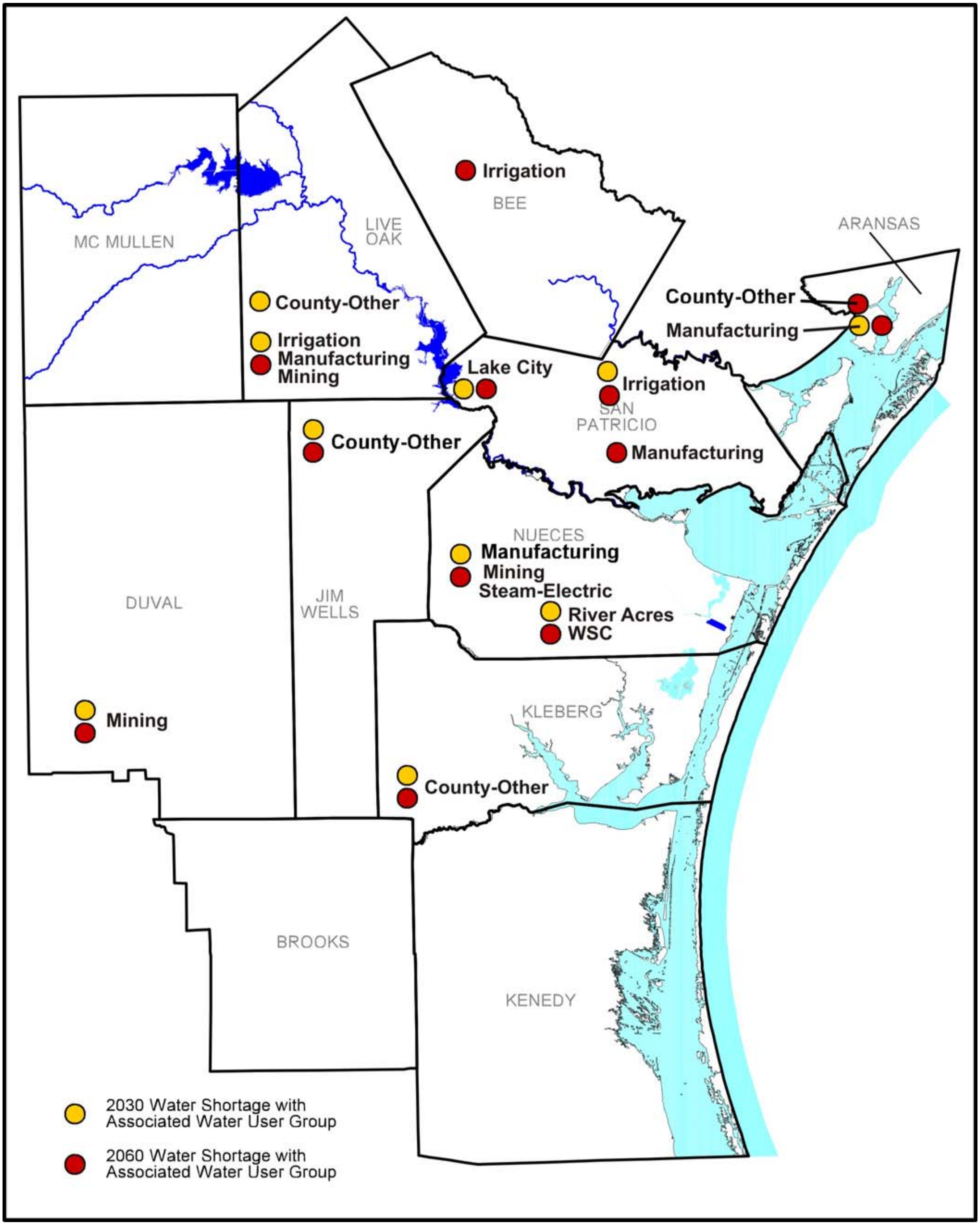
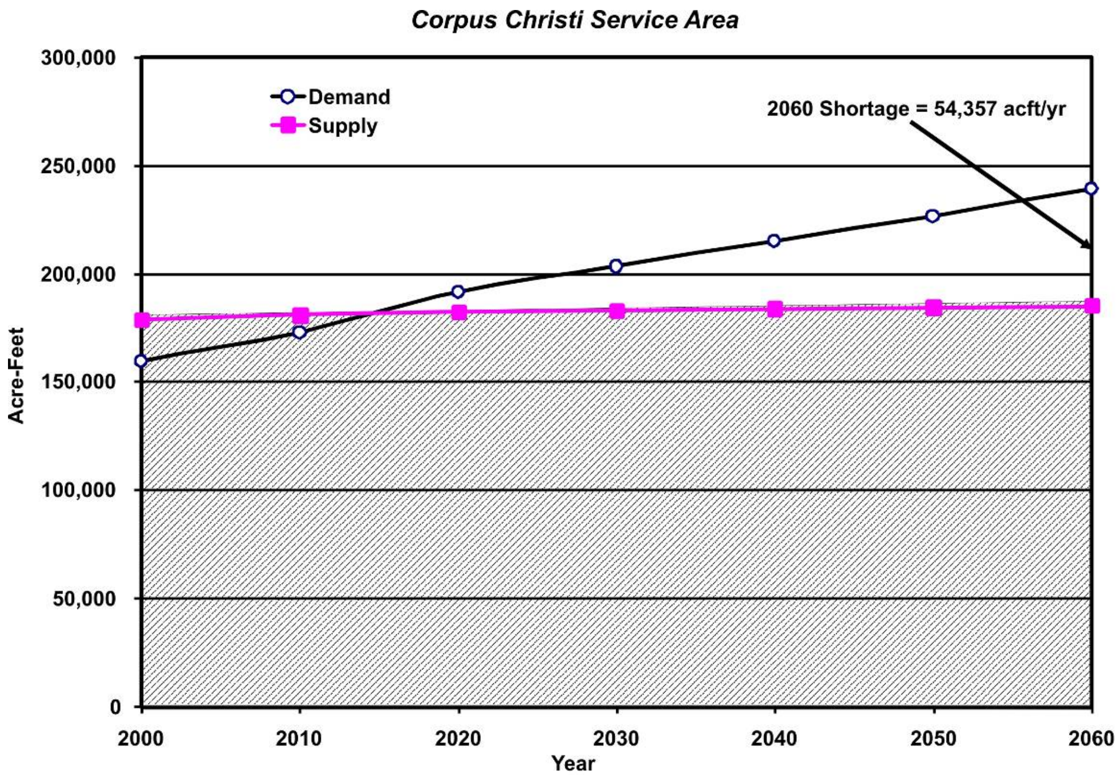


Figure ES-8. Location and Type of Use for 2030 and 2060 Water Supply Shortage



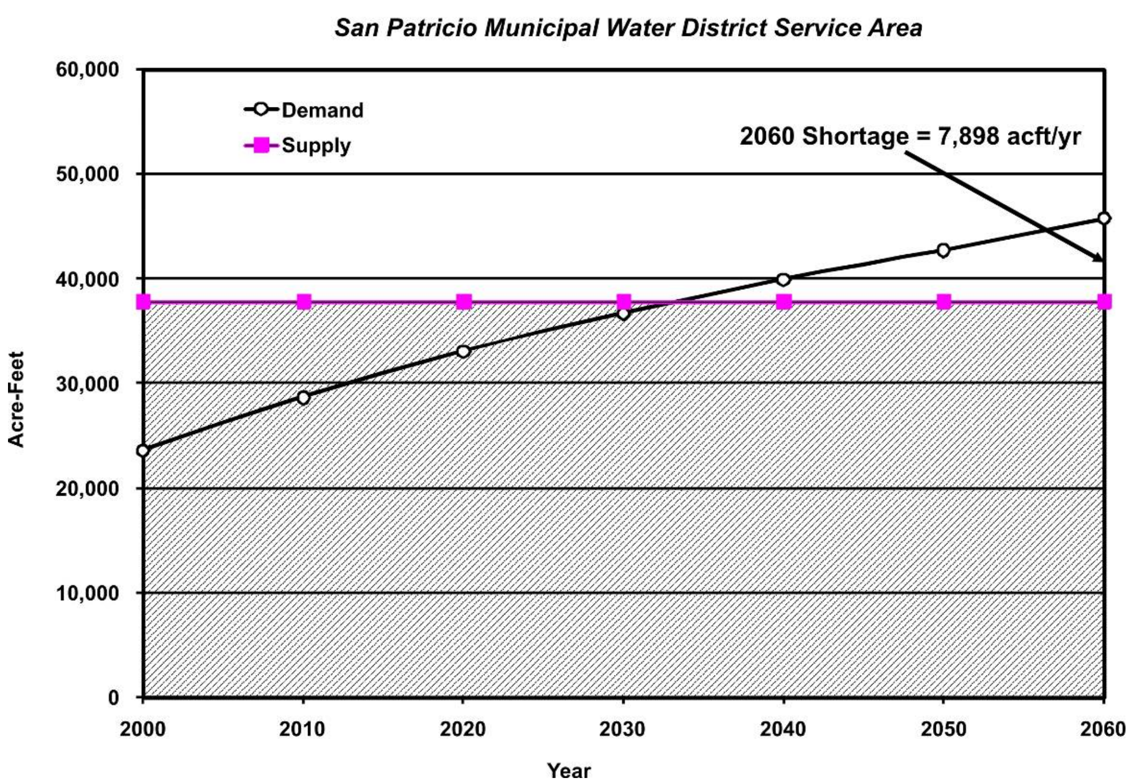
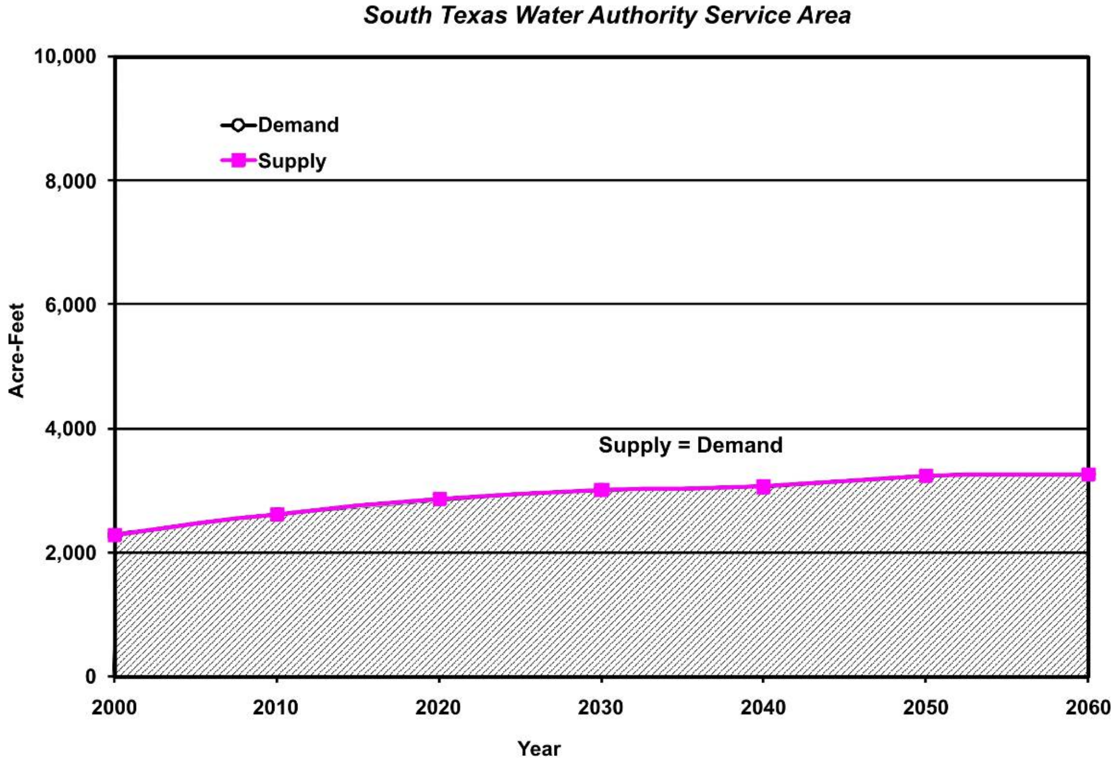


Figure ES-9. Water Supply vs. Demand for Major Water Providers
Water Plan Findings and Recommendations
(Page 1 of 2)



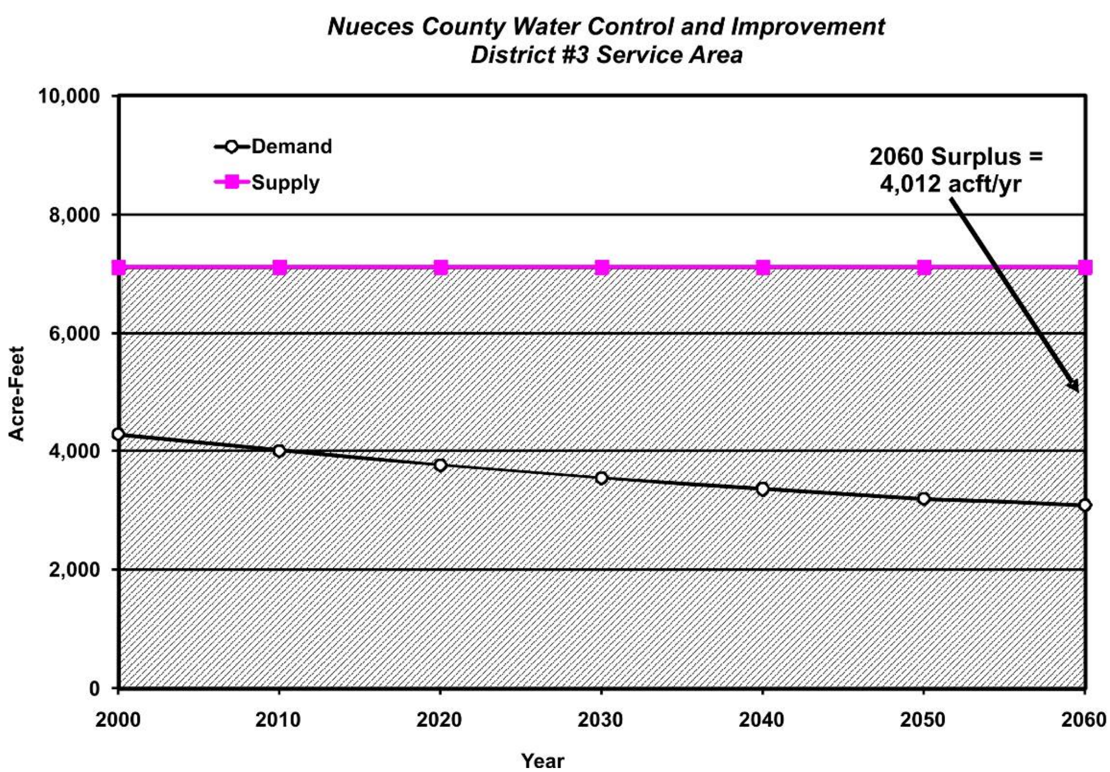


Figure ES-9. Water Supply vs. Demand for Major Water Providers Water Plan Findings and Recommendations (Page 2 of 2)

and/or cost of implementation, that are also included in the plan. The strategies identified as potentially feasible are tabulated in Tables ES-3 and ES-4. Table ES-3 summarizes potential strategies for the Corpus Christi Service Area, while Table ES-4 summarizes strategies to other service areas. Additionally, Figure ES-10 provides a graphical comparison of unit costs and quantities of water provided for selected strategies evaluated. Section 4C in Volume II contains sections discussing each of these possible strategies in detail.

Table ES-5 summarizes findings and recommendations for every water user group with projected water shortages. The table also lists each municipality and water user group by county. Water demands are listed for years 2010, 2030, and 2060. Shortages are listed for years 2010, 2030, and 2060, along with recommended actions to meet these shortages. The recommended water supply plans are presented by county in greater detail in Section 4B of Volume I. Water management strategies recommended in the Coastal Bend Region could produce new supplies in excess of the projected regional need of 75,744 acft in Year 2060. Supplies exceed shortages in case water growth patterns and demands exceed TWDB projections or supplies are reduced under current interbasin water supply contracts.

Table ES-6 summarizes those strategies that are recommended in the regional water plan. Total estimated project cost (in September 2008 dollars) for the recommended water management strategies for the Coastal Bend Region is $546,164,950. Table ES-7 summarizes alternative water management strategies developed as part of the planning process.

Future projects involving authorization from either the TCEQ and/or TWDB, which are not specifically addressed in the plan, are considered to be consistent with the plan under the following circumstances:

- TWDB receives applications for financial assistance for many types of water supply projects, including water conservation, and when appropriate, wastewater reuse strategies. Other projects involve repairing, replacing, or expanding treatment plants, pump stations, pipelines, and water storage facilities. The CBRWPG considers projects that do not involve the development of or connection to a new water source to be consistent with the regional water plan even though not specifically recommended in the plan.

Table ES-3.
Potential Water Management Strategies to Meet Long-Term Needs for Wholesale Water Providers

WMS ID	Water Management Strategy	Additional Water Supply (acft/yr)	Total Project Cost	Annual Cost	Unit Cost of Additional Treated Water ($ per acft/yr)	Degree of Water Quality Improvement	Environmental Issues/ Special Concerns
N-1	**Municipal Water Conservation**	up to 1,428	Variable; Regional Cost up to $1,052,529[1]	Variable	$423-$448	No Change	Possible reduction in return flows to bay and estuary.
N-3	**Manufacturing Water Conservation**						
N-3-1	Blending of Texana Water	up to 2,050	Not Applicable	Not Applicable	Not Applicable[2]	Significant Improvement	None
N-3-2	Outlet works to remove high TDS from Calallen Pool	150-730	$2,904,000	$511,000[3]	$700-$2,146[3]	Significant Improvement	None
N-3-3	Intake Modifications	150-300	$7,694,000	$875,000[3]	$2,916-$5,506[3]	Significant Improvement	None
N-3-4	Pipeline from LCC to Calallen	19,600-23,900	$159,655,000	up to $24,715,000[3]	$1,070-$1,203[3]	Significant Improvement	Potentially significant environmental impacts/Construction and maintenance of pipeline corridors
N-4	**Mining Water Conservation**	up to 259	Highly Variable	Highly Variable	Variable	No Change	None
N-5	**Reclaimed Wastewater Supplies**	250	Not Applicable	$206,500[5,9]	$826[5]	No Change	Potential reduction of freshwater inflows to estuary/Construction and maintenance of pipeline corridors
N-7	**Gulf Coast Aquifer Supplies**						
	Groundwater supplies from Bee and/or San Patricio Counties	up to 18,000	$59,245,000	$15,354,000[3,9]	$853[3,4]	Some Degradation	Potential for increased freshwater inflows to estuary
N-8	**Multi-Year ASR along STWA Pipeline**	Negligible	Not Applicable[6]	Not Applicable[6]	-	No Change	Minor impacts
	Seasonal ASR in CC Distribution System	None	Variable				
N-10	**Pipeline from CCR to LCC[10]**	33,700	$138,067,000	$26,821,000[3,9]	$679[3]	No Change	Reduction in stream flows between CCR and LCC
N-11	**Off-channel Reservoir near Lake Corpus Christi[10]**	30,340	$105,201,950	$21,696,800[3,9]	$715[3]	No Change	Direct impact to 4,000 to 6,000 acres, depending on reservoir size
N-12	**Voluntary Redistribution and USACOE Nueces Feasibility Study**	Variable	Variable	Variable	Variable	Variable	Possible cost reduction with federal participation. Ecosystem restoration benefits. Portion of projects may be used for additional inflows to Nueces Bay and Estuary.
N-13	**Stage II of Lake Texana**						
	Palmetto Bend (On-Channel)	22,964[11]	$232,828,000	$27,855,000[3,9]	$1,213[3]	No Change	Direct impact to 4,769 acres
	Lavaca River Diversion and Off-Channel Reservoir	26,242[11]	$224,183,000	$26,971,000[3,9]	$1,027[3]	No Change	Direct impact to around 3,000 acres.
N-14	**Garwood Pipeline**	35,000	$112,798,000	$23,958,000[3,9]	$685[3]	No Change	Construction and maintenance of pipeline corridors and off-channel storage
N-17	**Desalination**						
	Desalination of Seawater[7,10]	28,000	$260,914,000	$47,498,000	$1,696	Significant Improvement	Brine from desalt plant requires disposal. Construction and maintenance of pipeline corridor
N-19	**O.N. Stevens WTP Improvements**	32,996 in 2060	$31,324,000[8]	$7,554,000	$146 in 2060	No change	None
N-20	**Brackish Groundwater Desalination[10]**	18,000	$108,331,000	$17,584,000	$977	Significant Improvement	Brine from desalt plant requires disposal. Construction and maintenance of pipeline corridor

1 Assumes unit costs of $423 to $448/acft.
2 Cost of Manufacturing Water Conservation not determined.
3 Cost has been adjusted to include treatment. Cost for treatment is estimated at $326 per acft.
4 Cost based on 18,000 acft supply.
5 See Section 4C.5. Costs to maintain ongoing Nueces Delta studies are $500,000 per year (assumed cost associated with Allison Demonstration Project is 25 percent). Treatment cost of $326/acft have been added.
6 ASR is not recommended as a viable water management strategy to provide water supply. Costs are not included.
7 Additional water supply is unlimited. Supply numbers and unit costs are shown for a 25 MGD facility.
8 Total project cost includes improvements to the following WTP components: raw influent, raw water intake pump station, and O.N. Stevens solids handling facilities.
9 Annual costs calculated as the unit cost times the additional water supply volume. For Gulf Coast Aquifer Supplies the full 18,000 acft/yr yield was used. For both the Lake Texana options the annual cost is based on the full yield of the project. Annual costs for the portion of supplies allotted to the Coastal Bend wholesale water providers is less as shown in Sections 4B.11 and 4B.12.
10 There is federal participation opportunities for these projects. Federal participation is assumed in water supply plans (Section 4B) and Section 4C.10.
11 Full yield shown for projects. Only portion of project identified for Region N.

Table ES-4.
Potential Water Management Strategies to Meet Long-Term Needs for Local Service Areas

WMS	Water Management Strategy	Additional Water Supply (acft/yr)	Total Project Cost	Annual Cost	Unit Cost of Additional Treated Water ($ per acft/yr)	Degree of Water Quality Improvement	Environmental Issues/ Special Concerns
N-1	**Municipal Water Conservation**	up to 2,415	Variable; Regional Cost up to $1,052,529[1]	Variable	$423-$448	No Change	Possible reduction in return flows to bay and estuary.
N-2	**Irrigation Water Conservation**	up to 342	Highly Variable	$3,900 - $78,000	$228[2]	No Change	None
N-4	**Mining Water Conservation**	up to 2,343	Highly Variable	Highly Variable	Variable	No Change	None
N-5	**Reclaimed Wastewater Supplies**	250	Not Applicable	$206,500[3]	$826[3]	No Change	Potential reduction of freshwater inflows to estuary/Construction and maintenance of pipeline corridors
N-7	**Gulf Coast Aquifer Supplies**						
	Drill additional well	Variable	Variable; up to $8,110,000[4]	Variable; up to $925,000[4]	Variable	Some Degradation	Minor impacts
	Brackish groundwater desalination (local projects)	Variable	Variable; up to $12,250,000[5]	Variable; up to $2,207,000[5]	Variable	Significant Improvement	Brine from desalt plant requires disposal by evaporation, deep well injection, blending, or discharging to saltwater body.
N-12	**Voluntary Redistribution/ Reallocation**	Variable	Variable; as needed	Variable; as needed	$685[6]	Variable	None
N-18	**Potential System Interconnections**						
	Duval County	974-2,520	Up to $30,113,000	Up to $4,823,000	$1,161-$1,914	Some Negative Impact	Construction and maintenance of pipeline corridor.
	Jim Wells County	246-1,434	Up to $10,824,000	Up to $1,929,000	$1,345-$2,248	Some Negative Impact	Construction and maintenance of pipeline corridor.
	Brooks County	2554	$16,195,000	$3,523,000	$1,379	Some Negative Impact	Construction and maintenance of pipeline corridor.
	San Patricio County	125-1,120	$2,517,000 to $3,136,000	$401,000 to $1,018,000	$909- $3,208	Some Negative Impact	Construction and maintenance of pipeline corridor.

[1]Assumes unit costs of $423 to $448/acft.

[2]Unit cost for raw water supplies.

[3]See Section 4C.5. Costs to maintain ongoing Nueces Delta studies are $500,000 per year (assumed cost associated with Allison Demonstration Project is 25 percent). Treatment cost of $326/acft have been added.

[4]Costs based on drilling 23 wells for San Patricio County – Irrigation.

[5]Estimated cost for 3 MGD facility. In Section 4B, the largest local brackish groundwater desalination plant considered was for Freer. The project cost for the 1.2 MGD plant i s $6,899,000. This results in an annual cost of $1,121,000 for a unit cost of $834 per acft.

[6]Unit cost of $685 per acft assumed to be comparable to cost of Garwood water. Costs should be revised in the future, as rate study information becomes available .

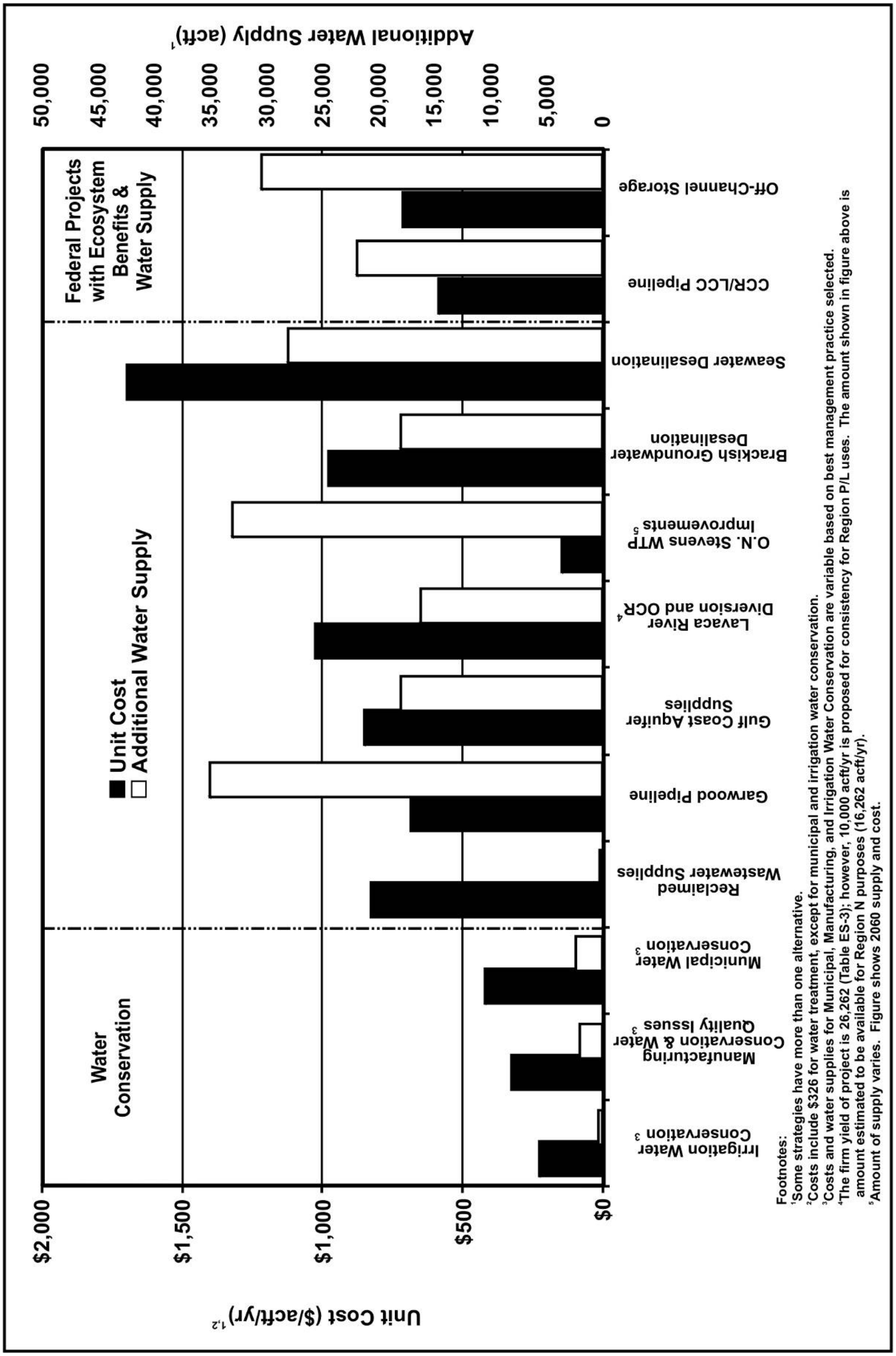


Figure ES-10. Comparison of Unit Costs and Water Supply Quantities for Potential Water Management Strategies for Coastal Bend

Table ES-5.
Water Plan Summary for Coastal Bend Region

County/Water User Group	Demand (acft)			Need (Shortage) (acft)			Recommended Management Strategies to Meet Need (Shortage)
	2010	2030	2060	2010	2030	2060	
Aransas County	**See Section 4A.3.1**						**See Section 4B.2**
Aransas Pass (P)	**168**	**195**	**169**	none	none	none	
Fulton	**307**	**365**	**318**	none	none	none	
Rockport	**1,590**	**1,868**	**1,620**	none	none	none	
County-Other	**1,766**	**2,016**	**1,728**	none	none	(1,443)	Increase contract amount provided by Wholesale Water Provider (San Patricio Municipal Water District).
Manufacturing	**267**	**292**	**331**	(72)	(97)	(136)	Gulf Coast Aquifer Supplies – Drill additional well.
Steam-Electric	**0**	**0**	**0**	none	none	none	
Mining	**103**	**123**	**146**	none	none	none	
Irrigation	**0**	**0**	**0**	none	none	none	
Livestock	**23**	**23**	**23**	none	none	none	
Bee County	**See Section 4A.3.2**						**See Section 4B.3**
Beeville	**2,619**	**2,722**	**2,618**	none	none	none	
El Oso WSC (P)	**62**	**66**	**64**	none	none	none	
County-Other	**1,661**	**1,704**	**1,609**	none	none	none	
Manufacturing	**1**	**1**	**1**	none	none	none	
Steam-Electric	**0**	**0**	**0**	none	none	none	
Mining	**36**	**42**	**48**	none	none	none	
Irrigation	**3,796**	**4,632**	**6,243**	none	none	(890)	Gulf Coast Aquifer Supplies – Drill additional well.
Livestock	**995**	**995**	**995**	none	none	none	
Brooks County	**See Section 4A.3.3**						**See Section 4B.4**
Falfurrias	**2,135**	**2,795**	**3,032**	none	none	none	Additional municipal water conservation recommended by CBRWPG for all municipal entities with reported use greater than 165 gpcd in 2060.
County-Other	**180**	**62**	**13**	none	none	none	
Manufacturing	**0**	**0**	**0**	none	none	none	
Steam-Electric	**0**	**0**	**0**	none	none	none	
Mining	**150**	**167**	**184**	none	none	none	
Irrigation	**24**	**23**	**21**	none	none	none	
Livestock	**747**	**747**	**747**	none	none	none	
Duval County	**See Section 4A.3.4**						**See Section 4B.5**
Benavides	**326**	**334**	**302**	none	none	none	
Freer	**645**	**663**	**600**	none	none	none	
San Diego (P)	**479**	**479**	**426**	none	none	none	
County-Other	**950**	**987**	**895**	none	none	none	Additional municipal water conservation recommended by CBRWPG for all municipal entities with reported use greater than 165 gpcd in 2060.

Table ES-5 (Continued)

County/Water User Group	Demand (acft)			Need (Shortage) (acft)			Recommended Management Strategies to Meet Need (Shortage)
	2010	2030	2060	2010	2030	2060	
Duval County (cont.)	**See Section 4A.3.4**						**See Section 4B.5**
Manufacturing	**0**	**0**	**0**	none	none	none	
Steam-Electric	**0**	**0**	**0**	none	none	none	
Mining	**5,860**	**7,119**	**8,553**	(1,738)	(2,973)	(4,205)	Mining water conservation including potential reuse; consider possible socioeconomic impact analysis of unmet needs.
Irrigation	**4,444**	**4,289**	**4,064**	none	none	none	
Livestock	**873**	**873**	**873**	none	none	none	
Jim Wells County	**See Section 4A.3.5**						**See Section 4B.6**
Alice	**5,606**	**6,076**	**5,904**	none	none	none	Additional municipal water conservation recommended by CBRWPG for all municipal entities with reported use greater than 165 gpcd in 2060.
Orange Grove	**374**	**405**	**393**	none	none	none	Additional municipal water conservation recommended by CBRWPG for all municipal entities with reported use greater than 165 gpcd in 2060.
Premont	**858**	**931**	**905**	none	none	none	Additional municipal water conservation recommended by CBRWPG for all municipal entities with reported use greater than 165 gpcd in 2060.
San Diego (P)	**103**	**106**	**101**	none	none	none	
County-Other	**2,127**	**2,238**	**2,130**	(167)	(262)	(170)	Gulf Coast Aquifer Supplies – Drill additional well.
Manufacturing	**0**	**0**	**0**	none	none	none	
Steam-Electric	**0**	**0**	**0**	none	none	none	
Mining	**423**	**484**	**550**	none	none	none	
Irrigation	**3,278**	**2,528**	**1,717**	none	none	none	
Livestock	**1,064**	**1,064**	**1,064**	none	none	none	
Kenedy County	**See Section 4A.3.6**						**See Section 4B.7**
County-Other	**50**	**53**	**53**	none	none	none	
Manufacturing	**0**	**0**	**0**	none	none	none	
Steam-Electric	**0**	**0**	**0**	none	none	none	
Mining	**1**	**1**	**1**	none	none	none	
Irrigation	**107**	**107**	**107**	none	none	none	
Livestock	**901**	**901**	**901**	none	none	none	
Kleberg County	**See Section 4A.3.7**						**See Section 4B.8**
Kingsville	**4,570**	**4,604**	**4,619**	none	none	none	
Ricardo WSC	**682**	**1,130**	**1,397**	none	none	none	
County-Other	**799**	**930**	**1,004**	none	(81)	(155)	Gulf Coast Aquifer Supplies – Drill additional well.
Manufacturing	**0**	**0**	**0**	none	none	none	
Steam-Electric	**0**	**0**	**0**	none	none	none	
Mining	**2,917**	**2,207**	**2,232**	none	none	none	
Irrigation	**866**	**644**	**410**	none	none	none	
Livestock	**1,900**	**1,900**	**1,900**	none	none	none	

Table ES-5 (Continued)

County/Water User Group	***Demand (acft)***			***Need (Shortage) (acft)***			***Recommended Management Strategies to Meet Need (Shortage)***
	2010	***2030***	***2060***	***2010***	***2030***	***2060***	
Live Oak County	**See Section 4A.3.8**						**See Section 4B.9**
Choke Canyon WS (P)	**397**	**435**	**346**	none	none	none	
El Oso WSC (P)	**206**	**223**	**176**	none	none	none	
George West	**703**	**767**	**608**	none	none	none	Additional municipal water conservation recommended by CBRWPG for all municipal entities with reported use greater than 165 gpcd in 2060.
McCoy WSC	**54**	**58**	**46**	none	none	none	
Three Rivers	**465**	**505**	**399**	none	none	none	Additional municipal water conservation recommended by CBRWPG for all municipal entities with reported use greater than 165 gpcd in 2060.
County-Other	**748**	**808**	**638**	none	(44)	none	Gulf Coast Aquifer Supplies – Drill additional well.
Manufacturing	**1,946**	**2,032**	**2,194**	(337)	(559)	(764)	Voluntary Redistribution of City of Three Rivers supply.
Steam-Electric	**0**	**0**	**0**	none	none	none	
Mining	**3,894**	**4,583**	**5,341**	(64)	(928)	(1,755)	Mining water conservation including potential reuse; consider possible socioeconomic impact analysis of unmet needs.
Irrigation	**3,289**	**2,840**	**2,277**	(627)	(514)	(373)	Irrigation water conservation; Gulf Coast Aquifer Supplies – drill additional well.
Livestock	**833**	**833**	**833**	none	none	none	
McMullen County	**See Section 4A.3.9**						**See Section 4B.10**
Choke Canyon WS (P)	**43**	**42**	**35**	none	none	none	
County-Other	**143**	**138**	**117**	none	none	none	Additional municipal water conservation recommended by CBRWPG for all municipal entities with reported use greater than 165 gpcd in 2060.
Manufacturing	**0**	**0**	**0**	none	none	none	
Steam-Electric	**0**	**0**	**0**	none	none	none	
Mining	**195**	**207**	**218**	none	none	none	
Irrigation	**0**	**0**	**0**	none	none	none	
Livestock	**659**	**659**	**659**	none	none	none	
Nueces County	**See Section 4A.3.10**						**See Section 4B.11**
Agua Dulce	**112**	**107**	**103**	none	none	none	
Aransas Pass (P)	**26**	**53**	**81**	none	none	none	
Bishop	**444**	**422**	**404**	none	none	none	
Corpus Christi	**61,953**	**73,592**	**86,962**	none	none	none	
Driscoll	**122**	**171**	**224**	none	none	none	
Nueces County WCID #4	**1,913**	**3,729**	**5,655**	none	none	none	Additional municipal water conservation recommended by CBRWPG for all municipal entities with reported use greater than 165 gpcd in 2060.
Port Aransas	**2,606**	**4,558**	**6,637**	none	none	none	Additional municipal water conservation recommended by CBRWPG for all municipal entities with reported use greater than 165 gpcd in 2060.
River Acres WSC	**429**	**646**	**881**	(138)	(355)	(590)	Voluntary Redistribution- increase contracted amount from Nueces County WCID #3.
Robstown	**2,110**	**2,024**	**1,953**	none	none	none	
County-Other	**894**	**395**	**118**	(261)	none	none	Increase contracted amount provided by Wholesale Water Providers (City of Corpus Christi).

Table ES-5 (Concluded)

County/Water User Group	Demand (acft)			Need (Shortage) (acft)			Recommended Management Strategies to Meet Need (Shortage)
	2010	2030	2060	2010	2030	2060	
Nueces County (cont.)	**See Section 4A.3.10**						**See Section 4B.11**
Manufacturing	**46,510**	**53,425**	**63,313**	none	(15,203)	(39,550)	Development of additional water supplies for City of Corpus Christi and SPMWD considered jointly. (Manufacturing Water Conservation, O.N. Stevens Water Treatment Plant Improvements, Reclaimed Wastewater Supplies, Garwood Pipeline, Off-Channel Reservoir, Gulf Coast Aquifer Groundwater Supplies, and Lavaca River Diversion and Off-Channel Reservoir).[1]
Steam-Electric	**7,316**	**16,733**	**27,664**	none	(4,755)	(13,183)	Development of additional water supplies for City of Corpus Christi (O.N. Stevens Water Treatment Plant Improvements, Reclaimed Wastewater Supplies, Garwood Pipeline, Off-Channel Reservoir, Gulf Coast Aquifer Groundwater Supplies, and Lavaca River Diversion and Off-Channel Reservoir).[1]
Mining	**1,472**	**1,599**	**1,724**	none	(570)	(1,624)	Mining water conservation including potential reuse; Development of additional water supplies for City of Corpus Christi (O.N. Stevens Water Treatment Plant Improvements, Reclaimed Wastewater Supplies, Garwood Pipeline, Off-Channel Reservoir, Gulf Coast Aquifer Groundwater Supplies, and Lavaca River Diversion and Off-Channel Reservoir).[1]
Irrigation	**1,449**	**1,077**	**692**	none	none	none	
Livestock	**279**	**279**	**279**	none	none	none	
San Patricio County	**See Section 4A.3.11**						**See Section 4B.12**
Aransas Pass (P)	**1,405**	**1,828**	**2,386**	none	none	none	
Gregory	**239**	**223**	**210**	none	none	none	
Ingleside	**1,294**	**2,202**	**3,395**	none	none	none	
Ingleside On The Bay	**92**	**130**	**181**	none	none	none	
Lake City	**79**	**99**	**125**	none	(11)	(37)	Gulf Coast Aquifer Supplies – Drill additional well.
Mathis	**648**	**615**	**586**	none	none	none	
Odem	**330**	**361**	**408**	none	none	none	
Portland	**2,399**	**3,290**	**4,498**	none	none	none	
Sinton	**1,052**	**1,076**	**1,135**	none	none	none	
Taft	**586**	**648**	**736**	none	none	none	
County-Other	**1,946**	**2,189**	**2,533**	none	none	none	
Manufacturing	**15,096**	**18,111**	**22,283**	none	none	(6,455)	Development of additional water supplies for City of Corpus Christi and SPMWD considered jointly. (Manufacturing Water Conservation, O.N. Stevens Water Treatment Plant Improvements, Reclaimed Wastewater Supplies, Garwood Pipeline, Off-Channel Reservoir, Gulf Coast Aquifer Groundwater Supplies, and Lavaca River Diversion and Off-Channel Reservoir).[1]
Steam-Electric	**0**	**0**	**0**	none	none	none	
Mining	**99**	**108**	**117**	none	none	none	
Irrigation	**8,631**	**10,531**	**14,195**	none	(750)	(4,414)	Gulf Coast Aquifer Supplies – Drill additional well.
Livestock	**564**	**564**	**564**	none	none	none	
Total Needs by Water User Type							
Municipal	**111,495**	**132,063**	**151,474**	(566)	(753)	(2,395)	Municipal Water Conservation, Irrigation Water Conservation, Manufacturing Water Conservation and Nueces River Water Quality, Mining Water Conservation, Voluntary Redistribution, Additional Local Gulf Coast Aquifer Supplies, O.N. Stevens Water Treatment Plant Improvements, Reclaimed Wastewater Supplies, Garwood Pipeline, Off-Channel Reservoir, Gulf Coast Aquifer Groundwater Supplies, and Lavaca River Diversion and Off-Channel Reservoir.
Manufacturing	**63,820**	**73,861**	**88,122**	(409)	(15,859)	(46,905)	
Steam-Electric	**7,316**	**16,733**	**27,664**	—	(4,755)	(13,183)	
Mining	**15,150**	**16,640**	**19,114**	(1,802)	(4,471)	(7,584)	
Irrigation	**25,884**	**26,671**	**29,726**	(627)	(1,264)	(5,677)	
Livestock	**8,838**	**8,838**	**8,838**	—	—	—	
Region N Total	**232,503**	**274,806**	**324,938**	**(3,404)**	**(27,102)**	**(75,744)**	

(P) = Partial listing — water user group is in multiple counties.

[1] Alternative water management strategies are CCR/LCC Pipeline, Stage II Lake Texana, Brackish Groundwater Desalination, and Seawater Desalination.

- TCEQ considers water rights applications for various types of uses (e.g., recreation, navigation, irrigation, hydroelectric power, industrial, recharge, municipal, and others). Many of these applications are for small amounts of water, some are temporary, and some are even non-consumptive. Because waters of the Nueces River Basin are fully appropriated to the City of Corpus Christi and others, any new water rights application for consumptive water use from this Basin will need to protect the existing water rights or provide appropriate mitigation to existing water right owners. Throughout the Coastal Bend Region, the types of small projects that may arise are so unpredictable that the CBRWPG is of the opinion that each project should be considered by the TWDB and TCEQ on their merits, and that the Legislature foresaw this situation and provided appropriate language for each agency to deal with it.

  (Note: The provision related to TCEQ is found in Texas Water Code §11.134. It provides that the Commission shall grant an application to appropriate surface water, including amendments, only if the proposed appropriator addresses a water supply need in a manner consistent with an approved regional water plan. TCEQ may waive this requirement if conditions warrant. For TWDB funding, Texas Water Code §16.053(j) states that after January 5, 2002, TWDB may provide financial assistance to a water supply project only after the Board determines that the needs to be addressed by the project will be addressed in a manner that is consistent with that appropriate regional water plan. The TWDB may waive this provision if conditions warrant.)

ES.9 Social and Economic Impacts of Not Meeting Projected Water Needs

If projected water needs are not met, the region could expect 520 fewer people in 2010, 13,590 fewer in 2030, and 66,280 fewer in 2060 under drought of record water supply conditions. The expected 2060 population under the unmet water need (shortage) condition would be 7.5 percent lower than the region's growth projection with adequate water supplies.

The estimated effect of projected water shortages upon income in the region, are $57.26 million per year in 2010, $1,617.17 million per year in 2030, and $7,840.56 million per year in 2060. If the water needs are left entirely unmet, the level of shortage in 2010 results in 430 fewer jobs than would be expected if the water needs of 2010 are fully met. The gap in job growth due to water shortages grows to 11,275 fewer jobs by 2030 and 55,025 few jobs by 2060. Socioeconomic impacts of unmet needs were evaluated by the TWDB and costs of unmet needs were provided to represent regional impacts of leaving water needs entirely unmet, representing a worst-case scenario (Appendix F).

Tables ES-6.
Summary of Recommended Water Management Strategies in the Coastal Bend Region

ID	Recommended Water Management Strategy	Total Capital Costs	First Decade Estimated Annual Average Unit Cost ($/acft/yr)	Water Supply Volume (acrt/yr) 2010	2020	2030	2040	2050	2060	Year 2060 Estimated Annual Average Unit Cost ($/acft/yr)
N-1	**Municipal Water Conservation**									
	Alice	N/A	$423	50	133	219	306	438	585	$423
	Duval County-Other	N/A	$423	6	13	21	27	44	63	$423
	Falfurrias	N/A	$423	1	38	95	156	228	309	$423
	George West	N/A	$423	5	14	25	33	45	57	$423
	McMullen County-Other	N/A	$423	1	2	3	5	7	10	$423
	Nueces County WCID #4	N/A	$448	0	0	56	135	261	384	$448
	Orange Grove	N/A	$423	3	8	14	18	28	38	$423
	Port Aransas	N/A	$448	28	115	238	406	615	843	$448
	Premont	N/A	$423	9	22	36	49	70	92	$423
	Three Rivers	N/A	$423	3	8	14	18	27	34	$423
N-2	**Irrigation Conservation**									
	Live Oak County	N/A	$228	17	52	103	169	248	342	$228
N-3	**Manufacturing Conservation**	N/A	N/A	1,260	1,418	1,576	1,734	1,892	2,050	N/A
N-4	**Mining Water Conservation**									
	Duval County	N/A	N/A	147	332	534	761	1,014	1,283	N/A
	Live Oak County	N/A	N/A	97	216	344	485	639	801	N/A
	Nueces County	N/A	N/A	37	78	120	164	210	259	N/A
N-5	**Reclaimed Wastewater Supplies**	N/A	$826	250	250	250	250	250	250	$826
N-7	**Gulf Coast Aquifer Groundwater Supplies (Local)**									
	Aransas County - Manufacturing	$257,000	$135	200	200	200	200	200	200	$25
	Bee County - Irrigation	$1,763,000	$100	0	0	0	0	2,016	2,016	$100
	Jim Wells County - Other	$980,000	$213	565	565	565	565	565	565	$62
	Kleberg County - Other	$587,000	$185	0	400	400	400	400	400	$58
	Lake City	$343,000	$444	0	80	80	80	80	80	$75
	Live Oak County - Irrigation	$1,058,000	$100	1,210	1,210	1,210	1,210	1,210	1,210	$24
	Live Oak County - Other	$315,000	$438	0	80	80	80	80	80	$100
	San Patricio County - Irrigation	$8,110,000	$100	0	0	9,000	9,000	9,000	9,000	$24
N-7	**Gulf Coast Aquifer Groundwater Supplies (Regional)**	$59,245,000	$853	0	0	11,000	11,000	11,000	18,000	$566
N-11	**Off-Channel Reservoir**[1]	$105,201,950	$715	0	0	30,340	30,340	30,340	30,340	$578
N-12	**Voluntary Redistribution of City of Three Rivers Surplus**									
	Live Oak County - Manufacturing	N/A	$685	337	483	559	615	657	764	$685
	River Acres WSC	N/A	$798	138	255	355	445	522	590	$798
N-12	**Increase contracted amount provided by Wholesale Water Providers**									
	Aransas County - Other	N/A	$442	0	0	0	0	1,527	1,443	$471
	Nueces County - Other	N/A	$652	261	0	0	0	0	0	$0
N-13	**Lavaca River Diversion & Off-Channel Reservoir**[2]	$224,183,000	$1,027	0	0	0	0	0	16,242	$1,027
N-14	**Garwood Pipeline**	$112,798,000	$685	0	35,000	35,000	35,000	35,000	35,000	$402
N-19	**O.N. Stevens Water Treatment Plan Improvments**[3]	$31,324,000	$178	42,329	40,048	38,102	36,366	34,817	32,996	$146

1. Capital cost shown assume Federal and/or State participation of 65%. Without this funding, the total project cost is $30 0,577,000.
2. Total cost shown is not prorated between Region N and P; however, it is understood that Region N is only responsible for a portion of the total project cost.
3. Total capital cost include improvements to the following WTP components: raw influent, raw water intake pump station, and O.N. Stevens solids handling facilities.

N/A = Not Applicable

Table ES-7.
Summary of Alternative Water Management Strategies in the Coastal Bend Region

ID	Recommended Water Management Strategy	Total Capital Costs	First Decade Estimated Annual Average Unit Cost ($/acft)	Water Supply Volume (acft)						Year 2060 Estimated Annual Average Unit Cost ($/acft)
				2010	2020	2030	2040	2050	2060	
N-10	CCR/LCC Pipeline[1]	$48,324,000	$588	0	0	0	21,905	21,905	21,905	$588
N-13	Stage II Lake Texana (On-Channel)[2]	$232,828,000	$1,213	0	0	0	0	0	12,964	$1,213
N-17	Seawater Desalination	$260,914,000	$1,696	0	0	0	28,000	28,000	28,000	$1,696
N-20	Brackish Groundwater Desalination	$108,331,000	$977	0	0	0	18,000	18,000	18,000	$977

1. Capital cost shown assume Federal and/or State participation of 65%. Without this funding, the total project cost is $138,067,000.
2. Total cost shown is not prorated between Region N and P; however, it is understood that Region N is only responsible for a portion of the total project cost.

Section 1
Planning Area Description
[31 TAC §357.7 (a)(1)]

1.1 Water Use Background

The area represented by the Coastal Bend Regional Water Planning Group ("Region N" or "Coastal Bend Region") includes the following counties: Aransas, Bee, Brooks, Duval, Jim Wells, Kenedy, Kleberg, Live Oak, McMullen, Nueces, and San Patricio (Figure 1-1). The Coastal Bend Region has four regional wholesale water providers: the City of Corpus Christi, San Patricio Municipal Water District (SPMWD), South Texas Water Authority (STWA), and Nueces County Water Control and Improvement District #3 (Nueces County WCID #3). The City of Corpus Christi, the largest of the four, sells water to two of the other regional water providers—SPMWD and STWA. The City of Corpus Christi and the SPMWD distribute water to cities, water districts, and water supply corporations which in turn provide water to residential, commercial, and industrial customers. SPMWD also sells water directly to large industrial facilities located on the La Quinta Ship Channel. STWA provides water to cities and water supply corporations that supply both residential and commercial customers within the western portion of Nueces County as well as Kleberg County. The smallest regional wholesale water provider, Nueces County WCID #3, provides water to the City of Robstown and other municipal entities within the western portion of Nueces County.

Municipal and industrial water use accounts for the greatest amount of water demand in the Coastal Bend Region, totaling 85 percent of the region's total water use in 2000 (Figure 1-2). The major water demand areas are primarily municipal systems in the greater Corpus Christi area, as well as large industrial (manufacturing, steam-electric, and mining) users located along the Corpus Christi and La Quinta Ship Channels. Agriculture (irrigation and livestock) is the third largest category of water use in the region (Figure 1-2). Based on recent water use records, the City of Corpus Christi provides supplies for about 67 percent of the municipal and industrial water demand in the region (not including supplies to SPMWD or STWA).

1.2 Water Resources and Quality

1.2.1 Surface Water Sources

The Coastal Bend Region depends mostly on surface water sources for municipal and industrial water supply use. The two major surface water resources include the Choke Canyon

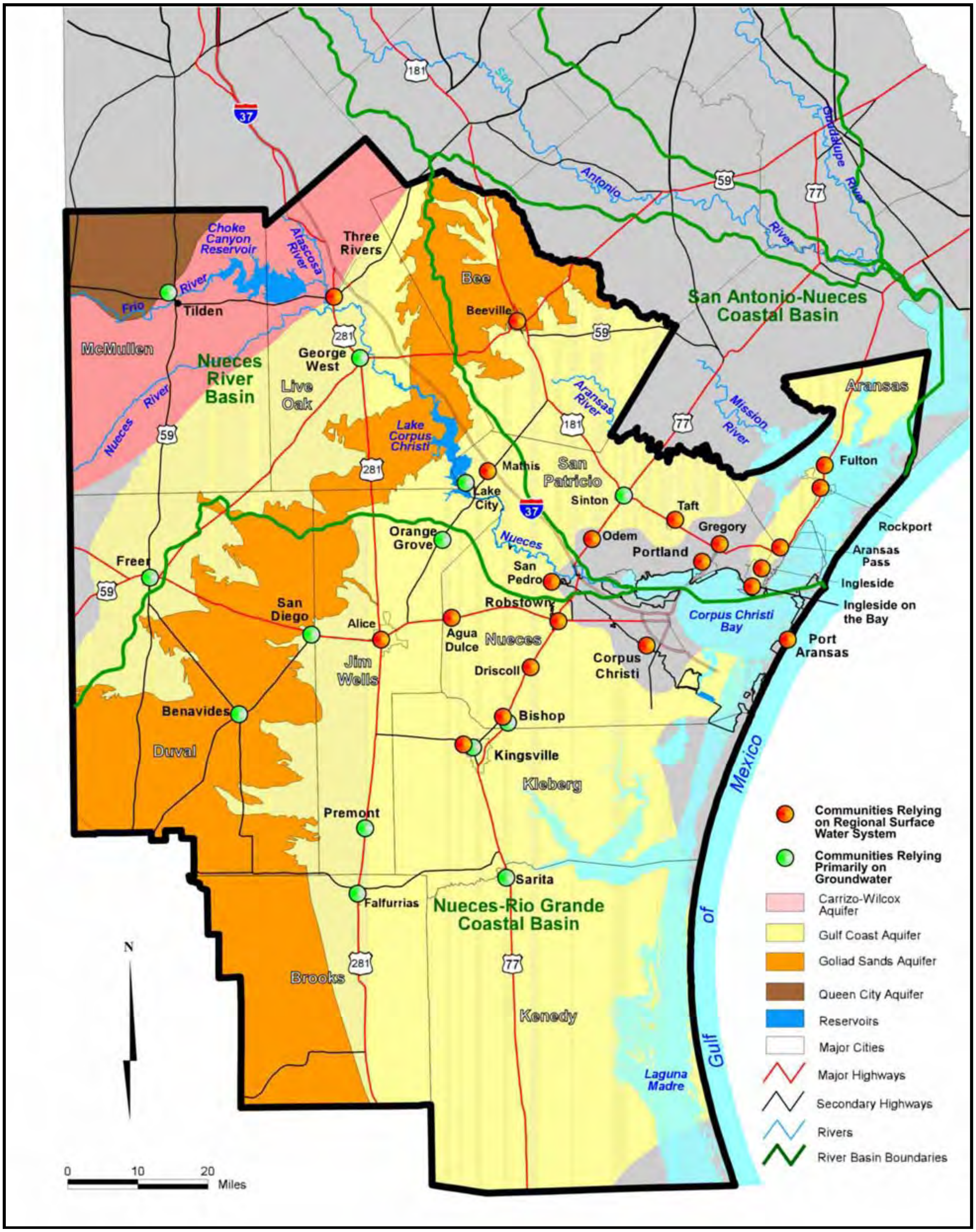


Figure 1-1. Water Providers in the Planning Region

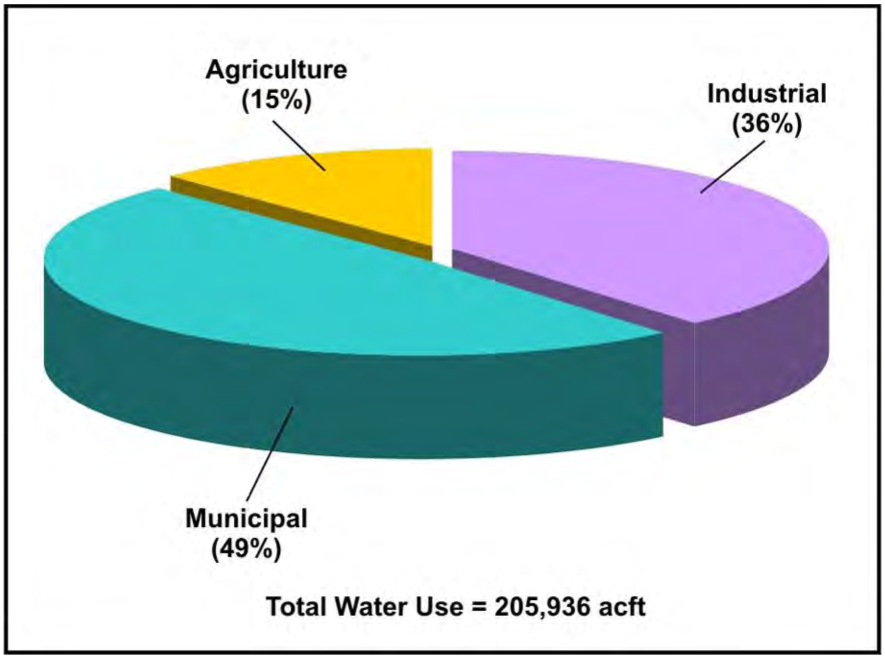


Figure 1-2. 2000 Water Use in the Coastal Bend Regional Water Planning Area

Reservoir/Lake Corpus Christi System (CCR/LCC System) in the Nueces River Basin and Lake Texana on the Navidad River in Jackson County. Water supply from Lake Texana is transported to the Coastal Bend Region via the Mary Rhodes Pipeline and provides the Coastal Bend Region with 41,840 acre-feet per year (acft/yr) and 12,000 acft/yr on an interruptible basis, according to the contract between the City of Corpus Christi and the Lavaca-Navidad River Authority (LNRA). Based on 2010 sediment conditions and Phase IV operating policy, including the 2001 Agreed Order governing freshwater pass-throughs to Nueces Estuary, the CCR/LCC System with supplies from Lake Texana has a safe annual yield of 205,000 acft/yr in 2010. The safe annual yield is based on keeping 75,000 acft in system storage (i.e., storage reserve of 7 percent CCR/LCC System) during the critical month of the drought of record. The Coastal Bend Regional Water Planning Group adopted use of safe yield supply for the 2011 Plan, which provides approximately 22,000 acft less than firm yield supply in 2010 (227,000 acft).

The Nueces River Authority's 2008 Basin Summary Report[1] compiled information on 13 water quality parameters for 44 segments in the San Antonio-Nueces Coastal Basin, the Nueces River Basin, the Nueces-Rio Grande Coastal Basin, and the adjacent bays and estuaries. The

[1] Nueces River Authority, "2008 Basin Summary Report for San Antonio-Nueces Coastal Basin, Nueces River Basin, and Nueces-Rio Grande Coastal Basin," August 2008.

report compiled results from 303 (d) List of Impaired Waters and 305 (b) Water Quality Inventory for a 7-year period from December 1, 1999 through November 30, 2006 and found that the water quality is generally good. However, there are some areas of concern. A few stream segments within the region, as well as local bays and estuaries, had elevated levels of dissolved solids, nutrients, bacteria, and low dissolved oxygen levels (Table 1-1).

The water quality of the water from Lake Texana has been reported as good. In fact, it exceeds the general quality of the water supply from the Nueces River Basin and has less Total Dissolved Solids (TDS) than the Nueces River water. However, because Lake Texana water is blended with Nueces River water prior to treatment, the higher Total Suspended Solids (TSS) levels in the Lake Texana water and the pH difference between the two different sources requires precise controls during the treatment process.

1.2.2 Groundwater Sources

Some areas in the region are dependent on groundwater. There are two major aquifers that lie beneath the region—the Carrizo-Wilcox and Gulf Coast Aquifers (Figure 1-1). (Note: For in-depth descriptions of these aquifer systems, the reader is referred to the extensive list of references in Appendix A.) The Carrizo-Wilcox Aquifer contains moderate to large amounts of either fresh or slightly saline water. Slightly saline water is defined as water that contains 1,000 to 3,000 milligrams per liter (mg/L) of dissolved solids. Although this aquifer reaches from the Rio Grande River north into Arkansas, it only underlies parts of McMullen and Live Oak Counties within the Coastal Bend Region. In this downdip portion of the Carrizo-Wilcox Aquifer, the water is softer, hotter (140 degrees Fahrenheit), and contains more dissolved solids.

The Gulf Coast Aquifer underlies all counties within the Coastal Bend Region and yields moderate to large amounts of both fresh and slightly saline water. The Gulf Coast Aquifer, extending from Northern Mexico to Florida, is comprised of five aquifer formations: Catahoula, Jasper, Burkeville, Evangeline, and Chicot. The Evangeline and Chicot Aquifers are the uppermost water formations within the Gulf Coast Aquifer System and, consequently, are the formations utilized most commonly. The Evangeline portion of the Gulf Coast Aquifer features the highly transmissive Goliad Sands. The Chicot portion of the Gulf Coast Aquifer is comprised of many different geologic formations; however, the Beaumont and Lissie Formations are predominant in the Chicot Aquifer within the Coastal Bend area. The Burkeville Aquifer is

Table 1-1.
Water Quality Concerns

Surface Water Resource (Stream Segment Number)	*Water Quality Concerns*	*Water Quality Impairments*
Aransas River Tidal (*2003*)	Orthophosphorus (OP)	Enterococcus
Aransas River Above Tidal (*2004*)	Low DO, Nitrite + Nitrate (N+N), OP, and Total Phosphorus	
Nueces River Below Corpus Christi (*2102*)	Chlorophyll-a, TDS*, Chloride*, and Sulfate*	
Lake Corpus Christi (*2103*)	Chlorophyll-a, OP, Total Phosphorus, TDS*, Chloride*, and Sulfate*	
Nueces above Frio River (*2104*)		Low Dissolved Oxygen (DO), Fish Community Habitat, and Macrobenthos Community
Nueces River / Lower Frio River (*2106*)	Chloride	TDS
Atascosa River (*2107*)	OP, Chlorophyll -a, Chloride, and Sulfate	E. coli, Low DO, and Habitat
San Miguel Creek (*2108*)	Chlorophyll-a	E. coli
Choke Canyon Reservoir (*2116*)	Low DO	Low DO
Frio Above Choke Canyon Reservoir (*2117*)	N+N	E. coli
Petronila Creek Tidal (2203)	Chlorophyll-a	
Petronila Creek above Tidal (*2204*)	Chlorophyll-a	TDS, Chloride, and Sulfate
San Antonio Bay / Hynes Bay / Guadalupe Bay (*2462*)	N+N, Total Phosphorus*, Chlorophyll -a*	
Mesquite Bay / Carlos Bay / Ayres Bay (*2463*)		
Aransas Bay (*2471*)	Chlorophyll-a*	
Copano Bay (*2472*)	Total Phosphorus*	Fecal Coliform
St. Charles Bay (*2473*)	Low DO, Enterococcus*	
Corpus Christi Bay (*2481*)		Enterococcus
Nueces Bay (*2482*)	Total Phosphorus*	
Redfish Bay (*2483*)		Bacteria for Oyster Waters
Corpus Christi Inner Harbor (*2484*)	Ammonia, N+N, and Chlorophyll-a	
Oso Bay (*2485*)	Chlorophyll-a, Total Phosphorus, and Ammonia	Low DO, Enterococcus, Bacteria for Oyster Waters
Laguna Madre (*2491*)	Chlorophyll-a, N+N, Ammonia*, Total Phosphorus*	Low DO and Bacteria for Oyster Waters
Baffin Bay / Alazan Bay / Cayodel Grullo / Laguna Salada (*2492*)	Chlorophyll-a, Ammonia*, Total Phosphorus*	

Source: Nueces River Authority 2008 Basin Summary Report - San Antonio-Nueces Coastal Basin, Nueces River Basin, and Nueces-Rio Grande Coastal Basin, August 2008.
Note: The 2008 Assessment included data from December 1, 1999 through November 30, 2006.
* Indicates possible concerns or increasing trends.

predominantly clay, and therefore provides limited water supplies. The Texas Water Development Board (TWDB) developed a Central Gulf Coast Groundwater Availability Model (CGCGAM) used by the Coastal Bend Region to determine groundwater availability. The TWDB CGCGAM includes four aquifer layers: Jasper, Burkeville, Evangeline, and Chicot.

Within Texas, the Houston area is the largest user of the Gulf Coast Aquifer. Due to growing population and water demand in that area, over-pumping of the aquifer has resulted in subsidence of up to 9 feet being recorded in Harris County. While not as severe as in the Houston area, subsidence has been reported within the Gulf Coast Aquifer in the Coastal Bend Region. In 1979, the Texas Department of Water Resources developed a Gulf Coast Aquifer Model to evaluate pumpage, water level drawdowns, and subsidence for the 10-year period of 1960 through 1969 for Houston, Jackson-Wharton Counties, and Kingsville areas. The objective of the study was to compare modeled results to historical water level declines and subsidence.[2] Areas in Kleberg County have recorded a 0.5-foot drop in elevation due to pumping of the Gulf Coast Aquifer. However, due to the increase in surface water use within Kleberg County, water levels of the aquifer are rising and the rate of subsidence has diminished. Water quality in the shallower parts of the aquifer is generally good; however, there is saltwater intrusion occurring in the southeast portion of the aquifer along the coastline. It should also be noted that the water quality deteriorates moving southwestward towards the Texas-Mexico border.

The Yegua-Jackson is an official minor aquifer and covers parts of McMullen, Live Oak, and Bee counties within the Coastal Bend Region.

1.2.3 Major Springs

Due to most areas having an underlying impervious clay layer, there has not been much opportunity for springs to form in the Coastal Bend Region. According to *Springs of Texas-Volume I* by Gunnar Brune, there are 18 small springs in the Coastal Bend Region with flows between 0.28 and 2.8 cfs and a number of these springs produce saline, hard, alkaline spring water. These are the largest documented springs in the Coastal Bend Region. There are no major springs in the Coastal Bend Region.

[2] "Groundwater Availability in Texas," Texas Department of Water Resources, Report 238, September 1979.

1.3 Economic Aspects

In 2000, the population of the Coastal Bend Region was 541,184 with a regional average per capita income of $19,833, ranging from $14,876 in Brooks County to $26,458 in McMullen County.[3] By 2007, the estimated population for the Coastal Bend Region was 549,686 with a regional average per capita income of $27,518, ranging from $20,887 in Bee County to $33,970 in Nueces County.[4] The Corpus Christi Metropolitan Statistical Area (MSA), consisting of Aransas, Nueces, and San Patricio Counties, accounts for 75 percent of the Coastal Bend Region's population and 79 percent of the total personal income. In 2007, the total personal income in the Coastal Bend Region was nearly $17.3 billion, including net earnings, dividends, and personal transfer receipts[5,6] (Figure 1-3).

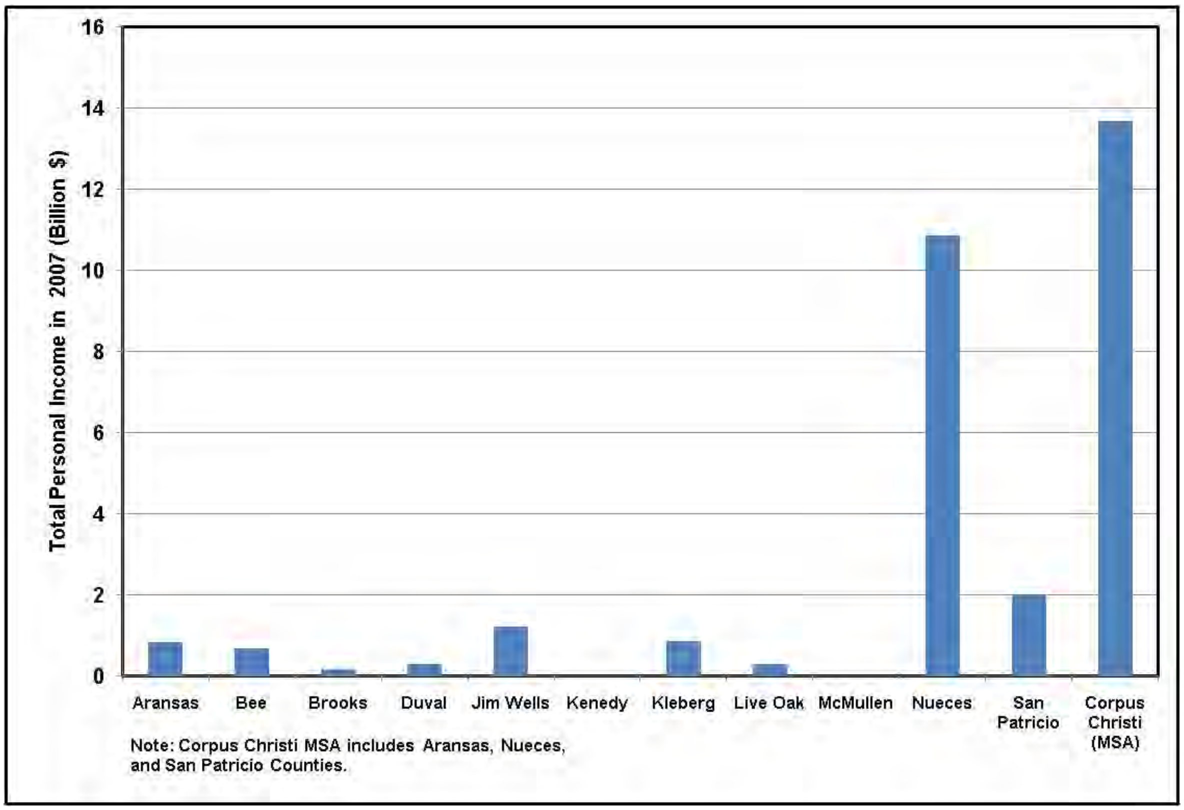


Figure 1-3. Total Personal Income (Earnings) by County

[3] U.S. Department of Commerce Bureau of Economic Analysis, Regional Economic Information System (REIS) Database, 2007.
[4] Ibid
[5] Ibid.
[6] Personal transfer receipts are government payments to individuals, including retirement and disability insurance and medical services.

The primary economic activities within the Coastal Bend Region include oil/gas production and refining, petrochemical manufacturing, military installations, retail and wholesale trade, agriculture, and service industries including health services, tourism/recreation industries, and governmental agencies. In 2007, these industries employed nearly 311,000 people in the Coastal Bend Region with annual compensation to employees of over $11.1 billion (Figures 1-4 and 1-5).[7] The service industries sector had the biggest economic impact in 2007, with a total compensation to employees of economic contribution of $3.8 billion, while employing 48% of the total workforce within the Region (Figures 1-4 and 1-5). The service industries sector includes information, finance and insurance, real estate, educational, and health care and social assistance businesses. Health services, the largest economic service industry contributor, generated nearly $1.2 billion in compensation to employees in 2007 for the Coastal Bend Region.

The retail/wholesale trade sector is also a large contributor to the local economy. In 2007, 14% of the local workforce was employed by this sector, receiving total compensation of $1.2 billion (Figures 1-4 and 1-5).

Government agencies accounted for more than 52,000 jobs (18 percent of total employment) in the Coastal Bend Region. In 2007, these government agencies—consisting of federal, military, state and local government—had total compensation to employees of over $2.9 billion.

The petrochemical and refining industries had total compensation to employees of almost $600 million in 2007.

Agriculture accounts for a major portion of the land use within the Coastal Bend Region. Of the cultivated land in 2007, over 97 percent was dryland farmed and approximately 34,666 acres of cultivated land was irrigated (Table 1-2). The dominant crops of the region are corn, wheat, sorghum, cotton, and hay. Livestock is a major agricultural product of the Coastal Bend Region. In 2007, livestock products made up 38.5 percent of the total market value of agriculture products.[8]

Fishing is another industry that adds to the economic value of the Coastal Bend Region. In 2007, reported bay and gulf commercial fishing generated over $44 million in sales and value

[7] U.S. Department of Commerce Bureau of Economic Analysis, REIS Database, 2007.
[8] 2007 Census of Agriculture.

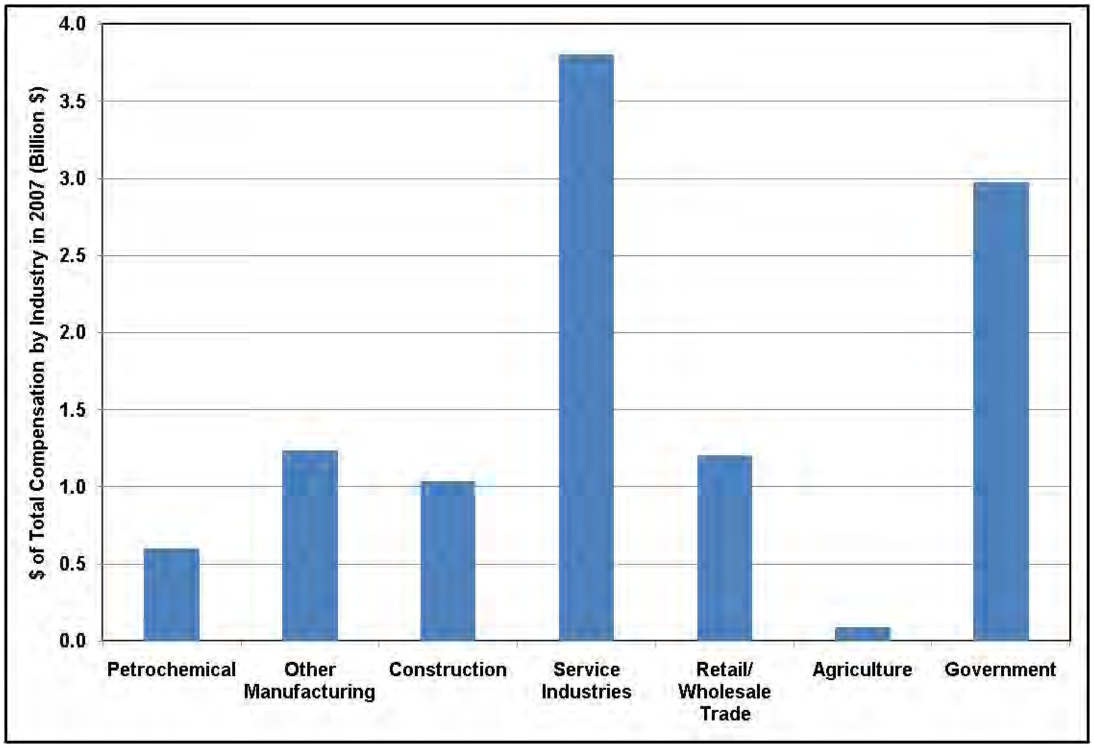


Figure 1-4. Total Compensation to Coastal Bend Region by Sector

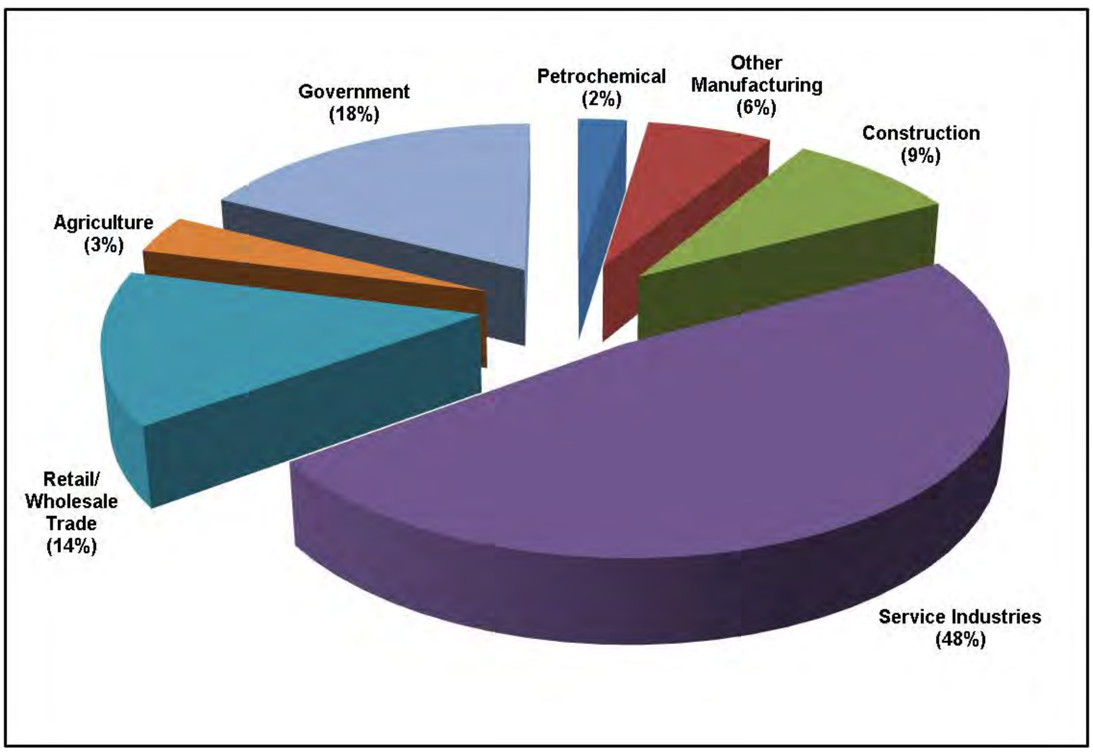


Figure 1-5. 2007 Percentages of Major Employment by Sector in the Coastal Bend Region — Total Number Employed – 310,898

Table 1-2.
Coastal Bend Regional Water Planning Area Agriculture Statistics — 2007

Counties	Region	Aransas	Bee[1]	Brooks	Duval	Jim Wells	Kenedy	Kleberg	Live Oak	McMullen	Nueces	San Patricio
Total Cropland (acres)	1,277,255	N/A	104,923	58,384	120,349	150,931	2,797	82,645	90,632	38,464	369,433	258,697
Irrigated Cropland (acres)	34,666	14	5,738	1,523	4,596	1,757	407	13	2,063	N/A	4,322	14,233
Irrigated Cropland/Total Cropland	2.7%	N/A	5.5%	2.6%	3.8%	1.2%	14.6%	0.0%	2.3%	N/A	1.2%	5.5%
Total Market Value of Agr icultural Product ($1,000)	450,631	1,669	39,203	19,111	14,771	61,034	N/A	64,991	20,968	8,778	110,905	109,201
Market Value of Crop Products Sold ($1,000)	277,253	45	19,075	911	3,946	24,862	N/A	25,073	5,356	295	108,055	89,635
Market Value of Livestock Products Sold ($1,000)	173,378	1,624	20,128	18,200	10,825	36,172	N/A	39,919	15,612	8,483	2,850	19,565
Crop Products/Total Agricultural Products	61.5%	2.7%	48.7%	4.8%	26.7%	40.7%	N/A	38.6%	25.5%	3.4%	97.4%	82.1%
Livestock Products/Total Agricultural Products	38.5%	97.3%	51.3%	95.2%	73.3%	59.3%	N/A	61.4%	74.5%	96.6%	2.6%	17.9%

N/A = Not Available

[1] Bee GCD indicated that about 7,600 acres were irrigated in Bee County in 2009.

to the Region.[9] Overall impact to the State's economy of commercial fishing, sport fishing and other recreational activities has been estimated by the TWDB to be $814 million per year for the 352,000-acre Nueces Estuary System.

Unemployment rates in the Region in 1990 were between 6 and 7 percent, whereas in 1996 the unemployment rate ranged between 8 and 9 percent. In 2008, the unemployment rate for the Coastal Bend Region was 4.9 percent.[10]

1.4 Identified Threats to Agricultural and Natural Resources

The Coastal Bend Region's agricultural business relies on groundwater for irrigation and water for livestock. During previous planning efforts, in developing the 2001 and 2006 Plans, the Coastal Bend Regional Water Planning Group identified continuing groundwater depletion as a threat to agricultural and natural resources. The Coastal Bend Region also recognizes the following additional potential threats to agricultural and natural resources:

- Shortage of freshwater and economically accessible groundwater attributable to increased irrigation demands.
- Shortage of freshwater and economically accessible groundwater attributable to development of natural gas from the shale in the Eagleford Group and water demands associated with hydraulic fracturing of wells.
- Deterioration of surface water quality associated with sand and gravel operations and other activities.
- Deterioration of groundwater quality and increasing concerns of possible arsenic and uranium contamination attributable to uranium mining activities.
- Impacts of potential off-channel reservoir on terrestrial wildlife habitats.
- Potential impacts to threatened, endangered, and other species of concern.
- Potential impacts of brush control and other land management practices as currently considered in Federal studies.
- Abandoned wells (oil, gas, and water).

These threats are considered for each water management strategy, and when applicable, are specifically addressed in Section 4C.

1.5 Resource Aspects and Threatened, Endangered, and Rare Species of the Coastal Bend Region

While the Coastal Bend Region is known for its valuable mineral resources, especially oil and gas, this area also contains a rich diversity of living natural resources. The Coastal Bend

[9] U.S. Department of Commerce Bureau of Economic Analysis, REIS Database, 2007.
[10] Texas Workforce Commission, 2008.

Region contains three distinct natural regions; the South Texas Brush Country which characterizes the inland portion of the region, the Coastal Sand Plains along the southern coastline, and the Gulf Coast Prairies and Marshes along the northern coastline (Figure 1-6).

Regional water plan guidelines require the additional reporting of environmental factors for water management strategies. These factors include any possible effects to wildlife habitat, cultural resources, environmental water needs, and inflows to bays and estuaries. Each water management strategy summary (Section 4C) includes a discussion of these environmental considerations and potential impacts associated with project implementation.

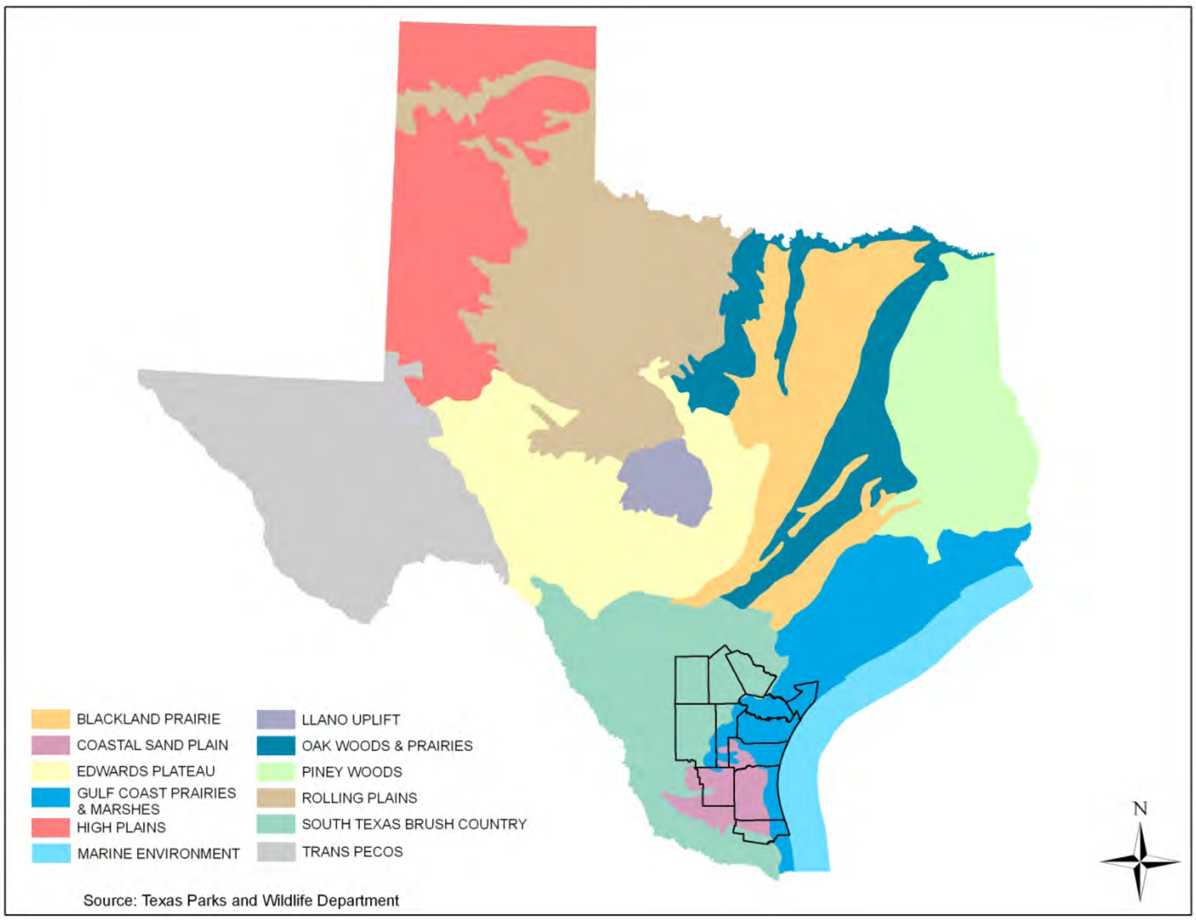


Figure 1-6. Natural Regions of Texas

Because the Coastal Bend Region is located along many migratory flyways, birds comprise a major portion of the wildlife population found within the area. The area provides many birds unique nesting and forage resources within its coastal prairies, wetlands, and riverine ecosystems. The endangered brown pelican utilizes the Coastal Bend's natural resources year-round while the endangered whooping crane is only found seasonally.

The Coastal Bend Region provides habitat for numerous state- and federally-listed endangered and threatened species. These listed species include birds, amphibians, reptiles, fish, mammals, and vascular plants (Table 1-3). Texas Parks and Wildlife and U.S. Fish and Wildlife Service- Southwest Region Ecological Service maintain maps identifying potential habitats (by county) of each endangered or threatened species. These potential habitats are considered for each water management strategy and when possibly impacted, are noted in the appropriate water management strategy summary (Section 4C).

Bay and estuary systems depend on freshwater inflows for maintaining habitats and productivity. Freshwater inflows provide a mixing gradient that establishes a range of salinity, as well as nutrients that are important to the productivity of estuarine systems. In addition, freshwater inflows deposit sediments, which help maintain the deltas and barrier islands that protect the bays and marshes. Without freshwater inflows, many plant and animal species could not survive. In accordance with an order issued by the Texas Commission on Environmental Quality (TCEQ) in 1995, and the subsequent 2001 Agreed Order amendment, Choke Canyon Reservoir and Lake Corpus Christi are operated in such a way as to "pass through" a certain target amount of water each month to the Nueces Bay and Estuary. This water provides the important freshwater inflows needed by the Nueces Estuary based on maximum harvest studies and inflow recommendations.

According to the TPWD,[11] the maximum harvest flow to the Nueces Bay and Estuary produced slightly higher harvests of red drum, black drum, spotted sea trout, and brown shrimp but slightly decreased amounts of blue crab.

The presence of widespread underlying impervious clay layers has resulted in the limited formation of springs within the Coastal Bend Region. According to *Springs of Texas- Volume I* by Gunnar Brune, there are only 18 small springs documented within the Coastal Bend Region, a number of which produce saline, hard, alkaline spring water. These springs have recorded flows

[11] Texas Parks and Wildlife Department, "Freshwater Inflow Recommendation for the Nueces Estuary," September 2002.

Table 1-3.
Endangered and Threatened Species of the Coastal Bend Region

Common Name	*Scientific Name*	*County for which Species is Listed*	*Federal Status*	*State Status*
Black bear	*Ursus americanus*	Historic in Aransas, Duval, and McMullen	Threatened	Threatened
Black Lace Cactus	*Echinocereus reichenbachii var. albertii*	Jim Wells, Kleberg	Endangered	Endangered
Black-spotted newt	*Notophthalmus meridionalis*	Aransas, Bee, Brooks, Duval, Jim Wells, Kenedy, Kleberg, Live Oak, McMullen, Nueces, San Patricio	___	Threatened
Black-striped snake	*Coniophanes imperialis*	Kenedy	___	Threatened
Brown Pelican	*Pelecanus occidentalis*	Aransas, Kenedy, Kleberg, Nueces, San Patricio	Endangered	Endangered
Cactus Ferruginous Pygmy-Owl	*Glaucidium brasilianum cactorum*	Brooks, Kenedy	___	Threatened
Coues' rice rat	*Oryzomys couesi*	Kenedy	___	Threatened
Eskimo Curlew	*Numenius borealis*	Historic in Aransas, Kenedy, Kleberg, Nueces, San Patricio	Endangered	Endangered
Green Sea Turtle	*Chelonia mydas*	Aransas, Kenedy, Kleberg, Nueces, San Patricio	Threatened	Threatened
Hawksbill Sea Turtle	*Eretmochelys imbricata*	Aransas, Kenedy, Kleberg, Nueces, San Patricio	Endangered	Endangered
Indigo snake	*Drymarchon corais*	Bee, Brooks, Duval, Jim Wells, Kenedy, Kleberg, Live Oak , McMullen, Nueces, San Patricio	___	Threatened
Interior Least Tern	*Sterna antillarum athalassos*	Live Oak, McMullen	Endangered	Endangered
Jaguar	*Panthera onca*	Brooks, Kenedy, Kleberg	Endangered	Endangered
Gulf coast Jaguarundi	*Herpailurus (=Felis) yaguarondi cacomitli*	Aransas, Brooks, Kleberg, Live Oak, San Patricio	Endangered	Endangered
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	Aransas, Kenedy, Kleberg, Nueces, San Patricio	Endangered	Endangered
Leatherback Sea Turtle	*Dermochelys coriacea*	Aransas, Kenedy, Kleberg, Nueces, San Patricio	Endangered	Endangered
Loggerhead Sea Turtle	*Caretta caretta*	Aransas, Kenedy, Kleberg, Nueces, San Patricio	Threatened	Threatened
Louisiana black bear	*Ursus americanus luteolus*	Historic in Aransas	Threatened	Threatened
Mexican treefrog	*Smilisca baudinii*	Kenedy	___	Threatened
Northern Aplomado Falcon	*Falco femoralis septentrionalis*	Migrant in Aransas, Brooks, Jim Wells, Kenedy, Kleberg, Nueces, San Patricio	Endangered	Endangered
Northern Beardless-Tyrannulet	*Camptostoma imberbe*	Brooks, Kenedy, Kleberg	___	Threatened
Northern cat-eyed snake	*Leptodeira septentrionalis*	Brooks, Kenedy, Kleberg	___	Threatened
Ocelot	*Leopardus (=Felis) pardalis*	Aransas, Bee, Brooks, Duval, Jim Wells, Kenedy, Kleberg, Live Oak, McMullen, Nueces, San Patricio	Endangered	Endangered

Table 1-3 (Continued)

Common Name	Scientific Name	County for which Species is Listed	Federal Status	State Status
Opossum pipefish	*Microphis brachyurus*	Aransas, Kenedy, Kleberg, Nueces, San Patricio	___	Threatened
Peregrine falcon	*Falco peregrinus anatum* (American)	Nesting/Migrant in Aransas, Bee, Brooks, Duval, Jim Wells, Kenedy, Kleberg, Live Oak, McMullen, Nueces, San Patricio	___	Threatened
	Falco peregrinus	Nesting/migrant in Aransas, Bee, Brooks, Duval, Jim Wells, Kenedy, Kleberg, Live Oak, McMullen, Nueces, San Patricio	___	Threatened
Piping Plover	*Charadrius melodus*	Migrant in Aransas, Kenedy, Kleberg, Nueces, San Patricio	Threatened	Threatened
Red wolf	*Canis rufus*	Historic in Aransas, Bee, Jim Wells, Kenedy, Kleberg, Live Oak, McMullen, Nueces, San Patricio	Endangered	Endangered
Reddish Egret	*Egretta rufescens*	Aransas, Kleberg, Nueces, San Patricio	___	Threatened
Reticulate collared lizard	*Crotaphytus reticulates*	Duval, Jim Wells, Live Oak, McMullen Counties	___	Threatened
Rose-throated Becard	*Pachyramphus aglaiae*	Kenedy	___	Threatened
Sheep frog	*Hypopachus variolosus*	Aransas, Bee, Brooks, Duval, Jim Wells, Kleberg, Live Oak, San Patricio	___	Threatened
Slender Rush Pea	*Hoffmannseggia tenella*	Kleberg, Nueces	Endangered	Endangered
Smalltooth sawfish	*Pristis pectinata*	Aransas, Kenedy, Kleberg, Nueces, San Patricio	Endangered	Endangered
Sooty Tern	*Sterna fuscata*	Aransas, Kenedy, Kleberg, Nueces, San Patricio	___	Threatened
South Texas Ambrosia	*Ambrosia cheiranthifolia*	Jim Wells, Kleberg, Nueces	Endangered	Endangered
South Texas Siren	*Siren sp.1*	Jim Wells, Kenedy, Kleberg, San Patricio	___	Threatened
Southern yellow bat	*Lasiurus ega*	Brooks, Kenedy, Kleberg, Nueces, San Patricio	___	Threatened
Texas Botteri's Sparrow	*Aimophila botterii texana*	Brooks, Duval, Jim Wells, Kenedy, Kleberg, Nueces	___	Threatened
Texas horned lizard	*Phrynosoma cornutum*	Aransas, Bee, Brooks, Duval, Jim Wells, Kenedy, Kleberg, Live Oak, McMullen, Nueces, San Patricio	___	Threatened
Texas scarlet snake	*Cemophora coccinea lineri*	Aransas, Brooks, Jim Wells, Kenedy, Kleberg, Nueces, San Patricio	___	Threatened
Texas tortoise	*Gopherus berlandieri*	Aransas, Bee, Brooks, Duval, Jim Wells, Kenedy, Kleberg, Live Oak, McMullen, Nueces, San Patricio	___	Threatened

Table 1-3 (Concluded)

Common Name	Scientific Name	County for which Species is Listed	Federal Status	State Status
Timber/canebrake rattlesnake	*Crotalus horridus*	Aransas, San Patricio	___	Threatened
Tropical Parula	*Parula pitiayumi*	Kenedy	___	Threatened
Walkers's manioc	*Manihot walkerae*	Duval	Endangered	Endangered
West Indian manatee	*Trichechus manatus*	Aransas, Kenedy, Kleberg, Nueces, San Patricio	Endangered	Endangered
White-faced Ibis	*Plegadis chihi*	Aransas, Bee, Duval, Jim Wells, Kleberg, Live Oak, Nueces, San Patricio	___	Threatened
White-nosed coati	*Nasua narica*	Aransas, Bee, Brooks, Duval, Jim Wells, Kenedy, Kleberg, Nueces, San Patricio	___	Threatened
White-tailed hawk	*Buteo albicaudatus*	Nesting/migrant in Aransas, Bee, Brooks, Jim Wells, Kenedy, Kleberg, Live Oak , Nueces, San Patricio	___	Threatened
Whooping Crane	*Grus americana*	Resident in Aransas, Migrant in Bee, Jim Wells, Live Oak, McMullen, Nueces, San Patricio	Endangered	Endangered
Wood Stork	*Mycteria Americana*	Migrant in Aransas, Bee, Brooks, Duval, Jim Wells, Kenedy, Kleberg, Live Oak, McMullen, Nueces, San Patricio	___	Threatened
Zone-tailed Hawk	*Buteo albonotatus*	Kenedy	___	Threatened

Source: TPWD, Annotated County List of Rare Species, Aransas, Bee, Brooks, Duval, Jim Wells, Kleberg, Kenedy, Live Oak, McMullen, Nueces, and San Patricio Counties (updated May 2009).
--- Not Federally Listed as Endangered or Threatened

which range from 0.28 to 2.8 cfs. Before 1965, the Coast Bend Region relied heavily on groundwater for irrigation, an action which resulted in decreased groundwater levels and springflows. Since that time, irrigation water demands have been substantially reduced due to a decrease in the amount of irrigated acreage and more efficient irrigation practices. These actions could presumably result in a lessening of adverse impacts to existing local springs.

1.6 Water Quality Initiatives

The Clean Water Act of 1972 established a Federal program for restoring, maintaining, and protecting the nation's water resources. The Clean Water Act remains focused on eliminating discharge of pollutants into water resources and making rivers and streams fishable and swimmable. Water quality standards are to be met by industries, states, and communities under the Clean Water Act. Since the enactment of the Clean Water Act, more than two-thirds of the nation's waters have become fishable and swimmable, as well as a noticeable decrease of wetland and soil loss. One aspect of the Clean Water Act is the National Pollutant Discharge Elimination System (NPDES). This program regulates and monitors pollutant discharges into water resources. Whereas in the past the Environmental Protection Agency and the State of Texas each required separate permits to discharge (one under NPDES and one under state law), recently, the State of Texas has received delegation to administer a joint "TPDES" program.

In 1998, the Clean Water Action Plan (Plan) was initiated to meet the original goals of the Clean Water Act. The main priority of this Plan is to identify watersheds and their level of possible concern. The identification of these concerns has been defined within the Texas Unified Watershed Assessment (Assessment). Each watershed was then placed into one of four defined categories—Category I: Watersheds in need of restoration, Category II: Watersheds in need of preventive action to sustain water quality, Category III: Pristine Watersheds, and Category IV: Watersheds with insufficient data. Within the Nueces River Basin some areas of concern have been placed on the Clean Water Act 303(d) medium priority list; consequently both TCEQ and the Environmental Protection Agency are targeting these areas as a Category I.

The State of Texas has initiated other water quality programs. The Texas Clean Rivers Act of 1991 created the Clean Rivers Program within TCEQ. The purpose of this program is to maintain and improve the water quality of the State of Texas's river basins with aid from river authorities and municipalities. The Clean Rivers Program encourages public education, watershed planning, and water conservation, as well as provides technical assistance to identify pollutants and improve water quality in contaminated areas.

In the Coastal Bend Region, the Nueces River Authority (NRA) and TCEQ share the responsibility for surface water monitoring under the Clean Rivers Program. Surface water monitoring within the Coastal Bend Region focuses on freshwater stream segments within the Nueces River Basin, as well as local coastal waters. Each year, NRA and TCEQ coordinate sampling stations and divide stream segment stations between each other in order to eliminate sampling duplication. TCEQ and NRA work together to create the 305(b) Water Quality Inventory Report, which provides an overview of the status of surface waters in the Nueces River Basin and Nueces Coastal Basins. The TCEQ is responsible for administering the Total Maximum Daily Load Program, which addresses the water quality concerns of highest priority as identified in the 305(b) list. Under both the Clean Water Act and the Clean Rivers Program, surface waters must be sampled and monitored for identification of pollutants and possible areas of concern. Currently, certain water segments within the Nueces River Basin are posing some concerns (Table 1-1).

1.7 2006 Coastal Bend Regional Water Plan

Senate Bill 1 was enacted by the 75th Session of the Texas Legislature in 1997. It specified that water plans be developed for regions of Texas and provided that future regulatory and financing decisions of the TCEQ and the TWDB be consistent with approved regional water plans. Furthermore, Senate Bill 1 specified that regional water planning groups submit a regional water plan by January 2001, and at least as frequently as every 5 years thereafter, for TWDB approval and inclusion in the state water plan. In January 2001, the Coastal Bend Region submitted a plan for a 50-year planning period from 2000 to 2050.

In direct response to directives of Senate Bill 2 (77^{th} Texas Legislature, 2001), the CBRWPG revised the January 3, 2001, Coastal Bend Regional Water Plan completed under Senate Bill 1. In January 2006, the Coastal Bend Region submitted a plan for a 55-year planning period from 2000 to 2060 (2006 Coastal Bend Regional Water Plan), which consisted of water supply planning information, projected needs in the Region, and the Region's proposed water plans to meet needs. The total population of the Coastal Bend Region was projected to increase from 541,184 in 2000 to 885,665 by 2060. Similarly, the total water demand was projected to increase from 205,936 acft to 308,577 acft by 2060. There were 14 individual cities and water user groups (i.e., non-municipal water users, such as industrial and agricultural users) that showed projected needs during the 55-year planning horizon. Water management strategies were identified by the Coastal Bend Region to potentially meet water supply shortages. The TWDB evaluated social and economic impacts of not meeting projected water needs, which was included in the 2006 Coastal Bend Regional Water Plan.

1.8 2007 State Water Plan

In Water for Texas 2007 (State Plan), the TWDB utilized information and recommendations from the 16 individual 2006 Regional Water Plans developed by the Regional Water Planning Groups established under Senate Bill 1. In the State Plan, TWDB acknowledges that each Regional Water Planning Group identified many of the same basic recommendations to meet future water demands. These recommendations include: continue regional planning funding, support for groundwater conservation districts, brush control, water reuse, continued support of groundwater availability modeling, conservation education, ongoing funding for groundwater supply projects, and support of alternative water management strategies.

Also, within the State Plan, the TWDB submitted the twelve strategies that were recommended by the Coastal Bend Region in their 2006 Coastal Bend Regional Water Plan. These included:

- Municipal water conservation;
- Irrigation water conservation;
- Manufacturing water conservation;
- Mining water conservation;
- Seawater desalination;
- Additional supply from the Gulf Coast Aquifer;
- Reclaimed wastewater supplies;
- Nueces off-channel reservoir;
- Nueces feasibility projects (LCC/CC Pipeline);
- Palmetto Bend Stage II;
- Voluntary Redistribution of Existing Supplies; and
- Garwood Pipeline.

The State Plan also includes the Coastal Bend Region's policy recommendations to support managing all water resources on a conjunctive use basis, repeal junior rights provision regarding interbasin transfers, development of common set of standards for disposal of "reject" water for industrial and municipal desalination facilities and oil/gas industry, and encourage regional groundwater management where feasible.

In addition to summarizing each Regional Water Planning Group's recommendations, the TWDB defined its own policy recommendations. These included:

- Financing water management strategies;
- Reservoir site designation and acquisition;
- Interbasin transfers of surface water;
- Environmental water needs;
- Water conservation;
- Expedited amendment process; and
- Indirect reuse.

1.9 Local and Previous Regional Water Plans

There has been a number of regional water planning studies done for the Coastal Bend Region, focusing mainly on municipal and industrial water supply issues (refer to Appendix A for list of references). The following is a summary of the major planning efforts in the last 15 years.

In 1989, the Coastal Bend Alliance of Mayors created a Regional Water Task Force. The Regional Water Task Force Final Report,[12] issued in June of 1990, examined the historical and current regional water supply situation and made recommendations for water supply development in the area.

Throughout 1990 and 1991, the TWDB, NRA, the City of Corpus Christi, Edwards Underground Water District, and the STWA sponsored a study[13] that focused on the development of additional water supplies within the Nueces River Basin. The objectives of the study centered upon determining the feasibility of constructing additional recharge structures for the Edwards Aquifer within the basin. The study was also concerned with the effects of the proposed recharge structures on the firm yield of the CCR/LCC System and the required inflows to the Nueces Estuary. The recommendations that emerged from this study determined that additional recharge structures would increase the recharge of the Edwards Aquifer. The study also recommended that additional evaluations consider water supply alternatives for the CCR/LCC System service area as well as a benefit/cost analysis of each additional recharge project. Finally, one of the most useful products to emerge from this study is the Lower Nueces River Basin and Estuary Model, which is still used for evaluating reservoir-operating alternatives.

In 1991, a joint investigation sponsored by the LNRA, the Alamo Conservation and Reuse District, and the City of Corpus Christi, studied additional water supplies for the cities of San Antonio and Corpus Christi. The study[14] addressed the feasibility of transferring water from Lake Texana (Palmetto Bend Project), developing Stage II of the Palmetto Bend Project (Palmetto Bend Stage II), and acquiring water from the Colorado River. The cost and efficiency

[12] Rauschuber, et al., "Regional Water Task Force: Final Report," Regional Water Conference, Coastal Bend Alliance of Mayors, Corpus Christi Area Economic Development Corporation, Port of Corpus Christi-Board of Trade, Dr. Manuel L. Ibanez, President, Texas A&I University, June 30, 1990.
[13] HDR Engineering, Inc. (HDR), et al., "Nueces River Basin Regional Water Supply Planning Study – Phase I," Vols. 1, 2, and 3, Nueces River Authority (NRA), et al., May 1991.
[14] HDR, "Regional Water Planning Study, Cost Update for Palmetto Bend Stage 2 and Yield Enhancement Alternative for Lake Texana and Palmetto Bend Stage 2," Lavaca-Navidad River Authority, et. al., May 1991.

of the diversion projects that would deliver the water to both cities was examined as well. The final recommendation of this study was to purchase the water from Lake Texana and the Garwood Irrigation Company water rights in the Colorado River and construct diversion structures to both San Antonio and Corpus Christi.

In 1992, the TWDB and the cities of Houston, Corpus Christi, and San Antonio initiated the *Trans-Texas Water Program* to address the water supply needs for each of these cities. The Corpus Christi service area was comprised of virtually the same region as the Coastal Bend Region with the exceptions that Refugio and Atascosa Counties were included in the study and Kenedy County was excluded from the study. The City of Corpus Christi, the Port of Corpus Christi Authority, the Corpus Christi Board of Trade, the TWDB, and the LNRA sponsored the *Trans-Texas Water Program* study[15] for the Corpus Christi Service Area. In 1993, an interim report (Phase I) was issued to give an overview of the objectives of the Program for the Corpus Christi Service Area.

Objectives of the *Trans-Texas Water Program* for the Corpus Christi Service Area:

- Determine water demands for a 50-year period (2000 through 2050);
- Identify possible water supply options that will meet the projected water demands; and
- Provide a general assessment of each water supply alternative as well as their cost and environmental impacts.

In Phase II, twenty-two different water supply alternatives were evaluated. Combinations of these alternatives would be necessary to meet the projected water demands. The 1995 report[16] on Phase II of the *Trans-Texas Water Program* study for the Corpus Christi Service Area recommended two integrated water supply plans (Plan A and Plan B). Both Plan A and Plan B recommended such water supply alternatives as the incorporation of changes in the CCR/LCC System operating policies and the 1995 Agreed Order for freshwater inflows to the Nueces Estuary. Other alternatives included additional water conservation practices within the service area and construction of pipelines from Lake Texana and the Colorado River. However, Plan A recommended the construction of an additional pipeline from Choke Canyon Reservoir to Lake Corpus Christi, whereas Plan B recommended obtaining additional water from the Colorado River as well as modifying the target operating elevation of Lake Corpus Christi. Each

[15] HDR, et al., "Trans-Texas Water Program – Corpus Christi Study Area – Phase II Report," City of Corpus Christi, et. al., September 1995.
[16] Ibid.

recommended plan from the *Trans-Texas Water Program* potentially provided the additional 100,000 acft that were projected as being needed in the study area by the year 2050.

In 1995, SPMWD sponsored a system evaluation study.[17] This study was developed in an effort to establish future water demands, evaluate SPMWD's current facilities and supplies, and recommend possible water supply alternatives for SPMWD's service area. The 1995 plan defined four water supply alternatives that would allow SPMWD to meet projected demands. These alternatives included: the purchasing of additional, or all, treated water from the City of Corpus Christi; expansion of SPMWD's existing facilities; or constructing a new water treatment facility near Odem or Portland. Phase I also recommended that a Phase II study be conducted for the preferred alternative to better identify the cost of the selected project, the time schedule commitment, any environmental issues, and the financial impact the alternative might have on the SPMWD. Based on the Phase II study, SPMWD began to upgrade their existing systems in 1997, including pipe refurbishment and construction of a microfiltration plant. In late 2000, SPMWD finished building the microfiltration plant and pipeline that connects their facilities with the Mary Rhodes Pipeline, which can divert an average of 7.5 million gallons per day of Lake Texana water into a new 193 million-gallon aboveground reservoir, where it is blended with incoming Nueces River water.

TWDB and NRA sponsored a regional water planning study to examine possible water supply alternatives for Duval and Jim Wells Counties. The regional water supply study[18] recommended that Freer, San Diego, and Benavides initiate surface water projects to replace existing groundwater sources. The study also determined that it would be best for Premont and Orange Grove to remain on groundwater supplies.

The Coastal Bend Bays and Estuaries Program (CBBEP) has developed the Coastal Bend Bays Plan[19] (Bays Plan) for the Coastal Bend Region. This plan is a long-term, comprehensive management plan designed to restore, maintain, and protect the Coastal Bend Region's bay and estuary ecosystems. Included within the Bays Plan is the allowance for coordination with the Regional Water Planning Group. The CBBEP does not possess taxing, federal, state, or local authority. Rather the CBBEP coordinates the implementation of the Bays Plan by providing

[17] Naismith Engineering, Inc. (NEI), et al., "Study of System Capacity, Evaluation of System Condition, and Projections of Future Water Demands – Phase 1," San Patricio Municipal Water District, September 1995.
[18] NEI, et al., "Regional Water Supply Study, Duval and Jim Wells Counties, Texas," NRA, et al., October 1996.
[19] "Coastal Bend Bays Plan," Coastal Bend Bays and Estuaries Program, August 1998.

limited amounts of technical and financial assistance towards meeting operating goals. CBBEP operating goals include:

- Understand the interdependence of the bays and estuaries with human uses;
- Maintain clean water quality for native living resources as well as providing clean waters for recreation;
- Maintain freshwater inflows;
- Preserve open spaces to meet growing populations; and
- Manage the region's bays and estuaries so they may survive catastrophic events and adapt to condition changes.

In 1998, the Texas Agricultural Extension Service published the *Wetland and Coastal Resources Information Manual for Texas*, 2nd Edition, which includes the Texas Wetland Plan. Initiated in April of 1994, the Texas Wetland Plan employs a non-regulatory, voluntary approach to conserving Texas' wetlands. The plan describes how wetlands have economic and ecological benefits, such as flood control, improved water quality, harvestable products, and habitat for fish, shellfish, and wildlife resources. It also identifies each type of wetland resource throughout the State of Texas and then makes recommendations for conservation actions. The focus of the plan includes enhancing the landowner's ability to use existing incentive programs and other land use options through outreach and technical assistance, developing and encouraging land management options that provide an economic incentive for conserving existing wetlands or restoring former ones, and coordinating regional wetlands conservation efforts. The plan addresses each of these goals by utilizing such tools as education, economic incentives, statewide and regional conservation, assessment and evaluation, and coordination and funding activities.

In 1997, the 75th Session of the Texas Legislature passed Senate Bill 1, specifying that water plans be developed for regions of Texas as well as providing the future regulatory and financing decisions of the TCEQ and the TWDB be consistent with the approved regional water plans. In January 2001, the Coastal Bend Region submitted a plan for a 50-year planning period from 2000 to 2050, which consisted of water supply planning information, projected needs in the Region, and the Region's proposed water plans to meet needs. The total population of the Coastal Bend Region was projected to increase from 569,292 in 2000 to 943,912 by 2050. Similarly, the total water demand was projected to increase from 223,797 acft to 309,754 acft by 2050. There were 20 individual cities and water user groups (i.e., non-municipal water users, such as industrial and agricultural users) that showed projected needs during the 50-year planning horizon. Water management strategies were identified by the Coastal Bend Region to potentially meet water supply shortages. The TWDB evaluated social and economic impacts of not meeting projected water needs, which was included in the 2001 Coastal Bend Regional Water Plan.

In Water for Texas 2002 (State Plan), the TWDB utilized information and recommendations from the 16 individual Regional Water Plans developed by the Regional Water Planning Groups established under Senate Bill 1. Within the State Plan, the TWDB submitted the 12 water management strategies that were recommended by the Coastal Bend Region in their 2001 Coastal Bend Regional Water Plan.

The State Plan also included the Coastal Bend Region's recommendations to further investigate large-scale desalination, interregional cooperation on interbasin transfers and the exchange of surface water rights, and consideration for setting groundwater pumping level cutoffs.

1.10 Groundwater Conservation Districts

The Texas Legislature authorized in 1947 the creation of groundwater conservation districts to conserve and protect groundwater and later recognized them, in 1997, as the "preferred method of determining, controlling, and managing groundwater resources." According to Texas Water Code statue, the purpose of groundwater districts is to provide for the conservation, preservation, protection, and recharge of underground water and prevent waste and control subsidence caused by pumping water.[20] There are ten counties in the 11-county Coastal Bend Region that contain groundwater conservation districts: Bee, Brooks, Duval, Jim Wells, Kleberg, Live Oak, McMullen, Nueces, Kenedy, and San Patricio (Figure 1-7). Information regarding groundwater conservation districts, including contact list, can be found on the TWDB website (http://www.twdb.state.tx.us/GwRD/GCD/gcdhome.htm).

1.10.1 Bee Groundwater Conservation District

The Bee Groundwater Conservation District was created and adopted Management Rules in September 2002 and amended those rules in December 2005. The Rules require registration for all existing and future wells in the District. The District imposes spacing and production limitations on new users and limits pumping to 10 gallons/minute per acre owned or operated at a maximum annual production of 1 acft per acre.

[20] Texas Water Code б 36.0015.

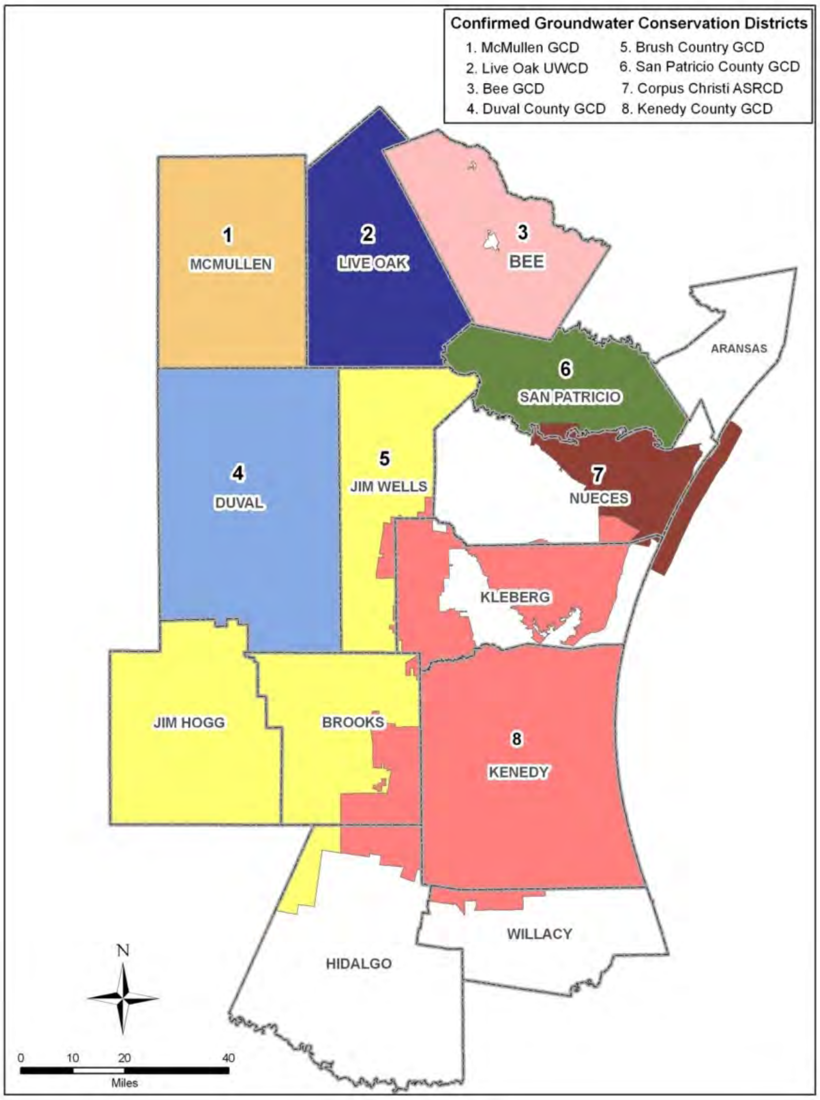


Figure 1-7. Groundwater Conservation Districts in Region N

1.10.2 Brush Country Groundwater Conservation District

Brush Country Groundwater Conservation District was created by the 81st Texas Legislature in 2009 and includes Brooks and Jim Wells Counties within the Coastal Bend Region as well as Jim Hogg County and a portion of Hidalgo County in Region M. District rules have not been established.

1.10.3 Corpus Christi Aquifer Storage and Recovery Conservation District

The Corpus Christi Aquifer Storage and Recovery Conservation District was created in 2005 by the 79th Texas Legislature. The District is located in Aransas, Kleberg, Nueces, and San

Patricio Counties. As with other GCDs, the major purposes of the District are to: (1) provide for conservation, preservation, protection, and recharge, (2) prevent waste, and (3) control land surface subsidence. The primary objective of the District is to facilitate the operation of aquifer storage and recovery operations by the City of Corpus Christi. The District adopted a Management Plan in June 2008 and is in the process of developing a proposed 5-year plan.

1.10.4 Duval County Groundwater Conservation District

The Duval County GCD was created in 2005 by the 79th Texas Legislature. The District was approved by voters in 2009. The District currently does not have a Groundwater Management Plan.

1.10.5 Live Oak Underground Water Conservation District

The Live Oak Underground Water Conservation District (LOUWCD) was created June 14, 1989 and confirmed November 7, 1989. The District adopted Management Rules in June 1998 and amended the Rules in July 2000. The Rules require registration for all existing and future wells in the District. The District imposes spacing and production limitations on new users and limits pumping to 10 gallons/minute per acre at a maximum annual production of 8 acft per acre. The District does not allow operation of Aquifer Storage and Recovery projects.

The Live Oak Underground Water Conservation District Management Plan was amended and adopted, by unanimous vote of all directors, on July 26, 2005.

1.10.6 McMullen Groundwater Conservation District

The McMullen Groundwater Conservation District was created and published District Rules in November 1999. The Rules, amended in August 2003 and again in November 2008, require registration for all existing and future wells in the District. The District imposes spacing and production limitations on new users and limits pumping to 10 gallons/minute per acre owned or operated at a maximum annual production of 1 acft per acre. The District does not allow operation of Aquifer Storage and Recovery projects.

1.10.7 Kenedy County Groundwater Conservation District

Kenedy County Groundwater Conservation District was created in 2003 and includes all of Kenedy County and parts of Brooks, Jim Wells, Kleberg, and Nueces Counties. The Rules, amended in January 2009, require registration for all existing and future wells in the District. The

District imposes spacing and production limitations on new users and limits annual production to 0.75 acre-inch/acre/year. New production limits will be determined once the Managed Available Groundwater is determined for the District.

1.10.8 San Patricio County Groundwater Conservation District

The San Patricio County GCD was created by the 79th Texas Legislature in 2005. The San Patricio County GCD is currently in the process of developing a Groundwater Management Plan.

1.11 Groundwater Management Areas

Groundwater Management Areas were created "in order to provide for the conservation, preservation, protection, recharging and prevention of waste of the groundwater, and of groundwater reservoirs or their subdivisions, and to control subsidence caused by withdrawal of water from those groundwater reservoirs or their subdivisions…"[21] In December 2002, the TWDB designated 16 Groundwater Management Areas (GMAs) covering the entire state. There are three GMAs within the Coastal Bend Planning Area: 1) GMA 13 (McMullen County); 2) GMA 15 (Bee County); and 3) GMA 16 (all 11 Coastal Bend Planning Area Counties).

Originally, the areas were designated for determining which districts needed to coordinate joint planning by sharing their management plans. In 2005, the Legislature revised the direction of groundwater management. The new requirements, codified in Texas Water Code Chapter 36.108, required joint planning in management areas among groundwater conservation districts. The new requirement indicated that, "Not later than September 1, 2010, and every five years thereafter, the districts shall consider groundwater availability models and other data or information for the management area and shall establish desired future conditions for the relevant aquifers within the management area."

This means that, rather than individual districts determining how much groundwater was available, the districts would meet together, at least annually, to review groundwater management plans and accomplishments in the groundwater management area. Pursuant to House Bill 1763, districts are required to work together within a groundwater management area to develop desired future conditions (DFCs). The DFCs are a description of aquifers condition and production at some time in the future. This description is a precursor to developing

[21] Section 35.001, Chapter 35, Title 2, Texas Water Code.

groundwater availability, also called managed available groundwater (MAG). Both the TWDB and the TCEQ have processes developed and codified in their rules for the purpose of appealing either the DFCs or the joint planning process.

The TWDB is responsible for providing each groundwater conservation district and regional water planning group, located wholly or partly in the management area, with the MAG associated with the DFCs adopted by the districts. Groundwater availability models and other data or information may help in establishing managed available groundwater for the relevant aquifers within the management area. Once the MAG is determined, the districts begin issuing groundwater withdrawal permits to support the desired future condition of the aquifer up to the total amount of managed available groundwater. These permits express desired future conditions by only allowing withdrawals that will support the conditions established by the GMA. As of January 2010, none of the GMA's located in the Coastal Bend Region had established desired future conditions.

1.12 Current Status of Water Resources Planning and Management

Currently, the Coastal Bend Region is planning to meet future water demands in a number of ways. The City of Corpus Christi contracted with LNRA to receive 41,840 acft/yr from Lake Texana, which is delivered to the Region via the Mary Rhodes Pipeline. In 2002, LNRA submitted an application to TCEQ for an amendment to their water right, which would allow LNRA to divert an additional 7,500 acft of interruptible water to the Region. In July 2003, the LNRA entered into an agreement with the City of Corpus Christi to provide the Region an additional 4,500 acft water on an interruptible basis. This resulted in a total interruptible supply of 12,000 acft/yr provided to the Region from Lake Texana. In addition, the City of Corpus Christi has purchased 35,000 acft of water rights from the Garwood Irrigation Company to be transported to the Coastal Bend Region via an extension of the Mary Rhodes Pipeline.

For rural municipal communities and non-municipal water users that have historically used groundwater supplies, new groundwater availability studies (using the TWDB CGCGAM) indicate that in most cases, groundwater is available to meet local demands in the future.

A Water Resources Advisory Committee (WRAC) consists of nine members who represent various community interests. The advisory committee is appointed by the Mayor with approval of City of Corpus Christi City Council. With an understanding of regional water issues, the WRAC is tasked to monitor the effectiveness of the City's water related activities including advising the Mayor and City Council on the appropriateness of the City's current ordinances, suggested changes to ordinances, and response to activities to operate the water system efficiently in compliance with regulatory requirements.[22]

1.13 Assessment of Water Conservation and Drought Preparation

Besides extensive studies of the Coastal Bend Region's water needs and future resources, much of the Region has implemented the City of Corpus Christi's Water Conservation and Drought Contingency Plan. The City of Corpus Christi's Water Conservation Plan,[23] updated in April 2009, focuses on two goals: (1) to reduce summertime peak pumping, and (2) to reduce overall per capita consumption by 1 percent per year from the City's consumption of 233 gallons per capita per day (gpcd) in 2008 to 212 gpcd by 2018. The plan provides everyday water conservation tips, including plumbing codes and retrofit programs, and educational demonstrations and programs for the public. The City of Corpus Christi's Water Conservation Plan outlines a Drought Contingency Plan, which is implemented when current water supplies are threatened. In 2001, the City of Corpus Christi amended their Drought Contingency Plan to reflect changes to the operation of the CCR/LCC System. These amendments removed the "Conditions" hierarchical stages in their Drought Contingency Plan, which were previously used to implement the different water conservation measures as the threat of water shortage increased. The Drought Contingency Plan, updated in April 2009, is initiated as the percentage of combined storage of the CCR/LCC System decreases and includes water reduction targets based on storage levels (Table 1-4).

In addition, during severe drought conditions, both municipal and wholesale customers are subject to water allocation from the City of Corpus Christi. In turn, wholesale customers are responsible to impose similar allocations on their customers. The City's Water Conservation Plan includes water conservation targets and goals for their wholesale customers (Table 1-4).

The City of Corpus Christi's Water Conservation Plan recognizes its long-held conservation-based water rate structure, universal metering and a meter repair/replacement program, and leak detection program. Other programs outlined within the water conservation plan are such practices as reuse and recycling of wastewater and greywater, the establishment of landscape ordinances, and an outlined procedure to determine and control unaccounted-for water

[22] City of Corpus Christi website, December 2009.
[23] City of Corpus Christi Water Conservation and Drought Contingency Plan, Amended April 28, 2009.

loss. The City of Corpus Christi's Water Conservation Plan not only recognizes the ongoing water conservation practices within the City of Corpus Christi service area but it also defined water conservation goals. City of Corpus Christi water conservation goals include:

- Reduce the City's per capita water use by 1% per year;
- Limit unaccounted-for water from the City's system to no more than 10 percent (based on a moving 5-year average); and
- Assist City customers in continuing efforts toward water conservation.

Table 1-4.
City of Corpus Christi Drought Contingency Plan

Combined Storage below 50%	• City Manager issues a public notice requesting voluntary conservation measures • Target water demand reduction of 1 percent, including wholesale water contracts
Combined Storage below 40%	• City Manager issues a public notice implementing required water conservation measures • Outdoor watering restricted; no outdoor watering allowed between 10:00 a.m. and 6:00 p.m. • No runoff from yards or plants into gutters or streets allowed • All defective plumbing in a home or business must be addressed • No water shall be allowed to flow constantly through a tap, hydrant, valve, or otherwise by any user • Target Inflows to Nueces Bay are reduced to 1,200 acft per month • Target water demand reduction of 5 percent, including wholesale water contracts
Combined Storage below 30%	• City Manager publishes a lawn-watering schedule • Target Inflows to Nueces Bay are reduced to 0 acft per month • Target water demand reduction of 10 percent, including wholesale water contracts
Combined Storage below 20%	• Target water demand reduction of 15 percent, including wholesale water contracts

The TCEQ provides guidance for Water Conservation and Drought Contingency Plans in 30 TAC Chapter 288, which requires "specific, quantified 5- and 10-year targets for water savings to be included in all water conservation plans to be submitted to the TCEQ no later than

May 1, 2005." In addition to the City of Corpus Christi plan outline above, the following entities have provided a TCEQ approved water conservation plan and/or drought contingency plan to the Coastal Bend RWPG:

- Aransas County MUD #1;
- City of Alice;
- City of Aransas Pass;
- City of Beeville;
- City of Ingleside;
- City of Kingsville;
- City of Portland;
- City of Rockport;
- Nueces WSC;
- Ricardo WSC;
- Rincon WSC; and
- South Texas Water Authority.

1.14 TWDB Water Loss Audit Data

In December 2004 in response to House Bill 3338, the TWDB adopted rules to require retail public utilities, as defined by Texas Water Code §13.002, to perform a water loss audit and submit water loss audit forms to the TWDB every five years.[24] Pursuant to TWDB Rules[25] for regional water planning, regional water planning groups are required to include information compiled by the TWDB from water loss audits performed by retail public utilities and shall consider strategies to address any issues identified in the water loss audit information compiled by the TWDB.

In January 2007, the TWDB issued a report titled "An Analysis of Water Loss as Reported by Public Water Suppliers in Texas (Final Report)," which includes water loss data by region for regional water planning groups to consider while developing the 2011 Regional Water Plans. The report included data acquired as part of the 2005 Water Loss Audit, which is the first time that this water loss audit methodology has been used by many retail public utilities. The

[24] In accordance with Texas Administrative Code §358.6.
[25] In accordance with Texas Administrative Code §357.7(a)(1)(M) and Texas Administrative Code §357.7(a)(7)(a)(iv).

report indicates that "some of the self-reported data may be suspect and in need of further refinement." Furthermore, a "balancing adjustment" was used by the TWDB when compiling data from the 2005 Water Loss Audit to represent amounts of water left over after all known and unknown uses of consumption and losses were accounted for and subtracted from the input volume. Since it is difficult to determine if these unaccounted for supplies are attributed to actual losses, unbilled water supplies, fire fighting, or other uses, it is challenging to differentiate "water losses" from beneficial unaccounted for supplied. It is anticipated that efforts to assess water losses will improve with future water audits filed on a five year basis, as retail public utilities become more familiar with reporting methodologies and the TWDB provides additional guidance and support.

According to the TWDB[26], the 2005 Water Loss Audit was primarily intended to gather information about water losses from retail public utilities and identify any significant reporting issues. On December 16, 2009, the TWDB provided "one methodology for how TWDB calculates percentage water loss for water systems." Using the methodology provided by the TWDB, of the 31 retail public utilities in the Coastal Bend Region who reported water loss data, 13 of those reported total water losses of less than 10%. Of those 13 utilities, six reported water loss of less than 5% which appears suspect. Four of the utilities reported zero (or negative) water loss. The remaining 18 utilities, reported losses greater than 10%.

The TWDB rules require that regional water planning groups consider water management strategies to address issues identified in the water loss audits, which were provided by the TWDB on August 3, 2009. The Coastal Bend Regional Water Planning Group acknowledges the water loss data provided by the TWDB; however, because much of the self-reported data from the water loss audits is highly suspect and is unreliable, the RWPG cannot make recommendations concerning specific water management strategies for specific water user groups. It is hoped that future water loss audit information will improve in accuracy and be useful in the future as a basis for making specific water management strategy recommendations for water user groups.

[26] Based on phone conversation with John Sutton on August 11, 2009.

Section 2
Population and Water Demand Projections
[31 TAC §.57.7 (a)(2)]

2.1 Introduction

For the 2011 Coastal Bend Regional Water Plan (Plan), the TWDB did not issue new population or water demand projections due to the lack of new Census data. The Coastal Bend RWPG did request a water demand revision for irrigation in Bee and San Patricio Counties. This is discussed further in the Irrigation Water Demand Section. In all other cases, the population and water demand projections remained identical to the 2006 Plan. Population projections were developed for cities with a population greater than 500, water supply corporations and special utility districts using volumes of 280 acft or more in 2000, and 'county-other' to capture those people living outside the cities or water utility service areas for each county. Water demand projections were developed by type of use: municipal for cities and water supply corporations/special utility districts (along with a 'county-other' for each county), and countywide for manufacturing, steam-electric, mining, irrigation, and livestock. This section presents these figures for the 11-county Coastal Bend Regional Water Planning Area. These counties are located within three river basins: the Nueces River Basin, the San Antonio-Nueces Coastal Basin, and the Nueces-Rio Grande Coastal Basin (Figure 2-1). The population projections are a consensus-based "most-likely" scenario of growth, based on recent and prospective growth trends as determined by the opinions of a Technical Advisory Committee consisting of state agencies, key interest groups, and the general public. The demand projections for each type of water use were made under various assumptions that will be addressed in each water-use section below.

Appendix C contains population, per capita water use, and water demand projections for each city and county-other and manufacturing (including steam-electric, if applicable), mining, and irrigation and livestock water demand projections by county and river basin.

2.2 Population Projections

From 1980 to 2000, the population in the 11-county region grew by 72,927 (from 468,257 to 541,184), an increase of 15.6 percent (0.73 percent compound annual growth), as shown in Table 2-1. This compares with a statewide increase in population of 46.5 percent

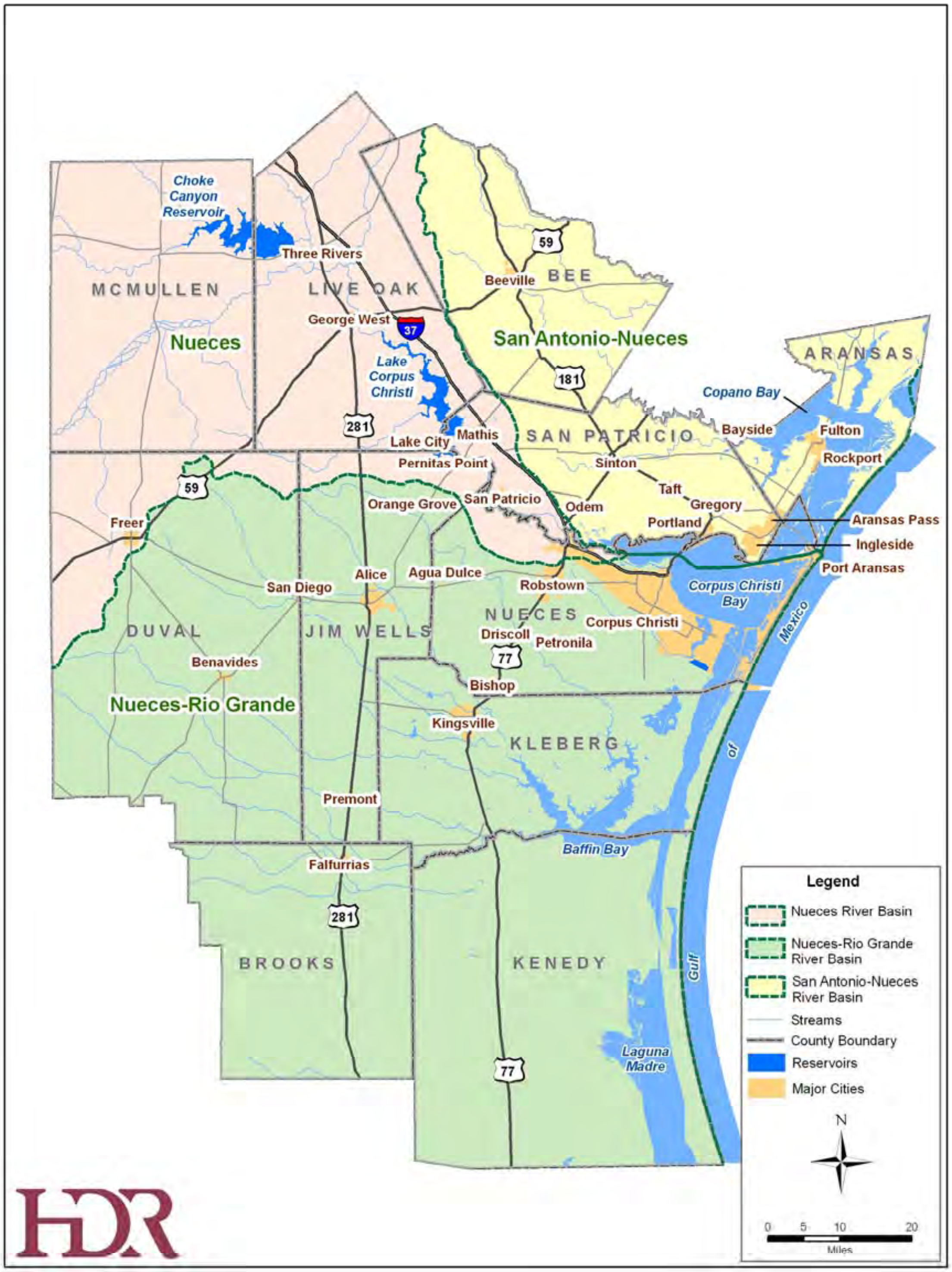


Figure 2-1. Coastal Bend Region River Basin Boundaries

Table 2-1.
Coastal Bend Regional Population
(by County and River Basin)

	Historical			Projections[1]						Percent Growth[2]	Percent Growth[2]
	1980	1990	2000	2010	2020	2030	2040	2050	2060	(1980-00)	(2000-60)
County											
Aransas	14,260	17,892	22,497	26,863	30,604	32,560	32,201	30,422	28,791	2.31%	0.41%
Bee	26,030	25,135	32,359	34,298	36,099	37,198	37,591	37,598	36,686	1.09%	0.21%
Brooks	8,428	8,204	7,976	8,607	9,303	9,909	10,288	10,399	10,349	-0.28%	0.44%
Duval	12,517	12,918	13,120	13,881	14,528	14,882	14,976	14,567	13,819	0.24%	0.09%
Jim Wells	36,498	37,679	39,326	42,434	45,303	47,149	47,955	47,615	46,596	0.37%	0.28%
Kenedy	543	460	414	467	495	523	527	529	537	-1.35%	0.43%
Kleberg	33,358	30,274	31,549	36,959	40,849	43,370	44,989	47,118	47,212	-0.28%	0.67%
Live Oak	9,606	9,556	12,309	13,735	14,929	15,386	15,018	13,808	12,424	1.25%	0.02%
McMullen	789	817	851	920	957	918	866	837	793	0.38%	-0.12%
Nueces	268,215	291,145	313,645	358,278	405,492	447,014	483,692	516,265	542,327	0.79%	0.92%
San Patricio	58,013	58,749	67,138	80,701	95,381	109,518	122,547	134,806	146,131	0.73%	1.30%
Total for Region	468,257	492,829	541,184	617,143	693,940	758,427	810,650	853,964	885,665	0.73%	0.82%
River Basin											
Nueces	38,122	40,062	56,482	62,655	68,897	73,705	77,095	79,088	80,134	1.99%	0.58%
Nueces-Rio Grande	341,308	360,810	372,608	422,954	473,751	516,683	552,859	584,074	606,293	0.44%	0.81%
San Antonio-Nueces	88,827	91,957	112,094	131,534	151,292	168,039	180,696	190,802	199,238	1.17%	0.96%
Total for Region	**468,257**	**492,829**	**541,184**	**617,143**	**693,940**	**758,427**	**810,650**	**853,964**	**885,665**	**0.73%**	**0.82%**
Total for Texas	**14,229,191**	**16,986,510**	**20,851,790**	**24,909,072**	**29,108,012**	**33,040,035**	**36,877,046**	**41,054,973**	**45,533,734**	**1.93%**	**1.31%**

[1]Projections from Texas Water Development Board.
[2]Compound annual growth rate.

(1.93 percent annually). The majority of the growth occurred in Nueces and San Patricio Counties, the two largest counties in the region by population. Combined, they accounted for 75 percent of the total increase, and in 2000 their populations totaled 70 percent of the region. In 2000, 58.0 percent of the region's total population lived in Nueces County, 12.4 percent in San Patricio County, 7.3 percent in Jim Wells County, 6.0 percent in Bee County, 5.8 percent in Kleberg County, and less than 5.0 percent in each of the remaining six counties.

The population in the 11-county region is projected to increase by 344,481 from 2000 to 2060, an increase of 63.7 percent (0.82 percent annually), as shown in Table 2-1. This compares to a statewide projected population growth in the same period of 118 percent (1.31 percent annually). The total population for the region in 2000 was 2.6 percent of the 20.85 million population statewide. It declines slightly by 2060, to 1.9 percent of the projected 45.5 million statewide totals. In 2060, it is projected that 61.2 percent of the region's population will live in Nueces County, 16.5 percent in San Patricio County, 5.3 percent in Kleberg County, 5.3 percent in Jim Wells County, and less than 5.0 percent in each of the remaining seven counties. Figure 2-2 shows the trend in population for the region from 1990 to 2060.

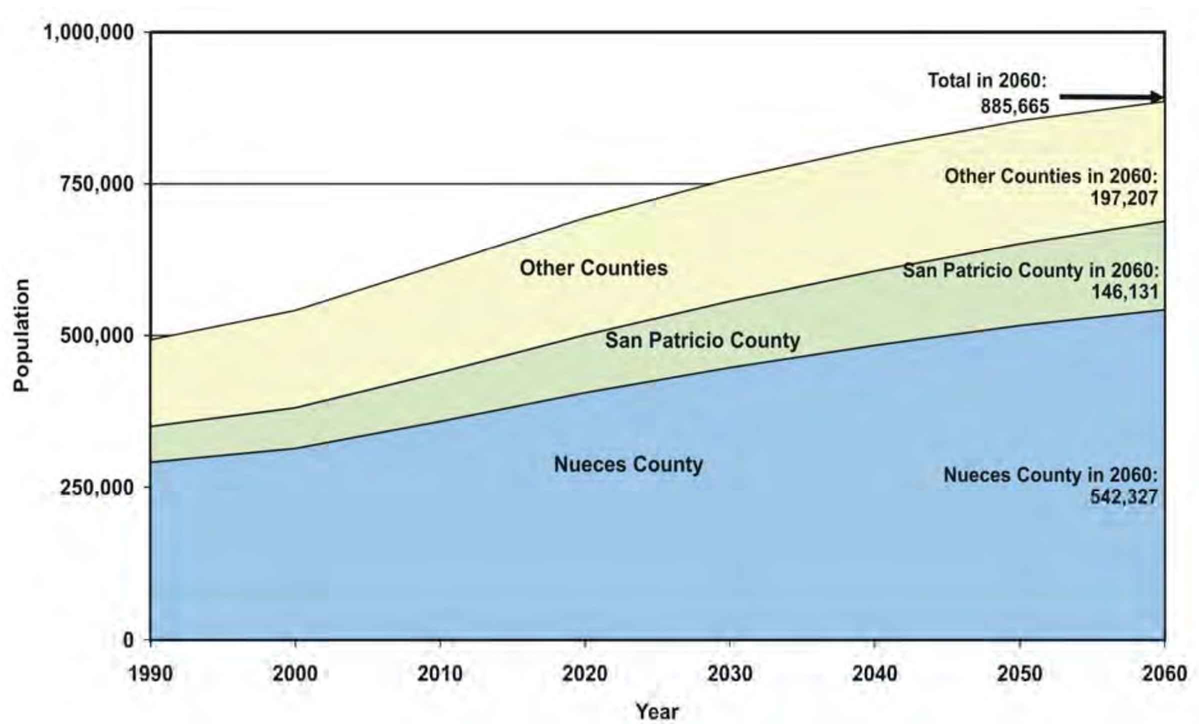


Figure 2-2. Coastal Bend Region Population

San Patricio and Nueces Counties are the fastest growing counties in the region, with future projections growing at an annual rate higher than the regional average of 0.82 percent (Figure 2-3). The population growth in those counties accounts for 89.3 percent of the total increase over the next 60 years. Aransas, Bee, Brooks, Duval, Jim Wells, Kenedy, Kleberg and Live Oak Counties all have positive annual growth rates, but less than the regional average. The growth rate in McMullen County, the second smallest county in the region, is negative, as their population is anticipated to decline over the 60-year period, from 851 to 793.

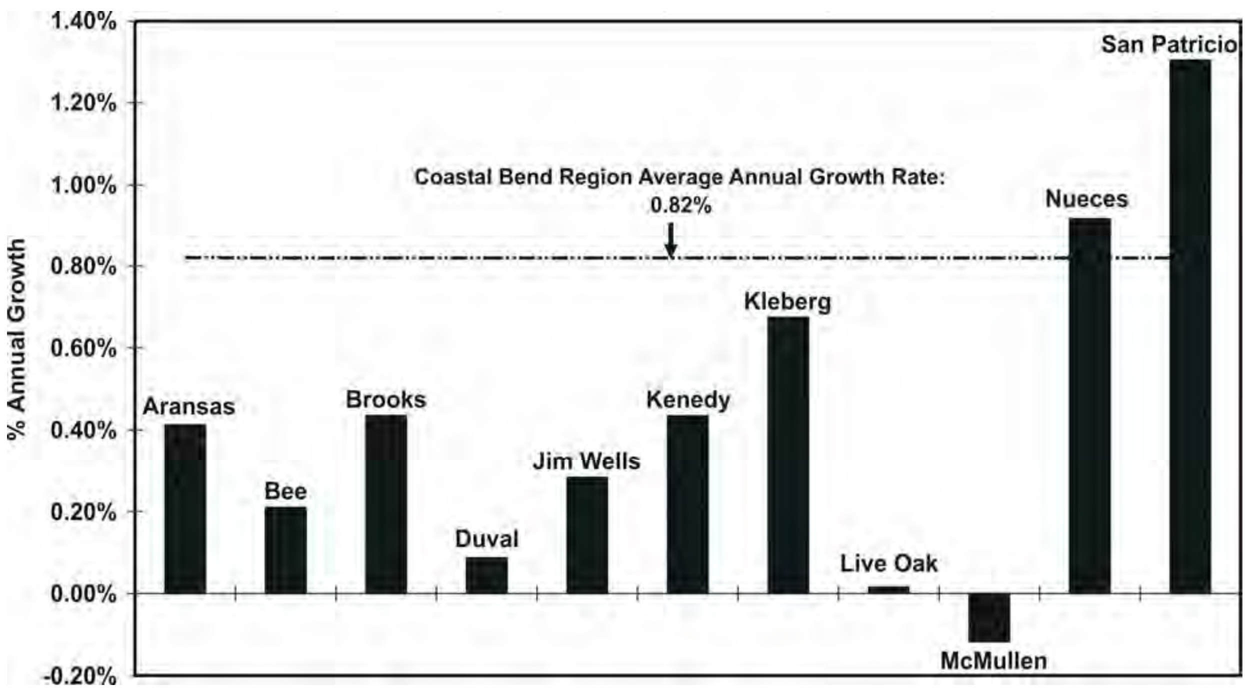


Figure 2-3. Percent Annual Population Growth Rate for 2000 through 2060 by County

Corpus Christi and Kingsville are the two largest cities in the region, accounting for 56.0 percent of the total population in 2000, increasing to 56.4 percent of the total in 2060. Population projections for the 46 cities, water supply corporations, and 'county-other' users in the region are shown in Table 2-2. County-Other category includes persons residing outside of cities and also outside water utility boundaries. Population for water user groups by county and river basin is included in Appendix C.

Table 2-2.
Coastal Bend Region Population
(by City/County)

City/County	Historical			Projections						Percent Growth[2]	Percent Growth[2]
	1980	1990	2000	2010	2020	2030	2040	2050	2060	1980-00	2000-60
ARANSAS PASS (P)	860	912	867	1,035	1,179	1,255	1,241	1,172	1,110	0.04%	0.41%
FULTON		763	1,553	1,854	2,113	2,248	2,223	2,100	1,987	N/A	0.41%
ROCKPORT	3,686	5,355	7,385	8,818	10,046	10,688	10,570	9,987	9,451	3.54%	0.41%
COUNTY-OTHER	9,714	10,862	12,692	15,156	17,266	18,369	18,167	17,163	16,243	1.35%	0.41%
Aransas County	*14,260*	*17,892*	*22,497*	*26,863*	*30,604*	*32,560*	*32,201*	*30,422*	*28,791*	*2.31%*	*0.41%*
BEEVILLE	14,574	13,547	13,129	13,916	14,646	15,092	15,252	15,255	14,885	-0.52%	0.21%
EL OSO WSC (P)		271	320	339	357	368	372	372	363	N/A	0.21%
COUNTY-OTHER	11,456	11,317	18,910	20,043	21,096	21,738	21,967	21,971	21,438	2.54%	0.21%
Bee County	*26,030*	*25,135*	*32,359*	*34,298*	*36,099*	*37,198*	*37,591*	*37,598*	*36,686*	*1.09%*	*0.21%*
FALFURRIAS	6,103	5,788	5,297	6,981	8,316	9,310	9,924	10,178	10,215	-0.71%	1.10%
COUNTY-OTHER	2,325	2,416	2,679	1,626	987	599	364	221	134	0.71%	-4.87%
Brooks County	*8,428*	*8,204*	*7,976*	*8,607*	*9,303*	*9,909*	*10,288*	*10,399*	*10,349*	*-0.28%*	*0.44%*
BENAVIDES	1,978	1,788	1,686	1,784	1,867	1,912	1,925	1,872	1,776	-0.80%	0.09%
FREER	3,213	3,271	3,241	3,429	3,589	3,676	3,699	3,598	3,414	0.04%	0.09%
SAN DIEGO (P)	4,331	4,109	3,928	4,156	4,350	4,456	4,484	4,361	4,137	-0.49%	0.09%
COUNTY-OTHER	2,995	3,750	4,265	4,512	4,722	4,838	4,868	4,736	4,492	1.78%	0.09%
Duval County	*12,517*	*12,918*	*13,120*	*13,881*	*14,528*	*14,882*	*14,976*	*14,567*	*13,819*	*0.24%*	*0.09%*
ALICE	20,961	19,788	19,010	20,512	21,899	22,792	23,181	23,017	22,524	-0.49%	0.28%
ORANGE GROVE	1,212	1,175	1,288	1,390	1,484	1,544	1,571	1,559	1,526	0.30%	0.28%
PREMONT	2,984	2,914	2,772	2,991	3,193	3,323	3,380	3,356	3,284	-0.37%	0.28%
SAN DIEGO (P)	894	874	825	890	950	989	1,006	999	978	-0.40%	0.28%
COUNTY-OTHER	10,447	12,928	15,431	16,651	17,777	18,501	18,817	18,684	18,284	1.97%	0.28%
Jim Wells County	*36,498*	*37,679*	*39,326*	*42,434*	*45,303*	*47,149*	*47,955*	*47,615*	*46,596*	*0.37%*	*0.28%*
COUNTY-OTHER	543	460	414	467	495	523	527	529	537	-1.35%	0.43%
Kenedy County	*543*	*460*	*414*	*467*	*495*	*523*	*527*	*529*	*537*	*-1.35%*	*0.43%*
KINGSVILLE	28,808	25,276	25,575	26,844	27,756	28,347	28,727	29,226	29,248	-0.59%	0.22%
RICARDO WSC		1,503	2,301	5,687	8,122	9,700	10,713	12,046	12,105	N/A	2.81%
COUNTY-OTHER	4,550	3,495	3,673	4,428	4,971	5,323	5,549	5,846	5,859	-1.06%	0.78%
Kleberg County	*33,358*	*30,274*	*31,549*	*36,959*	*40,849*	*43,370*	*44,989*	*47,118*	*47,212*	*-0.28%*	*0.67%*
CHOKE CANYON WS (P)		539	2,250	2,511	2,729	2,812	2,745	2,524	2,271	N/A	0.02%
EL OSO (P)		*812*	1,000	1,116	1,213	1,250	1,220	1,122	1,009	N/A	0.01%
GEORGE WEST	2,627	2,586	2,524	2,816	3,061	3,155	3,079	2,831	2,548	-0.20%	0.02%
MCCOY WSC (P)		185	443	494	537	554	540	497	447	N/A	0.01%
THREE RIVERS	2,133	1,889	1,878	2,096	2,278	2,347	2,291	2,107	1,896	-0.63%	0.02%
COUNTY-OTHER	4,846	3,545	4,214	4,702	5,111	5,268	5,143	4,727	4,253	-0.70%	0.02%
Live Oak County	*9,606*	*9,556*	*12,309*	*13,735*	*14,929*	*15,386*	*15,018*	*13,808*	*12,424*	*1.25%*	*0.02%*

Table 2-2.
Coastal Bend Region Population (by City/County) (Concluded)

City/County	Historical 1980	Historical 1990	Historical 2000	Projections 2010	Projections 2020	Projections 2030	Projections 2040	Projections 2050	Projections 2060	Percent Growth[2] 1980-00	Percent Growth[2] 2000-60
CHOKE CANYON WS (P)		60	250	270	281	270	254	246	233	N/A	-0.12%
COUNTY-OTHER	789	757	601	650	676	648	612	591	560	-1.35%	-0.12%
McMullen County	*789*	*817*	*851*	*920*	*957*	*918*	*866*	*837*	*793*	*0.38%*	*-0.12%*
AGUA DULCE		794	737	737	737	737	737	737	737	N/A	0.00%
ARANSAS PASS (P)	5	22	70	163	259	343	417	482	534	14.11%	3.44%
BISHOP	3,706	3,337	3,305	3,305	3,305	3,305	3,305	3,305	3,305	-0.57%	0.00%
CORPUS CHRISTI	231,999	257,453	277,450	316,058	356,123	391,077	421,761	448,879	470,523	0.90%	0.88%
DRISCOLL		688	825	1,090	1,364	1,603	1,813	1,999	2,147	N/A	1.61%
NUECES COUNTY WCID #4		2,192	4,663	9,434	14,385	18,704	22,496	25,847	28,521	N/A	3.06%
PORT ARANSAS	1,968	2,233	3,370	5,565	7,843	9,830	11,575	13,117	14,348	2.73%	2.44%
RIVER ACRES WSC		2,130	2,750	3,947	5,189	6,273	7,224	8,065	8,736	N/A	1.95%
ROBSTOWN	12,100	12,849	12,727	12,727	12,727	12,727	12,727	12,727	12,727	0.25%	0.00%
COUNTY-OTHER	18,437	9,447	7,748	5,252	3,560	2,415	1,637	1,107	749	-4.24%	-3.82%
Nueces County	*268,215*	*291,145*	*313,645*	*358,278*	*405,492*	*447,014*	*483,692*	*516,265*	*542,327*	*0.79%*	*0.92%*
ARANSAS PASS (P)	6,308	6,246	7,201	8,653	10,225	11,739	13,134	14,447	15,660	0.66%	1.30%
GREGORY	2,739	2,458	2,318	2,318	2,318	2,318	2,318	2,318	2,318	-0.83%	0.00%
INGLESIDE	5,436	5,696	9,388	15,003	21,080	26,933	32,327	37,402	42,090	2.77%	2.53%
INGLESIDE ON THE BAY		529	659	857	1,071	1,277	1,467	1,646	1,811	N/A	1.70%
LAKE CITY		465	526	619	719	816	905	989	1,066	N/A	1.18%
MATHIS	5,667	5,423	5,034	5,034	5,034	5,034	5,034	5,034	5,034	-0.59%	0.00%
ODEM	2,363	2,366	2,499	2,701	2,920	3,131	3,325	3,508	3,677	0.28%	0.65%
PORTLAND	12,023	12,224	14,827	18,786	23,071	27,197	31,000	34,578	37,884	1.05%	1.58%
SINTON	6,044	5,549	5,676	5,869	6,078	6,279	6,465	6,640	6,801	-0.31%	0.30%
TAFT	3,686	3,222	3,396	3,661	3,947	4,223	4,477	4,716	4,937	-0.41%	0.63%
COUNTY-OTHER	13,747	14,571	15,614	17,200	18,918	20,571	22,095	23,528	24,853	0.64%	0.78%
San Patricio County	*58,013*	*58,749*	*67,138*	*80,701*	*95,381*	*109,518*	*122,547*	*134,806*	*146,131*	*0.73%*	*1.30%*
Total For Region	**468,257**	**492,829**	**541,184**	**617,143**	**693,940**	**758,427**	**810,650**	**853,964**	**885,665**	**0.73%**	**0.82%**

Notes:
[1] Projections from Texas Water Development Board
[2] Compound annual growth rate
(P) Partial

2.3 Water Demand Projections

The TWDB water demand projections have been compiled for each type of consumptive water use: municipal, manufacturing, steam-electric power, mining, irrigation, and livestock. In these consumptive types of water use there is a “loss” in water. In non-consumptive water use, such as navigation, hydroelectric generating, or recreation, there is little or no water loss. As shown in Table 2-3, total water use for the region is projected to increase by 119,002 acft/yr between 2000 and 2060, from 205,936 acft/yr to 324,938 acft/yr, a 57.8 percent rise. Municipal, manufacturing, steam-electric, irrigation, and mining water use are all projected to increase, while livestock use is unchanged. The trend in total water use for 2000 to 2060 is shown in Figure 2-4. In 2000, 48.5 percent of the total water use was for municipal purposes, 26.4 percent for manufacturing, 4.3 percent for steam-electric water, 5.8 percent for mining, 10.7 percent for irrigation, and 4.3 percent for livestock. In 2060, municipal use as a percentage of the total is projected to decrease to 46.6 percent, manufacturing use to increase to 27.1 percent, steam-electric water use to increase to 8.5 percent, mining use to increase to 5.9 percent, irrigation water use to decrease to 9.1 percent, and livestock use to decrease to 2.8 percent. These components of total water use for 2000 and 2060 are shown in Figure 2-5.

Table 2-3.
Coastal Bend Region Total Water Demand by Type of Use and River Basin (acft/yr)

	Historical		***Projections[1]***					
	1990	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
Water Use								
Municipal	108,620	99,950	111,495	122,861	132,063	139,425	146,036	151,474
Manufacturing	43,611	54,481	63,820	69,255	73,861	78,371	82,283	88,122
Steam-Electric	2,404	8,799	7,316	14,312	16,733	19,683	23,280	27,664
Mining	7,563	11,897	15,150	16,524	16,640	17,490	18,347	19,114
Irrigation	14,237	21,971	25,884	26,152	26,671	27,433	28,450	29,726
Livestock	9,624	8,838	8,838	8,838	8,838	8,838	8,838	8,838
Total for Region	**186,059**	**205,936**	**232,503**	**257,942**	**274,806**	**291,240**	**307,234**	**324,938**
River Basin								
Nueces	23,734	38,217	41,060	51,000	54,365	57,964	61,846	66,587
Nueces-Rio Grande	135,782	137,622	153,474	165,077	175,110	184,817	193,843	203,406
San Antonio-Nueces	26,543	30,097	37,969	41,865	45,331	48,459	51,545	54,945
Total for Region	**186,059**	**205,936**	**232,503**	**257,942**	**274,806**	**291,240**	**307,234**	**324,938**

[1] Projections from Texas Water Development Board

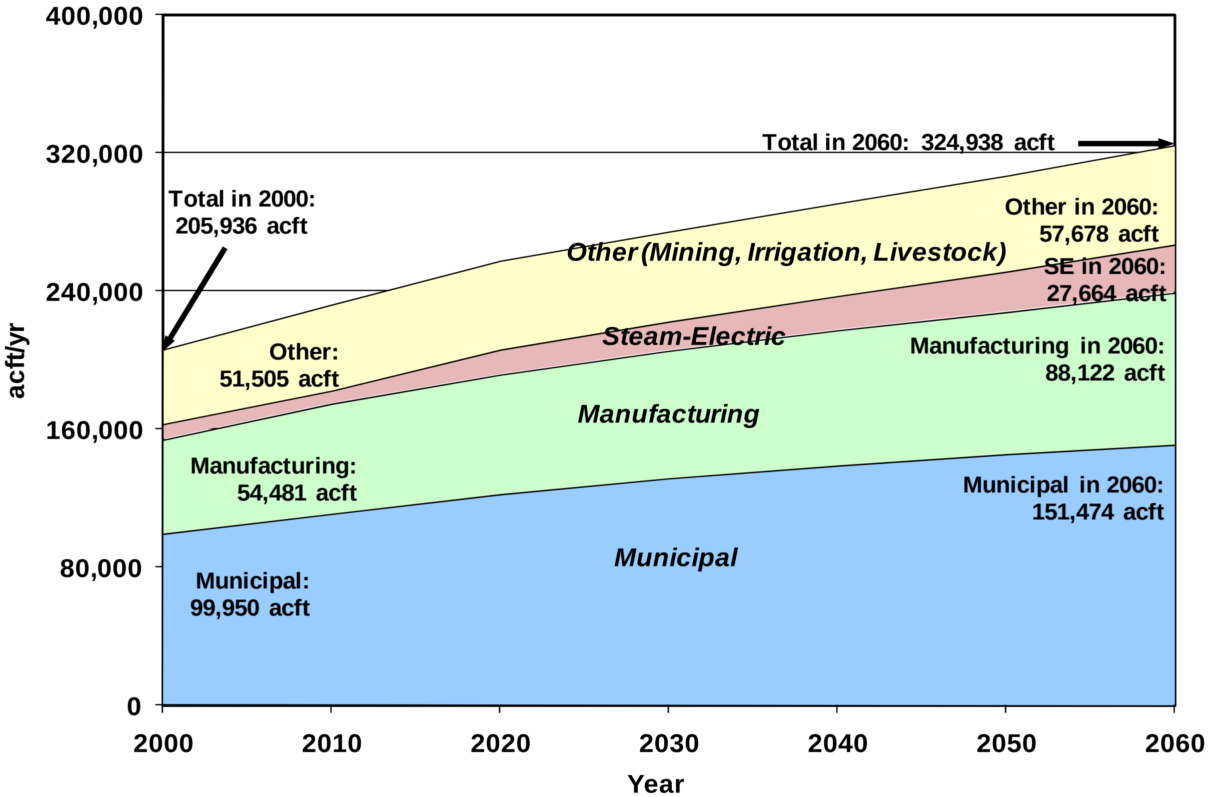


Figure 2-4. Coastal Bend Region Water Demand

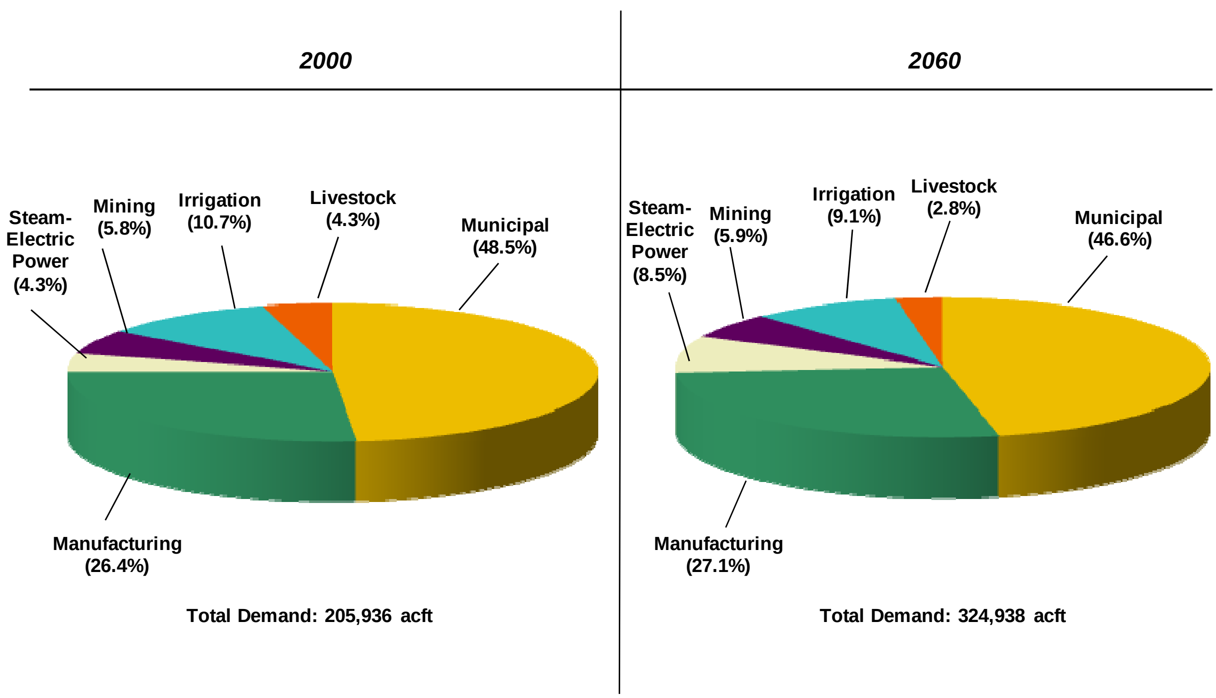


Figure 2-5. Total Water Demand by Type of Use

The Coastal Bend Region is located within three river basins: the Nueces River Basin, the San Antonio-Nueces Coastal Basin, and the Nueces-Rio Grande Coastal Basin. Total water demand in each basin is shown in Table 2-3. Water demands for water user groups by county and river basin are included in Appendix C.

2.3.1 Municipal Water Demand

Water that is used by households (e.g., drinking, bathing, food preparation, dishwashing, laundry, flushing toilets, lawn watering and landscaping, swimming pools and hot tubs) commercial establishments (e.g., restaurants, car washes, hotels, laundromats, and office buildings) and for fire protection, public recreation and sanitation are all referred to as municipal water. This type of water must meet safe drinking water standards as specified by Federal and State laws and regulations.

The TWDB computes the municipal water demand projections by multiplying the projected population of an entity by the entity's projected per capita water use, adjusted for conservation savings. Again, projected population is the "most-likely" scenario. The projected per capita water use takes into account current plumbing fixtures as well as anticipated effects of the 1991 State Water-Efficient Plumbing Act and is estimated based on year 2000 water use, which represents below-normal rainfall in most of the state. The projected per capita water use is an "expected" scenario of water conservation including installation of water-efficient plumbing fixtures as defined by the 1991 State Water-Efficient Plumbing Act. In all cases, applying this conservation scenario to the per capita use results in a declining per capita water use over time.

In 2000 total municipal use in the Coastal Bend Region was 99,950 acft/yr. Nueces and San Patricio Counties accounted for 71.6 percent of the total. Municipal use is projected to increase 51.5 percent to 151,474 acft by year 2060 (Table 2-4). Brooks, Nueces, and San Patricio Counties will experience the largest increases, 54.6 percent, 64.3 percent, and 82.5 percent, respectively. By 2060, Nueces and San Patricio Counties will account for 78.7 percent of the total municipal water use in the region (Figure 2-6).

The increase in municipal water demand correlates to an increase in the region's population. This is illustrated in the entities of the City of Corpus Christi and Ricardo Water Supply Corporation (WSC). Both are projected to experience large increases in population, and as a result, in water use as well. Corpus Christi's water use is projected to increase 56.3 percent over the next 60 years while Ricardo WSC's increase is projected to increase 372.0 percent.

Table 2-4.
Coastal Bend Region Municipal Water Demand by County and River Basin (acft/yr)

County	Historical		Projections[1]					
	1990	2000	2010	2020	2030	2040	2050	2060
Aransas	2,614	3,314	3,831	4,263	4,444	4,326	4,053	3,835
Bee	3,569	4,220	4,342	4,456	4,492	4,439	4,397	4,291
Brooks	1,150	1,970	2,315	2,621	2,857	2,994	3,043	3,045
Duval	2,090	2,323	2,400	2,453	2,463	2,428	2,345	2,223
Jim Wells	6,535	8,562	9,068	9,526	9,756	9,761	9,640	9,433
Kenedy	44	46	50	52	53	53	52	53
Kleberg	6,261	5,415	6,051	6,436	6,664	6,762	7,008	7,020
Live Oak	1,796	2,350	2,573	2,750	2,796	2,693	2,459	2,213
McMullen	109	175	186	190	180	168	160	152
Nueces	76,521	62,702	70,609	78,691	85,697	91,988	97,882	103,018
San Patricio	7,931	8,873	10,070	11,423	12,661	13,813	14,997	16,191
Total for Region	**108,620**	**99,950**	**111,495**	**122,861**	**132,063**	**139,425**	**146,036**	**151,474**
River Basin								
Nueces	10,862	10,017	10,832	11,628	12,184	12,521	12,698	12,821
Nueces-Rio Grande	84,992	74,787	83,683	92,369	99,570	105,617	111,198	115,677
San Antonio-Nueces	12,766	15,146	16,980	18,864	20,309	21,287	22,140	22,976
Total for Region	**108,620**	**99,950**	**111,495**	**122,861**	**132,063**	**139,425**	**146,036**	**151,474**

[1] Projections from Texas Water Development Board

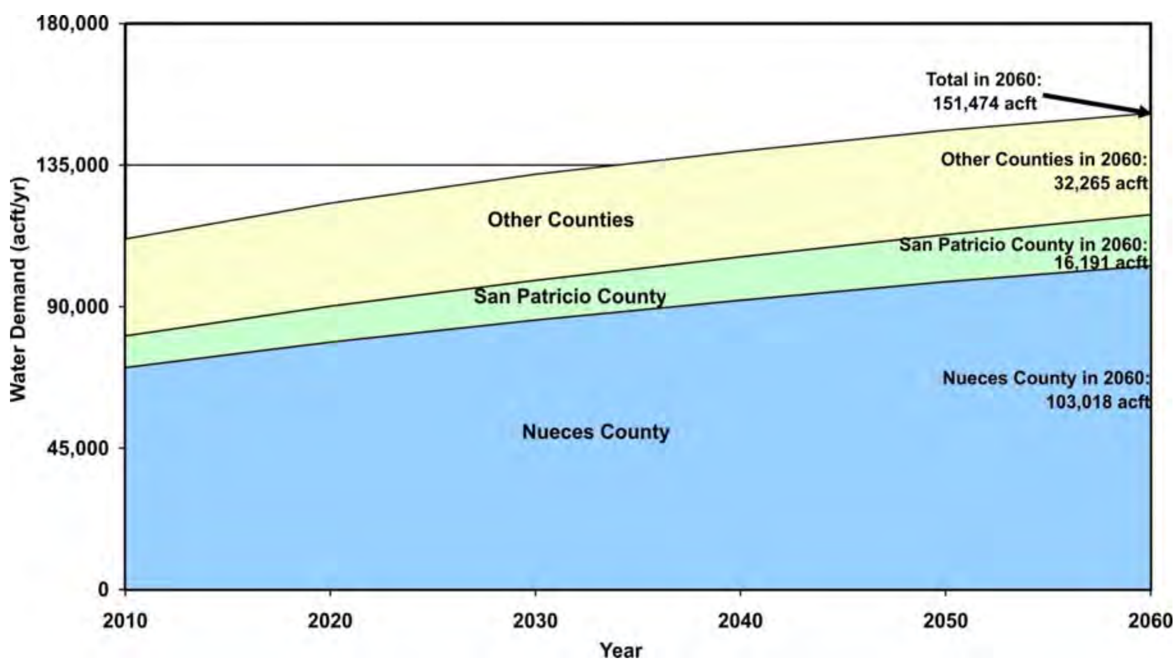


Figure 2-6. Coastal Bend Region Municipal Water Demand

However, the increase in water use for each of these entities is less than their respective increases in population (i.e., low flow plumbing fixtures). This is attributable to a declining per capita water use, which includes conservation built-in the TWDB demand projections. Per capita water use in Corpus Christi is projected to decline 7.8 percent, from 179 gallons per capita daily (gpcd) in 2000 to 165 gpcd in 2060. Per capita water use for Ricardo WSC was estimated to be 115 gpcd in 2000, declining 10.4 percent to 103 gpcd in 2060. Municipal water use projections for the 46 entities in the region are presented in Table 2-5.

2.3.2 Manufacturing Water Demand

Manufacturing is an integral part of the Texas economy, and for many industries, water plays a key role in the manufacturing process. Some of these processes require direct consumption of water as part of the products; others consume very little water but use a large quantity for cleaning and cooling. Whether the water is a product component or used to transport waste heat and materials, it is considered manufacturing water use. The water-using manufacturers in the 11-county Coastal Bend Region are food processing, chemicals, petroleum refining, stone and concrete, fabricated metal, and electronic and electrical equipment. Of these industries present in the region, chemicals and petroleum refining are the largest and biggest water users.

The TWDB projects manufacturing water demand by taking industry-specific water demand coefficients, adjusted for water-use efficiencies (recycling/reuse), and applying them to growth trends for each industry. These growth trends assume expansion of existing capacity and building of new facilities; continuation of historical trends of interaction between oil price changes and industrial activity; and that the makeup of each county's manufacturing base remains constant throughout the 60-year planning period.

In 2000, total manufacturing water use for Coastal Bend Region was 54,481 acft. Nueces and San Patricio Counties accounted for 96.3 percent of this total (Table 2-6). Manufacturing use is projected to be 73,861 acft in 2030 and 88,122 acft in 2060, a 61.7 percent increase. In 2060, Nueces and San Patricio Counties are projected to account for 97.1 percent of the total manufacturing water use in the region (Figure 2-7). This projected increase can be attributed to continued growth in the petroleum refining industry in Nueces and San Patricio Counties.

The TWDB water demand projections show minimal water use for manufacturing activities in Bee and McMullen County. According to the local groundwater conservation districts, water is being used for manufacturing activities in Bee and McMullen Counties. Due to time constraints and TWDB guidance, these manufacturing demands were not evaluated in detail for the 2011 Plan but should be considered in future planning efforts.

Table 2-5.
Coastal Bend Region Municipal Water Demand by City/County
(acft/yr)

	Historical		Projections[1]					
City/County	1990	2000	2010	2020	2030	2040	2050	2060
Aransas Pass (P)	116	146	168	186	195	190	179	169
Fulton	128	261	307	346	365	359	336	318
Rockport	1,001	1,357	1,590	1,778	1,868	1,823	1,712	1,620
County-Other	1,369	1,550	1,766	1,953	2,016	1,954	1,826	1,728
Aransas County	*2,614*	*3,314*	*3,831*	*4,263*	*4,444*	*4,326*	*4,053*	*3,835*
Beeville	1,929	2,529	2,619	2,690	2,722	2,699	2,683	2,618
El Oso (P)		60	62	65	66	66	65	64
County-Other	1,640	1,631	1,661	1,701	1,704	1,674	1,649	1,609
Bee County	*3,569*	*4,220*	*4,342*	*4,456*	*4,492*	*4,439*	*4,397*	*4,291*
Falfurrias	819	1,661	2,135	2,515	2,795	2,957	3,021	3,032
County-Other	331	309	180	106	62	37	22	13
Brooks County	*1,150*	*1,970*	*2,315*	*2,621*	*2,857*	*2,994*	*3,043*	*3,045*
Benavides	456	315	326	333	334	330	319	302
Freer	521	624	645	659	663	655	633	600
San Diego (P)	660	471	479	482	479	467	449	426
County-Other	453	913	950	979	987	976	944	895
Duval County	*2,090*	*2,323*	*2,400*	*2,453*	*2,463*	*2,428*	*2,345*	*2,223*
Alice	3,581	5,281	5,606	5,912	6,076	6,102	6,033	5,904
Orange Grove	212	353	374	394	405	406	402	393
Premont	970	807	858	905	931	935	925	905
San Diego (P)	140	99	103	105	106	105	103	101
County-Other	1,632	2,022	2,127	2,210	2,238	2,213	2,177	2,130
Jim Wells County	*6,535*	*8,562*	*9,068*	*9,526*	*9,756*	*9,761*	*9,640*	*9,433*
County-Other	44	46	50	52	53	53	52	53
Kenedy County	*44*	*46*	*50*	*52*	*53*	*53*	*52*	*53*
Kingsville	4,776	4,440	4,570	4,601	4,604	4,569	4,616	4,619
Ricardo WSC		296	682	955	1,130	1,236	1,390	1,397
County-Other	1,485	679	799	880	930	957	1,002	1,004
Kleberg County	*6,261*	*5,415*	*6,051*	*6,436*	*6,664*	*6,762*	*7,008*	*7,020*

Table 2-5 (Concluded)

City/County	Historical		Projections[1]					
	1990	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Choke Canyon WS (P)		360	397	425	435	421	384	346
El Oso WSC (P)		189	206	220	223	215	196	176
George West	530	642	703	754	767	738	675	608
McCoy WSC		50	54	57	58	56	51	46
Three Rivers	379	425	465	498	505	485	444	399
County-Other	887	684	748	796	808	778	709	638
Live Oak County	*1,796*	*2,350*	*2,573*	*2,750*	*2,796*	*2,693*	*2,459*	*2,213*
Choke Canyon WS (P)		40	43	44	42	39	37	35
County-Other	109	135	143	146	138	129	123	117
McMullen County	*109*	*175*	*186*	*190*	*180*	*168*	*160*	*152*
Agua Dulce	99	115	112	110	107	105	103	103
Aransas Pass (P)	3	12	26	41	53	64	73	81
Bishop	465	459	444	433	422	411	404	404
Corpus Christi	66,966	55,629	61,953	68,212	73,592	78,422	82,961	86,962
Driscoll	88	97	122	148	171	191	208	224
Nueces County WCID #4		977	1,913	2,884	3,729	4,460	5,124	5,655
Port Aransas	1,308	1,601	2,606	3,655	4,558	5,355	6,068	6,637
River Acres WSC		314	429	546	646	736	813	881
Robstown	2,429	2,153	2,110	2,067	2,024	1,982	1,953	1,953
County-Other	5,163	1,345	894	595	395	262	175	118
Nueces County	*76,521*	*62,702*	*70,609*	*78,691*	*85,697*	*91,988*	*97,882*	*103,018*
Aransas Pass (P)	792	1,210	1,405	1,615	1,828	2,015	2,201	2,386
Gregory	239	249	239	231	223	216	210	210
Ingleside	613	873	1,294	1,771	2,202	2,607	3,016	3,394
Ingleside On The Bay		74	92	112	130	148	164	181
Lake City		70	79	89	99	107	116	125
Mathis	770	671	648	632	615	598	586	586
Odem	260	319	330	347	361	372	389	408
Portland	1,794	1,976	2,399	2,868	3,290	3,715	4,106	4,498
Sinton	789	1,036	1,052	1,062	1,076	1,086	1,108	1,135
Taft	432	559	586	619	648	672	703	735
County-Other	2,242	1,836	1,946	2,077	2,189	2,277	2,398	2,533
San Patricio County	*7,931*	*8,873*	*10,070*	*11,423*	*12,661*	*13,813*	*14,997*	*16,191*
Total for Region	**108,620**	**99,950**	**111,495**	**122,861**	**132,063**	**139,425**	**146,036**	**151,474**

[1] Projections from Texas Water Development Board
(P) Partial

Table 2-6.
Coastal Bend Region Manufacturing Water Demand by County and River Basin (acft/yr)

County	Historical		Projections[1]					
	1990	2000	2010	2020	2030	2040	2050	2060
Aransas	283	235	267	281	292	302	311	331
Bee	1	1	1	1	1	1	1	1
Brooks	0	0	0	0	0	0	0	0
Duval	0	0	0	0	0	0	0	0
Jim Wells	0	0	0	0	0	0	0	0
Kenedy	0	0	0	0	0	0	0	0
Kleberg	0	0	0	0	0	0	0	0
Live Oak	943	1,767	1,946	1,998	2,032	2,063	2,088	2,194
McMullen	0	0	0	0	0	0	0	0
Nueces	34,949	39,763	46,510	50,276	53,425	56,500	59,150	63,313
San Patricio	7,435	12,715	15,096	16,699	18,111	19,505	20,733	22,283
Total for Region	**43,611**	**54,481**	**63,820**	**69,255**	**73,861**	**78,371**	**82,283**	**88,122**
River Basin								
Nueces	2,154	10,196	11,931	13,006	13,935	14,849	15,650	16,761
Nueces-Rio Grande	33,865	38,486	45,016	48,661	51,709	54,685	57,250	61,280
San Antonio-Nueces	7,592	5,799	6,873	7,588	8,217	8,837	9,383	10,081
Total for Region	**43,611**	**54,481**	**63,820**	**69,255**	**73,861**	**78,371**	**82,283**	**88,122**

[1] Projections from Texas Water Development Board

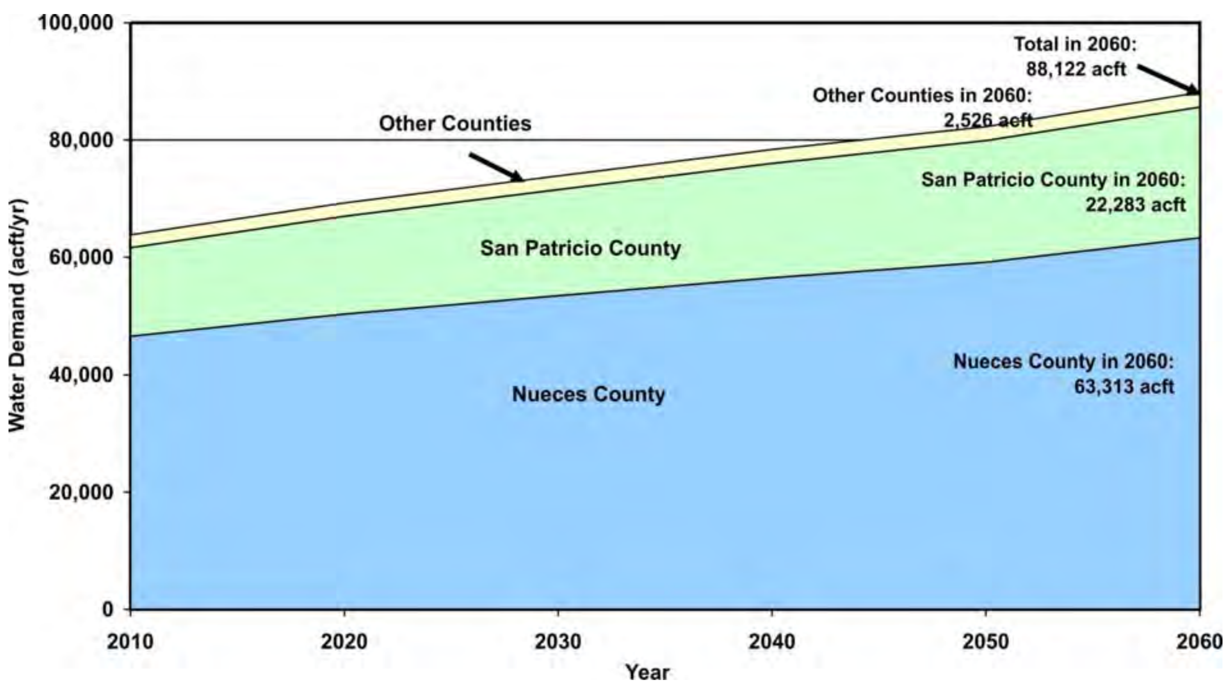


Figure 2-7. Coastal Bend Region Manufacturing Water Demand

As noted previously, petroleum refining is one of the largest industries in the region, accounting for about 60 percent of all manufacturing water use. Corpus Christi, in Nueces County, is home to nearly 13 percent of Texas' petroleum refining capacity. The refineries in the Corpus Christi area have implemented significant water conservation and water use efficiency improvement programs. These refineries use between 35 and 46 gallons of water per barrel of crude petroleum refined, compared to the State average of 100 gallons per barrel refined.[1]

2.3.3 Steam-Electric Water Demand

The TWDB and Bureau of Economic Geology (BEG) released a report entitled "Water Demand Projections for Power Generation in Texas" on August 31, 2008. This report contained updated demand projections for steam-electric power. The TWDB allowed planning groups to select their preferred set of steam-electric water demand projections from either the 2006 Plan or the BEG study. The Coastal Bend RWPG adopted the 2006 Plan steam-electric water demands for use in the 2011 Plan.

Projections for steam-electric power water demand are based on power generation projections—determined by population and manufacturing growth—and on generating capacity and water use for that projected capacity. The steam-electric generation process uses water in boilers and for cooling the generating equipment. The usual practice is to use freshwater with a very low concentration of dissolved solids for boiler feed water and to use either freshwater or saline water for power plant cooling purposes. At two of the three plants located in Corpus Christi in Nueces County, freshwater is used for the boiler feed and seawater is used for cooling. The Nueces Bay Power Station is not currently operating. The use of saltwater for cooling at Topaz (formerly AEP-CPL's) Barney Davis Power Station saves approximately 6,300 acft/yr in freshwater (1999 figures). At the third plant, Lon C. Hill, fresh water is used for the boiler feed and cooling. Table 2-7 shows that in 2000, 8,799 acft/yr of water was used. According to AEP,[2] approximately two-thirds of water used in Year 2000 was forced evaporation of saltwater. In 2060, steam-electric demands for freshwater are projected to be 27,664 acft/yr (Figure 2-8). The large increase between 2010 and 2020 is attributable to a proposed, new 1,200 MW plant in

[1] "Report of Water Use for Refineries and Selected Cities in Texas, 1976-1987," South Texas Water Authority, Kingsville, Texas, 1990.
[2] Correspondence with Greg Carter, AEP-CPL.

Nueces County. For projected water demands from 2020 to 2060, the projected fresh water use is estimated to be over three-quarters of the total projected steam- electric water demand.[3]

2.3.4 Mining Water Demand

Projections for mining water demand are based on projected production of mineral commodities, and historic rates of water use, moderated by water requirements of technological processes used in mining.

The development of natural gas from the shale in the Eagleford Group has begun in several counties in the Coastal Bend Region. Water demands associated with these mining activities are not included in Table 2-8, but may impact local groundwater use, especially in the Carrizo Aquifer. It is anticipated that in the near future about 200 acft/yr of water use will be used for hydraulic fracturing of wells in each of these three counties: McMullen, Bee, and Live

Table 2-7.
Coastal Bend Region Steam-Electric Water Demand by County and River Basin (acft/yr)

	Historical		*Projections[1]*					
County	***1990***	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
Aransas	0	0	0	0	0	0	0	0
Bee	0	0	0	0	0	0	0	0
Brooks	0	0	0	0	0	0	0	0
Duval	0	0	0	0	0	0	0	0
Jim Wells	0	0	0	0	0	0	0	0
Kenedy	0	0	0	0	0	0	0	0
Kleberg	0	0	0	0	0	0	0	0
Live Oak	0	0	0	0	0	0	0	0
McMullen	0	0	0	0	0	0	0	0
Nueces	2,404	8,799	7,316	14,312	16,733	19,683	23,280	27,664
San Patricio	0	0	0	0	0	0	0	0
Total for Region	**2,404**	**8,799**	**7,316**	**14,312**	**16,733**	**19,683**	**23,280**	**27,664**
River Basin								
Nueces	2,347	3,768	3,133	10,977	12,834	15,097	17,855	21,218
Nueces-Rio Grande	57	5,031	4,183	3,335	3,899	4,586	5,425	6,446
San Antonio-Nueces	0	0	0	0	0	0	0	0
Total for Region	**2,404**	**8,799**	**7,316**	**14,312**	**16,733**	**19,683**	**23,280**	**27,664**

[1] Projections from Texas Water Development Board

[3] TWDB, "Power Generation Water Use in Texas for the Years 2000 Through 2060", January 2003.

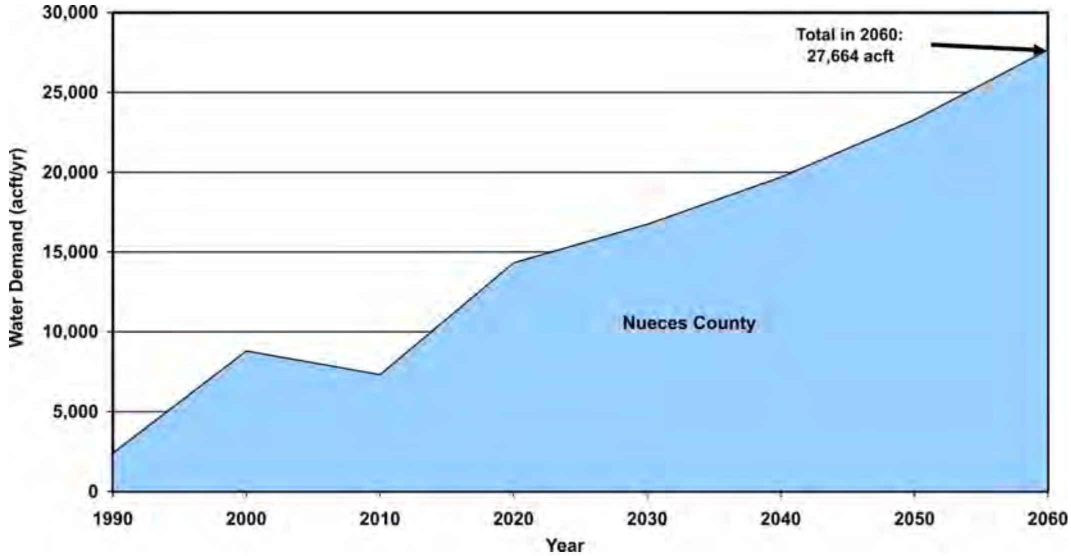


Figure 2-8. Coastal Bend Region Steam-Electric Water Demand

Oak.[4] Furthermore, uranium mining is in the initial phases of exploration in Live Oak County and is anticipated to use additional groundwater supplies. The impacts of developing gas wells in the Eagleford shale and uranium mining activities on groundwater supplies in the Coastal Bend Region should be considered in future planning efforts.

In 2000 for the 11 counties of the Coastal Bend Planning Area, 11,897 acft was used in the mining of sand, gravel, and in the production of crude oil. Water is required in the mining of these minerals either for processing, leaching to extract certain ores, controlling dust at the plant site, or for reclamation. Duval, Kleberg and Live Oak Counties accounted for 82.2 percent of the 2000 total use (Table 2-8). Mining water use in 2030 is expected to be 16,640 acft and is projected to increase to 19,114 acft in 2060, a 60.7 percent from 2000 to 2060. Duval, Kleberg, and Live Oak Counties, which will increase at 88.2 percent, 4.9 percent, and 72.0 percent, respectively, will account for 84.4 percent of the 2060 total use (Figure 2-9).

2.3.5 Irrigation Water Demand

Irrigated crop production in Coastal Bend Region is practiced in 9 of the 11 counties. Irrigation surveys[5] by the Natural Resource Conservation Service reported 23,975 acres of irrigated farmland in 2000, with over 97 percent irrigated with groundwater. In 2007, of the

[4] Correspondence from Bee GCD, McMullen GCD, and Live Oak GCD in November 2009.
[5] Surveys of Irrigation in Texas, TWDB Report 347, August 2001.

Table 2-8.
Coastal Bend Region Mining Water Demand by County and River Basin (acft/yr)

County	Historical		Projections[1]					
	1990	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
Aransas	0	81	103	115	123	131	139	146
Bee	20	29	36	40	42	44	46	48
Brooks	145	127	150	161	167	173	179	184
Duval	3,049	4,544	5,860	6,630	7,119	7,610	8,108	8,553
Jim Wells	393	347	423	461	484	507	530	550
Kenedy	4	1	1	1	1	1	1	1
Kleberg	1,221	2,127	2,917	2,934	2,207	2,216	2,225	2,232
Live Oak	2,385	3,105	3,894	4,319	4,583	4,845	5,108	5,341
McMullen	239	176	195	203	207	211	215	218
Nueces	50	1,275	1,472	1,555	1,599	1,641	1,682	1,724
San Patricio	57	85	99	105	108	111	114	117
Total for Region	**7,563**	**11,897**	**15,150**	**16,524**	**16,640**	**17,490**	**18,347**	**19,114**
River Basin								
Nueces	3,787	5,046	6,350	7,068	7,515	7,963	8,414	8,814
Nueces-Rio Grande	3,719	5,876	7,662	8,246	7,875	8,239	8,609	8,938
San Antonio-Nueces	57	975	1,138	1,210	1,250	1,288	1,324	1,362
Total for Region	**7,563**	**11,897**	**15,150**	**16,524**	**16,640**	**17,490**	**18,347**	**19,114**

[1] Projections from Texas Water Development Board

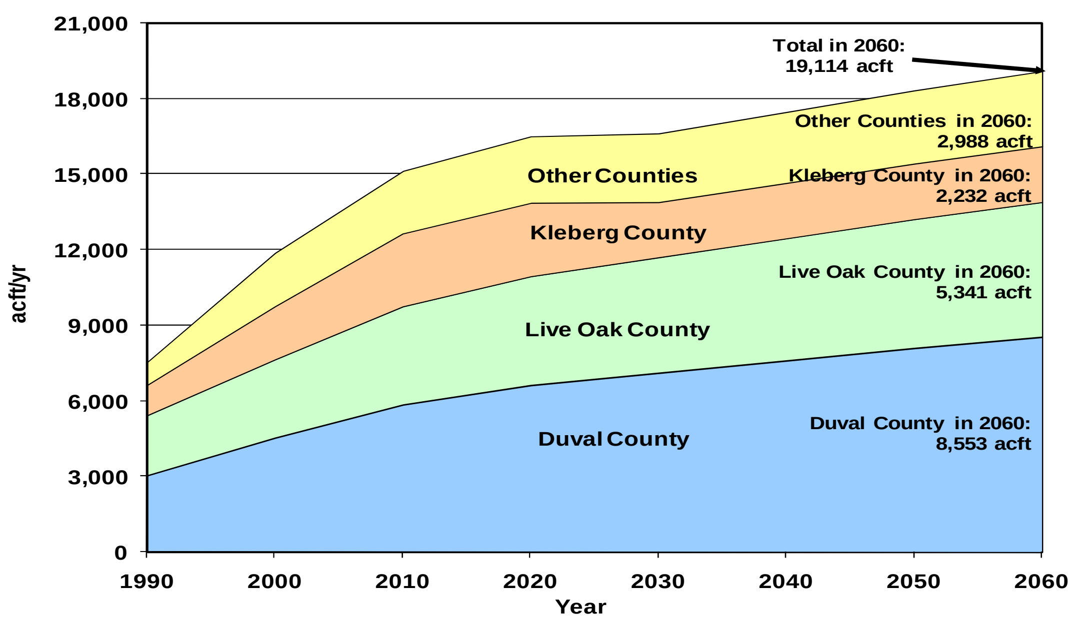


Figure 2-9. Coastal Bend Region Mining Water Demand

7,015 farms in the region, 238 had 34,666 acres of irrigated farmland.[6] The region receives on average about 29.2 inches of rainfall per year, which is generally adequate for dry-land crops. Irrigated cropland only accounts for 2.7 percent of all harvested cropland.[7] Major crops include corn, cotton, sorghum, hay and wheat.

The irrigation water demand projections are based on specific assumptions regarding crop prices, crop yields, agricultural policy, and technological advances in irrigation systems. The TWDB estimated 2000 total irrigated water use in the Coastal Bend Region at 21,971 acft based on irrigation water use surveys (Table 2-9). Duval and San Patricio Counties accounted for 41.4 percent of that total. Irrigated water use is projected to increase by 35.3 percent from 2000 to 2060, 21,971 acft to 29,726 acft (Figure 2-10). This increase is attributable to a projected increase is the number of acres being irrigated within the region. It should be noted that in Bee and Live Oak Counties, most irrigation occurs in the southern portion of those counties in the more productive Evangeline layers of the Gulf Coast Aquifer.

On June 26, 2009, the Coastal Bend RWPG requested the TWDB to modify the irrigation water demand projections for Bee and San Patricio Counties based on recent, historical irrigation water use trends for these counties and comparing these to the 2006 Regional Water Plan irrigation water demand projections. After considering the requested change, the TWDB approved the change in irrigation water demand for Bee and San Patricio Counties. This change resulted in an increased irrigation demand of 9,594 acft/yr in 2030 and 16,361 acft/yr in 2060 as compared to the 2006 Plan.

2.3.6 Livestock Water Demand

In the 11-county Coastal Bend Region, the principal livestock type is beef cattle, with some dairy herds. Livestock drinking water is obtained from wells, stock watering tanks that are dug/constructed on the ranches, and streams that flow through the ranches.

The livestock water demand projections are based upon estimates of the maximum carrying capacity of the rangeland of the area and the estimated number of gallons of water per head of livestock per day. In 2000, livestock water use for the Coastal Bend region was 8,838 acft: 21.5 percent in Kleberg County, 12.0 percent in Jim Wells County, 11.3 percent in Bee County, 10.2 percent in Kenedy County, and 45.0 percent in the remaining counties.

[6] U.S Department of Agriculture, 2007 Census of Agriculture.
[7] Ibid.

Table 2-9.
Coastal Bend Region Irrigation Water Demand by County and River Basin (acft/yr)

County	Historical		Projections[1]					
	1990	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Aransas	0	0	0	0	0	0	0	0
Bee	3,474	2,798	3,796	4,193	4,632	5,116	5,652	6,243
Brooks	350	25	24	24	23	22	21	21
Duval	2,586	4,524	4,444	4,365	4,289	4,212	4,138	4,064
Jim Wells	1,189	3,731	3,278	2,878	2,528	2,221	1,953	1,717
Kenedy	0	107	107	107	107	107	107	107
Kleberg	461	1,002	866	745	644	555	477	410
Live Oak	3,333	3,539	3,289	3,056	2,840	2,639	2,451	2,277
McMullen	0	0	0	0	0	0	0	0
Nueces	1,734	1,680	1,449	1,250	1,077	928	801	692
San Patricio	1,110	4,565	8,631	9,534	10,531	11,633	12,850	14,195
Total for Region	**14,237**	**21,971**	**25,884**	**26,152**	**26,671**	**27,433**	**28,450**	**29,726**
River Basin								
Nueces	5,483	6,971	6,597	6,103	5,679	5,316	5,008	4,754
Nueces-Rio Grande	4,214	8,100	7,585	7,123	6,715	6,347	6,019	5,723
San Antonio-Nueces	4,540	6,900	11,702	12,926	14,277	15,770	17,423	19,249
Total for Region	**14,237**	**21,971**	**25,884**	**26,152**	**26,671**	**27,433**	**28,450**	**29,726**

[1] Projections from Texas Water Development Board

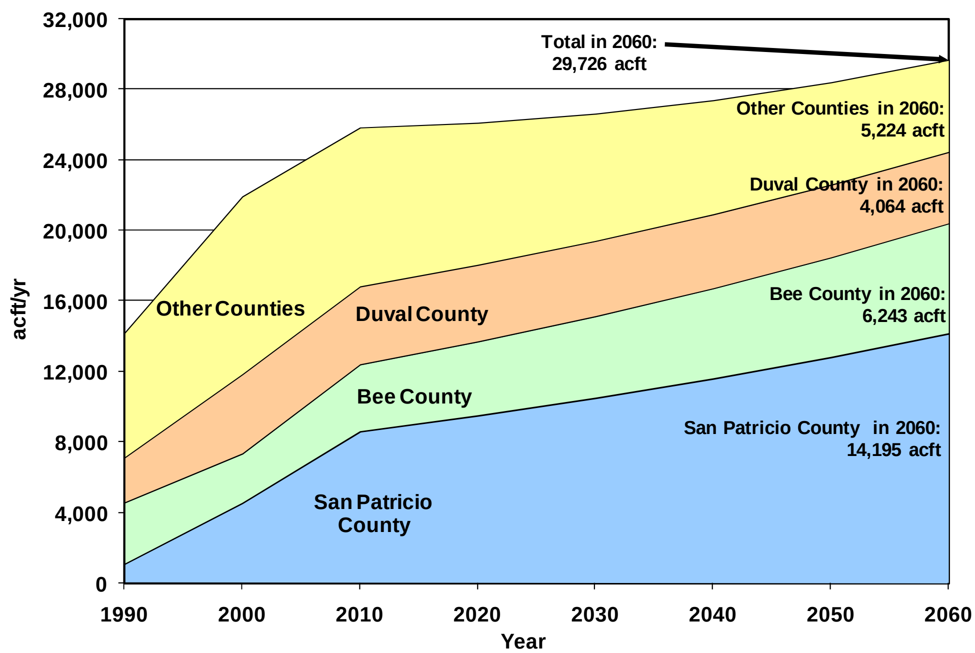


Figure 2-10. Coastal Bend Region Irrigation Water Demand

Table 2-10.
Coastal Bend Region Livestock Water Demand by County and River Basin (acft/yr)

County	Historical		Projections[1]					
	1990	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Aransas	52	23	23	23	23	23	23	23
Bee	1,088	995	995	995	995	995	995	995
Brooks	816	747	747	747	747	747	747	747
Duval	1,177	873	873	873	873	873	873	873
Jim Wells	907	1,064	1,064	1,064	1,064	1,064	1,064	1,064
Kenedy	1,065	901	901	901	901	901	901	901
Kleberg	1,745	1,900	1,900	1,900	1,900	1,900	1,900	1,900
Live Oak	1,170	833	833	833	833	833	833	833
McMullen	484	659	659	659	659	659	659	659
Nueces	373	379	279	279	279	279	279	279
San Patricio	747	564	564	564	564	564	564	564
Total for Region	**9,624**	**8,838**	**8,838**	**8,838**	**8,838**	**8,838**	**8,838**	**8,838**
River Basin								
Nueces	2,500	2,219	2,219	2,219	2,219	2,219	2,219	2,219
Nueces-Rio Grande	5,613	5,342	5,342	5,342	5,342	5,342	5,342	5,342
San Antonio-Nueces	1,511	1,277	1,277	1,277	1,277	1,277	1,277	1,277
Total for Region	**9,624**	**8,838**	**8,838**	**8,838**	**8,838**	**8,838**	**8,838**	**8,838**

[1] Projections from Texas Water Development Board

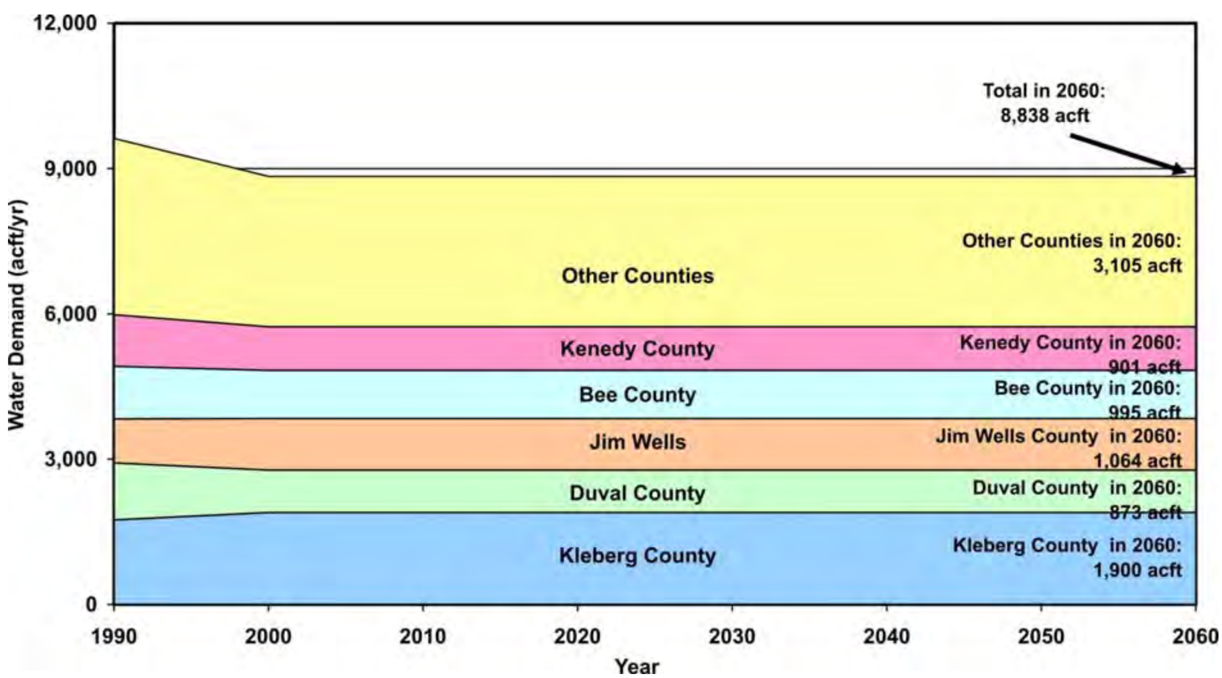


Figure 2-11. Coastal Bend Region Livestock Water Demand

From 2000 to 2060, water use for livestock use is projected by the TWDB to remain constant at 8,838 acft (Figure 2-11 and Table 2-10).

2.4 Water Demand Projections for Wholesale Water Providers

There are four regional wholesale water providers in the Coastal Bend Region: the City of Corpus Christi, SPMWD, STWA, and Nueces WCID #3. The City of Corpus Christi provides water to SPMWD and STWA, as shown in Table 2-11. The City of Corpus Christi is contracted to provide 40,000 act/yr to SPMWD (up to 30,000 acft/yr of raw water and 10,000 acft/yr of treated water supplies) and meet demands of STWA and their customers. For the 2011 Plan, water supply constraints are considered based on system yield (raw water) or water treatment plant capacity (treated water). Accordingly, the water demands for each wholesale water provider and their customers are shown in Table 2-11 and are categorized according to raw or treated water demands for ease of comparison to supplies discussed in Sections 3 and 4A. The City of Corpus Christi and SPMWD provide both raw and treated water supplies to their customers. STWA solely provides treated water supplies to its customers. Nueces County WCID # 3 provides a majority of treated water supplies to its customers and also provides a small amount of raw water for local irrigation uses. Water use for wholesale water providers by county and river basin are included in Appendix C.

Table 2-11.
Coastal Bend Region Water Demand Projections for Wholesale Water Providers

Wholesale Water Provider (Water User/County)	2000 (acft/yr)	2010 (acft/yr)	2020 (acft/yr)	2030 (acft/yr)	2040 (acft/yr)	2050 (acft/yr)	2060 (acft/yr)
CITY OF CORPUS CHRISTI							
Raw Water Demand							
Municipal							
Jim Wells County							
City of Alice	5,281	5,606	5,912	6,076	6,102	6,033	5,904
Bee County							
City of Beeville	2,529	2,619	2,691	2,722	2,699	2,683	2,618
San Patricio County							
City of Mathis	671	648	632	615	598	586	586
San Patricio MWD *(based on water supply contract)*	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Live Oak County							
City of Three Rivers	3,363	3,363	3,363	3,363	3,363	3,363	3,363
Non-Municipal							
Manufacturing (Nueces County)[1]	9,698	11,343	12,262	13,030	13,780	14,426	15,441
Mining (Nueces County)	1,189	1,375	1,453	1,494	1,534	1,572	1,612
Total Raw Water Demand	**52,731**	**54,954**	**56,313**	**57,300**	**58,076**	**58,663**	**59,524**
Treated Water Demand							
Municipal							
San Patricio County							
San Patricio MWD *(based on water supply contract)*	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Nueces County							
Nueces County WCID #4 (Port Aransas)[2]	977	1,913	2,884	3,729	4,460	5,124	5,655
City of Corpus Christi	55,629	61,953	68,212	73,592	78,422	82,961	86,962
County-Other[3,4]	116	116	116	116	116	116	116
Kleberg County							
South Texas Water Authority *(based on water supply contract)*	2,284	2,619	2,867	3,011	3,065	3,236	3,260
Non-Municipal							
Manufacturing (Nueces County)[5]	29,093	34,030	36,785	39,089	41,339	43,278	46,324
Steam-Electric (Nueces County)[6]	8,799	7,316	14,312	16,733	19,683	23,280	27,664
Total Treated Water Demand	**106,898**	**117,947**	**135,176**	**146,270**	**157,085**	**167,995**	**179,981**
Total Water Demand	**159,629**	**172,901**	**191,489**	**203,570**	**215,161**	**226,658**	**239,505**
River Basin							
Nueces	13,606	13,683	22,144	24,525	27,266	30,468	34,292
Nueces- Rio Grande	102,735	115,724	125,730	135,372	144,219	152,507	161,569
San Antonio- Nueces	43,288	43,494	43,615	43,673	43,676	43,683	43,644
Total Water Demand	**159,629**	**172,901**	**191,489**	**203,570**	**215,161**	**226,658**	**239,505**
SAN PATRICIO MUNICIPAL WATER DISTRICT							
Raw Water Demand							
Non-Municipal							
Manufacturing (San Patricio County)[7]	7,841	7,841	7,841	7,841	7,841	7,841	7,841
Total Raw Water Demand	**7,841**	**7,841**	**7,841**	**7,841**	**7,841**	**7,841**	**7,841**
Treated Water Demand							

Table 2-11 (Continued)

Wholesale Water Provider (Water User/County)	***2000 (acft/yr)***	***2010 (acft/yr)***	***2020 (acft/yr)***	***2030 (acft/yr)***	***2040 (acft/yr)***	***2050 (acft/yr)***	***2060 (acft/yr)***
SAN PATRICIO MUNICIPAL WATER DISTRICT (cont.)							
Municipal							
Nueces County							
City of Aransas Pass	12	26	41	53	64	73	81
Nueces County WCID #4 (Port Aransas)	1,601	2,606	3,655	4,558	5,355	6,068	6,637
San Patricio County							
City of Aransas Pass	1,210	1,405	1,615	1,828	2,016	2,201	2,386
City of Gregory	249	239	231	223	216	210	210
City of Ingleside	873	1,294	1,771	2,202	2,607	3,016	3,395
City of Ingleside on the Bay	74	92	112	130	148	164	181
City of Portland	1,976	2,399	2,869	3,290	3,716	4,106	4,498
City of Odem	319	330	347	361	372	389	408
City of Taft	559	586	619	648	672	703	736
County-Other	975	1,033	1,103	1,163	1,209	1,274	1,345
Aransas County							
City of Aransas Pass	146	168	186	195	190	179	169
City of Fulton	261	307	346	365	359	336	318
City of Rockport	1,357	1,590	1,778	1,868	1,823	1,712	1,620
County-Other[2]	1,338	1,524	1,686	1,740	1,687	1,575	1,491
Non-Municipal							
Manufacturing (San Patricio County)[8]	4,865	7,244	8,846	10,257	11,650	12,877	14,426
Total Treated Water Demand	**15,815**	**20,839**	**25,205**	**28,881**	**32,084**	**34,883**	**37,901**
Total Water Demand	**23,656**	**28,684**	**33,046**	**36,722**	**39,925**	**42,724**	**45,742**
River Basin							
Nueces	7,152	8,491	9,393	10,187	10,971	11,662	12,534
Nueces- Rio Grande	1,601	2,606	3,655	4,558	5,355	6,068	6,637
San Antonio- Nueces	14,903	17,587	19,998	21,977	23,599	24,994	26,571
Total Water Demand	**23,656**	**28,684**	**33,046**	**36,722**	**39,925**	**42,724**	**45,742**
SOUTH TEXAS WATER AUTHORITY							
Municipal							
Nueces County							
City of Agua Dulce	115	112	110	107	105	103	103
City of Driscoll	97	122	148	171	191	208	224
City of Bishop	420	317	309	301	294	289	289
County-Other	213	213	213	213	213	213	213
Kleberg County							
City of Kingsville	1,221	1,352	1,382	1,385	1,350	1,397	1,400
Ricardo WSC	218	503	705	834	912	1,026	1,031
Total Water Demand (All Treated)	**2,284**	**2,619**	**2,867**	**3,011**	**3,065**	**3,236**	**3,260**
River Basin							
Nueces	0	0	0	0	0	0	0
Nueces- Rio Grande	2,284	2,619	2,867	3,011	3,065	3,236	3,260
San Antonio- Nueces	0	0	0	0	0	0	0
Total Water Demand	**2,284**	**2,619**	**2,867**	**3,011**	**3,065**	**3,236**	**3,260**

Table 2-11 (Concluded)

Wholesale Water Provider (Water User/County)	***2000 (acft/yr)***	***2010 (acft/yr)***	***2020 (acft/yr)***	***2030 (acft/yr)***	***2040 (acft/yr)***	***2050 (acft/yr)***	***2060 (acft/yr)***
NUECES COUNTY WCID #3							
Nueces County							
County-Other	155	155	155	155	155	155	155
City of Robstown	2,153	2,110	2,067	2,024	1,982	1,953	1,953
River Acres WSC	291	291	291	291	291	291	291
Total Water Demand (All Treated)	**2,599**	**2,556**	**2,513**	**2,470**	**2,428**	**2,399**	**2,399**
River Basin							
Nueces	291	291	291	291	291	291	291
Nueces- Rio Grande	2,308	2,265	2,222	2,179	2,137	2,108	2,108
San Antonio- Nueces	0	0	0	0	0	0	0
Total Water Demand	**2,599**	**2,556**	**2,513**	**2,470**	**2,428**	**2,399**	**2,399**

Notes:

1. Calculated based on 25% of the Nueces County Manufacturing demand being for raw water. This is based upon City billing records for 2001 through 2005.
2. The TWDB provides separate decadal water demands for Nueces County WCID #4 and the City of Port Aransas. Based on conversations with the City of Corpus Christi and San Patricio Municipal Water District (SPMWD) in February 2005, the City is shown to provide water supplies to Nueces County WCID #4 and SPMWD is shown to provide water supplies to Port Aransas to meet demands. Of the total water demand for both entities in Year 2060, the TWDB projections show Nueces County WCID #4 having 46% of the demand and 54% for the City of Port Aransas.
3. Includes Violet WSC.
4. The City of Corpus Christi does not meet full demand (i.e. additional supply from groundwater).
5. Calculated based on 75% of the Nueces County Manufacturing Demand being for treated water. This is based upon City billing records for 2001 through 2005, the most recent data which was readily available.
6. Steam-Electric water demands include Lon Hill and potential, future steam-electric power plants accounted by TWDB studies. As a conservative estimate, future steam-electric water demands are assumed to be provided treated water.
7. Based on total raw water contracts of 7MGD.
8. Remaining Manufacturing demand (San Patricio County) after accounting for raw water sales.

Section 3
Evaluation of Current
Water Supplies in the Region
[31 TAC §357.7 (a)(3)]

3.1 Surface Water Supplies

The Coastal Bend Region is located within three river basins: the Nueces River Basin, the San Antonio-Nueces Coastal Basin, and the Nueces-Rio Grande Coastal Basin (Figure 3-1). Streamflows in the two coastal basins are highly variable and intermittent and do not supply large quantities of water. However, streamflow in the Nueces River and its tributaries, along with municipal and industrial water rights in the Nueces River Basin, comprise a significant supply of water used in the Coastal Bend Region, as this basin drains about 17,000 square miles. These water rights provide authorization for an owner to divert, store and use the water; however, it does not guarantee that a dependable supply will be available from their source. The availability of water to a water right is dependent on several factors including hydrologic conditions (i.e., rainfall, runoff, springflows), priority date of the water right, quantity of authorized storage, and any special conditions associated with the water right (e.g., instream flow conditions, maximum diversion rate). Because the Nueces River Basin is subject to periods of significant drought and low flows, storage is very important to help "firm up" water rights.

3.1.1 Texas Water Right System

The State of Texas owns the surface water within the state watercourses and is responsible for the appropriation of these waters. Surface water is currently allocated by the TCEQ, formerly Texas Natural Resource Conservation Commission, for the use and benefit of all people of the state. Texas water law is based on the riparian and prior appropriation doctrines. The riparian doctrine extends from the Spanish and Mexican governments that ruled Texas prior to 1836. After 1840, the riparian doctrine provided landowners the rights to make reasonable use of water for irrigation or for other consumptive uses. In 1889, the prior appropriation doctrine was first adopted by Texas, which is based on the concept of "first in time is first in right." Over the years, the riparian and prior appropriation doctrines resulted in a system that was very difficult to manage. Various types of water rights existed simultaneously and many rights were unrecorded. In 1967, the Texas Legislature passed the Water Rights Adjudication Act that

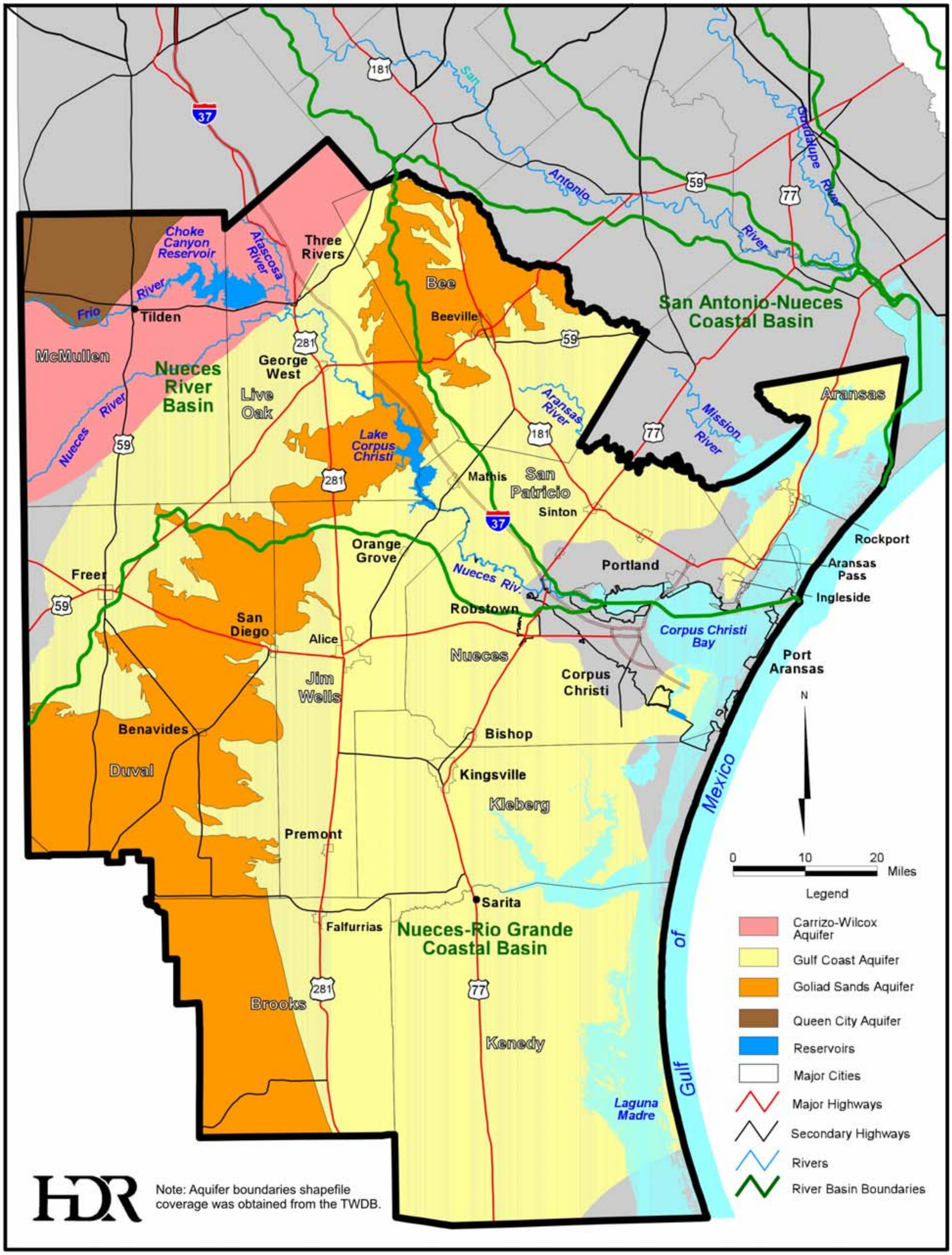


Figure 3-1. Watershed Boundaries and Aquifer Location Map

merged the riparian water rights into the prior appropriation system, creating a unified water permit system.

The adjudication process took many years, stretching into the late 1980s before it was finally completed. In the end, Certificates of Adjudication were issued for entities recognized as having legitimate water rights. Today, individuals or groups seeking a new water right must submit an application to the TCEQ. The TCEQ determines if the water right will be issued and under what conditions. The water rights grant a certain quantity of water to be diverted and/or stored, a priority date, location of diversion, and other restrictions. The priority date of a water right is essential to the operation of the water rights system. Each right is issued a priority date based on the date each right was filed at the TCEQ. When diverting or storing water for use, all water right holders must adhere to the priority system. A right holder must allow water to be passed to downstream senior water rights when conditions are such that the senior water rights would not be otherwise satisfied. Other restrictions may include a maximum diversion rate and instream flow restrictions to protect existing water rights and provide environmental flows for instream needs and needs of estuary systems, although most water rights issued prior to 1985 do not include such conditions. An important exception to the rule is Certificate of Adjudication Number (CA#) 21-3214 for Choke Canyon Reservoir, which represents approximately 75% of the Nueces River Basin water rights and requires instream flows and freshwater flows for the Nueces Estuary. Operations of the CCR/LCC System are governed, in part, by CA #21-3214, within which Special Conditions B and E state:

B. (Part)

> "Owners shall provide not less than 151,000 acft of water per annum for the estuaries by a combination of releases and spills from the reservoir system at Lake Corpus Christi Dam and return flows to the Nueces and Corpus Christi Bays and other receiving estuaries."

E.

> "Owners shall continuously maintain a minimum flow of 33 cubic feet per second below the dam at Choke Canyon Reservoir."

Special Condition B of CA #21-3214 further states:

> "Water provided to the estuaries from the reservoir system under this paragraph shall be released in such quantities and in accordance with such operational procedures as may be ordered by the Commission."

Hence, the certificate provided for a means to further establish specific rules governing operations of the CCR/LCC System with respect to maintaining freshwater inflows to the Nueces Estuary.

To address concerns about the health of the Nueces Estuary, a Technical Advisory Committee (TAC) chaired by the TCEQ was formed in 1990 to establish operational guidelines for the CCR/LCC System and desired monthly freshwater inflows to the Nueces Estuary. These operational guidelines were summarized in the 1992 Interim Order.[1]

The 1992 Interim Order established a monthly schedule of desired freshwater inflows to Nueces Bay to be satisfied by spills, return flows, runoff below Lake Corpus Christi, and/or dedicated releases from the CCR/LCC System. Mechanisms for relief from reservoir releases under the Interim Order were based on inflow banking, monthly salinity variation in upper Nueces Bay, and implementation of drought contingency measures tied to CCR/LCC System Storage.

The Nueces Estuary Advisory Council (NEAC) was formed under the 1992 Interim Order and charged with continued study of the interdependent relationship between the firm yield of the CCR/LCC System and the health of the Nueces Estuary. One of NEAC's primary goals was to evaluate the 1992 Interim Order and other alternative release policies and recommend a more permanent reservoir operations plan for providing freshwater inflows to the Nueces Estuary. This goal was to be achieved within 5 years of NEAC's formation.

The goal of recommending a more permanent reservoir operations plan was fulfilled on April 28, 1995, when the TCEQ issued an order regarding reservoir operations for freshwater inflows to the Nueces Estuary, known as the 1995 Agreed Order.[2] This Agreed Order is very similar to the Interim Order, with one major exception—monthly releases (pass-throughs) to the estuary were limited to CCR/LCC System inflows and stored water is not required to meet estuary freshwater flow needs.

On April 17, 2001, the TCEQ issued an amendment to the 1995 Agreed Order to revise operational procedures in accordance with revisions requested by the City of Corpus Christi.

[1] Texas Water Commission, Interim Order Establishing Operational Procedures Pertaining to Special Condition B, Certificate of Adjudication No. 21-3214, held by the City of Corpus Christi, et al., March 9, 1992.
[2] Texas Commission on Environmental Quality (TCEQ), Agreed Order Establishing Operational Procedures Pertaining to Special Condition B, Certificate of Adjudication No. 21-3214, held by City of Corpus Christi, et al., April 28, 1995.

Changes included: (1) passage of inflows to Nueces Bay and Estuary at 40 percent and 30 percent reservoir system capacity upon institution of mandatory outdoor watering restrictions; (2) calculating reservoir system storage capacity based on most recently completed bathymetric surveys; and (3) provisions for operating Rincon Bayou diversions and conveyance facility from Calallen Pool to enhance the amount of freshwater to the Nueces Bay and Delta. All CCR/LCC System yield analyses presented as part of this study were performed using the 2001 Agreed Order.

3.1.2 Types of Water Rights

There are various types of water rights. Water rights are characterized as Certificates of Adjudication, permits, short-term permits, or temporary permits. Certificates of Adjudication were issued in perpetuity for approved claims during the adjudication process. This type of water right was generally issued based on historical use rather than water availability. As a consequence, the amount of water to which rights on paper are entitled to generally exceeds the amount of water available during a drought. The TCEQ issues new permits generally when normal flows are sufficient to meet 75 percent of the requested amount 75 percent of the time. Permits, like Certificates of Adjudication, are issued in perpetuity and may be bought and sold like other property interests. Short-term permits may be issued by the TCEQ in areas where waters are fully appropriated, but not yet being fully used. Term permits are usually issued for 10 years and may be renewed if, after 10 years, water in the basin is still not being fully used by other water right holders. Temporary permits are issued for up to 3 years. Temporary permits are issued mainly for roadway and other construction projects, where water is used to suppress dust, to compact soils, and to start the growth of new vegetation.

Water rights can include the right to divert and/or store the appropriated water. A run-of-river water right provides for the diversion of streamflows and generally does not include a significant storage volume for use during dry periods. A run-of-river right may be limited by streamflow, pumping rate, or diversion location.

Water rights that include provisions for storage of water allow a water right holder to impound streamflows for use at a later time. The storage provides water for use during dry periods, when water may not be available due to hydrologic conditions or because flows are required to be passed to downstream senior water rights.

Water rights are generally diverted and used within the river basin of origin. An interbasin transfer permit is required of all water that is diverted from one river basin and used in another basin. For diversion of water from a river basin for use in an adjoining coastal basin, such as from the Nueces River Basin to either the San Antonio-Nueces or the Nueces-Rio Grande Coastal Basins, the procedure is simplified and does not require an extensive process.

The annual availability of a water right is typically considered in terms of firm yield or safe yield supply. According to the TCEQ, the firm yield is defined as "that amount of water, based upon a simulation utilizing historic streamflows, that the reservoir could have produced annually if it had been in place during the worst drought of record."[3] The water rights of Nueces County WCID #3 and small run-of river rights on the Nueces Basin (less than 2000 acft/yr) are based on firm yield analyses.

Safe yield supply represents a more conservative approach to determining minimum annual availability in areas where the severity of droughts is uncertain. Safe yield supply is the amount of water that can be withdrawn from a reservoir such that a given volume remains in reservoir storage during the critical month of the drought of record. The surface water availabilities for the largest water rights in the Nueces Basin (i.e., City of Corpus Christi and their customers) are based on safe yield analyses and assume a reserve of 75,000 acft (i.e., 7 percent LCC/CCR System storage) for future drought conditions.[4]

3.1.3 Water Rights in the Nueces River Basin

A total of 256 water rights exist in the Nueces River Basin with a total authorized diversion and consumptive use of 539,691 acft/yr.[5] It is important to note that a small percentage of the water rights make up a large percentage of the authorized diversion volume. In the Nueces River Basin, four water rights (1.5 percent) make up 483,444 acft/yr (89.5 percent) of the authorized diversion volume as shown in Figure 3-2. Of these, three water rights are in the Coastal Bend Region and account for 455,444 acft/yr of the 483,444 acft/yr total. The remaining 252 water rights primarily consist of small municipal, industrial, irrigation and recharge rights distributed throughout the river basin. Municipal and industrial diversion rights represent

[3] TCEQ, "A Regulatory Guidance Document for Applications to Divert, Store, or Use State Water," RG-141, June 1995.
[4] Safe yield analysis for the City of Corpus Christi and their customers (i.e. LCC/CCR/Lake Texana System) approved by the TWDB in their letter provided to the CBRWPG on April 30, 2009 for planning purposes in the 2010 Plan.
[5] The number of water rights and corresponding authorized diversion amounts are based on the Texas Commission on Environmental Quality's Water Rights Database dated November, 2003.

Major Water Rights*					
Water Right #	Owner	Diversion Rights (acft/yr)	Consumptive Rights (acft/yr)	Storage Rights	Notes
2464	City of Corpus Christi	304,898	304,898	300,000 1,175	Lake Corpus Christi Calallen Reservoir
3214	City of Corpus Christi, Nueces River Authority	139,000	139,000	700,000	Choke Canyon Reservoir
3082	Zavala-Dimmit Co. WCID #1	28,000	28,000	5,633	
2466	Nueces County WCID #3	11,546	11,546	0	

*Authorized Annual Diversions > 10,000 acft. Major water rights information obtained from the TCEQ.

Figure 3-2. Location of Major Water Rights in the Nueces River Basin

76 percent of all authorized diversion rights in the Nueces River Basin. Based in large part on water stored in the CCR/LCC System, which is subsequently delivered via the Nueces River to Calallen Dam at Corpus Christi for diversion, the City of Corpus Christi and the NRA hold 98 percent of these municipal and industrial rights in the *basin*.[6] With the inclusion of the municipal water rights held by the Nueces County WCID #3, diverted from the Nueces River upstream of the Calallen Dam, the Coastal Bend Region includes over 99 percent of the Nueces River Basin municipal and industrial surface water rights permits. Table 3-1 summarizes the surface water rights in the Nueces River Basin included in the Coastal Bend Planning Region.

Table 3-1.
Nueces River Basin Water Rights in the Coastal Bend Region

Water Right No.	Name	Annual Diversion Volume (acft/yr)	Reservoir Storage Capacity (acft)	Priority Date	Type of Use	Facility	County
2464	City of Corpus Christi	304,898	301,175	12/1913[1]	Municipal (51%) Industrial (49%) Irrigation (minimal) Mining (minimal)	Lake Corpus Christi (300,000 acft) and Calallen Dam (1,175 acft)	Nueces
2465A	Realty Traders & Exchange, Inc.	20	580	10/1952	Irrigation		San Patricio
2465B	Wayne Shambo	140	580	10/1952	Irrigation		San Patricio
2466	Nueces Co. WCID #3	11,546	0	2/1909[1]	Municipal (37%) Irrigation (63%)		Nueces
2467	Garnett T. & Patsy A. Brooks	221	0	2/1964	Irrigation		San Patricio
2468	CE Coleman Estate	27	0	2/1964	Irrigation		Nueces
2469	Ila M. Noakes Lindgreen	101	0	2/1964	Irrigation		Nueces
3141	Randy J. Corporron et. al.	8	0	12/1965	Irrigation		McMullen
3142	WL Flowers Machine & Welding Co.	132	100	12/1958	Irrigation		McMullen
3143	Ted W. True et. al.	220	40	12/1958	Irrigation		McMullen
3144	Harold W. Nix Et Ux	0	285	2/1969	Recreation		McMullen
3204	Richard P. Horton	233	0	12/1963	Irrigation		McMullen
3205	Richard P. Horton	103	122	12/1963	Irrigation		McMullen
3206	James L. House Trust	123	0	12/1966	Irrigation		McMullen
3214	Nueces River Authority and City of Corpus Christi	139,000	700,000	7/1976	Municipal (43%) Industrial (57%) Irrigation (minimal)	Choke Canyon Reservoir	Nueces/ Live Oak
3215	City of Three Rivers	1,500	2,500	9/1914	Municipal (47%) Irrigation (53%)		Live Oak
4402	City of Taft	600	0	9/1983	Irrigation		San Patricio
5065	Diamond Shamrock Refining[2]	0	0	6/1986	Irrigation		Live Oak
5145	San Miguel Electric Co-Op, Inc.	300	335	12/1990	Industrial		McMullen
	TOTAL	**459,172**					

[1] Water right with multiple priority dates. Earliest date shown in table.
[2] Diamond Shamrock irrigation right is used for irrigation from onsite process water return flows. In effect, this permit is for a reuse project.

[6] The Nueces River Authority's water right is for 20% of Choke Canyon Reservoir.

3.1.4 Coastal Basins

In addition to the Nueces River Basin, the Coastal Bend Regional Planning Area includes portions of two coastal river basins in Texas: the San Antonio-Nueces Coastal Basin and the Nueces-Rio Grande Coastal Basin. The San Antonio-Nueces Coastal Basin is located on the Texas Coast between the Nueces and Guadalupe-San Antonio River Basin. The drainage area of the basin is approximately 2,652 square miles, and it drains surface water runoff into Copano and Aransas Bays. The Nueces-Rio Grande Coastal Basin is located on the southern side of the Coastal Bend Region between the Nueces and Rio Grande Coastal Basins. This basin drains approximately 10,442 square miles into the Laguna Madre Estuary system. Combined, there are approximately 99 water rights in these two coastal basins authorizing diversions of about 1,838,600 acft/yr.[7] Approximately 1,738,000 acft (94 percent) of the combined authorized diversions are from within the Coastal Bend Region Planning Area, and of these rights, 1,699,000 acft (98 percent) are industrial diversions for steam-electric and manufacturing processes from the bays and saline water bodies along the coast. Most of this water is used for cooling purposes and is returned to the source. Based on the size and locations of the remaining freshwater rights in these coastal basins and on the lack of a major river or reservoir in these basins, there are few of these freshwater rights that are sustainable throughout an extended drought. In the San Antonio-Nueces Coastal Basin, firm yield supplies for irrigation users in Bee and San Patricio Counties total less than 200 acft/yr. The Nueces-Rio Grande Basin has firm yield supplies of 569 acft/yr for irrigation users in Nueces County. These water rights were considered as firm yield supplies for the irrigation users.

3.1.5 Interbasin Transfer Permits

A number of interbasin transfer permits exist in the Coastal Bend Regional Planning Area. These permits include authorizations for diversions from river basins north of the planning region into the Nueces River Basin. Both major interbasin transfer permits provide water to the City of Corpus Christi and include supplies from the Lavaca-Navidad and Colorado River Basins. The City of Corpus Christi benefits from an interbasin transfer permit[8] and a contract with the LNRA to divert 41,840 acft/yr on a firm basis and up to 12,000 acft/yr on an

[7] The number of water rights and corresponding authorized diversion amounts are based on the Texas Commission on Environmental Quality's Water Rights Database dated November 2003.
[8] TCEQ, Certificate of Adjudication No. 16-2095C, held by Lavaca-Navidad River Authority and Texas Water Development Board (TWDB), October 21, 1996.

interruptible basis from Lake Texana in the Lavaca-Navidad River Basin to the City's O.N. Stevens Water Treatment Plant. This water is delivered to the City via the Mary Rhodes Pipeline, which became operational in 1998. In addition, the pipeline was designed to convey a second interbasin transfer permit owned by the City of Corpus Christi. The second permit[9] allows the diversion of up to 35,000 acft/yr of run-of-river water on the Colorado River. Analyses of this water right, one of the most senior in the Colorado River Basin, indicate that nearly the full 35,000 acft/yr is available from this run-of-river right without off-channel storage.[10] Table 3-2 summarizes the major interbasin transfer permits in the Coastal Bend Region.

Table 3-2.
Summary of Major Interbasin Transfer Permits in the Coastal Bend Region

River Basin of Origin	Name of Interbasin Transfer Permit Holder	Description	Authorized Diversion (acft/yr)	Priority Date
Lavaca-Navidad	LNRA	Transfer from Lake Texana to adjacent river basins including the Nueces River Basin.	53,840[1]	5/1972
Colorado	City of Corpus Christi	Transfer from Garwood Irrigation Co. water right to the City of Corpus Christi.	35,000	11/1900

[1] City of Corpus Christi currently holds a contract with the Lavaca-Navidad River Authority to provide 41,840 acft/yr and a maximum of 12,000 acft/yr on an interruptible basis from Lake Texana to the City.

3.1.6 Water Supply Contracts

Many entities within the Coastal Bend Region obtain surface water through water supply contracts. These supplies are usually obtained from entities that have surface water rights to provide a specified or unspecified quantity of water each year to a buyer for an established unit price. The City of Corpus Christi is the largest provider of water supply contracts in the Coastal Bend Region. The City of Corpus Christi supplies water from the CCR/LCC System, including water from Lake Texana via the Mary Rhodes Pipeline, to two major wholesale customers: SPMWD and STWA. Each of these major wholesale customers in turn sells water to other entities within their service area. In addition to the two major wholesale customers, the City of Corpus Christi also provides wholesale raw surface water to a number of smaller customers.

[9] TCEQ, Certificate of Adjudication No. 14-5434B, held by the City of Corpus Christi (via the Garwood Irrigation Company), October 13, 1998.
[10] HDR Engineering, Inc. (HDR), "Dependability and Impact Analyses of Corpus Christi's Purchase of the Garwood Irrigation Company Water Right," Draft Report for the City of Corpus Christi, September 1998.

The City of Corpus Christi has contractual obligations to provide consumptive water use plus up to 10% growth each year to City of Alice, City of Beeville, City of Mathis, Nueces County WCID #4 (Port Aransas), Violet WSC, and South Texas Water Authority. The City of Corpus Christi is contracted to provide up to 3,363 acft/yr to City of Three Rivers and up to 40,000 acft/yr to San Patricio Municipal Water District (up to 30,000 acft/yr of raw water and 10,000 acft/yr of treated water supplied). Furthermore, the City of Corpus Christi provides raw and treated water supply to meet needs of Manufacturing, Mining, and Steam and Electric water users in Nueces County. SPMWD and STWA meet water needs of their customers (Figure 3-3). Within the Coastal Bend Region, the Nueces County WCID #3 also provides wholesale water supplies through contracts with a number of small municipalities, water supply corporations, and irrigators. Nueces County WCID #3 meets water needs of City of Robstown and City of North San Pedro and has contractual obligations to provide up to 291 acft/yr to River Acres WSC.

Figure 3-3 summarizes the major contract relationships in the Coastal Bend Region and Figure 3-4 presents water supply systems in the Coastal Bend Region. These relationships will be revisited in Section 4 when comparisons of supplies and demands in the region are presented.

3.1.7 Wholesale Water Providers

The Coastal Bend Region has four Wholesale Water Providers. The TCEQ defines Wholesale Water Providers as "any entity that has contracts to sell more than 1,000 acft of water wholesale in a given year." These include the City of Corpus Christi, SPMWD, STWA, and Nueces County WCID #3. Based on recent water use records, the City of Corpus Christi supplies about 67 percent of the municipal and industrial water demand in the region (not including supplies to SPMWD or STWA). SPMWD and STWA purchase 100 percent of their water from the City of Corpus Christi. The SPMWD subsequently treats and distributes water to numerous entities and supplies about 14 percent of the municipal and industrial water demand in the region. Both STWA and Nueces County WCID #3 provide less than 5 percent of the municipal and industrial water demand in the region. As for water supply planning, each Water User Group in the region was analyzed to the same level of detail to ensure that the needs of the entire region are met. If in the future the CBRWPG deems it necessary, the CBRWPG reserves the right to revisit wholesale water provider designations during subsequent planning efforts. Surface and groundwater availability is delineated by counties and river basins in Appendix C.

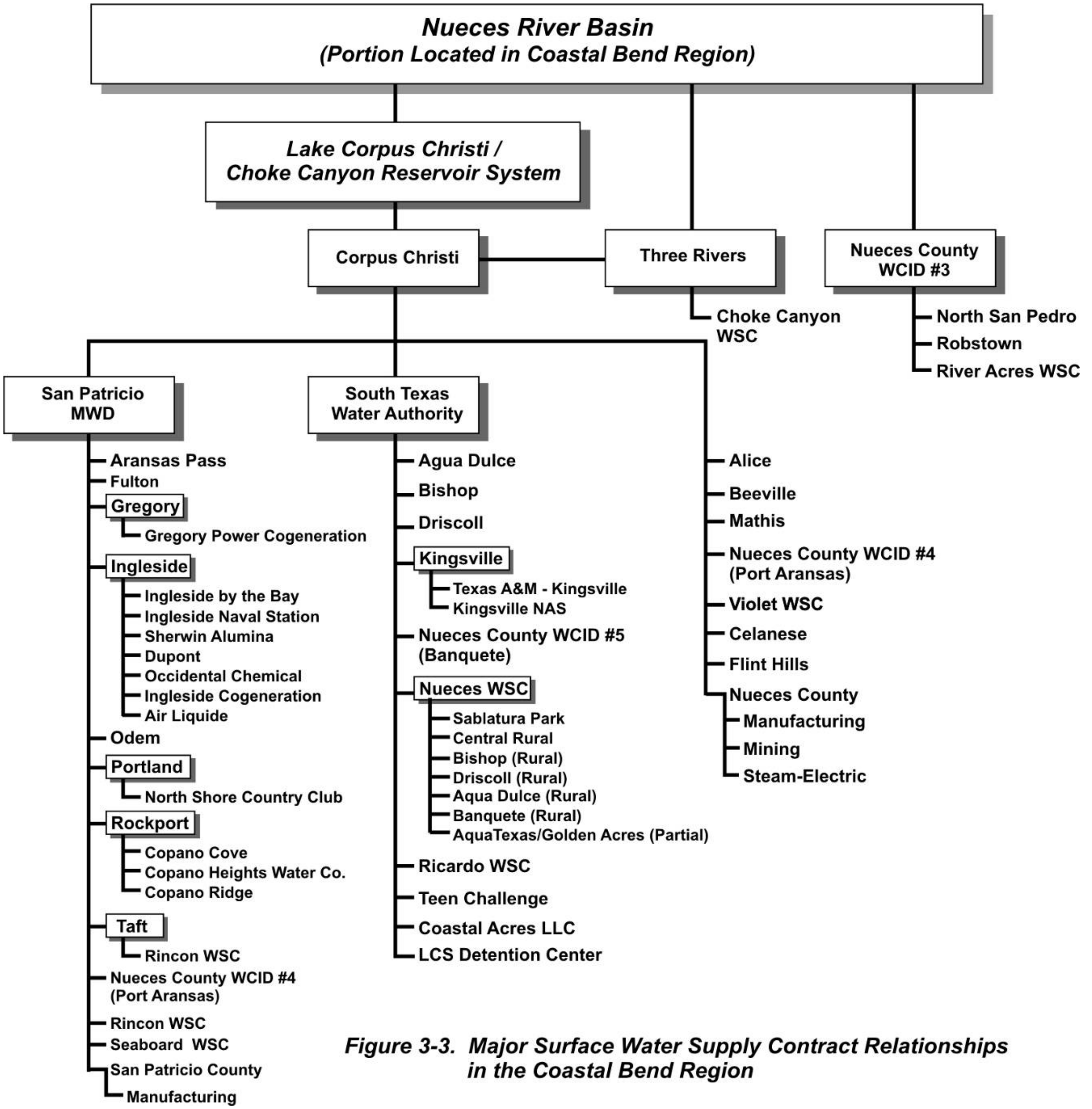
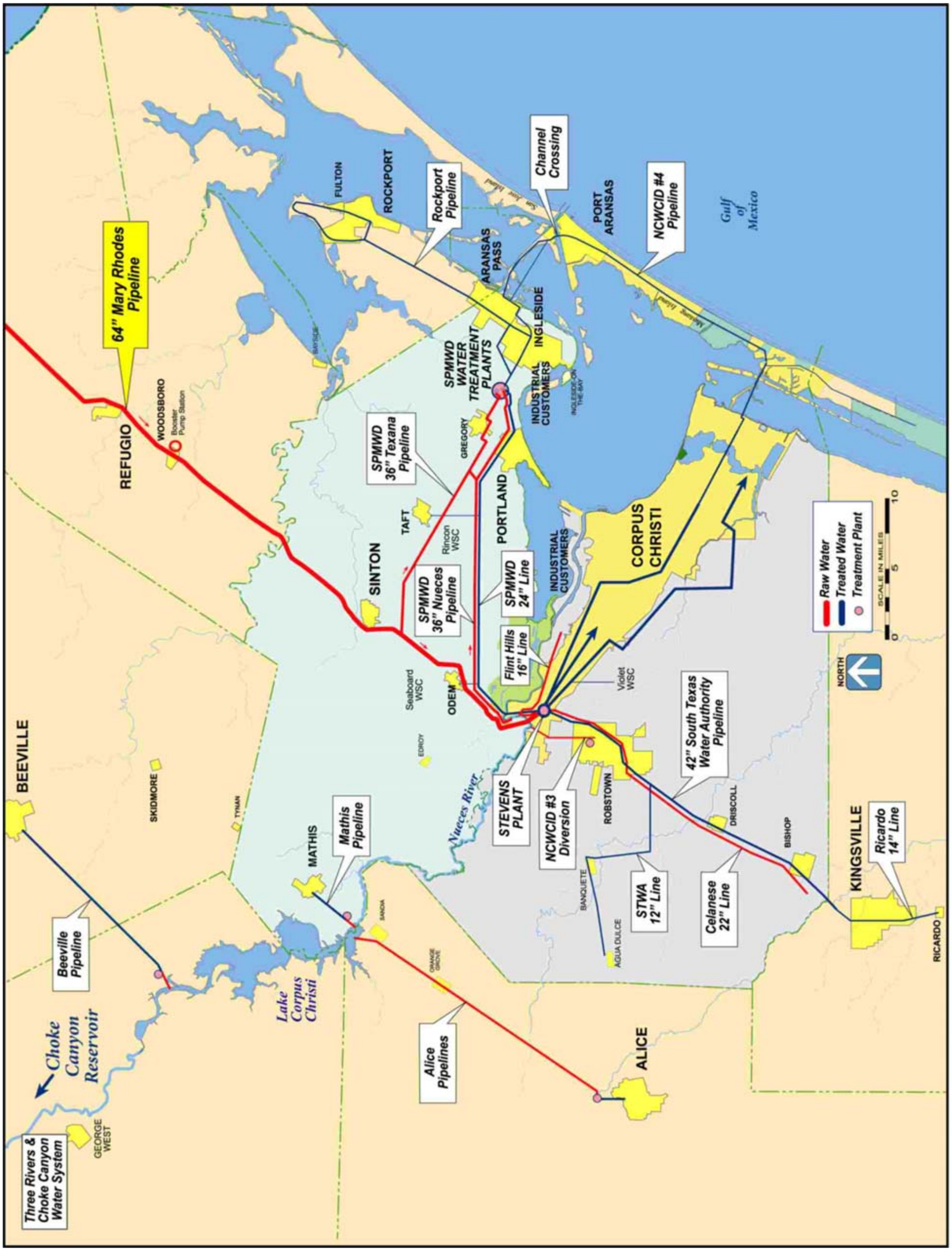


Figure 3-3. Major Surface Water Supply Contract Relationships in the Coastal Bend Region



Source: The Rodman Company

Figure 3-4. Coastal Bend Water Supply System

3.2 Reliability of Surface Water Supply

Hydrologic conditions are a primary factor that affects the reliability of a water right. Severe drought periods have been experienced in all areas of the Coastal Bend Region. Recurring droughts are common in the region with significant drought periods occurring in the 1950s, 1960s, 1980s, and 1990s. As shown in Figure 3-5, recent studies indicate that the 1990s drought appears to be the most severe on record for the CCR/LCC System,[11] decreasing average annual flows by 67,000 acft/yr (36 percent) when compare to flows in the 1950s.

Municipal and industrial water suppliers typically require a very high degree of reliability for their water sources. In most cases, interruptions to water supply are not acceptable, requiring the reliability of the supply to be 100 percent of the time. Municipal and industrial supplies are commonly based on firm yield; however, safe yield analyses are becoming commonly used in anticipation of future droughts greater in severity than the worst drought of record. Since each drought in the Nueces River Basin is more severe than previous droughts (Figure 3-5), the Coastal Bend Region has adopted use of safe yield analyses for supply from the CCR/LCC/Lake Texana System.

For reservoirs, the safe yield may decrease over time as a result of sedimentation. When a reservoir is constructed on a stream channel, the sediment carried by the stream accumulates on the bottom of the reservoir. This accumulation reduces the volume of water that can be stored in the reservoir, which in turn reduces the firm yield available for diversion. Sedimentation rates for the CCR/LCC System have been measured over a period of time and estimated sedimentation rates are well documented.[12] It is estimated that the CCR/LCC System capacity will be reduced by 47,850 acft due to sediment accumulations between 2010 and 2060.[13] For the 50-year planning period, the reduction in safe yield for future sedimentation was considered. Safe yield for the CCR/LCC System is presented for both the year 2010 and for the year 2060.

For Nueces County WCID #3 and smaller run-of-river water rights in the Nueces River Basin, firm yield supplies was based on the minimum annual supply that could be diverted over a historical period of record.

[11] HDR, "Water Supply Update for City of Corpus Christi Service Area," City of Corpus Christi, January 1999.

[12] Ibid.

[13] Calculation based on annual sedimentation rate of 717 acft/yr for LCC and 240 acft/yr for CCR.

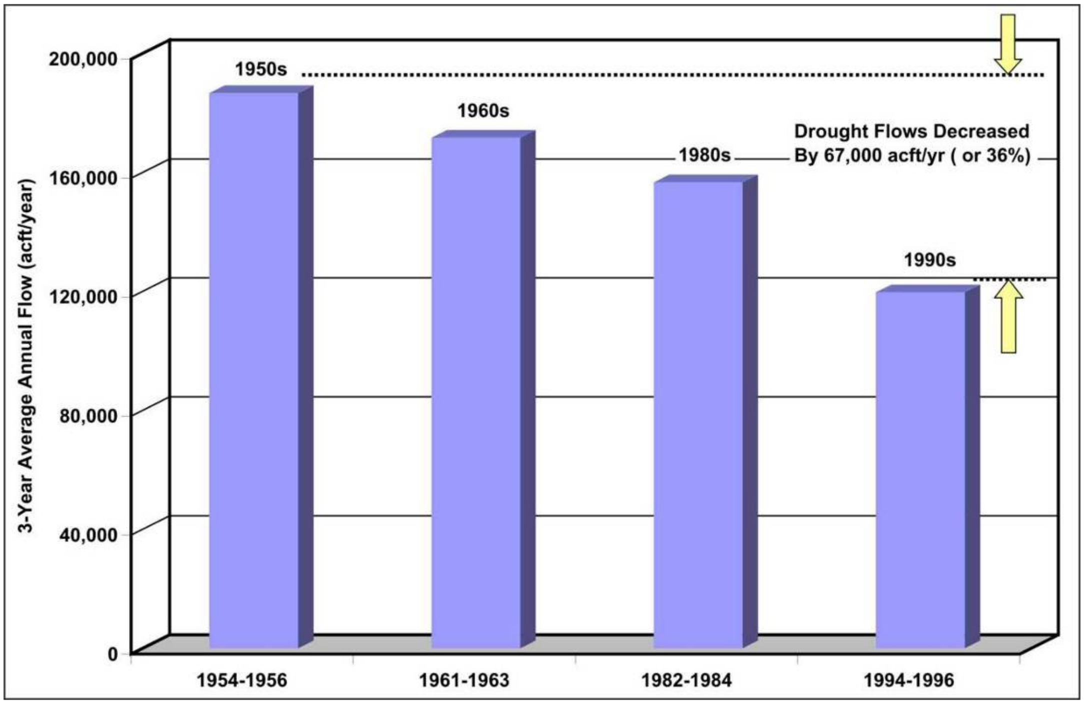


Figure 3-5.
3-Year Reservoir Inflows

3.3 Surface Water Availability

Two computer models were used to evaluate the water rights in the Nueces River Basin and within the Coastal Bend Region. The first model was a version of the Water Rights Analysis Package (WRAP) computer model developed by HDR Engineering, Inc. (HDR) for the TCEQ as part of its Water Availability Modeling (WAM) Program.[14] The WRAP model is designed for use as a water resources management tool. The model can be used to evaluate the reliability of existing water rights and to determine unappropriated streamflow potentially available for a new water right permit. WRAP simulates the management and use of streamflow and reservoirs over a historical period of record, adhering to the water right priority system. The second model used in determining surface water rights availability in the Nueces River Basin was the City of Corpus Christi Water Supply Model (formerly known as the Lower Nueces River Basin and Estuary Model (NUBAY)) developed under previous studies.[15] The City of Corpus Christi Water Supply Model focuses on the operations of the CCR/LCC/Lake Texana System and is capable of simulating this system subject to the City of Corpus Christi's Phased Operations Plan and the 2001 Agreed Order governing freshwater inflow passage to the Nueces Estuary. On April 30,

[14] HDR, "Water Availability in the Nueces River Basin," TCEQ, October 1999.
[15] HDR, Op. Cit., January 1999.

2009, the TWDB approved continued use of safe yield for development of the 2011 Plan for surface water supplies from the CCR/LCC/Lake Texana System. The City of Corpus Christi Water Supply Model was used to estimate the safe yield of the CCR/LCC/Lake Texana System and the TCEQ WAM WRAP Model was used to determine the firm yield availability of water to all other rights on the Nueces River and its tributaries within the Coastal Bend Region. A summary of the water rights and yield availability is presented in Table 3-3. These surface water supplies served as a basis for the supply and demand comparisons in Section 4.

3.4 Groundwater Availability

The Coastal Bend Region includes parts of four aquifers—two major (Gulf Coast and Carrizo-Wilcox Aquifers) and three minor (Yegua-Jackson, Queen City and Sparta Aquifers). Figure 3-1 shows the locations of the major aquifers. Table 3-4 summarizes estimates of groundwater availability on a sustained yield basis and projected groundwater use on a sustained yield basis, by aquifer, in the planning region. Groundwater availability estimates are based on either: (1) the amount of groundwater available based on 2001 Plan Coastal Bend Regional Water Planning Group (CBRWPG) groundwater analyses, or (2) Central Gulf Coast Groundwater Availability (CGCGAM) analyses from the 2006 Plan, as noted. Groundwater use is based on projected groundwater demands and is the same as used for CGCGAM analyses as presented in Section 4.

Of the four aquifers, the Gulf Coast Aquifer underlies each of the 11 counties in the planning region, is the primary groundwater resource in the Coastal Bend Region, and is capable of providing more than 80 percent of the region’s groundwater supply.

3.4.1 Gulf Coast Aquifer

The Gulf Coast Aquifer underlies all counties within the Coastal Bend Region and yields moderate to large amounts of fresh and slightly saline water. The Gulf Coast Aquifer, extending from Northern Mexico to Florida, is comprised of five water-bearing formations: Catahoula, Jasper, Burkeville Confining System, Evangeline, and Chicot. The Evangeline and Chicot Aquifers are the uppermost water-bearing formations, are the most productive and, consequently, are the formations utilized most commonly. The Evangeline Aquifer of the Gulf Coast Aquifer

Table 3-3.
Surface Water Rights Availability
Nueces River Basin Water Rights in the Coastal Bend Region

Water Right Owner	*Annual Permitted Diversion Volume (acft/yr)*	*Yield[1] (acft)*	*Type Of Use*	*Priority Date*	*County*
City of Corpus Christi and Nueces River Authority	497,738[2]	200,000[3]	Municipal & Industrial	12/1913[4]	Nueces
		14	Irrigation	12/1913	Nueces
		12	Mining	12/1913	Nueces
		200	Irrigation	12/1913	Live Oak
Reality Traders & Exchange, Inc.	20	0	Irrigation	10/1952	San Patricio
Wayne Shambo	140	0	Irrigation	10/1952	San Patricio
Nueces Co. WCID #3	4,246 7,300 11,546	3,665 3,438 7,103	Municipal Irrigation	2/1909[4]	Nueces
Garnett T. & Patsy A. Brooks	221	0	Irrigation	2/1964	San Patricio
CE Coleman Estate	27	0	Irrigation	2/1964	Nueces
Ila M. Noakes Lindgreen	101	0	Irrigation	2/1964	Nueces
Randy J. Corporron et. al.	8	0	Irrigation	12/1965	McMullen
WL Flowers Machine & Welding Co.	132	6	Irrigation	12/1958	McMullen
Ted W. True et. al.	220	0	Irrigation	12/1958	McMullen
Harold W Nix Et Ux	0	0	Recreation	2/1969	McMullen
Richard P. Horton	336	0	Irrigation	12/1963	McMullen
James L. House Trust	123	0	Irrigation	12/1966	McMullen
City of Three Rivers	700 800 1,500	700 800 1,500	Municipal Industrial	9/1914	Live Oak
City of Taft	600	0	Irrigation	9/1983	San Patricio
Diamond Shamrock Refining	0[5]	0	Irrigation	6/1986	Live Oak
San Miguel Electric Co-Op, Inc.	300	0	Industrial	12/1990	McMullen
Muriell E. McNeill	64	0	Irrigation	9/1989	Live Oak
City of Mathis	50	0	Irrigation	11/1996	San Patricio
TOTAL	513,126	208,835			

1 Firm yield computed assuming 2060 sediment accumulation in all reservoirs.
2 Corpus Christi annual permitted diversion includes CCR/LCC System (443,898 acft/yr) and LNRA contracts with Corpus Christi (41,840 acft/yr) and a maximum 12,000 acft/yr from Lake Texana on an interruptible basis.
3 Corpus Christi minimum annual supply equals computed 2060 safe yield of the CCR/LCC System with Lake Texana water as per HDR, March 2005.
4 Water right with multiple priority dates. Earliest date shown in table.
5 Diamond Shamrock irrigation right is for irrigation from on-site process water return flows. In effect, this permit is for a reuse project.

Table 3-4.
Groundwater Availability and Use from Aquifers within the Coastal Bend Region

Aquifer	2060 Availability (acft/yr)	2060 Use[1] (acft/yr)
Gulf Coast	96,944[2]	80,913
Carrizo-Wilcox	10,702[3]	513
Queen City	1,105[3]	-
Sparta	600[3]	-
Total	109,351	81,426

[1] Source: CGCGAM analyses (see Appendix D).
[2] Source: Groundwater model analysis as part of 2006 Plan and CGCGAM analyses (2009).
[3] TWDB, "Water for Texas," August 1997. (Data supporting the 1997 Texas State Water Plan.) Groundwater availability estimates were based on TWDB Report 238: Groundwater Availability in Texas estimates for the Nueces Basin prorated to applicable counties within the Coastal Bend Region by aquifer.

System features the highly transmissive Goliad Sands. The Chicot Aquifer is comprised of many different geologic formations; however, the Beaumont and Lissie Formations are predominant in the Coastal Bend Area. The Burkeville Confining System is a limited water-bearing formation and characterized as containing substantial amounts of clay.

A CGCGAM was developed by the TWDB to simulate steady-state, predevelopment and developed flow in the Gulf Coast Aquifer along the south Texas Gulf Coast and to assist in the determination of groundwater availability for the region. Steady-state, predevelopment flow conditions represent the state of the aquifer prior to development as a water supply source. Under these conditions, inflow from recharge is assumed to be equal to outflow to adjacent aquifers or other discharge areas and no significant diversion (pumpage) from aquifer storage is occurring. Under developed flow conditions, existing well fields and measured drawdowns are used to calibrate the aquifer parameters. The model consists of four layers with 1-mile (5,280-foot) grid spacing and extends from the outcrop areas in the Jasper outcrop areas in the west to the Gulf of Mexico in the east, and from the groundwater divide to the north through Colorado, Fort Bend, and Brazoria Counties to the south approximately midway through Jim Hogg, Brooks, and Kenedy Counties, as shown in Figure 3-6. The four layers from top to bottom are: Chicot, Evangeline, Burkeville Confining System, and Jasper. The Catahoula Confining System provides

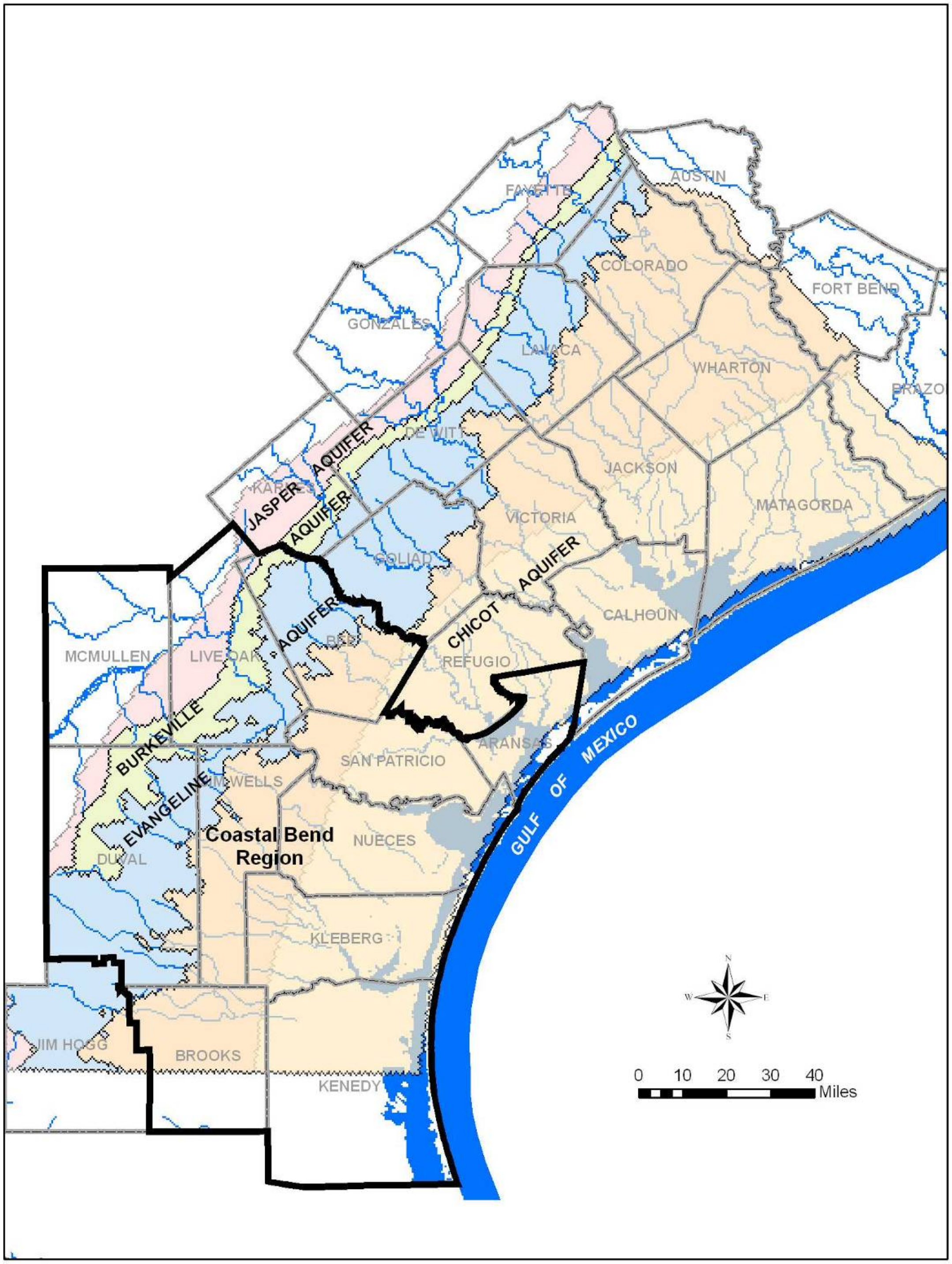


Figure 3-6. Location of Central Gulf Coast Groundwater Availability Model and Aquifer Layers

the base of the model and is not included as a model layer. The CGCGAM was use to calculate groundwater availability for Gulf Coast Aquifer groundwater supplies.

The model area includes all or parts of several Regional Water Planning Group areas including Region H, Lower Colorado (Region K), Lavaca/Navidad (Region P), South Central Texas (Region L), Coastal Bend (Region N), and Rio Grande (Region M). It also includes all or parts of 22 groundwater conservation districts (GCDs) including Live Oak Underground Water Conservation District (UWCD), McMullen GCD, Bee GCD, Kenedy County GCD, Duval County GCD, Brush Country GCD, San Patricio GCD, and the Corpus Christi Aquifer Storage and Recovery Conservation District for the Coastal Bend Region.

Predictive pumping estimates were developed using TWDB historical pumping amounts (Year 1999) prorated for anticipated groundwater use in 2000 to 2060 based on TWDB water demand projections using the following method:

- For entities solely using groundwater as their water supply, the projected groundwater pumpage was set equal to projected water demands.
- For entities using both groundwater and surface water, the future groundwater pumping was based on 2000 water use (i.e., if an entity satisfied their water demand using 20 percent groundwater in 2000, then the groundwater pumping in 2060 would be calculated at 20 percent their projected water demand in 2060).

The pumping amounts were distributed to individual cells for municipal, mining, steam-electric, and most manufacturing users. For irrigation, municipal county-other, and water supply corporations, pumping was distributed uniformly across the county to all active pumping cells included in the TWDB historical model. For more detail regarding the new Gulf Coast Aquifer model development and application, please refer to Appendix D.

The calibrated and verified groundwater flow model with projected pumping was used to run a number of groundwater availability simulations subject to acceptable drawdown and water quality constraints, as based on the following criteria adopted by the Coastal Bend Region, also used in the 2006 Plan:

1. Long-term (sustainable) pumping simulations (i.e., steady-state model simulation).
2. In the unconfined aquifer:
    a. Water level declines were limited to no more than 125 feet below predevelopment levels; and
    b. A minimum saturated thickness of 150 feet.
3. In the confined aquifer:
    a. Water level declines were limited to no more than 250 feet below predevelopment levels; and
    b. Water level declines were not to exceed 62.5 percent of the elevation difference between predevelopment flow heads and the top of the aquifer.

Based on these criteria, the available groundwater for the planning region was determined. The revised irrigation water demand increases for Bee and San Patricio Counties adopted by the CBRWPG were considered to be supplied by the Gulf Coast Aquifer. The increased water use did not exceed the groundwater drawdown constraints. There were three instances when the drawdown criteria were exceeded based on projected groundwater demands for Duval County-Mining, Live Oak County-Mining, and Live Oak County-Manufacturing users. In all cases, some of the pumping was distributed to nearby model cells. Based on the response of pumping that is distributed uniformly across the county, Live Oak and Duval Counties can likely sustain this pumping on a county basis without exceeding the drawdown criteria. However, the local groundwater supply, associated with assigned individual pumping cells, cannot fully support the groundwater demand; therefore, the groundwater supply for Live Oak Mining-Manufacturing and Duval-Mining in Section 4A has been prorated back so that drawdown does not exceed the adopted criteria.

The resulting groundwater available by county in the Coastal Bend Region is presented in Table 3-5. The issue of determining future acceptable drawdown (past Year 2060) should be considered in future planning cycles. It is important to note that these availabilities are long-term (sustainable) yields. In addition, should projects be proposed outside the Coastal Bend Region setting, the Coastal Bend Region requests that site-specific analyses be performed by the project participants to demonstrate to the Coastal Bend Region that no long-term detrimental impacts to the aquifer will result from said “over-pumpage.”

The TWDB is currently working with the Groundwater Management Areas (GMAs) to determine desired future conditions for the aquifer. Once these have been determined, the GAMs will be used to model those conditions to determine aquifer availability for future planning cycles. These values may be different than what has been previously adopted by the CBRWPG.

3.4.2 Carrizo-Wilcox Aquifer

Three counties within the Coastal Bend Region have significant Carrizo-Wilcox Aquifer reserves available to them. The Carrizo-Wilcox Aquifer contains moderate to large amounts of either fresh or slightly saline water. Slightly saline water is defined as water that contains 1,000 to 3,000 mg/L of dissolved solids. Although this aquifer reaches from the Rio Grande River north into Arkansas, it only underlies parts of McMullen, Live Oak, and Bee Counties within the

Coastal Bend Region. In this downdip portion of the Carrizo-Wilcox Aquifer, the water is soft, hot (140 degrees Fahrenheit), and contains more dissolved solids than in updip parts of the aquifer. Long-term groundwater available from the Carrizo-Wilcox in the region is summarized in Table 3-6. Groundwater availabilities are based on TWDB analyses and are carried over from the 2006 Plan.[16] According to project groundwater use in 2060, less than 1% of the groundwater supplies in the Coastal Bend Region are estimated to be supplied by the Carrizo-Wilcox aquifer (or about 513 acft/yr total combined for McMullen and Live Oak Counties) as shown in Table 3-6.

Table 3-5.
Groundwater Availability and Use from the Gulf Coast Aquifer within the Coastal Bend Region

County	***2060 Availability (acft/yr)***	***2060 Use[1] (acft/yr)***
Aransas	715[2]	715
Bee	17,053[2]	17,053
Brooks	3,325[2]	3,325
Duval	10,122[,4]	10,122
Jim Wells	5,902[2]	5,902
Kenedy	12,700[3]	251
Kleberg	9,700[3]	7,421
Live Oak	8,295[2]	8,295
McMullen	1,200[3]	34
Nueces	2,100[3]	1,963
San Patricio	25,832[2]	25,832
Total	96,944	80,913

[1] Source: CGCGAM analyses (see Appendix D).
[2] Availability based on 2060 use from Central Gulf Coast Groundwater Availability Model analyses.
[3] Source: CBRWPG Groundwater Model analysis as part of 2001 Plan.
[4] 600 acft for the City of Freer is from the Catahoula Formation, which is located in the Gulf Coast Aquifer but not included in the CGCGAM.

[16] TWDB, "Water for Texas," August 1997. (Data supporting the 1997 Texas State Water Plan.)

Table 3-6.
Groundwater Availability and Use from the Carrizo-Wilcox Aquifer within the Coastal Bend Region

County	2060 Availability[1] (acft/yr)	2060 Use[2] (acft/yr)
Bee	394	—
Live Oak	2,399	60
McMullen	7,909	453
Total	**10,702**	**513**

[1] Source: CBRWPG Groundwater model analysis as part of 2001 Plan.
[2] Source: CGCGAM analyses (see Appendix D).

3.4.3 Queen City and Sparta Aquifers

The Queen City and Sparta Aquifers are classified by the TWDB as minor aquifers and underlie McMullen County. The Queen City is a thick sand and sandy clay aquifer and runs from its southern boundary in Frio and LaSalle Counties northeasterly towards Louisiana. The Queen City Aquifer supplies small to moderate amounts of either fresh or slightly saline water in the Coastal Bend Region. The Sparta Aquifer is composed of interbedded sands and clays that yield small to moderate quantities with fresh to slightly saline quality. Long-term groundwater available from these aquifers, as tabulated by the TWDB,[17] and are carried over from the 2006 Plan, in Table 3-7. According to projected groundwater use in 2060, no water use is estimated from Queen City or Sparta sources.

Table 3-7.
Groundwater Availability and Use from the Queen City and Sparta Aquifers within the Coastal Bend Region

County	Aquifer	2060 Availability[1] (acft/yr)	2060 Use[2] (acft/yr)
McMullen	Queen City	1,105	—
McMullen	Sparta	600	—
Total		**1,705**	**—**

[1] Source: CBRWPG Groundwater Model analysis as part of 2001 Plan.
[2] Source: Central Gulf Coast GAM analyses (see Appendix D).

[17] Ibid.

3.4.4 Summary of Groundwater Availability

Groundwater resources in the Coastal Bend Region are made up of supplies from the Gulf Coast, Carrizo-Wilcox, Queen City, and Sparta Aquifers. Long-term (sustainable) yield from the aquifers, based on recent CGCGAM modeling of the Gulf Coast Aquifer (Appendix D) and estimates from the TWDB,[18] are summarized in Table 3-8. These availabilities were used in supply and demand comparisons in Section 4.

3.5 Drought Response

Texas Water Code Sections 16.053(e)(3)(A) and 31 TAC 357.5(e)(7) require that, for each source of water supply in the regional water planning area designated in accordance with

Table 3-8.
Total Groundwater Available in the Coastal Bend Region by County

County	***2060 Groundwater Availability (acft/yr)***				
	Gulf Coast Aquifer	***Carrizo-Wilcox Aquifer***	***Queen City Aquifer***	***Sparta Aquifer***	***Total***
Aransas	715	0	0	0	715
Bee	17,053	394	0	0	17,447
Brooks	3,325	0	0	0	3,325
Duval	10,122	0	0	0	10,122
Jim Wells	5,902	0	0	0	5,902
Kenedy	12,700	0	0	0	12,700
Kleberg	9,700	0	0	0	9,700
Live Oak	8,295	2,399	0	0	10,694
McMullen	1,200	7,909	1,105	600	10,814
Nueces	2,100	0	0	0	2,100
San Patricio	25,832	0	0	0	25,832
Total	**96,944**	**10,702**	**1,105**	**600**	**109,351**

31 TAC 357.7(a)(1), the regional water plan shall identify: (A) factors specific to each source of water supply to be considered in determining whether to initiate a drought response; and (B) actions to be taken as part of the response. The Texas Commission on Environmental Quality has model municipal water conservation and drought management plans for entities to use for guidance (Appendix E.1 and E.2). The City of Corpus Christi and their customers receive

[18] Ibid.

surface water supplies from Lake Texana, through contract agreement with Lavaca Navidad River Authority as described earlier in Section 3.1.5. The Lavaca Navidad River Authority's Drought Contingency responses are summarized in Table 3-9. The LNRA drought contingency plan is included in Appendix E.3. Table 3-10 summarizes the drought contingency plan of the City of Corpus Christi (largest wholesale water provider in the Coastal Bend Region) and shows both trigger conditions and actions to be taken. Water Conservation and Drought Contingency Plans for the City of Corpus Christi, San Patricio Municipal Water District, and South Texas Water Authority are included in Appendices E.4 to E.6.

Through water purchase agreements, the customers of the City of Corpus Christi are required to implement similar water conservation measures when conditions warrant. Table 3-11 includes a summary of drought contingency plans for entities supplied by groundwater, within the Region.

Supplies from other surface water sources such as run-of-river water rights are determined on the basis of minimum year availability and firm yield, respectively. Hence, the current surface water supplies presented herein are, by TWDB definition, dependable during drought. Factors that are typically considered in initiating drought response for surface water sources are streamflow and reservoir storage as they may be conveniently measured and monitored. In contrast to groundwater sources, water right priority with respect to other rights and special permit conditions regarding minimum instream flows can also be important factors in determining whether to initiate drought responses for surface water sources. In the Nueces River Basin, coordination with the TCEQ Watermaster is an essential drought response for all entities dependent upon surface water supply sources.

Table 3-9.
Lavaca Navidad River Authority's Drought Contingency Response

Drought Condition	***Reservoir System Storage***	***Actions***
Condition I – Compromised Reservoir Condition One	Lake Texana Reservoir elevation is at or below elevation 43.00 msl	1. LRNA will notify TCEQ Watermaster of reservoir condition. 2. Inform public, giving notice of reservoir condition to the customers served by the LNRA system and upstream water rights permit holders. Include in information to the public a recommendation that water users look for ways to conserve water. 3. *Impacts permit holders upstream of Lake Texana who divert water for irrigation purposes.* Diversions must cease within 24 hours following the time when the reservoir level drops below elevation 43.00 msl.
Condition II – Compromised Reservoir Condition Two	Lake Texana Reservoir elevation is at or below elevation 40.15 msl	In addition to Actions 1–3 under Conditions I, take the following actions 4. *Impacts freshwater releases to bays and estuaries.* LNRA may reduce the volume of freshwater releases to bays and estuaries to 5 cubic feet per second, when Lake Texana reaches elevation 40.15 (or roughly 78% of the reservoir capacity).
Condition III – Severe Local Drought Condition	Equal to or less than 30%	In addition to Actions 1–4 under Conditions I and II, take the following actions: 5. The goal is a 7% reduction of the use that would have occurred in the absence of drought contingency measures. *The water sales contract between the LNRA and City of Corpus Christi allows for the return of 10,400 acre-feet for meeting the needs of Jackson County.* 6. The affected communicates should continue implementation of relevant Drought Contingency Plan and water conservation actions. 7. Upon authorization by the TCEQ Watermaster, the LNRA will enact contractual provisions and assist the affected community as appropriate. 8. Certain industrial and commercial water uses which are not essential to the health and safety of the community should be prohibited; and 9. Through the news media, the public should be advised daily of the trigger conditions.

Table 3-10.
City of Corpus Christi Surface Water Sources Drought Contingency Response

Drought Condition	Reservoir System Storage	Actions
Condition I – Water Shortage Possibility	Below 50%	• City Manager issues a public notice to inform water users of the Corpus Christi water supply region to begin voluntary conservation measures. • Target water demand reduction of 1 percent, including for wholesale water contracts.
Condition II – Water Shortage Watch	Between 40% and 30%	• City Manager issues a public notice implementing required water conservation measures. • City Manager issues a public notice in a daily newspaper restricting outdoor watering between 10:00 am and 6:00 pm. • No runoff from yards or plants into gutters or streets allowed. • Prohibits defective plumbing in home or business establishment. • No water shall be allowed to flow constantly through a tap, hydrant, or valves by any user of water connected to the City system. • Requires City's wholesale customers to issue public notice advising water customers of required drought management measures. • Target inflows to Nueces Bay are reduced to 1,200 acre-ft per month. • Target water demand reduction of 5 percent, including for wholesale water contracts.
Condition III – Water Shortage Warning	Equal to or less than 30%	• In addition to Actions 1–8 under Conditions I and II, take the following actions: • City Manager issues a public notice and lawn watering schedule. • Target Inflows to Nueces Bay are reduced to 0 acre-feet per month. • Target water demand reduction of 10 percent, including for wholesale water contracts.
	Equal to or less than 20%	• Target water demand reduction of 15 percent, including for wholesale water contracts

Table 3-11.
Water Supply Systems Using Groundwater Sources - Drought Contingency Response

Groundwater Systems	Stage I (Voluntary)	Stage II	Stage III	Stage IV (if applicable)	Stage V (if applicable)
Utility Development & Research, Inc. (Riviera, TX)	***Customer Awareness*** Public announcement designed to increase water conservation	***Voluntary Water Conservation*** Overnight recovery rate reaches 4 feet - or - Pump hours per day is 17 hours.	***Mandatory Water Use Restrictions*** Overnight recovery rate reaches 2 feet - or - Pump hours per day is 20 hours.	***Critical Water Use Restrictions*** Overnight recovery rate reaches 0 feet - or - Pump hours per day is 22 hours.	
Escondido Creek Estates, Inc. (Kingsville, TX)	***Customer Awareness*** Public announcement designed to increase water conservation	***Voluntary Water Conservation*** Pump discharge flow is less than 180 gpm - or - Total daily demand as 60% of pumping capacity	***Mandatory Water Use Restrictions*** Pump discharge flow is less than 170 gpm - or - Total daily demand as 70% of pumping capacity	***Critical Water Use Restrictions*** Pump discharge flow is less than 160 gpm - or - Total daily demand as 80% of pumping capacity	
McCoy Water Supply Corporation (Service area includes 608 square miles located in Atascosa, Wilson, and Live Oak Counties)	***Mild Water Shortage Conditions*** Well flow from any regularly used well is less than 90% of full capacity. A storage facility is not filled for 72 consecutive hours. An elevated storage tank is out of service due to repainting or other required maintenance.	***Moderate Water Shortage Conditions*** Well flow from any regularly used well is less than 80% of full capacity. A storage facility is not filled for 96 consecutive hours.	***Severe Water Shortage Conditions*** Well flow from any regularly used well is less than 70% of full capacity. A storage facility is not filled for 120 consecutive hours.	***Critical Water Shortage Conditions*** Well flow from any regularly used well is less than 60% of full capacity. A storage facility is not filled for 144 consecutive hours.	***Emergency Water Shortage Conditions*** Major water line breaks, or pump or system failures occur, which cause unprecedented loss of capability to provide water service. Natural or man-made contamination of the water supply source(s).
El Oso Water Conservation District (Service area includes 500 square miles located in Karnes, Bee, Wilson, and Live Oak Counties)	***Mild Drought*** Average daily water usage reaches 85% of production capacity for three consecutive days. Consideration will be given to weather conditions, time of year and customer complaints of low water pressure. There is an extended period of low rainfall and daily use has risen 20% above the use for the same period during the previous year.	***Moderate Drought*** Average daily water use reaches 90% of production capacity for three consecutive days. Net water storage is continually decreasing on a daily basis, and falls below 80% storage for 48 hours. Water pressures fall to below 49 psi in the water distribution system, during non-peak water usage hours, as measured by the distribution line gages.	***Severe Drought*** The imminent or actual failure of a major component of the system that would interrupt water delivery for a prolonged period, or cause an immediate health or safety hazard. Water demand exceeds 97% of the production capacity for three consecutive days. Water demand exceeds 95% of production capacity for 30 days.		

Table 3-11.
Water Supply Systems Using Groundwater Sources - Drought Contingency Response (Continued)

Groundwater Systems	Stage I (Voluntary)	Stage II	Stage III	Stage IV (If applicable)	Stage V
El Oso Water Conservation District (Continued)			Other unforeseen events which could pose imminent health or safety risks to the public.		
City of Falfurrias and Falfurrias Utility Board (Service area includes City of Falfurrias and Brooks County)	***Mild Water Shortages Conditions*** Initiated when one or more of the following exist: Static water level in the Falfurrias Utility Board's water well(s) is equal to or below mean sea level. Specific capacity of the Falfurrias Utility Board's water well(s) is equal to or less than 5% of the well's original specific capacity. Total daily water demand equals or exceeds 2.5 million gallons for 10 consecutive days or 5 million gallons on a single day (e.g., based on the "safe" operating capacity of water supply facilities). Continually falling treated water reservoir levels that do not refill above 80% overnight (e.g., based on an evaluation of minimum treated water storage required to avoid system outage).	***Moderate Water Shortage Conditions*** Initiated when two or more of the previous conditions exist.	***Severe Water Shortage Conditions*** Initiated when three or more of the previous conditions exist.	***Critical Water Shortage Conditions*** Initiated when four or more of the previous conditions exist.	***Emergency Water Shortage Conditions*** Major water line breaks, or pump or system failures occur, which cause unprecedented loss of capability to provide water service; - or - Natural or man-made contamination of the water supply source(s).
Pettus Municipal Utility District (City of Pettus)	***Mild Water Shortage Conditions*** Total daily water demand equals or exceeds 85% of the system's safe operating capacity for three consecutive days or equals or exceeds 90% of system capacity on a single day.	***Moderate Water Shortage Conditions*** Total daily water demand equals or exceeds 90% of the system's safe operating capacity for three consecutive days or equals or exceeds 95% of system capacity on a single day.	***Severe Water Shortage Condition*** Total daily water demand equals or exceeds 95% of the system's safe operating capacity for three consecutive days, or equals or exceeds 100% of capacity on a single day.	***Critical Water Shortage Conditions*** Total daily water demand equals or exceeds 100% of the system's safe operating capacity for three consecutive days, or equals or exceeds 100% of capacity on a single day.	***Emergency Water Shortage Conditions*** System outage due to equipment failure.

Table 3-11.
Water Supply Systems Using Groundwater Sources - Drought Contingency Response (Continued)

Groundwater Systems	Stage I (Voluntary)	Stage II	Stage III	Stage IV (If applicable)	Stage V
San Diego Municipal Water District No. 1 (City of San Diego)	***Mild Water Shortage Conditions*** Annually, beginning on May 1 through October 31 of every year. When the water supply available to the San Diego Municipal Utility District No. 1 is equal or less than 70% of storage capacity. When the static water level in the San Diego Municipal Water Utility District No. 1 well(s) is equal or less than 100 feet above water pump level. When the specific capacity of the San Diego Municipal Utility District No. 1 well(s) is equal to or less than 70% of the well's original specific capacity. When total daily water demands equal or exceed one million gallons for three consecutive days.	***Moderate Water Shortage Conditions*** Water levels fall below 70% of storage capacity. Water demands exceed 70% of water well capacity. When the static water level in the San Diego Municipal Utility District No. 1 well(s) is equal to or less than 100 feet above water pumps.	***Severe Water Shortage Conditions*** Water levels fall below 50% of storage capacity. Water demands exceed 90% of water well capacity. When the static water level in the San Diego Municipal Utility District No. 1 well(s) is equal to or less than 100 feet above water pumps. System outages due to equipment failure.	***Emergency Water Shortage Conditions*** Major water line breaks, or pump or system failures occur, which cause unprecedented loss of capability to provide water service - or - Natural or man-made contamination of the water supply source(s).	
Freer WCID	***Mild Water Shortage Conditions*** ***(voluntary)*** Annually, beginning May 1 through September 1. When the static level in the Freer WCID is equal to or less than 10 feet above sea level. When the specific capacity of the Freer WCID wells are equal to or less than 70% of the well's original specific capacity. When total daily water demand equals or exceeds 700,000 gallons for 10 consecutive days or 700,000 gallons on a single	***Moderate Water Shortage Conditions*** When total daily water demand equals or exceeds 700,000 gallons for 10 consecutive days or 700,000 gallons on a single day.	***Severe Water Shortage Conditions*** When the specific capacity of the Freer WCID wells is equal to or less than 70% of the well's original specific capacity.	***Critical Water Shortage Conditions*** When the static water level in the Freer WCID wells is equal to or less than 10 feet above sea level.	

Table 3-11.
Water Supply Systems Using Groundwater Sources - Drought Contingency Response (Concluded)

Groundwater Systems	Stage I (Voluntary)	Stage II	Stage III	Stage IV (If applicable)	Stage V
Aransas County Municipal Utility District No. 1	***Mild Drought Conditions (voluntary) — Target Reduction in Well Run Time = 5%*** *When demand on the District's water supply reaches or exceeds 70% of the production capacity of such facilities for 5 consecutive days.*	***Moderate Drought Conditions — Target Reduction in Well Run Time = 10%*** *When demand on the District's water supply reaches or exceeds 90% of the production capacity of such facilities for 3 consecutive days.*	***Severe Drought Conditions — Target Reduction in Well Run Time = 15%*** *When demand on the District's water supply reaches or exceeds 100% of the production capacity of such facilities for 24 hours.*		
Blueberry Hills Water Works, LLC	***Customer Awareness (voluntary)*** *Annually, beginning April 1 through September 30* *Water customers are requested to voluntarily limit the use of water fro nonessential purposes and to practice water conservation.*	***Voluntary Water Conservation (voluntary)*** *Overnight recovery fails to restore 90% of full storage capacity.* *Production or distribution limitations.*	***Mandatory Water Use Restrictions*** *Overnight recovery fails to restore 85% of full storage capacity.* *Production or distribution limitations.*	***Critical Water Use Restrictions*** *Overnight recovery fails to restore 80% of full storage capacity.* *Production or distribution limitations.*	
McMullen County WCID #2	***Mild Water Shortage Conditions (voluntary)*** *When total daily water demands equals or exceeds 2 million gallons on 3 consecutive days or 2.2 million gallons on a single day.*	***Moderate Water Shortage Conditions*** *When total daily water demands equals or exceeds 2 million gallons on 3 consecutive days or 2.2 million gallons on a single day and/or continually falling treated water reservoir levels do not refill above 90% overnight.*	***Severe Water Shortage Conditions*** *When total daily water demands equals or exceeds 2 million gallons on 3 consecutive days or 2.2 million gallons on a single day and/or continually falling treated water reservoir levels do not refill above 80% overnight.*	***Critical Water Shortage Conditions*** *When total daily water demands equals or exceeds 2 million gallons on 3 consecutive days or 2.2 million gallons on a single day and/or continually falling treated water reservoir levels do not refill above 75% overnight.*	***Emergency Water Shortage Conditions*** Major line breaks, or pump or system failures occur, which cause unprecedented loss of capacity to provide water service. Natural or man-made contamination of water supply source(s).
City of Orange Grove	***Mild Water Shortage Conditions (voluntary)*** *When the static water level in City Water Well No. 4 is equal or more than 140 feet below the top of the casing.* *When total daily water demands equals or exceeds 90% of system safe operating capacity which is 750,000 gallons per day, for 10 consecutive days.*	***Moderate Water Shortage Conditions*** *When the static water level in City Water Well No. 4 drops to 150 feet below the top of the casing.*	***Severe Water Shortage Conditions*** *When the static water level in City Water Well No. 4 reaches 160 feet below the top of the casing.*	***Critical Water Shortage Conditions*** *When the static water level in City Water Well No. 4 reaches 165 feet below the top of the casing.*	***Emergency Water Shortage Conditions*** Major line breaks, or pump or system failures occur, which cause unprecedented loss of capacity to provide water service. Natural or man-made contamination of water supply source(s).

3.6 Potential for Emergency Transfers of Surface Water

TWDB Rules, Section 357.5(i) direct that the RWPG include recommendations for the emergency transfer of surface water and further direct that a determination be made of the portion of each right for non-municipal use that may be transferred without causing unreasonable damage to the property of the non-municipal water right holder. Senate Bill 1, Section 3.03 amends Texas Water Code Section 11.139 and allows the Executive Director of TCEQ, after notice to the Governor, to issue emergency permits or temporarily suspend or amend permit conditions without notice or hearing to address emergency conditions for a limited period of not more than 120 days if an imminent threat to public health and safety exists. A person desiring to obtain an emergency authorization is required to justify the request to TCEQ. If TCEQ determines the request is justified, it may issue an emergency authorization without notice and hearing, or with notice and hearing, if practicable. Applicants for emergency authorizations are required to pay fair market value for the water they are allowed to divert, as well as any damages caused by the transfer. In transferring the quantity of water pursuant to an emergency authorization request, the Executive Director, or the TCEQ, shall allocate the requested quantity among two or more water rights held for purposes other than domestic or municipal purposes.

Surface water availability models have been developed for the streams of Coastal Bend Region (Region N) in which the locations, quantities, and yields of the surface water rights of the region have been determined (Table 3-3). The Regional Water Plan incorporates Table 3-3 as a primary source of information to water user groups and the TCEQ for use in cases of emergencies that result in a threat to public health and safety. Water user groups who are located in proximity to one or more existing surface water diversion permits for non-municipal use can readily estimate quantities of water that might be available for emergency use applications, and TCEQ may also consider Table 3-3 in its administration of this provision of Senate Bill 1.

Section 4A
Comparison of Water Demands with Water Supplies to Determine Needs
[31 TAC §357.7(a)(5-7)]

4A.1 Introduction

In this section, the demand projections from Section 2 and the supply projections from Section 3 are brought together to estimate projected water needs in the Coastal Bend Region for the next 50 years. As a recap, Section 2 presented demand projections for six types of use: municipal, manufacturing, steam-electric, mining, irrigation, and livestock. Municipal water demand projections are shown for each city with a population of more than 500 and for County-Other users in each county. Section 3 presented surface water availability by water right and groundwater availability and projected use by aquifer.

For each of the 11 counties in the Coastal Bend Region there is a summary page that highlights specific supply and demand information in Section 4A.3, followed by two tables. The first table contains supply and demand comparisons for the six types of water use; the second table contains supply and demand comparisons for the municipal water user groups in the county.

Section 4A.6 summarizes the water supply and demand picture for the entire region, focusing on those cities and other users that have immediate and/or long-term needs.

4A.2 Allocation Methodology

Surface water and groundwater availability was allocated among the six user groups using the methods explained below.

4A.2.1 Surface Water Allocation

Surface water in the region that is available to meet projected demands consists of the yield of reservoirs, dependable supply of run-of-river water rights through drought of record conditions, and local on-farm sources. Surface water rights were allocated as supplies according to their stated type of use: municipal, industrial (manufacturing, steam-electric, and mining), and irrigation. Municipal supply was further allocated among cities and other municipal water supply entities. This was done by obtaining water seller information (i.e., which wholesale water providers resell water to other water supply entities) and water purchase contract limits between buyers and sellers, provided by the TWDB and Wholesale Water Providers. In most cases, for those cities purchasing water on a wholesale basis the contract amount remains constant through 2060. It was also assumed that water associated with a wholesaler that is not resold remains as an available supply to the wholesaler. In the case where a wholesaler's supply is deficient to meet its own demands and contract requirements, a shortage would be expected for their non-municipal customers. Also in the case of surface water, the available supplies were compared to the water treatment plant (WTP) capacities shown in Table 4A-1. If the total available surface water supplies were greater than treatment plant capacity, the supplies were constrained by the treatment plant capacity. A detailed explanation of water demand and supplies for Wholesale Water Providers is described in Section 4A.4. Figure 4A-1 presents major contract relationships in the Coastal Bend Region and Figure 4A-2 shows how the surface water in the Coastal Bend Region is distributed.

Two situations deserve special attention regarding raw water supplies for the region. The City of Corpus Christi (City) has 200,000 acft in available safe yield supply in 2060, through its own water right in the Nueces Basin from the CCR/LCC System and a contract with the Lavaca-Navidad River Authority for a base amount of 41,840 acft/yr and up to 12,000 acft on an interruptible basis from Lake Texana. These supplies are referred to collectively as supplies from the CCR/LCC/Lake Texana System. The City also has a permit to divert up to 35,000 acft/yr of run-of-river water under its interbasin transfer permit on the Colorado River (via the Garwood Irrigation Co.). While the City owns the water right on the Colorado River, it does not have the facilities to divert this water and convey it to the City. Therefore, under the rules governing the regional water planning process, this water is not a current water supply. The facilities to deliver Colorado River water to the region are analyzed as a water supply option in Section 4C.14 in Volume II.

From this availability—CCR/LCC/Lake Texana System—Corpus Christi supplies its municipal customers throughout the Coastal Bend Region and manufacturing, mining, and steam-electric customers in Nueces County (Figure 4A-1). San Patricio Municipal Water District (SPMWD) has a contract to buy 40,000 acft of raw and treated water from the City of Corpus Christi and provides water to municipal customers in Aransas, Nueces and San Patricio Counties, as well as manufacturing needs in San Patricio County. South Texas Water Authority (STWA) supplies municipal and rural customers in Nueces and Kleberg Counties. Nueces County WCID #3 supplies municipal customers in Nueces County.

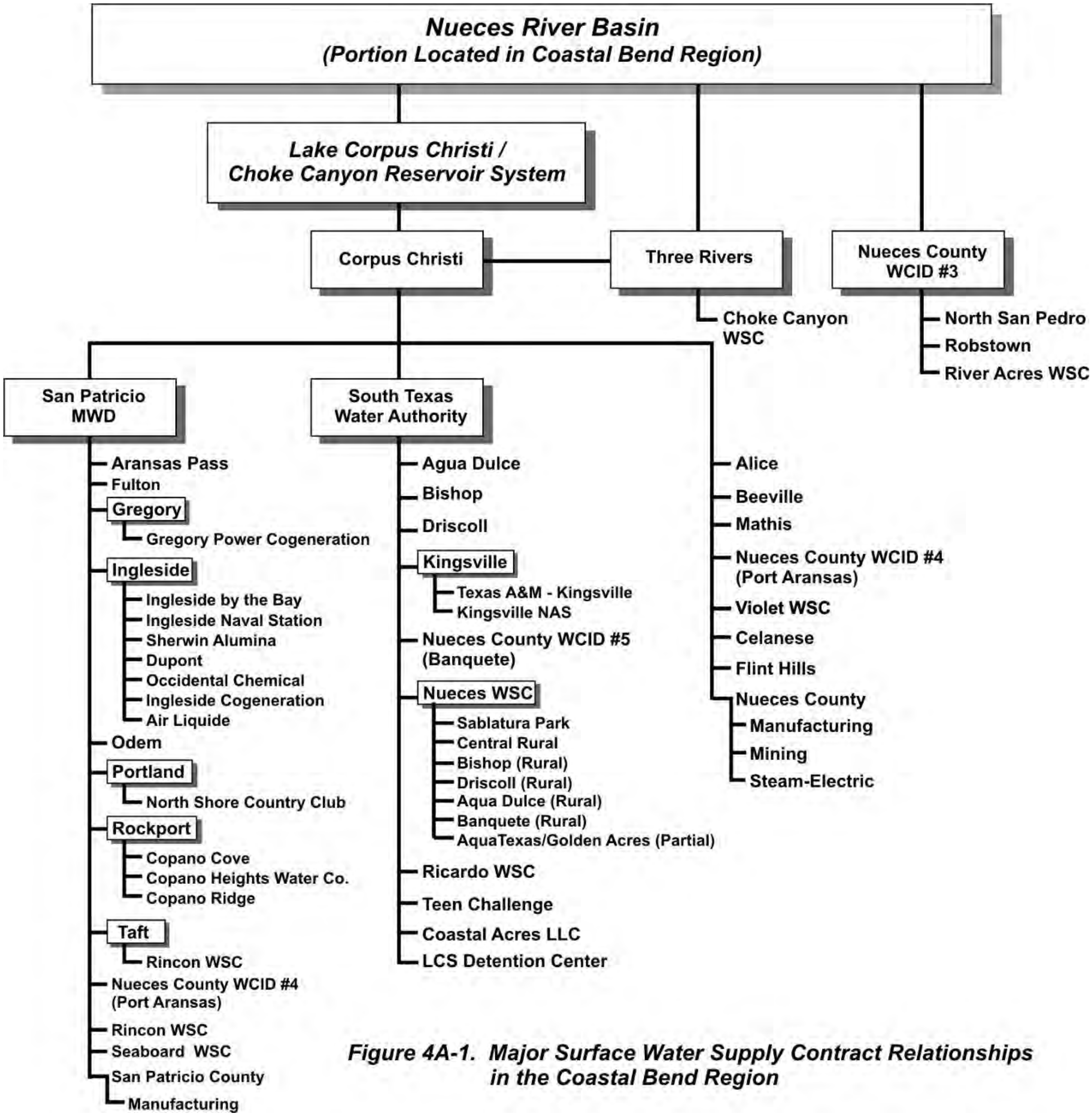
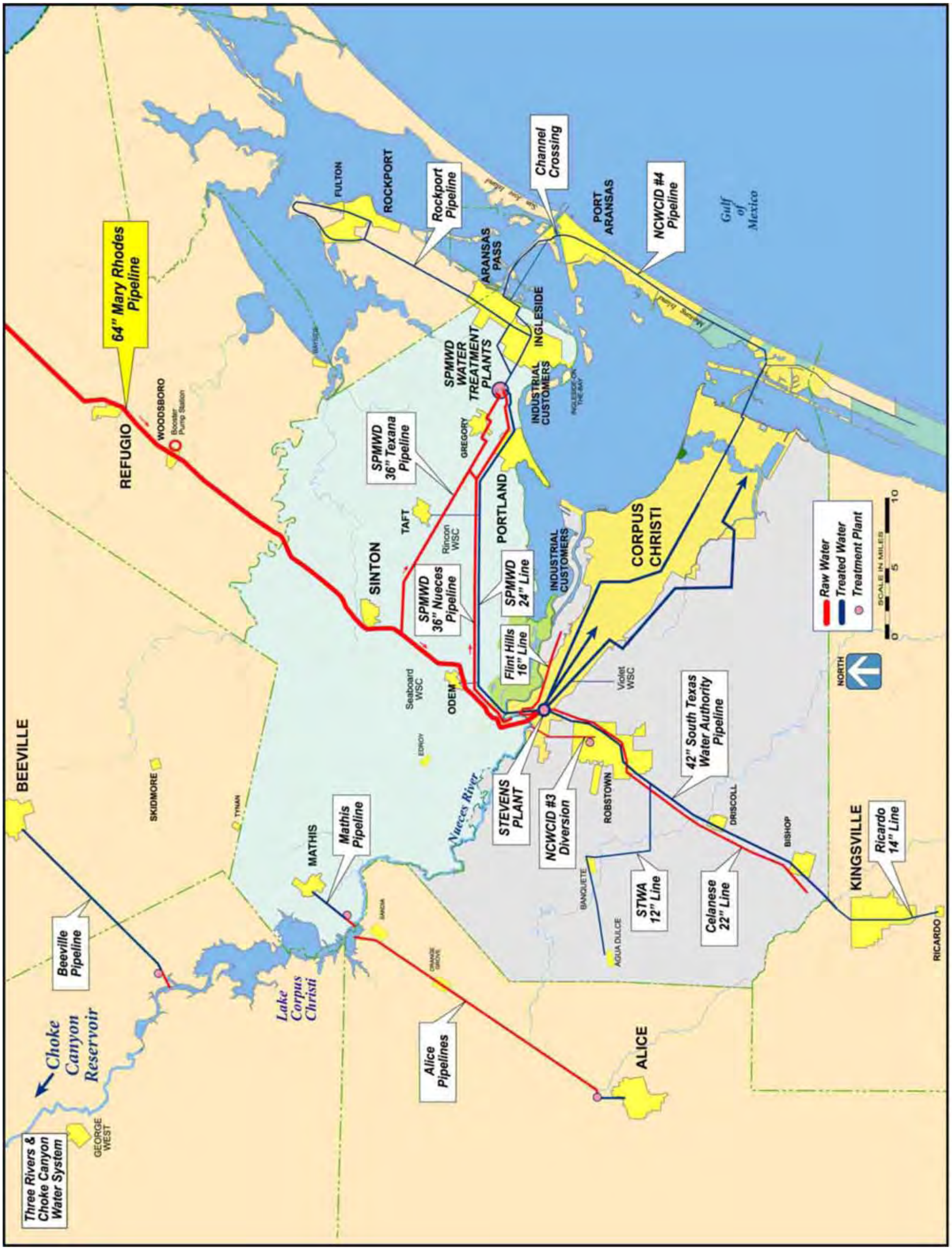


Figure 4A-1. Major Surface Water Supply Contract Relationships in the Coastal Bend Region



Source: The Rodman Company

Figure 4A-2. Coastal Bend Water Supply System

The final process in the allocation of surface water supplies was to examine the available WTP capacity for each entity with a WTP and compare that capacity to existing raw water supplies. The WTP capacity was calculated based on average day production using a peaking factor of 2:1 (i.e., the normal rated design flows shown in Table 4A-1 were divided by 2), except for the City, SPMWD, and the City of Alice where a 1.4:1 peaking factor was used based on historical data provided. If the WTP capacity was insufficient to treat the existing raw water supplies, then surface water supplies to that entity were limited to the current WTP treatment capacity. Current WTP capacities are shown in Table 4A-1.

Table 4A-1.
Water Treatment Plant Capacities for Region N Water User Groups

Entity	***Normal Rated Design Flow (MGD)***	***Average Day WTP Capacity (MGD)[1]***
City of Beeville	6.9	3.5
City of Alice	8.7	6.2[2]
City of Three Rivers	1.7	0.9
City of Mathis	2.0	1.0
City of Corpus Christi	159.0	113.6[2]
San Patricio MWD	25.0	17.9[2]
Nueces County WCID #3	6.6	3.3

1. Average day WTP capacities calculated as ½ of normal rated design flow.
2. Calculation based on 1.4:1 peaking factor.

Local surface water supply from stock ponds and streams is available to meet livestock needs when groundwater supplies are insufficient to meet those demands. Generally, these ponds are not large enough to require a water rights permit (>200 acft of storage).

4A.2.2 Groundwater Allocation

For the previous 2001 and 2006 Regional Water Plans, total groundwater availability in the region was determined based on the long-term sustainable pumpage of each of the aquifers in the region using an analytical groundwater model developed for the Coastal Bend Region and the Central Gulf Coast Groundwater Availability Model developed by the TWDB. This approach was carried over to the 2011 Plan for the Carrizo-Wilcox, Queen City, and Sparta Aquifers. For the Gulf Coast Aquifer, which provided over 90 percent of the groundwater supply in 2000, the TWDB's Central Gulf Coast

Groundwater Availability Model was used during development of the 2006 Plan to determine projected groundwater use from 2000 to 2060. Predictive pumping estimates were developed based on historic water use and projected water demands. The model was used to simulate the effects of future pumping on Gulf Coast Aquifer water levels, and to determine groundwater availability subject to acceptable drawdown constraints, as discussed in Section 3.4.1. There were only three instances when the drawdown criteria were exceeded based on projected groundwater demands through 2060. These included Duval County-Mining, Live Oak County-Mining, and Live Oak County-Manufacturing. In these instances, pumping was limited so that the drawdown in 2060 does not exceed the adopted drawdown criteria. For all other groundwater users, supply is limited to either well capacity or projected groundwater use, whichever is less. Well capacities were generally set at one-half the actual well capacity to accommodate for peak demands. For each county, groundwater is allocated among five of the six user groups—municipal, manufacturing, mining, irrigation, and livestock. Nueces County is the only county in the Coastal Bend Region with steam-electric demands, and these are met with surface water supplies. Groundwater supply was allocated in the following manner:

<u>Municipal Use</u>

- For cities, groundwater supply was based upon projected water use or well capacity reported to TCEQ, whichever is less.
- For rural areas, well capacities were estimated as 125 percent of the 2000 usage from the Gulf Coast Aquifer. Groundwater supply was based upon projected water use or well capacities, whichever is less.

<u>Irrigation Use</u>

- Irrigation supply was estimated as either the projected demand in each decade or well capacity, whichever is less. The well capacity was estimated as the amount of water used by irrigators in 2000. For Bee and San Patricio Counties, the well capacity was assumed to be equal to the maximum annual pumping during the 2000 to 2006 time period based on TWDB records. The well capacities for Bee and San Patricio Counties were set equal to 5,311 acft/yr and 9,698 acft/yr, respectively. Actual well capacity pumping constraints may be different than those estimated based on previous maximum annual irrigation water use. Most irrigation water in the Coastal Bend Region is applied during growing seasons, and therefore wells may be capable of providing additional supplies for peak use conditions. Surface water supplies for Bee, Live Oak, Nueces, and San Patricio Counties were also considered.

<u>Manufacturing Use</u>

- The manufacturing well capacity was generally estimated as 130 percent of the 2000 usage from the Gulf Coast Aquifer. Groundwater supply was based on projected water use or estimated well capacities, whichever is less. In cases when the projected water use on that portion (i.e., county and river basin) of the aquifer exceeded the adopted drawdown criteria, supply was prorated downwards.

Mining Use

- The mining supply was estimated as either the projected demand in each decade or well capacity, whichever is less. A portion of the projected water demand in Nueces County is met with surface water supplies. In cases when the projected water use on that portion (i.e., county and river basin) of the aquifer exceeded the adopted drawdown criteria, supply was prorated downwards.

Livestock Use

- The groundwater supply for livestock was calculated based on 1997 groundwater use reported by TWDB, represented as a percent of total groundwater used to meet demands. This percent of groundwater used is applied to each livestock demand by decade. The remaining demand is met with local surface water supplies.

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4A-3 County Summaries — Comparison of Demand to Supply

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4A.3.1 Comparison of Demand to Supply – Aransas County

A summary of population, water demands, water supply, and shortages are shown by decade for the 2000 through 2060 period in Table 4A-2 for all categories of water use. Table 4A-3 includes a summary of municipal demands.

Demands

- For the period 2000 to 2060, municipal demand increases from 3,314 acft in 2000 to 4,444 acft in 2030 and to 3,835 acft in 2060.
- Manufacturing demand increases from 235 acft to 331 acft from 2000 to 2060.
- Mining demand increases from 81 to 146 acft from 2000 to 2060.
- There is no irrigation demand projected; livestock demand is constant at 23 acft/yr.

Supplies

- Surface water from the CCR/LCC/Lake Texana System is supplied to municipalities by the City of Corpus Christi via the SPMWD.
- Groundwater supplies are from the Gulf Coast Aquifer.
- Surface water for livestock needs is provided from on-farm and local sources.

Comparison of Demand to Supply

- There are municipal shortages from 2050 to 2060, with the greatest shortage attributable to County-Other users in 2050 (1,527 acft), due to insufficient surface water supply for SPMWD.
- There are immediate and long-term shortages through 2060 for manufacturing users. Groundwater supply to manufacturing users is limited by well capacity, which results in groundwater supplies to the county being 136 acft less than projected groundwater use for Aransas County in 2060 (Section 3.4).

Table 4A-2.
Aransas County
Population, Water Supply, and Water Demand Projections

	Population Projection	2000	2010	2020	2030	2040	2050	2060
		22,497	26,863	30,604	32,560	32,201	30,422	28,791
	Supply and Demand by Type of Use	**2000 (acft)**	**2010 (acft)**	**2020 (acft)**	**2030 (acft)**	**2040 (acft)**	**2050 (acft)**	**2060 (acft)**
Municipal	Municipal Demand (See Table 4A-3)	3,314	3,831	4,263	4,444	4,326	4,053	3,835
	Municipal Existing Supply							
	Groundwater	212	242	267	276	267	250	236
	Surface water	3,102	3,589	3,996	4,168	4,059	2,276	2,156
	Total Existing Municipal Supply	3,314	3,831	4,263	4,444	4,326	2,526	2,392
	Municipal Balance	0	0	0	0	0	(1,527)	(1,443)
Industrial	Manufacturing Demand	235	267	281	292	302	311	331
	Manufacturing Existing Supply							
	Groundwater	195	195	195	195	195	195	195
	Surface water	0	0	0	0	0	0	0
	Total Manufacturing Supply	195	195	195	195	195	195	195
	Manufacturing Balance	(40)	(72)	(86)	(97)	(107)	(116)	(136)
	Steam-Electric Demand	0	0	0	0	0	0	0
	Steam-Electric Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Steam-Electric Supply	0	0	0	0	0	0	0
	Steam-Electric Balance	0	0	0	0	0	0	0
	Mining Demand	81	103	115	123	131	139	146
	Mining Existing Supply							
	Groundwater	81	103	115	123	131	139	146
	Surface water	0	0	0	0	0	0	0
	Total Mining Supply	81	103	115	123	131	139	146
	Mining Balance	0	0	0	0	0	0	0
Agriculture	Irrigation Demand	0	0	0	0	0	0	0
	Irrigation Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Irrigation Supply	0	0	0	0	0	0	0
	Irrigation Balance	0	0	0	0	0	0	0
	Livestock Demand	23	23	23	23	23	23	23
	Livestock Existing Supply							
	Groundwater	2	2	2	2	2	2	2
	Surface water	21	21	21	21	21	21	21
	Total Livestock Supply	23	23	23	23	23	23	23
	Livestock Balance	0	0	0	0	0	0	0
Total	Municipal and Industrial Demand	3,630	4,201	4,659	4,859	4,759	4,503	4,312
	Existing Municipal and Industrial Supply							
	Groundwater	488	540	577	594	593	584	577
	Surface water	3,102	3,589	3,996	4,168	4,059	2,275	2,155
	Total Municipal and Industrial Supply	3,590	4,129	4,573	4,762	4,652	2,859	2,732
	Municipal and Industrial Balance	(40)	(72)	(86)	(97)	(107)	(1,644)	(1,580)
	Agriculture Demand	23	23	23	23	23	23	23
	Existing Agricultural Supply							
	Groundwater	2	2	2	2	2	2	2
	Surface water	21	21	21	21	21	21	21
	Total Agriculture Supply	23	23	23	23	23	23	23
	Agriculture Balance	0	0	0	0	0	0	0
	Total Demand	3,653	4,224	4,682	4,882	4,782	4,526	4,335
	Total Supply							
	Groundwater	490	542	579	596	595	586	579
	Surface water	3,123	3,610	4,017	4,189	4,080	2,297	2,177
	Total Supply	3,613	4,152	4,596	4,785	4,675	2,883	2,756
	Total Balance	(40)	(72)	(86)	(97)	(107)	(1,644)	(1,580)

Table 4A-3.
Aransas County
Municipal Water Demand and Supply by City/County
(acft)

City/County	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Aransas Pass							
Demand	146	168	186	195	190	179	169
Supply	146	168	186	195	190	179	169
Groundwater	—	—	—	—	—	—	—
Surface Water	146	168	186	195	190	179	169
Balance	—	—	—	—	—	—	—
Fulton							
Demand	261	307	346	365	359	336	318
Supply	261	307	346	365	359	336	318
Groundwater	—	—	—	—	—	—	—
Surface Water	261	307	346	365	359	336	318
Balance	—	—	—	—	—	—	—
Rockport							
Demand	1,357	1,590	1,778	1,868	1,823	1,712	1,620
Supply	1,357	1,590	1,778	1,868	1,823	1,712	1,620
Groundwater	—	—	—	—	—	—	—
Surface Water	1,357	1,590	1,778	1,868	1,823	1,712	1,620
Balance	—	—	—	—	—	—	—
County-Other							
Demand	1,550	1,766	1,953	2,016	1,954	1,826	1,728
Supply	1,550	1,766	1,953	2,016	1,954	299	285
Groundwater	212	242	267	276	267	250	236
Surface Water	1,338	1,524	1,686	1,740	1,687	49	49
Balance	—	—	—	—	—	(1,527)	(1,443)
Total for Aransas County							
Demand	3,314	3,831	4,263	4,444	4,326	4,053	3,835
Supply	3,314	3,831	4,263	4,444	4,326	2,526	2,392
Groundwater	212	242	267	276	267	250	236
Surface Water	3,102	3,589	3,996	4,168	4,059	2,276	2,156
Balance	—	—	—	—	—	(1,527)	(1,443)

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4A.3.2 Comparison of Demand to Supply – Bee County

A summary of population, water demands, water supply, and shortages are shown by decade for the 2000 through 2060 period in Table 4A-4 for all categories of water use. Table 4A-5 includes a summary of municipal demands.

Demands

- For the period 2000 to 2060, municipal demand increases from 4,220 acft in 2000 to 4,492 acft in 2030 and to 4,291 acft in 2060.
- Manufacturing demand is constant at 1 acft from 2000 to 2060.
- Mining demand increases from 29 acft in 2000 to 48 acft in 2060.
- For the period 2000 to 2060, irrigation demand increases from 2,798 acft to 6,243 acft; livestock demand is constant at 995 acft.

Supplies

- Surface water is provided to the City of Beeville from the CCR/LCC System by the City of Corpus Christi.
- Surface water for livestock needs is provided from on-farm/local sources.
- Groundwater supplies are from the Gulf Coast Aquifer.
- Groundwater supply for irrigation was set equal to the maximum pumping from 2000 to 2006 (i.e. estimated well capacity).

Comparison of Demand to Supply

- There are sufficient municipal, industrial, and livestock supplies through 2060.
- Supplies for irrigation are constrained by well capacity, resulting in an irrigation shortage of 299 acft/yr in 2050, increasing to 890 acft/yr in 2060.

Table 4A-4.
Bee County
Population, Water Supply, and Water Demand Projections

	Population Projection	Year 2000	2010	2020	2030	2040	2050	2060
		32,359	34,298	36,099	37,198	37,591	37,598	36,686
	Supply and Demand by Type of Use	**2000 (acft)**	**2010 (acft)**	**2020 (acft)**	**2030 (acft)**	**2040 (acft)**	**2050 (acft)**	**2060 (acft)**
Municipal	Municipal Demand (See Table 4A-5)	4,220	4,342	4,456	4,492	4,439	4,397	4,291
	Municipal Existing Supply							
	Groundwater	1,691	1,723	1,766	1,770	1,740	1,714	1,673
	Surface water	2,529	2,619	2,691	2,722	2,699	2,683	2,618
	Total Existing Municipal Supply	4,220	4,342	4,457	4,493	4,439	4,397	4,291
	Municipal Balance	0	0	1	1	0	0	0
Industrial	Manufacturing Demand	1	1	1	1	1	1	1
	Manufacturing Existing Supply							
	Groundwater	1	1	1	1	1	1	1
	Surface water	0	0	0	0	0	0	0
	Total Manufacturing Supply	1	1	1	1	1	1	1
	Manufacturing Balance	0	0	0	0	0	0	0
	Steam-Electric Demand	0	0	0	0	0	0	0
	Steam-Electric Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Steam-Electric Supply	0	0	0	0	0	0	0
	Steam-Electric Balance	0	0	0	0	0	0	0
	Mining Demand	29	36	40	42	44	46	48
	Mining Existing Supply							
	Groundwater	29	37	40	42	44	46	48
	Surface water	0	0	0	0	0	0	0
	Total Mining Supply	29	37	40	42	44	46	48
	Mining Balance	0	1	0	0	0	0	0
Agriculture	Irrigation Demand	2,798	3,796	4,193	4,632	5,116	5,652	6,243
	Irrigation Existing Supply							
	Groundwater	2,756	3,754	4,151	4,590	5,074	5,311	5,311
	Surface water[1]	42	42	42	42	42	42	42
	Total Irrigation Supply	2,798	3,796	4,193	4,632	5,116	5,353	5,353
	Irrigation Balance	0	0	0	0	0	(299)	(890)
	Livestock Demand	995	995	995	995	995	995	995
	Livestock Existing Supply							
	Groundwater	88	88	88	88	88	88	88
	Surface water	907	907	907	907	907	907	907
	Total Livestock Supply	995	995	995	995	995	995	995
	Livestock Balance	0	0	0	0	0	0	0
Total	Municipal and Industrial Demand	4,250	4,379	4,497	4,535	4,484	4,444	4,340
	Existing Municipal and Industrial Supply							
	Groundwater	1,721	1,761	1,807	1,814	1,785	1,761	1,722
	Surface water	2,529	2,619	2,691	2,722	2,699	2,683	2,618
	Total Municipal and Industrial Supply	4,250	4,380	4,498	4,536	4,484	4,444	4,340
	Municipal and Industrial Balance	0	1	1	1	0	0	0
	Agriculture Demand	3,793	4,791	5,188	5,627	6,111	6,647	7,238
	Existing Agricultural Supply							
	Groundwater	2,844	3,842	4,239	4,678	5,162	5,399	5,399
	Surface water	949	949	949	949	949	949	949
	Total Agriculture Supply	3,793	4,791	5,188	5,627	6,111	6,348	6,348
	Agriculture Balance	0	0	0	0	0	(299)	(890)
	Total Demand	8,043	9,170	9,685	10,162	10,595	11,091	11,578
	Total Supply							
	Groundwater	4,565	5,603	6,046	6,492	6,947	7,160	7,121
	Surface water	3,478	3,568	3,640	3,671	3,648	3,632	3,567
	Total Supply	8,043	9,171	9,686	10,163	10,595	10,792	10,688
	Total Balance	0	1	1	1	0	(299)	(890)

[1] Surface water supplies from run-of-river water rights in the San Antonio-Nueces Coastal Basin.

Table 4A-5.
Bee County
Municipal Water Demand and Supply by City/County
(acft)

City/County	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Beeville							
Demand	2,529	2,619	2,691	2,722	2,699	2,683	2,618
Supply[1]	2,529	2,619	2,691	2,722	2,699	2,683	2,618
Groundwater	—	—	—	—	—	—	—
Surface Water	2,529	2,619	2,691	2,722	2,699	2,683	2,618
Balance	—	—	—	—	—	—	—
El Oso WSC							
Demand	60	62	65	66	66	65	64
Supply	60	62	65	66	66	65	64
Groundwater	60	62	65	66	66	65	64
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
County-Other							
Demand	1,631	1,661	1,701	1,704	1,674	1,649	1,609
Supply	1,631	1,661	1,701	1,704	1,674	1,649	1,609
Groundwater	1,631	1,661	1,701	1,704	1,674	1,649	1,609
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
Total for Bee County							
Demand	4,220	4,342	4,457	4,493	4,439	4,397	4,291
Supply	4,220	4,342	4,457	4,493	4,439	4,397	4,291
Groundwater	1,691	1,723	1,766	1,770	1,740	1,714	1,673
Surface Water	2,529	2,619	2,691	2,722	2,699	2,683	2,618
Balance	—	—	—	—	—	—	—

[1] According to the City of Beeville's contract with City of Corpus Christi, the City provides supply equal to the greater supply of previous years plus 10 percent. This amount was greater than demand; therefore supply was set equal to the demand. The City of Beeville's WTP capacity of 3.45 MGD (or 3,864 acft/yr) is not expected to limit surface water availability.

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4A.3.3 Comparison of Demand to Supply – Brooks County

A summary of population, water demands, water supply, and shortages are shown by decade for the 2000 through 2060 period in Table 4A-6 for all categories of water use. Table 4A-7 includes a summary of municipal demands.

Demands

- For the period 2000 to 2060, municipal demand increases from 1,970 acft in 2000 to 2,857 acft in 2030 and to 3,045 acft in 2060.
- Mining demand increases from 127 acft to 184 acft from 2000 to 2060.
- For the period 2000 to 2060, irrigation demand decreases from 25 acft to 21 acft; livestock demand is constant at 747 acft.

Supplies

- Surface water for livestock needs is provided from on-farm/local sources.
- Groundwater supplies are from the Gulf Coast Aquifer.

Comparison of Demand to Supply

- There are sufficient municipal, industrial, and agricultural supplies through 2060.

Table 4A-6.
Brooks County
Population, Water Supply, and Water Demand Projections

Population Projection		Year 2000	2010	2020	2030	2040	2050	2060
		7,976	8,607	9,303	9,909	10,288	10,399	10,349

Supply and Demand by Type of Use		2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Municipal	Municipal Demand (See Table 4A-7)	1,970	2,315	2,621	2,857	2,994	3,043	3,045
	Municipal Existing Supply							
	Groundwater	1,970	2,315	2,621	2,857	2,994	3,043	3,045
	Surface water	0	0	0	0	0	0	0
	Total Existing Municipal Supply	1,970	2,315	2,621	2,857	2,994	3,043	3,045
	Municipal Balance	0	0	0	0	0	0	0
Industrial	Manufacturing Demand	0	0	0	0	0	0	0
	Manufacturing Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Manufacturing Supply	0	0	0	0	0	0	0
	Manufacturing Balance	0	0	0	0	0	0	0
	Steam-Electric Demand	0	0	0	0	0	0	0
	Steam-Electric Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Steam-Electric Supply	0	0	0	0	0	0	0
	Steam-Electric Balance	0	0	0	0	0	0	0
	Mining Demand	127	150	161	167	173	179	184
	Mining Existing Supply							
	Groundwater	127	150	161	167	173	179	184
	Surface water	0	0	0	0	0	0	0
	Total Mining Supply	127	150	161	167	173	179	184
	Mining Balance	0	0	0	0	0	0	0
Agriculture	Irrigation Demand	25	24	24	23	22	21	21
	Irrigation Existing Supply							
	Groundwater	25	24	24	23	22	21	21
	Surface water	0	0	0	0	0	0	0
	Total Irrigation Supply	25	24	24	23	22	21	21
	Irrigation Balance	0	0	0	0	0	0	0
	Livestock Demand	747	747	747	747	747	747	747
	Livestock Existing Supply							
	Groundwater	75	75	75	75	75	75	75
	Surface water	672	672	672	672	672	672	672
	Total Livestock Supply	747	747	747	747	747	747	747
	Livestock Balance	0	0	0	0	0	0	0
Total	Municipal and Industrial Demand	2,097	2,465	2,782	3,024	3,167	3,222	3,229
	Existing Municipal and Industrial Supply							
	Groundwater	2,097	2,465	2,782	3,024	3,167	3,222	3,229
	Surface water	0	0	0	0	0	0	0
	Total Municipal and Industrial Supply	2,097	2,465	2,782	3,024	3,167	3,222	3,229
	Municipal and Industrial Balance	0	0	0	0	0	0	0
	Agriculture Demand	772	771	771	770	769	768	768
	Existing Agricultural Supply							
	Groundwater	100	99	99	98	97	96	96
	Surface water	672	672	672	672	672	672	672
	Total Agriculture Supply	772	771	771	770	769	768	768
	Agriculture Balance	0	0	0	0	0	0	0
	Total Demand	2,869	3,236	3,553	3,794	3,936	3,990	3,997
	Total Supply							
	Groundwater	2,197	2,564	2,881	3,122	3,264	3,318	3,325
	Surface water	672	672	672	672	672	672	672
	Total Supply	2,869	3,236	3,553	3,794	3,936	3,990	3,997
	Total Balance	0	0	0	0	0	0	0

Table 4A-7
Brooks County
Municipal Water Demand and Supply by City/County
(acft)

City/County	2000	2010	2020	2030	2040	2050	2060
Falfurrias							
Demand	1,661	2,135	2,515	2,795	2,957	3,021	3,032
Supply	1,661	2,135	2,515	2,795	2,957	3,021	3,032
Groundwater	1,661	2,135	2,515	2,795	2,957	3,021	3,032
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
County-Other							
Demand	309	180	106	62	37	22	13
Supply	309	180	106	62	37	22	13
Groundwater	309	180	106	62	37	22	13
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
Total for Brooks County							
Demand	1,970	2,315	2,621	2,857	2,994	3,043	3,045
Supply	1,970	2,315	2,621	2,857	2,994	3,043	3,045
Groundwater	1,970	2,315	2,621	2,857	2,994	3,043	3,045
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—

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4A.3.4 Comparison of Demand to Supply – Duval County

A summary of population, water demands, water supply, and shortages are shown by decade for the 2000 through 2060 period in Table 4A-8 for all categories of water use. Table 4A-9 includes a summary of municipal demands.

Demands

- For the period 2000 to 2060, municipal demand increases from 2,323 acft in 2000 to 2,463 acft in 2030 and decreases to 2,223 acft in 2060.
- Mining demand increases from 4,544 acft in 2000, to 7,119 acft in 2030, to 8,553 acft in 2060.
- For the period 2000 to 2060, irrigation demand decreases from 4,524 acft to 4,064 acft; livestock demand is constant at 873 acft.

Supplies

- Surface water for livestock needs is provided from on-farm/local sources.
- Groundwater supplies are from the Gulf Coast Aquifer, except for Freer which has groundwater supplies from the Catahoula formation.

Comparison of Demand to Supply

- Groundwater supply for Duval County-Mining is limited by Coastal Bend Region drawdown criteria, described in Section 3.4. Duval County-Mining can receive 51% of their projected groundwater use in 2060 and still meet drawdown criteria, which accounts for the difference in groundwater supplies to the county and projected groundwater use for Duval County (Section 3.4).
- Due to limited groundwater availability without exceeding drawdown criteria and increased demand, mining has near- and long-term shortages with the highest projected shortage of 4,205 acft in 2060.

Table 4A-8. Duval County Population, Water Supply, and Water Demand Projections

Population Projection		Year 2000	2010	2020	2030	2040	2050	2060
		13,120	13,881	14,528	14,882	14,976	14,567	13,819
Supply and Demand by Type of Use		**2000 (acft)**	**2010 (acft)**	**2020 (acft)**	**2030 (acft)**	**2040 (acft)**	**2050 (acft)**	**2060 (acft)**
Municipal	Municipal Demand (See Table 4A-9)	2,323	2,400	2,453	2,463	2,428	2,345	2,223
	Municipal Existing Supply							
	Groundwater	2,323	2,400	2,453	2,463	2,428	2,345	2,223
	Surface water	0	0	0	0	0	0	0
	Total Existing Municipal Supply	2,323	2,400	2,453	2,463	2,428	2,345	2,223
	Municipal Balance	0	0	0	0	0	0	0
Industrial	Manufacturing Demand	0	0	0	0	0	0	0
	Manufacturing Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water							
	Total Manufacturing Supply	0	0	0	0	0	0	0
	Manufacturing Balance	0	0	0	0	0	0	0
	Steam-Electric Demand	0	0	0	0	0	0	0
	Steam-Electric Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water							
	Total Steam-Electric Supply	0	0	0	0	0	0	0
	Steam-Electric Balance	0	0	0	0	0	0	0
	Mining Demand	4,544	5,860	6,630	7,119	7,610	8,108	8,553
	Mining Existing Supply							
	Groundwater	4,544	4,122	4,112	4,146	4,224	4,299	4,348
	Surface water	0	0	0	0	0	0	0
	Total Mining Supply	4,544	4,122	4,112	4,146	4,224	4,299	4,348
	Mining Balance	0	(1,738)	(2,518)	(2,973)	(3,386)	(3,809)	(4,205)
Agriculture	Irrigation Demand	4,524	4,444	4,365	4,289	4,212	4,138	4,064
	Irrigation Existing Supply							
	Groundwater	4,524	4,444	4,365	4,289	4,212	4,138	4,064
	Surface water	0	0	0	0	0	0	0
	Total Irrigation Supply	4,524	4,444	4,365	4,289	4,212	4,138	4,064
	Irrigation Balance	0	0	0	0	0	0	0
	Livestock Demand	873	873	873	873	873	873	873
	Livestock Existing Supply							
	Groundwater	87	87	87	87	87	87	87
	Surface water	786	786	786	786	786	786	786
	Total Livestock Supply	873	873	873	873	873	873	873
	Livestock Balance	0	0	0	0	0	0	0
Total	Municipal and Industrial Demand	6,867	8,260	9,083	9,582	10,038	10,453	10,776
	Existing Municipal and Industrial Supply							
	Groundwater	6,867	6,522	6,565	6,609	6,652	6,644	6,571
	Surface water	0	0	0	0	0	0	0
	Total Municipal and Industrial Supply	6,867	6,522	6,565	6,609	6,652	6,644	6,571
	Municipal and Industrial Balance	0	(1,738)	(2,518)	(2,973)	(3,386)	(3,809)	(4,205)
	Agriculture Demand	5,397	5,317	5,238	5,162	5,085	5,011	4,937
	Existing Agricultural Supply							
	Groundwater	4,611	4,531	4,452	4,376	4,299	4,225	4,151
	Surface water	786	786	786	786	786	786	786
	Total Agriculture Supply	5,397	5,317	5,238	5,162	5,085	5,011	4,937
	Agriculture Balance	0	0	0	0	0	0	0
	Total Demand	12,264	13,577	14,321	14,744	15,123	15,464	15,713
	Total Supply							
	Groundwater	11,478	11,053	11,017	10,985	10,951	10,869	10,722
	Surface water	786	786	786	786	786	786	786
	Total Supply	12,264	11,839	11,803	11,771	11,737	11,655	11,508
	Total Balance	0	(1,738)	(2,518)	(2,973)	(3,386)	(3,809)	(4,205)

Table 4A-9.
Duval County
Municipal Water Demand and Supply by City/County
(acft)

City/County	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Benavides							
Demand	315	326	333	334	330	319	302
Supply	315	326	333	334	330	319	302
Groundwater	315	326	333	334	330	319	302
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
Freer							
Demand	624	645	659	663	655	633	600
Supply	624	645	659	663	655	633	600
Groundwater	624	645	659	663	655	633	600
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
San Diego							
Demand	471	479	482	479	467	449	426
Supply	471	479	482	479	467	449	426
Groundwater	471	479	482	479	467	449	426
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
County-Other							
Demand	913	950	979	987	976	944	895
Supply	913	950	979	987	976	944	895
Groundwater	913	950	979	987	976	944	895
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
Total for Duval County							
Demand	2,323	2,400	2,453	2,463	2,428	2,345	2,223
Supply	2,323	2,400	2,453	2,463	2,428	2,345	2,223
Groundwater	2,323	2,400	2,453	2,463	2,428	2,345	2,223
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—

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4A.3.5 Comparison of Demand to Supply – Jim Wells County

A summary of population, water demands, water supply, and shortages are shown by decade for the 2000 through 2060 period in Table 4A-10 for all categories of water use. Table 4A-11 includes a summary of municipal demands.

Demands

- For the period 2000 to 2060, municipal demand increases from 8,562 acft in 2000 to 9,756 acft in 2030 and decreases to 9,433 acft in 2060.
- Mining demand increases from 347 acft in 2000 to 550 acft in 2060.
- For the period 2000 to 2060, irrigation demand decreases from 3,731 acft to 1,717 acft; livestock demand is constant at 1,064 acft.

Supplies

- Surface water is provided to the City of Alice from the CCR/LCC System by the City of Corpus Christi; livestock needs are met with on-farm/local sources.
- Groundwater supplies are from the Gulf Coast Aquifer. San Diego groundwater supply is obtained from Duval County.

Comparison of Demand to Supply

- There are sufficient municipal supplies available through 2060 for Alice, Orange Grove, San Diego, and Premont.
- County-Other shows immediate and long-term shortages to 2060. Groundwater supply to County-Other users is limited by well capacity (Section 3.4), which results in groundwater supplies to the county being 170 acft less than projected groundwater use for Jim Wells County in 2060.
- There are sufficient water supplies through 2060 to meet projected mining, irrigation, and livestock demands.

Table 4A-10.
Jim Wells County
Population, Water Supply, and Water Demand Projections

		Year						
Population Projection		**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
		39,326	42,434	45,303	47,149	47,955	47,615	46,596
Supply and Demand by Type of Use		**2000 (acft)**	**2010 (acft)**	**2020 (acft)**	**2030 (acft)**	**2040 (acft)**	**2050 (acft)**	**2060 (acft)**
Municipal	Municipal Demand (See Table 4A-11)	8,562	9,068	9,526	9,756	9,761	9,640	9,433
	Municipal Existing Supply							
	Groundwater	3,203	3,295	3,376	3,418	3,418	3,397	3,359
	Surface water	5,281	5,606	5,912	6,076	6,102	6,033	5,904
	Total Existing Municipal Supply	8,484	8,901	9,288	9,494	9,520	9,430	9,263
	Municipal Balance	(78)	(167)	(238)	(262)	(241)	(210)	(170)
Industrial	Manufacturing Demand	0	0	0	0	0	0	0
	Manufacturing Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Manufacturing Supply	0	0	0	0	0	0	0
	Manufacturing Balance	0	0	0	0	0	0	0
	Steam-Electric Demand	0	0	0	0	0	0	0
	Steam-Electric Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Steam-Electric Supply	0	0	0	0	0	0	0
	Steam-Electric Balance	0	0	0	0	0	0	0
	Mining Demand	347	423	461	484	507	530	550
	Mining Existing Supply							
	Groundwater	347	423	461	484	507	530	550
	Surface water	0	0	0	0	0	0	0
	Total Mining Supply	347	423	461	484	507	530	550
	Mining Balance	0	0	0	0	0	0	0
Agriculture	Irrigation Demand	3,731	3,278	2,878	2,528	2,221	1,953	1,717
	Irrigation Existing Supply							
	Groundwater	3,731	3,278	2,878	2,528	2,221	1,953	1,717
	Surface water	0	0	0	0	0	0	0
	Total Irrigation Supply	3,731	3,278	2,878	2,528	2,221	1,953	1,717
	Irrigation Balance	0	0	0	0	0	0	0
	Livestock Demand	1,064	1,064	1,064	1,064	1,064	1,064	1,064
	Livestock Existing Supply							
	Groundwater	106	106	106	106	106	106	106
	Surface water	958	958	958	958	958	958	958
	Total Livestock Supply	1,064	1,064	1,064	1,064	1,064	1,064	1,064
	Livestock Balance	0	0	0	0	0	0	0
Total	Municipal and Industrial Demand	8,909	9,491	9,987	10,240	10,268	10,170	9,983
	Existing Municipal and Industrial Supply							
	Groundwater	3,550	3,718	3,837	3,902	3,926	3,927	3,909
	Surface water	5,281	5,606	5,912	6,076	6,102	6,033	5,904
	Total Municipal and Industrial Supply	8,831	9,324	9,749	9,978	10,028	9,960	9,813
	Municipal and Industrial Balance	(78)	(167)	(238)	(262)	(240)	(210)	(170)
	Agriculture Demand	4,795	4,342	3,942	3,592	3,285	3,017	2,781
	Existing Agricultural Supply							
	Groundwater	3,837	3,384	2,984	2,634	2,327	2,059	1,823
	Surface water	958	958	958	958	958	958	958
	Total Agriculture Supply	4,795	4,342	3,942	3,592	3,285	3,017	2,781
	Agriculture Balance	0	0	0	0	0	0	0
	Total Demand	13,704	13,833	13,929	13,832	13,553	13,187	12,764
	Total Supply							
	Groundwater	7,387	7,102	6,821	6,536	6,253	5,986	5,732
	Surface water	6,239	6,564	6,870	7,034	7,060	6,991	6,862
	Total Supply	13,626	13,666	13,691	13,570	13,313	12,977	12,594
	Total Balance	(78)	(167)	(238)	(262)	(240)	(210)	(170)

Table 4A-11.
Jim Wells County
Municipal Water Demand and Supply by City/County
(acft)

City/County	2000	2010	2020	2030	2040	2050	2060
Alice[1]							
Demand	5,281	5,606	5,912	6,076	6,102	6,033	5,904
Supply	5,281	5,606	5,912	6,076	6,102	6,033	5,904
Groundwater	—	—	—	—	—	—	—
Surface Water	5,281	5,606	5,912	6,076	6,102	6,033	5,904
Balance	—	—	—	—	—	—	—
Orange Grove							
Demand	353	374	394	405	406	402	393
Supply	353	374	394	405	406	402	393
Groundwater	353	374	394	405	406	402	393
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
Premont							
Demand	807	858	905	931	935	925	905
Supply	807	858	905	931	935	925	905
Groundwater	807	858	905	931	935	925	905
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
San Diego							
Demand	99	103	105	106	105	103	101
Supply	99	103	105	106	105	103	101
Groundwater	99	103	105	106	105	103	101
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
County-Other							
Demand	2,022	2,127	2,210	2,238	2,213	2,177	2,130
Supply	1,944	1,960	1,972	1,976	1,972	1,967	1,960
Groundwater	1,944	1,960	1,972	1,976	1,972	1,967	1,960
Surface Water	—	—	—	—	—	—	—
Balance	(78)	(167)	(238)	(262)	(241)	(210)	(170)

Table 4A-11 (Concluded)

City/County	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
Total for Jim Wells County							
Demand	8,562	9,068	9,526	9,756	9,794	9,640	9,433
Supply	8,484	8,901	9,288	9,494	9,520	9,430	9,263
Groundwater	3,203	3,295	3,376	3,418	3,418	3,397	3,359
Surface Water	5,281	5,606	5,912	6,076	6,102	6,033	5,904
Balance	(78)	(167)	(238)	(262)	(241)	(210)	(170)

[1] According to the City of Alice's contract with the City of Corpus Christi, the City provides supply equal to the greater supply of the previous years plus 10 percent. This amount was greater than demand; therefore supply was set equal to demand. The City of Alice's estimated average day WTP capacity of 6.2 MGD (or 6,944 acft/yr) is not expected to limit surface water availability.

4A.3.6 Comparison of Demand to Supply – Kenedy County

A summary of population, water demands, water supply, and shortages are shown by decade for the 2000 through 2060 period in Table 4A-12 for all categories of water use. Table 4A-13 includes a summary of municipal demands.

Demands

- For the period 2000 to 2060, municipal demand increases from 46 acft in 2000 to 53 acft in 2060.
- Mining demand is constant at 1 acft from 2000 to 2060.
- For the period 2000 to 2060, irrigation is constant at 107 acft and livestock demand is constant at 901 acft.

Supplies

- Surface water for livestock needs is provided from on-farm and local sources.
- Groundwater supplies are from the Gulf Coast Aquifer.

Comparison of Demand to Supply

- All municipal, industrial, and agriculture demands are met through 2060.

Table 4A-12.
Kenedy County
Population, Water Supply, and Water Demand Projections

	Population Projection	2000	2010	2020	2030	2040	2050	2060
		414	467	495	523	527	529	537
	Supply and Demand by Type of Use	**2000 (acft)**	**2010 (acft)**	**2020 (acft)**	**2030 (acft)**	**2040 (acft)**	**2050 (acft)**	**2060 (acft)**
Municipal	Municipal Demand (See Table 4A-13)	46	50	52	53	53	52	53
	Municipal Existing Supply							
	Groundwater	46	50	52	53	53	52	53
	Surface water	0	0	0	0	0	0	0
	Total Existing Municipal Supply	46	50	52	53	53	52	53
	Municipal Balance	0	0	0	0	0	0	0
Industrial	Manufacturing Demand	0	0	0	0	0	0	0
	Manufacturing Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Manufacturing Supply	0	0	0	0	0	0	0
	Manufacturing Balance	0	0	0	0	0	0	0
	Steam-Electric Demand	0	0	0	0	0	0	0
	Steam-Electric Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Steam-Electric Supply	0	0	0	0	0	0	0
	Steam-Electric Balance	0	0	0	0	0	0	0
	Mining Demand	1	1	1	1	1	1	1
	Mining Existing Supply							
	Groundwater	1	1	1	1	1	1	1
	Surface water	0	0	0	0	0	0	0
	Total Mining Supply	1	1	1	1	1	1	1
	Mining Balance	0	0	0	0	0	0	0
Agriculture	Irrigation Demand	107	107	107	107	107	107	107
	Irrigation Existing Supply							
	Groundwater	107	107	107	107	107	107	107
	Surface water	0	0	0	0	0	0	0
	Total Irrigation Supply	107	107	107	107	107	107	107
	Irrigation Balance	0	0	0	0	0	0	0
	Livestock Demand	901	901	901	901	901	901	901
	Livestock Existing Supply							
	Groundwater	90	90	90	90	90	90	90
	Surface water	811	811	811	811	811	811	811
	Total Livestock Supply	901	901	901	901	901	901	901
	Livestock Balance	0	0	0	0	0	0	0
Total	Municipal and Industrial Demand	47	51	53	54	54	53	54
	Existing Municipal and Industrial Supply							
	Groundwater	47	51	53	54	54	53	54
	Surface water	0	0	0	0	0	0	0
	Total Municipal and Industrial Supply	47	51	53	54	54	53	54
	Municipal and Industrial Balance	0	0	0	0	0	0	0
	Agriculture Demand	1,008	1,008	1,008	1,008	1,008	1,008	1,008
	Existing Agricultural Supply							
	Groundwater	197	197	197	197	197	197	197
	Surface water	811	811	811	811	811	811	811
	Total Agriculture Supply	1,008	1,008	1,008	1,008	1,008	1,008	1,008
	Agriculture Balance	0	0	0	0	0	0	0
	Total Demand	1,055	1,059	1,061	1,062	1,062	1,061	1,062
	Total Supply							
	Groundwater	244	248	250	251	251	250	251
	Surface water	811	811	811	811	811	811	811
	Total Supply	1,055	1,059	1,061	1,062	1,062	1,061	1,062
	Total Balance	0	0	0	0	0	0	0

Table 4A-13.
Kenedy County
Municipal Water Demand and Supply by City/County
(acft)

City/County	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
County-Other							
Demand	46	50	52	53	53	52	53
Supply	46	50	52	53	53	52	53
Groundwater	46	50	52	53	53	52	53
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
Total for Kenedy County							
Demand	46	50	52	53	53	52	53
Supply	46	50	52	53	53	52	53
Groundwater	46	50	52	53	53	52	53
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—

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4A.3.7 Comparison of Demand to Supply – Kleberg County

A summary of population, water demands, water supply, and shortages are shown by decade for the 2000 through 2060 period in Table 4A-14 for all categories of water use. Table 4A-15 includes a summary of municipal demands.

Demands

- For the period 2000 to 2060, municipal demand increases from 5,415 acft in 2000 to 7,020 acft in 2060.
- Mining demand increases from 2,127 acft in 2000 to 2,207 acft in 2030 to 2,232 acft in 2060.
- For the period 2000 to 2060, irrigation demand decreases from 1,002 acft to 410 acft; livestock demand is constant at 1,900 acft.

Supplies

- Surface water is supplied to municipal users from the CCR/LCC/Lake Texana System by the City of Corpus Christi via the STWA; some livestock needs are met with on-farm/local sources.
- Groundwater supplies are from the Gulf Coast Aquifer.

Comparison of Demand to Supply

- The City of Kingsville supplies its own groundwater and purchases surface water from the STWA and has no projected shortages through 2060.
- Due to increasing demand, County-Other users show a shortage from 2020 through 2060. Groundwater supply to County-Other users is limited by well capacity.
- Groundwater supply to City of Kingsville and Kleberg County-other users is limited by well capacity, which results in groundwater supplies to the county being 155 acft less than projected groundwater use for Kleberg County in 2060 (Section 3.4)
- There are sufficient mining, irrigation, and livestock supplies through 2060.

Table 4A-14. Kleberg County Population, Water Supply, and Water Demand Projections

		Year						
Population Projection		**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
		31,549	36,959	40,849	43,370	44,989	47,118	47,212
Supply and Demand by Type of Use		**2000 (acft)**	**2010 (acft)**	**2020 (acft)**	**2030 (acft)**	**2040 (acft)**	**2050 (acft)**	**2060 (acft)**
Municipal	Municipal Demand (See Table 4A-15)	5,415	6,051	6,436	6,664	6,762	7,008	7,020
	Municipal Existing Supply							
	Groundwater	3,976	4,196	4,318	4,364	4,392	4,432	4,434
	Surface water	1,439	1,855	2,087	2,219	2,262	2,423	2,431
	Total Existing Municipal Supply	5,415	6,051	6,405	6,583	6,654	6,855	6,865
	Municipal Balance	0	0	(31)	(81)	(108)	(153)	(155)
Industrial	Manufacturing Demand	0	0	0	0	0	0	0
	Manufacturing Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Manufacturing Supply	0	0	0	0	0	0	0
	Manufacturing Balance	0	0	0	0	0	0	0
	Steam-Electric Demand	0	0	0	0	0	0	0
	Steam-Electric Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Steam-Electric Supply	0	0	0	0	0	0	0
	Steam-Electric Balance	0	0	0	0	0	0	0
	Mining Demand	2,127	2,917	2,934	2,207	2,216	2,225	2,232
	Mining Existing Supply							
	Groundwater	2,127	2,917	2,934	2,207	2,216	2,225	2,232
	Surface water	0	0	0	0	0	0	0
	Total Mining Supply	2,127	2,917	2,934	2,207	2,216	2,225	2,232
	Mining Balance	0	0	0	0	0	0	0
Agriculture	Irrigation Demand	1,002	866	745	644	555	477	410
	Irrigation Existing Supply							
	Groundwater	1,002	866	745	644	555	477	410
	Surface water	0	0	0	0	0	0	0
	Total Irrigation Supply	1,002	866	745	644	555	477	410
	Irrigation Balance	0	0	0	0	0	0	0
	Livestock Demand	1,900	1,900	1,900	1,900	1,900	1,900	1,900
	Livestock Existing Supply							
	Groundwater	190	190	190	190	190	190	190
	Surface water	1,710	1,710	1,710	1,710	1,710	1,710	1,710
	Total Livestock Supply	1,900	1,900	1,900	1,900	1,900	1,900	1,900
	Livestock Balance	0	0	0	0	0	0	0
Total	Municipal and Industrial Demand	7,542	8,968	9,370	8,871	8,978	9,233	9,252
	Existing Municipal and Industrial Supply							
	Groundwater	6,103	7,114	7,252	6,571	6,608	6,657	6,666
	Surface water	1,439	1,855	2,087	2,219	2,262	2,423	2,431
	Total Municipal and Industrial Supply	7,542	8,969	9,339	8,790	8,870	9,080	9,097
	Municipal and Industrial Balance	0	1	(31)	(81)	(108)	(153)	(155)
	Agriculture Demand	2,902	2,766	2,645	2,544	2,455	2,377	2,310
	Existing Agricultural Supply							
	Groundwater	1,192	1,056	935	834	745	667	600
	Surface water	1,710	1,710	1,710	1,710	1,710	1,710	1,710
	Total Agriculture Supply	2,902	2,766	2,645	2,544	2,455	2,377	2,310
	Agriculture Balance	0	0	0	0	0	0	0
	Total Demand	10,444	11,734	12,015	11,415	11,433	11,610	11,562
	Total Supply							
	Groundwater	7,295	8,170	8,187	7,405	7,353	7,324	7,266
	Surface water	3,149	3,565	3,797	3,929	3,972	4,133	4,141
	Total Supply	10,444	11,735	11,984	11,334	11,325	11,457	11,407
	Total Balance	0	1	(31)	(81)	(108)	(153)	(155)

Table 4A-15.
Kleberg County
Municipal Water Demand and Supply by City/County
(acft)

City/County	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
Kingsville							
Demand	4,440	4,570	4,601	4,604	4,569	4,616	4,619
Supply	4,440	4,570	4,601	4,604	4,569	4,616	4,619
Groundwater	3,219	3,219	3,219	3,219	3,219	3,219	3,219
Surface Water	1,221	1,351	1,382	1,385	1,350	1,397	1,400
Balance	—	—	—	—	—	—	—
Ricardo WSC							
Demand	296	682	955	1,130	1,236	1,390	1,397
Supply	296	682	955	1,130	1,236	1,390	1,397
Groundwater	78	179	250	296	324	364	366
Surface Water	218	503	705	834	912	1,026	1,031
Balance	—	—	—	—	—	—	—
County-Other							
Demand	679	799	880	930	957	1,002	1,004
Supply	679	799	849	849	849	849	849
Groundwater	679	799	849	849	849	849	849
Surface Water	—	—	—	—	—	—	—
Balance	—	—	(31)	(81)	(108)	(153)	(155)
Total for Kleberg County							
Demand	5,415	6,051	6,436	6,664	6,762	7,008	7,020
Supply	5,415	6,051	6,405	6,583	6,654	6,855	6,865
Groundwater	3,976	4,196	4,318	4,364	4,392	4,432	4,434
Surface Water	1,439	1,855	2,087	2,219	2,262	2,423	2,431
Balance	—	—	(31)	(81)	(108)	(153)	(155)

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4A.3.8 Comparison of Demand to Supply – Live Oak County

A summary of population, water demands, water supply, and shortages are shown by decade for the 2000 through 2060 period in Table 4A-16 for all categories of water use. Table 4A-17 includes a summary of municipal demands.

Demands

- For the period 2000 to 2060, municipal demand increases from 2,350 acft in 2000 to 2,796 acft in 2030 and decreases to 2,213 acft in 2060.
- Manufacturing demands increase from 1,767 acft in 2000 to 2,194 acft in 2060.
- Mining demand increases from 3,105 acft to 5,341 acft from 2000 to 2060.
- For the period 2000 to 2060, irrigation demand decreases from 3,539 acft to 2,277 acft; livestock demand is constant at 833 acft.

Supplies

- Surface water is supplied from the CCR/LCC/Lake Texana System and City of Three Rivers water rights on the Nueces River firm supply of 700 acft/yr; some livestock needs are met with on-farm/local sources.
- In January 2004, Choke Canyon WSC was purchased by the City of Three Rivers. Choke Canyon WSC water demands are split between Live Oak and McMullen Counties. Surface water supplies from City of Three Rivers supplement groundwater supplies to meet former Choke Canyon WSC customer needs.
- Groundwater supplies are from the Carrizo-Wilcox and Gulf Coast Aquifers.

Comparison of Demand to Supply

- Three Rivers has a surplus of 3,453 acft in 2000 and 3,463 acft in 2060, after meeting their water demands for Choke Canyon WSC and City of Three Rivers. Due to this surplus, the overall municipal demand for the county is met through 2060.
- Live Oak County-Other users show a shortage from 2020 to 2040, due to groundwater supplies being limited by well capacity.
- Mining has near- and long-term shortages through 2060 due to increasing water demand. Groundwater supplies for Live Oak-Mining are limited by Coastal Bend Region drawdown criteria, described in Section 3.4. Live Oak- Mining can receive 67 percent of their projected groundwater use in 2060 and still meet drawdown criteria.
- Manufacturing has immediate and long-term shortages through 2060 due to increasing water demand and groundwater supplies limited by drawdown criteria. Live Oak-Manufacturing can receive 63% of their projected groundwater use in 2060 and still meet drawdown criteria.
- Irrigation has immediate and long-term shortages, limited by availability of groundwater.
- In 2060, the groundwater supplies to the county are less than projected groundwater use for Live Oak County (Section 3.4) attributable to supply reductions described above for Live Oak County Mining, Manufacturing, and Irrigation users.
- Livestock has sufficient supply through 2060.

Table 4A-16.
Live Oak County
Population, Water Supply, and Water Demand Projections

	Population Projection	***Year***						
		2000	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
		12,309	13,735	14,929	15,386	15,018	13,808	12,424
	Supply and Demand by Type of Use	***Year***						
		2000 (acft)	***2010 (acft)***	***2020 (acft)***	***2030 (acft)***	***2040 (acft)***	***2050 (acft)***	***2060 (acft)***
Municipal	Municipal Demand (See Table 4A-17)	2,350	2,573	2,750	2,796	2,693	2,459	2,213
	Municipal Existing Supply							
	Groundwater	1,768	1,896	1,972	1,985	1,945	1,805	1,645
	Surface water	4,050	4,045	4,043	4,042	4,043	4,046	4,049
	Total Existing Municipal Supply	5,818	5,941	6,015	6,027	5,988	5,851	5,694
	Municipal Balance	3,468	3,368	3,265	3,231	3,295	3,392	3,481
Industrial	Manufacturing Demand	1,767	1,946	1,998	2,032	2,063	2,088	2,194
	Manufacturing Existing Supply							
	Groundwater	754	809	715	673	648	631	630
	Surface water	800	800	800	800	800	800	800
	Total Manufacturing Supply	1,554	1,609	1,515	1,473	1,448	1,431	1,430
	Manufacturing Balance	(213)	(337)	(483)	(559)	(615)	(657)	(764)
	Steam-Electric Demand	0	0	0	0	0	0	0
	Steam-Electric Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Steam-Electric Supply	0	0	0	0	0	0	0
	Steam-Electric Balance	0	0	0	0	0	0	0
	Mining Demand	3,105	3,894	4,319	4,583	4,845	5,108	5,341
	Mining Existing Supply							
	Groundwater	3,105	3,830	3,841	3,655	3,611	3,604	3,586
	Surface water	0	0	0	0	0	0	0
	Total Mining Supply	3,105	3,830	3,841	3,655	3,611	3,604	3,586
	Mining Balance	0	(64)	(478)	(928)	(1,234)	(1,504)	(1,755)
Agriculture	Irrigation Demand	3,539	3,289	3,056	2,840	2,639	2,451	2,277
	Irrigation Existing Supply							
	Groundwater	2,649	2,462	2,287	2,126	1,975	1,835	1,704
	Surface water	200	200	200	200	200	200	200
	Total Irrigation Supply	2,849	2,662	2,487	2,326	2,175	2,035	1,904
	Irrigation Balance	(690)	(627)	(569)	(514)	(464)	(416)	(373)
	Livestock Demand	833	833	833	833	833	833	833
	Livestock Existing Supply							
	Groundwater	417	417	417	417	417	417	417
	Surface water	416	416	416	416	416	416	646
	Total Livestock Supply	833	833	833	833	833	833	833
	Livestock Balance	0	0	0	0	0	0	0
Total	Municipal and Industrial Demand	7,222	8,413	9,067	9,411	9,601	9,655	9,748
	Existing Municipal and Industrial Supply							
	Groundwater	5,627	6,535	6,528	6,313	6,204	6,040	5,861
	Surface water	4,850	4,845	4,843	4,842	4,843	4,846	4,849
	Total Municipal and Industrial Supply	10,477	11,380	11,371	11,155	11,047	10,886	10,710
	Municipal and Industrial Balance	3,255	2,967	2,304	1,744	1,446	1,231	962
	Agriculture Demand	4,372	4,122	3,889	3,673	3,472	3,284	3,110
	Existing Agricultural Supply							
	Groundwater	3,066	2,879	2,704	2,543	2,392	2,252	2,121
	Surface water	616	616	616	616	616	616	616
	Total Agriculture Supply	3,682	3,495	3,320	3,159	3,008	2,868	2,737
	Agriculture Balance	(690)	(627)	(569)	(514)	(464)	(416)	(373)
	Total Demand	11,594	12,535	12,956	13,084	13,073	12,939	12,858
	Total Supply							
	Groundwater	8,693	9,414	9,232	8,856	8,596	8,292	7,982
	Surface water	5,466	5,461	5,459	5,458	5,459	5,462	5,465
	Total Supply	14,159	14,875	14,691	14,314	14,055	13,754	13,447
	Total Balance	2,565	2,340	1,835	1,230	982	815	589

Note: City of Three Rivers acquired Choke Canyon WSC in January 2004. Choke Canyon WSC supply/demands in Live Oak County are met by the City of Three Rivers (Live Oak County).

Table 4A-17.
Live Oak County
Municipal Water Demand and Supply by City/County
(acft)

City/County	2000	2010	2020	2030	2040	2050	2060
Choke Canyon WSC							
Demand	360	397	425	435	421	384	346
Supply	365	406	430	437	422	386	350
Groundwater	193	179	174	171	168	165	163
Surface Water[1]	172	227	256	266	254	221	187
Balance	5	9	5	2	1	2	4
El Oso WSC							
Demand	189	206	220	223	215	196	176
Supply	189	206	220	223	215	196	176
Groundwater	189	206	220	223	215	196	176
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
George West							
Demand	642	703	754	767	738	675	608
Supply	642	703	754	767	738	675	608
Groundwater	642	703	754	767	738	675	608
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
McCoy WSC							
Demand	50	54	57	58	56	51	46
Supply	60	60	60	60	60	60	60
Groundwater[2]	60	60	60	60	60	60	60
Surface Water	—	—	—	—	—	—	—
Balance	10	6	3	2	4	9	14
Three Rivers							
Demand	425	465	498	505	485	444	399
Supply	3,878	3,818	3,787	3,776	3,789	3,825	3,862
Groundwater	—	—	—	—	—	—	—
Surface Water[3]	3,878	3,818	3,787	3,776	3,789	3,825	3,862
Balance	3,453	3,353	3,289	3,271	3,304	3,381	3,463

Table 4A-16 (Concluded)

City/County	2000	2010	2020	2030	2040	2050	2060
County-Other							
Demand	684	748	796	808	778	709	638
Supply	684	748	764	764	764	709	638
Groundwater	684	748	764	764	764	709	638
Surface Water	—	—	—	—	—	—	—
Balance	—	—	(32)	(44)	(14)	—	—
Total for Live Oak County							
Demand	2,350	2,573	2,750	2,796	2,693	2,459	2,213
Supply	5,818	5,941	6,015	6,027	5,988	5,851	5,694
Groundwater	1,768	1,896	1,972	19,85	19,45	1,805	1,645
Surface Water	4,050	4,045	4,043	4,042	4,043	4,046	4,049
Balance	3,468	3,368	3,265	3,231	3,295	3,392	3,481

[1]Surface water supplied by City of Three Rivers.
[2]Groundwater supplies from the Carrizo-Wilcox aquifer.
[3]700 acft/yr is supplied by City of Three Rivers and remainder by City of Corpus Christi.

4A.3.9 Comparison of Demand to Supply – McMullen County

A summary of population, water demands, water supply, and shortages are shown by decade for the 2000 through 2060 period in Table 4A-18 for all categories of water use. Table 4A-19 includes a summary of municipal demands.

Demands

- For the period 2000 to 2060, municipal demand increases from 175 acft in 2000 to 190 acft in 2020 and then decreases to 152 acft in 2060.
- Mining demand increases from 176 acft to 218 acft from 2000 to 2060.
- Livestock demand is constant at 659 acft.

Supplies

- In January 2004, Choke Canyon WSC was purchased by the City of Three Rivers. Choke Canyon WSC water demands are split between Live Oak and McMullen Counties. Surface water supplies from City of Three Rivers supplement groundwater supplies to meet former Choke Canyon WSC customer needs.
- Groundwater supplies are from the Carrizo-Wilcox and Gulf Coast Aquifers.
- Surface water for livestock needs is met by on-farm/local sources.

Comparison of Demand to Supply

- All municipal, industrial, and agricultural demands are met through 2060.
- Groundwater availability is from four source aquifers: Gulf Coast (1,200 acft/yr); Carrizo-Wilcox (7,909 acft/yr); Queen City (1,105 acft/yr); and Sparta (600 acft/yr). The highest amount of groundwater needed to satisfy demands is 487 acft/yr in 2060.
- The largest source, the Carrizo-Wilcox Aquifer, is somewhat difficult to access due to depth, water chemistry, and temperature (140° F).
- All municipal, industrial, and agricultural demands are met through 2060.

Table 4A-18.
McMullen County
Population, Water Supply, and Water Demand Projections

Population Projection	2000	2010	2020	2030	2040	2050	2060
	851	920	957	918	866	837	793

	Supply and Demand by Type of Use	2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Municipal	Municipal Demand (See Table 4A-19)	175	186	190	180	168	160	152
	Municipal Existing Supply							
	Groundwater	203	203	203	203	203	203	203
	Surface water	13	18	20	21	20	17	14
	Total Existing Municipal Supply	216	221	223	224	223	220	217
	Municipal Balance	41	35	33	44	55	60	65
Industrial	Manufacturing Demand	0	0	0	0	0	0	0
	Manufacturing Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Manufacturing Supply	0	0	0	0	0	0	0
	Manufacturing Balance	0	0	0	0	0	0	0
	Steam-Electric Demand	0	0	0	0	0	0	0
	Steam-Electric Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Steam-Electric Supply	0	0	0	0	0	0	0
	Steam-Electric Balance	0	0	0	0	0	0	0
	Mining Demand	176	195	203	207	211	215	218
	Mining Existing Supply							
	Groundwater	176	195	203	207	211	215	218
	Surface water	0	0	0	0	0	0	0
	Total Mining Supply	176	195	203	207	211	215	218
	Mining Balance	0	0	0	0	0	0	0
Agriculture	Irrigation Demand	0	0	0	0	0	0	0
	Irrigation Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Irrigation Supply	0	0	0	0	0	0	0
	Irrigation Balance	0	0	0	0	0	0	0
	Livestock Demand	659	659	659	659	659	659	659
	Livestock Existing Supply							
	Groundwater	66	66	66	66	66	66	66
	Surface water	593	593	593	593	593	593	593
	Total Livestock Supply	659	659	659	659	659	659	659
	Livestock Balance	0	0	0	0	0	0	0
Total	Municipal and Industrial Demand	351	381	393	387	379	375	370
	Existing Municipal and Industrial Supply							
	Groundwater	379	398	406	410	414	418	421
	Surface water	13	18	20	21	20	17	14
	Total Municipal and Industrial Supply	392	416	426	431	434	435	435
	Municipal and Industrial Balance	41	35	33	44	55	60	65
	Agriculture Demand	659	659	659	659	659	659	659
	Existing Agricultural Supply							
	Groundwater	66	66	66	66	66	66	66
	Surface water	593	593	593	593	593	593	593
	Total Agriculture Supply	659	659	659	659	659	659	659
	Agriculture Balance	0	0	0	0	0	0	0
	Total Demand	1,010	1,040	1,052	1,046	1,038	1,034	1,029
	Total Supply							
	Groundwater	445	464	472	476	480	484	487
	Surface water	606	611	613	614	613	610	607
	Total Supply	1,051	1,075	1,085	1,090	1,093	1,094	1,094
	Total Balance	41	35	33	44	55	60	65

Table 4A-19.
McMullen County
Municipal Water Demand and Supply by City/County
(acft)

City/County	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Choke Canyon WSC							
Demand	40	43	44	42	39	37	35
Supply	47	52	54	55	54	51	48
Groundwater	34	34	34	34	34	34	34
Surface Water	13	18	20	21	20	17	14
Balance	7	9	10	13	15	14	13
County-Other							
Demand	135	143	146	138	129	123	117
Supply	169	169	169	169	169	169	169
Groundwater	169	169	169	169	169	169	169
Surface Water	—	—	—	—	—	—	—
Balance	34	26	23	31	40	46	52
Total for McMullen County							
Demand	175	186	190	180	168	160	152
Supply	216	221	223	224	223	220	217
Groundwater	203	203	203	203	203	203	203
Surface Water	13	18	20	21	20	17	14
Balance	41	35	33	44	55	60	65

[1]Most groundwater supplies are from the Carrizo-Wilcox aquifer.

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4A.3.10 Comparison of Demand to Supply – Nueces County

A summary of population, water demands, water supply, and shortages are shown by decade for the 2000 through 2060 period in Table 4A-20 for all categories of water use. Table 4A-21 includes a summary of municipal demands.

Demands

- For the period 2000 to 2060, municipal demand increases from 62,702 acft in 2000 to 103,018 acft in 2060.
- Manufacturing demand increases from 39,763 acft in 2000 to 63,313 acft in 2060.
- Mining demand increases from 1,275 acft in 2000 to 1,724 acft in 2060; steam-electric demand increases from 8,799 acft in 2000 to 27,664 acft in 2060. Steam-Electric water demands include Lon Hill and potential, future steam-electric power plants as accounted for by TWDB studies.
- For the period 2000 to 2060, irrigation demand decreases from 1,680 acft to 692 acft; livestock demand is constant at 279 acft.

Supplies

- Surface water is supplied from the CCR/LCC/Lake Texana System by the City of Corpus Christi, SPMWD, STWA, and Nueces County WCID #3; some livestock needs are met with on-farm/local sources.
- Groundwater supplies are from the Gulf Coast Aquifer.

Comparison of Demand to Supply

- River Acres WSC has shortages from 2000 to 2060, with the greatest shortage of 590 acft in 2060. These shortages are attributable to contract limits with Nueces WCID #3.
- County-Other receives water supplies from the City of Corpus Christi, STWA, and Nueces County WCID #3. Their projected water demands decrease and surface water supplies remain constant based on contracts.
- Manufacturing has shortages ranging from 5,946 acft/yr in 2020 to 39,550 acft/yr in 2060. A 2020 shortage is attributable to water treatment plant constraints at the O.N. Stevens Plant. For later decades, the shortages are attributable to both raw water and water treatment plant constraints. For more detailed discussion, see Section 4A.2.1.
- Steam-Electric has shortages ranging from 1,982 acft/yr in 2020 to 13,183 acft/yr in 2060. A 2020 shortage is attributable to water treatment plant constraints on the O.N. Stevens Plant. For later decades, the shortages are attributable to both raw water and water treatment plant constraints.
- Mining has long-term shortages from 2030 through 2060, ranging from 570 acft/yr in 2030 to 1,624 acft/yr in 2060.
- There are sufficient irrigation and livestock supplies through 2060.

Table 4A-20. Nueces County Population, Water Supply, and Water Demand Projections

	Population Projection	2000	2010	2020	2030	2040	2050	2060
		313,645	358,278	405,492	447,014	483,692	516,265	542,327
	Supply and Demand by Type of Use	**2000 (acft)**	**2010 (acft)**	**2020 (acft)**	**2030 (acft)**	**2040 (acft)**	**2050 (acft)**	**2060 (acft)**
Municipal	Municipal Demand (See Table 4A-21)	62,702	70,609	78,691	85,697	91,988	97,882	103,018
	Municipal Existing Supply							
	Groundwater	325	276	235	178	155	140	132
	Surface water	82,129	79,235	78,201	85,310	91,648	97,554	102,679
	Total Existing Municipal Supply	82,454	79,511	78,436	85,488	91,803	97,694	102,811
	Municipal Balance	19,752	8,902	(255)	(209)	(185)	(188)	(207)
Industrial	Manufacturing Demand	39,763	46,510	50,276	53,425	56,500	59,150	63,313
	Manufacturing Existing Supply							
	Groundwater	972	1,137	1,229	1,306	1,381	1,446	1,548
	Surface water	38,791	45,373	41,636	36,916	32,741	27,144	22,215
	Total Manufacturing Supply	39,763	46,510	42,865	38,222	34,122	28,590	23,763
	Manufacturing Balance	0	0	(7,411)	(15,203)	(22,378)	(30,560)	(39,550)
	Steam-Electric Demand	8,799	7,316	14,312	16,733	19,683	23,280	27,664
	Steam-Electric Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	8,799	7,316	12,330	11,978	12,224	13,093	14,481
	Total Steam-Electric Supply	8,799	7,316	12,330	11,978	12,224	13,093	14,481
	Steam-Electric Balance	0	0	(1,982)	(4,755)	(7,459)	(10,187)	(13,183)
	Mining Demand	1,275	1,472	1,555	1,599	1,641	1,682	1,724
	Mining Existing Supply							
	Groundwater	74	85	90	93	95	98	100
	Surface water	1,201	1,387	1,465	936	0	0	0
	Total Mining Supply	1,275	1,472	1,555	1,029	95	98	100
	Mining Balance	0	0	0	(570)	(1,546)	(1,584)	(1,624)
Agriculture	Irrigation Demand	1,680	1,449	1,250	1,077	928	801	692
	Irrigation Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water[1]	4,007	4,007	4,007	4,007	4,007	4,007	4,007
	Total Irrigation Supply	4,007	4,007	4,007	4,007	4,007	4,007	4,007
	Irrigation Balance	2,327	2,558	2,757	2,930	3,079	3,206	3,315
	Livestock Demand	279	279	279	279	279	279	279
	Livestock Existing Supply							
	Groundwater	80	80	80	80	80	80	80
	Surface water	199	199	199	199	199	199	199
	Total Livestock Supply	279	279	279	279	279	279	279
	Livestock Balance	0	0	0	0	0	0	0
Total	Municipal and Industrial Demand	112,539	125,907	144,834	157,454	169,812	181,994	195,719
	Existing Municipal and Industrial Supply							
	Groundwater	1,371	1,498	1,554	1,577	1,631	1,684	1,780
	Surface water	130,920	133,311	133,632	135,140	136,613	137,791	139,375
	Total Municipal and Industrial Supply	132,291	134,311	135,186	136,717	138,244	139,475	141,155
	Municipal and Industrial Balance	19,752	8,902	(9,648)	(20,737)	(31,568)	(42,519)	(54,564)
	Agriculture Demand	1,959	1,728	1,529	1,356	1,207	1,080	971
	Existing Agricultural Supply							
	Groundwater	80	80	80	80	80	80	80
	Surface water	4,206	4,206	4,206	4,206	4,206	4,206	4,206
	Total Agriculture Supply	4,286	4,286	4,286	4,286	4,286	4,286	4,286
	Agriculture Balance	2,327	2,558	2,757	2,930	3,079	3,206	3,315
	Total Demand	114,498	127,635	146,363	158,810	171,019	183,074	196,690
	Total Supply							
	Groundwater	1,451	1,578	1,634	1,657	1,711	1,764	1,860
	Surface water	135,126	137,517	137,838	139,346	140,819	141,997	143,581
	Total Supply	136,577	139,095	139,472	141,003	142,530	143,761	145,441
	Total Balance	22,079	11,460	(6,891)	(17,807)	(28,489)	(39,313)	(51,249)

[1] Includes 569 acft surface water supply from run-of-river water rights in the Nueces-Rio Grande Coastal Basin.

Table 4A-21.
Nueces County
Municipal Water Demand and Supply by City/County
(acft)

City/County	2000	2010	2020	2030	2040	2050	2060
Agua Dulce							
Demand	115	112	110	107	105	103	103
Supply	115	112	110	107	105	103	103
Groundwater	—	—	—	—	—	—	—
Surface Water	115	112	110	107	105	103	103
Balance	—	—	—	—	—	—	—
Aransas Pass							
Demand	12	26	41	53	64	73	81
Supply	12	26	41	53	64	73	81
Groundwater	—	—	—	—	—	—	—
Surface Water	12	26	41	53	64	73	81
Balance	—	—	—	—	—	—	—
Bishop							
Demand	459	444	433	422	411	404	404
Supply	551	444	433	422	411	404	404
Groundwater	131	127	124	121	117	115	115
Surface Water	420	317	309	301	294	289	289
Balance	92	—	—	—	—	—	—
Corpus Christi							
Demand	55,629	61,953	68,212	73,592	78,422	82,961	86,962
Supply	75,979	71,254	68,212	73,592	78,422	82,961	86,962
Groundwater	—	—	—	—	—	—	—
Surface Water	75,979	71,254	68,212	73,592	78,422	82,961	86,962
Balance	20,350	9,301	—	—	—	—	—
Driscoll							
Demand	97	122	148	171	191	208	224
Supply	97	122	148	171	191	208	224
Groundwater	—	—	—	—	—	—	—
Surface Water	97	122	148	171	191	208	224
Balance	—	—	—	—	—	—	—
Nueces County WCID #4							
Demand	977	1,913	2,884	3,729	4,460	5,124	5,655
Supply	977	1,913	2,884	3,729	4,460	5,124	5,655
Groundwater	—	—	—	—	—	—	—
Surface Water	977	1,913	2,884	3,729	4,460	5,124	5,655
Balance	—	—	—	—	—	—	—

Table 4A-20 (Concluded)

City/County	2000	2010	2020	2030	2040	2050	2060
Port Aransas							
Demand	1,601	2,606	3,655	4,558	5,355	6,068	6,637
Supply	1,601	2,606	3,655	4,558	5,355	6,068	6,637
Groundwater	—	—	—	—	—	—	—
Surface Water	1,601	2,606	3,655	4,558	5,355	6,068	6,637
Balance	—	—	—	—	—	—	—
River Acres WSC							
Demand	314	429	546	646	736	813	881
Supply	291	291	291	291	291	291	291
Groundwater	—	—	—	—	—	—	—
Surface Water	291	291	291	291	291	291	291
Balance	(23)	(138)	(255)	(355)	(445)	(522)	(590)
Robstown							
Demand	2,153	2,110	2,067	2,024	1,982	1,953	1,953
Supply	2,153	2,110	2,067	2,024	1,982	1,953	1,953
Groundwater	—	—	—	—	—	—	—
Surface Water	2,153	2,110	2,067	2,024	1,982	1,953	1,953
Balance	—	—	—	—	—	—	—
County-Other							
Demand	1,345	894	595	395	262	175	118
Supply	678	633	595	541	522	509	501
Groundwater	194	149	111	57	38	25	17
Surface Water	484	484	484	484	484	484	484
Balance	(667)	(261)	—	146	260	334	383
Total for Nueces County							
Demand	62,702	70,609	78,691	85,697	91,988	97,882	103,018
Supply	82,454	79,511	78,436	85,488	91,803	97,694	102,811
Groundwater	325	276	235	178	155	140	132
Surface Water	82,129	79,235	78,201	85,310	91,648	97,554	102,679
Balance	19,752	8,902	(255)	(209)	(185)	(188)	(207)

4A.3.11 Comparison of Demand to Supply – San Patricio County

A summary of population, water demands, water supply, and shortages are shown by decade for the 2000 through 2060 period in Table 4A-22 for all categories of water use. Table 4A-23 includes a summary of municipal demands.

Demands

- For the period 2000 to 2060, municipal demand increases from 8,873 acft in 2000 to 16,191 acft in 2060.
- Manufacturing demand increases from 12,715 acft in 2000 to 22,283 acft in 2060.
- Mining increases from 85 acft in 2000 to 117 acft in 2060.
- For the period 2000 to 2060, irrigation demand increases from 4,565 acft to 14,195 acft; livestock demand is constant at 564 acft.

Supplies

- Surface water is supplied from the CCR/LCC/Lake Texana System by the City of Corpus Christi; the SPMWD has a contract to purchase 40,000 acft of water annually from the City of Corpus Christi; some livestock demands are met with on-farm/local sources.
- Groundwater supplies are from the Gulf Coast Aquifer.
- Groundwater supply for irrigation was set equal to the maximum pumping from 2000 to 2006 (i.e. estimated well capacity).

Comparison of Demand to Supply

- Lake City is projected to have shortages from 2020 through 2060. Groundwater supply to Lake City is limited by well capacity, which results in groundwater supplies to the county being 37 acft less than projected groundwater use for San Patricio County in 2060 (Section 3.4).
- Supplies for irrigation are constrained by well capacity, resulting in an irrigation shortage of 750 acft/yr in 2030, increasing to 4,414 acft/yr in 2060.
- There are sufficient mining supplies through the year 2060.
- Manufacturing has projected shortages from 2,081 acft/yr in 2040 to 6,455 acft in 2060 as a result of both raw water constraints and treatment plants' constraints.

Table 4A-22.
San Patricio County
Population, Water Supply, and Water Demand Projections

	Population Projection	Year 2000	2010	2020	2030	2040	2050	2060
		67,138	80,701	95,381	109,518	122,547	134,806	146,131
	Supply and Demand by Type of Use	**2000 (acft)**	**2010 (acft)**	**2020 (acft)**	**2030 (acft)**	**2040 (acft)**	**2050 (acft)**	**2060 (acft)**
Municipal	Municipal Demand (See Table 4A-23)	8,873	10,070	11,423	12,661	13,813	14,997	16,191
Municipal	Municipal Existing Supply							
Municipal	Groundwater	1,967	2,044	2,124	2,190	2,242	2,320	2,411
Municipal	Surface water	6,906	8,026	9,299	10,460	11,554	12,649	13,745
Municipal	Total Existing Municipal Supply	8,873	10,070	11,423	12,650	13,796	14,969	16,156
Municipal	Municipal Balance	0	0	(1)	(11)	(19)	(28)	(37)
Industrial	Manufacturing Demand	12,715	15,096	16,699	18,111	19,505	20,733	22,283
Industrial	Manufacturing Existing Supply							
Industrial	Groundwater	9	11	12	13	14	15	16
Industrial	Surface water	12,706	15,085	16,687	18,098	17,410	17,365	15,812
Industrial	Total Manufacturing Supply	12,715	15,096	16,699	18,111	17,424	17,380	15,828
Industrial	Manufacturing Balance	0	0	0	0	(2,081)	(3,353)	(6,455)
Industrial	Steam-Electric Demand	0	0	0	0	0	0	0
Industrial	Steam-Electric Existing Supply							
Industrial	Groundwater	0	0	0	0	0	0	0
Industrial	Surface water	0	0	0	0	0	0	0
Industrial	Total Steam-Electric Supply	0	0	0	0	0	0	0
Industrial	Steam-Electric Balance	0	0	0	0	0	0	0
Industrial	Mining Demand	85	99	105	108	111	114	117
Industrial	Mining Existing Supply							
Industrial	Groundwater	85	99	105	108	111	114	117
Industrial	Surface water	0	0	0	0	0	0	0
Industrial	Total Mining Supply	85	99	105	108	111	114	117
Industrial	Mining Balance	0	0	0	0	0	0	0
Agriculture	Irrigation Demand	4,565	8,631	9,534	10,531	11,633	12,850	14,195
Agriculture	Irrigation Existing Supply							
Agriculture	Groundwater	4,565	8,631	9,534	9,698	9,698	9,698	9,698
Agriculture	Surface water[1]	83	83	83	83	83	83	83
Agriculture	Total Irrigation Supply	4,648	8,714	9,617	9,781	9,781	9,781	9,781
Agriculture	Irrigation Balance	83	83	83	(750)	(1,852)	(3,069)	(4,414)
Agriculture	Livestock Demand	564	564	564	564	564	564	564
Agriculture	Livestock Existing Supply							
Agriculture	Groundwater	57	57	57	57	57	57	57
Agriculture	Surface water	507	507	507	507	507	507	507
Agriculture	Total Livestock Supply	564	564	564	564	564	564	564
Agriculture	Livestock Balance	0	0	0	0	0	0	0
Total	Municipal and Industrial Demand	21,673	25,265	28,227	30,880	33,429	35,844	38,591
Total	Existing Municipal and Industrial Supply							
Total	Groundwater	2,061	2,154	2,241	2,311	2,367	2,449	2,544
Total	Surface water	19,612	23,111	25,986	28,558	28,964	30,014	29,557
Total	Total Municipal and Industrial Supply	21,673	25,265	28,227	30,869	31,331	32,463	32,101
Total	Municipal and Industrial Balance	0	0	0	(11)	(2,098)	(3,381)	(6,490)
Total	Agriculture Demand	5,129	9,195	10,098	11,095	12,197	13,414	14,759
Total	Existing Agricultural Supply							
Total	Groundwater	4,622	8,688	9,591	9,755	9,755	9,755	9,755
Total	Surface water	590	590	590	590	590	590	590
Total	Total Agriculture Supply	5,212	9,278	10,181	10,345	10,345	10,345	10,345
Total	Agriculture Balance	83	83	83	(750)	(1,852)	(3,069)	(4,414)
Total	Total Demand	26,802	34,460	38,325	41,975	45,626	49,258	53,350
Total	Total Supply							
Total	Groundwater	6,683	10,842	11,832	12,066	12,122	12,204	12,299
Total	Surface water	20,202	23,701	26,576	29,148	29,554	30,604	30,147
Total	Total Supply	26,885	34,543	38,408	41,214	41,676	42,808	42,446
Total	Total Balance	83	83	83	(761)	(3,950)	(6,450)	(10,904)

[1] Surface water supplies from run-of-river water rights in the San Antonio-Nueces Coastal Basin.

Table 4A-23.
San Patricio County
Municipal Water Demand and Supply by City/County
(acft)

City/County	2000	2010	2020	2030	2040	2050	2060
Aransas Pass							
Demand	1,210	1,405	1,615	1,828	2,016	2,201	2,386
Supply	1,210	1,405	1,615	1,828	2,016	2,201	2,386
Groundwater	—	—	—	—	—	—	—
Surface Water	1,210	1,405	1,615	1,828	2,016	2,201	2,386
Balance	—	—	—	—	—	—	—
Gregory							
Demand	249	239	231	223	216	210	210
Supply	249	239	231	223	216	210	210
Groundwater	—	—	—	—	—	—	—
Surface Water	249	239	231	223	216	210	210
Balance	—	—	—	—	—	—	—
Ingleside							
Demand	873	1,294	1,771	2,202	2,607	3,016	3,395
Supply	873	1,294	1,771	2,202	2,607	3,016	3,395
Groundwater	—	—	—	—	—	—	—
Surface Water	873	1,294	1,771	2,202	2,607	3,016	3,395
Balance	—	—	—	—	—	—	—
Ingleside on the Bay							
Demand	74	92	112	130	148	164	181
Supply	74	92	112	130	148	164	181
Groundwater	—	—	—	—	—	—	—
Surface Water	74	92	112	130	148	164	181
Balance	—	—	—	—	—	—	—
Lake City							
Demand	70	79	89	99	107	116	125
Supply	70	79	88	88	88	88	88
Groundwater	70	79	88	88	88	88	88
Surface Water	—	—	—	—	—	—	—
Balance	—	—	(1)	(11)	(19)	(28)	(37)
Mathis							
Demand	671	648	632	615	598	586	586
Supply	800	648	632	615	598	586	586
Groundwater	—	—	—	—	—	—	—
Surface Water	671	648	632	615	598	586	586
Balance	—	—	—	—	—	—	—

Table 4A-22 (Concluded)

City/County	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Odem							
Demand	319	330	347	361	372	389	408
Supply	319	330	347	361	372	389	408
Groundwater	—	—	—	—	—	—	—
Surface Water	319	330	347	361	372	389	408
Balance	—	—	—	—	—	—	—
Portland							
Demand	1,976	2,399	2,869	3,290	3,716	4,106	4,498
Supply	1,976	2,399	2,869	3,290	3,716	4,106	4,498
Groundwater	—	—	—	—	—	—	—
Surface Water	1,976	2,399	2,869	3,290	3,716	4,106	4,498
Balance	—	—	—	—	—	—	—
Sinton							
Demand	1,036	1,052	1,062	1,076	1,086	1,108	1,135
Supply	1,036	1,052	1,062	1,076	1,086	1,108	1,135
Groundwater	1,036	1,052	1,062	1,076	1,086	1,108	1,135
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
Taft							
Demand	559	586	619	648	672	703	736
Supply	559	586	619	648	672	703	736
Groundwater	—	—	—	—	—	—	—
Surface Water	559	586	619	648	672	703	736
Balance	—	—	—	—	—	—	—
County-Other							
Demand	1,836	1,946	2,077	2,189	2,277	2,398	2,533
Supply	1,836	1,946	2,077	2,189	2,277	2,398	2,533
Groundwater	861	913	974	1,026	1,068	1,124	1,188
Surface Water	975	1,033	1,103	1,163	1,209	1,274	1,345
Balance	—	—	—	—	—	—	—
Total for San Patricio County							
Demand	8,873	10,070	11,423	12,661	13,815	14,997	16,193
Supply	8,873	10,070	11,423	12,650	13,796	14,969	16,156
Groundwater	1,967	2,044	2,124	2,190	2,242	2,320	2,411
Surface Water	6,906	8,026	9,299	10,460	11,554	12,649	13,745
Balance	—	—	(1)	(11)	(19)	(28)	(37)

4A.4 Wholesale Water Providers — Comparison of Demand and Supply

The Coastal Bend Region has four wholesale water providers. These include the City of Corpus Christi (City), San Patricio Municipal Water District (SPMWD), South Texas Water Authority (STWA), and Nueces County WCID #3.

The City of Corpus Christi provides water to SPMWD and STWA, who then supply water to their customers, as shown in Figure 4A-1. SPMWD receives up to 40,000 acft/yr of raw and treated water from the City according to their contract. The most typical contract between the City and its customers includes providing water at the greater amount supplied in previous years plus 10 percent. When projecting customer supplies (2010 to 2060), it was assumed that either: (1) supply increased each year by 10 percent, or (2) supply was equal to demand, whichever is less.

4A.5 Safe Yield Supply to Demands

The Coastal Bend Region adopted use of safe yield supply for the three largest wholesale water providers: City of Corpus Christi, SPMWD, and STWA and their customers. The safe yield supplies assume a reserve of 75,000 acft (i.e., 7 percent CCR/LCC/Lake Texana System storage) as a drought management strategy to plan for future droughts greater than the drought of record. Table 4A-24 shows the safe yield water supply for each Wholesale Water Provider, the amount of water supplied to each customer, and resulting water surplus or shortage after meeting customer needs. This analysis is shown for both the raw water and treated water components of the City of Corpus Christi and SPMWD systems. However, treated and raw water shortages are not additive, but are instead shown in the table only to differentiate raw water source shortages. As discussed earlier, the larger of the raw water or treated water plant capacity shortages by decade are used for planning purposes. STWA and their customers receive only treated water supplies. The City of Corpus Christi water supply for 2010 is 205,000 acft, which includes supplies from the CCR/LCC/Lake Texana System and a base amount of 41,840 acft/yr and up to 12,000 acft/yr on an interruptible basis from Lake Texana. This System supply diminishes to 200,000 acft by 2060 because of reservoir sedimentation.

The City of Corpus Christi, after meeting demands and/or contracts with its customers, has raw water supply shortages from 2030 to 2060, indicating a need for increased source water supplies. In addition, beginning in 2020, the City has shortages associated with the treated water customers, indicating that the current treatment plant capacity is not sufficient to meet future treated water needs. The shortages are applied to industrial users in Nueces County (Manufacturing, Mining, and Steam-

Table 4A-24.
Surface Water Allocation/Wholesale

Wholesale Water Provider (Water User/County)	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
City of Corpus Christi							
Raw Water Supply/Needs Analysis							
Safe Yield Supply (CCR/LCC Texana System)	**206,000**	**205,000**	**204,000**	**203,000**	**202,000**	**201,000**	**200,000**
Current Treatment Capacity[1]	127,248	127,248	127,248	127,248	127,248	127,248	127,248
Raw Water Available for Sales	78,752	77,752	76,752	75,752	74,752	73,752	72,752
Raw Water Contract Sales							
Municipal							
Jim Wells County							
City of Alice	5,281	5,606	5,912	6,076	6,102	6,033	5,904
Bee County							
City of Beeville	2,529	2,619	2,691	2,722	2,699	2,683	2,618
San Patricio County							
City of Mathis	671	648	632	615	598	586	586
San Patricio MWD	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Live Oak County							
City of Three Rivers	3,363	3,363	3,363	3,363	3,363	3,363	3,363
Non-Municipal							
Manufacturing (Nueces County)[2]	9,698	11,343	12,262	13,030	13,780	14,426	15,441
Total Raw Water Demand	**51,542**	**53,579**	**54,860**	**55,806**	**56,542**	**57,091**	**57,912**
Treated Water Supply/Needs Analysis							
O.N. Stevens WTP Capacity[1]	**127,248**	**127,248**	**127,248**	**127,248**	**127,248**	**127,248**	**127,248**
Treated Water Contract Sales							
Municipal							
San Patricio County							
San Patricio MWD[3]	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Nueces County							
Nueces County WCID #4[4]	977	1,913	2,884	3,729	4,460	5,124	5,655
City of Corpus Christi	55,629	61,953	68,212	73,592	78,422	82,961	86,962
County-Other[5,6]	116	116	116	116	116	116	116
Kleberg County							
South Texas Water Authority	2,284	2,619	2,867	3,011	3,065	3,236	3,260
Non-Municipal							
Mining (Nueces County)[5]	1,201	1,387	1,465	1,506	1,546	1,584	1,624
Manufacturing (Nueces County)[7]	29,093	34,030	36,785	39,089	41,339	43,278	46,324
Steam-Electric (Nueces County)[8]	8,799	7,316	14,312	16,733	19,683	23,280	27,664
Total Treated Water Demand	**108,099**	**119,334**	**136,641**	**147,776**	**158,631**	**169,579**	**181,605**

Table 4A-24 (Continued)

Wholesale Water Provider (Water User/County)	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
Treated Water Surplus/Shortage (applied to Nueces County Mining, Manufacturing and Steam-Electric)	**19,149**	**7,914**	**(9,393)**	**(20,528)**	**(31,383)**	**(42,331)**	**(54,357)**
Total Water Supply/Needs Analysis							
Safe Yield Supply (CCR/LCC Texana System)	**206,000**	**205,000**	**204,000**	**203,000**	**202,000**	**201,000**	**200,000**
Total Raw Water and Treated Water Demands	**159,641**	**172,913**	**191,501**	**203,582**	**215,173**	**226,670**	**239,517**
Total Raw Water Surplus/Shortage	**46,359**	**32,087**	**12,499**	**(582)**	**(13,173)**	**(25,670)**	**(39,517)**
San Patricio Municipal Water District							
Raw Water Supply/Needs Analysis							
Contract Purchases from City of Corpus Christi	**40,000**	**40,000**	**40,000**	**40,000**	**40,000**	**40,000**	**40,000**
Current Treatment Capacity[9]	20,003	20,003	20,003	20,003	20,003	20,003	20,003
Purchased Treated Water from City	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Total Treated Water Supply	30,003	30,003	30,003	30,003	30,003	30,003	30,003
Raw Water Available for Sales	9,997	9,997	9,997	9,997	9,997	9,997	9,997
Raw Water Contract Sales							
Non-Municipal							
Manufacturing (San Patricio County)[10]	7,841	7,841	7,841	7,841	7,841	7,841	7,841
Total Raw Water Demand	**7,841**	**7,841**	**7,841**	**7,841**	**7,841**	**7,841**	**7,841**
Treated Water Supply/Needs Analysis							
Total Treated Water Supply	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**
Treated Water Contract Sales							
Municipal							
Nueces County							
City of Aransas Pass	12	26	41	53	64	73	81
Port Aransas	1,601	2,606	3,655	4,558	5,355	6,068	6,637
San Patricio County							
City of Aransas Pass	1,210	1,405	1,615	1,828	2,016	2,201	2,386
City of Gregory	249	239	231	223	216	210	210
City of Ingleside	873	1,294	1,771	2,202	2,607	3,016	3,395
City of Ingleside on the Bay	74	92	112	130	148	164	181
City of Portland	1,976	2,399	2,869	3,290	3,716	4,106	4,498
City of Odem	319	330	347	361	372	389	408
City of Taft	559	586	619	648	672	703	736
County-Other	975	1,033	1,103	1,163	1,209	1,274	1,345

Table 4A-24 (Continued)

Wholesale Water Provider (Water User/County)	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
Aransas County							
City of Aransas Pass	146	168	186	195	190	179	169
City of Fulton	261	307	346	365	359	336	318
City of Rockport	1,357	1,590	1,778	1,868	1,823	1,712	1,620
County-Other	1,338	1,524	1,686	1,740	1,687	1,575	1,491
Non-Municipal							
Manufacturing (San Patricio County)[11]	4,865	7,244	8,846	10,257	11,650	12,877	14,426
Total Treated Water Demand	**15,815**	**20,839**	**25,205**	**28,881**	**32,084**	**34,883**	**37,901**
Treated Water Surplus/Shortage (applied to Aransas County-Other and San Patricio County Manufacturing)	**14,188**	**9,164**	**4,798**	**1,122**	**(2,081)**	**(4,880)**	**(7,898)**
Total Water Supply/Needs Analysis							
Total Water Supply	**40,000**	**40,000**	**40,000**	**40,000**	**40,000**	**40,000**	**40,000**
Total Raw Water and Treated Water Demands	**23,656**	**28,680**	**33,046**	**36,722**	**39,925**	**42,724**	**45,742**
Total Raw Water Surplus/Shortage	**16,344**	**11,320**	**6,954**	**3,278**	**75**	**(2,724)**	**(5,742)**
South Texas Water Authority							
Total Surface Water Right	0	0	0	0	0	0	0
Contract Purchases	2,284	2,619	2,867	3,011	3,065	3,236	3,260
Contract Sales							
Municipal							
Nueces County							
City of Agua Dulce	115	112	110	107	105	103	103
City of Driscoll	97	122	148	171	191	208	224
City of Bishop	420	317	309	301	294	289	289
County-Other[5,12]	213	213	213	213	213	213	213
Kleberg County							
City of Kingsville	1,221	1,352	1,382	1,385	1,350	1,397	1,400
Ricardo WSC	218	503	705	834	912	1,026	1,031
Total Contract Sales	**2,284**	**2,619**	**2,867**	**3,011**	**3,065**	**3,236**	**3,260**
Surplus/Shortage	—	—	—	—	—	—	—
Nueces County WCID #3							
Total Surface Water Right (firm yield)[13]	7,103	7,103	7,103	7,103	7,103	7,103	7,103
Contract Sales							
Municipal							
Nueces County							

Table 4A-24 (Concluded)

Wholesale Water Provider (Water User/County)	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
County-Other[5,14]	155	155	155	155	155	155	155
City of Robstown	2,153	2,110	2,067	2,024	1,982	1,953	1,953
River Acres WSC[15]	291	291	291	291	291	291	291
Non-Municipal							
Nueces County Irrigation[16]	1,680	1,449	1,250	1,077	928	801	692
Total Contract Sales	**4,279**	**4,005**	**3,763**	**3,547**	**3,356**	**3,200**	**3,091**
Surplus/Shortage	**2,824**	**3,098**	**3,340**	**3,556**	**3,747**	**3,903**	**4,012**

[1] Average day treatment capacity calculated as 159 MGD with a peaking capacity of 1.4:1 (159MGD/1.4 = 113.6MGD or 127,248 acft/yr). The max day to average day (peaking factor) of 1.4 is the average peaking factor of the plant for the time period 2004 to 2009.

[2] Calculated based on 25% of the Nueces County Manufacturing demand being for raw water. This is based on City billing records for 2001 through 2005.

[3] Corpus Christi's contract with San Patricio MWD specifies that 10,000 acft/yr will be treated water, the remaining 30,000 acft/yr is raw water.

[4] The TWDB provides separate decadal water demands for Nueces County WCID #4 and the City of Port Aransas. Based on conversations with the City of Corpus Christi and the San Patricio Municipal Water District (SPMWD) in February 2005, the City is shown to provide water supplies to Nueces County WCID #4 and SPMWD is shown to provide water supplied to Port Aransas to meet demands. Of the total demand for both entities in Year 2060, the TWDB projections show Nueces County WCID #4 having 46% of the demand with 54% for the City of Port Aransas.

[5] Wholesale water provider does not meet full demand (i.e. additional supply from groundwater).

[6] Includes Violet WSC.

[7] Calculated based on 75% of the Nueces County Manufacturing demand being for treated water. This is based on City billing records for 2001 through 2005.

[8] Steam-Electric water demands include Lon Hill and potential, future steam-electric power plants as accounted by TWDB studies. As a conservative estimate, future steam-electric water demands are assumed to be provided treated water.

[9] Average day treatment capacity calculated as 25MGD with a peaking capacity of 1.4:1 (25MGD/1.4 = 17.9MGD or 20,003 acft/yr).

[10] Based on total raw water contracts of 7MGD.

[11] Remaining Manufacturing demand (San Patricio County) after accounting for raw water sales.

[12] Includes Coastal Bend Youth City, Nueces County WCID #5, Nueces WSC, and other rural water users.

[13] Surface water right volume has been increased from 3,665 acft/yr to 7,103 acft/yr with the condition that the additional volume can only be used for non-municipal purposes.

[14] Includes City of San Pedro.

[15] Limited by contract. May opt to increase contract amount to cover needs.

[16] Includes all of the projected irrigation demands in Nueces County.

Electric), as shown in Table 4A-20. SPMWD, authorized to receive 40,000 acft/yr of water from the City of Corpus Christi, meets the demands of its customers and has a raw water surplus through 2040. After 2040, SPMWD will need to obtain additional raw water supplies. Similar to the City of Corpus Christi, SPMWD has shortages associated with treated water supplies beginning in 2040, indicating that the current treatment plant capacity is not sufficient to meet future treated water needs. SPMWD's shortages are applied to Aransas County-Other and San Patricio County Manufacturing as shown in Table 4A-3 and Table 4A-22, respectively. STWA receives treated water supplies to meet the demands of its customers, consistent with the terms of the present contracts, and has no projected shortages. Nueces County WCID #3 receives dependable supply through run-of-river water rights and is able to meet contracts with its customers and have a surplus through 2060.

4A.6 Region Summary

When comparing total available supplies to total demands, the region shows a current surplus until 2020. By the year 2020, a shortage of 7,912 acft exists and increases to a shortage of 68,499 acft by 2060 (Table 4A-25). A portion of this shortage is associated with treatment plant capacity constraints and is not necessarily a raw water shortage.

4A.6.1 Municipal and Industrial Summary

On a regional basis, Municipal and Industrial entities (Manufacturing, Steam-Electric, and Mining) show a surplus of 9,929 acft in 2010, although shortages of 409 acft are anticipated for remotely located Manufacturing entities and 1,801 acft for remotely located Mining entities. Due to increasing manufacturing demands, there are shortages of 22,372 acft by 2030 for municipal and industrial users increasing to 66,137 acft by 2060. Shortages in supplies provided by the City of Corpus Christi via the CCR/LCC/Lake Texana System were accumulated in industrial (mining, steam-electric, and/or manufacturing) demands in San Patricio and Nueces Counties, and Aransas County-Other.

Municipal demands account for approximately 47 percent of total demands in the region. Surface water accounts for approximately 87 percent of 2060 municipal supplies, with groundwater accounting for 13 percent. Although there is a region-wide municipal surplus, several cities and County-Others are experiencing near- and/or long-term shortages. These shortages are summarized in Table 4A-26.

Manufacturing demands account for 27 percent of total demands in 2060. The majority of these demands, 97 percent, are in Nueces and San Patricio Counties. Aransas, Bee, and Live Oak Counties make up the remaining 3 percent. Surface water supplies provide 94 percent of total manufacturing supplies in 2060; groundwater 6 percent. Region-wide there is a manufacturing supply deficit of 409 acft in 2010 increasing to 46,905 acft by 2060.

Table 4A-25.
Coastal Bend Region Summary
Population, Water Supply, and Water Demand Projections

	Population Projection	Year						
		2000	2010	2020	2030	2040	2050	2060
		541,184	617,143	693,940	758,427	810,650	853,954	885,665
	Supply and Demand by Type of Use	**Year**						
		2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Municipal	Municipal Demand	99,950	111,495	122,861	132,063	139,425	146,036	151,474
	Municipal Existing Supply							
	Groundwater	17,684	18,641	19,387	19,758	19,838	19,701	19,414
	Surface water	105,449	104,993	106,249	115,018	122,387	127,681	133,596
	Total Existing Municipal Supply	123,133	123,634	125,636	134,776	142,225	147,382	153,010
	Municipal Surplus (Shortage)	23,183	12,139	2,775	2,713	2,800	1,346	1,536
Industrial	Manufacturing Demand	54,481	63,820	69,255	73,861	78,371	82,283	88,122
	Manufacturing Existing Supply							
	Groundwater	1,931	2,153	2,152	2,188	2,239	2,288	2,390
	Surface water	52,297	61,258	59,123	55,814	50,951	45,309	38,827
	Total Manufacturing Supply	54,228	63,411	61,275	58,002	53,190	47,597	41,217
	Manufacturing Surplus (Shortage)	(253)	(409)	(7,980)	(15,859)	(25,181)	(34,686)	(46,905)
	Steam-Electric Demand	8,799	7,316	14,312	16,733	19,683	23,280	27,664
	Steam-Electric Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	8,799	7,316	12,330	11,978	12,224	13,093	14,481
	Total Steam-Electric Supply	8,799	7,316	12,330	11,978	12,224	13,093	14,481
	Steam-Electric Surplus (Shortage)	0	0	(1,982)	(4,755)	(7,549)	(10,187)	(13,183)
	Mining Demand	11,897	15,150	16,524	16,640	17,490	18,347	19,114
	Mining Existing Supply							
	Groundwater	10,696	11,962	12,063	11,233	11,324	11,450	11,530
	Surface water	1,201	1,387	1,465	936	0	0	0
	Total Mining Supply	11,897	13,349	13,528	12,169	11,324	11,450	11,530
	Mining Surplus (Shortage)	0	(1,801)	(2,996)	(4,471)	(6,166)	(6,897)	(7,584)
Agriculture	Irrigation Demand	21,971	25,884	26,152	26,671	27,433	28,450	29,726
	Irrigation Existing Supply							
	Groundwater	19,359	23,566	24,091	24,005	23,864	23,540	23,032
	Surface water	4,332	4,332	4,332	4,332	4,332	4,332	4,332
	Total Irrigation Supply	23,691	27,898	28,423	28,337	28,196	27,872	27,364
	Irrigation Surplus (Shortage)	1,720	2,014	2,271	1,666	763	(578)	(2,362)
	Livestock Demand	8,838	8,838	8,838	8,838	8,838	8,838	8,838
	Livestock Existing Supply							
	Groundwater	1,258	1,258	1,258	1,258	1,258	1,258	1,258
	Surface water	7,580	7,580	7,580	7,580	7,580	7,580	7,580
	Total Livestock Supply	8,838	8,838	8,838	8,838	8,838	8,838	8,838
	Livestock Surplus (Shortage)	0	0	0	0	0	0	0
Total	Municipal & Industrial Demand	175,127	197,781	222,952	239,297	254,969	269,946	286,374
	Existing Municipal & Industrial Supply							
	Groundwater	30,311	32,756	33,602	33,179	33,401	33,439	33,334
	Surface water	167,746	174,954	179,167	183,746	185,562	186,083	186,904
	Total Municipal & Industrial Supply	198,057	207,710	212,769	216,925	218,963	219,522	220,238
	Municipal & Industrial Surplus (Shortage)	22,930	9,929	(10,183)	(22,372)	(36,006)	(50,425)	(66,137)
	Agriculture Demand	30,809	34,722	34,990	35,509	36,271	37,288	38,564
	Existing Agricultural Supply							
	Groundwater	20,617	24,824	25,349	25,263	25,122	24,798	24,290
	Surface water	11,912	11,912	11,912	11,912	11,912	11,912	11,912
	Total Agriculture Supply	32,529	36,736	37,261	37,175	37,034	36,710	36,202
	Agriculture Surplus (Shortage)	1,720	2,014	2,271	1,666	763	(578)	(2,362)
	Total Demand	205,936	232,503	257,942	274,806	291,240	307,234	324,938
	Total Supply							
	Groundwater	50,928	57,580	58,951	58,442	58,523	58,237	57,624
	Surface water	179,658	186,866	191,079	195,658	197,474	197,995	198,816
	Total Supply	230,586	244,446	250,030	254,100	255,997	256,232	256,440
	Total Surplus (Shortage)	24,650	11,943	(7,912)	(20,706)	(35,243)	(51,003)	(68,499)

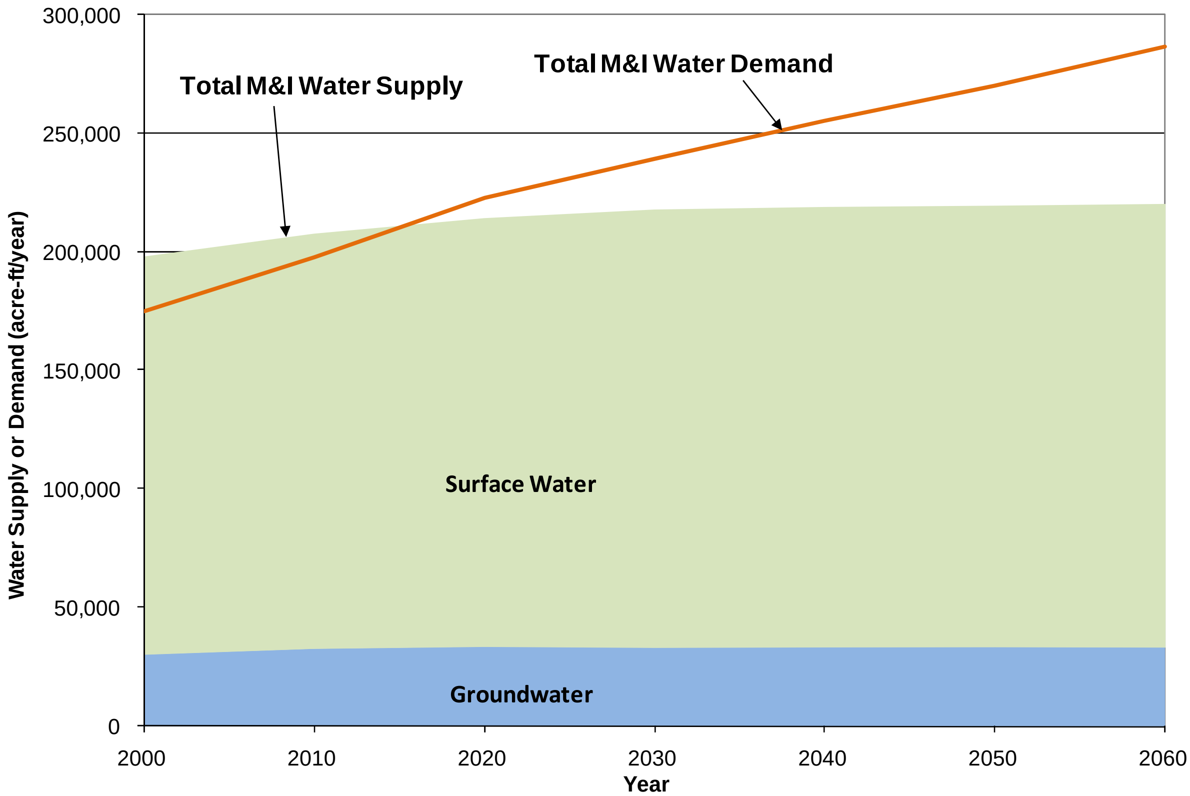

Figure 4A-3. Municipal and Industrial Supply and Demand

Table 4A-26.
Cities/County-Other with Projected Water Shortages

County/City	Projected Shortages (acft) 2010	2030	2060
Aransas County			
County-Other	—	—	(1,443)
Jim Wells County			
County-Other	(167)	(262)	(170)
Kleberg County			
County-Other	—	(81)	(155)
Live Oak County			
County-Other	—	(44)	—
Nueces County			
River Acres WSC	(138)	(355)	(590)
County-Other	(261)	—	—
San Patricio County			
Lake City	—	(11)	(37)

Nueces County shows manufacturing shortages beginning between 2010 and 2020; and San Patricio shows manufacturing shortages beginning between 2030 and 2040. In 2060, Nueces and San Patricio Counties have shortages of 39,550 acft and 6,455 acft, respectively (Table 4A-27). Aransas and Live Oak Counties show both near- and long-term manufacturing shortages from 2010 through 2060. Aransas County shows modest manufacturing shortages of 72 acft in 2010 increasing to 136 acft by 2060. Live Oak County-Manufacturing has shortages of 337 acft in 2010 and 764 acft by 2060.

Table 4A-27.
Manufacturing with Projected Water Shortages

	Projected Shortages (acft)		
County	**2010**	**2030**	**2060**
Aransas County	(72)	(97)	(136)
Live Oak County	(337)	(559)	(764)
Nueces County	—	(15,203)	(39,550)
San Patricio County	—	—	(6,455)

As for the remaining industrial demands, there are insufficient surface water supplies to meet steam-electric demands, all of which is in Nueces County, beginning in 2020. Steam-Electic in Nueces County is projected to have a shortage of 1,982 acft/yr in 2020, increasing to 13,183 acft/yr in 2060 (Table 4A-28).

Table 4A-28.
Steam-Electric with Projected Water Shortages

	Projected Shortages (acft)		
County	**2010**	**2030**	**2060**
Nueces County	—	(4,755)	(13,183)

The regional mining demand, 19,114 acft, accounts for only 6 percent of total demand in 2060. Region-wide there is insufficient groundwater to meet mining demands, with shortages increasing each decade from 1,801 in 2010 to 7,584 in 2060. Duval and Live Oak Counties show immediate and long-term shortages from 2010 to 2060. Nueces County shows mining shortages beginning in 2030. Mining shortages are summarized in Table 4A-29.

Table 4A-29.
Mining with Projected Water Shortages

County	Projected Shortages (acft)		
	2010	2030	2060
Duval County	(1,738)	(2,973)	(4,205)
Live Oak County	(64)	(928)	(1,755)
Nueces	—	(570)	(1,624)

4A.6.2 Agriculture Summary

Due to increasing irrigation demands and limited current well capacity, irrigation is showing a current surplus of 2,014 acft in 2010 and a shortage of 2,362 acft in 2060.[1] Irrigation demand increases over the 50-year planning period and in 2060 represents 9 percent of total demand. Surface water supplies are 15 percent of total irrigation supplies with groundwater accounting for 85 percent of the total. Irrigation shortages are summarized in Table 4A-30.

Table 4A-30.
Irrigation with Projected Water Shortages

County/City	Projected Shortages (acft)		
	2010	2030	2060
Bee County	—	—	(890)
Live Oak County	(627)	(514)	(373)
San Patricio County	—	(750)	(4,414)

Livestock demand remains constant at 8,838 acft over the 50-year planning period and in 2060 represents 3 percent of total demand. For each county, groundwater was allocated based on 1997 use. Surface water supplies were assumed to consist of local, on-farm sources and used to meet demands.

[1] Irrigation shortages on a regional basis are reduced by surpluses in Nueces County. However, it is more appropriate in Region N to consider irrigation shortages on a county-wide basis where the demands occur, since most irrigation water supplies are from local groundwater wells and it is often costly and impractical to transport irrigation water supplies across county lines.

4A.6.3 Summary

Overall, the Coastal Bend Region has sufficient supplies to meet the demands of the six water user groups through 2010. However, as discussed in the previous section, various water user groups are showing shortages throughout the 50-year planning period. Water groups with shortages in 2030 and 2060 are presented in Figure 4A-4.

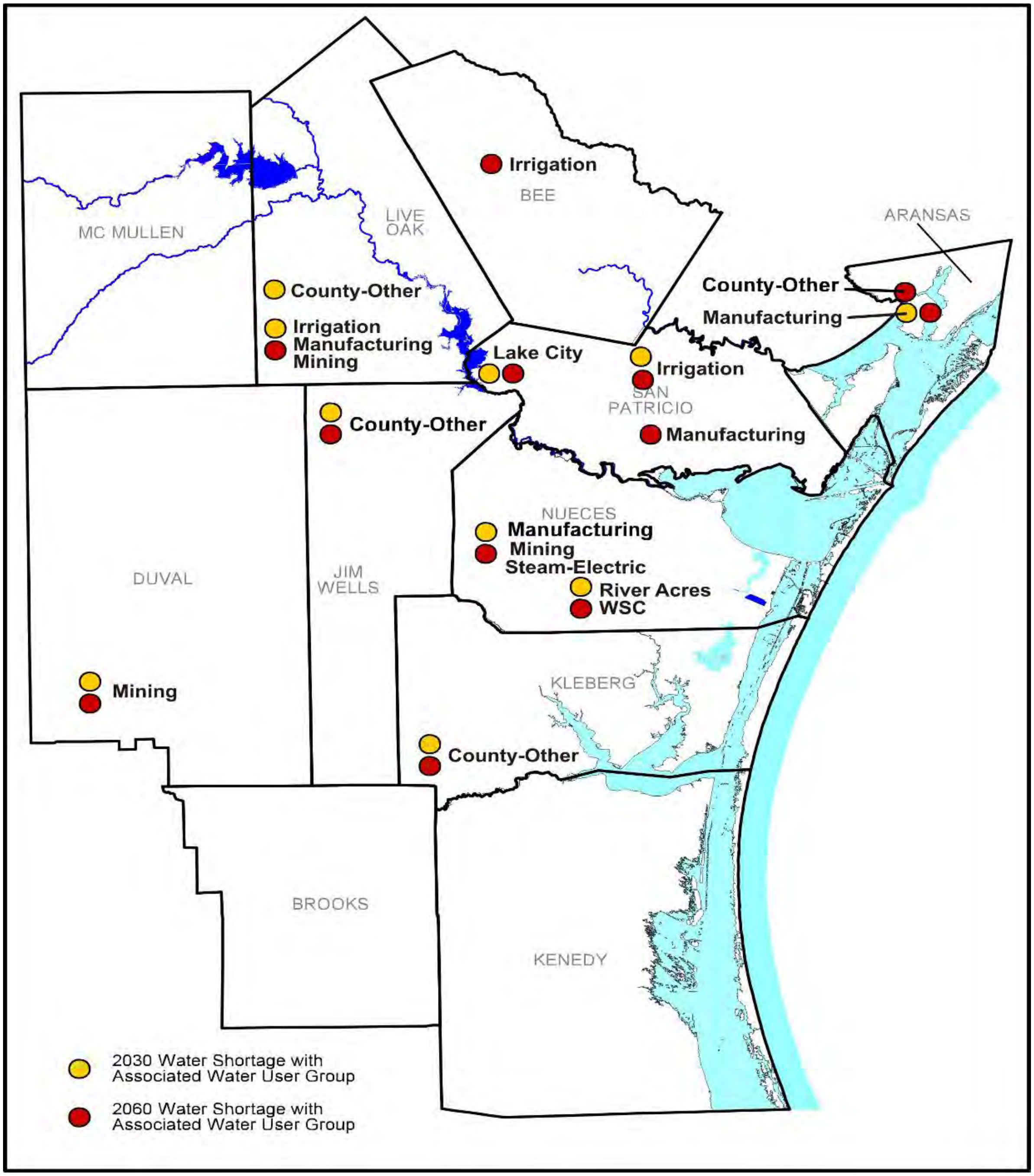

Figure 4A-4. Location and Type of Use for 2030 and 2060 Water Supply Shortages

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Section 4B
Water Supply Plans

4B.1 Summary of Water Management Strategies

A total of 20 water management strategies were investigated during the development of the Coastal Bend Regional Water Plan. At their regular public meeting on June 11, 2009, the Coastal Bend Regional Water Planning Group approved their process for identifying and evaluating potentially feasible water management strategies for the Coastal Bend Region. Many of these strategies include several water supply options within the main strategy. Strategies are summarized in Tables 4B.1-1 and 4B.1-2. The potentially feasible water management strategies selected by the CBRWPG for the 2011 Plan, are based on those identified in the 2006 Plan, in addition to new projects identified by Wholesale Water Providers and other water user groups. Results from studies since the 2006 Plan assisted in the selection process of potentially feasible water management strategies.

Table 4B.1-1 shows potential strategies for Wholesale Water Providers in Region N with shortages and Table 4B.1-2 shows potential strategies for other service areas. In both tables, strategies that were selected for inclusion as recommended or alternatives strategies in the plan are in bold. All strategies are compared with respect to four areas of concern: (1) additional water supply; (2) unit cost of treated water; (3) degree of water quality improvement; and (4) environmental issues and special concerns. A graphical comparison of how each significant strategy compares to the others with respect to unit cost and water supply quantity is shown in Figure 4B.1-1. A detailed description of the analysis of each strategy is included in Section 4C in Volume II of this report (refer to Sections 4C.1 through 4C.20). In these detailed descriptions, each strategy was evaluated with respect to ten impact categories, as required by TWDB rules. These categories are shown in Table 4B.1-3.

Recommended plans to meet the specific needs of the cities and other water user groups during the planning period (2000 through 2060) are presented in the following sections. The water management strategies summarized in Tables 4B.1-1 and 4B.1-2 and discussed in detail in Section 4C (Volume II of this report) provided the options for building each plan to meet the specific shortages. The plans are organized by county and water user group in the following sections (Sections 4B.2 – 4B.12).

Table 4B.1-1.
Potential Water Management Strategies to Meet Long-Term Needs for Wholesale Water Providers

WMS ID	*Water Management Strategy*	*Additional Water Supply (acft/yr)*	*Total Project Cost*	*Annual Cost*	*Unit Cost of Additional Treated Water ($ per acft/yr)*	*Degree of Water Quality Improvement*	*Environmental Issues/ Special Concerns*
N-1	**Municipal Water Conservation**	up to 1,428	Variable; Regional Cost up to $1,052,529[1]	Variable	$423-$448	No Change	Possible reduction in return flows to bay and estuary.
N-3	**Manufacturing Water Conservation**						
N-3-1	Blending of Texana Water	up to 2,050	Not Applicable	Not Applicable	Not Applicable[2]	Significant Improvement	None
N-3-2	Outlet works to remove high TDS from Calallen Pool	150-730	$2,904,000	$511,000[3]	$700-$2,146 [3]	Significant Improvement	None
N-3-3	Intake Modifications	150-300	$7,694,000	$875,000[3]	$2,916-$5,506 [3]	Significant Improvement	None
N-3-4	Pipeline from LCC to Calallen	19,600-23,900	$159,655,000	up to $24,715,000[3]	$1,070-$1,203 [3]	Significant Improvement	Potentially significant environmental impacts/Construction and maintenance of pipeline corridors
N-4	**Mining Water Conservation**	up to 259	Highly Variable	Highly Variable	Variable	No Change	None
N-5	**Reclaimed Wastewater Supplies**	250	Not Applicable	$206,500[5,9]	$826[5]	No Change	Potential reduction of freshwater inflows to estuary/Construction and maintenance of pipeline corridors
N-7	**Gulf Coast Aquifer Supplies**						
	Groundwater supplies from Bee and/or San Patricio Counties	up to 18,000	$59,245,000	$15,354,000[3,9]	$853 [3,4]	Some Degradation	Potential for increased freshwater inflows to estuary
N-8	**Multi-Year ASR along STWA Pipeline**	Negligible	Not Applicable[6]	Not Applicable[6]	-	No Change	Minor impacts
	Seasonal ASR in CC Distribution System	None	Variable				
N-10	**Pipeline from CCR to LCC[10]**	33,700	$138,067,000	$26,821,000[3,9]	$679 [3]	No Change	Reduction in stream flows between CCR and LCC
N-11	**Off-channel Reservoir near Lake Corpus Christi[10]**	30,340	$105,201,950	$21,696,800[3,9]	$715 [3]	No Change	Direct impact to 4,000 to 6,000 acres, depending on reservoir size
N-12	**Voluntary Redistribution and USACOE Nueces Feasibility Study**	Variable	Variable	Variable	Variable	Variable	Possible cost reduction with federal participation. Ecosystem restoration benefits. Portion of projects may be used for additional inflows to Nueces Bay and Estuary.
N-13	**Stage II of Lake Texana**						
	Palmetto Bend (On-Channel)	22,964[11]	$232,828,000	$27,855,000[3,9]	$1,213 [3]	No Change	Direct impact to 4,769 acres
	Lavaca River Diversion and Off-Channel Reservoir	26,242[11]	$224,183,000	$26,971,000[3,9]	$1,027 [3]	No Change	Direct impact to around 3,000 acres.
N-14	**Garwood Pipeline**	35,000	$112,798,000	$23,958,000[3,9]	$685 [3]	No Change	Construction and maintenance of pipeline corridors and off-channel storage
N-17	**Desalination**						
	Desalination of Seawater[7,10]	28,000	$260,914,000	$47,498,000	$1,696	Significant Improvement	Brine from desalt plant requires disposal. Construction and maintenance of pipeline corridor
N-19	**O.N. Stevens WTP Improvements**	32,996 in 2060	$31,324,000[8]	$7,554,000	$146 in 2060	No change	None
N-20	**Brackish Groundwater Desalination[10]**	18,000	$108,331,000	$17,584,000	$977	Significant Improvement	Brine from desalt plant requires disposal. Construction and maintenance of pipeline corridor

1 Assumes unit costs of $423 to $448/acft.
2 Cost of Manufacturing Water Conservation not determined.
3 Cost has been adjusted to include treatment. Cost for treatment is estimated at $326 per acft.
4 Cost based on 18,000 acft supply.
5 See Section 4C.5. Costs to maintain ongoing Nueces Delta studies are $500,000 per year (assumed cost associated with Allison Demonstration Project is 25 percent). Treatment cost of $326/acft have been added.
6 ASR is not recommended as a viable water management strategy to provide water supply. Costs are not included.
7 Additional water supply is unlimited. Supply numbers and unit costs are shown for a 25 MGD facility.
8 Total project cost includes improvements to the following WTP components: raw influent, raw water intake pump station, and O.N. Stevens solids handling facilities.
9 Annual costs calculated as the unit cost times the additional water supply volume. For Gulf Coast Aquifer Supplies the full 18,000 acft/yr yield was used. For both the Lake Texana options the annual cost is based on the full yield of the project. Annual costs for the portion of supplies allotted to the Coastal Bend wholesale water providers is less as shown in Sections 4B.11 and 4B.12.
10 There is federal participation opportunities for these projects. Federal participation is assumed in water supply plans (Section 4B) and Section 4C.10.
11 Full yield shown for projects. Only portion of project identified for Region N.

Table 4B.1-2.
Potential Water Management Strategies to Meet Long-Term Needs for Local Service Areas

WMS	*Water Management Strategy*	*Additional Water Supply (acft/yr)*	*Total Project Cost*	*Annual Cost*	*Unit Cost of Additional Treated Water ($ per acft/yr)*	*Degree of Water Quality Improvement*	*Environmental Issues/ Special Concerns*
N-1	**Municipal Water Conservation**	up to 2,415	Variable; Regional Cost up to $1,052,529[1]	Variable	$423-$448	No Change	Possible reduction in return flows to bay and estuary.
N-2	**Irrigation Water Conservation**	up to 342	$1,095,700	$3,900 - $78,000	$228[2]	No Change	None
N-4	**Mining Water Conservation**	up to 2,343	Highly Variable	Highly Variable	Variable	No Change	None
N-5	**Reclaimed Wastewater Supplies**	250	Not Applicable	$206,500[3]	$826[3]	No Change	Potential reduction of freshwater inflows to estuary/Construction and maintenance of pipeline corridors
N-7	**Gulf Coast Aquifer Supplies**						
	Drill additional well	Variable	Variable; up to $8,110,000[4]	Variable; up to $925,000[4]	Variable	Some Degradation	Minor impacts
	Brackish groundwater desalination (local projects)	Variable	Variable; up to $12,250,000[5]	Variable; up to $2,207,000[5]	Variable	Significant Improvement	Brine from desalt plant requires disposal by evaporation, deep well injection, blending, or discharging to saltwater body.
N-12	**Voluntary Redistribution/ Reallocation**	Variable	Variable; as needed	Variable; as needed	$685[6]	Variable	None
N-18	**Potential System Interconnections**						
	Duval County	974-2,520	Up to $30,113,000	Up to $4,823,000	$1,161-$1,914	Some Negative Impact	Construction and maintenance of pipeline corridor.
	Jim Wells County	246-1,434	Up to $10,824,000	Up to $1,929,000	$1,345-$2,248	Some Negative Impact	Construction and maintenance of pipeline corridor.
	Brooks County	2554	$16,195,000	$3,523,000	$1,379	Some Negative Impact	Construction and maintenance of pipeline corridor.
	San Patricio County	125-1,120	$2,517,000 to $3,136,000	$401,000 to $1,018,000	$909- $3,208	Some Negative Impact	Construction and maintenance of pipeline corridor.

[1]Assumes unit costs of $423 to $448/acft.

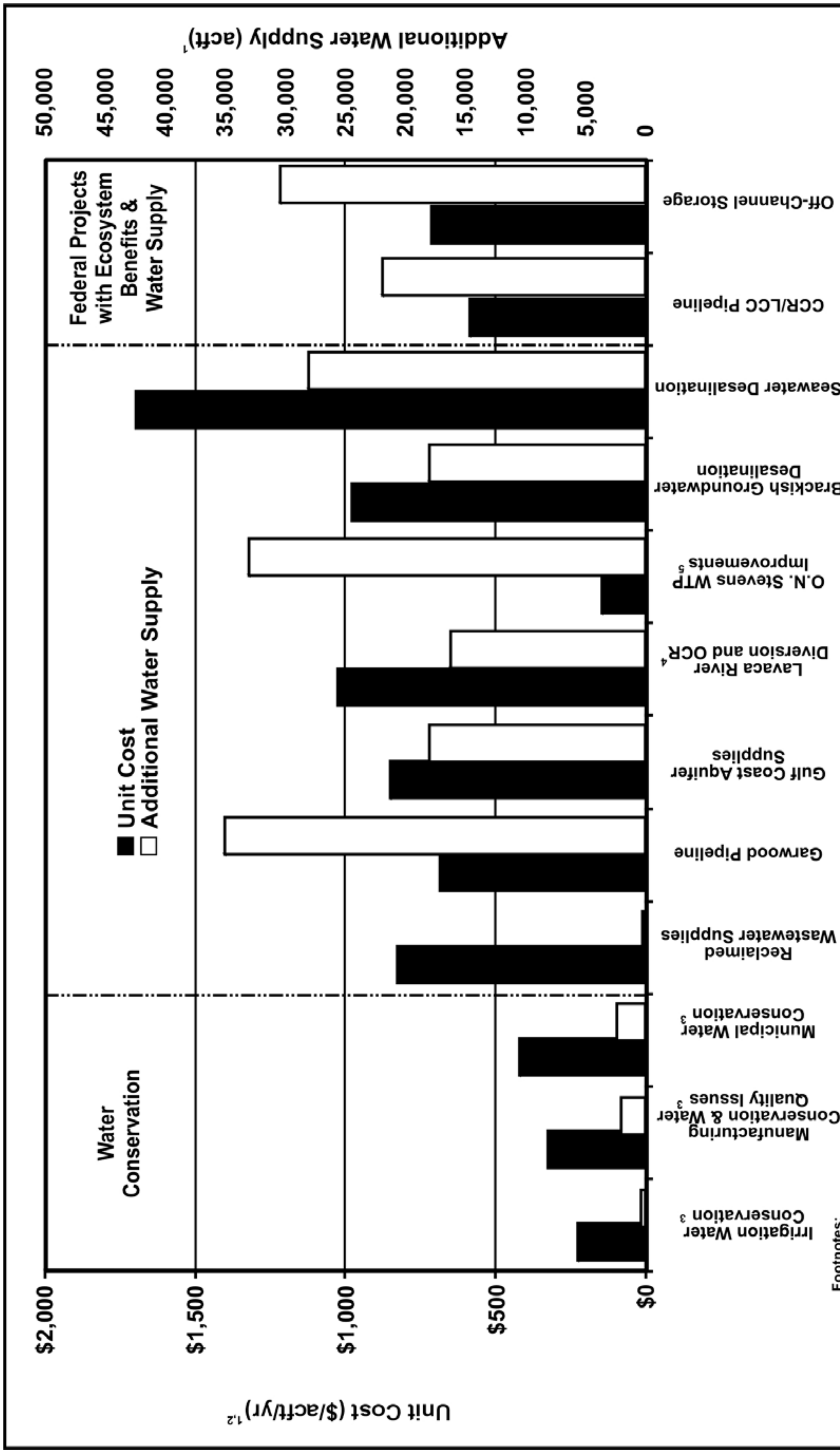
[2]Unit cost for raw water supplies.

[3]See Section 4C.5. Costs to maintain ongoing Nueces Delta studies are $500,000 per year (assumed cost associated with Allison Demonstration Project is 25 percent). Treatment cost of $326/acft have been added.

[4]Costs based on drilling 23 wells for San Patricio County – Irrigation.

[5]Estimated cost for 3 MGD facility. In Section 4B, the largest local brackish groundwater desalination plant considered was for Freer. The project cost for the 1.2 MGD plant i s $6,899,000. This results in an annual cost of $1,121,000 for a unit cost of $834 per acft.

[6]Unit cost of $685 per acft assumed to be comparable to cost of Garwood water. Costs should be revised in the future, as rate study information becomes available .



Footnotes:
[1]Some strategies have more than one alternative.
[2]Costs include $326 for water treatment, except for municipal and irrigation water conservation.
[3]Costs and water supplies for Municipal, Manufacturing, and Irrigation Water Conservation are variable based on best management practice selected.
[4]The firm yield of project is 26,262 (Table 4B.1-1); however, 10,000 acft/yr is proposed for consistency for Region P/L uses. The amount shown in figure above is amount estimated to be available for Region N purposes (16,262 acft/yr).
[5]Amount of supply varies. Figure shows 2060 supply and cost.

Figure 4B.1-1. Comparison of Unit Costs and Water Supply Quantities for Potential Water Management Strategies for Coastal Bend

Table 4B.1-3.
Summary of Impact Categories for Evaluation of Water Management Strategies

a.	Water Supply 1. Quantity 2. Reliability 3. Cost of Treated Water
b.	Environmental factors 1. Instream flows 2. Bay and Estuary Inflows 3. Wildlife Habitat 4. Wetlands 5. Threatened and Endangered Species 6. Cultural Resources 7. Water Quality a. dissolved solids b. salinity c. bacteria d. chlorides e. bromide f. sulfate g. uranium h. arsenic i. other water quality constituents
c.	Impacts to State water resources
d.	Threats to agriculture and natural resources in region
e.	Recreational impacts
f.	Equitable comparison of strategies
g.	Interbasin transfers
h.	Third party social and economic impacts from voluntary redistribution of water
i.	Efficient use of existing water supplies and regional opportunities
j.	Effect on navigation

According to the TWDB,[1] regional planning is a reconnaissance-level effort and a detailed investigation of project impacts is beyond the scope and mandate of this effort. The impacts, costs, and benefit of large-scale projects such as reservoirs or major diversions would, if implemented, undergo additional and extensive evaluation during permitting under Section 404 of the Clean Water Act, the National Environmental Protection Action, and any other applicable federal, state, or local regulations.

Drought Management is not a recommended water management strategy to meet projected water needs in the Coastal Bend Region, in part because it cannot be demonstrated to

[1] TWDB Memo, "Texas Water Development Board Comments for the Coastal Bend Regional Water Planning Group (Region N) Initially Prepared Plan, Contract No. 2002-483-459," September 28, 2005.

be an economically feasible strategy. The TWDB socioeconomic impact analysis of unmet water needs in Coastal Bend Region shows total losses[2] (Table 4B.1-4) due to unmet water needs (shortages) of $17,656 per acft/yr in 2010 increasing to $108,168 per acft/yr in 2060.

Table 4B.1-4
Projected Water Needs (Shortages) and Business, Personal Income, and Tax Losses from Unmet Water Needs in the Coastal Bend Region

Year	*Projected Water Need (Shortage) (acft/yr)*	*Total Losses* ($millions/yr)*	*Cost per acft*
2010	3,404	60.1	$17,656
2020	14,084	452.02	$32,095
2030	27,102	1,691.56	$62,415
2040	41,949	2,612.98	$62,289
2050	57,994	6,317.69	$108,937
2060	75,744	8,193.04	$108,168

* Sum of business and personal income losses, and taxes lost as provided by the TWDB.
Source: TWDB, "Socioeconomic Impacts of Projected Water Shortages for the Coastal Bend Regional Water Planning Area", January 2010.

Clearly, the cost for water to meet projected water needs is only a fraction of the total loss associated with business, personal income, and tax revenue losses from not having the quantities of water needed. For example, in 2010 income losses are $57,260,000 (or $16,821 per acft of shortage), and tax losses are $2,840,000 (or $835 per acft of shortage)[3] while short-term costs of water for recommended water management strategies in the 2011 Regional Water Plan range from $90 per acft for Municipal Conservation (using more water efficient showerheads and aerators), up to $5,506/acft/yr[4] for modifying industrial intake structures near Calallen Pool.

The Water Conservation water management strategies recommended in the 2011 Regional Water Plan, together with the other water management strategies appear to the CBRWPG to be superior to the use of Drought Management strategies that are costly to the economy and the people of the region, and unpredictable as to time of occurrence and duration.

[2] Includes business production and sales impacts, personal income losses, and tax losses identified by the TWDB in "Socioeconomic Impacts of Projected Water Shortages for the Coastal Bend Regional Water Planning Area," January 2010.
[3] Calculated based on Table 15 on page 29 in TWDB report and total projected regional water needs.
[4] Unit cost has been adjusted to include treatment. Cost for treatment is estimated at $326 per acft.

The uncertainty and the cost associated therewith is not acceptable to the CBRWPG, thus Drought Management is not included as a recommended water management strategy. However, the CBRWPG recommends that entities with drought management plans implement their plans during droughts.

Socioeconomic impacts of unmet needs will be evaluated by the TWDB and costs of unmet needs will be provided to represent regional impacts of leaving water needs entirely unmet, representing a worst-case scenario. Costs of unmet needs are included in the water supply plan when recommended to meet shortages, such as for Live Oak County Mining and Duval County Mining. The draft TWDB report is included as Appendix F. A summary of the plans for the Region's four Wholesale Water Providers is presented in Section 4B.13.

Additionally, future projects involving authorization from either the TCEQ and/or TWDB which are not specifically addressed in the plan are considered to be consistent with the plan under the following circumstances:

1. TWDB receives applications for financial assistance for many types of water supply projects, including water conservation, and when appropriate, wastewater reuse strategies. Other projects involve repairing, replacing, or expanding treatment plants, pump stations, pipelines and water storage facilities including ASR. The RWPG considers projects that do not involve the development of or connection to a new water source to be consistent with the regional water plan even though not specifically recommended in the plan.
2. TCEQ considers water rights applications for various types of uses (e.g., recreation, navigation, irrigation, hydroelectric power, industrial, recharge, municipal and others). Many of these applications are for small amounts of water, some are temporary, and some are even non-consumptive. Because waters of the Nueces River Basin are fully appropriated to the City of Corpus Christi and others, any new water rights application for consumptive water use from this Basin will need to protect the existing water rights or provide appropriate mitigation to existing water right owners. Throughout the Coastal Bend Region the types of small projects that may arise are so unpredictable that the RWPG is of the opinion that each project should be considered by the TWDB and TNRCC on their merits, and that the Legislature foresaw this situation and provided appropriate language for each agency to deal with it.

(Note: The provision related to TCEQ is found in Texas Water Code §11.134. It provides that the Commission shall grant an application to appropriate surface water, including amendments, only if the proposed appropriator addresses a water supply need in a manner consistent with an approved regional water plan. TCEQ may waive this requirement if conditions warrant. For TWDB funding, Texas Water Code §16.053(j) states that after January 5, 2002 TWDB may provide financial assistance to a water supply project only after the Board determines that the needs to be addressed by the project will be addressed in a manner that is consistent with that appropriate regional water plan. The TWDB may waive this provision if conditions warrant.)

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4B.2 Aransas County Water Supply Plan

Table 4B.2-1 lists each water user group in Aransas County and their corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4B.2-1.
Aransas County Surplus/(Shortage)

Water User Group	Surplus/(Shortage)[1] 2030 (acft/yr)	Surplus/(Shortage)[1] 2060 (acft/yr)	Comment
City of Aransas Pass	0	0	Supply equals demand
City of Fulton	0	0	Supply equals demand
City of Rockport	0	0	Supply equals demand
County-Other	0	(1,443)	Projected shortages in 2050 and 2060 — see plan below
Manufacturing	(97)	(136)	Projected shortages from 2010 to 2060 — see plan below
Steam-Electric	none	none	No demands projected
Mining	0	0	Supply equals demand
Irrigation	none	none	No demands projected
Livestock	0	0	Supply equals demand

[1] From Tables 4A-2 and 4A-3, Section 4 – Comparison of Water Demands with Water Supplies to Determine Needs.

4B.2.1 City of Aransas Pass

The City of Aransas Pass is in Aransas, Nueces, and San Patricio Counties; consequently, its water demand and supply values are split into the tables for each county. Aransas Pass contracts with the San Patricio Municipal Water District (SPMWD) to purchase treated water. The contract allows the City of Aransas Pass to purchase only the water that it needs. No shortages are projected for the City of Aransas Pass and no changes in water supply are recommended.

4B.2.2 City of Fulton

The City of Fulton has a contract with the SPMWD to purchase treated water. The contract allows the City to purchase only the water that it needs. No shortages are projected for the City of Fulton and no changes in water supply are recommended.

4B.2.3 City of Rockport

The City of Rockport has a contract with the SPMWD to purchase treated water. The contract allows the City of Rockport to purchase only the water that it needs. No shortages in annual water supplies are projected for the City of Rockport and no changes in water supplies are recommended.

4B.2.4 County-Other

4B.2.4.1 Description

- Source: Groundwater – Gulf Coast Aquifer
  Surface Water – CCR/LCC/Texana System purchased from the SPMWD and run-of-river rights from San Antonio-Nueces River Basin
- Estimated Reliable Supply: 236 to 276 acft/yr (groundwater)
  49 to 1,740 acft/yr (surface water)
- System Description: Served by SPMWD and groundwater supplies with estimated well capacity of 295 acft/yr

4B.2.4.2 Options Considered

The County-Other demand projection category is intended to capture the demands of single-family rural municipal demands as well as demands for small rural water supply systems. The Aransas County-Other water user group has projected shortages of 1,527 acft/yr in 2050 and 1,443 acft/yr in 2060. Their shortages are attributed to shortages for SPMWD, based on customer needs exceeding existing maximum contracted supply of 40,000 acft from City of Corpus Christi as well as SPMWD water treatment constraints. Table 4B.2-2 lists the water management strategy to meet customer needs (Aransas County-Other), references to the report section discussing the strategy, total project cost, and unit costs that were considered for meeting the shortage for County-Other in Aransas County. The Water Management Strategies for SPMWD are discussed in Section 4B.12.12.

Table 4B.2-2.
Water Management Strategies Considered for Aransas County-Other

Option	Yield (acft/yr)	Approximate Cost[1]	
		Total	Unit ($/acft)
Increase contracted amount provided by Wholesale Water Providers	up to 1,527	N/A	$442-$471[2]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] Unit cost based on development of water management strategies for wholesale water providers in Table 4B.11-7.
N/A — Not applicable; wholesale water provider will bear cost of project.

4B.2.4.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend Regional Water Planning Group (CBRWPG) and TWDB, the following water supply plan is recommended to meet the projected 2050 and 2060 shortages for County-Other in Aransas County:

- Increase contracted amount provided by Wholesale Water Provider (SPMWD)

In addition to the management strategies listed above, the CBRWPG supports strategies for increased conservation and reuse of existing supplies.

4B.2.4.4 Costs

The recommended Water Supply Plan including anticipated costs is summarized by decade in Table 4B.2-3.

Table 4B.2-3.
Recommended Plan Costs by Decade for Aransas County-Other

Plan Element	2010	2020	2030	2040	2050	2060
Projected Surplus/(Shortage) (acft/yr)	—	—	—	—	(1,527)	(1,443)
Increase Contracted Amount provided by Wholesale Water Provider (San Patricio Municipal Water District)						
Supply From Plan Element (acft/yr)	—	—	—	—	1,527	1,443
Total Annual Cost ($/yr)	—	—	—	—	$674,900	$679,700
Total Unit Cost ($/acft)	—	—	—	—	$442	$471

[1]Unit cost based on development of water management strategies for wholesale water providers in Table 4B.11-7.

4B.2.5 Manufacturing

4B.2.5.1 Description

- Source: Groundwater – Gulf Coast Aquifer
- Estimated Reliable Supply: 195 acft/yr (groundwater)
- System Description: Various manufacturing operations

4B.2.5.2 Options Considered

The Aransas County manufacturing water user group has projected shortages of 72 acft/yr in 2010, 97 acft/yr in 2030, and 136 acft/yr in 2060. Their shortages are attributed to limited well capacity of 195 acft/yr estimated using the procedure in Section 4A.2.2. Table 4B.2-4 lists the water management strategies, references to the report section discussing the strategy, total project cost, and unit costs that were considered for meeting the shortage for Aransas County- Manufacturing.

Table 4B.2-4.
Water Management Strategies Considered for Aransas County-Manufacturing

Option	*Yield (acft/yr)*	*Approximate Cost[1]*	
		Total	*Unit ($/acft)*
Gulf Coast Aquifer Groundwater Supplies — Drill Additional Well(s) (Section 4C.7)	200	$257,000[2]	$135[2]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] Source of Cost Estimate: Section 4C.7, Table 4C.7-14. Cost estimates are based on size and depth of well(s) to meet needs and do not include any additional treatment..

4B.2.5.3 Water Supply Plan

Working within the planning criteria established by the CBRWPG and TWDB, the following water supply plan is recommended to meet the projected 2010 to 2060 shortages for Aransas County-Manufacturing:

- Gulf Coast Aquifer Groundwater Supplies — Drill Additional Well(s)

In addition to the management strategy listed above, the CBRWPG supports strategies for increased conservation and reuse of existing supplies.

4B.2.5.4 Costs

The recommended Water Supply Plan, including anticipated costs, is summarized by decade in Table 4B.2-5.

Table 4B.2-5.
Recommended Plan Costs by Decade for Aransas County-Manufacturing

Plan Element	2010	2020	2030	2040	2050	2060
Projected Surplus/(Shortage) (acft/yr)	(72)	(86)	(97)	(107)	(116)	(136)
Gulf Coast Aquifer Groundwater Supplies — Drill Additional Well(s)						
Supply From Plan Element (acft/yr)[1]	200	200	200	200	200	200
Total Annual Cost ($/yr)[2]	$27,000	$27,000	$27,000	$5,000	$5,000	$5,000
Total Unit Cost ($/acft)[2]	$135	$135	$135	$25	$25	$25

[1] Supply from additional wells supplied at constant annual rate (Section 4C.7.2.1).
[2] Source of Cost Estimate: Section 4C.7. Table 4C.7-14. Cost estimates are based on size and depth of well(s) to meet needs and do not include any additional treatment. Assumes debt service based on RWP guidelines. Reduction in cost after Year 2030 assumes debt service has been paid.

4B.2.6 Steam-Electric

No steam-electric demand exists or is projected for the county.

4B.2.7 Mining

The mining water demands in Aransas County are met by groundwater from the Gulf Coast Aquifer. No shortages are projected for mining users and no changes in water supply are recommended.

4B.2.8 Irrigation

No irrigation demand exists or is projected for the county.

4B.2.9 Livestock

The livestock water demands in Aransas County are met by groundwater from the Gulf Coast Aquifer and surface water from local on-farm sources. No shortages are projected for livestock and no changes in water supply are recommended.

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4B.3 Bee County Water Supply Plan

Table 4B.3-1 lists each water user group in Bee County and their corresponding surplus or shortage in years 2030 and 2060. Irrigation is projected to have a shortage during the planning period, as shown in Table 4B.3-1.

Table 4B.3-1. Bee County Surplus/(Shortage)

Water User Group	Surplus/(Shortage)[1]		Comment
	2030 (acft/yr)	2060 (acft/yr)	
City of Beeville	0	0	Supply equals demand
El Oso WSC	0	0	Supply equals demand
County-Other	0	0	Supply equals demand
Manufacturing	0	0	Supply equals demand
Steam-Electric	none	none	No demands projected
Mining	0	0	Supply equals demand
Irrigation	0	(890)	Projected shortages in 2050 and 2060 — see plan below
Livestock	0	0	Supply equals demand

[1] From Tables 4A-4 and 4A-5, Section 4 – Comparison of Water Demands with Water Supplies to Determine Needs.

4B.3.1 City of Beeville

The City of Beeville contracts with City of Corpus Christi to purchase raw water from the CCR/LCC System. The contract allows the City of Beeville to purchase only the water that it needs. No shortages are projected for the City of Beeville and no changes in water supply are recommended.

4B.3.2 El Oso WSC

El Oso Water Supply Corporation is located in both Bee and Live Oak Counties; consequently, its water demand and supply values are split into tables for each county. The El Oso Water Supply Corporation receives groundwater supplies from the Gulf Coast Aquifer. No shortages are projected for El Oso Water Supply Corporation and no changes in water supply are recommended.

4B.3.3 County-Other

Bee County-Other demands are met with groundwater from the Gulf Coast Aquifer. No shortages are projected for County-Other entities and no changes in water supply are recommended.

4B.3.4 Manufacturing

There are small manufacturing water demands in Bee County. These demands are met by groundwater from the Gulf Coast Aquifer. According to the local groundwater conservation district[1], more water is being used for manufacturing activities in Bee County. Due to time constraints and TWDB guidance, these manufacturing water demands were not evaluated in detail for the 2011 Plan but should be considered in future planning efforts. No shortages are projected for manufacturing and no changes in water supply are recommended.

4B.3.5 Steam-Electric

No steam-electric demand exists or is projected for the county.

4B.3.6 Mining

There are small mining water demands in Bee County. These demands are met by groundwater from the Gulf Coast Aquifer. No shortages are projected for mining and no changes in water supply are recommended. According to the local groundwater conservation district[1], the development of natural gas from the shale in the Eagleford Group has begun in Bee County. Water demands associated with these mining activities are not included in projected TWDB water demands, but may impact local groundwater use in the Carrizo Aquifer. The impacts of developing gas wells in the Eagleford shale on groundwater supplies in the Coastal Bend Region should be considered in future planning efforts.

[1] Correspondence from Bee GCD in November 2009.

4B.3.7 Irrigation

4B.3.7.1 Description

- Source: Groundwater – Gulf Coast Aquifer; Surface water – Surface water rights
- Estimated Reliable Supply: Maximum of 5,311 acft/yr (groundwater); 42 acft/yr (surface water)
- System Description: Various irrigation operations

4B.3.7.2 Options Considered

The Bee County irrigation water user group has projected shortages of 299 acft/yr in 2050 and 890 acft/yr in 2060. Their shortages are attributed to limited well capacity of 5,311 acft/yr estimated using the procedure described in Section 4A.2.2. Table 4B.3-2 lists the water management strategies, references to the report section discussing the strategy, total project cost, and unit costs that were considered for meeting the shortage for Bee County-Irrigation. Irrigation water conservation was considered; however, it was not recommended due to the fact that according to data developed by the TWDB and local GCD data the irrigation water application efficiency in Bee County already exceeds 80%, equal to the maximum efficiency achieved with this strategy.

Table 4B.3-2.
Water Management Strategies Considered for Bee County-Irrigation

Option	Yield (acft/yr)	Approximate Cost[1]	
		Total	Unit ($/acft)
Gulf Coast Aquifer Groundwater Supplies — Drill Additional Well(s) (Section 4C.7)	2,016	$1,763,000[2]	$100[2]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] Source of Cost Estimate: Section 4C.7, Table 4C.7-9. Cost estimates are based on size and depth of well(s) to meet needs and do not include any additional treatment.

4B.3.7.3 Water Supply Plan

Working within the planning criteria established by the CBRWPG and TWDB, the following water supply plan is recommended to meet the projected 2050 and 2060 shortages for Bee County-Irrigation:

- Gulf Coast Aquifer Groundwater Supplies — Drill Additional Well(s)

In addition to the management strategy listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.3.7.4 Costs

The recommended Water Supply Plan, including anticipated costs, is summarized by decade in Table 4B.3-3.

Table 4B.3-3.
Recommended Plan Costs by Decade for Bee County-Irrigation

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Surplus/(Shortage) (acft/yr)	—	—	—	—	(299)	(890)
Gulf Coast Aquifer Groundwater Supplies — Drill Additional Well(s)						
Supply From Plan Element (acft/yr)[1]	—	—	—	—	2,016	2,016
Total Annual Cost ($/yr)[2]	—	—	—	—	$202,000	$202,000
Total Unit Cost ($/acft)[2]	—	—	—	—	$100	$100

[1] Supply from additional wells set equal to approximately twice the projected shortage to account for peaking.

[2] Source of Cost Estimate: Section 4C.7. Table 4C.7-9. Cost estimates are based on size and depth of well(s) to meet needs and do not include any additional treatment.

4B.3.8 Livestock

The livestock water demands in Bee County are met by groundwater from the Gulf Coast Aquifer and surface water from local on-farm sources. No shortages are projected for livestock and no changes in water supply are recommended.

4B.4 Brooks County Water Supply Plan

Table 4B.4-1 lists each water user group in Brooks County and their corresponding surplus or shortage in years 2030 and 2060. All water user groups in Brooks County have an adequate supply, as shown in Table 4B.4-1.

Table 4B.4-1.
Brooks County Surplus/(Shortage)

Water User Group	*Surplus/(Shortage)*[1] 2030 (acft/yr)	*Surplus/(Shortage)*[1] 2060 (acft/yr)	*Comment*
City of Falfurrias	0	0	Supply equals demand
County-Other	0	0	Supply equals demand
Manufacturing	0	0	No demands projected
Steam-Electric	0	0	No demands projected
Mining	0	0	Supply equals demand
Irrigation	0	0	Supply equals demand
Livestock	0	0	Supply equals demand

[1] From Tables 4A-6 and 4A-7, Section 4 – Comparison of Water Demands with Water Supplies to Determine Needs.

4B.4.1 City of Falfurrias

The City of Falfurrias receives groundwater supplies from the Gulf Coast Aquifer. No shortages are projected for the City of Falfurrias. The water demands for the City of Falfurrias increase over the planning period. In 2000, the City of Falfurrias had a per capita per day usage of 280 gallons per capita per day (gpcd) which is projected to decrease to 265 gpcd in 2060 (after built-in savings for low flow plumbing fixtures), based on TWDB water demand and population projections. The CBRWPG recommends additional water conservation of 15 percent by 2060 for all municipal entities with reported use greater than 165 gpcd in 2060 (Section 4C.1). The estimated water saved with additional water conservation increases from 1 acft/yr in Year 2010 to 309 acft/yr in Year 2060 (See Table 4C.1-4). The cost of water savings for additional water conservation ranges from $283 in Year 2010 to $130,882 in Year 2060 (See Table 4C.1-7).

4B.4.2 County-Other

The Brooks County-Other municipal users receive groundwater supplies from the Gulf Coast Aquifer. No shortages are projected for Brooks County-Other and no changes in water supply are recommended.

4B.4.3 Manufacturing

No manufacturing demand exists or is projected for the county.

4B.4.4 Steam-Electric

No steam-electric demand exists or is projected for the county.

4B.4.5 Mining

The mining water demands in Brooks County are met by groundwater from the Gulf Coast Aquifer. No shortages are projected for mining and no changes in water supply are recommended.

4B.4.6 Irrigation

The irrigation water demands in Brooks County are met by groundwater from the Gulf Coast Aquifer. No shortages are projected for irrigation and no changes in water supply are recommended.

4B.4.7 Livestock

The livestock water demands in Brooks County are met by groundwater from the Gulf Coast Aquifer and surface water from local on-farm sources. No shortages are projected for livestock and no changes in water supply are recommended.

4B.5 Duval County Water Supply Plan

Table 4B.5-1 lists each water user group in Duval County and their corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4B.5-1.
Duval County Surplus/(Shortage)

Water User Group	Surplus/(Shortage)[1]		Comment
	2030 (acft/yr)	2060 (acft/yr)	
City of Benavides	0	0	Supply equals demand
City of Freer	0	0	Supply equals demand
City of San Diego	0	0	Supply equals demand
County-Other	0	0	Supply equals demand
Manufacturing	none	none	No demands projected
Steam-Electric	none	none	No demands projected
Mining	(2,973)	(4,205)	Projected shortages for entire planning period— see plan below
Irrigation	0	0	Supply equals demand
Livestock	0	0	Supply equals demand

[1] From Tables 4A-8 and 4A-9, Section 4 – Comparison of Water Demands with Water Supplies to Determine Needs.

4B.5.1 City of Benavides

The City of Benavides receives groundwater supplies from the Goliad Sands of the Gulf Coast Aquifer. No shortages are projected for the City of Benavides. Although projections indicate that Benavides' current wells will produce adequate supply to meet their anticipated demand, there is local concern that the quality of the water produced by the city's wells will decline to the point that advanced treatment will be necessary to stay in compliance with regulatory water quality guidelines. If the City of Benavides requires groundwater desalination for their highest water demand over the planning period, a 0.6 MGD reverse osmosis membrane system would be sufficient as discussed in Section 4C.7.2.3. If no additional infrastructure is required, it is estimated then the total capital cost for a membrane water treatment plant will be

$3,127,000, and total project cost will be $4,633,000. Total annual cost will be $688,000, resulting in a unit cost of $1,024 per acft, or $3.14 per 1,000 gallons, assuming full utilization of the treatment plant.

4B.5.2 City of Freer

The City of Freer receives groundwater supplies from the Catahoula Tuff. No shortages are projected for the City of Freer. Although projections indicate that Freer's current wells will produce adequate supply to meet their anticipated demand, there is local concern that the quality of the water produced by the city's wells will decline to the point that advanced treatment will be necessary to stay in compliance with regulatory water quality guidelines. If the City of Freer requires groundwater desalination for their highest water demand over the planning period, a 1.2 MGD reverse osmosis membrane system would be sufficient as discussed in Section 4C.7.2.3. If no additional infrastructure is required, it is estimated then the total capital cost for a membrane water treatment plant will be $4,733,000, and total project cost will be $6,899,000. Total annual cost will be $1,121,000, resulting in a unit cost of $834 per acft, or $2.56 per 1,000 gallons, assuming full utilization of the treatment plant.

4B.5.3 City of San Diego

The City of San Diego is in both Duval and Jim Well Counties; consequently, its water demand and supply values are split into tables for each county. The City of San Diego receives groundwater supplies from the Goliad Sands of the Gulf Coast Aquifer. The City of Alice has run a 16-inch water transmission line to Hwy 281 bypass, approximately 8 to 9 miles from the City of San Diego.[1] This pipeline could be extended to provide water supply from the City of Alice to San Diego.

No shortages are projected for the City of San Diego. Although projections indicate that San Diego's current wells will produce adequate supply to meet their anticipated demand, there is local concern that the quality of the water produced by the city's wells will decline to the point that advanced treatment will be necessary to stay in compliance with regulatory water quality guidelines. If the City of San Diego requires groundwater desalination for their highest water demand over the planning period, a 1 MGD reverse osmosis membrane system would be

[1] Conservation with Carl Crull, July 2005.

Sufficient as discussed in Section 4C.7.2.3. If no additional infrastructure is required, it is estimated that the total capital cost for a membrane WTP will be $4,313,000, and total project cost will be $6,304,000. Total annual cost will be $1,000,000, resulting in a unit cost of $893 per acft, or $2.74 per 1,000 gallons assuming full utilization of the treatment plant.

4B.5.4 County-Other

Duval County-Other municipal users receive groundwater supplies from the Gulf Coast Aquifer. No shortages are projected for the Duval County-Other. In 2000 Duval County-Other has a per capita per day usage of 191 gallons per capita per day (gpcd) and an estimated usage of 178 gpcd in 2060 (after built-in savings for low flow plumbing fixtures), based on TWDB water demand and population projections. The CBRWPG recommends additional water conservation of 15 percent by 2060 for all municipal entities with reported use greater than 165 gpcd in 2060. The estimated water saved with additional water conservation increases from 6 acft/yr in Year 2010 to 63 acft/yr in Year 2060 (See Table 4C.1-4). The cost of water savings for additional water conservation ranges from $2,431 in Year 2010 to $26,467 in Year 2060(See Table 4C.1-7).

4B.5.5 Manufacturing

No manufacturing demand exists or is projected for the county.

4B.5.6 Steam-Electric

No steam-electric demand exists or is projected for the county.

4B.5.7 Mining

4B.5.7.1 Description

- Source: Groundwater – Gulf Coast Aquifer;
- Estimated Reliable Supply: 4,122 to 4,348 acft/yr; and
- System Description: Various mining operations.

4B.5.7.2 Options Considered

The Duval County mining water user group has projected shortages of 1,738 acft/yr in 2010 which increases to 4,205 acft/yr in 2060. Their shortages are attributed to reducing pumping to meet drawdown constraints established by the CBRWPG. Table 4B.5-2 lists the water management strategies, references to the report section discussing the strategy, total project cost, and unit costs that were considered for meeting the shortage for Duval County-Mining.

Table 4B.5-2.
Water Management Strategies Considered for Duval County-Mining

Option	***Yield (acft/yr)***	***Approximate Cost[1]***	
		Total	***Unit ($/acft)***
Mining Water Conservation (Section 4C.4)	147 to 1,283	N/A[2]	N/A[2]
No Action	—	$22,370,000 to $54,120,000[3]	$12,870[3]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] Costs are unavailable for Mining Water Conservation Best Management Practices (Section 4C.4).
[3] Total economic impact of not meeting needs (i.e. "no action" alternative) was provided by the TWDB (see Appendix F). Annual impact of not meeting needs is presented by decade in Table 4B.5-3. Unit cost was calculated based on annual cost provided by the TWDB and shortage calculated.
N/A = Not applicable.
TBD= To be determined.

4B.5.7.3 Water Supply Plan

Working within the planning criteria established by the CBRWPG and TWDB, the following water supply plan is recommended to reduce the projected 2010 to 2060 shortages for Duval County-Mining:

- Mining Water Conservation (which might include water reuse)
- No Action

Mining water conservation is only able to meet a portion of the projected shortage. It is probable that Duval County mining users could avoid excessive drawdowns by spreading out the area of their wells, instead of concentrating them in a small area represented by a cluster of adjacent cells. This option is discussed in Section 4C.7.2, including costs to drill an additional 11 wells to meet the projected shortages. The costs estimates take into consideration size and depth of wells.

In addition to the management strategy listed above, the CBRWPG supports strategies for reuse of existing supplies.

4B.5.7.4 Costs

For mining water conservation, the Water Conservation Implementation Task Force Guide includes a list of Best Management Practices for industries (included in Section 4C.4) but does not include specific costs. Therefore, no additional capital costs can be reasonably calculated for the mining water plan. The recommended Water Supply Plan, including anticipated supplies to meet shortages is summarized by decade in Table 4B.5-3.

Table 4B.5-3.
Recommended Plan Costs by Decade for Duval County-Mining

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Surplus/(Shortage) (acft/yr)	(1,738)	(2,518)	(2,973)	(3,386)	(3,809)	(4,205)
Mining Water Conservation						
Supply From Plan Element (acft/yr)	147	332	534	761	1,014	1,283
Annual Cost ($/yr)[1]	N/A	N/A	N/A	N/A	N/A	N/A
Unit Cost ($/acft)[1]	N/A	N/A	N/A	N/A	N/A	N/A
No Action						
Annual Cost ($/yr)[2]	$22,370,000	$32,410,000	$38,260,000	$43,580,000	$49,020,000	$54,120,000
Unit Cost ($/acft)	$12,870	$12,870	$12,870	$12,870	$12,870	$12,870

[1] Costs are unavailable for Mining Water Conservation Best Management Practices (Section 4C.4). Conservation savings and costs are by nature facility specific. Since mining entities are presented on a county basis and are not individually identified, identification of costs for specific water management strategies are not appropriate.
[2] Includes lost income and lost business taxes associated with not meeting needs as provided in the TWDB Socioeconomic Impact Report (Appendix F). Unit cost was calculated based on annual cost provided by the TWDB and shortage calculated.
N/A = Not applicable

4B.5.8 Irrigation

Irrigation demands in Duval County are declining over the planning period. The county-wide decline in water use is likely due to expected reductions in irrigated land in the future, however this would imply a reversal of the trend observed in reported irrigated acreage from 1994 to 2000 (Section 4C.2). These demands are met by groundwater from the Gulf Coast Aquifer. No shortages are projected for irrigation and no changes in water supply are recommended.

4B.5.9 Livestock

The livestock water demands in Duval County are met by groundwater from the Gulf Coast Aquifer and surface water from local on-farm sources. No shortages are projected for livestock and no changes in water supply are recommended.

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4B.6 Jim Wells County Water Supply Plan

Table 4B.6-1 lists each water user group in Jim Wells County and their corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4B.6-1.
Jim Wells County Surplus/(Shortage)

Water User Group	Surplus/(Shortage)[1] 2030 (acft/yr)	Surplus/(Shortage)[1] 2060 (acft/yr)	Comment
City of Alice	0	0	Supply equals demand
City of Orange Grove	0	0	Supply equals demand
City of Premont	0	0	Supply equals demand
City of San Diego	0	0	Supply equals demand
County-Other	(262)	(170)	Projected shortages for entire planning period — see plan below
Manufacturing	none	none	No demands projected
Steam-Electric	none	none	No demands projected
Mining	0	0	Supply equals demand
Irrigation	0	0	Supply equals demand
Livestock	0	0	Supply equals demand

[1] From Tables 4A-10 and 4A-11, Section 4 – Comparison of Water Demands with Water Supplies to Determine Needs.

4B.6.1 City of Alice

The City of Alice has a contract to purchase water from the City of Corpus Christi via Lake Corpus Christi. The City also maintains a small reservoir in town, Lake Alice, which serves as temporary storage of waters from Lake Corpus Christi. This reservoir is fed naturally by a small watershed and has no effective firm yield. No shortages are projected for the City of Alice. In 2000 the City of Alice had a per capita per day usage of 248 gallons per capita per day (gpcd) and a projected usage of 234 gpcd in 2060 (after built-in savings for low flow plumbing fixtures), based on TWDB water demand and population projections. The CBRWPG recommends additional water conservation of 15 percent by 2060 for all municipal entities with reported use greater than 165 gpcd in 2060 (Section 4C.1). The City of Alice is currently studying ways to reduce water use. The estimated water saved with additional water conservation increases from 50 acft/yr in Year 2010 to 585 acft/yr in Year 2060 (See Table 4C.1-4). The cost of water savings for additional water conservation ranges from $21,240 in Year 2010 to $247,695 in Year 2060 (See Table 4C.1-7).

4B.6.2 City of Orange Grove

The City of Orange Grove's water supply is from the Gulf Coast Aquifer. No shortages are projected for the City of Orange Grove. In 2000 the City of Orange Grove had a per capita per day usage of 245 gallons per capita per day (gpcd) and a projected usage of 230 gpcd in 2060 (after built-in savings for low flow plumbing fixtures), based on TWDB water demand and population projections. The CBRWPG recommends additional water conservation of 15 percent by 2060 for all municipal entities with reported use greater than 165 gpcd in 2060 (Section 4C.1). The estimated water saved with additional water conservation increases from 3 acft/yr in Year 2010 to 38 acft/yr in Year 2060 (See Table 4C.1-4). The cost of water savings for additional water conservation ranges from $1,087 in Year 2010 to $15,869 in Year 2060 (See Table 4C.1-7).

4B.6.3 City of Premont

The City of Premont's water supply is from the Gulf Coast Aquifer. No shortages are projected for the City of Premont. In 2000 the City of Premont had a per capita per day usage of 260 gallons per capita per day (gpcd) and a projected usage of 246 gpcd in 2060 (after built-in savings for low flow plumbing fixtures), based on TWDB water demand and population projections. The CBRWPG recommends additional water conservation of 15 percent by 2060 for all municipal entities with reported use greater than 165 gpcd in 2060 (Section 4C.1). The estimated water saved with additional water conservation increases from 9 acft/yr in Year 2010 to 92 acft/yr in Year 2060 (See Table 4C.1-4). The cost of water savings for additional water conservation ranges from $3,813 in Year 2010 to $39,077 in Year 2060 (See Table 4C.1-7).

4B.6.4 City of San Diego

The City of San Diego is in both Duval and Jim Well Counties; consequently, its water demand and supply values are split into tables for each county. The City of San Diego receives groundwater supplies from the Goliad Sands of the Gulf Coast Aquifer. The City of Alice has run a 16-inch water transmission line to Hwy 281 bypass, approximately 8 to 9 miles from the City of San Diego.[1] This pipeline could be extended to provide water supply from the City of Alice to San Diego.

No shortages are projected for the City of San Diego. Although projections indicate that San Diego's current wells will produce adequate supply to meet their anticipated demand, there is local concern that the quality of the water produced by the city's wells will decline to the point that advanced treatment will be necessary to stay in compliance with regulatory water quality guidelines as discussed in Section 4C.7.2.3. If the City of San Diego requires groundwater desalination for their highest water demand over the planning period, a 1 MGD reverse osmosis membrane system would be sufficient. If no additional infrastructure is required, it is estimated that the total capital cost for a membrane WTP will be $4,313,000, and total project cost will be $6,304,000. Total annual cost will be $1,000,000, resulting in a unit cost of $893 per acft, or $2.74 per 1,000 gallons assuming full utilization of treatment plant.

4B.6.5 County-Other

4B.6.5.1 Description

- Source: Groundwater - Gulf Coast Aquifer;
- Estimated Reliable Supply: 1,944- 1,976 acft/yr; and
- System Description: Limited by well capacity in Nueces-Rio Grande River Basin.

4B.6.5.2 Options Considered

The County-Other demand projection category is intended to capture the demands of single-family rural municipal demands as well as demands for small rural water supply systems. Jim Wells County-Other users have projected shortages of 167 acft/yr in 2010 increasing to 170 acft/yr in 2060. Near-term (2010) and long-term shortages (2060) are about 8 percent of demand. Table 4B.6-2 lists the water management strategies, references to the report sections discussing the strategy, total project cost, and unit costs that were considered for meeting the Jim Wells County Other shortages.

[1] Conservation with Carl Crull, July 2005.

Table 4B.6-2.
Water Management Strategies Considered for Jim Wells County-Other

Option	Yield (acft/yr)	Approximate Cost[1]	
		Total	Unit ($/acft)
Gulf Coast Aquifer Groundwater Supplies — Drill Additional Well(s) (Section 4C.7)	565	$980,000[2]	$213[2]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] Source of Cost Estimate: Section 4C.7. Table 4C.7-5, 0.6 MGD WTP, fully utilized. Cost estimates are based on size and depth of well(s) to meet needs.

4B.6.5.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages for the Jim Wells County-Other users:

- Gulf Coast Aquifer Supplies – Drill additional well(s).

In addition to the management strategy listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.6.5.4 Costs

Groundwater supplies for Jim Wells County-Other users are currently limited by well capacity. Two new wells would be required to meet the projected shortages for Jim Wells County-Other. The recommended Water Supply Plan including anticipated costs is summarized by decade in Table 4B.6-3.

Table 4B.6-3.
Recommended Plan Costs by Decade for Jim Wells County-Other

Plan Element	2010	2020	2030	2040	2050	2060
Projected Surplus/(Shortage) (acft/yr)	(167)	(238)	(262)	(241)	(210)	(170)
Gulf Coast Aquifer Groundwater Supplies — Drill Additional Well(s)						
Supply From Plan Element (acft/yr)[1]	565	565	565	565	565	565
Total Annual Cost ($/yr)[2]	$120,000	$120,000	$120,000	$35,000	$35,000	$35,000
Total Unit Cost ($/acft)[2]	$213	$213	$213	$62	$62	$62

[1] Supply from additional wells set equal to approximately twice the projected shortage to account for peaking.
[2] Source of Cost Estimate: Section 4C.7. Table 4C.7-5, 0.6 MGD WTP, fully utilized. Cost estimates are based on

size and depth of well(s) to meet needs. Assumes debt service based on RWP guidelines. Reduction in cost after Year 2030 assumes debt service has been paid.

4B.6.6 Manufacturing

No manufacturing demand exists or is projected for the county.

4B.6.7 Steam-Electric

No steam-electric demand exists or is projected for the county.

4B.6.8 Mining

Mining demands are met by groundwater from the Gulf Coast Aquifer. No shortages are projected for mining and no changes in water supply are recommended.

4B.6.9 Irrigation

Irrigation demands are met by groundwater from the Gulf Coast Aquifer. No shortages are projected for irrigation and no changes in water supply are recommended.

4B.6.10 Livestock

The livestock water demands in Jim Wells County are met by groundwater from the Gulf Coast Aquifer and surface water from local on-farm sources. No shortages are projected for livestock and no changes in water supply are recommended.

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4B.7 Kenedy County Water Supply Plan

Table 4B.7-1 lists each water user group in Kenedy County and their corresponding surplus or shortage in years 2030 and 2060. All water user groups in Kenedy County have an adequate supply, as shown in Table 4B.7-1.

Table 4B.7-1.
Kenedy County Surplus/(Shortage)

Water User Group	Surplus/(Shortage)[1] 2030 (acft/yr)	Surplus/(Shortage)[1] 2060 (acft/yr)	Comment
County-Other	0	0	Supply equals demand
Manufacturing	0	0	No demands projected
Steam-Electric	0	0	No demands projected
Mining	0	0	Supply equals demand
Irrigation	0	0	Supply equals demand
Livestock	0	0	Supply equals demand

[1] From Tables 4A-12 and 4A-13, Section 4 – Comparison of Water Demands with Water Supplies to Determine Needs.

4B.7.1 County-Other

The Kenedy County-Other municipal users receive groundwater supplies from the Gulf Coast Aquifer. No shortages are projected for Kenedy County-Other entities and no changes in water supply are recommended.

4B.7.2 Manufacturing

No manufacturing demand exists or is projected for the county.

4B.7.3 Steam-Electric

No steam-electric demand exists or is projected for the county.

4B.7.4 Mining

The mining water demands in Kenedy County are met by groundwater from the Gulf Coast Aquifer. No shortages are projected for mining and no changes in water supply are recommended.

4B.7.5 Irrigation

The irrigation water demands in Kenedy County are met by groundwater from the Gulf Coast Aquifer. No shortages are projected for irrigation and no changes in water supply are recommended.

4B.7.6 Livestock

The livestock water demands in Kenedy County are met by groundwater from the Gulf Coast Aquifer and surface water from local on-farm sources. No shortages are projected for livestock and no changes in water supply are recommended.

4B.8 Kleberg County Water Supply Plan

Table 4B.8-1 lists each water user group in Kleberg County and their corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4B.8-1.
Kleberg County Surplus/(Shortage)

Water User Group	Surplus/(Shortage)[1]		Comment
	2030 (acft/yr)	2060 (acft/yr)	
City of Kingsville	0	0	Supply equals demand
Ricardo WSC	0	0	Supply equals demand
County-Other	(81)	(155)	Projected shortages from 2020 to 2060 — see plan below
Manufacturing	none	none	No demands projected
Steam-Electric	none	none	No demands projected
Mining	0	0	Supply equals demand
Irrigation	0	0	Supply equals demand
Livestock	0	0	Supply equals demand

[1] From Tables 4A-14 and 4A-15, Section 4 – Comparison of Water Demands with Water Supplies to Determine Needs.

4B.8.1 City of Kingsville

The City of Kingsville has a contract with the South Texas Water Authority (STWA) to purchase treated surface water from the CCR/LCC/Texana System. The City also has five wells with a combined capacity of 6.3 MGD (or 7,055 acft/yr) that pump groundwater from the Gulf Coast Aquifer. South Texas Water Authority provides water to the Ricardo Water Supply Corporation via a pass through agreement with the City of Kingsville. However, since the City of Kingsville does not meet its water needs with 100% surface water, the Ricardo WSC is receiving groundwater supplies from Kingsville's wells.[1] The current contract between the City and the STWA allows Kingsville to purchase up to $350,000 of treated water. This feature of the contract was used in 2020 and beyond to ensure sufficient water supplies to meet the City's needs through 2060. No shortages are projected for Kingsville and no changes in water supply are recommended.

[1] Correspondence from Carola Serrato, May 2005.

4B.8.2 Ricardo WSC

STWA provides water to the Ricardo Water Supply Corporation via a pass through agreement with the City of Kingsville. However, since the City of Kingsville does not meet its water needs with 100% surface water, the Ricardo WSC is receiving groundwater supplies from the City of Kingsville's wells.[2] Ricardo WSC is in the process of preparing the final easement acquisition for additional dedicated surface water line to connect directly to STWA's 42" treated water line. Ricardo WSC demands are met with surface water supplies and groundwater from the Gulf Coast Aquifer. No shortages are projected for Ricardo WSC and no changes in water supply are recommended.

4B.8.3 County-Other

4B.8.3.1 Description

- Source: Groundwater - Gulf Coast Aquifer;
- Estimated Reliable Supply: 849 acft/yr (groundwater); and
- System Description: Individual Wells.

4B.8.3.2 Options Considered

County-Other demands in Kleberg County have shortages of 31 acft/yr in 2020 which increase to 155 acft/yr in 2060. Long-term shortages in 2060 are about 15 percent of demand. Table 4B.8-2 lists the water management strategies, references to the report section discussing the strategy, total project cost, and unit costs that were considered for meeting the shortage for County-Other in Kleberg County.

Table 4B.8-2.
Water Management Strategies Considered for Kleberg County-Other

Option	Yield (acft/yr)	Approximate Cost[1]	
		Total	Unit ($/acft)
Gulf Coast Aquifer Groundwater Supplies — Drill Additional Well(s)(Section 4C.7)	400	$587,000[2]	$185[2]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] Source of Cost Estimate: Section 4C.7. Table 4C.7-6, 0.4 MGD water treatment plant, fully utilized. Cost estimates are based on size and depth of well(s) to meet needs.

[2] Correspondence from Carola Serrato, May 2005.

4B.8.3.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages for County-Other in Kleberg County:

- Gulf Coast Aquifer Groundwater Supplies- Drill additional well(s).

In addition to the management strategy listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.8.3.4 Costs

The County-Other demand projection category is intended to capture the demands of single-family rural municipal demands as well as demands for small rural water supply systems. The recommended Water Supply Plan, including anticipated costs is summarized by decade in Table 4B.8-3.

Table 4B.8-3.
Recommended Plan Costs by Decade for Kleberg County-Other

Plan Element	2010	2020	2030	2040	2050	2060
Projected Surplus/(Shortage) (acft/yr)	—	(31)	(81)	(108)	(153)	(155)
Gulf Coast Aquifer Groundwater Supplies — Drill Additional Well(s)						
Supply From Plan Element (acft/yr)[1]	—	400	400	400	400	400
Total Annual Cost ($/yr)[2]	—	$74,000	$74,000	$74,000	$23,000	$23,000
Total Unit Cost ($/acft)[2]	—	$185	$185	$185	$58	$58

[1] Supply from additional wells set equal to approximately twice the projected shortage to account for peaking.

[2] Source of Cost Estimate: Section 4C.7. Table 4C.7-6, 0.4 MGD water treatment plant, fully utilized. Cost estimates are based on size and depth of well(s) to meet needs. Assumes debt service based on RWP guidelines. Reduction in cost after Year 2040 assumes debt service has been paid.

4B.8.4 Manufacturing

No manufacturing demand exists or is projected for the county.

4B.8.5 Steam-Electric

No steam-electric demand exists or is projected for the county.

4B.8.6 Mining

Mining water demands in Kleberg County are met by groundwater from the Gulf Coast Aquifer. No shortages are projected for mining and no changes in water supply are recommended.

4B.8.7 Irrigation

Irrigation demands in Kleberg County are declining over the planning period. These demands are met by groundwater from the Gulf Coast Aquifer. No shortages are projected for irrigation and no changes in water supply are recommended.

4B.8.8 Livestock

The livestock demands in Kleberg County are met by groundwater from the Gulf Coast Aquifer and surface water from local on-farm sources. No shortages are projected for livestock and no changes in water supply are recommended.

4B.9 Live Oak County Water Supply Plan

Table 4B.9-1 lists each water user group in Live Oak County and their corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4B.9-1.
Live Oak County Surplus/(Shortage)

Water User Group	***Surplus/(Shortage)[1]***		***Comment***
	2030 (acft/yr)	***2060 (acft/yr)***	
Choke Canyon WSC	2	4	Projected surplus — supplies and demands split between Live Oak and McMullen Counties
El Oso WSC	0	0	Supply equals demand
City of George West	0	0	Supply equals demand
McCoy WSC	2	14	Projected surplus
City of Three Rivers	3,271	3,463	Projected surplus
County-Other	(44)	0	Projected shortages in 2020, 2030, and 2040 — see plan below
Manufacturing	(559)	(764)	Projected shortages from 2010 to 2060 — see plan below
Steam-Electric	none	none	No demands projected
Mining	(928)	(1,755)	Projected shortages from 2010 to 2060 — see plan below
Irrigation	(514)	(373)	Projected shortages from 2010 to 2060 — see plan below
Livestock	0	0	Supply equals demand

[1] From Tables 4A-16 and 4A-17, Section 4 – Comparison of Water Demands with Water Supplies to Determine Needs.

4B.9.1 Choke Canyon WSC

Choke Canyon WSC has service areas in Live Oak and McMullen Counties, with a portion of their total water demand and supplies allocated to each county (Tables 4A-16 and 4A-18). In January 2004, Choke Canyon WSC was purchased by the City of Three Rivers. Choke Canyon water supply demands are met with groundwater from the Gulf Coast Aquifer and surface water supplies from the City of Three Rivers. No shortages are projected for Choke Canyon WSC and no changes in water supply are recommended.

4B.9.2 El Oso WSC

El Oso Water Supply Corporation is located in both Bee and Live Oak Counties; consequently, its water demand and supply values are split into tables for each county. The El Oso Water Supply Corporation receives groundwater supplies from the Gulf Coast Aquifer. No shortages are projected for El Oso Water Supply Corporation and no changes in water supply are recommended.

4B.9.3 City of George West

The City of George West's demands are met with groundwater from the Gulf Coast Aquifer. No shortages are projected for George West. In 2000 the City of George West had a per capita per day usage of 227 gallons per capita per day (gpcd) and a projected usage of 213 gpcd in 2060 (after built-in savings for low flow plumbing fixtures), based on TWDB water demand and population projections. The CBRWPG recommends additional water conservation of 15 percent by 2060 for all municipal entities with reported use greater than 165 gpcd in 2060. The estimated water saved with additional water conservation increases from 5 acft/yr in Year 2010 to 57 acft/yr in Year 2060 (See Table 4C.1-4). The cost of water savings for additional water conservation ranges from $1,961 in Year 2010 to $24,166 in Year 2060(See Table 4C.1-7).

4B.9.4 McCoy WSC

McCoy WSC's demands are met with groundwater from the Carrizo-Wilcox Aquifer. No shortages are projected for McCoy WSC and no changes in water supply are recommended.

4B.9.5 City of Three Rivers

The City of Three Rivers' demands are met with surface water rights on the Nueces River. No shortages are projected for Three Rivers. In 2000 the City of Three Rivers had a per capita per day usage of 202 gallons per capita per day (gpcd) and a projected usage of 188 gpcd in 2060 (after built-in savings for low flow plumbing fixtures), based on TWDB water demand and population projections. The CBRWPG recommends additional water conservation of 15 percent by 2060 for all municipal entities with reported use greater than 165 gpcd in 2060. The estimated water saved with additional water conservation increases from 3 acft/yr in Year

2010 to 34 acft/yr in Year 2060 (See Table 4C.1-4). The cost of water savings for additional water conservation ranges from $1,068 in Year 2010 to $14,508 in Year 2060(See Table 4C.1-7).

Part of the City of Three River's surplus has been reallocated to Manufacturing use in the county (Table 4B.9-2).

Table 4B.9-2. Reallocation of Surplus Supplies by Decade for City of Three Rivers

Plan Element	2010	2020	2030	2040	2050	2060
Original Projected Surplus (acft/yr)	3,353	3,289	3,271	3,304	3,381	3,463
Reallocated Surplus (acft/yr)	337[1]	483[1]	559[1]	615[1]	657[1]	764[1]
Remaining Projected Surplus (acft/yr)	3,016	2,806	2,712	2,689	2,724	2,699

[1] Reallocated to Live Oak-Manufacturing users (Section 4B.9.7)

4B.9.6 County-Other

4B.9.6.1 Description

- Source: Groundwater - Gulf Coast Aquifer
- Estimated Reliable Supply: 764 acft per year
- System Description: Individual Wells and Small Water Supply Systems

4B.9.6.2 Options Considered

County-Other demand in Live Oak County has shortages of 32 acft/yr in 2020, which is reduced in subsequent decades to 14 acft/yr in 2040. Projected groundwater demands decrease after 2030, and groundwater supplies are sufficient to meet projected demands in 2050 and 2060. Groundwater supplies are limited by the estimated well capacity, based on the procedure in Section 4A.2. Table 4B.9-3 lists the water management strategies, references to the report section discussing the strategy, total project cost, and unit costs that were considered for meeting the shortage for County-Other in Live Oak County.

Table 4B.9-3.
Water Management Strategies Considered for Live Oak County-Other

Option	Yield (acft/yr)	Approximate Cost[1] Total	Approximate Cost[1] Unit ($/acft)
Gulf Coast Aquifer Groundwater Supplies — Drill Additional Well(s) (Section 4C.7)	80	$315,000[2]	$438[2]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] Source of Cost Estimate: Section 4C.7. Table 4C.7-7, 0.1 MGD water treatment plant fully utilized. Cost estimates are based on size and depth of well(s) to meet needs.

4B.9.6.3 Water Supply Plan

Working within the planning criteria established by the CBRWPG and TWDB, the following water supply plan is recommended to meet the projected shortages for County-Other in Live Oak County:

- Gulf Coast Aquifer Groundwater Supplies – Drill Additional Well(s).

In addition to the management strategy listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.9.6.4 Costs

The function of the County-Other demand projection category is to capture the demands of single family rural municipal demands as well as demands for small rural water supply systems. The recommended Water Supply Plan including anticipated costs is summarized by decade in Table 4B.9-4.

Table 4B.9-4.
Recommended Plan Costs by Decade for Live Oak County-Other

Plan Element	2010	2020	2030	2040	2050	2060
Projected Surplus/(Shortage) (acft/yr)	—	(32)	(44)	(14)	—	—
Gulf Coast Aquifer Groundwater Supplies — Drill Additional Well(s)						
Supply From Plan Element (acft/yr)[1]	—	80	80	80	80	80
Total Annual Cost ($/yr)[2]	—	$35,000	$35,000	$35,000	$8,000	$8,000
Total Unit Cost ($/acft)[2]	—	$438	$438	$438	$100	$100

[1] Supply from additional wells set equal to approximately twice the projected shortage to account for peaking.
[2] Source of Cost Estimate: Section 4C.7. Table 4C.7-7, 0.1 MGD water treatment plant fully utilized. Cost estimates are based on size and depth of well(s) to meet needs. Reduction in cost after Year 2040 assumes debt service has been paid.

4B.9.7 Manufacturing

4B.9.7.1 Description

- Source: Groundwater - Gulf Coast Aquifer and Nueces Basin run-of-the-river surface water rights for manufacturing use (owned by the City of Three Rivers)
- Estimated Reliable Supply: 800 acft/yr (surface water)
  630 to 809 acft/yr (groundwater)
- System Description: Individual Wells and various manufacturing operations

4B.9.7.2 Options Considered

Manufacturing demand in Live Oak County has shortages during the entire planning period and increase from 337 acft/yr in 2010 to 764 acft/yr in 2060. Groundwater supplies are limited by drawdown criteria established by the CBRWPG (Section 3). Table 4B.9-5 lists the water management strategies, references to the report section discussing the strategy, total project cost, and unit costs that were considered for meeting the shortage for Manufacturing in Live Oak County.

Table 4B.9-5.
Water Management Strategies Considered for Live Oak County-Manufacturing

Option	Yield (acft/yr)	Approximate Cost[1]	
		Total	Unit ($/acft)
Voluntary Redistribution of City of Three Rivers surplus (Section 4C.12)	337 to 764	N/A[2]	$685[3]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] Costs not applicable (see discussion in Section 4C.12.2).
[3] Unit cost of $685 per acft assumed to be comparable to the cost of Garwood water.
N/A = Not applicable.

4B.9.7.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages for County-Other in Live Oak County:

- Voluntary Redistribution of City of Three Rivers surplus.

It is probable that Live Oak manufacturing users could avoid excessive drawdowns by spreading out the area of their wells, instead of concentrating them in a small area represented by a cluster of adjacent cells. This option is discussed in Section 4C.7.2, including costs to drill an additional two (2) wells to meet the projected shortages.

In addition to the management strategy listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.9.7.4 Costs

The recommended Water Supply Plan is summarized by decade in Table 4B.9-6.

Table 4B.9-6.
Recommended Plan Costs by Decade for Live Oak County-Manufacturing

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Surplus/(Shortage) (acft/yr)	(337)	(483)	(559)	(615)	(657)	(764)
Voluntary Redistribution of City of Three Rivers Surplus						
Supply From Plan Element (acft/yr)	337	483	559	615	657	764
Total Annual Cost ($/yr)	$230,800	$330,900	$382,900	$421,300	$450,000	$523,300
Total Unit Cost ($/acft)[1]	$685	$685	$685	$685	$685	$685
[1] Unit cost of $685 per acft assumed to be comparable to cost of Garwood water.						

4B.9.8 Steam-Electric

No steam-electric demand exists or is currently projected for the county.

4B.9.9 Mining

According to the local groundwater conservation district[1], the development of natural gas from the shale in the Eagleford Group has begun in Live Oak County. Water demands associated with these mining activities are not included in projected TWDB water demands, but may impact local groundwater use in the Carrizo Aquifer. Furthermore, uranium mining is in the initial phases of exploration in Live Oak County and is anticipated to use additional groundwater supplies. The impacts of developing gas wells in the Eagleford shale and uranium mining activities on groundwater supplies in the Coastal Bend Region should be considered in future planning efforts.

[1] Correspondence from Live Oak UWCD in November 2009.

4B.9.9.1 Description

- Source: Groundwater – Gulf Coast Aquifer
- Estimated Reliable Supply: 3,105 to 3,841 acft/yr
- System Description: Various mining operations

4B.9.9.2 Options Considered

The mining supply in Live Oak County has shortages for the entire planning period and increase from 64 acft per year in 2010 to 1,755 acft per year in 2060. Groundwater supplies are limited by drawdown criteria established by the CBRWPG (Section 3). Table 4B.9-7 lists the water management strategies, references to the report sections discussing the strategy, total project cost, and unit costs that were considered for meeting the Live Oak County mining shortages.

Table 4B.9-7.
Water Management Strategies Considered for Live Oak County-Mining

Option	Yield (acft/yr)	Approximate Cost[1]	
		Total	Unit ($/acft)
Mining Water Conservation (Section 4C.4)	97 to 801[2]	N/A[2]	N/A[2]
No Action	—	$1,050,000 to $7,700,000[3]	$2,197 to $4,388[3]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] Yield based on 15 percent reduction in demand recommended by CBRWPG (Section 4C.4.2).
[3] Total economic impact of not meeting needs (i.e. "no action" alternative) was provided by the TWDB (see Appendix F). Annual impact of not meeting regional needs is presented by decade in Table 4B.9-8. Unit cost was calculated based on annual cost provided by the TWDB and shortage calculated.
N/A = Not applicable.

4B.9.9.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is recommended to meet the projected near-term and long-term shortages for Live Oak County mining:

- Mining Water Conservation (which might include water reuse), and
- No Action.

Mining water conservation is only able to meet a portion of the projected shortage.

It is probable that Live Oak mining users could avoid excessive drawdowns by spreading out the area of their wells, instead of concentrating them in a small area represented by a cluster of adjacent cells. This option is discussed in Section 4C.7.2, including costs to drill an additional five wells to meet the projected shortages. The costs estimates take into consideration size and depth of wells.

In addition to the management strategies listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.9.9.4 Costs

For mining water conservation, the Water Conservation Implementation Task Force Guide includes a list of Best Management Practices for industries (included in Section 4C.4) but does not include specific costs. Therefore, no additional capital costs can be reasonably calculated for the mining water plan. The recommended Water Supply Plan including anticipated costs is summarized by decade in Table 4B.9-8.

Table 4B.9-8.
Recommended Plan Costs by Decade for Live Oak County-Mining

Plan Element	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
Projected Surplus/(Shortage) (acft/yr)	(64)	(478)	(928)	(1,234)	(1,504)	(1,755)
Mining Water Conservation						
Supply From Plan Element (acft/yr)	97	216	344	485	639	801
Annual Cost ($/yr)[1]	N/A	N/A	N/A	N/A	N/A	N/A
Unit Cost ($/acft)[1]	N/A	N/A	N/A	N/A	N/A	N/A
No Action						
Annual Cost ($/yr)[2]	-	$1,050,000	$2,040,000	$2,710,000	$6,600,000	$7,700,000
Unit Cost ($/acft)[2]		$2,197	$2,197	$2,197	$4,388	$4,388

[1] Costs are unavailable for Mining Water Conservation Best Management Practices (Section 4C.4). Conservation savings and costs are by nature facility specific. Since mining entities are presented on a county basis and are not individually identified, identification of costs for specific water management strategies are not appropriate.
[2] Includes lost output, lost income, and lost business taxes associated with not meeting needs as provided in the TWDB Socioeconomic Impact Report (Appendix F). Unit cost was calculated based on annual cost provided by the TWDB and shortage calculated.
N/A = Not Applicable

4B.9.10 Irrigation

4B.9.10.1 Description

- Source: Groundwater - Gulf Coast Aquifer;
- Estimated Reliable Supply: 1,704 to 2,649 acft/yr (groundwater); and
- System Description: Various on-farm irrigation systems.

4B.9.10.2 Options Considered

The Irrigation supply in Live Oak County shows a projected shortage for the entire planning period. Due to projected water demand declines for irrigation users in Live Oak County, shortages decrease from 827 acft/yr in 2010 to 573 acft/yr in 2060. The county-wide decline in water use is likely due to expected reductions in irrigated land in the future, however this would imply a reversal of the trend observed in reported irrigated acreage from 1994 to 2000 (Section 4C.2). Shortages are approximately 25 percent of demand in 2010 and 2060. Groundwater supplies are limited by the approach used to calculate groundwater and surface water supplies based on 2000 use (Section 4A.2). Table 4B.9-9 lists the water management strategies, references to the report sections discussing the strategy, total project cost, and unit costs that were considered for meeting the Live Oak County Irrigation shortages.

Table 4B.9-9.
Water Management Strategies Considered for Live Oak County-Irrigation

Option	*Yield (acft/yr)*	*Approximate Cost*[1]	
		Total	*Unit ($/acft)*
Irrigation Conservation (Section 4C.2)	17 to 342[2]	Variable[2]	$228[2]
Gulf Coast Aquifer Supplies – Drill Additional Well(s) (Section 4C.7)	1,210	$1,058,000[3]	$100[3]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft per year) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] Source of Cost Estimate: Section 4C.2. Irrigation Conservation is estimated to cost $78,000 per year in Year 2060 to implement furrow irrigation best management practice to achieve a water savings of 342 acft at an average cost of $228 per acft. LESA/LEPA are less expensive options.
[3] Source of Cost Estimate: Section 4C.7, Table 4C.7-10. Cost estimates are based on size and depth of well(s) to meet needs.

4B.9.10.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages for Irrigation in Live Oak County:

- Irrigation Conservation (Furrow/LESA/LEPA); and
- Gulf Coast Aquifer Groundwater Supplies- Drill Additional Well(s).

Although irrigation demands are projected to decrease, the affects of irrigation conservation will not be significant in earlier decades. To meet near-term shortages drilling three additional wells will provide the additional water supply to meet projected shortages. Irrigation conservation savings are anticipated to increase from 17 acft/yr in 2010 to 342 acft/yr in 2060 (Section 4C.2). In addition to the management strategies listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.9.10.4 Costs

The recommended Water Supply Plan including anticipated costs is summarized by decade in Table 4B.9-10.

Table 4B.9-10.
Recommended Plan Costs by Decade for Live Oak County-Irrigation

Plan Element	2010	2020	2030	2040	2050	2060
Projected Surplus/(Shortage) (acft/yr)	(627)	(569)	(514)	(464)	(416)	(373)
Irrigation Conservation						
Supply From Plan Element (acft/yr)	17	52	103	169	248	342
Annual Cost ($/yr)	$3,900	$11,900	$23,500	$38,500	$56,500	$78,000
Unit Cost ($/acft)[1]	$228	$228	$228	$228	$228	$228
Gulf Coast Aquifer Groundwater Supplies – Drill Additional Well(s)						
Supply From Plan Element (acft/yr)[2]	1,210	1,210	1,210	1,210	1,210	1,210
Annual Cost ($/yr)[3]	$121,000	$121,000	$121,000	$29,000	$29,000	$29,000
Unit Cost ($/acft)[3]	$100	$100	$100	$24	$24	$24
Total Annual Cost ($/yr)	$124,900	$132,900	$144,500	$67,500	$85,500	$107,000
Total Unit Cost ($/acft)[4]	$102	$105	$110	$49	$59	$69

1 Costs shown based on implementing furrow dikes as a water conservation strategy (Section 4C.2).
2 Supply from additional wells set equal to approximately twice the projected shortage to account for peaking.
3 Source of Cost Estimate: Section 4C.7, Table 4C.7-10. Cost estimates are based on size and depth of well(s) to meet needs. Assumes debt service based on RWP guidelines. Reduction in cost after Year 2030 assumes debt service has been paid.
4 Weighted average unit cost of the one or two management strategies that have associated total annual costs, based on projected supply needed.

4B.9.11 Livestock

The livestock demands in Live Oak County are met by groundwater from the Gulf Coast Aquifer and surface water from local on-farm sources. No shortages are projected for livestock and no changes in water supply are recommended.

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4B.10 McMullen County Water Supply Plan

Table 4B.10-1 lists each water user group in McMullen County and their corresponding surplus or shortage in years 2030 and 2060. All water user groups in McMullen County have an adequate supply, as shown in Table 4B.10-1.

Table 4B.10-1.
McMullen County Surplus/(Shortage)

Water User Group	*Surplus/(Shortage)*[1] 2030 (acft/yr)	2060 (acft/yr)	*Comment*
Choke Canyon WSC	13	13	Projected surplus — supplies and demands split between Live Oak and McMullen Counties
County-Other	31	52	Projected surplus
Manufacturing	0	0	No demands projected
Steam-Electric	0	0	No demands projected
Mining	0	0	Supply equals demand
Irrigation	0	0	No demands projected
Livestock	0	0	Supply equals demand

[1] From Tables 4A-18 and 4A-19, Section 4 – Comparison of Water Demands with Water Supplies to Determine Needs.

4B.10.1 Choke Canyon WSC

In January 2004, Choke Canyon WSC was purchased by the City of Three Rivers. The TWDB did not provide updated population and water demands for planning groups to use in developing the 2011 Plan, since the TWDB does not have updated census data for the current planning effort. Therefore, Choke Canyon WSC demands used in the 2011 Plan are the same as those shown in the 2006 Plan. For future planning efforts, Choke Canyon WSC should be removed as a separate water user group and the projected population and water demands for Choke Canyon WSC should be added to the City of Three Rivers projections.

Choke Canyon WSC has service areas in Live Oak and McMullen Counties, with a portion of their total water demand and supplies allocated to each county (Tables 4A-17 and 4A-19). Choke Canyon WSC water demands are met with groundwater from the Gulf Coast Aquifer and surface water supplies from the City of Three Rivers. No shortages are projected for Choke Canyon WSC and no changes in water supply are recommended.

4B.10.2 County-Other

The McMullen County-Other municipal users receive groundwater supplies from the Carrizo-Wilcox, Queen City, and Sparta Aquifers. No shortages are projected for McMullen County-Other entities. In 2000 McMullen County-Other had a per capita per day usage of 201 gallons per capita per day (gpcd) which is projected to decrease to 187 gpcd in 2060 (after built-in savings for low flow plumbing fixtures), based on TWDB water demand and population projections. The CBRWPG recommends additional water conservation of 15 percent by 2060 for all municipal entities with reported use greater than 165 gpcd in 2060. The estimated water saved with additional water conservation increases from 1 acft/yr in Year 2010 to 10 acft/yr in Year 2060 (See Table 4C.1-4). The cost of water savings for additional water conservation ranges from $272 in Year 2010 to $4,264 in Year 2060 (See Table 4C.1-7).

4B.10.3 Manufacturing

No manufacturing demand exists or is projected for the county. According to the local groundwater conservation district[1], water is being used for manufacturing activities in McMullen County. Due to time constraints and TWDB guidance, these manufacturing water demands were not evaluated in detail for the 2011 Plan but should be considered in future planning efforts.

4B.10.4 Steam-Electric

No steam-electric demand exists or is projected for the county.

4B.10.5 Mining

Mining water demands in McMullen County show a small increase over the planning period from 195 acft/yr in 2010 to 218 acft/yr in 2060. These demands are met by groundwater from the Carrizo-Wilcox Aquifer. No shortages are projected for mining and no changes in water supply are recommended. According to the local groundwater conservation district[1], the development of natural gas from the shale in the Eagleford Group has begun in McMullen County. Water demands associated with these mining activities are not included in projected TWDB water demands, but may impact local groundwater use in the Carrizo Aquifer. The impacts of developing gas wells in the Eagleford shale on groundwater supplies in the Coastal Bend Region should be considered in future planning efforts.

[1] Correspondence from McMullen GCD in November 2009.

4B.10.6 Irrigation

No irrigation demand exists or is projected for the county.

4B.10.7 Livestock

The livestock water demands in McMullen County are met by groundwater from the Carrizo-Wilcox, Gulf Coast, Queen City, and Sparta Aquifers and surface water from local on-farm sources. No shortages are projected for livestock and no changes in water supply are recommended.

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4B.11 Nueces County Water Supply Plan

Table 4B.11-1 lists each water user group in Nueces County and their corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections. Water supply plans are also presented for some entities that need pumping/conveyance facilities to utilize water from wholesale water providers.

Table 4B.11-1.
Nueces County Surplus/(Shortage)

Water User Group	Surplus/(Shortage)[1] 2030 (acft/yr)	Surplus/(Shortage)[1] 2060 (acft/yr)	Comment
City of Agua Dulce	0	0	Supply equals demand
City of Aransas Pass	0	0	Supply equals demand
City of Bishop	0	0	Supply equals demand
City of Corpus Christi	0	0	Projected surplus through 2010, then supply equals demand
City of Driscoll	0	0	Supply equals demand
Nueces County WCID #4	0	0	Supply equals demand
City of Port Aransas	0	0	Supply equals demand
River Acres WSC	(355)	(590)	Projected shortage from 2010 to 2060 — see plan below
City of Robstown	0	0	Supply equals demand
County-Other	146	383	Projected shortage in 2010; Projected surplus from 2030 through 2060
Manufacturing	(15,203)	(39,550)	Projected shortage – see plan below
Steam-Electric	(4,755)	(13,183)	Projected shortage – see plan below
Mining	(570)	(1,624)	Projected shortage from 2030 to 2060 – see plan below
Irrigation	2,930	3,315	Projected Surplus
Livestock	0	0	Supply equals demand

[1] From Tables 4A-20 and 4A-21, Section 4 – Comparison of Water Demands with Water Supplies to Determine Needs.

4B.11.1 City of Agua Dulce

The City of Agua Dulce has a contract with the South Texas Water Authority (STWA) to purchase treated surface water from the CCR/LCC/Texana System. No shortages are projected for the City of Agua Dulce and no changes in water supply are recommended.

4B.11.2 City of Aransas Pass

The City of Aransas Pass is in Aransas, Nueces and San Patricio Counties; consequently, the water demand and supply values are split into the tables for each county. Aransas Pass contracts with the San Patricio Municipal Water District (SPMWD) to purchase treated water from the CCR/LCC/Texana System. The contract allows the City to purchase only the water that it needs. No shortages are projected for the City of Aransas Pass and no changes in water supply are recommended.

4B.11.3 City of Bishop

The City of Bishop has a contract with STWA to purchase treated surface water. Additionally, the City pumps groundwater from the Gulf Coast Aquifer. No shortages are projected for the City of Bishop and no changes in water supply are recommended.

4B.11.4 City of Corpus Christi

The City of Corpus Christi meets its demands with its own water rights in the CCR/LCC System and through a contract with the Lavaca-Navidad River Authority (LNRA) that provides water from Lake Texana. Although no shortages are projected for the City's own municipal needs, the City also provides surface water to SPMWD, STWA, and manufacturing and steam-electric water user groups in Nueces and San Patricio Counties. The City's contract with LNRA expires in 2035; however, it is anticipated that this contract will be renewed when it expires. Therefore, water supply tables in Section 4 and in the water supply plans for Nueces County-Manufacturing (Section 4B.11.10) and San Patricio County-Manufacturing (Section 4B.12.11) include Lake Texana contract water as existing supply throughout the 60-year planning horizon.

In addition to these water supply sources, the City has a permit to divert up to 35,000 acft/yr of run-of-river water under its interbasin transfer permit on the Colorado River (via the Garwood Irrigation Co.). While the City owns the water right on the Colorado River, it does not have the facilities to divert and convey this water to the City. In the long-term (beyond 2030), the City will have to access this water—either directly or via a trade—to help offset the manufacturing shortages in Nueces and San Patricio Counties.

4B.11.5 City of Driscoll

The City of Driscoll has a contract with STWA to purchase treated surface water from the CCR/LCC/Texana System. No shortages are projected for the City of Driscoll and no changes in water supply are recommended.

4B.11.6 Nueces County WCID #4

The Nueces County WCID #4 has contracts with City of Corpus Christi and SPMWD to purchase treated surface water from the CCR/LCC/Texana System and serves the City of Port Aransas. Nueces County WCID #4 and Port Aransas water demands were separately identified by the TWDB. Water supplies for Nueces County WCID #4 are provided by City of Corpus Christi. Water supplies for Port Aransas are provided by SPMWD. No shortages are projected for the Nueces County WCID #4. In 2000 Nueces County WCID #4 had a per capita per day usage of 187 gallons per capita per day (gpcd) and a projected usage of 177 gpcd in 2060 (after built-in savings for low flow plumbing fixtures), based on TWDB water demand and population projections. The CBRWPG recommends additional water conservation of 15 percent by 2060 for all municipal entities with reported use greater than 165 gpcd in 2060. The estimated water saved with additional water conservation increases from 56 acft/yr in Year 2030 to 384 acft/yr in Year 2060 (See Table 4C.1-4). The cost of water savings for additional water conservation ranges from $25,130 in Year 2010 to $171,880 in Year 2060 (See Table 4C.1-7).

4B.11.7 City of Port Aransas

The Nueces County WCID #4 has contracts with City of Corpus Christi and SPMWD to purchase treated surface water from the CCR/LCC System and serves the City of Port Aransas. Nueces County WCID #4 and Port Aransas water demands were separately identified by the TWDB. Water supplies for Nueces County WCID #4 are provided by City of Corpus Christi. Water supplies for Port Aransas are provided by SPMWD. No shortages are projected for Port Aransas. In 2000 the City of Port Aransas had a per capita per day usage of 424 gallons per capita per day (gpcd) and a projected usage of 413 gpcd in 2060 (after built-in savings for low flow plumbing fixtures), based on TWDB water demand and population projections. A possible reason for the high usage is due to a high influx of tourists. The CBRWPG recommends additional water conservation of 15 percent by 2060 for all municipal entities with reported use greater than 165 gpcd in 2060. The estimated water saved with additional water conservation increases from 28 acft/yr in Year 2010 to 843 acft/yr in Year 2060 (See Table 4C.1-4). The cost of water savings for additional water conservation ranges from $12,682 in Year 2010 to $377,721 in Year 2060 (See Table 4C.1-7).

4B.11.8 River Acres WSC

4B.11.8.1 Description

- Source: Surface Water — Nueces River (via Nueces County WCID #3);
- Estimated Reliable Supply: 291 acft/yr (surface water); and
- System Description: Small Water Supply Systems.

4B.11.8.2 Options Considered

River Acres WSC in Nueces County has a shortage for the entire planning period and increases from 138 acft/yr in 2010 to 590 acft/yr in 2060. River Acres WSC receives surface water supplies from Nueces County WCID #3. Nueces County WCID #3 has projected surpluses sufficient to meet River Acres WSC needs (Section 4A.4). Table 4B.11-2 lists the water management strategies, references to the report section discussing the strategy, total project cost, and unit costs that were considered for meeting the shortage for River Acres WSC.

Table 4B.11-2.
Water Management Strategies Considered for River Acres WSC

Option	Yield (acft/yr)	Approximate Cost[1]	
		Total	Unit ($/acft)
Voluntary Redistribution- increase contracted amount from Nueces County WCID #3 (Section 4C.12)	138 to 590	N/A[2]	$798[2]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] Unit cost of $798 per acft is to treat water for municipal use. Cost provided by Nueces County WCID #3.
N/A = Not applicable.

4B.11.8.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is recommended to meet the projected 2010 through 2060 shortages for River Acres WSC:

- Voluntary Redistribution- increase contracted amount from Nueces County WCID #3

In addition to the management strategies listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.11.8.4 Costs

The recommended Water Supply Plan including anticipated costs is summarized by decade in Table 4B.11-3.

Table 4B.11-3.
Recommended Plan Costs by Decade for River Acres WSC

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Surplus/(Shortage) (acft/yr)	(138)	(255)	(355)	(445)	(522)	(590)
Voluntary Redistribution – increase contracted amount from Nueces County WCID #3						
Supply From Plan Element (acft/yr)	138	255	355	445	522	590
Total Annual Cost ($/yr)	$110,200	$203,500	$283,300	$355,200	$416,600	$470,900
Total Unit Cost ($/acft)[1]	$798	$798	$798	$798	$798	$798
[1] Unit cost for treated water provided by Nueces County WCID #3.						

4B.11.9 City of Robstown

The City of Robstown has a contract with the Nueces County WCID #3 to purchase treated surface water from the Nueces River. No shortages are projected for the City of Robstown and no changes in water supply are recommended.

4B.11.10 County-Other

4B.11.10.1 Description

- Source: Surface Water – CCR/LCC/Texana System (via Corpus Christi, & STWA)
  – Nueces River (via Nueces County WCID #3)
  Groundwater – Gulf Coast Aquifer

- Estimated Reliable Supply: 484 acft/yr (surface water)
  17 to 194 acft/yr (groundwater)
- System Description: Individual Wells and Small Water Supply Systems

4B.11.10.2 Options Considered

County-Other demand in Nueces County has a shortage of 261 acft/yr in 2010. The Nueces County-Other water demands may have been underestimated, as reflected by decreasing demands over the planning period which contradicts water demand trends for water supply corporations included in Nueces County-Other projections. These water demand projections should be reevaluated for future water planning efforts. There is a surplus projected from 2030 through 2060 to counterbalance low water demand estimates. Table 4B.11-4 lists the water management strategies, references to the report section discussing the strategy, total project cost, and unit costs that were considered for meeting the shortage for Nueces County-Other.

Table 4B.11-4.
Water Management Strategies Considered for Nueces County-Other

Option	*Yield (acft/yr)*	*Approximate Cost*[1]	
		Total	*Unit ($/acft)*
Increase contracted amount provided by Wholesale Water Providers	261	$0[2]	$652[2]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] Assumes $2.00 per 1,000 gallons.

4B.11.10.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is recommended to meet the projected 2010 shortages for County-Other in Nueces County:

- Increase contracted amount provided by Wholesale Water Provider (City of Corpus Christi)

In addition to the management strategies listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.11.10.4 Costs

The recommended Water Supply Plan including anticipated costs is summarized by decade in Table 4B.11-5.

Table 4B.11-5.
Recommended Plan Costs by Decade for Nueces County-Other

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Surplus/(Shortage) (acft/yr)	(261)	—	—	—	—	—
Increase Contracted Amount provided Wholesale Water Provider (City of Corpus Christi)						
Supply From Plan Element (acft/yr)	261	—	—	—	—	—
Total Annual Cost ($/yr)	$170,200	—	—	—	—	—
Total Unit Cost ($/acft)	$652	—	—	—	—	—

4B.11.11 Manufacturing

4B.11.11.1 Description

The City of Corpus Christi provides the surface water for manufacturing in Nueces County from the CCR/LCC/Texana System. Additional manufacturing supplies are from the Gulf Coast Aquifer. The City also provides surface water for manufacturing in San Patricio County. *In the analysis that follows, the manufacturing needs of Nueces and San Patricio Counties are considered jointly*. Since water management strategies for this water user will likely be developed by Wholesale Water Providers, the total project costs and supplies are shown in the water supply plan. Appendix C.6 delineates water management strategy supplies and costs by water user group and county. A shortage in manufacturing supply occurs in 2020.

4B.11.11.2 Options Considered

Over 90 percent of the water supplied to Manufacturing users in Nueces and San Patricio Counties is from the CCR/LCC/Lake Texana System via Wholesale Water Providers (City of Corpus Christi and SPMWD). Beginning in 2020, shortages begin to appear and grow to a combined 46,005 acft/yr in 2060 (39,550 acft/yr in Nueces County and 6,455 acft/yr in San Patricio County). Table 4B.11-6 lists the water management strategies, references to the report section discussing the strategy, total project cost, and unit costs that were considered for meeting the shortage for manufacturing in Nueces and San Patricio Counties.

4B.11.11.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is one potential plan to meet the projected 2020 through 2060 shortages for manufacturing in Nueces and San Patricio Counties:

- Manufacturing Water Conservation;
- O.N. Stevens Water Treatment Plant Improvements;
- Reclaimed Wastewater Supplies;
- Garwood Pipeline;
- Off-Channel Reservoir;
- Gulf Coast Aquifer Groundwater Supplies; and
- Lavaca River Diversion and Off-Channel Reservoir.

In addition to these recommended projects, four projects are considered to be alternative water management strategies.

- CCR/LCC Pipeline;
- Stage II of Lake Texana;
- Brackish Groundwater Desalination; and
- Seawater Desalination.

In addition to the management strategies listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.11.11.4 Costs

The recommended Water Supply Plan including anticipated costs is summarized by decade in Table 4B.11-7.

Table 4B.11-6. Water Management Strategies Considered for Manufacturing in Nueces and San Patricio Counties

Option	***Yield (acft/yr)***	***Approximate Cost[1]***	
		Total	***Unit ($/acft)***
Manufacturing Conservation (Section 4C.3)	up to 2,050	N/A	N/A
O.N. Stevens Water Treatment Plant Improvements (Section 4C.19)	32,996 to 42,329	$31,324,000[2]	$459 to $524[2]
Reclaimed Wastewater Supplies (Section 4C.5)	250	N/A	$826[3]
Gulf Coast Aquifer Groundwater Supplies (Section 4C.7)	up to 18,000	$59,245,000[4]	$853[4]
Lavaca River Diversion & Off-Channel Reservoir (Section 4C.13)[5]	16,242	$224,183,000	$1,027
Garwood Pipeline (Section 4C.14)	35,000	$112,798,000[6]	$685[6]
Off-Channel Reservoir[7]	30,340[8]	$105,201,950[8]	$715[8]
CCR/LCC Pipeline[7]	21,905[9]	$48,324,000[9]	$588[9]
Stage II Lake Texana (Palmetto Bend) (Section 4C.13)[5]	12,964	$232,828,000	$1,213
Brackish Groundwater Desalination[10]	18,000	$108,331,000	$977
Seawater Desalination[10]	28,000	$260,914,000	$1,696

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered by wholesale water provider to the water supply entity or entities. Unit cost is for full utilization of project capacity.

[2] Total project cost includes improvements to the following WTP components: raw influent, raw water intake pump station, and O.N. Stevens solids handling facilities. Unit cost includes $326/acft for treatment.

[3] See Section 4C.5. Costs to maintain ongoing Nueces Delta studies are $500,000 per year (assumed cost associated with Allison Demonstration Project is 25 percent). Water supply for Allison Project based on ratio of yield recovered by a 2-MGD project as compared to an 8.8-MGD project. Costs to supply Allison discharge to delta includes $326/acft for treatment of additional yield. Annual cost not subject to 20 year debt service.

[4] Source of Cost Estimate: Section 4C.7, Table 4C.7-17. Unit cost includes $326/acft for treatment. Treatment may not be required if separate pipeline is constructed so that groundwater would not be blended with water in Mary Rhodes pipeline.

[5] Supplies are estimated based on assuming Region P/L industrial needs of 10,000 acft/yr. Unit costs are estimated based on a raw water cost of $701/acft for the Lavaca River Diversion and $887/acft for the Stage II of Lake Texana plus $326/acft for treatment. Total cost shown is not prorated between regions; however, it is understood that Region N is responsible for a portion of the total project cost.

[6] Source of Cost Estimate: Section 4C.14, Table 4C.14-2. Unit cost = $326/acft for treatment + $359/acft for raw water supply development.

[7] Total costs and unit costs are based on Federal or State funding participation of 65 percent for debt service costs. Water supplied is 65 percent of project potential, with 35 percent dedicated for ecosystem restoration or State/Federal purpose. $326/acft added for treatment of water supplied for CCR/LCC Pipeline option.

[8] Yield and costs shown assume Federal and/or State participation of 65%. Without this funding, the full yield of the project is 46,677 acft/yr, the total project cost is $300,577,000 and the unit cost is $896/acft including treatment.

[9] Yield and costs shown assume Federal and/or State participation of 65%. Without this funding, the full yield of the project is 33,700 acft/yr, the total project cost is $138,067,000 and the unit cost is $728/acft including treatment.

[10] Projects may have opportunities for federal or state participation. However, based on assumptions of 65% of federal or state funding participation for debt service costs and water supplies of 65% of project potential (with 35% dedicated for ecosystem restoration or state/federal purposes), federal or state participation would not be anticipated to reduce annual unit costs of water and therefore is not included in the cost estimate.

4B.11.12 Steam-Electric

The steam-electric users in Nueces County are provided water by City of Corpus Christi. Steam-electric users in Nueces County are projected to have shortages beginning in 2020. Since water management strategies for this water user will likely be developed by Wholesale Water Providers, the total project costs and supplies are shown in the water supply plan. Appendix C.6 delineates water management strategy supplies and costs by water user group and county.

4B.11.12.1 Description of Supply

- Source: Surface water – CCR/LCC System via City of Corpus Christi
- Estimated Reliable Supply: 7,316 to 14,481 acft/yr (surface water)
- System Description: Various steam-electric power operations

4B.11.12.2 Options Considered

The Nueces County steam-electric water user group has shortages of 1,982 acft/yr in 2020 increasing to 13,183 acft/yr in 2060, respectively. Table 4B.11-8 lists the water management strategies, references to the report section discussing the strategy, total project cost, and unit costs that were considered for meeting the shortage for steam-electric in Nueces County.

Table 4B.11-7. Potential Plan Costs by Decade for Manufacturing in Nueces and San Patricio Counties[1]

Plan Element	2010	2020	2030	2040	2050	2060
Recommended Water Management Strategies						
Projected Surplus/(Shortage)[2] (acft/yr)	—	(7,411)	(15,203)	(24,459)	(33,913)	(46,005)
Manufacturing Water Conservation[3]						
Supply From Plan Element (acft/yr)	1,260	1,418	1,576	1,734	1,892	2,050
Annual Cost ($/yr)	—	—	—	—	—	—
Unit Cost ($/acft)	—	—	—	—	—	—
O.N. Stevens Water Treatment Plant Improvements[4]						
Supply From Plan Element (acft/yr)	42,329	40,048	38,102	36,366	34,817	32,996
Annual Cost ($/yr)	$21,334,000	$20,625,000	$19,965,000	$16,692,000	$16,190,000	$15,574,000
Unit Cost ($/acft)	$504	$515	$524	$459	$465	$472
Reclaimed Wastewater Supplies[5]						
Supply From Plan Element (acft/yr)	250	250	250	250	250	250
Annual Cost ($/yr)	$206,500	$206,500	$206,500	$206,500	$206,500	$206,500
Unit Cost ($/acft)	$826	$826	$826	$826	$826	$826
Garwood Pipeline						
Supply From Plan Element (acft/yr)	—	35,000	35,000	35,000	35,000	35,000
Annual Cost ($/yr)	—	$23,958,000	$23,958,000	$23,958,000	$14,054,000	$14,054,000
Unit Cost ($/acft)	—	$685	$685	$685	$402	$402
Off-Channel Reservoir[6]						
Supply From Plan Element (acft/yr)	—	—	30,340	30,340	30,340	30,340
Annual Cost ($/yr)	—	—	$21,696,800	$21,696,800	$21,696,800	$17,536,500
Unit Cost ($/acft)	—	—	$715	$715	$715	$578
Gulf Coast Aquifer Groundwater Supplies						
Supply From Plan Element (acft/yr)			11,000	11,000	11,000	18,000
Annual Cost ($/yr)			$9,383,000	$9,383,000	$9,383,000	$10,188,000
Unit Cost ($/acft)			$853[7]	$853[7]	$853[7]	$566[7]
Lavaca River Diversion and Off-Channel Reservoir[8]						
Supply From Plan Element (acft/yr)	—	—	—	—	—	16,242
Annual Cost ($/yr)	—	—	—	—	—	$16,681,000
Unit Cost ($/acft)	—	—	—	—	—	$1,027
Total Annual Cost ($/yr)	$7,760,500	$31,718,500	$62,798,300	$60,067,300	$50,163,300	$63,489,000
Total Unit Cost ($/acft)	$177	$414	$540	$523	$442	$471
Alternative Water Management Strategies						
CCR/LCC Pipeline[9]						
Supply From Plan Element (acft/yr)	—	—	—	21,905	21,905	21,905
Annual Cost ($/yr)	—	—	—	$12,869,980	$12,869,980	$12,869,980
Unit Cost ($/acft)	—	—	—	$588	$588	$588
Stage II Lake Texana (Palmetto Bend)						
Supply From Plan Element (acft/yr)	—	—	—	—	—	12,964
Annual Cost ($/yr)	—	—	—	—	—	$15,725,000
Unit Cost ($/acft)	—	—	—	—	—	$1,213
Brackish Groundwater Desalination[10]						
Supply From Plan Element (acft/yr)	—	—	—	18,000	18,000	18,000
Annual Cost ($/yr)	—	—	—	$17,584,000	$17,584,000	$17,584,000
Unit Cost ($/acft)	—	—	—	$977	$977	$977

Table 4B.11-7 (Concluded)

Plan Element	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
Seawater Desalination[10]						
Supply From Plan Element (acft/yr)	—	—	—	28,000	28,000	28,000
Annual Cost ($/yr)	—	—	—	$47,498,000	$47,498,000	$47,498,000
Unit Cost ($/acft)	—	—	—	$1,696	$1,696	$1,696

1. Supplies shown exceed shortages in the event growth in demands exceeds TWDB projections or supplies are reduced under the City's contract with LNRA for Lake Texana water. Supplies and costs shown in this table represent full project yields. For delineation by water user group, see Appendix C.6.
2. Surplus/(Shortage) includes manufacturing for both Nueces and San Patricio Counties. Note: Shortages for Nueces County- Steam and Electric, Nueces County- Mining, and Aransas County- Other are identified in separate tables (i.e. total combined shortage is 62,255 acft/yr in Year 2060).
3. Water supply represents water saved by blending of Lake Texana water with Nueces River water. There may be an opportunity for additional water savings of up to 591 acft/yr with an interconnection to the Mary Rhodes Pipeline for industries with intakes in the Nueces River (See Section 4C.3). Annual cost of interconnection pipeline to MRP is $132,000. Impacts to other water users would need to be considered, prior to implementing project.
4. Supplies include 16,000 acft/yr generated with new sludge handling ponds and additional treated water supplies with improvements of plant capacity from 159 MGD to 200 MGD (average day) constrained by existing raw water supplies. Costs include $326/acft for treatment.
5. Costs to maintain ongoing Nueces Delta studies are $500,000 per year (assumed cost associated with Allison Demonstration Project is 25 percent). Water supply for Allison Project based on ratio of yield recovered by a 2-MGD project as compared to an 8.8-MGD project (See Section 4C.5). Costs to supply Allison discharge to delta includes $326/acft for treatment of additional yield. Annual cost not subject to 20 year debt service.
6. Annual costs and unit cost are based on Federal funding participation of 65 percent. Water supplied is 65 percent of project potential, with 35 percent dedicated for ecosystem restoration. $326/acft added for treatment of water supplied. Costs reduced in Year 2060 with debt service paid for pipeline. Debt service is 40 years for reservoir.
7. Assumes full utilization of project. Unit cost based on 18,000 acft project + $326/acft for treatment (See Section 4C.7) although treatment may not be required if separate pipeline is constructed so that groundwater would not be blended with water in Mary Rhodes pipeline.
8. Supplies are estimated based on assuming Region P/L industrial needs of 10,000 acft/yr. Unit costs are estimated based on a raw water cost of $701/acft and $326/acft for treatment.
9. Annual costs and unit cost are based on Federal or State funding participation of 65 percent for debt service costs. Water supplied is 65 percent of project potential, with 35 percent dedicated for ecosystem restoration or State/Federal purpose. $326/acft added for treatment of water supplied for CCR/LCC Pipeline option.
10. Projects may have opportunities for federal or state participation. However, based on assumptions of 65% of federal or state funding participation for debt service costs and water supplies of 65% of project potential (with 35% dedicated for ecosystem restoration or state/federal purposes), federal or state participation would not be anticipated to reduce annual unit costs of water and therefore is not included in the cost estimate.

Table 4B.11-8.
Water Management Strategies Considered for Steam-Electric in Nueces County

Option	Yield (acft/yr)	Approximate Cost[1] Total	Approximate Cost[1] Unit ($/acft)
O.N. Stevens Water Treatment Plant Improvements (Section 4C.19)	32,996 to 42,329	$31,324,000[2]	$459 to $524[2]
Reclaimed Wastewater Supplies (Section 4C.5)	250	N/A	$826[3]
Gulf Coast Aquifer Groundwater Supplies (Section 4C.7)	up to 18,000	$59,245,000[4]	$853[4]
Lavaca River Diversion & Off-Channel Reservoir (Section 4C.13)[5]	16,242	$224,183,000	$1,027
Garwood Pipeline (Section 4C.14)	35,000	$112,798,000[6]	$685[6]
Off-Channel Reservoir[7]	30,340[8]	$105,201,950[8]	$715[8]
CCR/LCC Pipeline[7]	21,905[9]	$48,324,000[9]	$588[9]
Stage II Lake Texana (Palmetto Bend) (Section 4C.13)[5]	12,964	$232,828,000	$1,213
Brackish Groundwater Desalination[10]	18,000	$108,331,000	$977
Seawater Desalination[10]	28,000	$260,914,000	$1,696

1 Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered by wholesale water provider to the water supply entity or entities. Unit cost is for full utilization of project capacity.

2 Total project cost includes improvements to the following WTP components: raw influent, raw water intake pump station, and O.N. Stevens solids handling facilities. Unit cost includes $326/acft for treatment.

3 See Section 4C.5. Costs to maintain ongoing Nueces Delta studies are $500,000 per year (assumed cost associated with Allison Demonstration Project is 25 percent). Water supply for Allison Project based on ratio of yield recovered by a 2-MGD project as compared to an 8.8-MGD project. Costs to supply Allison discharge to delta includes $326/acft for treatment of additional yield. Annual cost not subject to 20 year debt service.

4 Source of Cost Estimate: Section 4C.7, Table 4C.7-17. Unit cost includes $326/acft for treatment. Treatment may not be required if separate pipeline is constructed so that groundwater would not be blended with water in Mary Rhodes pipeline.

5 Supplies are estimated based on assuming Region P/L industrial needs of 10,000 acft/yr. Unit costs are estimated based on a raw water cost of $701/acft for the Lavaca River Diversion and $887/acft for the Stage II of Lake Texana plus $326/acft for treatment. Total cost shown is not prorated between regions; however, it is understood that Region N is responsible for a portion of the total project cost.

6 Source of Cost Estimate: Section 4C.14, Table 4C.14-2. Unit cost = $326/acft for treatment + $359/acft for raw water supply development.

7 Total costs and unit costs are based on Federal or State funding participation of 65 percent for debt service costs. Water supplied is 65 percent of project potential, with 35 percent dedicated for ecosystem restoration or State/Federal purpose. $326/acft added for treatment of water supplied for CCR/LCC Pipeline option.

8 Yield and costs shown assume Federal and/or State participation of 65%. Without this funding, the full yield of the project is 46,677 acft/yr, the total project cost is $300,577,000 and the unit cost is $896/acft including treatment.

9 Yield and costs shown assume Federal and/or State participation of 65%. Without this funding, the full yield of the project is 33,700 acft/yr, the total project cost is $138,067,000 and the unit cost is $728/acft including treatment.

10 Projects may have opportunities for federal or state participation. However, based on assumptions of 65% of federal or state funding participation for debt service costs and water supplies of 65% of project potential (with 35% dedicated for ecosystem restoration or state/federal purposes), federal or state participation would not be anticipated to reduce annual unit costs of water and therefore is not included in the cost estimate.

4B.11.12.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is one potential plan to meet the projected 2020 through 2060 shortages for steam-electric in Nueces County:

- O.N. Stevens Water Treatment Plant Improvements;
- Reclaimed Wastewater Supplies;
- Garwood Pipeline;
- Off-Channel Reservoir;
- Gulf Coast Aquifer Groundwater Supplies; and
- Lavaca River Diversion and Off-Channel Reservoir.

In addition to these recommended projects, four projects are considered to be alternative water management strategies.

- CCR/LCC Pipeline;
- Stage II of Lake Texana;
- Brackish Groundwater Desalination; and
- Seawater Desalination.

In addition to the management strategies listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.11.12.4 Costs

The recommended Water Supply Plan including anticipated costs is summarized by decade in Table 4B.11-9.

4B.11.13 Mining

4B.11.13.1 Description of Supply

- Source: Groundwater – Gulf Coast Aquifer
  Surface water – CCR/LCC System via City of Corpus Christi and small Nueces River Basin run-of-river water rights for mining users in Nueces County
- Estimated Reliable Supply: 74 to 100 acft/yr (groundwater)
  0 to 1,465 acft/yr (surface water)
- System Description: Various mining operations

Table 4B.11-9.
Potential Plan Costs by Decade for Steam-Electric in Nueces County[1]

Plan Element	2010	2020	2030	2040	2050	2060
Recommended Water Management Strategies						
Projected Surplus/(Shortage)[2] (acft/yr)	—	(1,982)	(4,755)	(7,459)	(10,187)	(13,183)
O.N. Stevens Water Treatment Plant Improvements[3]						
Supply From Plan Element (acft/yr)	42,329	40,048	38,102	36,366	34,817	32,996
Annual Cost ($/yr)	$21,334,000	$20,625,000	$19,965,000	$16,692,000	$16,190,000	$15,574,000
Unit Cost ($/acft)	$504	$515	$524	$459	$465	$472
Reclaimed Wastewater Supplies[4]						
Supply From Plan Element (acft/yr)	250	250	250	250	250	250
Annual Cost ($/yr)	$206,500	$206,500	$206,500	$206,500	$206,500	$206,500
Unit Cost ($/acft)	$826	$826	$826	$826	$826	$826
Garwood Pipeline						
Supply From Plan Element (acft/yr)	—	35,000	35,000	35,000	35,000	35,000
Annual Cost ($/yr)	—	$23,958,000	$23,958,000	$23,958,000	$14,054,000	$14,054,000
Unit Cost ($/acft)	—	$685	$685	$685	$402	$402
Off-Channel Reservoir[5]						
Supply From Plan Element (acft/yr)	—	—	30,340	30,340	30,340	30,340
Annual Cost ($/yr)	—	—	$21,696,800	$21,696,800	$21,696,800	$17,536,500
Unit Cost ($/acft)	—	—	$715	$715	$715	$578
Gulf Coast Aquifer Groundwater Supplies						
Supply From Plan Element (acft/yr)			11,000	11,000	11,000	18,000
Annual Cost ($/yr)			$9,383,000	$9,383,000	$9,383,000	$10,188,000
Unit Cost ($/acft)			$853[6]	$853[6]	$853[6]	$566[6]
Lavaca River Diversion and Off-Channel Reservoir[7]						
Supply From Plan Element (acft/yr)	—	—	—	—	—	16,242
Annual Cost ($/yr)	—	—	—	—	—	$16,681,000
Unit Cost ($/acft)	—	—	—	—	—	$1,027
Total Annual Cost ($/yr)	$7,760,500	$31,718,500	$62,798,300	$60,067,300	$50,163,300	$63,489,000
Total Unit Cost ($/acft)	$177	$414	$540	$523	$442	$471
Alternative Water Management Strategies						
CCR/LCC Pipeline[8]						
Supply From Plan Element (acft/yr)	—	—	—	21,905	21,905	21,905
Annual Cost ($/yr)	—	—	—	$12,869,980	$12,869,980	$12,869,980
Unit Cost ($/acft)	—	—	—	$588	$588	$588
Stage II Lake Texana (Palmetto Bend)						
Supply From Plan Element (acft/yr)	—	—	—	—	—	12,964
Annual Cost ($/yr)	—	—	—	—	—	$15,725,000
Unit Cost ($/acft)	—	—	—	—	—	$1,213

Table 4B.11-9 (Concluded)

Plan Element	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
Brackish Groundwater Desalination[9]						
Supply From Plan Element (acft/yr)	—	—	—	18,000	18,000	18,000
Annual Cost ($/yr)	—	—	—	$17,584,000	$17,584,000	$17,584,000
Unit Cost ($/acft)	—	—	—	$977	$977	$977
Seawater Desalination[9]						
Supply From Plan Element (acft/yr)	—	—	—	28,000	28,000	28,000
Annual Cost ($/yr)	—	—	—	$47,498,000	$47,498,000	$47,498,000
Unit Cost ($/acft)	—	—	—	$1,696	$1,696	$1,696

1 Supplies exceed shortages in case water growth patterns and demands exceed TWDB projections or supplies are reduced under the City's contract with LNRA for Lake Texana water. Supplies and costs shown in this table represent full project yields. For delineation by water user group, see Appendix C.6.

2 Surplus/(Shortage) includes steam-electric for Nueces County only. Note: Shortages for Nueces and San Patricio County- Manufacturing, Nueces County- Mining, and Aransas County- Other are identified in separate tables (i.e. total combined shortage is 62,255 acft/yr in Year 2060).

3 Supplies include 16,000 acft/yr generated with new sludge handling ponds and additional treated water supplies with improvements of plant capacity from 159 MGD to 200 MGD (average day) constrained by existing raw water supplies. Costs include $326/acft for treatment.

4 Costs to maintain ongoing Nueces Delta studies are $500,000 per year (assumed cost associated with Allison Demonstration Project is 25 percent). Water supply for Allison Project based on ratio of yield recovered by a 2-MGD project as compared to an 8.8-MGD project (See Section 4C.5). Costs to supply Allison discharge to delta includes $326/acft for treatment of additional yield.

5 Annual costs and unit cost are based on Federal funding participation of 65 percent. Water supplied is 65 percent of project potential, with 35 percent dedicated for ecosystem restoration. $326/acft added for treatment of water supplied. Costs reduced in Year 2060 with debt service paid for pipeline. Debt service is 40 years for reservoir.

6 Assumes full utilization of project. Unit cost based on 18,000 acft project + $326/acft for treatment (See Section 4C.7) although treatment may not be required if separate pipeline is constructed so that groundwater would not be blended with water in Mary Rhodes pipeline.

7 Supplies are estimated based on assuming Region P/L industrial needs of 10,000 acft/yr. Unit costs are estimated based on a raw water cost of $701/acft and $326/acft for treatment.

8 Annual costs and unit cost are based on Federal or State funding participation of 65 percent for debt service costs. Water supplied is 65 percent of project potential, with 35 percent dedicated for ecosystem restoration or State/Federal purpose. $326/acft added for treatment of water supplied for CCR/LCC Pipeline option.

9 Projects may have opportunities for federal or state participation. However, based on assumptions of 65% of federal or state funding participation for debt service costs and water supplies of 65% of project potential (with 35% dedicated for ecosystem restoration or state/federal purposes), federal or state participation would not be anticipated to reduce annual unit costs of water and therefore is not included in the cost estimate.

4B.11.13.2 Options Considered

Since water management strategies for this water user will likely be developed by Wholesale Water Providers, the total project costs and supplies are shown in the water supply plan. Appendix C.6 delineates water management strategy supplies and costs by water user group and county.

The Nueces County mining water user group has shortages of 570 acft/yr in 2030 increasing to 1,624 acft/yr in 2060, respectively. Table 4B.11-10 lists the water management strategies, references to the report section discussing the strategy, total project cost, and unit costs that were considered for meeting the shortage for mining in Nueces County.

4B.11.13.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is one potential plan to meet the projected 2030 through 2060 shortages for mining in Nueces County:

- Mining Water Conservation;
- O.N. Stevens Water Treatment Plant Improvements;
- Reclaimed Wastewater Supplies;
- Garwood Pipeline;
- Off-Channel Reservoir;
- Gulf Coast Aquifer Groundwater Supplies; and
- Lavaca River Diversion and Off-Channel Reservoir.

Table 4B.11-10.
Water Management Strategies Considered for Mining in Nueces County

		Approximate Cost[1]	
Option	***Yield (acft/yr)***	***Total***	***Unit ($/acft)***
Mining Conservation (Section 4C.4)	up to 259	N/A	N/A
O.N. Stevens Water Treatment Plant Improvements (Section 4C.19)	32,996 to 42,329	$31,324,000[2]	$459 to $524[2]
Reclaimed Wastewater Supplies (Section 4C.5)	250	N/A	$826[3]
Gulf Coast Aquifer Groundwater Supplies (Section 4C.7)	up to 18,000	$59,245,000[4]	$853[4]
Lavaca River Diversion & Off-Channel Reservoir (Section 4C.13)[5]	16,242	$224,183,000	$1,027
Garwood Pipeline (Section 4C.14)	35,000	$112,798,000[6]	$685[6]
Off-Channel Reservoir[7]	30,340[8]	$105,201,950[8]	$715[8]
CCR/LCC Pipeline[7]	21,905[9]	$48,324,000[9]	$588[9]
Stage II Lake Texana (Palmetto Bend) (Section 4C.13)[5]	12,964	$232,828,000	$1,213
Brackish Groundwater Desalination[10]	18,000	$108,331,000	$977
Seawater Desalination[10]	28,000	$260,914,000	$1,696

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered by the wholesale water provider to the water supply entity or entities. Unit cost is for full utilization of project capacity.

[2] Total project cost includes improvements to the following WTP components: raw influent, raw water intake pump station, and O.N. Stevens solids handling facilities. Unit cost includes $326/acft for treatment.

[3] See Section 4C.5. Costs to maintain ongoing Nueces Delta studies are $500,000 per year (assumed cost associated with Allison Demonstration Project is 25 percent). Water supply for Allison Project based on ratio of yield recovered by a 2-MGD project as compared to an 8.8-MGD project. Costs to supply Allison discharge to delta includes $326/acft for treatment of additional yield. Annual cost not subject to 20 year debt service.

[4] Source of Cost Estimate: Section 4C.7, Table 4C.7-17. Unit cost includes $326/acft for treatment. Treatment may not be required if separate pipeline is constructed so that groundwater would not be blended with water in Mary Rhodes pipeline.

[5] Supplies are estimated based on assuming Region P/L industrial needs of 10,000 acft/yr. Unit costs are estimated based on a raw water cost of $701/acft for the Lavaca River Diversion and $887/acft for the Stage II of Lake Texana plus $326/acft for treatment. Total cost shown is not prorated between regions; however, it is understood that Region N is responsible for a portion of the total project cost.

[6] Source of Cost Estimate: Section 4C.14, Table 4C.14-2. Unit cost = $326/acft for treatment + $359/acft for raw water supply development.
[7] Total costs and unit costs are based on Federal or State funding participation of 65 percent for debt service costs. Water supplied is 65 percent of project potential, with 35 percent dedicated for ecosystem restoration or State/Federal purpose. $326/acft added for treatment of water supplied for CCR/LCC Pipeline option.
[8] Yield and costs shown assume Federal and/or State participation of 65%. Without this funding, the full yield of the project is 46,677 acft/yr, the total project cost is $300,577,000 and the unit cost is $896/acft including treatment.
[9] Yield and costs shown assume Federal and/or State participation of 65%. Without this funding, the full yield of the project is 33,700 acft/yr, the total project cost is $138,067,000 and the unit cost is $728/acft including treatment.
[10] Projects may have opportunities for federal or state participation. However, based on assumptions of 65% of federal or state funding participation for debt service costs and water supplies of 65% of project potential (with 35% dedicated for ecosystem restoration or state/federal purposes), federal or state participation would not be anticipated to reduce annual unit costs of water and therefore is not included in the cost estimate.

In addition to these recommended projects, four projects are considered to be alternative water management strategies.

- CCR/LCC Pipeline;
- Stage II of Lake Texana;
- Brackish Groundwater Desalination; and
- Seawater Desalination.

In addition to the management strategies listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.11.13.4 Costs

The recommended Water Supply Plan including anticipated costs is summarized by decade in Table 4B.11-11.

4B.11.14 Irrigation

Irrigation demands in Nueces County are met with surface water supplies from Rio Grande-Nueces Basin run-of-river water supplies and Nueces County WCID #3 water permits from the Nueces River. There are no shortages in irrigation use in Nueces County and no changes in water supply are recommended.

4B.11.15 Livestock

The livestock demands in Nueces County are met by groundwater from the Gulf Coast Aquifer and surface water from local on-farm sources. No shortages are projected for livestock and no changes in water supply are recommended.

Table 4B.11-11.
Potential Plan Costs by Decade for Mining in Nueces County[1]

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Recommended Water Management Strategies						
Projected Surplus/(Shortage)[2] (acft/yr)	—	—	(570)	(1,546)	(1,584)	(1,624)
Mining Water Conservation[3]						
Supply From Plan Element (acft/yr)	37	78	120	164	210	259
Annual Cost ($/yr)	—	—	—	—	—	—
Unit Cost ($/acft)	—	—	—	—	—	—
O.N. Stevens Water Treatment Plant Improvements[4]						
Supply From Plan Element (acft/yr)	42,329	40,048	38,102	36,366	34,817	32,996
Annual Cost ($/yr)	$21,334,000	$20,625,000	$19,965,000	$16,692,000	$16,190,000	$15,574,000
Unit Cost ($/acft)	$504	$515	$524	$459	$465	$472
Reclaimed Wastewater Supplies[5]						
Supply From Plan Element (acft/yr)	250	250	250	250	250	250
Annual Cost ($/yr)	$206,500	$206,500	$206,500	$206,500	$206,500	$206,500
Unit Cost ($/acft)	$826	$826	$826	$826	$826	$826
Garwood Pipeline						
Supply From Plan Element (acft/yr)	—	35,000	35,000	35,000	35,000	35,000
Annual Cost ($/yr)	—	$23,958,000	$23,958,000	$23,958,000	$14,054,000	$14,054,000
Unit Cost ($/acft)	—	$685	$685	$685	$402	$402
Off-Channel Reservoir[6]						
Supply From Plan Element (acft/yr)	—	—	30,340	30,340	30,340	30,340
Annual Cost ($/yr)	—	—	$21,696,800	$21,696,800	$21,696,800	$17,536,500
Unit Cost ($/acft)	—	—	$715	$715	$715	$452
Gulf Coast Aquifer Groundwater Supplies						
Supply From Plan Element (acft/yr)			11,000	11,000	11,000	18,000
Annual Cost ($/yr)			$9,383,000	$9,383,000	$9,383,000	$10,188,000
Unit Cost ($/acft)			$853[7]	$853[7]	$853[7]	$566[7]
Lavaca River Diversion and Off-Channel Reservoir[8]						
Supply From Plan Element (acft/yr)	—	—	—	—	—	16,242
Annual Cost ($/yr)	—	—	—	—	—	$16,681,000
Unit Cost ($/acft)	—	—	—	—	—	$1,027
Total Annual Cost ($/yr)	$7,760,500	$31,718,500	$62,798,300	$60,067,300	$50,163,300	$63,489,000
Total Unit Cost ($/acft)	$177	$414	$540	$523	$442	$471
Alternative Water Management Strategies						
CCR/LCC Pipeline[9]						
Supply From Plan Element (acft/yr)	—	—	—	21,905	21,905	21,905
Annual Cost ($/yr)	—	—	—	$12,869,980	$12,869,980	$12,869,980
Unit Cost ($/acft)	—	—	—	$588	$588	$588
Stage II Lake Texana (Palmetto Bend)						
Supply From Plan Element (acft/yr)	—	—	—	—	—	12,964
Annual Cost ($/yr)	—	—	—	—	—	$15,725,000
Unit Cost ($/acft)	—	—	—	—	—	$1,213

Table 4B.11-11 (Concluded)

Plan Element	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
Brackish Groundwater Desalination[10]						
Supply From Plan Element (acft/yr)	—	—	—	18,000	18,000	18,000
Annual Cost ($/yr)	—	—	—	$17,584,000	$17,584,000	$17,584,000
Unit Cost ($/acft)	—	—	—	$977	$977	$977
Seawater Desalination[10]						
Supply From Plan Element (acft/yr)	—	—	—	28,000	28,000	28,000
Annual Cost ($/yr)	—	—	—	$47,498,000	$47,498,000	$47,498,000
Unit Cost ($/acft)	—	—	—	$1,696	$1,696	$1,696

[1] Supplies exceed shortages in case water growth patterns and demands exceed TWDB projections or supplies are reduced under the City's contract with LNRA for Lake Texana water. Supplies and costs shown in this table represent full project yields. For delineation by water user group, see Appendix C.6.

[2] Surplus/(Shortage) includes mining for Nueces County only. Note: Shortages for Nueces and San Patricio County- Manufacturing, Nueces County- Steam and Electric, and Aransas County- Other are identified in separate tables (i.e. total combined shortage is 62,255 acft/yr in Year 2060).

[3] Water supply represents water saved by implementing best management practices to reduce demand by 15% (Section 4C.4). Cost are unavailable for Mining Water Conservation Best Management Practices (Section 4C.4). Conservation savings and costs are by nature facility specific. Since mining entities are presented on a county basis and are not individually identified, identification of costs for specific water management strategies are not appropriate.

[4] Supplies include 16,000 acft/yr generated with new sludge handling ponds and additional treated water supplies with improvements of plant capacity from 159 MGD to 200 MGD (average day) constrained by existing raw water supplies. Costs include $326/acft for treatment.

[5] Costs to maintain ongoing Nueces Delta studies are $500,000 per year (assumed cost associated with Allison Demonstration Project is 25 percent). Water supply for Allison Project based on ratio of yield recovered by a 2-MGD project as compared to an 8.8-MGD project (See Section 4C.5). Costs to supply Allison discharge to delta includes $326/acft for treatment of additional yield.

[6] Annual costs and unit cost are based on Federal funding participation of 65 percent. Water supplied is 65 percent of project potential, with 35 percent dedicated for ecosystem restoration. $326/acft added for treatment of water supplied. Costs reduced in Year 2060 with debt service paid for pipeline. Debt service is 40 years for reservoir.

[7] Assumes full utilization of project. Unit cost based on 18,000 acft project + $326/acft for treatment (See Section 4C.7) although treatment may not be required if separate pipeline is constructed so that groundwater would not be blended with water in Mary Rhodes pipeline.

[8] Supplies are estimated based on assuming Region P/L industrial needs of 10,000 acft/yr. Unit costs are estimated based on a raw water cost of $701/acft and $326/acft for treatment.

[9] Annual costs and unit cost are based on Federal or State funding participation of 65 percent for debt service costs. Water supplied is 65 percent of project potential, with 35 percent dedicated for ecosystem restoration or State/Federal purpose. $326/acft added for treatment of water supplied for CCR/LCC Pipeline option.

[10] Projects may have opportunities for federal or state participation. However, based on assumptions of 65% of federal or state funding participation for debt service costs and water supplies of 65% of project potential (with 35% dedicated for ecosystem restoration or state/federal purposes), federal or state participation would not be anticipated to reduce annual unit costs of water and therefore is not included in the cost estimate.

4B.12 San Patricio County Water Supply Plan

Table 4B.12-1 lists each water user group in San Patricio County and their corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections. Water supply plans are also presented for some entities that need pumping/conveyance facilities to utilize their existing water resources, or to become a regional provider.

Table 4B.12-1. San Patricio County Surplus/(Shortage)

Water User Group	Surplus/(Shortage)[1]		Comment
	2030 (acft/yr)	2060 (acft/yr)	
City of Aransas Pass	0	0	Supply equals demand
City of Gregory	0	0	Supply equals demand
City of Ingleside	0	0	Supply equals demand
City of Ingleside on the Bay	0	0	Supply equals demand
Lake City	(11)	(37)	Projected shortages from 2020 to 2060 — see plan below
City of Mathis	0	0	Supply equals demand
City of Odem	0	0	Supply equals demand
City of Portland	0	0	Supply equals demand
City of Sinton	0	0	Supply equals demand
City of Taft	0	0	Supply equals demand
County-Other	0	0	Supply equals demand
Manufacturing	0	(6,455)	Projected shortages from 2040 to 2060 — see plan below
Steam-Electric	none	none	No demands projected
Mining	0	0	Supply equals demand
Irrigation	(750)	(4,414)	Projected shortages from 2030 to 2060 – see plan below
Livestock	0	0	Supply equals demand

[1] From Tables 4A-22 and 4A-23, Section 4 – Comparison of Water Demands with Water Supplies to Determine Needs.

4B.12.1 City of Aransas Pass

The City of Aransas Pass is in Aransas, Nueces and San Patricio Counties, consequently, its water demand and supply values are split into the tables for each county. Aransas Pass contracts with the San Patricio Municipal Water District (SPMWD) to purchase treated water from the CCR/LCC/Texana System. The contract allows the City to purchase only the water that it needs. No shortages are projected for the City of Aransas Pass and no changes in water supply are recommended.

4B.12.2 City of Gregory

The City of Gregory has a contract with the SPMWD to purchase treated water. The contract allows the City to purchase only the water that it needs. No shortages are projected for the City of Gregory and no changes in water supply are recommended.

4B.12.3 City of Ingleside

The City of Ingleside has a contract with the SPMWD to purchase treated water. The contract allows the City to purchase only the water that it needs. No shortages are projected for the City of Ingleside and no changes in water supply are recommended.

4B.12.4 City of Ingleside on the Bay

The City of Ingleside on the Bay has a contract with the SPMWD to purchase treated water. The contract allows the City to purchase only the water that it needs. No shortages are projected for the City of Ingleside on the Bay and no changes in water supply are recommended.

4B.12.5 Lake City

4B.12.5.1 Description

- Source: Groundwater – Gulf Coast Aquifer;
- Estimated Reliable Supply: 88 acft/yr; and
- System Description: Limited by well capacity.

4B.12.5.2 Options Considered

Lake City users have projected shortages of 11 acft/yr in 2030 increasing to 37 acft/yr in 2060. Table 4B.12-2 lists the water management strategies, references to the report sections discussing the strategy, total project cost, and unit costs that were considered for meeting the Lake City's shortages.

Table 4B.12-2.
Water Management Strategies Considered for Lake City

Option	Yield (acft/yr)	Approximate Cost[1]	
		Total	Unit ($/acft)
Gulf Coast Aquifer Supplies — Drill Additional Well (Section 4C.7)	80	$343,000	$444[2]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] Source of Cost Estimate: Section 4C.7, Table 4C.7-8, 0.07 MGD water treatment plant fully utilized. Cost estimates are based on size and depth of well(s) to meet needs.

4B.12.5.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages for the Lake City:

- Gulf Coast Aquifer Supplies- Drill one additional well.

In addition to the management strategy listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.12.5.4 Costs

Groundwater supplies for Lake City users are currently limited by well capacity. One new well would be required to meet the projected shortages for Lake City. The recommended Water Supply Plan including anticipated costs is summarized by decade in Table 4B.12-3.

Table 4B.12-3.
Recommended Plan Costs by Decade for Lake City

Plan Element	2010	2020	2030	2040	2050	2060
Projected Surplus/(Shortage) (acft/yr)	—	(1)	(11)	(19)	(28)	(37)
Gulf Coast Aquifer Supplies-Drill additional well						
Supply From Plan Element (acft/yr)[1]	—	80	80	80	80	80
Total Annual Cost ($/yr)[2]	—	$36,000	$36,000	$36,000	$6,000	$6,000
Total Unit Cost ($/acft)[2]	—	$444	$444	$444	$75	$75

[1] Supply from additional wells set equal to approximately twice the projected shortage to account for peaking.
[2] Source of Cost Estimate: Section 4C.7. Table 4C.7-8, 0.07 MGD water treatment plant fully utilized. Cost estimates are based on size and depth of well(s) to meet needs. Assumes debt service based on RWP guidelines. Reduction in cost after Year 2040 assumes debt service has been paid.

4B.12.6 City of Mathis

The City of Mathis has a contract with the City of Corpus Christi to purchase raw water from the CCR/LCC System. The contract allows the City to purchase only the water that it needs. No shortages are projected for the City of Mathis and no changes in water supply are recommended.

4B.12.7 City of Odem

The City of Odem has a contract with the SPMWD to purchase treated water. The contract allows the City to purchase only the water that it needs. No shortages are projected for the City of Odem and no changes in water supply are recommended.

4B.12.8 City of Portland

The City of Portland has a contract with the SPMWD to purchase treated water. The contract allows the City to purchase only the water that it needs. No shortages are projected for the City of Portland and no changes in water supply are recommended.

4B.12.9 City of Sinton

The City of Sinton meets its demands with groundwater pumped from the Gulf Coast Aquifer. The City has three wells with a total capacity of 3.67 MGD, or 2,055 acft/yr. The City of Sinton is expected to only pump water needed to meet projected demands. No shortages are projected for the City of Sinton and no changes in water supply are recommended

4B.12.10 City of Taft

The City of Taft has a contract with the SPMWD to purchase treated water. The contract allows the City to purchase only the water that it needs. No shortages are projected for the City of Taft and no changes in water supply are recommended.

4B.12.11 County-Other

County-Other demands are met with surface water from the CCR/LCC/Texana System provided by the SPMWD and groundwater from the Gulf Coast Aquifer. No shortages are projected for County-Other entities and no changes in water supply are recommended.

4B.12.12 Manufacturing

4B.12.12.1 Description

The City of Corpus Christi provides the surface water for manufacturing in Nueces County from the CCR/LCC/Texana System. Additional manufacturing supplies are from the Gulf Coast Aquifer. The City also provides surface water for manufacturing in San Patricio County. *In the analysis that follows, the manufacturing needs of Nueces and San Patricio Counties are considered jointly*. Since water management strategies for this water user will likely be developed by Wholesale Water Providers, the total project costs and supplies are shown in the water supply plan. Appendix C.6 delineates water management strategy supplies and costs by water user group and county. A shortage in manufacturing supply occurs in 2020.

4B.12.12.2 Options Considered

Over 90 percent of the water supplied to Manufacturing users in Nueces and San Patricio Counties is from the CCR/LCC/Lake Texana System via Wholesale Water Providers (City of Corpus Christi and SPMWD). Beginning in 2020, shortages begin to appear and grow to a combined 46,005 acft/yr in 2060 (39,550 acft/yr in Nueces County and 6,455 acft/yr in San Patricio County). Table 4B.12-4 lists the water management strategies, references to the report section discussing the strategy, total project cost, and unit costs that were considered for meeting the shortage for manufacturing in Nueces and San Patricio Counties.

4B.12.12.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is one potential plan to meet the projected 2020 through 2060 shortages for manufacturing in Nueces and San Patricio Counties:

- Manufacturing Water Conservation;
- O.N. Stevens Water Treatment Plant Improvements;
- Reclaimed Wastewater Supplies;
- Garwood Pipeline;
- Off-Channel Reservoir;
- Gulf Coast Aquifer Groundwater Supplies; and
- Lavaca River Diversion and Off-Channel Reservoir.

Table 4B.12-4.
Water Management Strategies Considered for Manufacturing in Nueces and San Patricio Counties

Option	Yield (acft/yr)	Approximate Cost[1] Total	Approximate Cost[1] Unit ($/acft)
Manufacturing Conservation (Section 4C.3)	up to 2,050	N/A	N/A
O.N. Stevens Water Treatment Plant Improvements (Section 4C.19)	32,996 to 42,329	$31,324,000[2]	$459 to $524[2]
Reclaimed Wastewater Supplies (Section 4C.5)	250	N/A	$826[3]
Gulf Coast Aquifer Groundwater Supplies (Section 4C.7)	up to 18,000	$59,245,000[4]	$853[4]
Lavaca River Diversion & Off-Channel Reservoir (Section 4C.13)[5]	16,242	$224,183,000	$1,027
Garwood Pipeline (Section 4C.14)	35,000	$112,798,000[6]	$685[6]
Off-Channel Reservoir[7]	30,340[8]	$105,201,950[8]	$715[8]
CCR/LCC Pipeline[7]	21,905[9]	$48,324,000[9]	$588[9]
Stage II Lake Texana (Palmetto Bend) (Section 4C.13)[5]	12,964	$232,828,000	$1,213
Brackish Groundwater Desalination[10]	18,000	$108,331,000	$977
Seawater Desalination[10]	28,000	$260,914,000	$1,696

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered by the wholesale water provider to the water supply entity or entities. Unit cost is for full utilization of project capacity.

[2] Total project cost includes improvements to the following WTP components: raw influent, raw water intake pump station, and O.N. Stevens solids handling facilities. Unit costs include $326/acft for treatment.

[3] See Section 4C.5. Costs to maintain ongoing Nueces Delta studies are $500,000 per year (assumed cost associated with Allison Demonstration Project is 25 percent). Water supply for Allison Project based on ratio of yield recovered by a 2-MGD project as compared to an 8.8-MGD project. Costs to supply Allison discharge to delta includes $326/acft for treatment of additional yield. Annual cost not subject to 20 year debt service.

[4] Source of Cost Estimate: Section 4C.7, Table 4C.7-17. Unit cost includes $326/acft for treatment. Treatment may not be required if separate pipeline is constructed so that groundwater would not be blended with water in Mary Rhodes pipeline.

[5] Supplies are estimated based on assuming Region P/L industrial needs of 10,000 acft/yr. Unit costs are estimated based on a raw water cost of $701/acft for the Lavaca River Diversion and $887/acft for the Stage II of Lake Texana plus $326/acft for treatment. Total cost shown is not prorated between regions; however, it is understood that Region N is responsible for a portion of the total project cost.

[6] Source of Cost Estimate: Section 4C.14, Table 4C.14-2. Unit cost = $326/acft for treatment + $359/acft for raw water supply development.

[7] Total costs and unit costs are based on Federal or State funding participation of 65 percent for debt service costs. Water supplied is 65 percent of project potential, with 35 percent dedicated for ecosystem restoration or State/Federal purpose. $326/acft added for treatment of water supplied for CCR/LCC Pipeline option.

[8] Yield and costs shown assume Federal and/or State participation of 65%. Without this funding, the full yield of the project is 46,677 acft/yr, the total project cost is $300,577,000 and the unit cost is $896/acft including treatment.

[9] Yield and costs shown assume Federal and/or State participation of 65%. Without this funding, the full yield of the project is 33,700 acft/yr, the total project cost is $138,067,000 and the unit cost is $728/acft including treatment.

[10] Projects may have opportunities for federal or state participation. However, based on assumptions of 65% of federal or state funding participation for debt service costs and water supplies of 65% of project potential (with 35% dedicated for ecosystem restoration or state/federal purposes), federal or state participation would not be anticipated to reduce annual unit costs of water and therefore is not included in the cost estimate.

In addition to these recommended projects, four projects are considered to be alternative water management strategies.

- CCR/LCC Pipeline;
- Stage II of Lake Texana;
- Brackish Groundwater Desalination; and
- Seawater Desalination.

In addition to the management strategies listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.12.12.4 Costs

The recommended Water Supply Plan including anticipated costs is summarized by decade in Table 4B.12-5.

4B.12.13 Steam-Electric

No steam-electric demand exists or is projected for the county.

4B.12.14 Mining

The mining demands in San Patricio County are met by groundwater from Gulf Coast Aquifer. No shortages are projected for mining and no changes in water supply are recommended.

4B.12.15 Irrigation

4B.12.15.1 Description

- Source: Groundwater – Gulf Coast Aquifer; Surface water – Surface water rights;
- Estimated Reliable Supply: Maximum of 9,698 acft/yr (groundwater); 83 acft/yr (surface water); and
- System Description: Various irrigation operations.

Table 4B.12-5. Potential Plan Costs by Decade for Manufacturing in Nueces and San Patricio Counties[1]

Plan Element	2010	2020	2030	2040	2050	2060
Recommended Water Management Strategies						
Projected Surplus/(Shortage)[2] (acft/yr)	—	(7,411)	(15,203)	(24,459)	(33,913)	(46,005)
Manufacturing Water Conservation[3]						
Supply From Plan Element (acft/yr)	1,260	1,418	1,576	1,734	1,892	2,050
Annual Cost ($/yr)	—	—	—	—	—	—
Unit Cost ($/acft)	—	—	—	—	—	—
O.N. Stevens Water Treatment Plant Improvements[4]						
Supply From Plan Element (acft/yr)	42,329	40,048	38,102	36,366	34,817	32,996
Annual Cost ($/yr)	$21,334,000	$20,625,000	$19,965,000	$16,692,000	$16,190,000	$15,574,000
Unit Cost ($/acft)	$504	$515	$524	$459	$465	$472
Reclaimed Wastewater Supplies[5]						
Supply From Plan Element (acft/yr)	250	250	250	250	250	250
Annual Cost ($/yr)	$206,500	$206,500	$206,500	$206,500	$206,500	$206,500
Unit Cost ($/acft)	$826	$826	$826	$826	$826	$826
Garwood Pipeline						
Supply From Plan Element (acft/yr)	—	35,000	35,000	35,000	35,000	35,000
Annual Cost ($/yr)	—	$23,958,000	$23,958,000	$23,958,000	$14,054,000	$14,054,000
Unit Cost ($/acft)	—	$685	$685	$685	$402	$402
Off-Channel Reservoir[6]						
Supply From Plan Element (acft/yr)	—	—	30,340	30,340	30,340	30,340
Annual Cost ($/yr)	—	—	$21,696,800	$21,696,800	$21,696,800	$17,536,500
Unit Cost ($/acft)	—	—	$715	$715	$715	$578
Gulf Coast Aquifer Groundwater Supplies						
Supply From Plan Element (acft/yr)			11,000	11,000	11,000	18,000
Annual Cost ($/yr)			$9,383,000	$9,383,000	$9,383,000	$10,188,000
Unit Cost ($/acft)			$853[7]	$853[7]	$853[7]	$566[7]
Lavaca River Diversion and Off-Channel Reservoir[8]						
Supply From Plan Element (acft/yr)	—	—	—	—	—	16,242
Annual Cost ($/yr)	—	—	—	—	—	$16,681,000
Unit Cost ($/acft)	—	—	—	—	—	$1,027
Total Annual Cost ($/yr)	$7,760,500	$31,718,500	$62,798,300	$60,067,300	$50,163,300	$63,489,000
Total Unit Cost ($/acft)	$177	$414	$540	$523	$442	$471
Alternative Water Management Strategies						
CCR/LCC Pipeline[9]						
Supply From Plan Element (acft/yr)	—	—	—	21,905	21,905	21,905
Annual Cost ($/yr)	—	—	—	$12,869,980	$12,869,980	$12,869,980
Unit Cost ($/acft)	—	—	—	$588	$588	$588
Stage II Lake Texana (Palmetto Bend)						
Supply From Plan Element (acft/yr)	—	—	—	—	—	12,964
Annual Cost ($/yr)	—	—	—	—	—	$15,725,000
Unit Cost ($/acft)	—	—	—	—	—	$1,213
Brackish Groundwater Desalination[10]						
Supply From Plan Element (acft/yr)	—	—	—	18,000	18,000	18,000
Annual Cost ($/yr)	—	—	—	$17,584,000	$17,584,000	$17,584,000
Unit Cost ($/acft)	—	—	—	$977	$977	$977

Table 4B.12-5 (Concluded)

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Seawater Desalination[10]						
Supply From Plan Element (acft/yr)	—	—	—	28,000	28,000	28,000
Annual Cost ($/yr)	—	—	—	$47,498,000	$47,498,000	$47,498,000
Unit Cost ($/acft)	—	—	—	$1,696	$1,696	$1,696

[1] Supplies shown exceed shortages in the event growth in demands exceeds TWDB projections or supplies are reduced under the City's contract with LNRA for Lake Texana water. Supplies and costs shown in this table represent full project yields. For delineation by water user group, see Appendix C.6.

[2] Surplus/(Shortage) includes manufacturing for both Nueces and San Patricio Counties. Note: Shortages for Nueces County-Steam and Electric, Nueces County- Mining, and Aransas County- Other are identified in separate tables (i.e. total combined shortage is 62,255 acft/yr in Year 2060).

[3] Water supply represents water saved by blending of Lake Texana water with Nueces River water. There may be an opportunity for additional water savings of up to 591 acft/yr with an interconnection to the Mary Rhodes Pipeline for industries with intakes in the Nueces River (See Section 4C.3). Annual cost of interconnection pipeline to MRP is $132,000. Impacts to other water users would need to be considered, prior to implementing MRP interconnection project.

[4] Supplies include 16,000 acft/yr generated with new sludge handling ponds and additional treated water supplies with improvements of plant capacity from 159 MGD to 200 MGD (average day) constrained by existing raw water supplies. Costs include $326/acft for treatment.

[5] Costs to maintain ongoing Nueces Delta studies are $500,000 per year (assumed cost associated with Allison Demonstration Project is 25 percent). Water supply for Allison Project based on ratio of yield recovered by a 2-MGD project as compared to an 8.8-MGD project (See Section 4C.5). Costs to supply Allison discharge to delta includes $326/acft for treatment of additional yield. Annual cost not subject to 20 year debt service.

[6] Annual costs and unit cost are based on Federal funding participation of 65 percent. Water supplied is 65 percent of project potential, with 35 percent dedicated for ecosystem restoration. $326/acft added for treatment of water supplied. Costs reduced in Year 2060 with debt service paid for pipeline. Debt service is 40 years for reservoir.

[7] Assumes full utilization of project. Unit cost based on 18,000 acft project + $326/acft for treatment (See Section 4C.7) although treatment may not be required if separate pipeline is constructed so that groundwater would not be blended with water in Mary Rhodes pipeline.

[8] Supplies are estimated based on assuming Region P/L industrial needs of 10,000 acft/yr. Unit costs are estimated based on a raw water cost of $701/acft and $326/acft for treatment.

[9] Annual costs and unit cost are based on Federal or State funding participation of 65 percent for debt service costs. Water supplied is 65 percent of project potential, with 35 percent dedicated for ecosystem restoration or State/Federal purpose. $326/acft added for treatment of water supplied for CCR/LCC Pipeline option.

[10] Projects may have opportunities for federal or state participation. However, based on assumptions of 65% of federal or state funding participation for debt service costs and water supplies of 65% of project potential (with 35% dedicated for ecosystem restoration or state/federal purposes), federal or state participation would not be anticipated to reduce annual unit costs of water and therefore is not included in the cost estimate.

4B.12.15.2 Options Considered

The San Patricio County irrigation water user group has projected shortages of 750 acft/yr in 2030 and 4,414 acft/yr in 2060. Their shortages are attributed to limited well capacity of 9,698 acft/yr estimated using the procedure in Section 4A.2.2. Table 4B.12-6 lists the water management strategies, references to the report section discussing the strategy, total project cost, and unit costs that were considered for meeting the shortage for San Patricio County-Irrigation. Irrigation water conservation was considered; however, it was not recommended due to the fact that according to data developed by the TWDB and local GCD data the irrigation water application efficiency in San Patricio County already exceeds 80%, equal to the maximum efficiency achieved with this strategy.

Table 4B.12-6.
Water Management Strategies Considered for San Patricio County-Irrigation

Option	Yield (acft/yr)	Approximate Cost[1]	
		Total	Unit ($/acft)
Gulf Coast Aquifer Groundwater Supplies — Drill Additional Well(s) (Section 4C.7)	9,275	$8,110,000[2]	$100[2]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] Source of Cost Estimate: Section 4C.7, Table 4C.7-11. Cost estimates are based on size and depth of well(s) to meet needs and do not include any additional treatment.

4B.12.15.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is recommended to meet the projected 2030 through 2060 shortages for San Patricio County-Irrigation:

- Gulf Coast Aquifer Groundwater Supplies — Drill Additional Well(s)

In addition to the management strategy listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.12.15.4 Costs

The recommended Water Supply Plan, including anticipated costs, is summarized by decade in Table 4B.12-7.

Table 4B.12-7.
Recommended Plan Costs by Decade for San Patricio County-Irrigation

Plan Element	2010	2020	2030	2040	2050	2060
Projected Surplus/(Shortage) (acft/yr)	—	—	(750)	(1,852)	(3,069)	(4,414)
Gulf Coast Aquifer Groundwater Supplies — Drill Additional Well(s)						
Supply From Plan Element (acft/yr)[1]	—	—	9,000	9,000	9,000	9,000
Total Annual Cost ($/yr)[2]	—	—	$925,000	$925,000	$925,000	$218,000
Total Unit Cost ($/acft)[2]	—	—	$100	$100	$100	$24

[1] Supply from additional wells set equal to approximately twice the projected shortage to account for peaking.
[2] Source of Cost Estimate: Section 4C.7. Table 4C.7-11. Cost estimates are based on size and depth of well(s) to meet needs and do not include any additional treatment. Assumes debt service based on RWP guidelines. Reduction in cost after Year 2050 assumes debt service has been paid.

4B.12.16 Livestock

The livestock water demands in San Patricio County are met by groundwater from the Gulf Coast Aquifer and surface water from local on-farm sources. No shortages are projected for livestock and no changes in water supply are recommended.

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4B.13 Wholesale Water Provider Water Supply Plans

Table 4B.13-1 lists each Wholesale Water Provider and their corresponding surplus or shortage in years 2030 and 2060. For each Wholesale Water Provider with a projected shortage, a water supply plan has been developed.

Table 4B.13-1.
Wholesale Water Provider Surplus/(Shortage)

Water User Group	Surplus/(Shortage)[1] 2030 (acft/yr)	Surplus/(Shortage)[1] 2060 (acft/yr)	Comment
City of Corpus Christi	(20,528)	(54,357)	Projected shortage — see plan below
San Patricio MWD	1,122	(7,898)	Projected shortage — see plan below
South Texas Water Authority	0	0	Supply equals demand
Nueces County WCID #3	3,556	4,012	Projected surplus

[1] Surplus/(Shortage) for each Wholesale Water Provider calculated by taking total surface water availability (constrained by water treatment plant capacity) less municipal retail and wholesale demands, steam-electric demands, manufacturing demands, and/or mining demands. (Table 4A-24).

4B.13.1 City of Corpus Christi

As the primary provider of surface water to the Coastal Bend Region, the City of Corpus Christi is the major Wholesale Water Provider in the region. Corpus Christi has 200,000 acft in available safe yield supply in 2060 through its own water right in the CCR/LCC System and a contract with LNRA from Lake Texana. This availability constitutes 93 percent of the total surface water availability in the region. Additionally, the City has a permit to divert up to 35,000 acft/yr run-of-river water under its interbasin transfer permit on the Colorado River (via the Garwood Irrigation Co.). While the City owns the water right on the Colorado River, it does not have the facilities to divert and convey this water to the City; therefore, the 35,000 acft is not included in the existing surface water availability in the region.

The City provides treated and raw water from the CCR/LCC/Texana System to the water user groups and other entities shown in Table 4B.13-2.

Table 4B.13-2.
Purchasers of Water from the City of Corpus Christi

Water User Group / Entity	*County*
San Patricio MWD	San Patricio
South Texas Water Authority	Kleberg, Nueces
City of Alice	Jim Wells
City of Beeville	Bee
City of Mathis	San Patricio
City of Three Rivers	Live Oak
Nueces County WCID #4 (Port Aransas)	Nueces
Nueces County-Other	Nueces
Steam-Electric	Nueces
Manufacturing	Nueces
Mining	Nueces

A comparison of Corpus Christi's demand and supply is presented in Section 4A.5 and is an analysis of the City's retail municipal demands and supplies available to meet those demands. The shortage listed in Table 4B.13-1 reflects the entire City's demands—both municipal retail and wholesale, as well as steam-electric, manufacturing and mining demands, as well as taking water treatment plant constraints into consideration. The shortage begins in 2030 and is due to large manufacturing and mining demands in Nueces and San Patricio Counties. For a list of the water management strategies available to meet these shortages, refer to the water supply plan for manufacturing in Nueces and San Patricio Counties in Section 4B.11.11.

The City has surpluses of 7,914 acft/yr in 2010 and a projected shortage of 9,393 acft/yr in 2020 (Table 4A-24). Part of the City of Corpus Christi's surplus has been reallocated to Nueces County-Other use (see Table 4B.11-3).

Table 4B.13-3.
Reallocation of Surplus Supplies by Decade for City of Corpus Christi (as Wholesale Water Provider)[1]

Plan Element	2010	2020	2030	2040	2050	2060
Original Projected Surplus (acft/yr)	7,914	—	—	—	—	—
Reallocated Surplus (acft/yr)	261[1]	—	—	—	—	—
Remaining Projected Surplus (acft/yr)	7,653	—	—	—	—	—

[1] Reallocated to Nueces County-Other users (Section 4B.11)

4B.13.2 San Patricio Municipal Water District

The San Patricio Municipal Water District (SPMWD) is the second largest Wholesale Water Provider in the region. SPMWD has a contract with the City of Corpus Christi to purchase water from both the CCR/LCC System and Lake Texana. SPMWD treats this water and provides it to the water user groups and other entities shown in Table 4B.13-4.

Table 4B.13-4.
Purchasers of Water from San Patricio MWD

Water User Group / Entity	County
City of Aransas Pass	Aransas, Nueces, San Patricio
City of Gregory	San Patricio
City of Ingleside	San Patricio
City of Ingleside by the Bay	San Patricio
City of Odem	San Patricio
City of Portland	San Patricio
City of Rockport	Aransas
City of Taft	San Patricio
Port Aransas	Nueces
County-Other	Aransas, San Patricio
City of Fulton	Aransas
Manufacturing	San Patricio

The shortage listed in Table 4B.13-1 reflects all of SPMWD's demands—both municipal retail and wholesale, as well as manufacturing demands. The shortage also takes into account water treatment plant constraints. The shortage begins in 2050 and is due to large manufacturing demands in San Patricio County and Aransas County-Other demands. For the water management strategies available to meet these shortages, refer to the water supply plan for manufacturing in Nueces and San Patricio Counties in Section 4B.11.1 and 4B.12.12.

4B.13.3 South Texas Water Authority

The South Texas Water Authority (STWA) is the third largest Wholesale Water Provider in the region. STWA has a contract with the City of Corpus Christi to purchase treated water from both the CCR/LCC System and Lake Texana. STWA provides this water to the water user groups and other entities shown in Table 4B.13-5.

Table 4B.13-5.
Purchasers of Water from South Texas Water Authority

Water User Group / Entity	*County*
City of Agua Dulce	Nueces
City of Driscoll	Nueces
City of Bishop	Nueces
Nueces County-Other[1]	Nueces
City of Kingsville	Kleberg
Ricardo WSC	Kleberg

[1] Includes Teen Challenge, LCS Detention Center, Nueces County WCID #5, Nueces WSC, Coastal Acres LLC and other rural water users.

There are no shortages listed in Table 4B.13-1 for South Texas Water Authority.

4B.13.4 Nueces County WCID #3

The Nueces County WCID #3 is the smallest Wholesale Water Provider in the region. Nueces County WCID #3 receives a firm yield of 7,103 acft/yr from its Nueces Basin run-of-river rights. Nueces County WCID #3 provides this water to the water user groups and other entities shown in Table 4B.13-6.

Table 4B.13-6.
Purchasers of Water from Nueces County WCID #3

Water User Group / Entity	County
City of Robstown	Nueces
River Acres WSC	Nueces
Nueces County-Other	Nueces

After meeting customer demands, Nueces County WCID #3 shows surpluses of 3,098 acft in 2010 increasing to 4,012 acft by 2060. Part of the Nueces County WCID #3 surplus has been reallocated to River Acres WSC (Table 4B.13-7).

Table 4B.13-7.
Reallocation of Surplus Supplies by Decade for Nueces County WCID #3 (as Wholesale Water Provider)[1]

Plan Element	2010	2020	2030	2040	2050	2060
Original Projected Surplus (acft/yr)	3,098	3,340	3,556	3,747	3,903	4,012
Reallocated Surplus (acft/yr)	138[1]	255[1]	355[1]	445[1]	522[1]	590[1]
Remaining Projected Surplus (acft/yr)	2,960	3,085	3,201	3,302	3,381	3,422

[1] Reallocated to River Acres WSC (Section 4B.11.8)

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Section 5
Impacts of Water Management Strategies on Key Parameters of Water Quality [31 TAC § 357.7(a)12] and Impacts of Moving Water from Rural and Agricultural Areas [31 TAC § 357.7(a)8(G)]

The guidelines for the 2011 Regional Water Plans include describing major impacts of recommended and alternative water management strategies on key parameters of water quality identified by the regional water planning group. This also includes consideration of third party social and economic impacts associated with voluntary redistribution of water from rural and agricultural areas, and affects of ground and surface water interrelationships on water resources of the state. Furthermore, 2011 Regional Water Plans should consider statutory provisions regarding interbasin transfers of surface water including summation of water needs in basins of origin and receiving basins.

5.1 Impacts of Water Management Strategies on Key Parameters of Water Quality

As part of the 2006 regional water planning process, the Coastal Bend Region identified key parameters of water quality to consider for water management strategies. The selection of key water quality parameters are based on water quality concerns identified in the Nueces River Authority's Basin Highlights Report, water user concerns expressed during Regional Water Planning Group meetings, and water quality studies conducted for water management strategies included in previous and current Plans and other regional studies. The Coastal Bend Region identified water quality parameters for six water management strategies, as shown in Figures 5-1 and 5-2.

The major impacts of recommended water management strategies on these key parameters of water quality are described in greater detail in the respective water management strategy summary (Section 4C). These identified water quality concerns present challenges that may need to be overcome before the water management strategy can be used as a water supply. For water quality parameters that cannot be fully addressed due to lack of available information or inconclusive water quality studies, the water management summary write-ups include recommendations for further studies prior to implementation as a water management strategy.

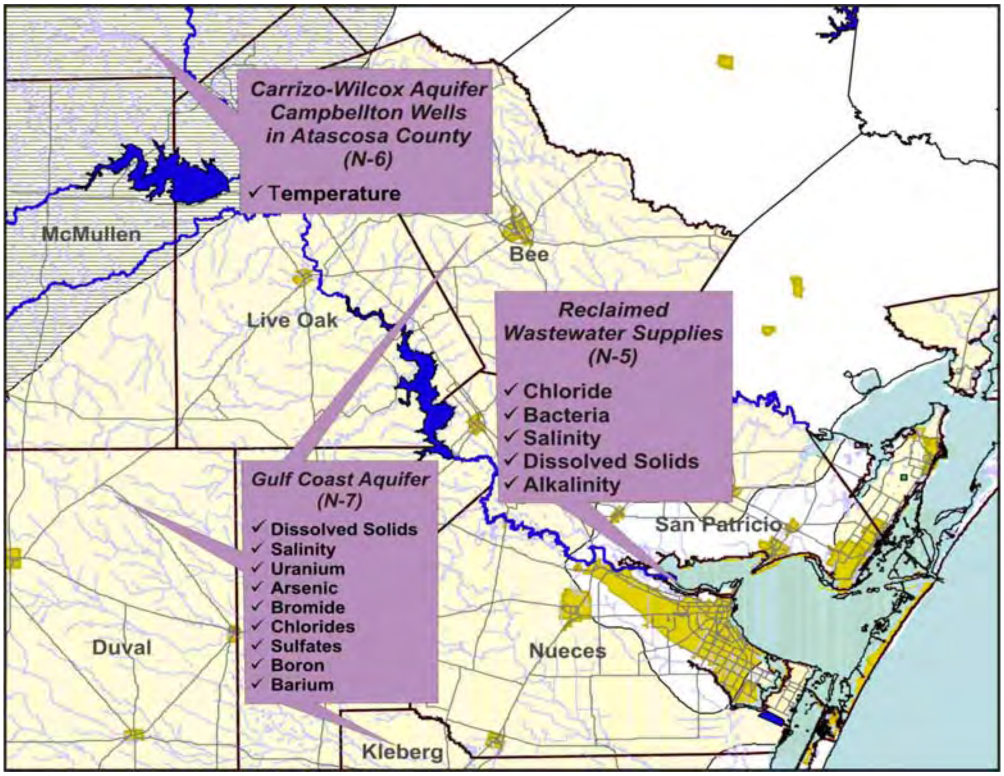

Figure 5-1. Water Quality Parameters to Consider for Water Management Strategies

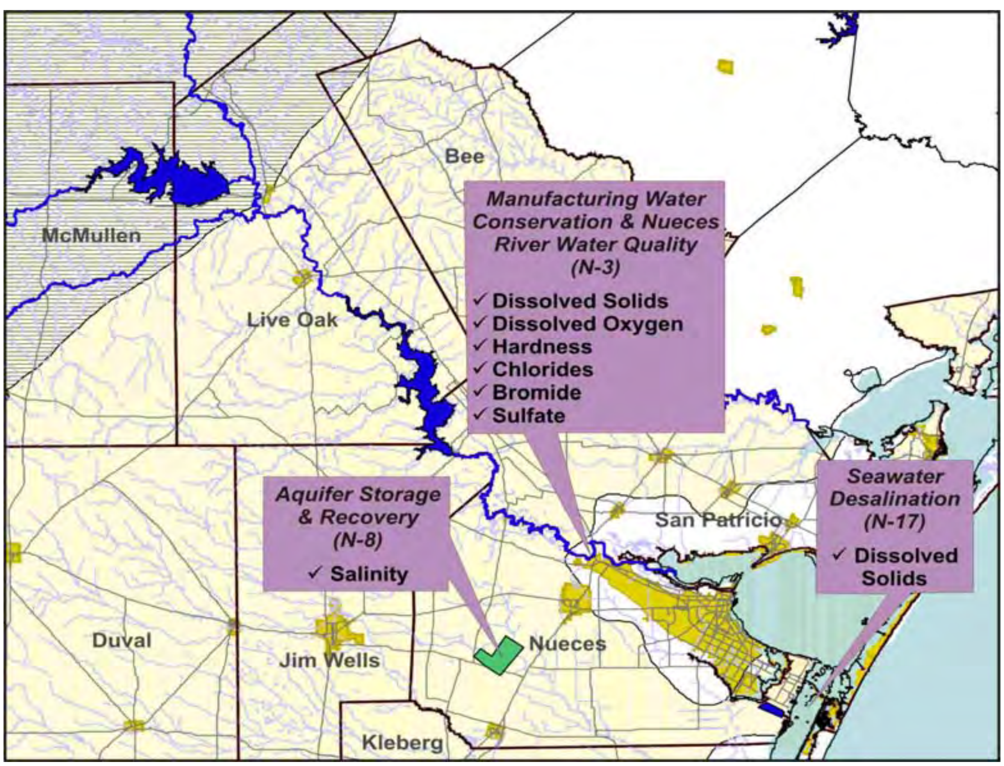

Figure 5-2. Water Quality Parameters to Consider for Water Management Strategies

5.2 Voluntary Redistribution of Water and Impacts of Moving Water from Rural and Agricultural Areas

Several opportunities for voluntary redistribution exist for the Coastal Bend Region, including: (1) reallocating surface water through utilization of unused supply and sales of existing water rights , (2) trading and transferring surface water rights with the South Central Texas Region (Region L), and (3) regional water supply opportunities associated with federal or state participation in projects as discussed in Section 4C.12.

Reallocation of unutilized surface water supply was recommended to meet both near-term and long-term shortages for Live Oak-Manufacturing and River Acres WSC. The 2011 Plan recommends the City of Three Rivers provide a portion of their un-utilized surface water to meet water needs for Live Oak-Manufacturing. The City of Three Rivers currently provides water to manufacturing users in Live Oak County and would likely require a contract modification to increase water supplies. Similarly, Nueces County WCID #3 currently provides water to River Acres WSC. Nueces County WCID #3 has unutilized surface water supply that could be provided to River Acres WSC to meet their needs and would likely require a contract modification. The impacts of voluntary redistribution of un-utilized surface water supply are expected to have minimal or no impacts on third party users or rural and agricultural areas.

Previous South Central Texas Regional Water Planning efforts considered a pipeline from Choke Canyon Reservoir to provide water to the South Central Texas Region in exchange for a desalination facility near the City of Corpus Christi. This water management strategy was not considered by the South Central Texas Region during this planning cycle.

Federal interests have studied several proposed South Central and Coastal Bend Region projects identified in this regional water plan to evaluate opportunities for flood mitigation, ecosystem restoration, water quality enhancements, and water supply benefits. The projects include desalination facilities, CCR/LCC Pipeline, Nueces Off-Channel Reservoir, recharge enhancement on the Upper Nueces, and brush management opportunities. State interests have participated in pilot programs and feasibility studies of seawater and brackish groundwater desalination projects in the South Texas region. The third party social and economic imp0acts resulting from voluntary redistribution will be considered in future studies.

The water management strategies recommended to meet water needs (Section 4B) do not include transferring water needed by rural and agricultural users and, therefore, are not considered to impact them. As discussed above, voluntary redistributions of unutilized surface water supplies for some rural and agricultural users are recommended and included in Section 4B – Water Supply Plans.

5.3 Groundwater and Surface Water Interrelationships Impacting Water Resources of the State

The Nueces River from Three Rivers to the Calallen Pool (including Lake Corpus Christi), hereafter referred to as the Lower Nueces Basin, is hydraulically connected to underlying Goliad Sands and alluvial sands of the Gulf Coast Aquifer. During the Phase I development of the 2011 Plan, studies were conducted to evaluate stream flow interaction with alluvial sands of the Gulf Coast Aquifer downstream of CCR to LCC using data collected during a field channel loss study as summarized in Appendix B. Groundwater and surface water interaction in the Lower Nueces Basin is very complex and could vary significantly based on seasonal events, antecedent drought or wet conditions and prolonged drought or wet conditions that could impact storage and released water from LCC. Additional studies were performed during the 2011 Regional Water Planning effort (presented in Section 4C.3) to evaluate groundwater and surface water interrelationships considered to potentially impact Lower Nueces Basin water quality that may affect water supplies diverted from the Calallen Pool. Studies are on-going by the City of Corpus Christi and others to help characterize and identify sources of water quality fluctuations in the Lower Nueces Basin. Key water quality parameters of consideration are shown in Figure 5-2.

5.4 Interbasin Transfers

A number of interbasin transfer permits exist in the Coastal Bend Regional Planning Area as discussed in Section 3.1.5. These permits include authorizations for diversions from river basins north of the planning region into the Nueces River Basin. Both major interbasin transfer permits provide water to the City of Corpus Christi and include supplies from the Lavaca-Navidad and Colorado River Basins. The City of Corpus Christi benefits from an interbasin transfer permit[1] and a contract with the Lavaca Navidad River Authority (LNRA) to divert 41,840 acft/yr on a firm basis and up to 12,000 acft/yr on an interruptible basis from Lake Texana in the Lavaca-Navidad River Basin to the City's O.N. Stevens Water Treatment Plant. In

[1] TCEQ, Certificate of Adjudication No. 16-2095C, held by Lavaca-Navidad River Authority and Texas Water Development Board (TWDB), October 21, 1996.

addition, a second permit[2] allows the diversion of up to 35,000 acft/yr of run-of-river water on the Colorado River. Analyses of this water right, one of the most senior in the Colorado River Basin, indicate that nearly the full 35,000 acft/yr is available from this run-of-river right without off-channel storage.[3]

This Plan includes recommended and alternative water management strategies for water supplies in the Coastal Bend Region that are being considered by the LNRA for development in the Lavaca- Navidad Basin including a Lavaca River Diversion and Off-Channel Reservoir (Lavaca River OCR) and Palmetto Bend Stage II. Water supply from Palmetto Bend Stage II requires an interbasin transfer from the Lavaca Region (Region P) to the Coastal Bend Region prior to project implementation. In accordance with Texas Water Code provisions, the projected shortage in the Lavaca Region is 67,740 acft/yr and is assigned to Jackson and Wharton County-Irrigation users.[4] The shortages are projected by Region P to be met by groundwater supplies. However, the LNRA has been approached by local industries requesting additional supplies of 10,000 acft/yr. Accordingly, the water supply from Palmetto Bend Stage II and Lavaca River OCR that is potentially available for Coastal Bend Region purposes is 12,964 acft/yr and 16,242 acft, respectively, which is reflected in the Section 4B water supply plans. Additional details regarding this potential interbasin transfer is included in Section 4C.13.

[2] TCEQ, Certificate of Adjudication No. 14-5434B, held by the City of Corpus Christi (via the Garwood Irrigation Company), October 13, 1998.
[3] HDR Engineering, Inc. (HDR), "Dependability and Impact Analyses of Corpus Christi's Purchase of the Garwood Irrigation Company Water Right," Draft Report for the City of Corpus Christi, September 1998.
[4] Lavaca Regional Planning Group Draft Initially Prepared Plan, draft estimates provided January 2010.

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Section 6
Water Conservation and
Drought Management Recommendations
[31 TAC §357.7(a)(11)]

The 2011 Coastal Bend Regional Water Plan (2011 Plan) includes water conservation and drought management recommendations pursuant to 31 Texas Administrative Code 357.7(a)11 and Texas Water Code 11.085. The guidelines require water user groups that obtain water from inter-basin transfers consider conservation as a water management strategy. The City of Corpus Christi (City) benefits from an interbasin transfer and contract with the Lavaca-Navidad River Authority (LNRA) to divert up to 53,840 acft/yr from Lake Texana in the Lavaca-Navidad River Basin, which includes a base contract of 41,840 acft/year and 12,000 acft/year on an interruptible basis. Although not considered as a current water supply, the City has a permit to divert up to 35,000 acft/year from the Colorado River Basin according to a purchase agreement with the Garwood Irrigation Company. The City's Water Conservation Plan (2009) addresses their goals and plan to conserve water. The City's Drought Contingency Plan (2009) identifies factors used to initiate a drought response and actions to be taken as part of the response (Section 5 of the plan). Both City Plans are included in Appendix E, along with a model water conservation and drought contingency plans.

The TCEQ provides guidance for Water Conservation and Drought Contingency Plans in 30 Texas Administrative Code Chapter 288, which requires entities applying for new water rights or an amendment to existing water right to prepare and implement a water conservation/drought contingency plan to be submitted with their application. Furthermore, 30 TAC Chapter 288, requires "specific, quantified five and ten year targets for water savings to be included in all water conservation plans to be submitted to the TCEQ no later than May 1, 2005." The rules go on to state that after the initial deadline, updated plans must be submitted every five years to coincide with the regional water planning cycles.

6.1 Water Conservation

The Coastal Bend Region has considered water conservation and drought management measures for each water user group with a need (projected water shortage) in accordance with Regional Water Planning Guidelines. The Coastal Bend Region recommends water conservation for municipal and non-municipal entities.

6.1.1 Municipal Water Conservation

The City of Corpus Christi, the largest municipal water user in the Coastal Bend Region, has demonstrated significant water savings attributable to water conservation efforts over the last decade. The City of Corpus Christi currently uses less water than comparable cities in the Central Texas region and is currently among the lowest in the state, for all climatological regions. The City's municipal water use was nearly 220 gallons per capita per day (gpcd) in 1990 and was reduced to 179 gpcd by 2000, a decrease of 41 gpcd in 10 years (or 19 percent). According to TWDB water use projections, the City of Corpus Christi water use is anticipated to decline to 165 gpcd by 2060.

The Coastal Bend Region encourages all municipal entities in the Coastal Bend Region to conserve water, regardless of per capita consumption. As part of the 2006 regional water planning process, the Coastal Bend Region recommended that water entities, with and without shortages, exceeding 165 gallons per capita per day reduce consumption by 15 percent by 2060 by using Best Management Practices (BMPs) provided by the Water Conservation Implementation Task Force. This criteria was used for the 2011 Plan. By reducing water use by 15 percent in addition to anticipated savings built into the TWDB projections for replacement of existing plumbing fixtures, the Coastal Bend Region is expected to reduce average consumption from 155 gpcd in 2000 to 137 gpcd by 2060 (a decrease of 12 percent). Assuming 100 percent participation in water conservation efforts for entities with greater than 165 gpcd, the anticipated regional savings is expected to increase from 104 acft/yr in Year 2010 to 2,415 acft/yr by Year 2060. A discussion of municipal conservation water savings, program costs, and unit costs for the Coastal Bend Region are included in Section 4C.1.

6.1.2 Non-municipal Water Conservation

In addition to the recommendation above for municipal water conservation, the Coastal Bend Region also recommended water conservation for industrial (manufacturing/mining) and irrigation users. The Coastal Bend Region recommended that manufacturing users continue to pursue opportunities to improve water quality, thereby reducing water consumption. Manufacturing entities can improve water quality through outlet works and intake modifications to reduce total dissolved solids, amongst other strategies as described in Section 4C.3. The Planning Group also recommended a 15 percent reduction in water demand for irrigation and mining entities with projected water needs that may be achieved using Best Management Practices (BMPs) identified by the Water Conservation Implementation Task Force.

There are three counties within the Coastal Bend Region with projected irrigation needs: Bee, Live Oak, and San Patricio. Irrigation conservation was considered for all three counties; however, according to data developed by the TWDB and local GCD data the irrigation water application efficiency in Bee and San Patricio Counties already exceeds 80%, equal to the maximum efficiency achieved with this strategy; therefore, no additional conservation is recommended for these two counties.[1] The total water savings for Live Oak County after 15 percent water demand reduction is 342 acft/yr, as shown in Table 6-1. There are multiple irrigation BMPs that irrigators can select from to attain this water savings, including furrow diking, low elevation spray applications (LESA), and low energy precision application (LEPA). The costs of these BMPs range from $109 per acft of water saved using LEPA systems to $228 per acft water saved using furrow dikes. A more detailed description of irrigation BMPs, costs, and water savings for the Coastal Bend Region are included in Section 4C.2.

Table 6-1.
Irrigation Water Conservation Savings

Counties using Irrigation Conservation	Irrigation Shortages in 2060 (acft/yr)		Water Savings in 2060 (acft/yr)
	Before Conservation	After Conservation (Reducing Demand By 15 Percent)	
Live Oak	(373)	(31)	342

There are three counties in the Coastal Bend Region with projected mining needs: Duval, Live Oak, and Nueces. The total water savings for these three counties after 15 percent water demand reduction is 2,343 acft/yr as shown in Table 6-2. There are multiple industrial BMPs identified by the Water Conservation Implementation Task Force, however data to quantify savings and costs is unavailable. The Coastal Bend Region recognizes that conservation savings and costs to implement mining BMPs are facility specific and assumes that mining users will implement those strategies that are practical, cost effective, and provide good water savings potential. A more detailed description of suggested mining BMPs for the Coastal Bend Region is included in Section 4C.4.

[1] Low-energy precision application systems (LEPA) analysis as an irrigation BMP is assumed to have the highest application efficiency rate of 80% (See Table 4C.2-4).

Table 6-2.
Mining Water Conservation Savings

Counties with Mining Needs	Irrigation Shortages in 2060 (acft/yr)		Water Savings in 2060 (acft/yr)
	Before Conservation	After Conservation (Reducing Demand By 15 Percent)	
Duval	(4,205)	(2,922)	1,283
Live Oak	(1,755)	(954)	801
Nueces	(1,624)	(1,365)	259
Total	**(7,584)**	**(5,241)**	**2,343**

6.2 Drought Management

All water supply entities and some major water right holders are required by Senate Bill 1 regulations to submit for approval to the Texas Commission for Environmental Quality (TCEQ) a Drought Contingency and Water Conservation Plan. These plans must detail the entities' plans to reduce water demand at times when the demand threatens the total capacity of the water supply delivery system or overall supplies are low (like during a drought).

The City of Corpus Christi's Drought Management Plan considers combined storage of the CCR/LCC System in determining whether to initiate a drought response. The City issues drought response measures based on 50 percent, 40 percent, 30 percent, and 20 percent of storage in the CCR/LCC System, as described in Table 3-10. Through water purchase agreements, the customers of the City of Corpus Christi (including wholesale water providers) are responsible to impose similar drought measures. Supplies from the CCR/LCC System are determined on the basis of minimum year availability and safe yield, respectively. Hence, the surface water supplies available to the three largest Coastal Bend wholesale water providers (City of Corpus Christi, San Patricio Municipal Water District, and South Texas Water Authority) are dependable during drought and have included drought provisions in the event that a future drought is greater in severity than the worst drought of record as discussed in Section 7.

Supplies from other surface water sources, such as run-of-river water rights for Nueces County WCID#3, the fourth wholesale water provider, are determined from analyses using TCEQ's Nueces River Water Availability Model and are dependable during drought.

The Nueces River Authority has on file, electronic copies of drought management plans for the following Coastal Bend region entities:

Wholesale Water Providers	**Date of Management Plan**
City of Corpus Christi	April 2009
San Patricio Municipal Water District	May 2005 (Amended)
South Texas Water Authority	April 2009
Other Entities	**Date of Management Plan**
City of Alice	July 2008
Aransas County MUD #1	April 2009
City of Aransas Pass	October 2008
City of Beeville	February 2000
City of Ingleside	July 2009
Nueces WSC	May 2009
City of Portland	March 2009
Rincon WSC	April 2009
City of Rockport	August 2009
City of Kingsville	April 2002
Ricardo WSC	June 2009

The Nueces River Authority also has on file, the Lavaca-Navidad River Authority Drought Contingency Plan, revised August 24, 2005.

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Section 7
Consistency with Long-Term Protection of the State's Water Resources, Agricultural Resources, and Natural Resources [31 TAC §357.7(a)(13) and §357.7(2)(C)

The 2011 Coastal Bend Regional Water Plan (2011 Plan) is consistent with long-term protection of the state's water resources, agricultural resources, and natural resources and is developed based on guidance principles outlined in the Texas Administrative Code Chapter 358-State Water Planning Guidelines. The 2011 Plan was produced with an understanding of the importance of orderly development, management, and conservation of water resources and is consistent with all laws applicable to water use for the state and regional water planning areas. Furthermore, the plan was developed according to principles governing surface water and groundwater rights. The 2001 TCEQ Agreed Order governing freshwater pass-throughs to the Nueces Estuary was strictly adhered to for current surface water supply projects and future water management strategies. For groundwater, the 2011 Plan also recognized principles for groundwater use in Texas and the authority of groundwater conservation districts within the Coastal Bend Region. The rules of groundwater conservation districts in the region and regional drawdown constraints developed previously by the Coastal Bend Groundwater Advisory Panel were followed when determining groundwater availability. The CBRWPG recognizes the need to protect groundwater quality and recommends routine water quality monitoring near in situ uranium mining and deep well injection operations. Local groundwater management areas and groundwater conservation districts are in the process of developing desired future conditions and groundwater availability numbers for use in future regional water planning efforts.

The 2011 Plan identifies actions and policies necessary to meet the Coastal Bend Region's near and long-term water needs by developing and recommending water management strategies to meet their needs with reasonable cost, good water quality, and sufficient protection of agricultural and natural resources of the state. The Coastal Bend Region recommended water management strategies that considered public interest of the state, wholesale water providers, protection of existing water rights, and opportunities that encourage voluntary transfers of water resources while balancing economic, social, and ecological viability. When needs could not be met economically with water management strategies, a socioeconomic impact analysis was performed to estimate the economic loss associated with not meeting these needs (Appendix F).

The 2006 Plan considered environmental information resulting from site-specific studies and ongoing water development projects when evaluating water management strategies. Cumulative effects of water management strategies on Nueces River instream flows and inflows to the Nueces estuary were considered, as summarized in Appendix K. A list of endangered and threatened species in the Coastal Bend Region for each county was obtained from the U.S. Fish and Wildlife Service and discussed in Section 1. Possible habitats for endangered and threatened species were considered for each water management strategy (Section 4C). The 2001 Agreed Order includes operational procedures for Choke Canyon Reservoir and Lake Corpus Christi and requires passage of inflows to the Nueces Bay and Estuary based on maximum harvest studies and inflow recommendations to maintain the health of the Nueces Estuary.

Due to most areas having an underlying impervious clay layer, there has not been much opportunity for springs to form in the Coastal Bend Region.

The 2011 Plan consists of initiatives to respond to drought conditions, such as the City of Corpus Christi Drought Management Plan, which included modifying the operation of the CCR/LCC System during drought conditions as required by the Agreed Order to conserve water. As a further drought protection provision, the Coastal Bend Region adopted use of safe yield analyses for purposes of determining water supply. The use of safe yield analyses anticipates that a future drought may occur that is greater in severity than the worst drought of record and reserves a certain amount of water in storage (i.e., 7 percent of CCR/LCC System) for such an event. Use of safe yield for the major water supplies in the Nueces River Basin is justified based on previous droughts in the basin over the past 70 years. Figure 7-1 shows how 3-year average annual inflows for the major reservoir system have been reduced for each of the past four significant droughts.

The Coastal Bend Region conducted numerous meetings during the 2011 planning cycle, with meetings open to the public and decisions based on accurate, objective, and reliable information. The Region coordinated water planning and management activities with local, regional, state, and federal agencies and participated in interregional meetings with the South Central Texas Region (Region L) and Lavaca Region (Region P) to identify common needs and worked together with Region L and Region P to develop interregional strategies in an open, equitable, and efficient manner. The Coastal Bend Region considered recommendations of stream segments with unique ecological value by Texas Parks and Wildlife (Appendix G) and sites of unique value for reservoirs. At this time, the Coastal Bend Region recommends that no stream segments with unique ecological value be designated. The Planning Group developed policy recommendations for the 2011 Plan including protection of water quality, consideration of environmental issues, interbasin transfers, groundwater management, request for additional studies for water supply projects (such as desalination), and continued funding for regional water planning efforts. The Planning Group policy recommendations are included in Section 8.

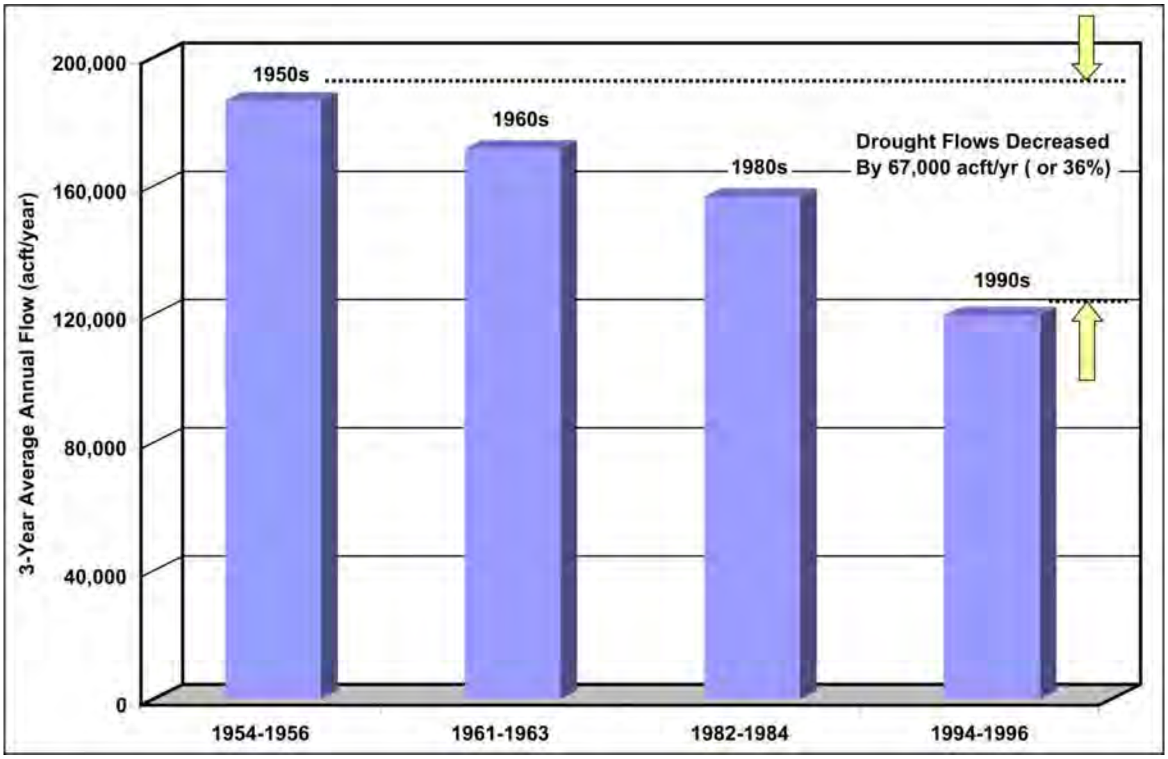

Figure 7-1. 3-Year Reservoir Inflows

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Section 8
Legislative Recommendations,
Unique Stream Segments, and Reservoir Sites
[31 TAC §357.7(a)(8-9); 31 TAC §357.8; 31 TAC §357.8]

Each of the 16 regional water planning groups may make recommendations to the TWDB regarding legislative and regional policy recommendations; identification of unique ecological stream segments; and identification of sites uniquely suited for reservoirs. The Coastal Bend RWPG selected a subcommittee to consider legislative and regional policy recommendations, which were adopted by the Coastal Bend Region. The following are the Coastal Bend Region's recommendations regarding these matters.

8.1 Legislative and Regional Policy Recommendations

Under the authority of Senate Bill 1, the Coastal Bend RWPG has developed the following legislative and regional policy recommendations.

8.1.1 General Policy Statement

I. The Texas Legislature is urged to declare that: i) all water resources of the State are hydrologically inter-related and should be managed on a "conjunctive use" basis, wherever possible; ii) existing water supplies should be more efficiently and effectively used through improved conservation and system operating policies; and iii) water re-use should be promoted, wherever practical, taking into account appropriate provisions for protection of downstream water rights, domestic and livestock uses, and environmental flows.

8.1.2 Interbasin Transfers

I. The Texas Legislature is urged to repeal the "Junior Rights" provision and the additional application requirements for interbasin transfers that were included in Senate Bill 1.

8.1.3 Desalination

I. The Texas Legislature is urged to direct TCEQ to investigate the current regulatory status of the "concentrate" or "reject water" produced during the desalination of brackish ground water, brackish surface water and seawater in industrial and municipal treatment processes and compare these to reject water requirements for the oil and gas industry and arrive at a common set of standards for the disposal of these waste products so that safe, economical methods of disposal will be available to encourage the application of these technologies in Texas.

II. The Texas Legislature is urged to direct TCEQ to work with TWDB and TPWD to develop information on the potential environmental impacts of concentrate discharges from seawater desalination facilities and to facilitate the permitting of these discharges into tidal waters where site specific information shows that minimal environment damage would occur.

III. Texas Legislature is urged to amend state laws governing the procurement of professional services by public agencies in order to allow municipalities, water districts, river authorities, smaller communities, and other public entities, provided that they have the expertise, to utilize alternatives to the traditional "Design-Bid-Build" methods for public work projects, including desalination facilities. For example, most large-scale desalination facilities built in the past 10 years are constructed using "Build-Own-Operate-Transfer" method, allowing for a cost-effective transfer of project risks to the private sector.[1]

8.1.4 Groundwater Management

I. The Texas Legislature is urged to provide funding for the Groundwater Management Areas to support their efforts towards the evaluation of groundwater availability and desired future conditions.

II. TWDB, TCEQ, and the Texas Railroad Commission are urged to expand and intensify their activities in collecting, managing, and disseminating information on groundwater conditions and aquifer characteristics throughout Texas.

III. TWDB is urged to continue funding for updates to the groundwater availability models, specifically the Central Gulf Coast GAM covering the Coastal Bend Region.

IV. The Texas Railroad Commission is urged to cooperate with TWDB and TCEQ to encourage oil and gas well drillers to furnish e-logs, well logs, and other information that might be available on shallow, groundwater bearing formations to facilitate the better identification of aquifer characteristics.

V. The Texas Legislature is urged to appropriate additional funds for TWDB to continue and expand their statewide groundwater data program and to appropriate new funds, through regional institutions such as Texas A&M University – Corpus Christi and Texas A&M University –Kingsville, for a regional research center to support research, data collection, monitoring, modeling, and outreach related to groundwater management activities in the Coastal Bend region of Texas.

VI. The Texas Legislature is urged to make funds available through regional water planning groups and groundwater conservation districts to educate the citizens of Texas about groundwater issues, as well as the powers and benefits of groundwater conservation districts.

VII. TCEQ is urged to amend rules and regulations to require routine water quality monitoring, by a non-partisan third-party, of mining operations and enforcement of

[1] "Large-Scale Seawater Desalination and Alternative Project Delivery", Design-Build DATELINE, February 2005.

water quality standards, including in situ mining and those with deep well injection practices.

VIII. The Texas Legislature is urged to prohibit in-situ mining in aquifers that serve as drinking water sources for residents and livestock.

IX. The Railroad Commission is urged to continue its identification of improperly plugged and abandoned oil and gas wells that adversely affect local groundwater supplies. Funding should be provided to address known problems and/or force responsible parties to properly plug abandoned wells, including oil, gas, and water wells.

X. The TWDB is urged to consider local mining projects (such as natural gas from the Eagleford shale) when developing mining water demand projections in the future for regional planning. The TWDB is urged to provide guidance on how planning groups should address local mining water projects, especially those associated with gas production from the Eagleford shale or other projects with variable, and often indeterminate production timelines.

8.1.5 Surface Water Management

I. The Texas Legislature is urged to provide funding for the development of periodic updates to surface water availability models, (WAMs), with specific consideration to updating the Nueces River Basin WAM though any new drought period.

II. The TCEQ is urged to enforce existing rules and regulations with respect to water impoundments.

8.1.6 Regional Water Resources Data Collection and Information Management

I. The Texas Legislature is urged to provide SB1 planning funds, through the Coastal Bend RWPG to a regional institution, to support regional water resources data collection and activities to develop and maintain a “Regional Water Resources Information Management System” for the Coastal Bend area.

8.1.7 Role of the RWPGs

I. The RWPG should play a role in facilitating public information/public education activities that promote a wider understanding of state and regional water issues and the importance of long-range regional water planning.

II. The Texas Legislature is urged to continue funding the TWDB to provide support for state mandated regional water planning group activities.

III. Public entities in the Coastal Bend Water Planning Region are urged to provide their share of continued funding for the administrative support activities that facilitate the Coastal Bend RWPG activities.

8.2 Identification of River and Stream Segments Meeting Criteria for Unique Ecological Value

The Coastal Bend Region considered TPWD's recommendations regarding the identification of river and stream segments which meet criteria for unique ecological value (Appendix G). In December 2009, the Coastal Bend Region recommended that no river or stream segments within the Coastal Bend Region be identified at this time.

8.3 Identification of Sites Uniquely Suited for Reservoirs

The 2007 State Water Plan recommended 19 unique reservoir sites throughout the state, which were then designated by the 80th Texas Legislature in Senate Bill 3 as sites of unique value for reservoir construction.[2] Of these, 2 of the 19 sites are water management strategies considered in this Plan to provide future supplies to the Coastal Bend Region: Nueces off-channel reservoir and Palmetto Bend Stage II. The Nueces off-channel reservoir is a recommended water management strategy and Palmetto Bend Stage II is an alternative water management strategy. The Coastal Bend Region supports the legislative action to identify general areas for reservoir sites. However, the Coastal Bend Region does not recommend specific tracts of land for the Nueces off-channel reservoir or Palmetto Bend Stage II and encourages those wishing to pursue such options to discuss with property owners and mediate if necessary prior to Federal, State, or local recommendation of specific location(s).

No sites uniquely suited for on-channel reservoirs in the Nueces Basin were identified by the Coastal Bend Region. The Coastal Bend Region supports initiatives by Region P and Lavaca Navidad River Authority (LNRA) regarding Palmetto Bend Stage II or an off-channel variation thereof.

8.4 Additional Recommendations

The following additional recommendations are under consideration by the Coastal Bend RWPG:

[2] According to Texas State Water Code Sections 16.051(g), A state agency or political subdivision of the state may not obtain a fee title or an easement that would significantly prevent the construction of a reservoir on a designated site. The designation of a unique reservoir site under this subsection terminates on September 1, 2015, unless there is an affirmative vote by a proposed project sponsor to make expenditures necessary in order to construct or file applications for permits required in connection with the construction of the reservoir under federal or state law.

- Studies of the potential to develop a large-scale, multiyear ASR system in the Gulf Coast Aquifer should be continued to help drought-proof the Region.
- Studies of desalination options to further reduce the cost of using seawater and/or brackish groundwater should be continued.
- Studies should be undertaken to analyze the effects/costs of new EPA Safe Drinking Water Act requirements regarding the treatment of problematic constituents in groundwater on users in the Coastal Bend Region.
- Feasibility studies should be undertaken to optimize and reduce, if possible, the costs of water system interconnects for the cities of San Diego, Freer, Benavides, Premont, and Falfurrias to improve the quantity and quality of potable water available to these cities. Additionally, an evaluation should be undertaken of the feasibility of a regional desalination facility for the treatment of poor quality groundwater to improve the quality of potable water to these cities.
- Feasibility studies should be undertaken to identify opportunities/costs to develop regional groundwater systems that could utilize poor quality groundwater in conjunction with a desalination treatment plant to more effectively manage groundwater resources within the Coastal Bend Region.
- A detailed inventory of irrigation systems, crops, and acreage should be undertaken to more accurately estimate irrigation demands in the region.
- Environmental studies of the segments of the Frio and Nueces Rivers downstream of Choke Canyon Reservoir and upstream of Lake Corpus Christi should be undertaken to fully evaluate the potential impacts of reduced instream flows, including groundwater recharge, associated with the option to construct a pipeline between the two reservoirs.
- The Coastal Bend Region should work with Region P on environmental studies associated with the potential construction of Palmetto Bend Stage II.
- The Coastal Bend Region should perform environmental field studies of potentially unique stream segments and potential unique reservoir sites provided additional clarification is provided by the Texas Legislature regarding the repercussions of identifying a stream segment as unique.
- Support studies to closely monitor discharges from sand and gravel operations in the Lower Nueces River.
- Support studies of construction and implementation of pilot desalination plant to quantify and qualify impacts of operating a brackish desalination facility in the Coastal Bend Region.

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Section 9
Water Infrastructure Funding Recommendations
[31 TAC §357.7(a)(14)]

9.1 Introduction

Senate Bill 2 (77^{th} Texas Legislature) requires that regional water plans include a description of financing needed to implement recommended water management strategies and projects, including how local governments and others propose to pay for water management strategies identified in the plan. The TWDB issued an Infrastructure Financing Report (IFR) Survey requesting information from water user groups with reported water needs any time during the projected planning period from Year 2010 to 2060.

9.2 Objectives of the Infrastructure Financing Report

The primary objectives of the Infrastructure Financing Report are as follows:

- To determine the financing options proposed by political subdivisions to meet future water infrastructure needs (including the identification of any State funding sources considered); and
- To determine what role(s) the RWPGs propose for the State in financing the recommended water supply projects.

9.3 Methods , Procedures, and Survey Responses

For the Coastal Bend Regional Water Planning Area, municipal water user groups having water needs and recommended water management strategies in the regional plan with an associated capital cost were surveyed using an on-line questionnaire provided by the TWDB. The Coastal Bend RWPG emailed three survey packages with supporting documentation that summarized recommended water management strategies identified in the initially prepared water plan — one to the City of Corpus Christi, one to San Patricio Municipal Water District; and one to the City of Lake City. The Coastal Bend Region had a 100% response rate (3 out of 3 surveys were completed). Supporting documentation is included in Appendix L.[1]

With respect to the role of the State in financing the recommended water supply projects, significant State participation is required in order to provide adequate funding for the implementation of water management strategies in the plan.

[1] Based on TWDB guidance, surveys were sent to wholesale water provider if their customers showed shortages.

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Section 10
Plan Adoption
[31 TAC §357.11-12]

10.1 Public Involvement Program

The public involvement program was incorporated at the onset of the CBRWPG water planning process in order to maximize the opportunity for public review and input into the process of developing the water plan as well as critique of the Initially Prepared Regional Water Plan.

The public involvement program included:

- An opportunity at all CBRWPG meetings for the public to comment on any aspect of the plan or planning process;
- Quarterly newsletters (see Appendix H):
  - 1. Fall 2008 (October 2008)
  - 2. Winter 2009 (February 2009)
  - 3. Spring 2010 (March 2010)
- <u>Public Hearing for Initially Prepared Plan</u>:
  April 8, 2010
  Johnny Calderon County Building
  710 Main Street, Robstown, Texas 78380
- Press releases and notices of public meetings; and
- Dedicated website for Coastal Bend RWPG information.

10.2 Coordination with Wholesale Water Providers

Information was provided by wholesale water providers located in the Coastal Bend Planning Region in June 2010 including their plans for future water supply projects for the CBRWPG water management planning process.

Representatives from water supply entities within the CBRWPG were also regularly notified of all CBRWPG meetings and public informational meetings.

10.3 Coastal Bend Regional Water Planning Group Meetings

The CBRWPG met at least quarterly in accordance with the approved bylaws. The CBRPWG has met on a more frequent basis as needed in order to facilitate and direct the water planning of the region. The following is a summary of the meetings:

Coastal Bend RWPG Meetings	
February 8, 2007	November 13, 2008
May 10, 2007	March 12, 2009
August 9, 2007	June 11, 2009
October 4, 2007	August 13, 2009
November 8, 2007	December 10, 2009
February 14, 2008	January 14, 2010
April 10, 2008	February 11, 2010
May 22, 2008	April 8, 2010
August 14, 2008	August 5, 2010

The CBRWPG requested that the TWDB execute the contract to develop the 2011 Regional Water Plan on February 15, 2008.

The CBRWPG also designated several subcommittees in order to expedite more specific work efforts and further increase the effectiveness and timeliness of the planning process. The following summarizes these committee and subcommittee meetings.

Executive Committee Meetings

- February 8, 2007
- May 10, 2007

Subcommittee on Policy Recommendations

- September 29,2009

The CBRWPG approved the Initially Prepared Plan on February 11, 2010 for submittal to the Texas Water Development Board. The CBRWPG approved responses to the comments received on the Initially Prepared Plan and approved the Final Plan on August 5, 2010. The comments received on the Coastal Bend Initially Prepared Plan with approved responses are included in Appendix M.

10.4 Regional Water Planning Group Chairs Conference Calls and Meetings

The Texas Water Development Board held a conference call meeting with Regional Water Planning Group chairs to provide guidance and respond to issues regarding the planning process on April 13, 2009.

10.5 Coordination with Other Regions

A coordination meeting between the Coastal Bend RWPG, the Lavaca RWPG, and the South Central Texas RWPG was held on April 8, 2009 in an effort to share information regarding water supply and water management strategies.

Harry Hafernick Recreation Center
Edna, Texas 77957

10.6 Coordination with Other Entities

An informational meeting with the Celanese-Bishop facility was held on February 19, 2009 to receive input and feedback on the development of certain water management strategies related to industry within the region. In addition, two similar meetings were also held with the City of Corpus Christi and other local industries on April 30, 2009 and September 24, 2009 to discuss water quality issues.

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Appendix A
List of References for In-Depth Description of the Region (from 2001 & 2006 Plans)

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State of Texas World Wide Web: http://www.texas.gov/

Texas Natural Resources Institute: http://www.tnri.tamu.edu/

Texas Water Supply and Conservation Education Program: http://www.tx-water-ed.tamu.edu

Office of the Secretary of State: http://sos.texas.tx.us/

Nueces River Authority: http://sci.tamucc.edu/~nra/

City of Corpus Christi: http://www.ci.corpus-christi.tx.us/servicemain.html

National Agricultural Statistics Services: http://www.nass.usda.gov/

Bureau of Economic Analysis: http://www.bea.doc.gov/

Environmental Protection Agency - Office of Water: http://www.epa.gov/watrhome/

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Appendix B
Summary of Phase I Studies

Study 1 - Evaluation of Additional Potential Regional Water Supplies for Delivery through the Mary Rhodes Pipeline, Including Gulf Coast Groundwater and Garwood Project

This study: (1) included an evaluation of water quality of potential new supplies, (2) identified potential blending and water chemistry issues, and (3) considered reservoir system operations with possible future supplies from the Gulf Coast Aquifer, Garwood project supplies for two delivery scenarios around and through Lake Texana, and additional Lake Texana water supplies as may be available through projects being considered by the Lavaca-Navidad River Authority.

A modified version of the Corpus Christi Water Quality and Treatment Model was utilized to analyze water quality and treatment requirements when blending different water sources. The model was developed to simulate treatment processes currently utilized at the O.N. Stevens Water Treatment Plant (WTP). Five blending scenarios were evaluated. The blending analysis did not indicate any large treatment issues at the O.N. Stevens WTP when blending groundwater supplies from the Gulf Coast Aquifer, surface water supplies from the Garwood Project, or additional supplies from Lake Texana with existing supplies from the Nueces River and Lake Texana.

The Corpus Christi Water Supply Model (CCWSM) was then used to evaluate various reservoir system operations and delivery scenarios with potential new supplies delivered through the MRP. System operations for five different combinations of existing and potential future water supplies through the MRP were simulated using the CCWSM at a fixed demand of 175,000 acft/yr. The five operating scenario combinations considered current and potential future water supplies for delivery through the MRP and, on average, the amount of MRP capacity in use ranged from 47% to 100%. Essentially, as more water supplies are available for delivery through the MRP, the supplies needed from the Choke Canyon Reservoir and Lake Corpus Christi (CCR/LCC) System decreases for a fixed demand. This results in more water stored in the CCR/LCC System, which increases reservoir pass-thrus of freshwater for the Nueces Bay and Estuary according to provisions of the 2001 Agreed Order.

The results from this study were considered during the update of the Gulf Coast Aquifer Supplies water management strategy (see Section 4C.07) and the Garwood Pipeline Project (see Section 4C.14).

Study 2 – Optimization and Implementation Studies for Off-Channel Reservoir

The 2006 Coastal Bend Regional Water Plan (2006 Plan) and the 2007 State Water Plan included the Nueces Off-Channel Reservoir (OCR) near Lake Corpus Christi as a recommended future water management strategy for the Coastal Bend Region to meet needs by Year 2040. Federal interests are studying opportunities for flood damage reduction, ecosystem restoration, and/or water supply benefits in South Texas. During the 2007 Texas legislative session, the Nueces Off-Channel Reservoir site was designated as one of 19 unique reservoir sites in the State of Texas. The Texas Water Development Board (TWDB) Reservoir Site Protection Study[1] recommended the Nueces Off-Channel Reservoir as one of the top-ranked sites in Texas for protection or acquisition.

The OCR is a water management strategy that could be used to (1) enhance the system yield of Choke Canyon Reservoir (CCR) and Lake Corpus Christi (LCC), (2) capture water that would otherwise spill from LCC, and (3) reduce flood events downstream of LCC (to a lesser extent) while still maintaining desired freshwater inflows to the Nueces Bay and Estuary pursuant to the Texas Commission on Environmental Quality (TCEQ) 2001 Agreed Order.

The 2006 Plan analysis showed the optimal size for the OCR is between 200,000 and 300,000 acft, with a diversion pipeline delivery rate between 750 and 1,500 cfs.

This study included further analysis of the OCR as a water management strategy for the Coastal Bend Region. The purposes of this study were to identify a preferred location for the OCR considering potential environmental impacts, optimize its capacity and diversion pipeline delivery rate, and evaluate alternative reservoir operating policies to assist with effective management of system storage and water supply yields.

The results of this study show that the optimal size for the OCR based on acceptable cost and project yield is 280,000 acft with a pipeline delivery rate of between 1,250 cfs and 1,500 cfs. The results from this study were used to update the Off-Channel Reservoir near Lake Corpus Christi water management strategy (see Section 4C.11).

[1] Texas Water Development Board, HDR Engineering, R.J. Brandes Company, et al "Reservoir Site Protection Study", TWDB Report 370, July 2008.

Study 3 – Implementation Analysis for Pipeline from CCR to LCC, Including Channel Loss Study Downstream of Choke Canyon Reservoir

The primary objective of this study was to evaluate stream flow interaction with alluvial sands of the Gulf Coast Aquifer downstream of CCR to LCC using data collected during a field channel loss study. A channel loss study was conducted from March 3- 28, 2008, during a fairly wet hydrologic period with LCC water levels ranging from 93.5 ft-msl to 93.8 ft-msl (or 96.1% - 98.3% LCC water storage capacity).

An overall 87 percent delivery rate (or 13 percent channel loss) from CCR to the Nueces River at Three Rivers Gage was measured during the channel loss study. These data agree closely with the City of Corpus Christi's previously estimated 84 percent delivery factor from CCR to Three Rivers.[2,3] From the Nueces River near Three Rivers to the Nueces River downstream of the confluence with Sulphur Creek near Oakville (a distance of 7.4 river miles), the data indicate between an 11 percent and 13 percent gain in stream flow. Based on this study, an overall channel loss was estimated to be between 2 and 3 percent for the 17.4 river mile stretch from CCR to the Nueces River near Sulphur Creek. This is significantly less than the results from previous studies which estimated channel losses from CCR to LCC over a distance of about 63 miles at about 37.8 percent (a delivery factor of 62.2 percent).

The groundwater and surface water interaction downstream of CCR to LCC is very complex and could vary significantly based on seasonal events, antecedent drought or wet conditions and prolonged drought or wet conditions that could impact storage in LCC. When LCC is at or near storage capacity (conservation pool elevation of 94 ft-msl), the alluvium system influenced by LCC stores water which would be expected to result in less channel losses from the Three Rivers Gage to LCC. The channel loss study was conducted when LCC was nearly full. Furthermore, after prolonged drought periods there could be less water stored in LCC and it would be expected that the alluvium system will act somewhat like a sponge and absorb streamflow traveling down the Nueces River towards LCC, resulting in higher channel losses. The results from this study were considered during the update of the Pipeline from CCR to LCC water management strategy (see Section 4C.10).

[2] HDR, "Updates and Enhancements to Lower Nueces River Basin Bay and Estuary Model and Corpus Christi Water Supply Model", January 2006.

[3] The March 2008 channel loss survey results reported an 87 percent delivery factor as compared to an 84 percent average delivery factor. This is less than a 4 percent difference, which might be attributable to seasonal differences as discussed in the Model Update report (January 2006).

Study 4 – Water Quality Modeling of Regional Water Supply System to Enhance Water Quality and Improve Industrial Water Conservation

In this study, a water quality component was added to the Corpus Christi Water Supply Model (CCWSM) to simulate chloride and TDS levels at the three water supply reservoirs and the Calallen Pool for a hydrologic period from 1934 to 2003. The CCWSM enhanced with the water quality database is capable of simulating chlorides and TDS for the existing CCR/LCC/Lake Texana system for various potential reservoir operating conditions. There are five municipal and industrial water supply intakes in the Calallen Pool area that have reported chlorides and TDS fluctuations. By using the CCWSM to evaluate the effects of various reservoir operations upon quality of water of the Calallen Pool, overall water quality of the Calallen Pool can be stabilized and the reliability of regional water supplies can be increased which will reduce water consumption and treatment costs. For example, poor raw water quality causes more water to be used in industrial cooling towers; therefore improvements to water quality will directly support industrial water conservation.

The calibrated CCWSM was used to evaluate four reservoir operating scenarios to determine the impacts to reservoir and Calallen Pool water quality, including: (1) variable trigger levels for water delivery from CCR to LCC, (2) safe versus firm yield, (3) constant versus a seasonal monthly delivery pattern from Lake Texana, and (4) monthly variable LCC trigger levels for water delivery from CCR.

For simulations with variable trigger levels for water delivery from CCR to LCC (Scenario 1), the higher trigger level of 86 ft-msl showed lower median chloride levels in CCR. There were no significant impacts to LCC, Calallen Pool, or Lake Texana water quality with variable trigger levels. For the safe versus firm yield evaluation (Scenario 2), median chloride levels increased about 13% and 10% for CCR and Calallen Pool, respectively, with safe yield analyses. For the seasonal versus monthly delivery pattern from Lake Texana (Scenario 3), no significant changes were reported to CCR, LCC, Calallen Pool, or Lake Texana water quality. With monthly variable LCC trigger levels in the summer (83 ft-msl) as compared to a constant LCC trigger level at 74 ft-msl (Scenario 4), median chloride levels decreased about 5% in CCR.

The results from this study were considered during the update of the Manufacturing Water Conservation and Nueces River Quality water management strategy (see Section 4C.03).

Study 5 – Region-Specific Water Conservation Best Management Practices (BMPs)

This study included gathering information for current water conservation programs in the Coastal Bend Region, developing a list of water conservation best management practices (BMPs) to promote to regional water users, distributing a water conservation survey throughout the Coastal Bend Region requesting voluntary feedback, and evaluating survey results. The survey had a response rate of 29% (21 responses out of 72 requests) for rural and urban communities throughout the eleven-county Coastal Bend Region for a range of utility sizes from small water supply corporations to the largest wholesale water provider in the region, the City of Corpus Christi. The completed surveys included system-specific information about voluntary water conservation programs implemented by water users in the Coastal Bend Region including: the amount of reduction in water consumption, program goals, costs, currently implemented BMPs, interest in additional water conservation BMPs, and challenges in implementing future water conservation measures.

According to survey responses, the primary objectives of water conservation programs in the Coastal Bend Region are to reduce (1) unaccounted for water, (2) per capita consumption, and/or (3) seasonal and peak water demands. The main reasons cited for a lack of interest in adding new BMPs to existing water conservation programs are cost and a lack of staff. In the future, the Texas Legislature should continue to provide funding to the TWDB and other state agencies for water conservation initiatives, including providing technical support and assistance to water user groups regarding public information programs; adoption of conservation rates; tracking the effectiveness of implemented BMPs; leak detection, repair, and monitoring; meter testing and replacement; or other BMPs included in their water conservation programs. Additional water conservation grants or low-interest loans may also provide needed assistance for water user groups that may be interested in implementing voluntary BMPs in the future.

The results from this study were considered during the update of the Municipal Water Conservation water management strategy (see Section 4C.01).

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Appendix C

Summary Graphs and Tables for Population, Water Demand and Supply Projections, and Water Management Strategies

Contents

Appendix C.1

City and County-Other Figures with Population, Per Capita Water Demand, and Municipal Water Demand/Supply Projections

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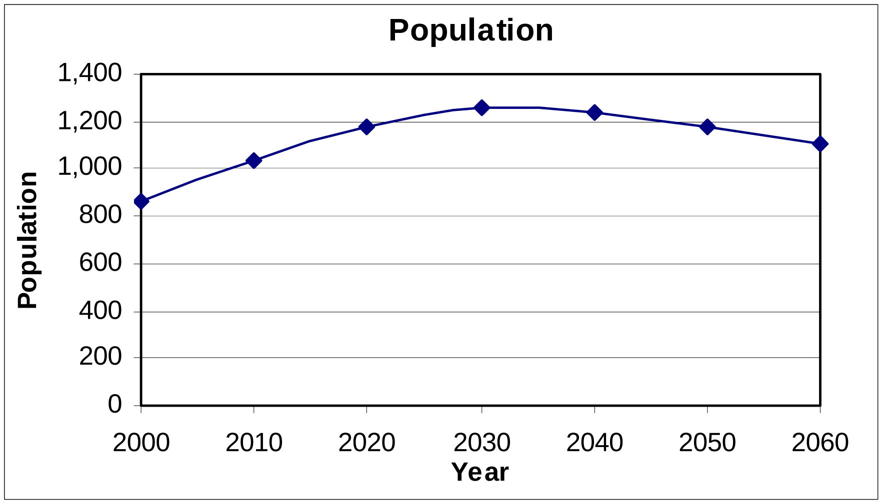
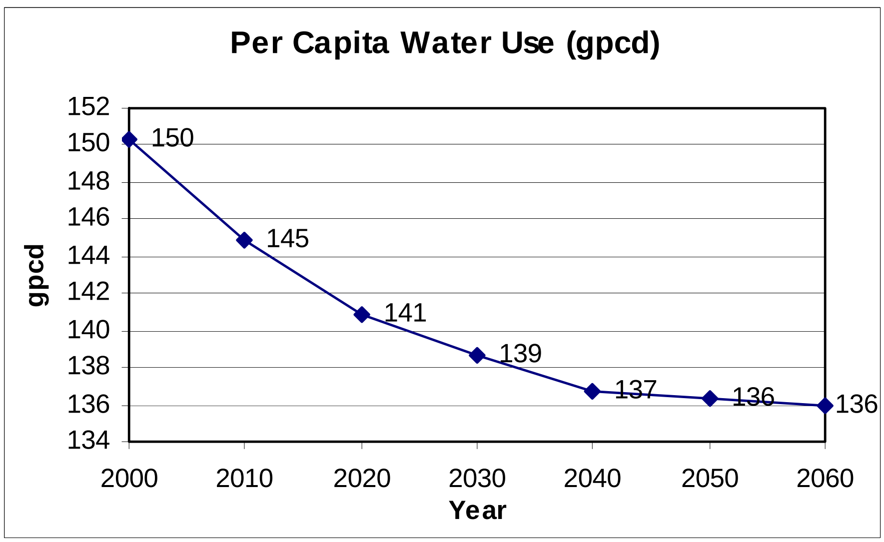
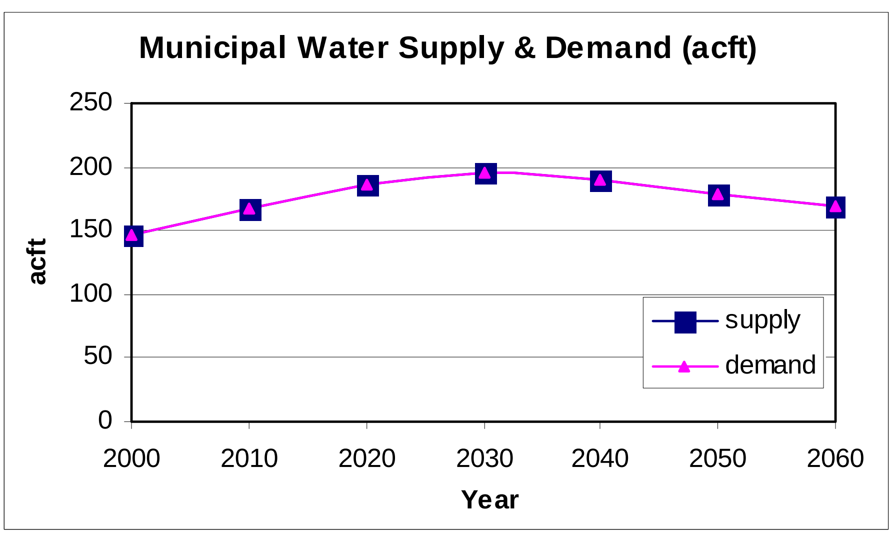
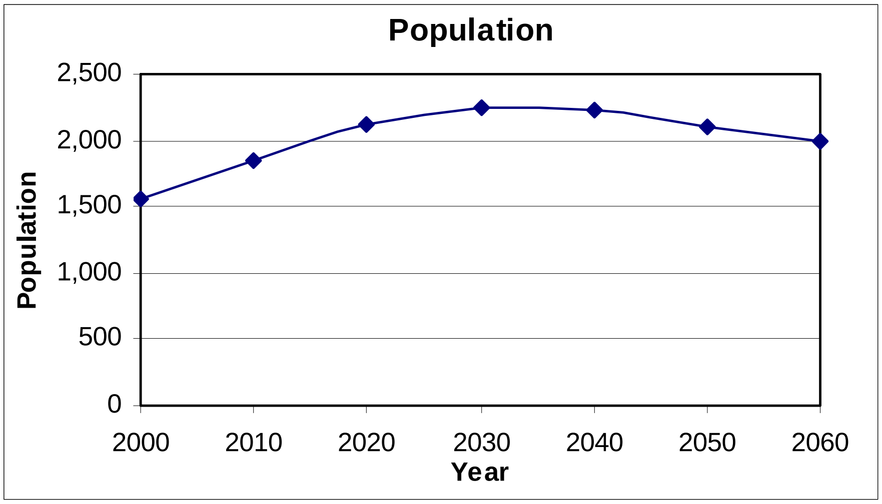
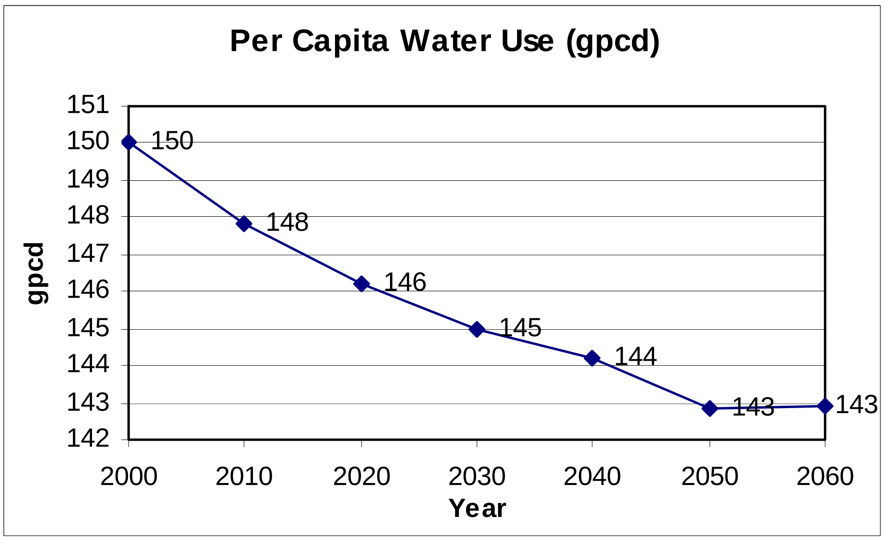


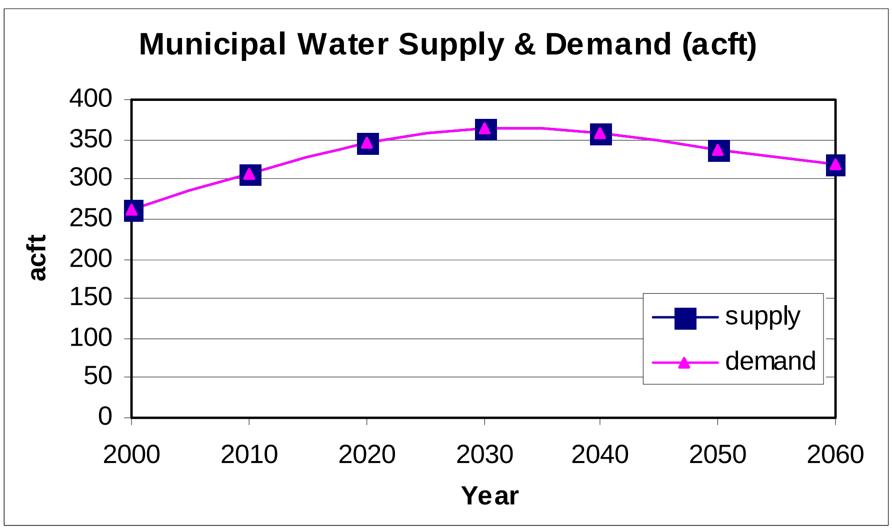




City of Fulton — Aransas County







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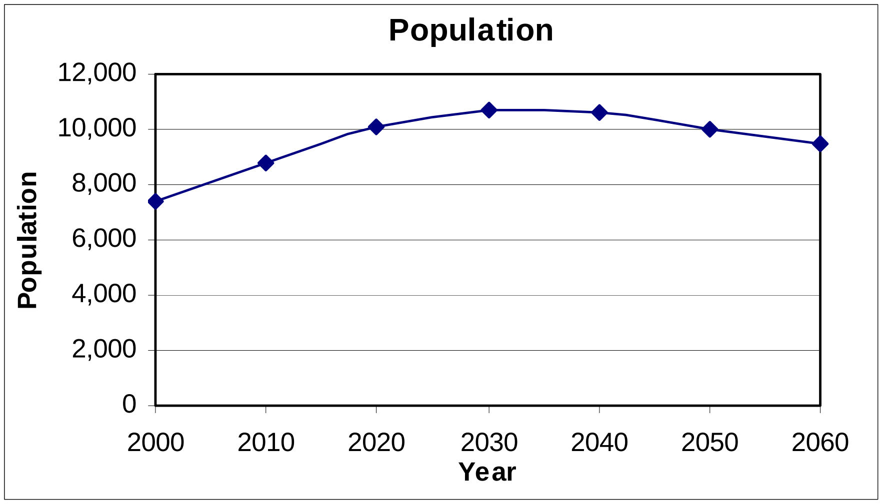
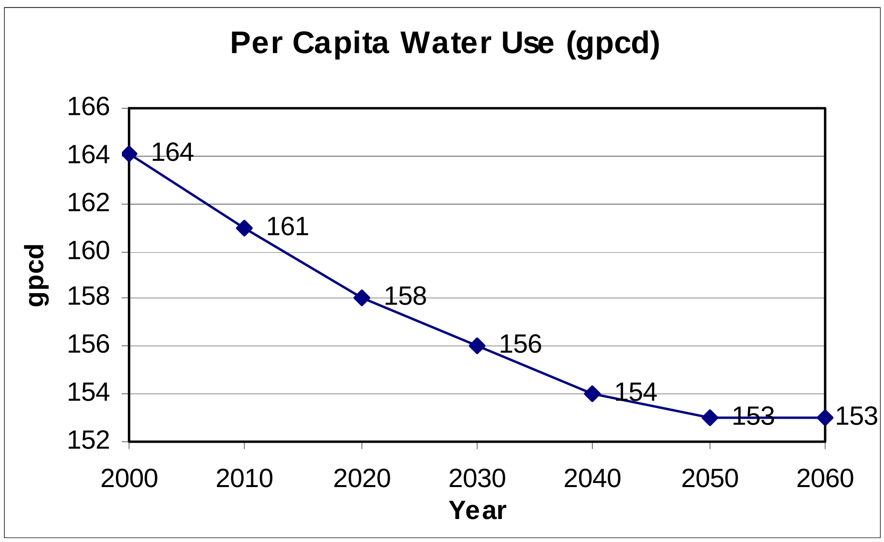
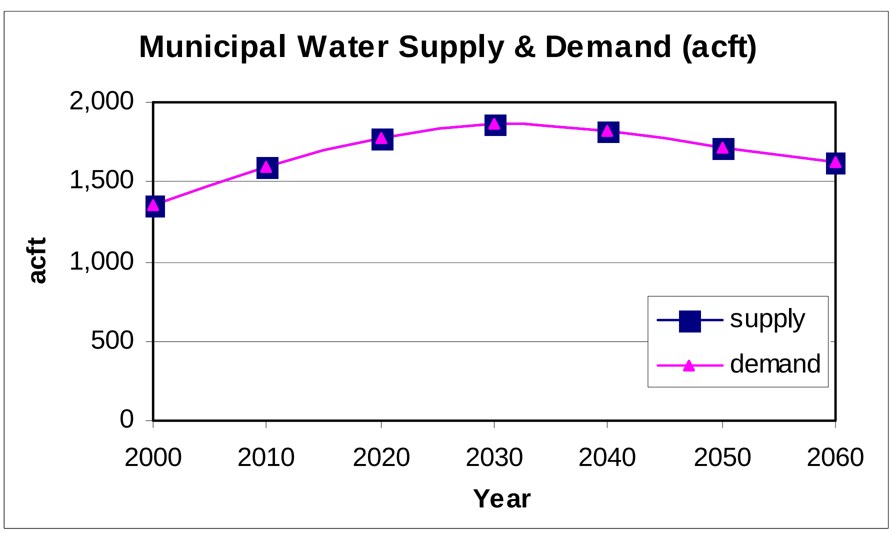
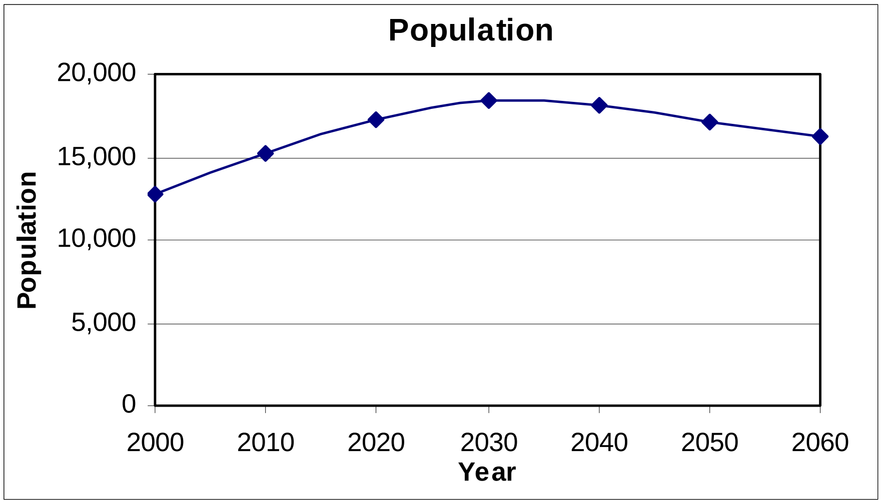
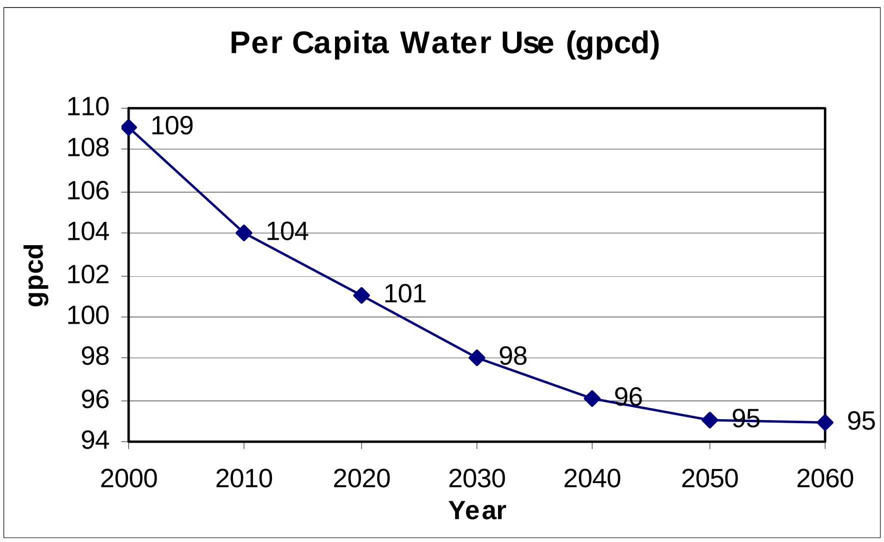


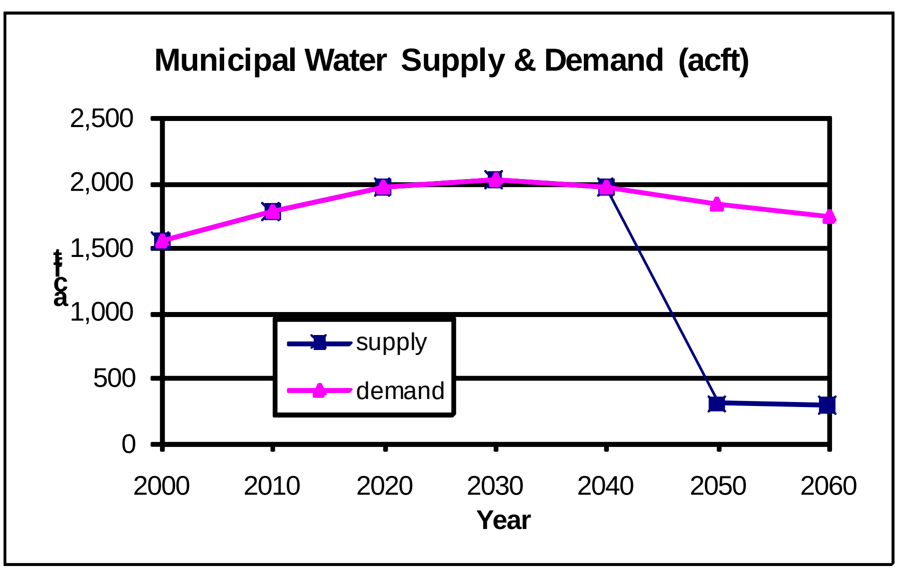




County-Other — Aransas County







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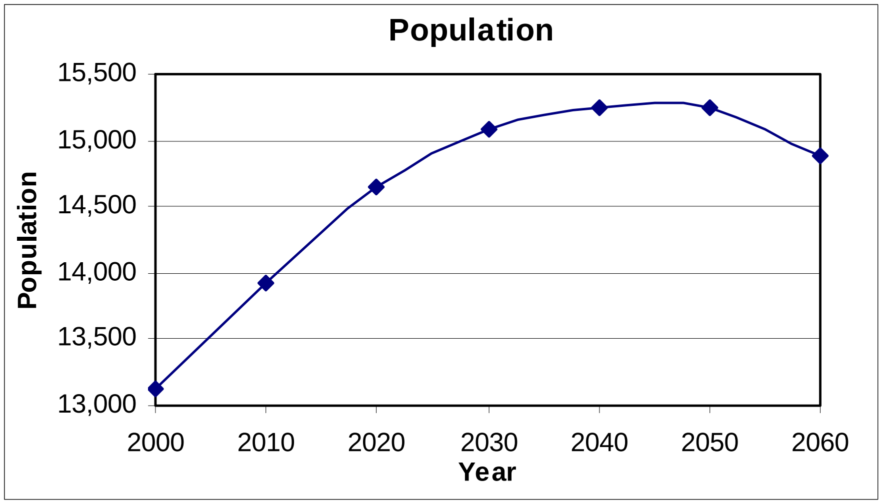
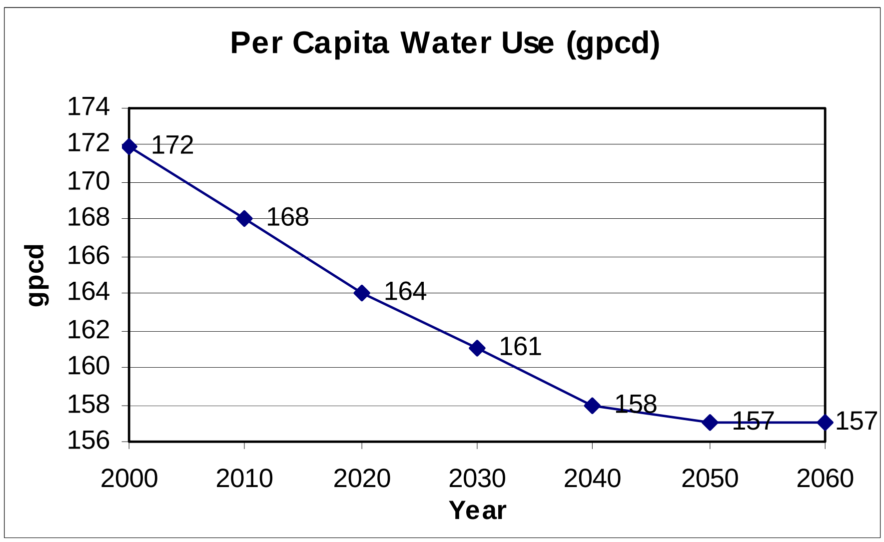
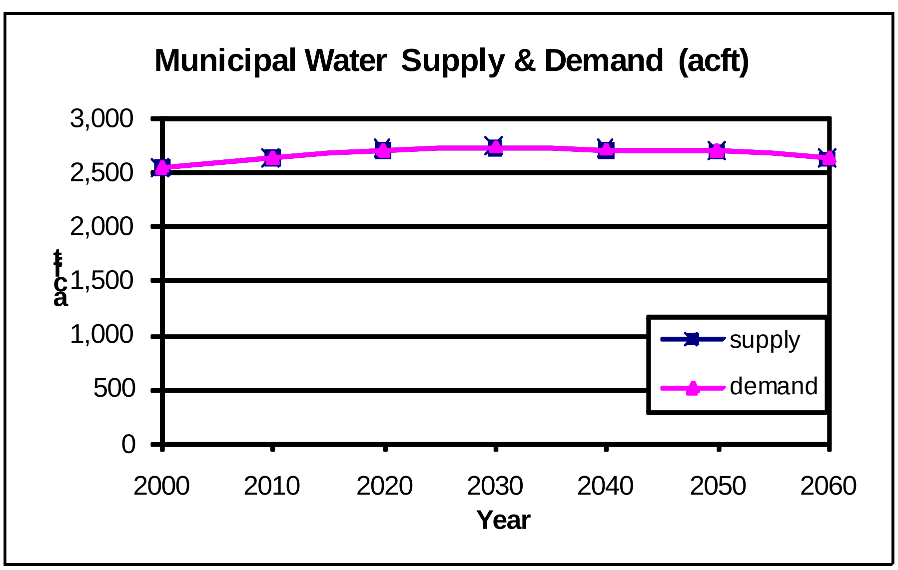
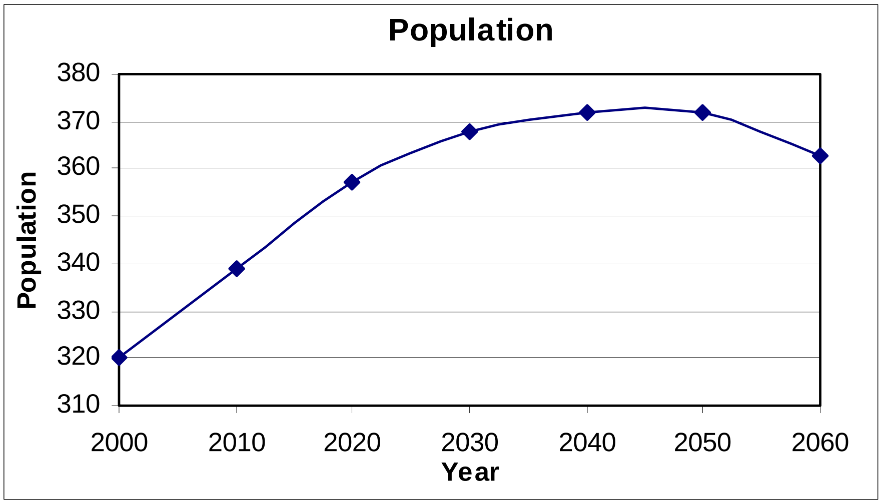
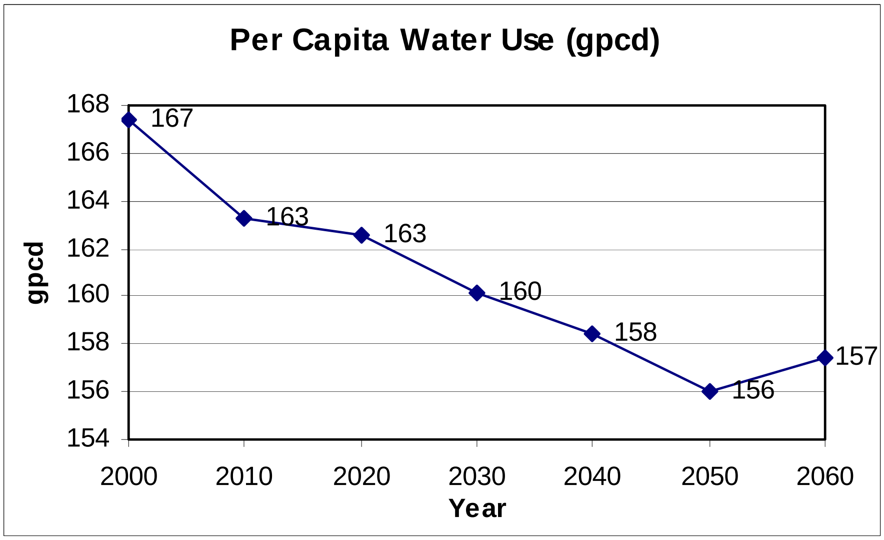


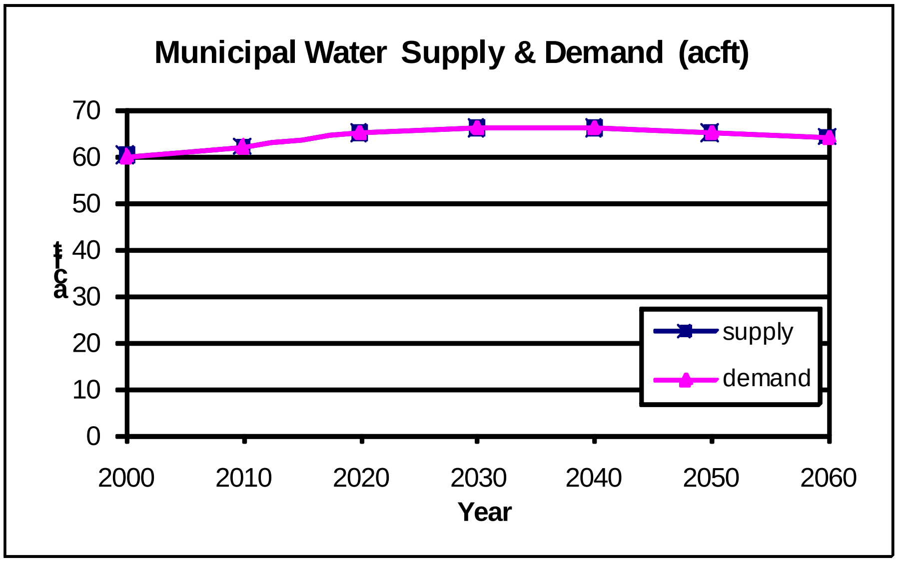




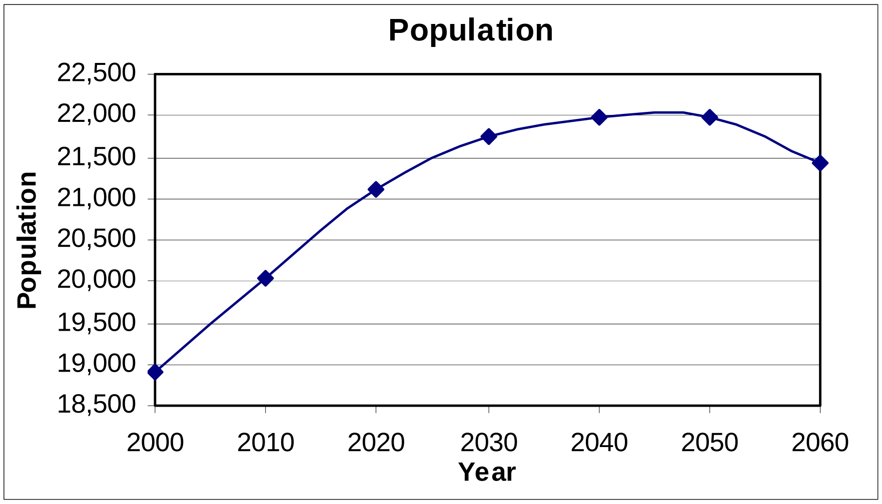
El Oso WSC — Bee County

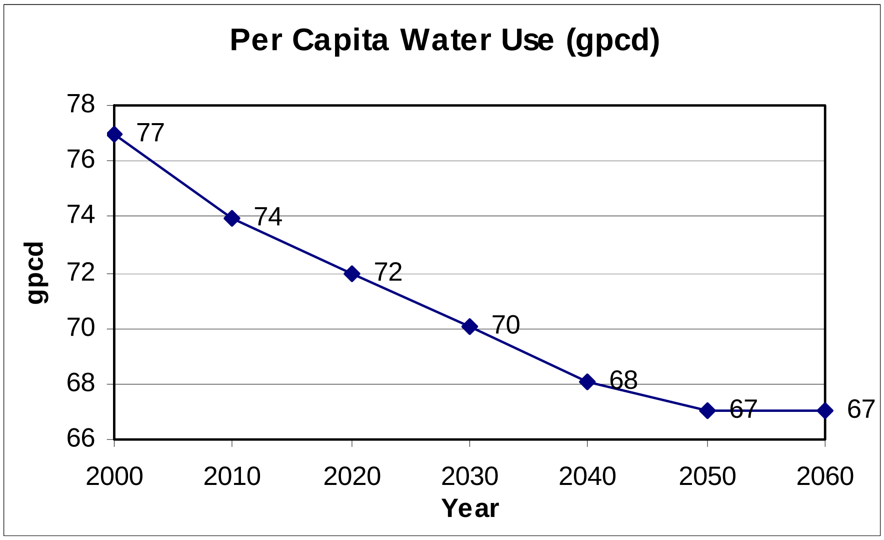


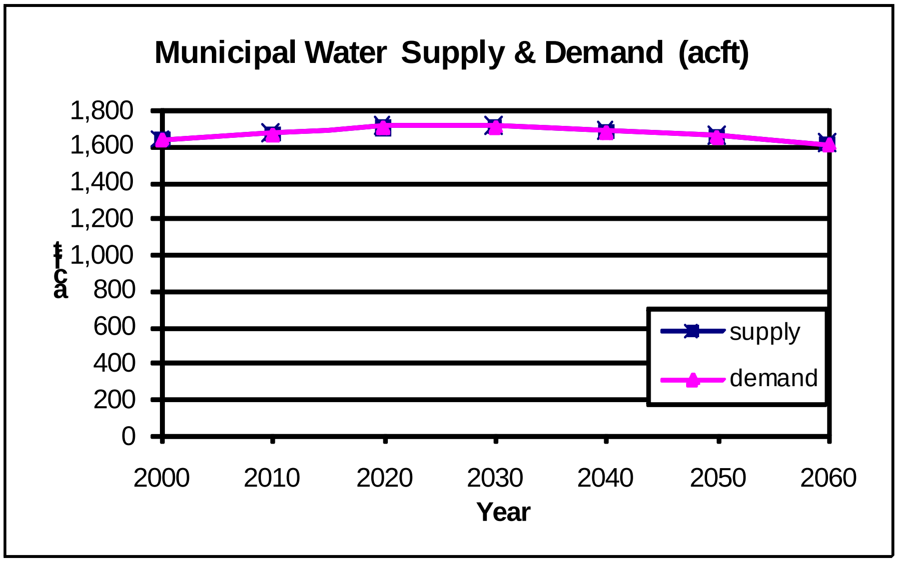




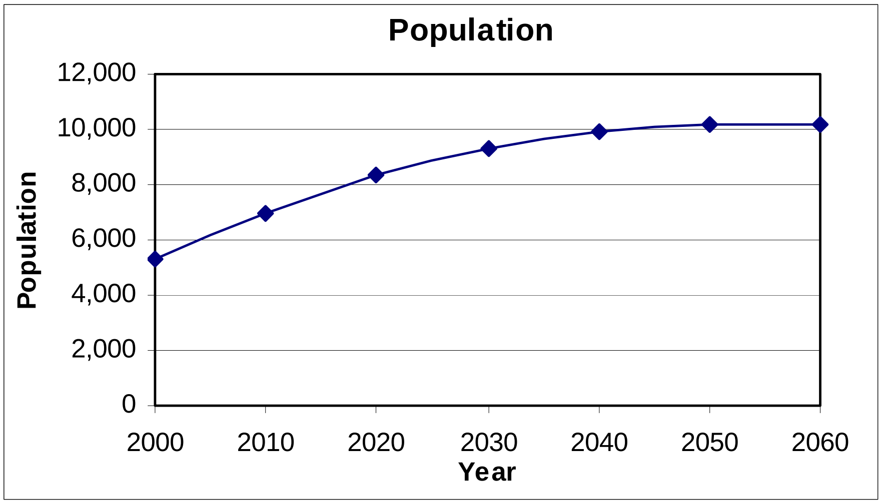
County-Other — Bee County

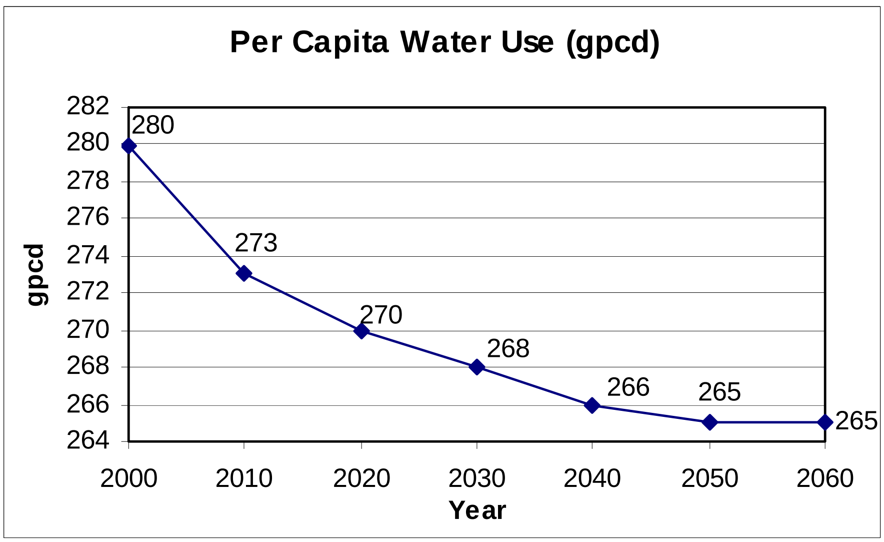


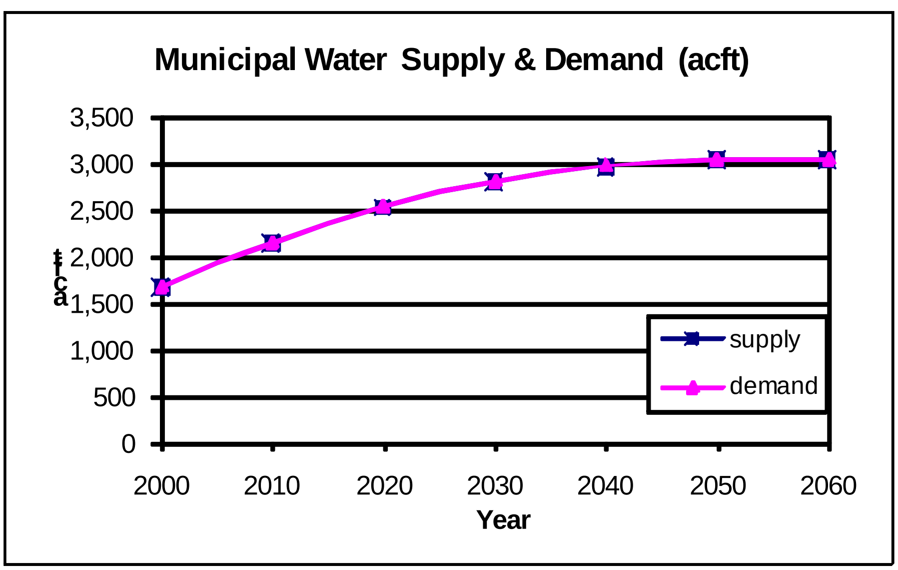




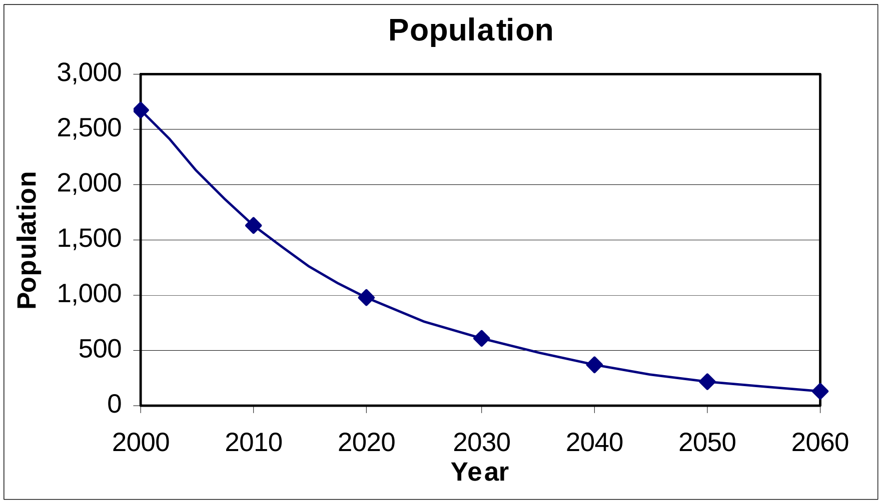
City of Falfurrias — Brooks County

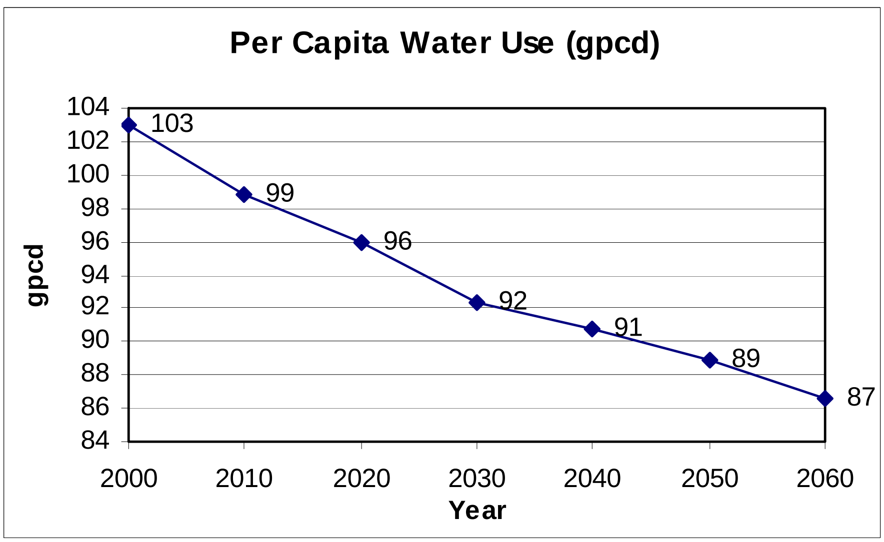


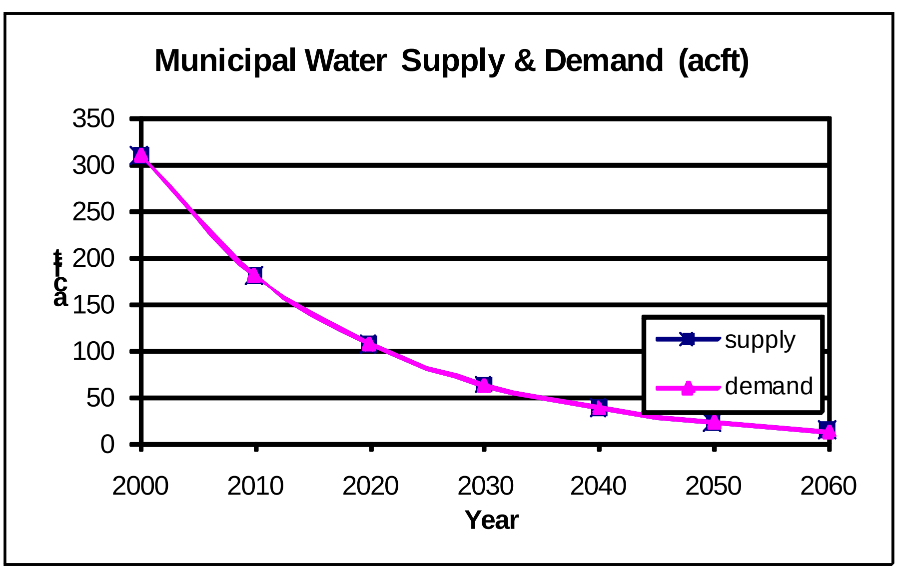




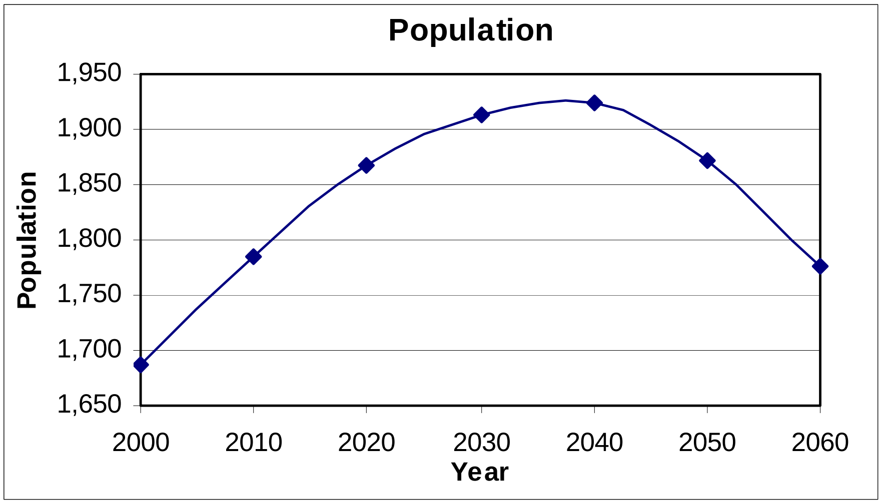
County-Other — Brooks County

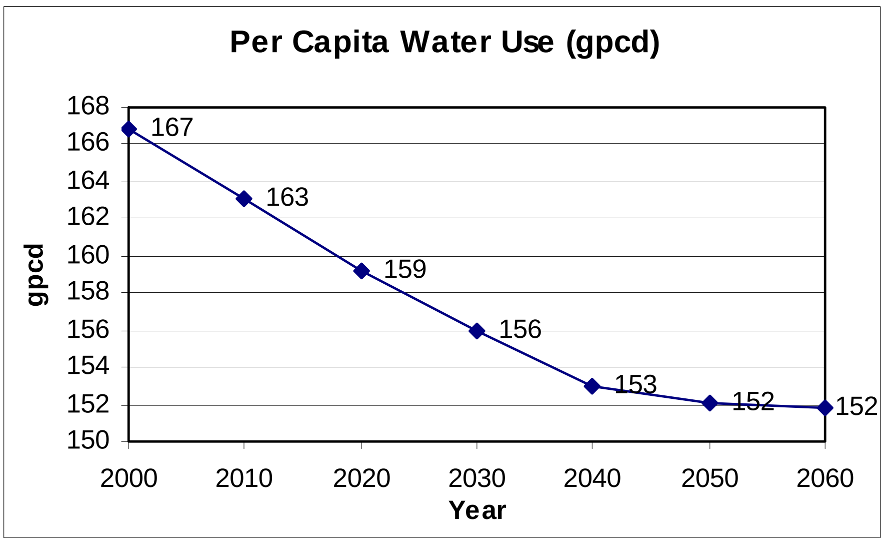


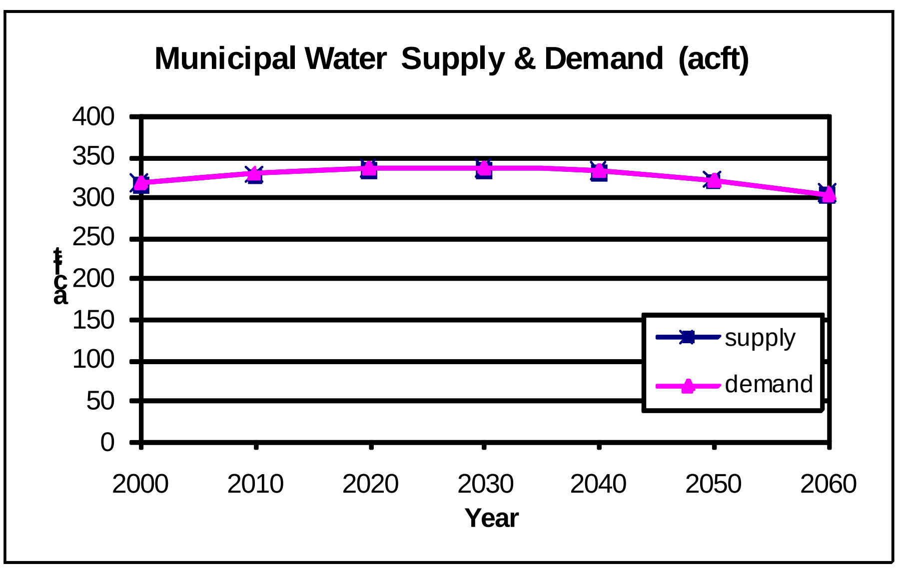




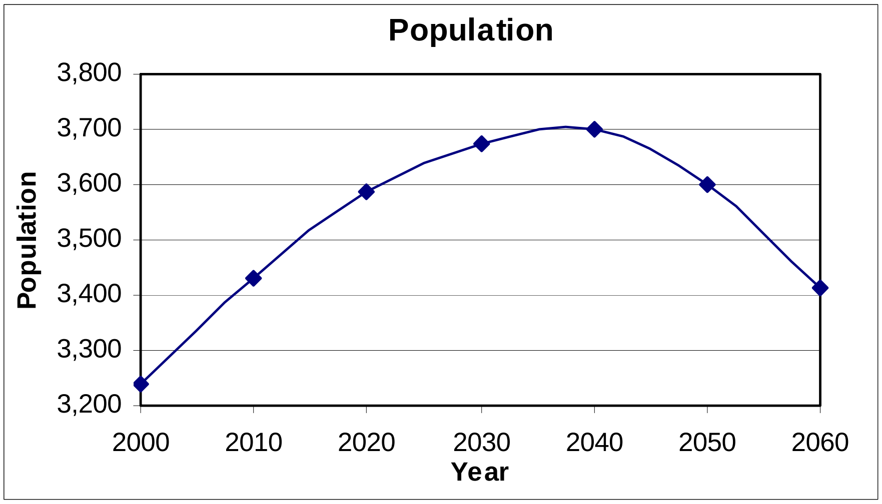
City of Benavides — Duval County

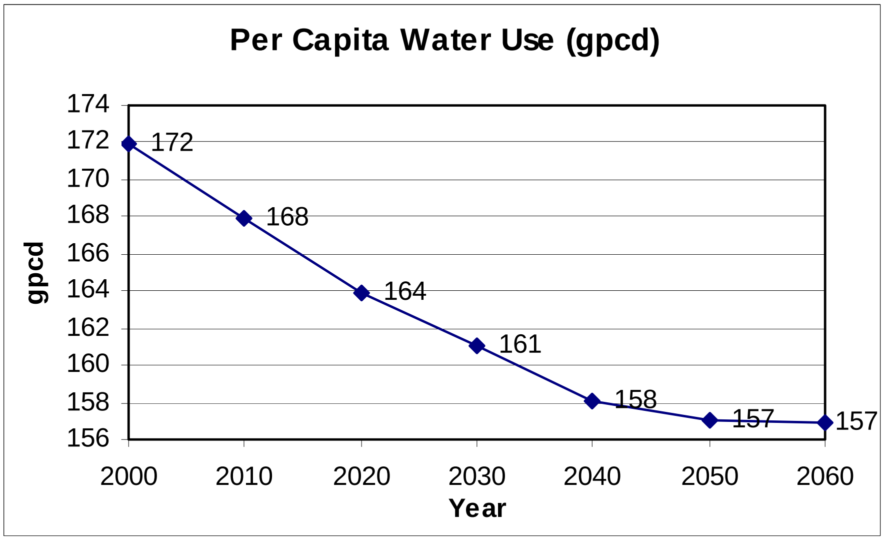


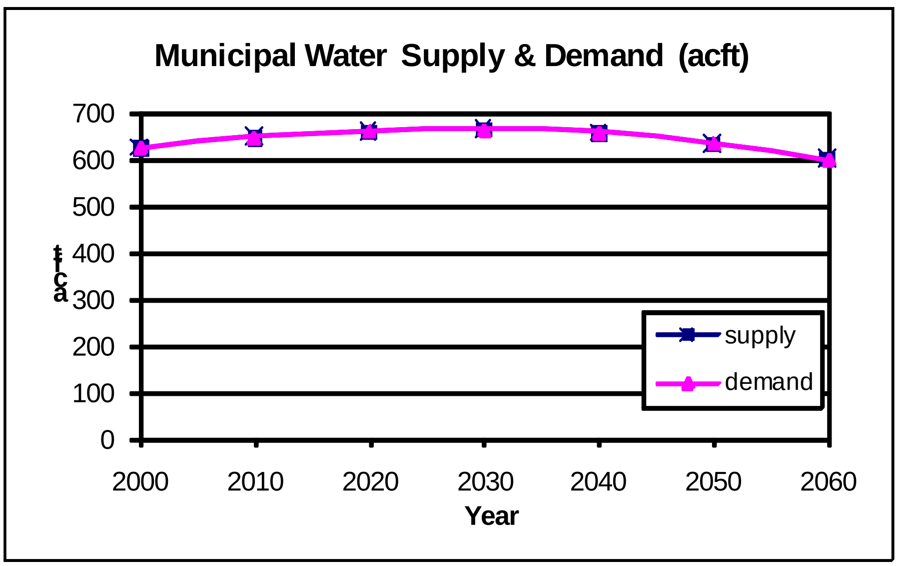




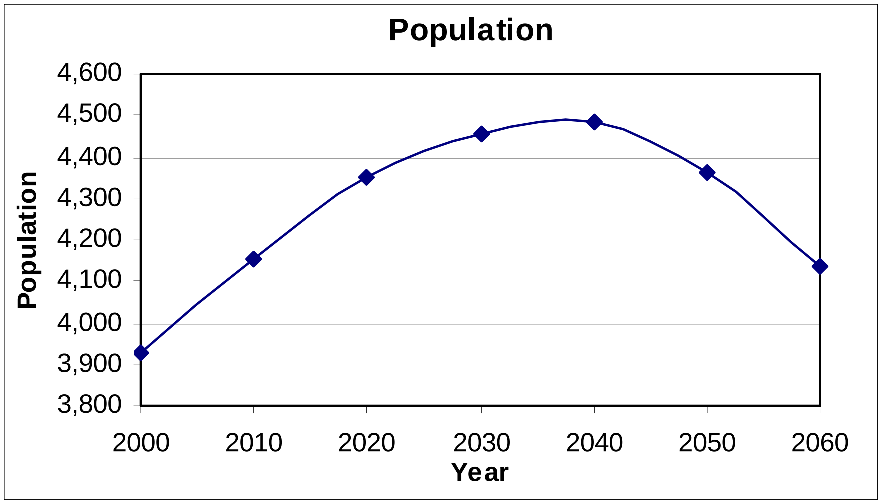
City of Freer — Duval County

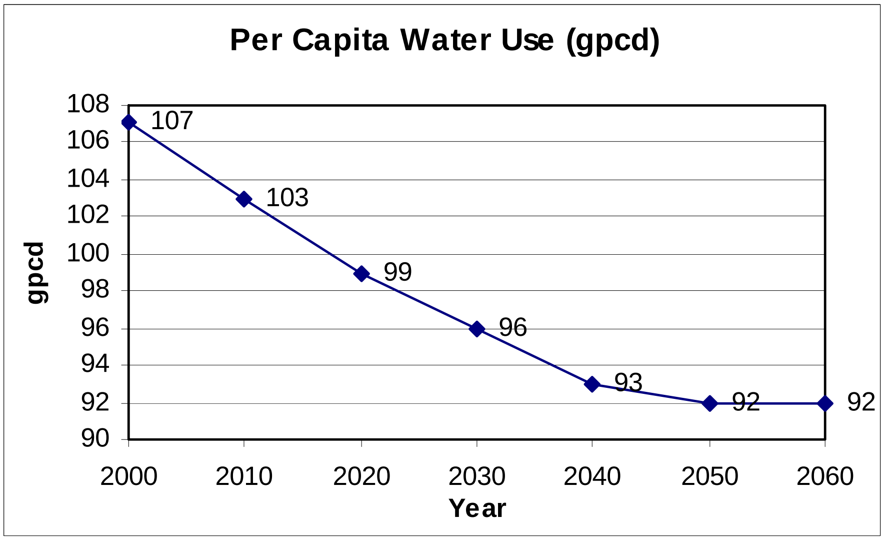


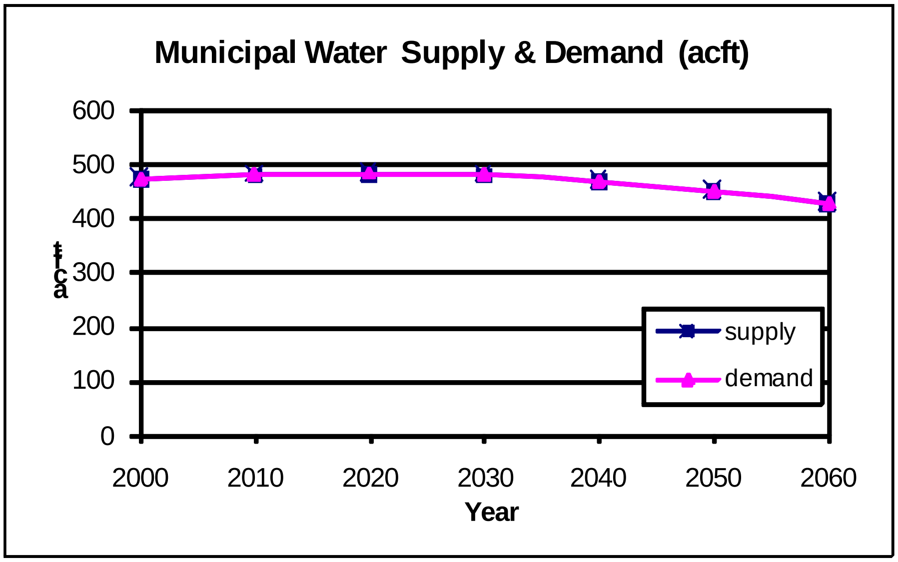




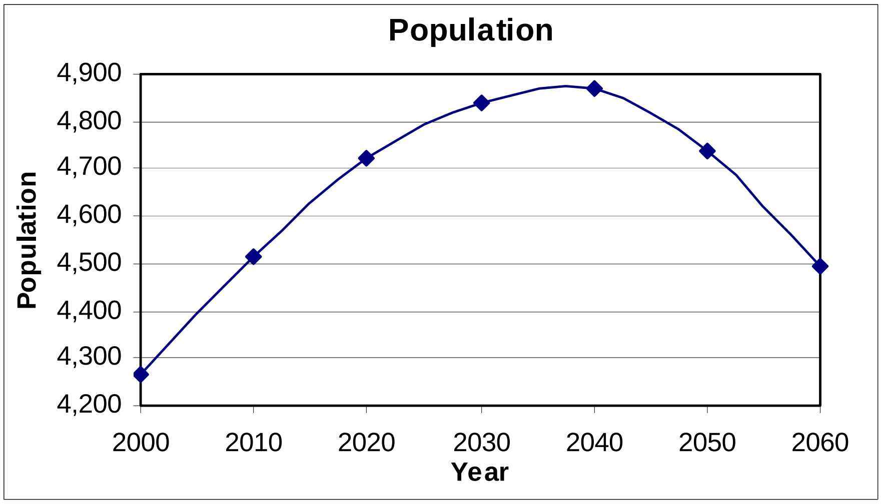
City of San Diego — Duval County

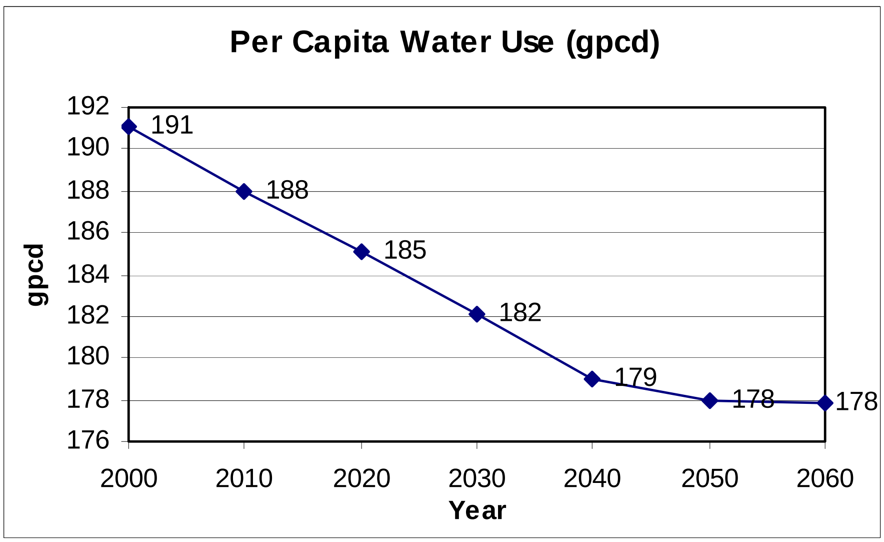


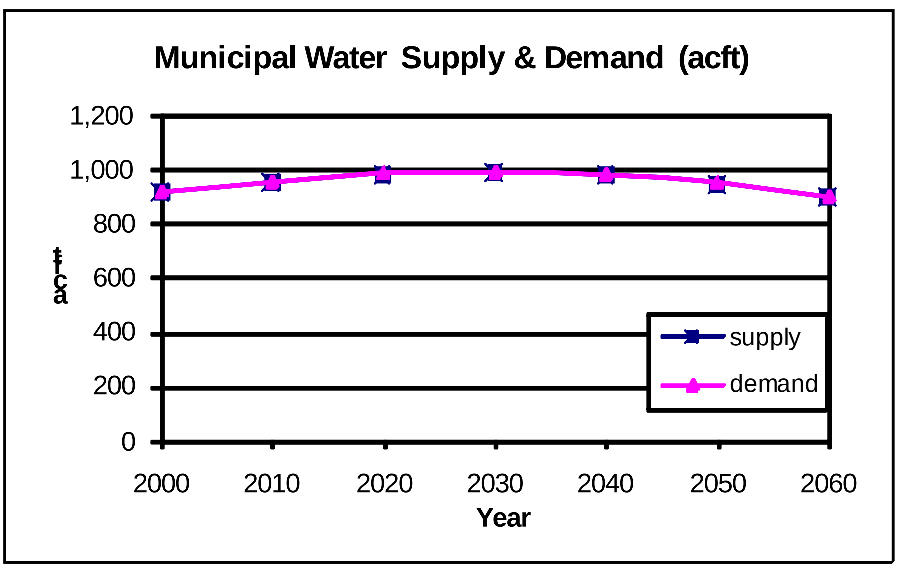




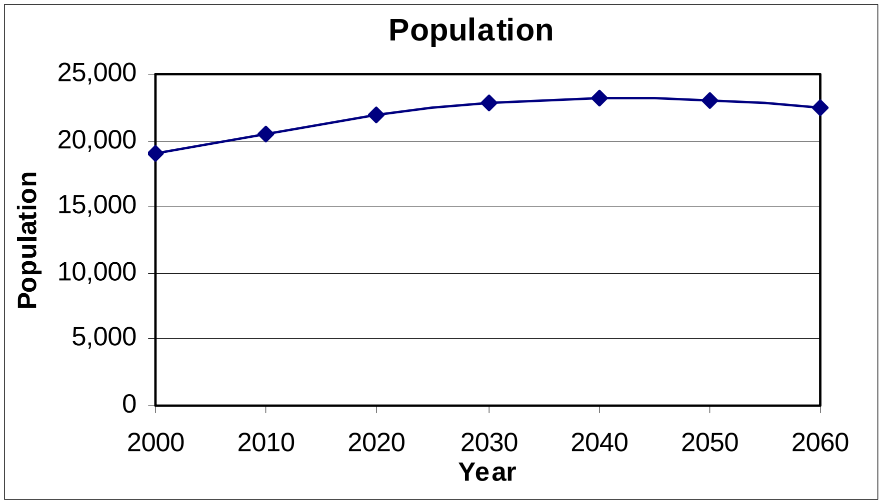
County-Other — Duval County

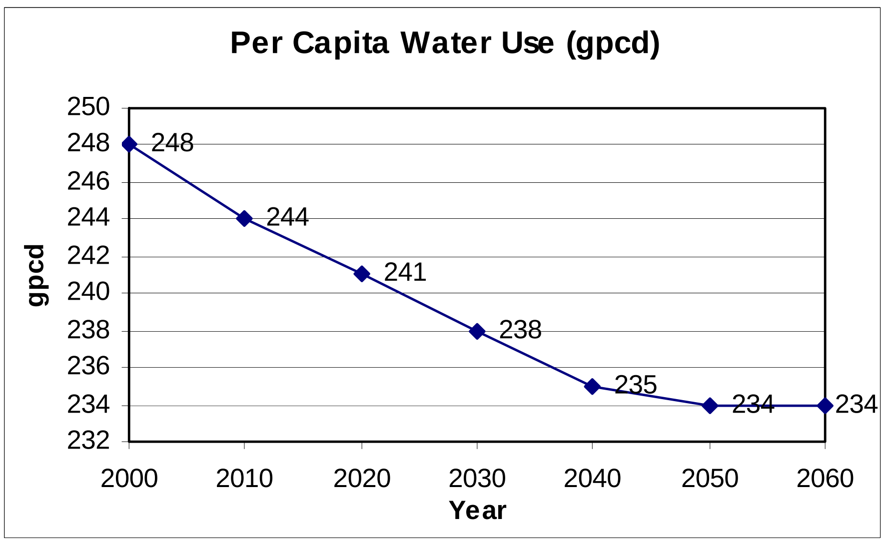


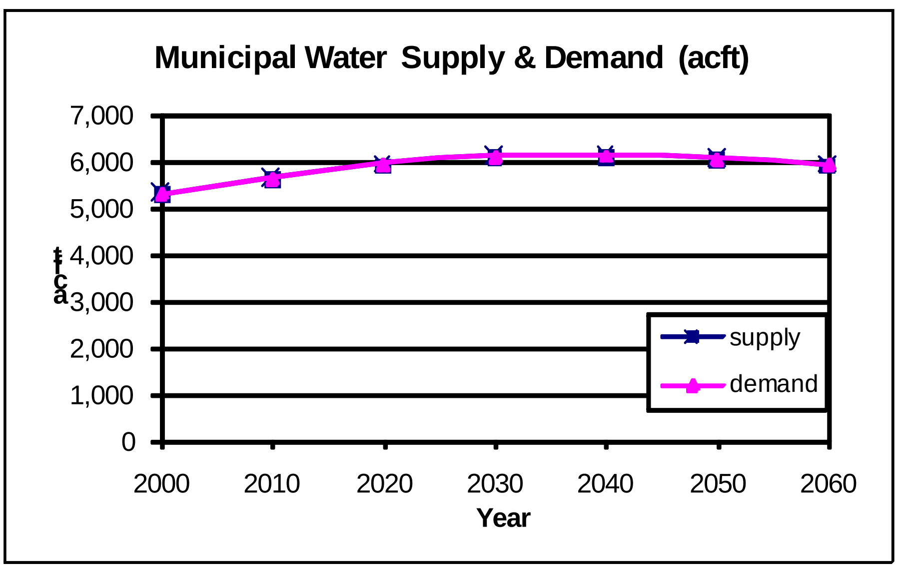




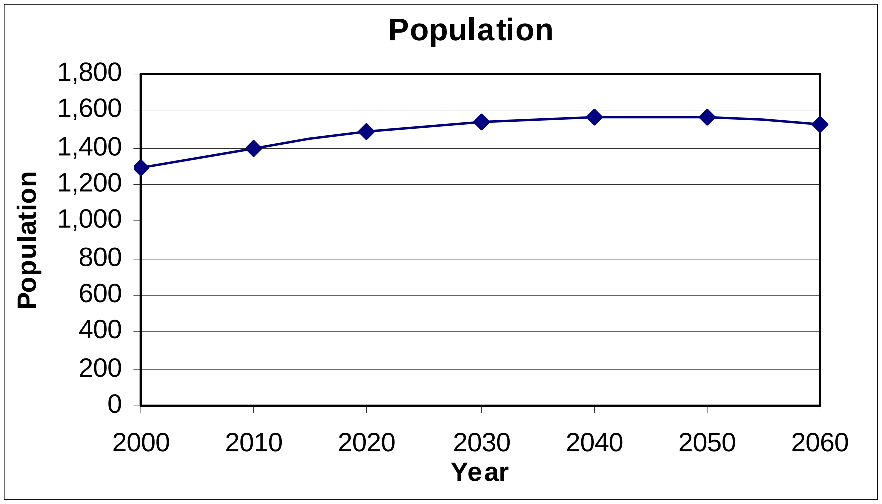
City of Alice — Jim Wells County

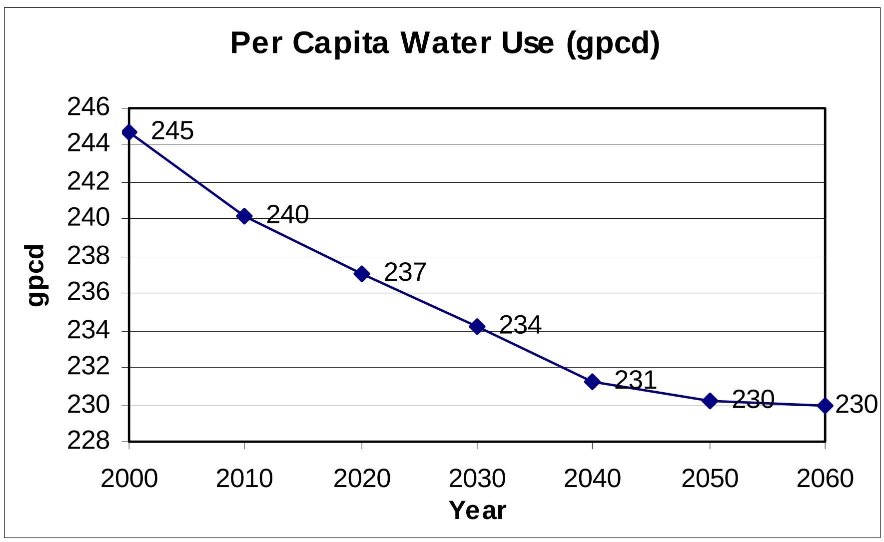


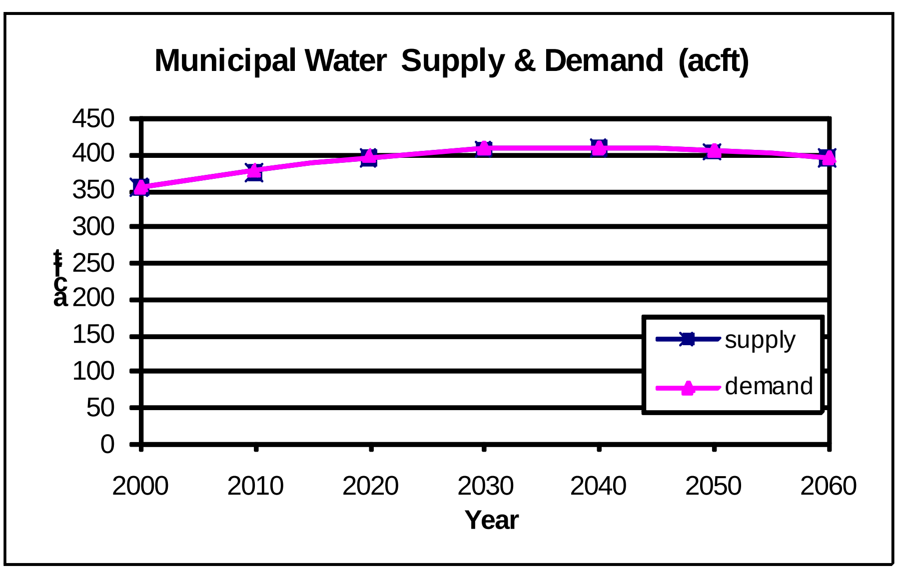




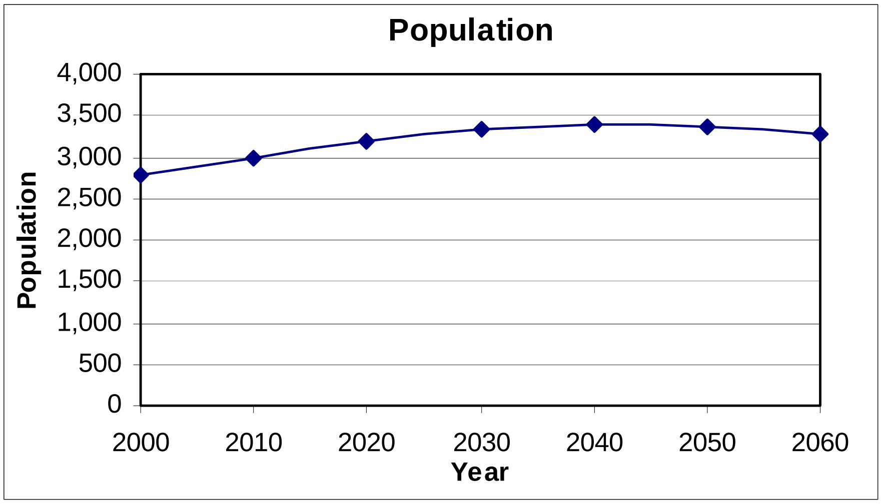
City of Orange Grove — Jim Wells County

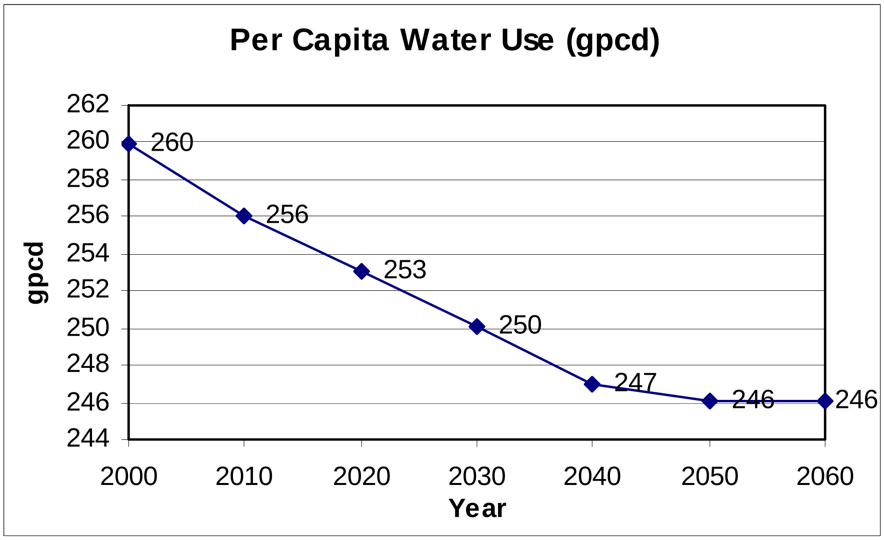


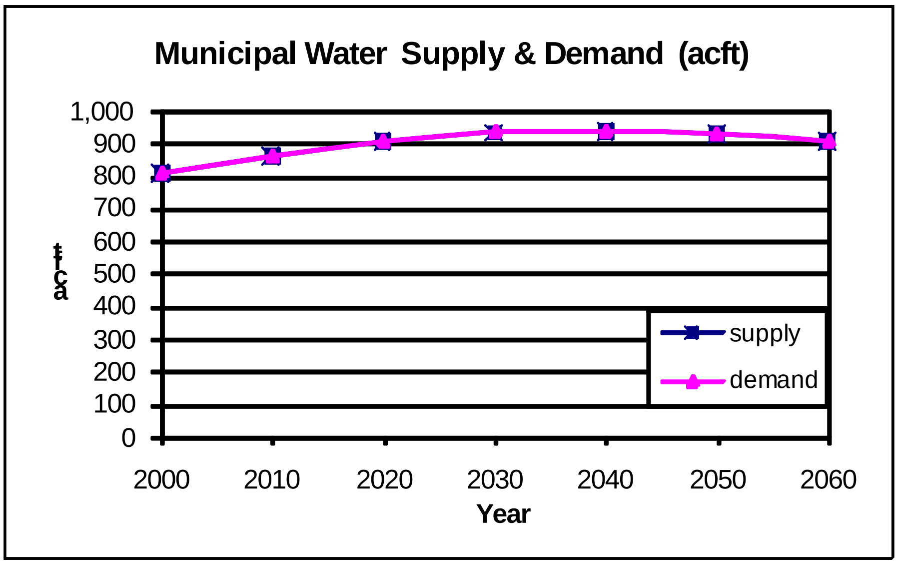




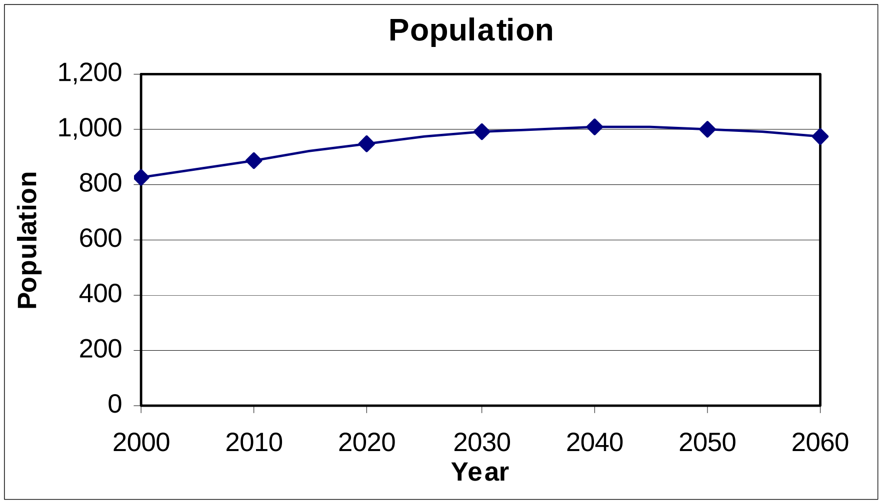
City of Premont — Jim Wells County

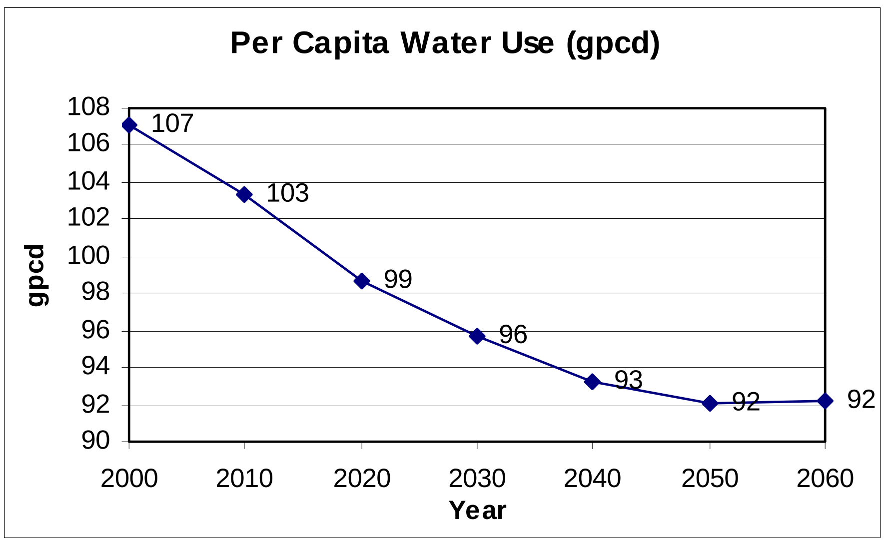


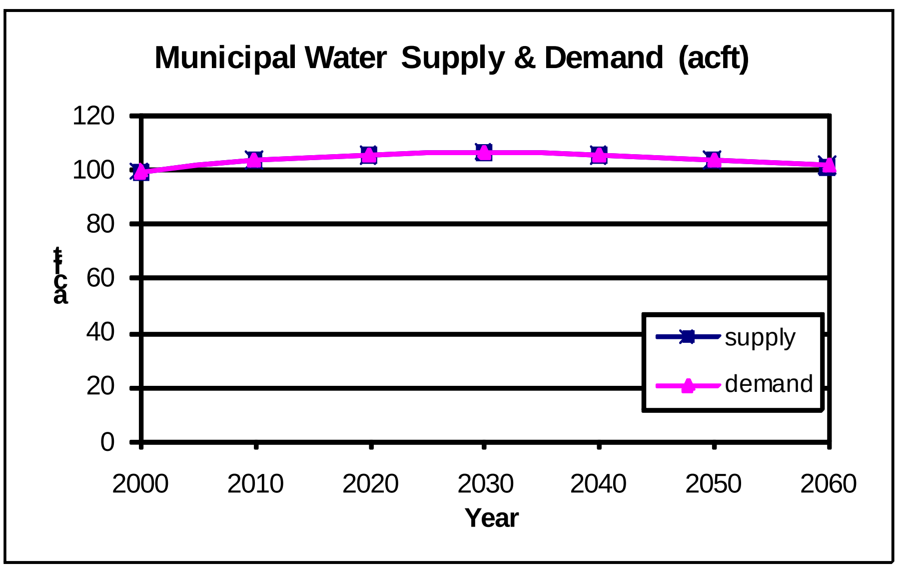




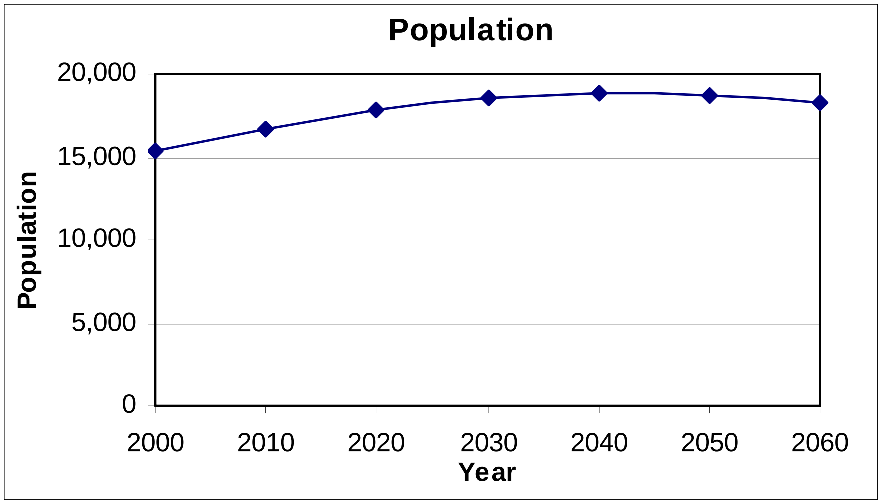
City of San Diego — Jim Wells County

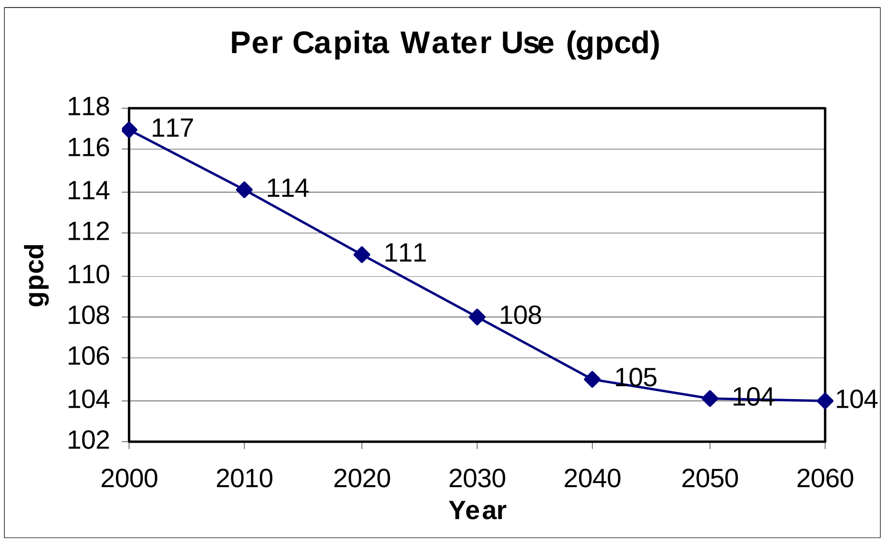


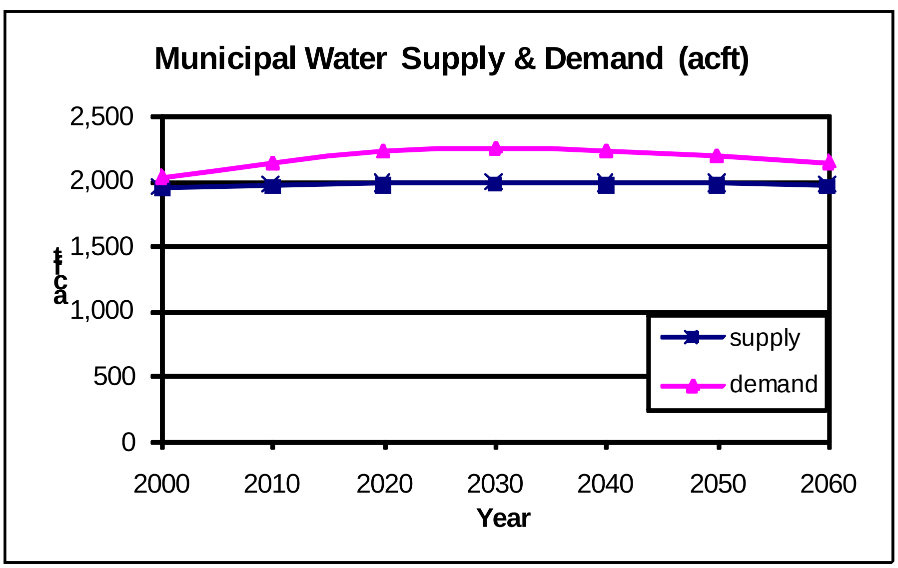




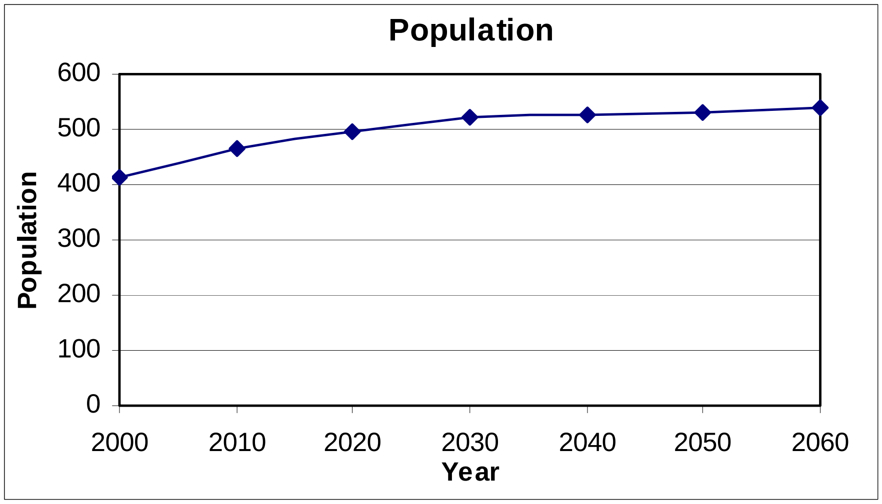
County-Other — Jim Wells County

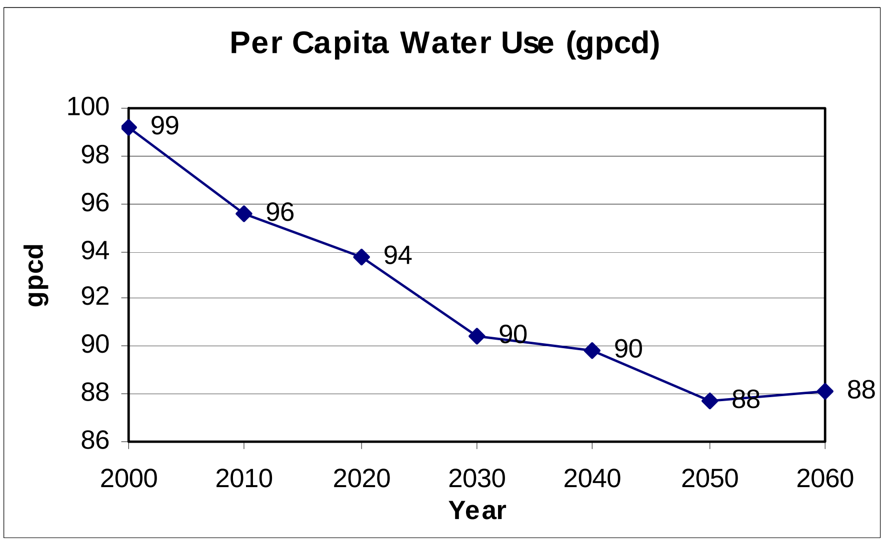


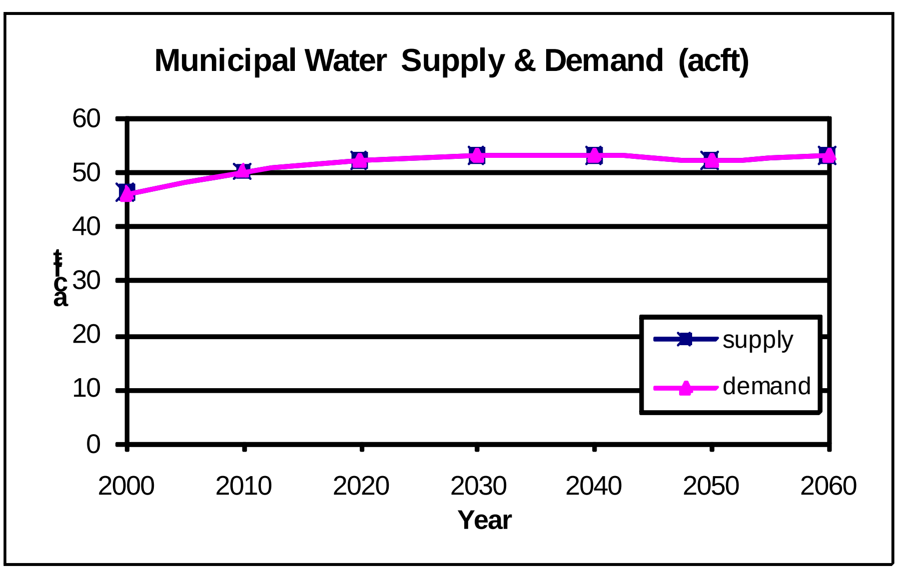




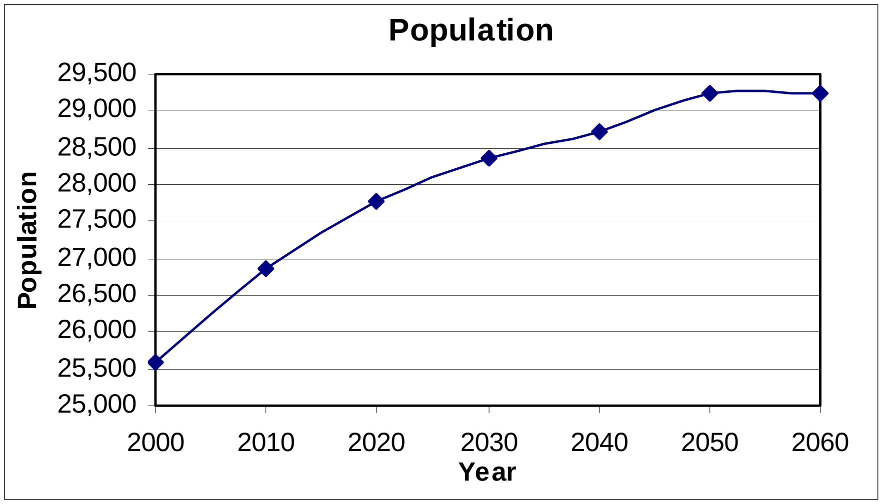
County-Other — Kenedy County

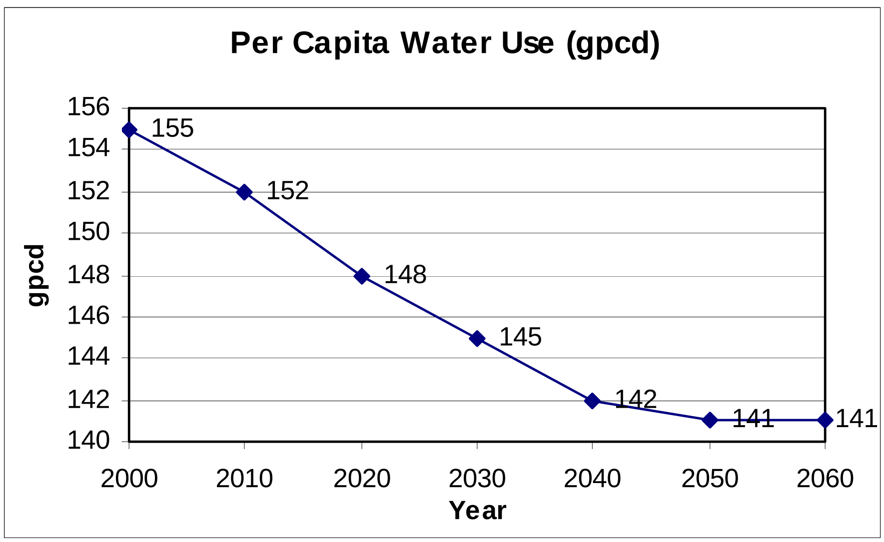


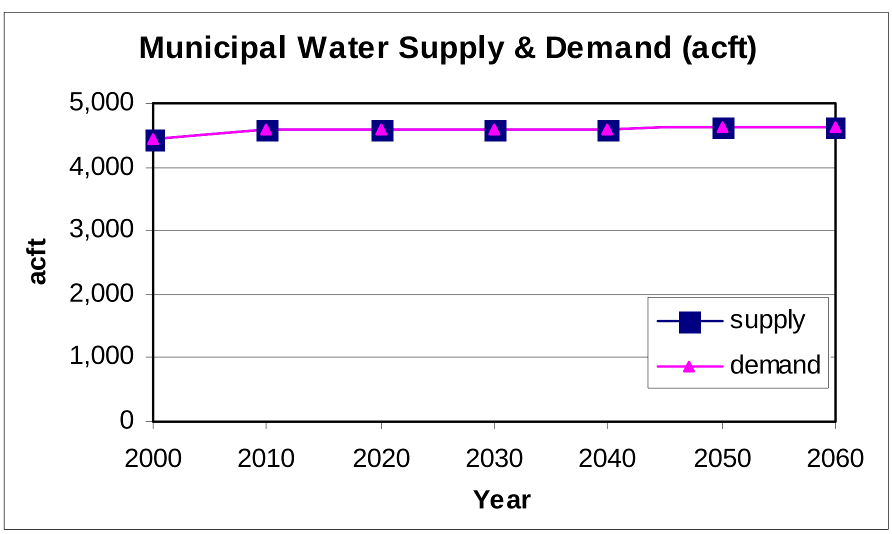




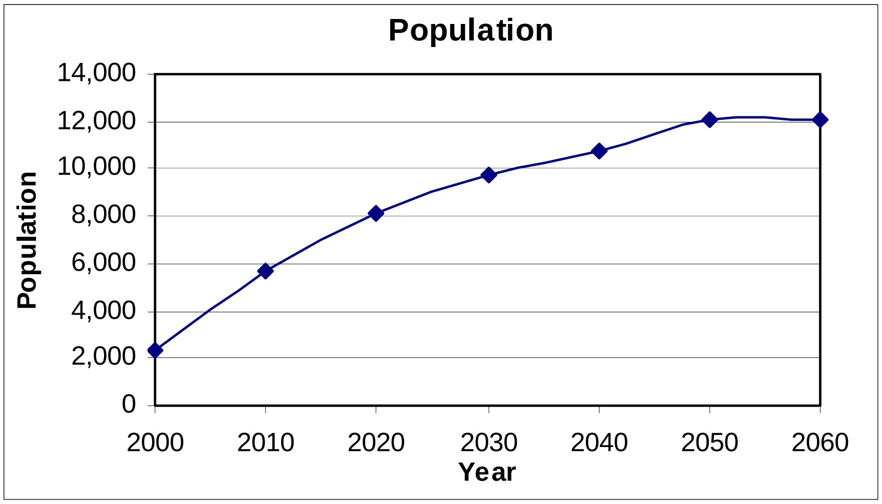
City of Kingsville — Kleberg County

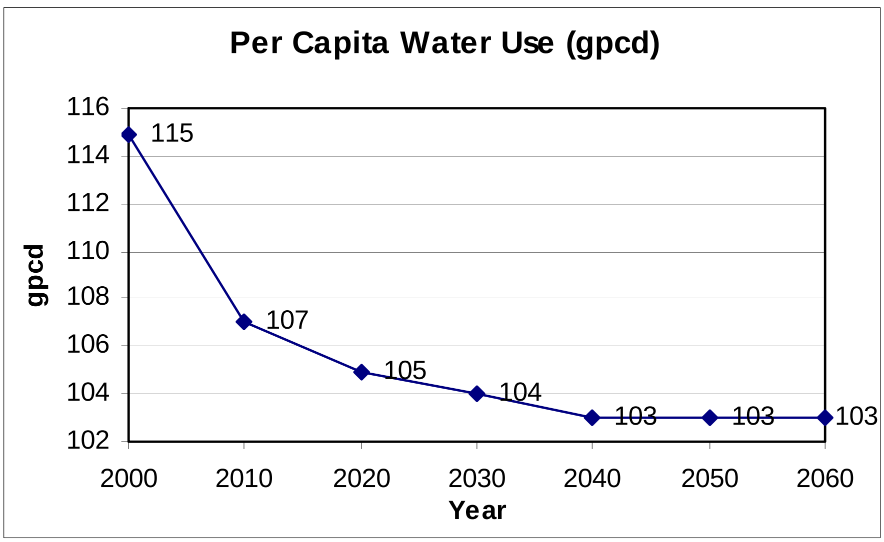


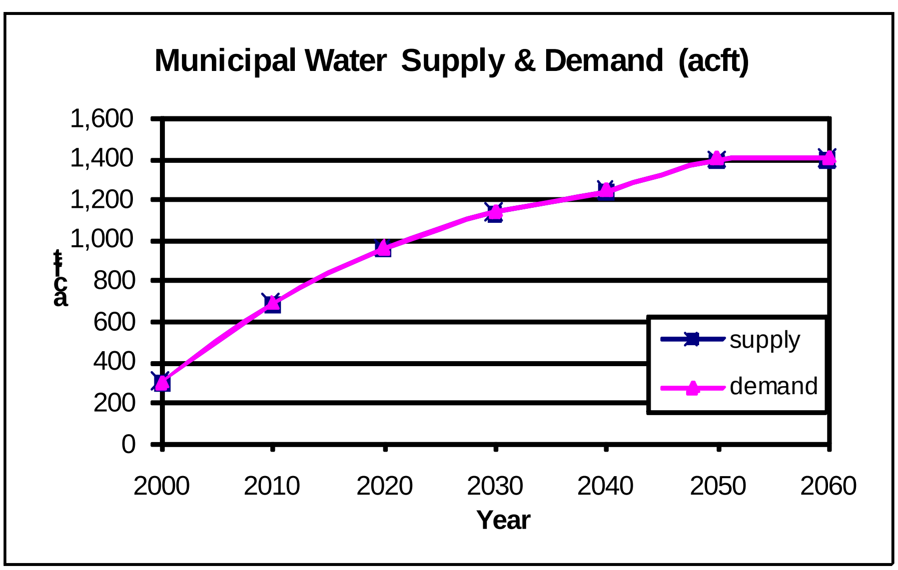




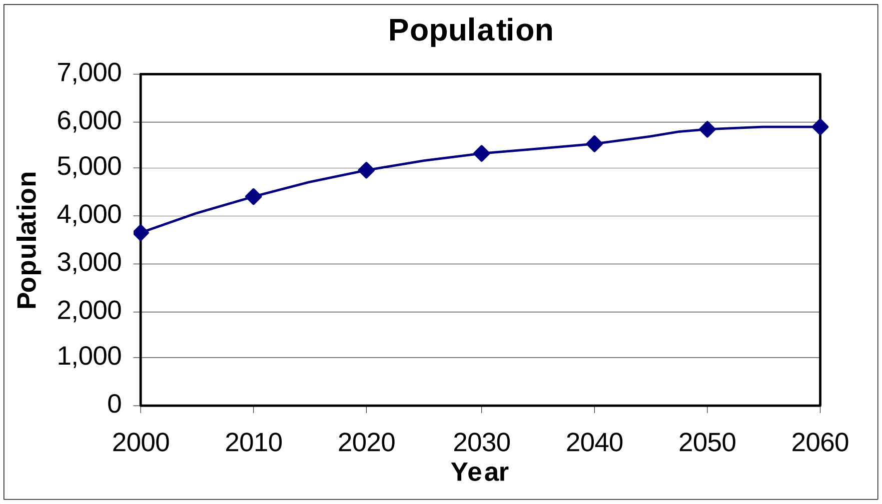
Ricardo WSC — Kleberg County

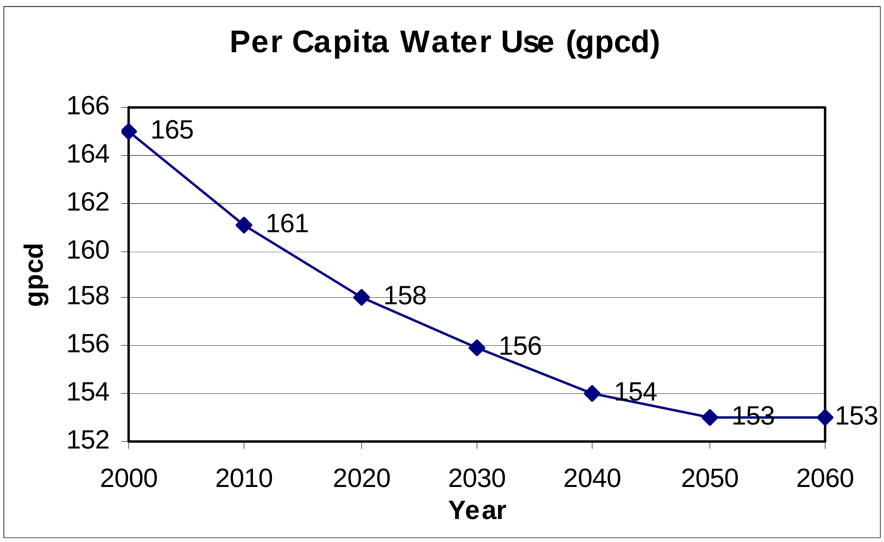


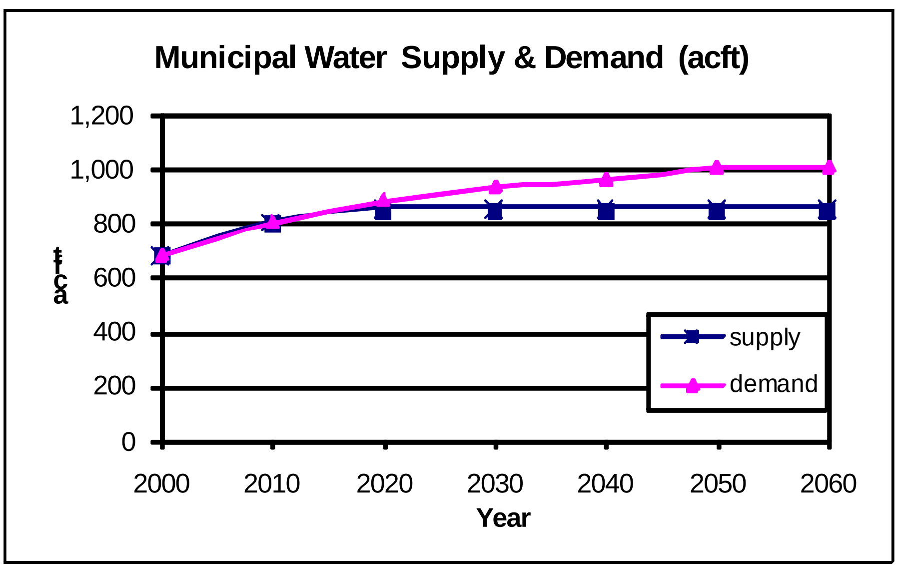




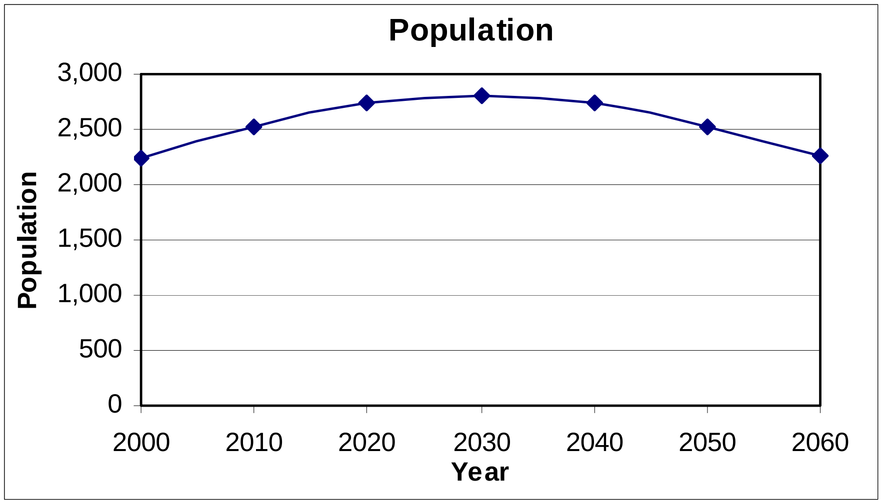
County-Other — Kleberg County

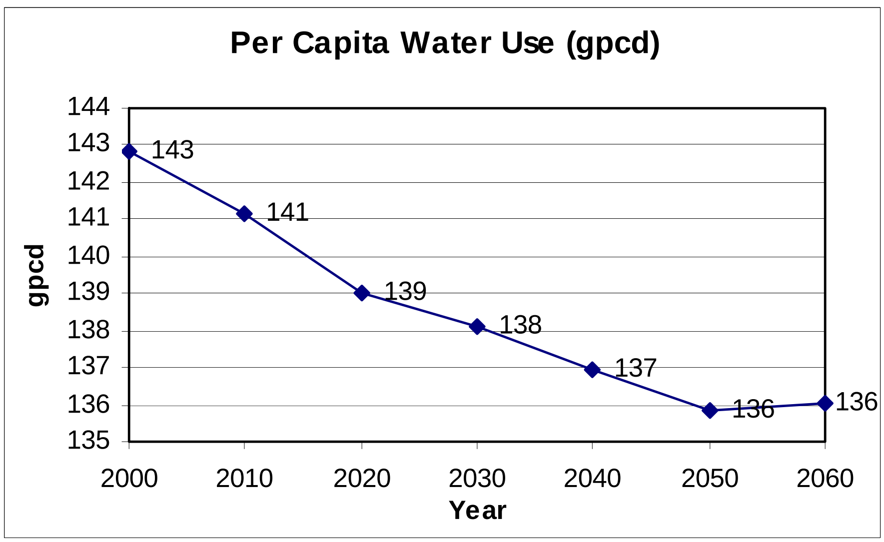


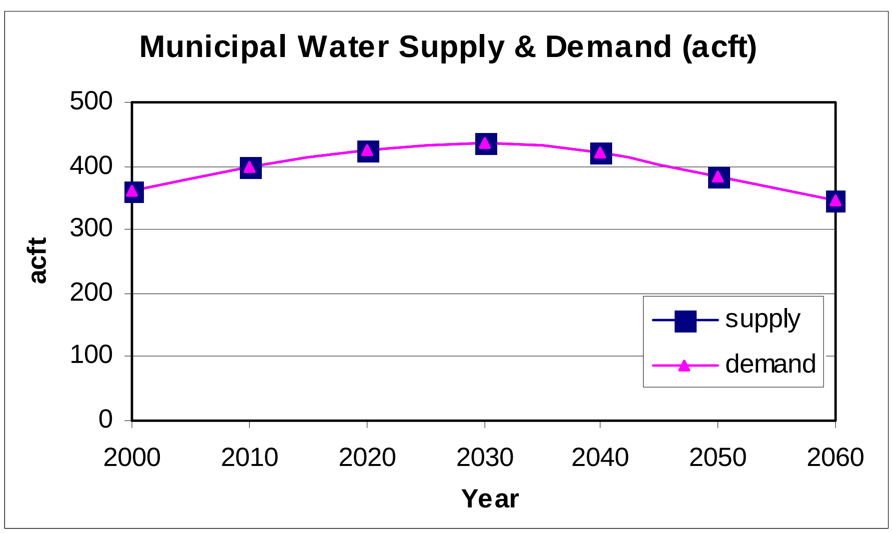




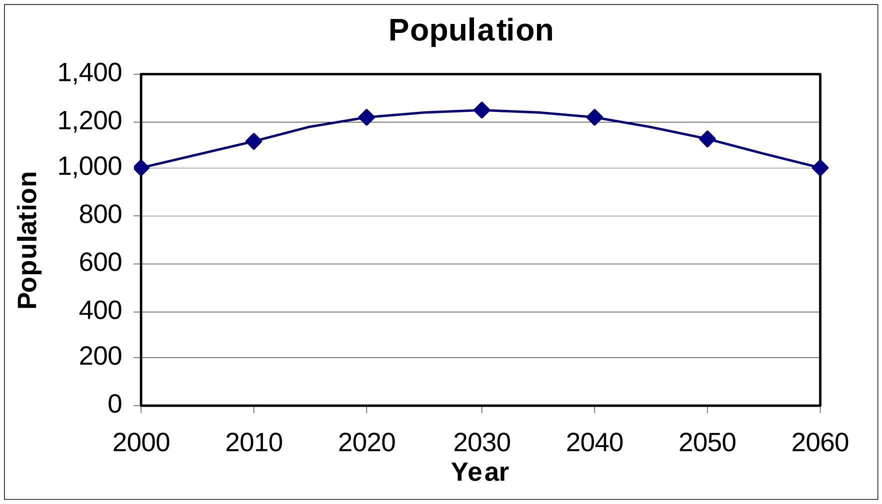
Choke Canyon WSC — Live Oak County

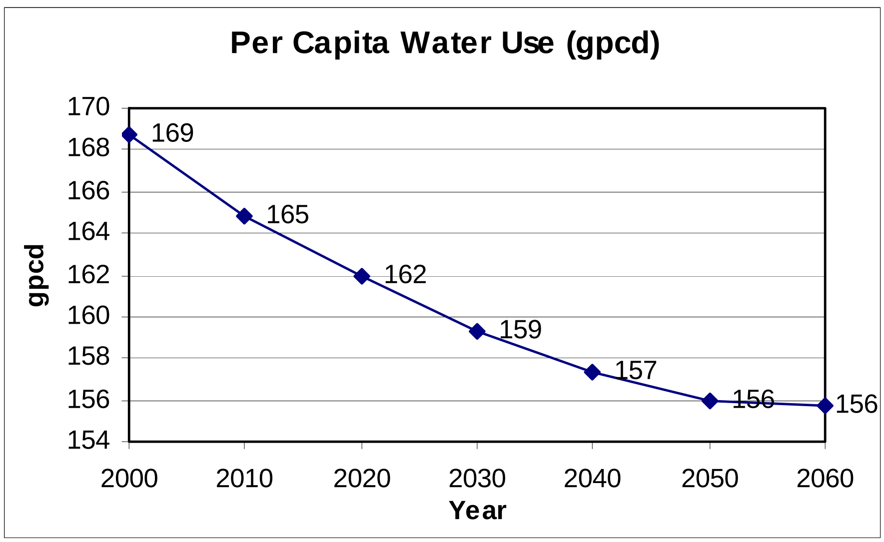


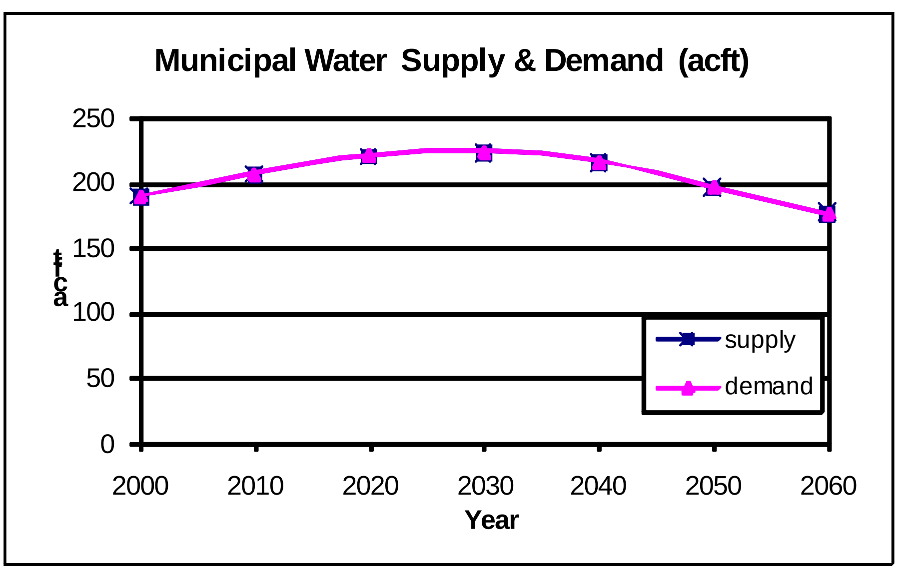




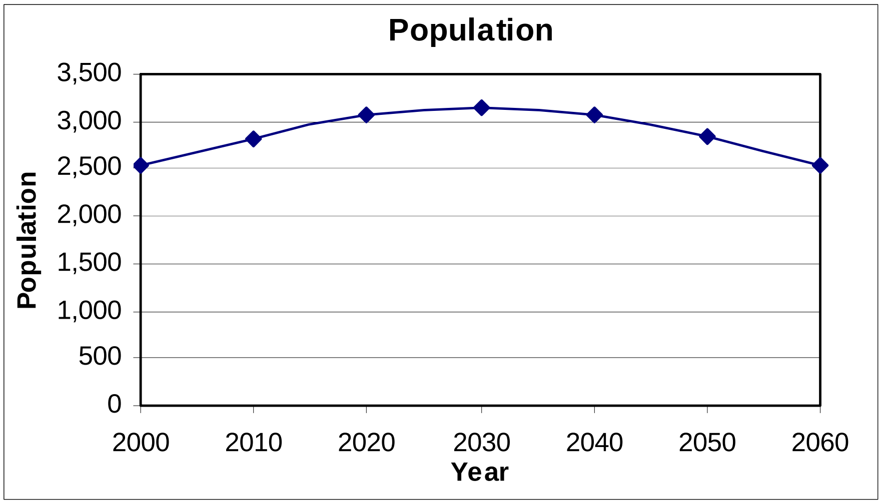
El Oso WSC — Live Oak County

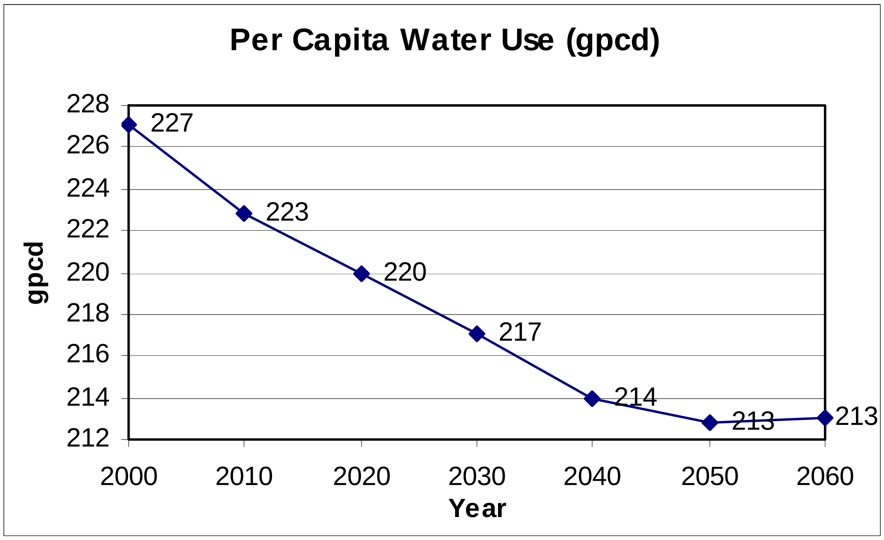


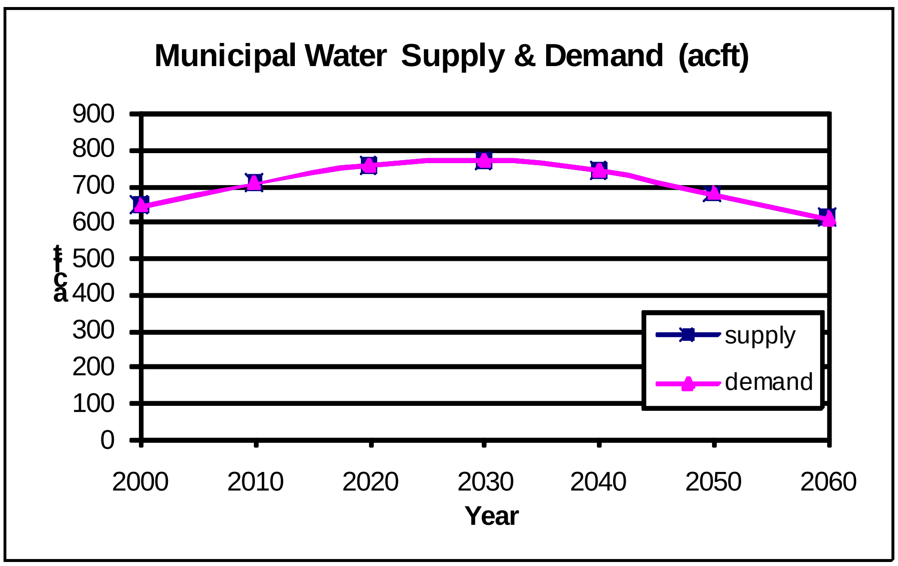




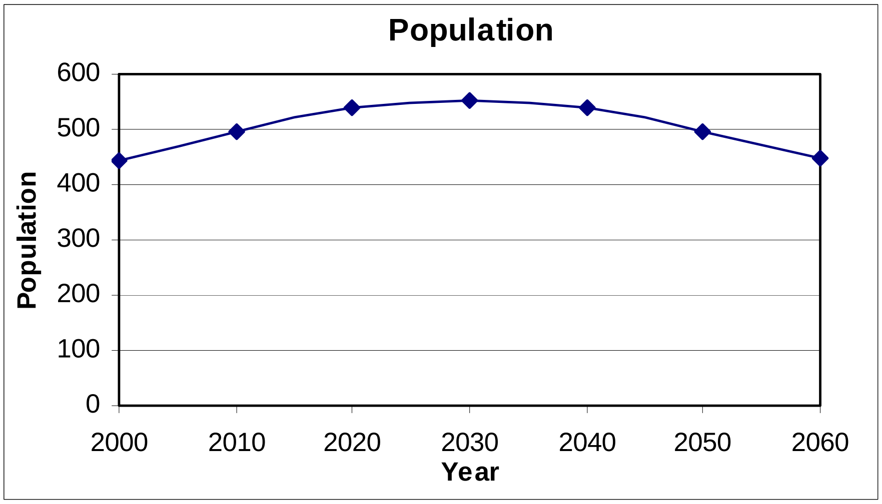
City of George West — Live Oak County

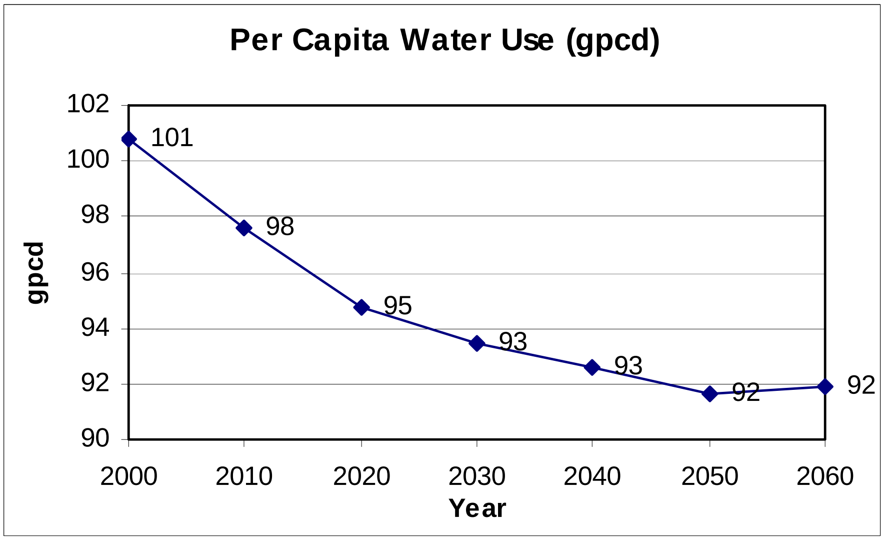


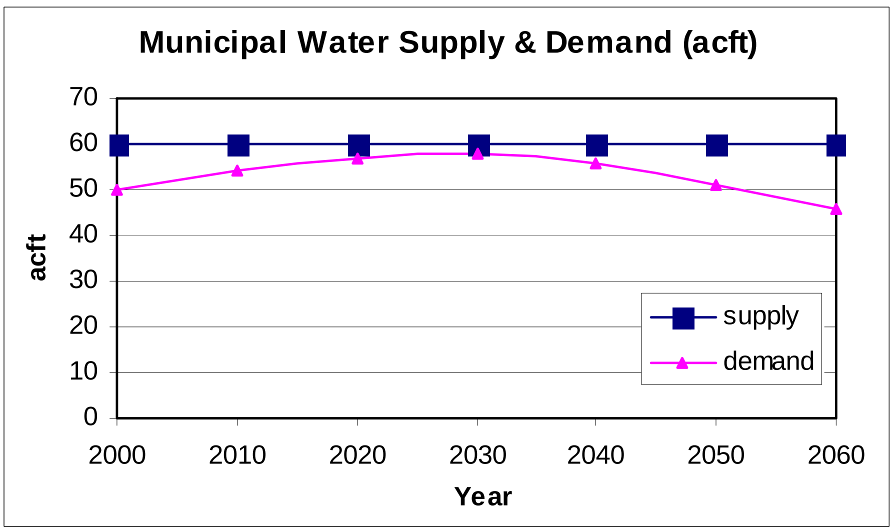




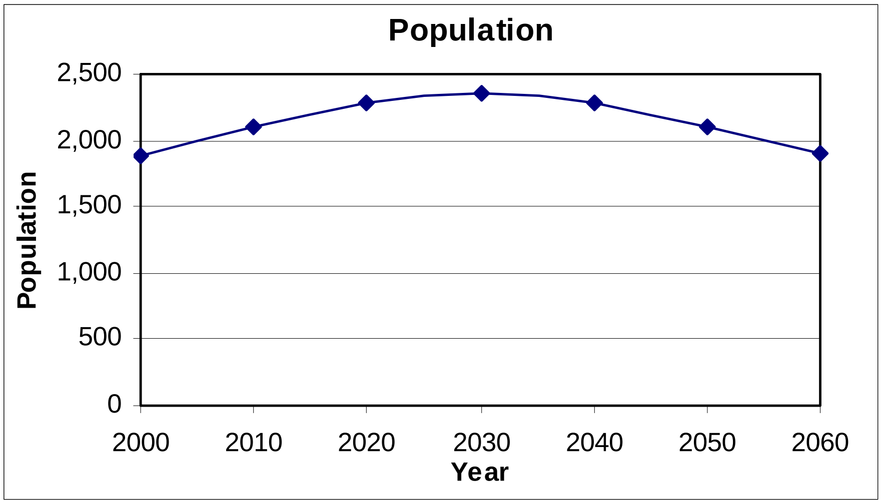
McCoy WSC — Live Oak County

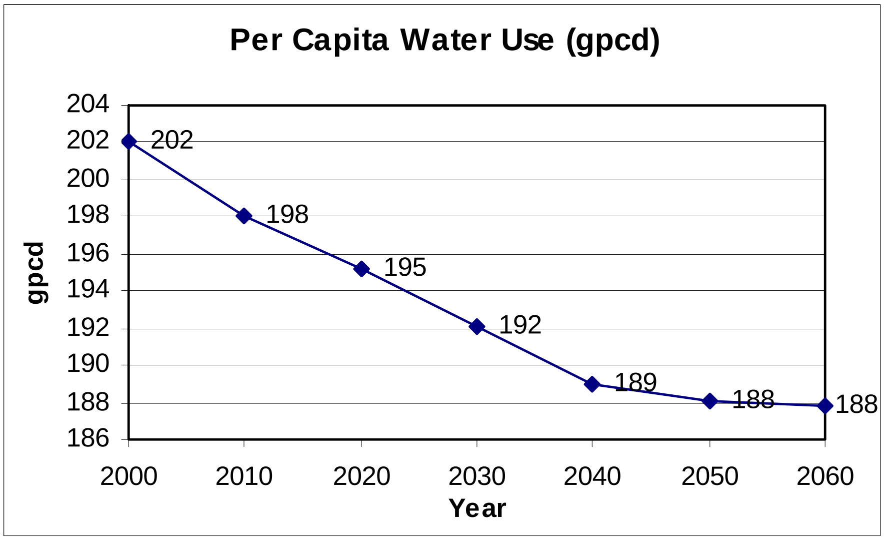


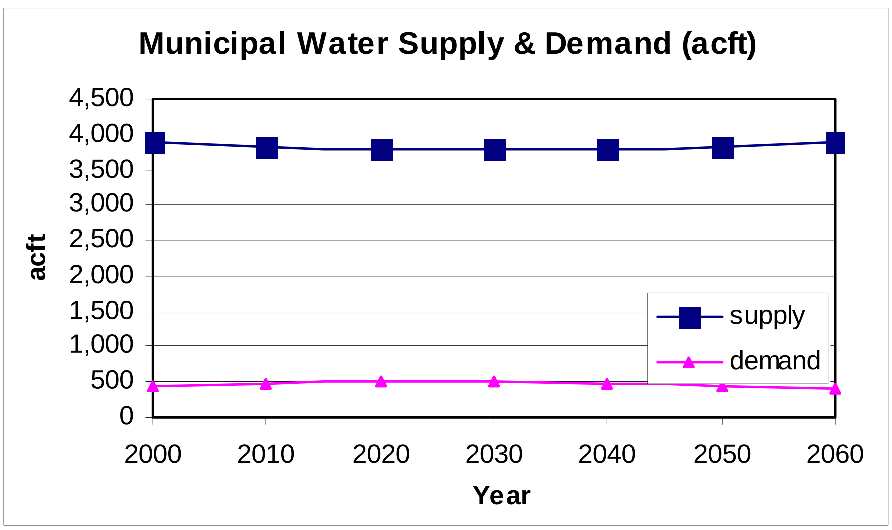




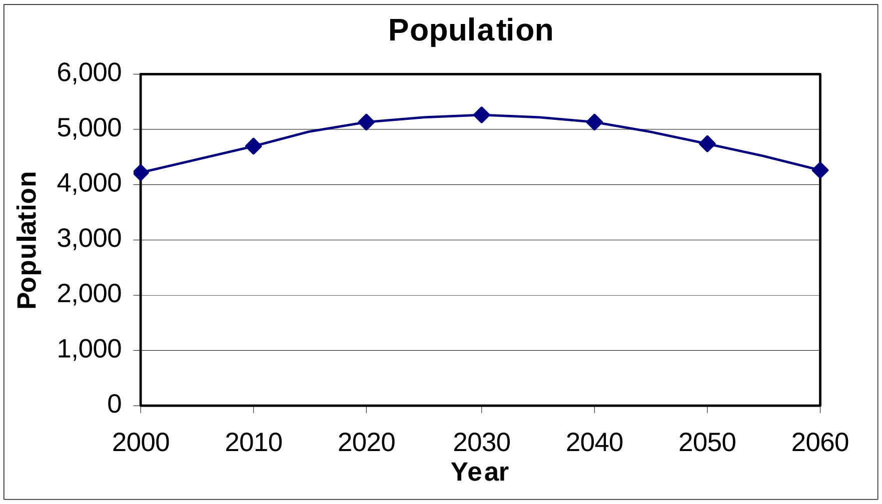
City of Three Rivers — Live Oak County

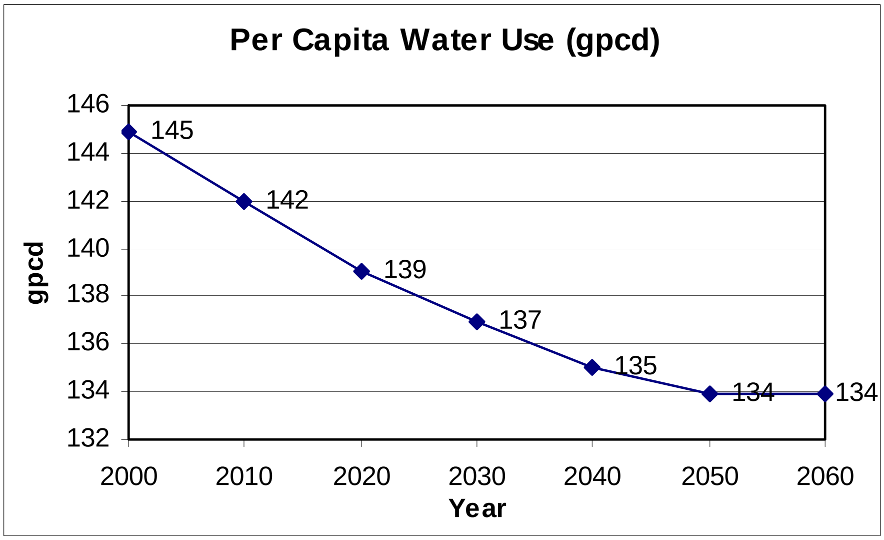


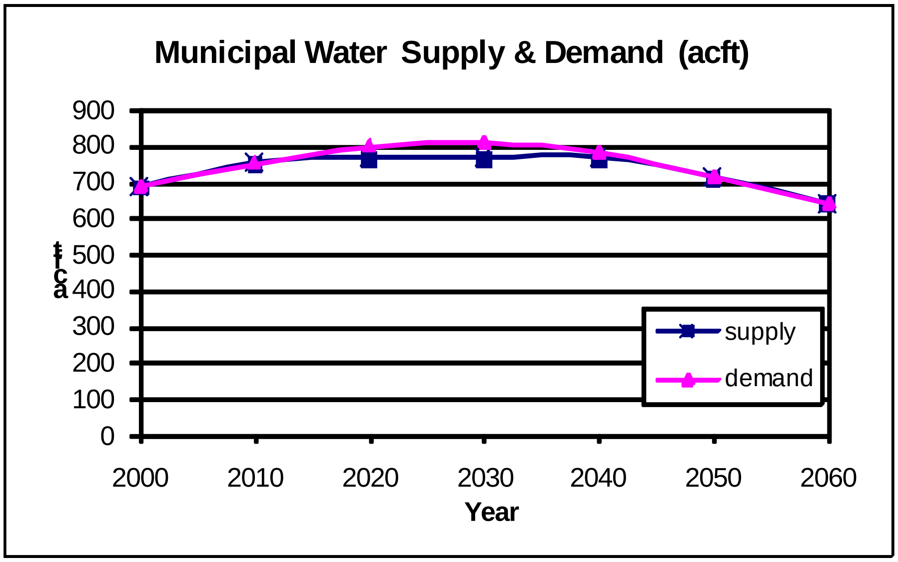




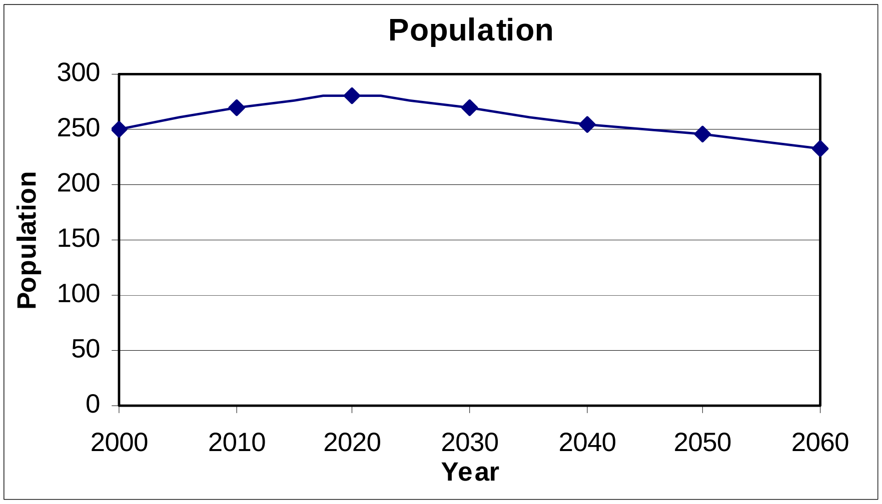
County-Other — Live Oak County

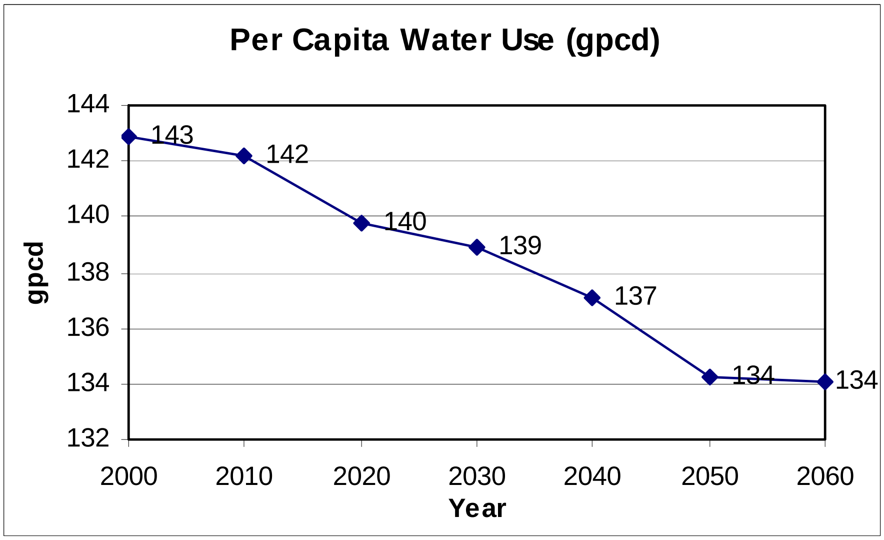


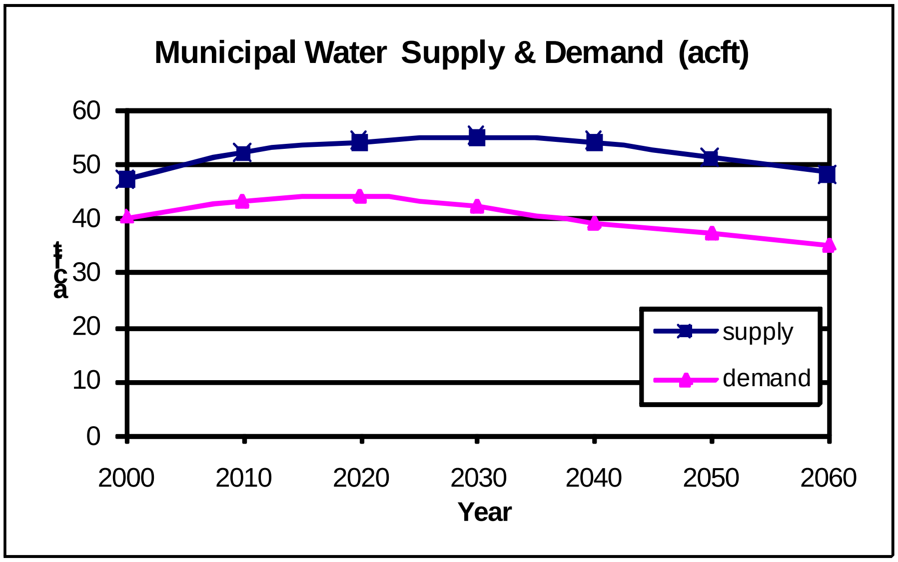




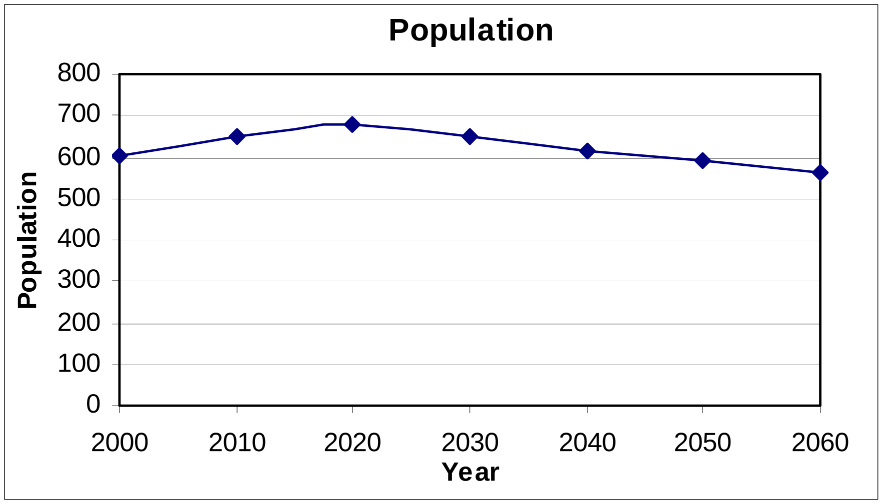
Choke Canyon WSC — McMullen County

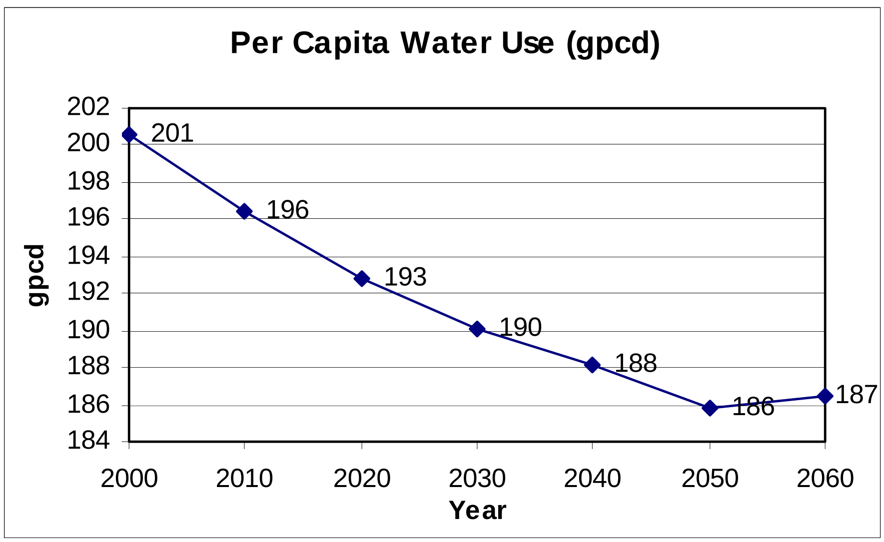


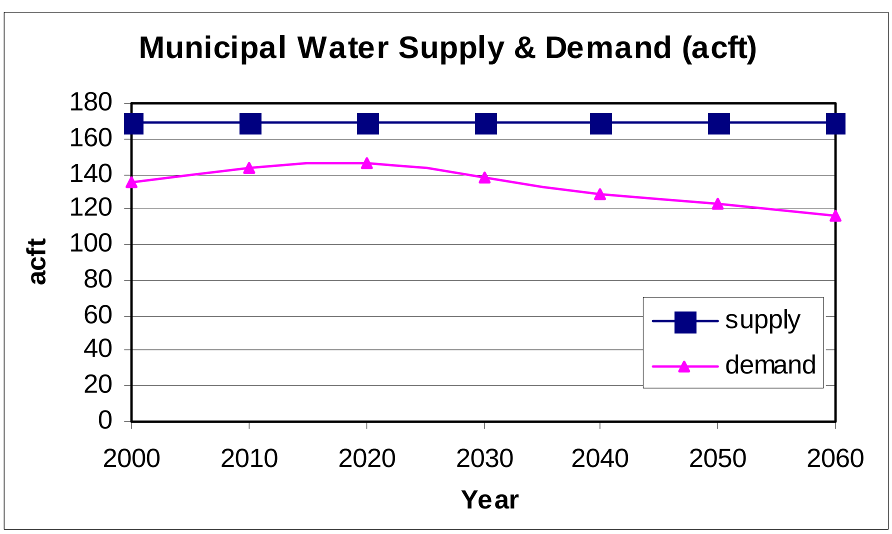




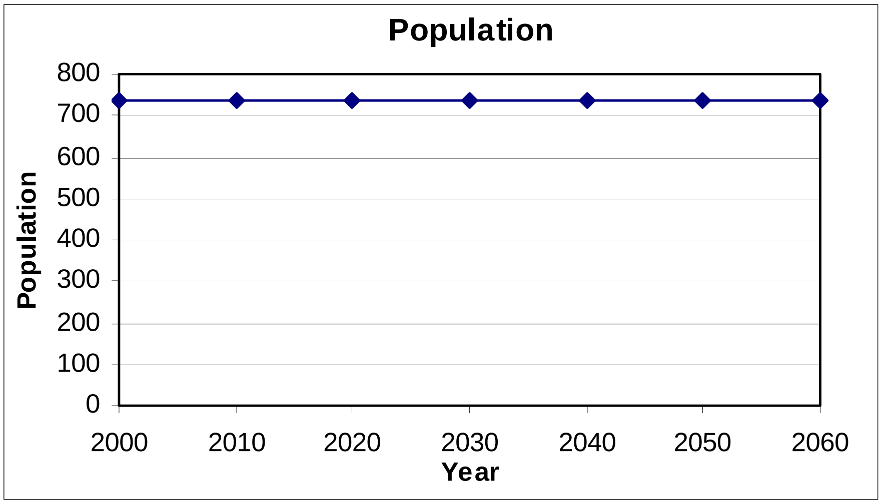
County-Other — McMullen County

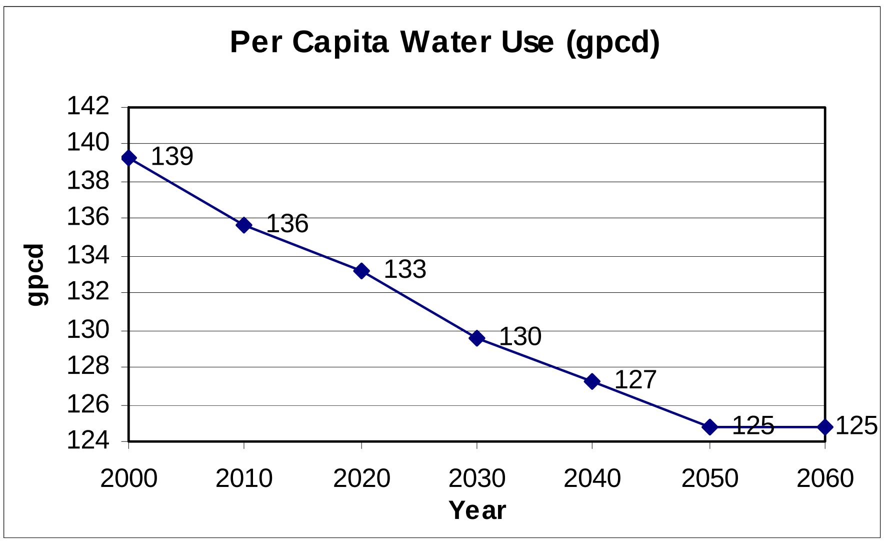


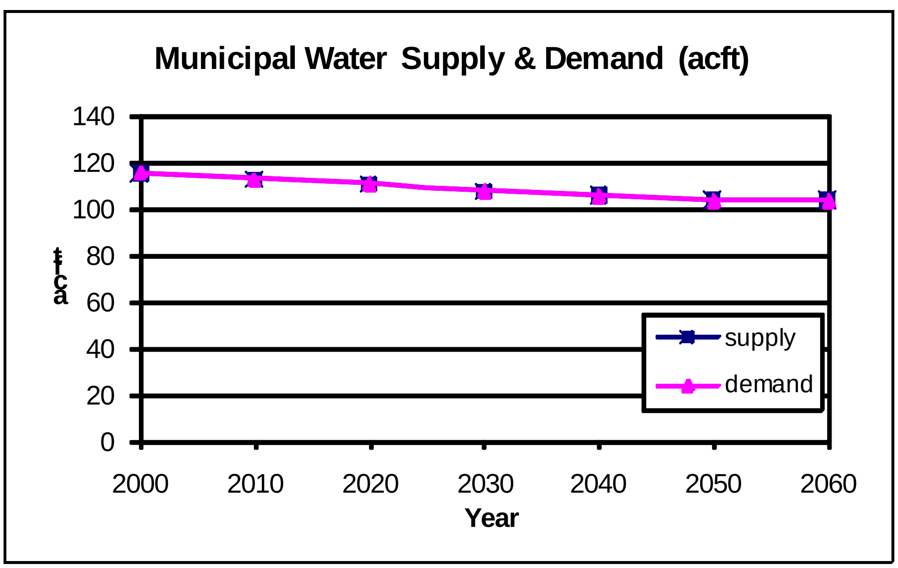




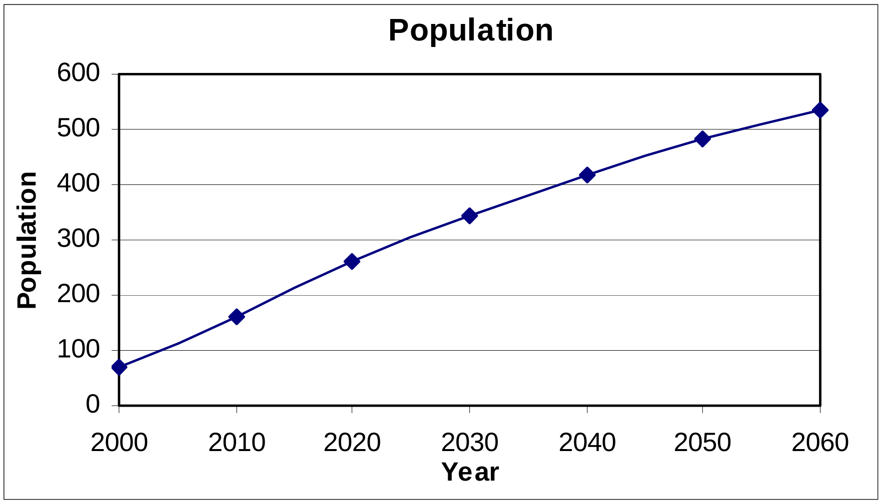
City of Agua Dulce — Nueces County

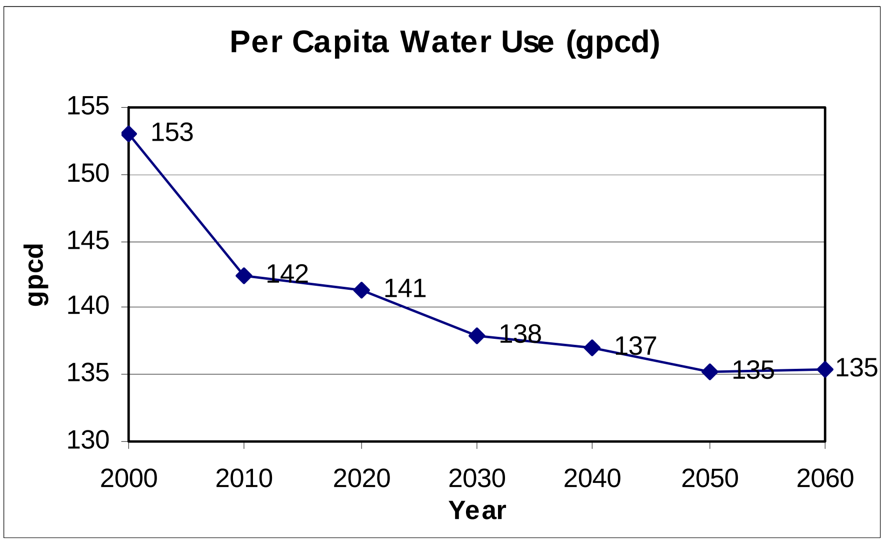


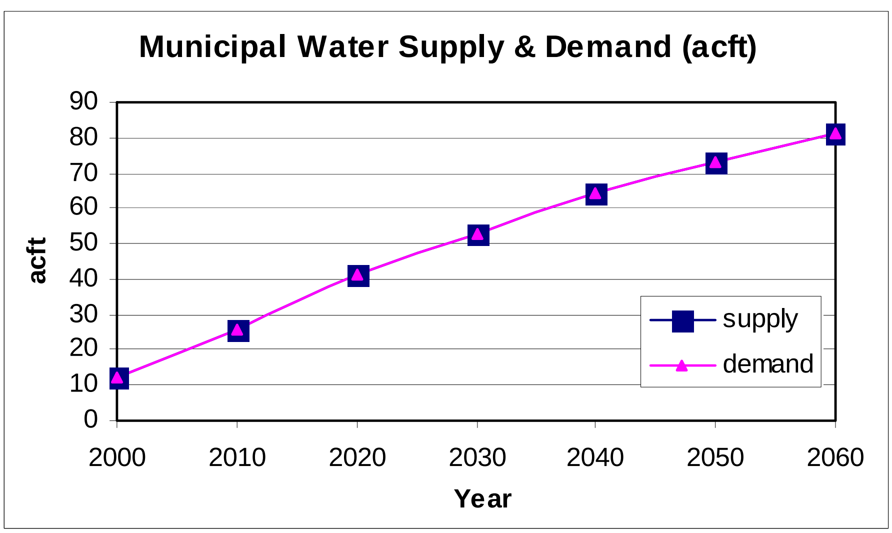




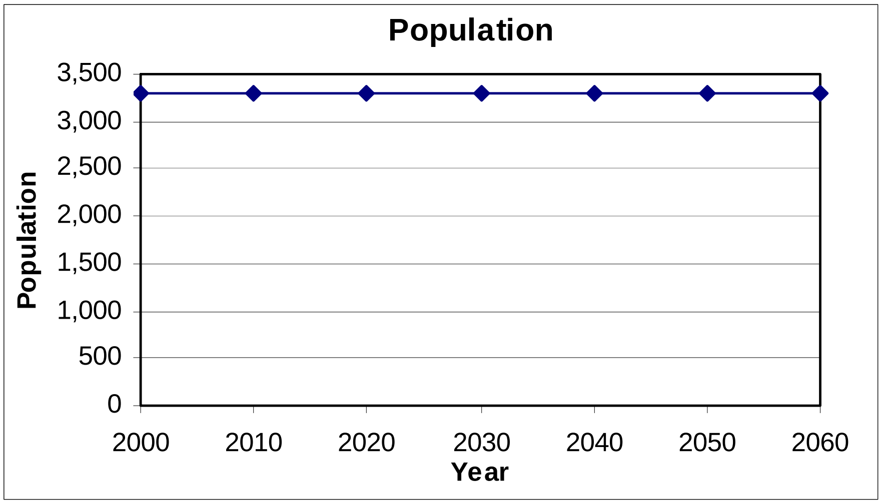
City of Aransas Pass — Nueces County

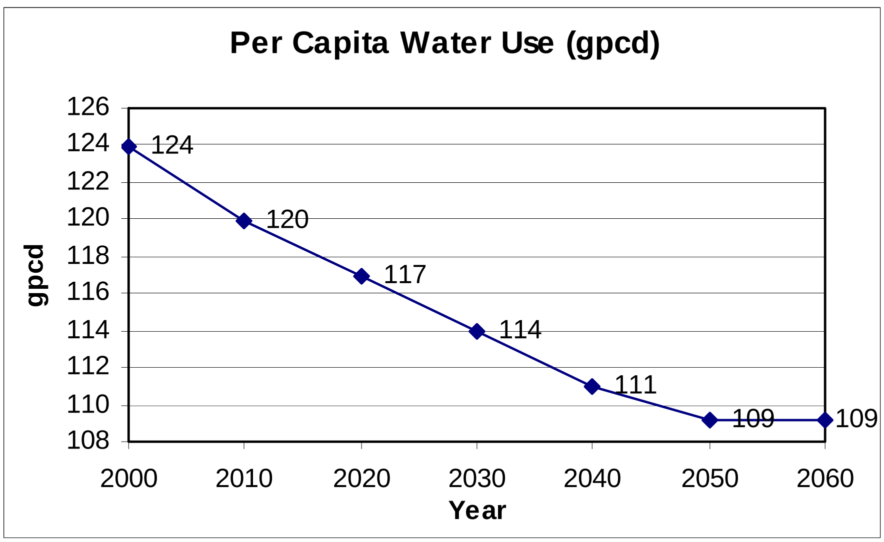


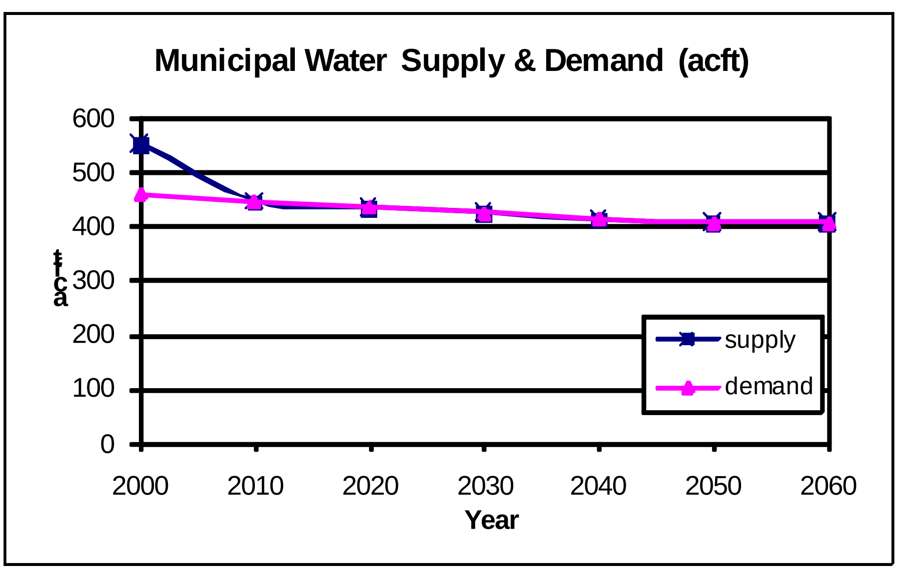




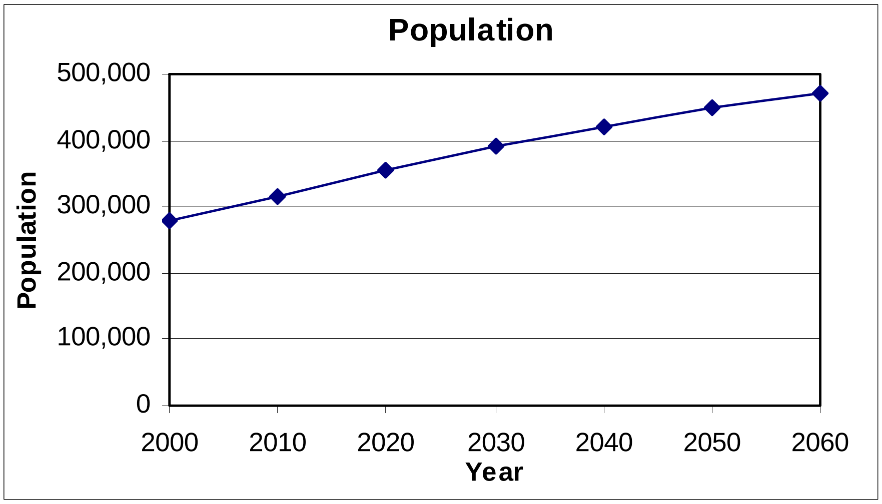
City of Bishop — Nueces County

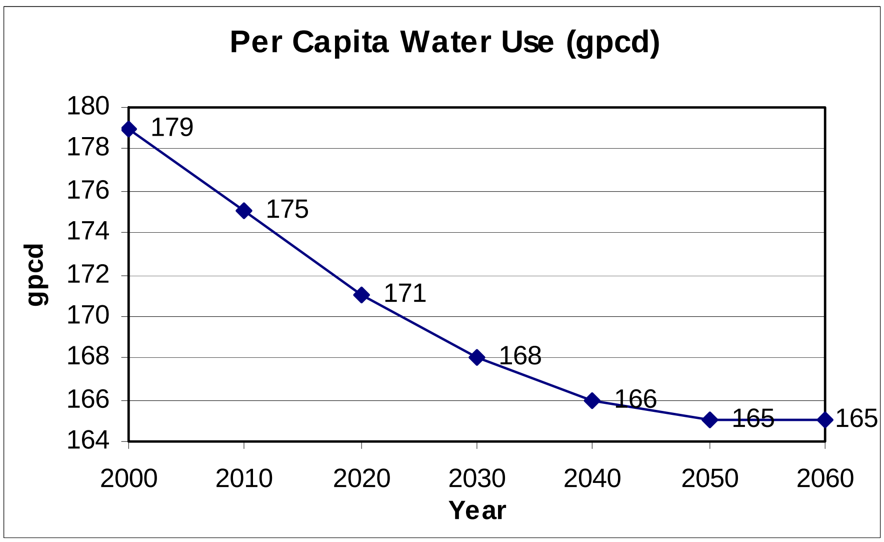


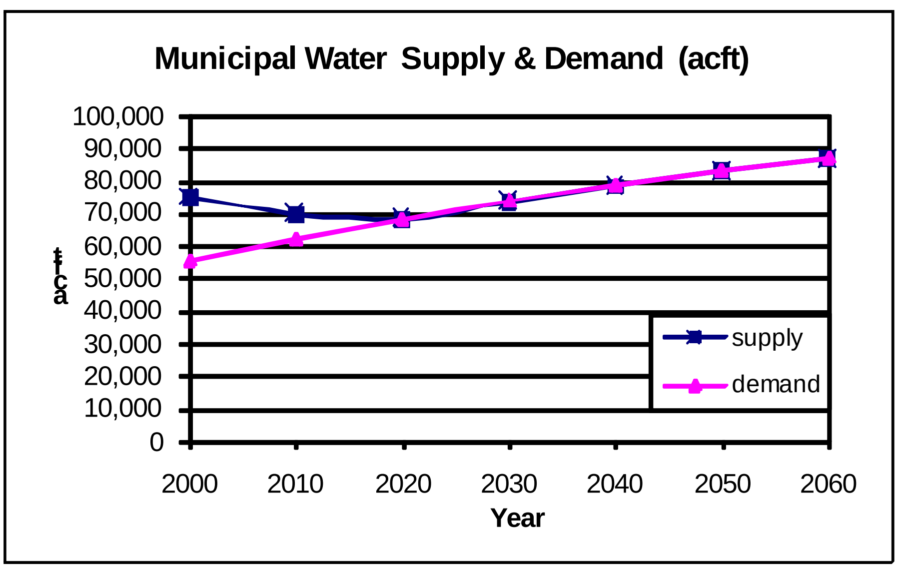




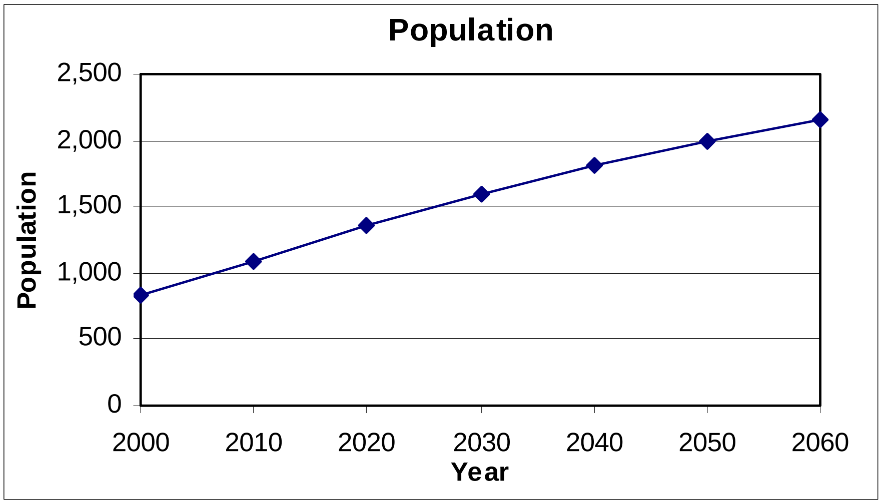
City of Corpus Christi — Nueces County

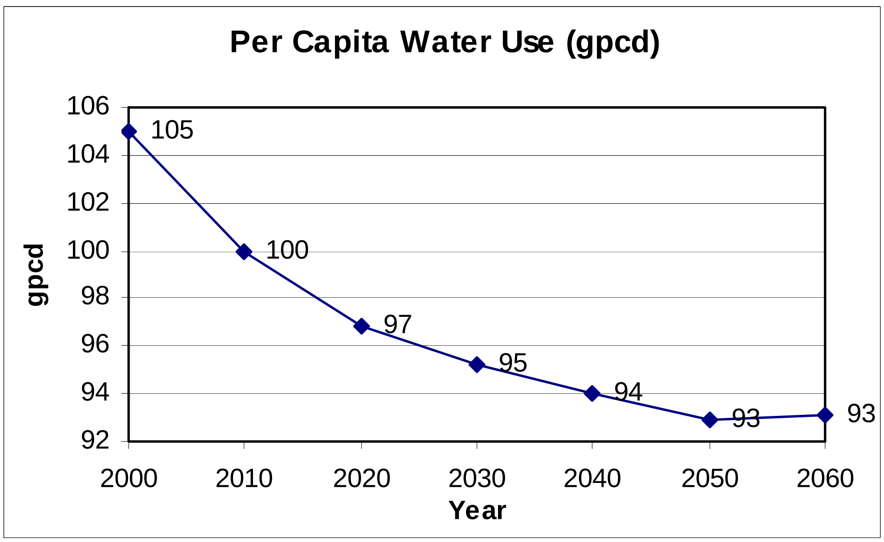


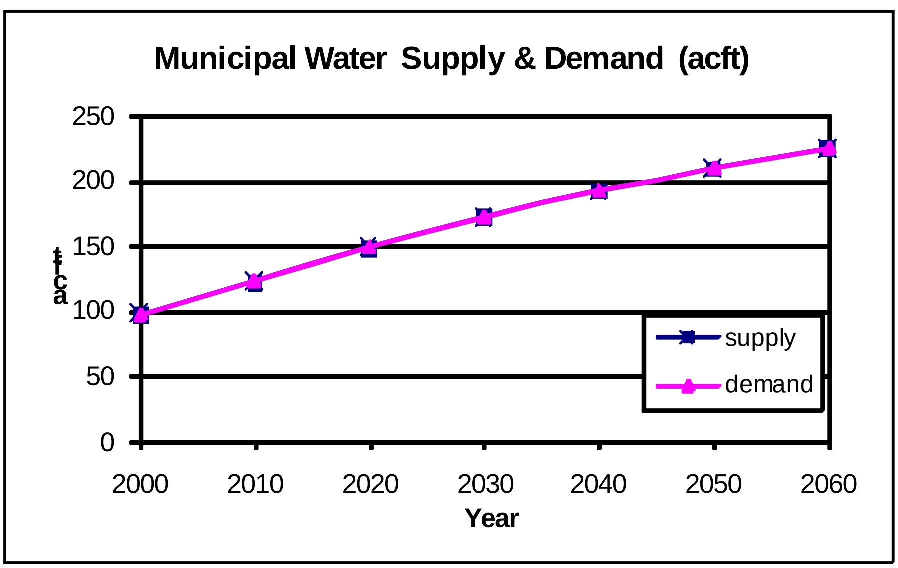




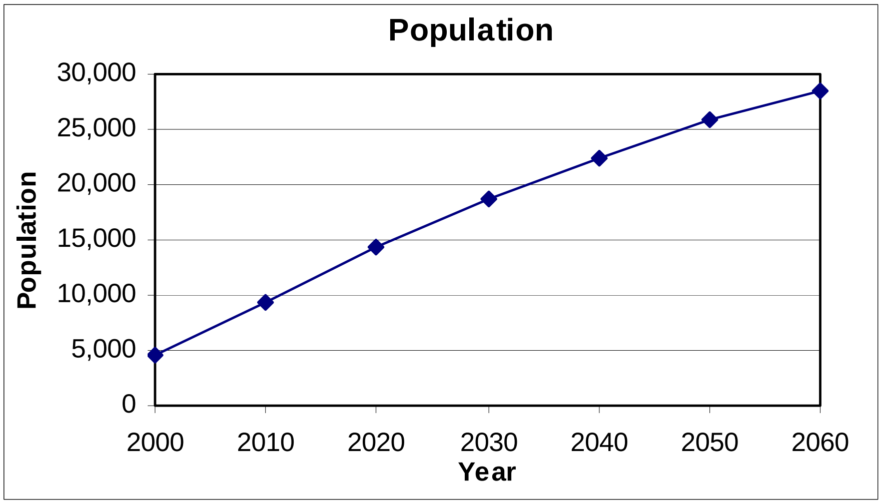
City of Driscoll — Nueces County

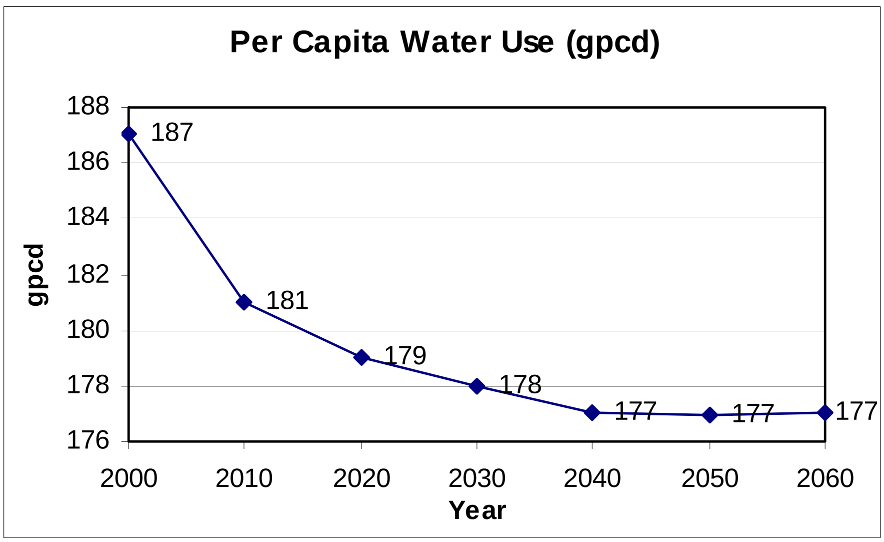


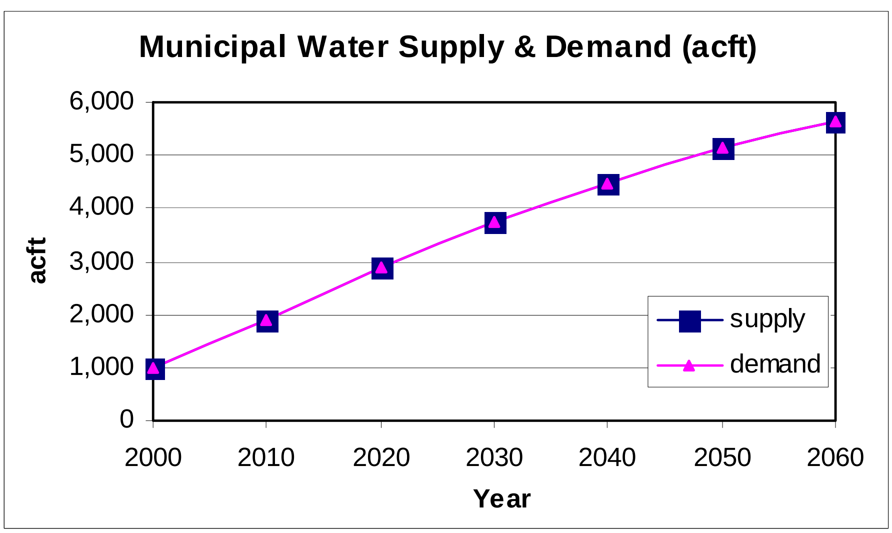




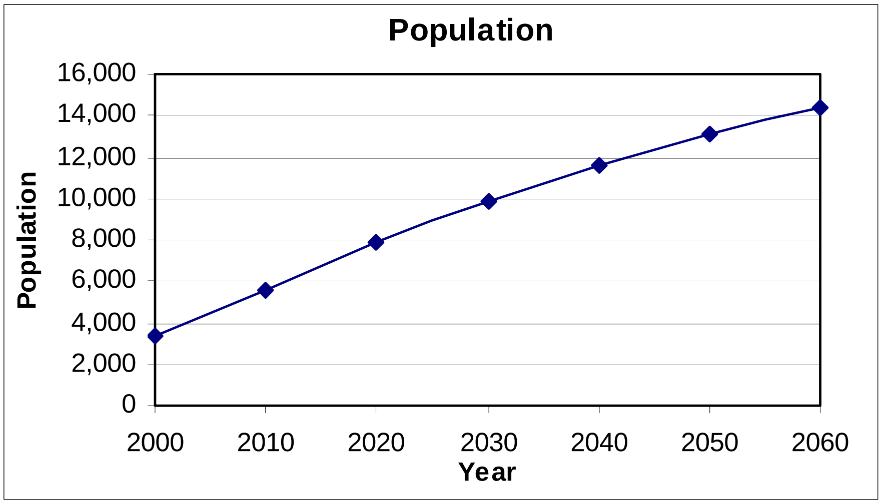
Nueces County WCID #4 — Nueces County

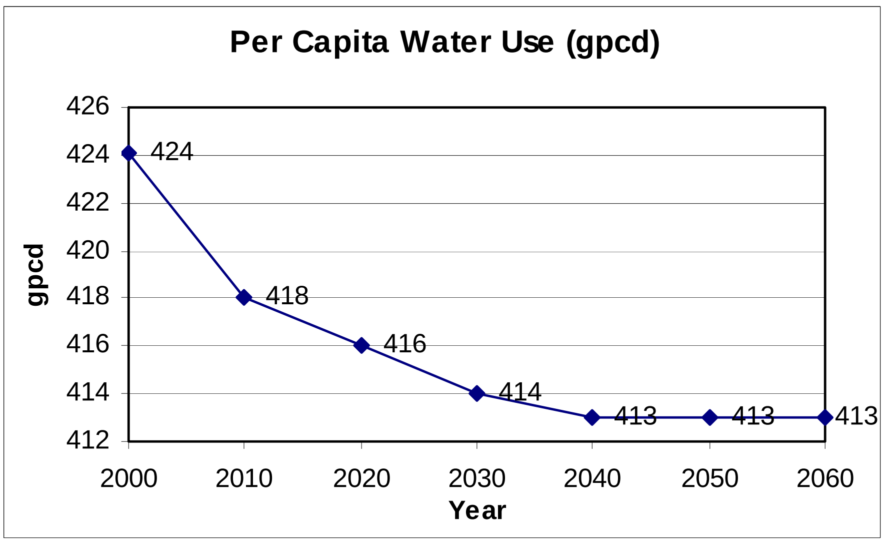


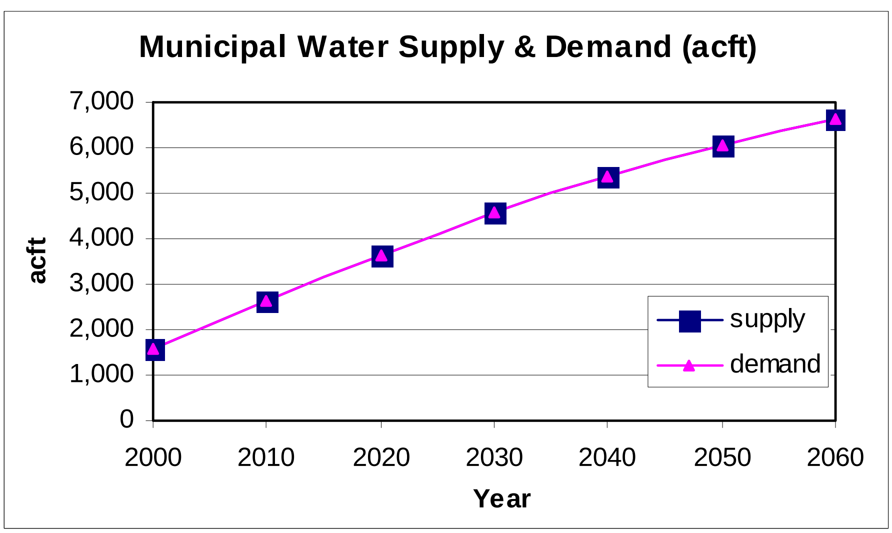




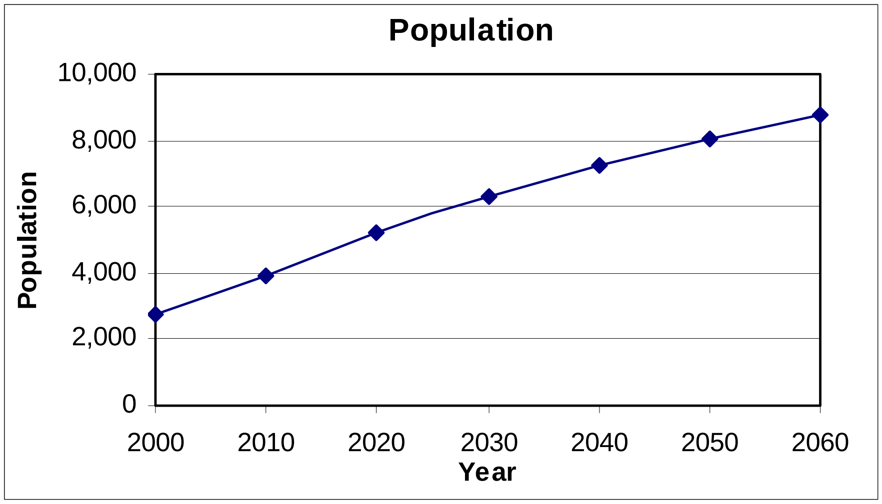
City of Port Aransas — Nueces County

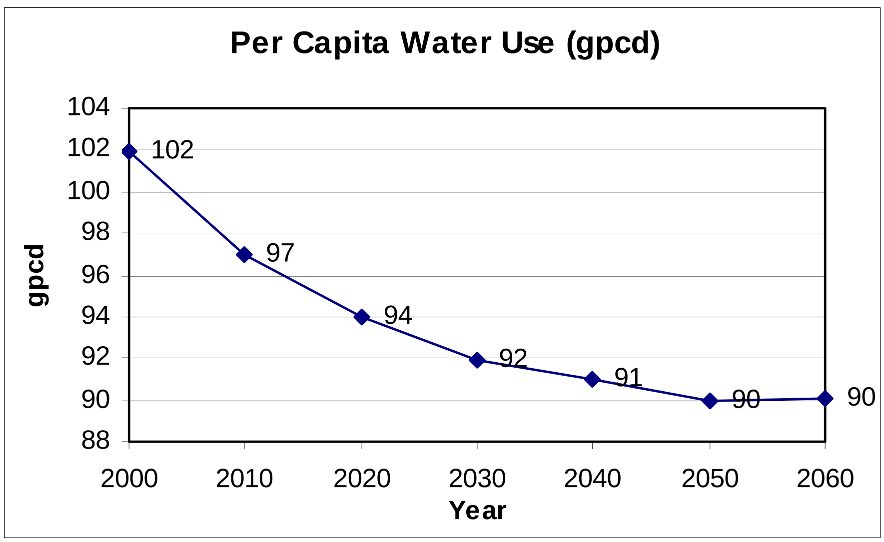


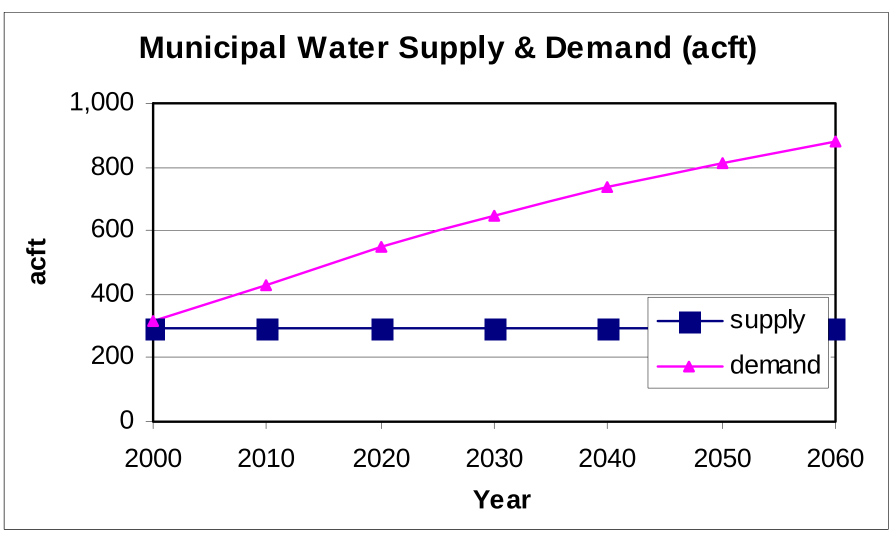




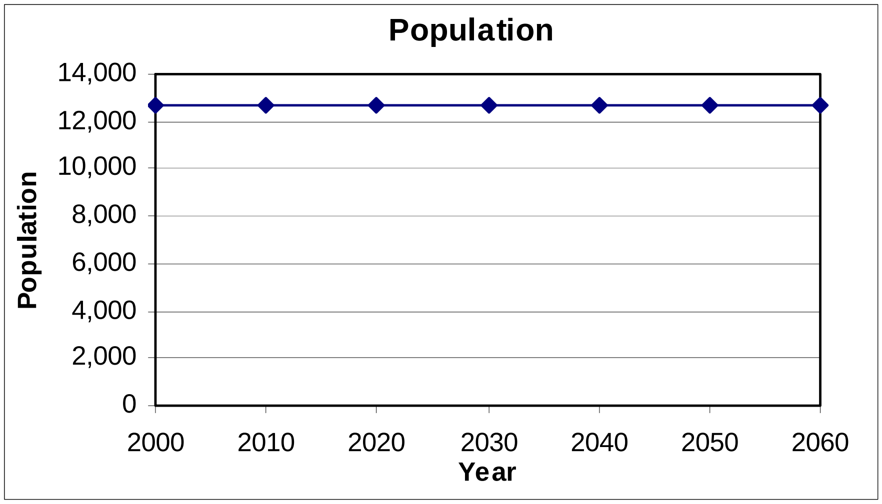
River Acres WSC — Nueces County

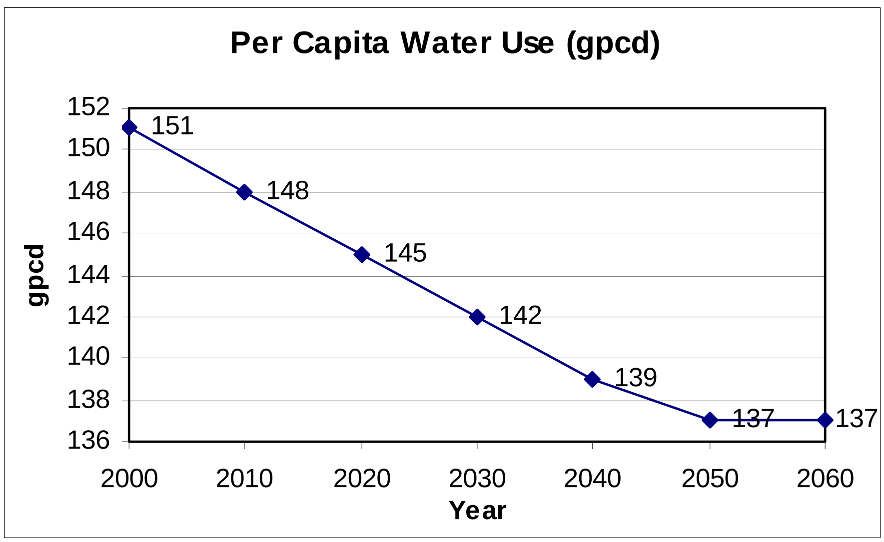


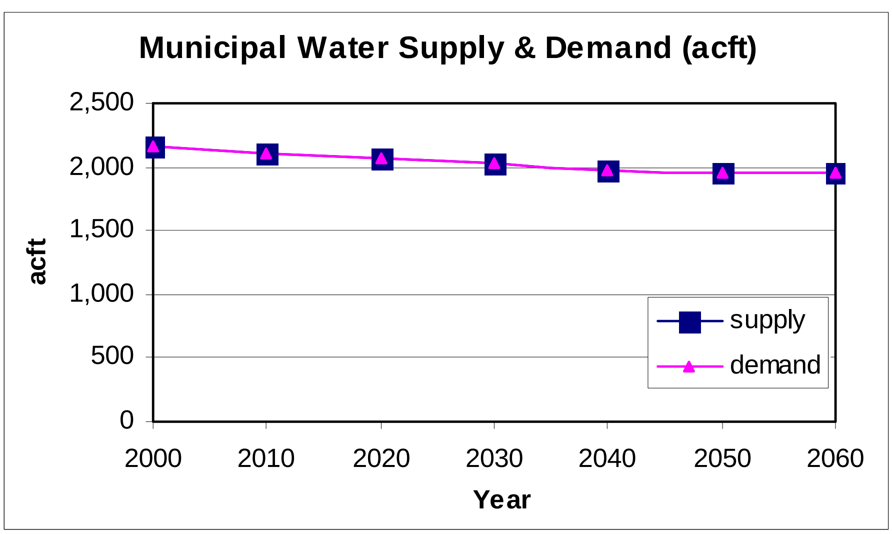




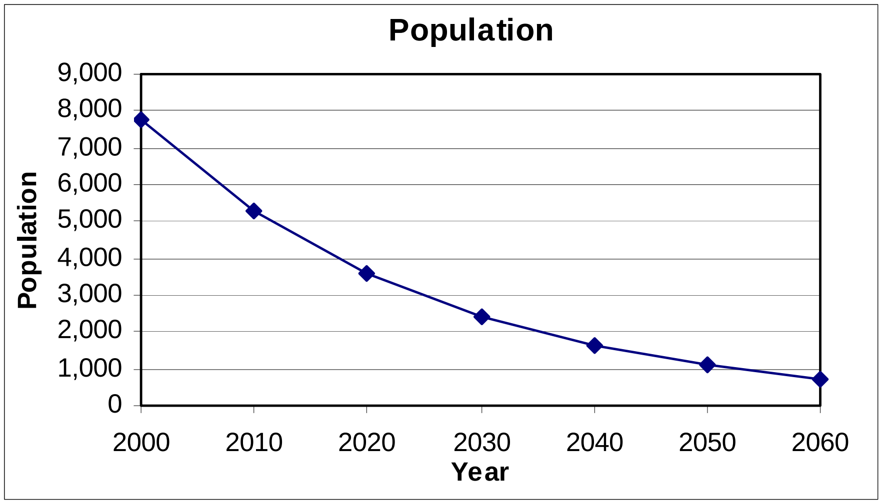
City of Robstown — Nueces County

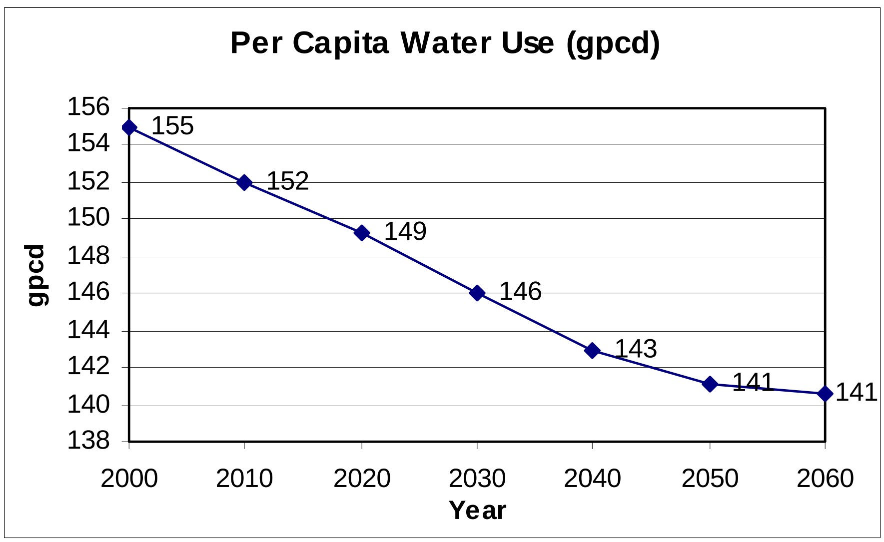


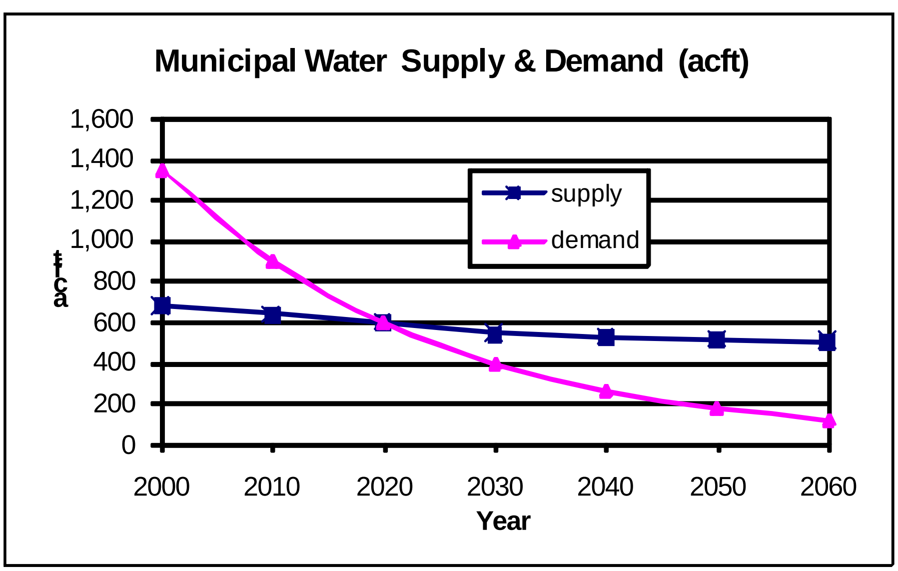




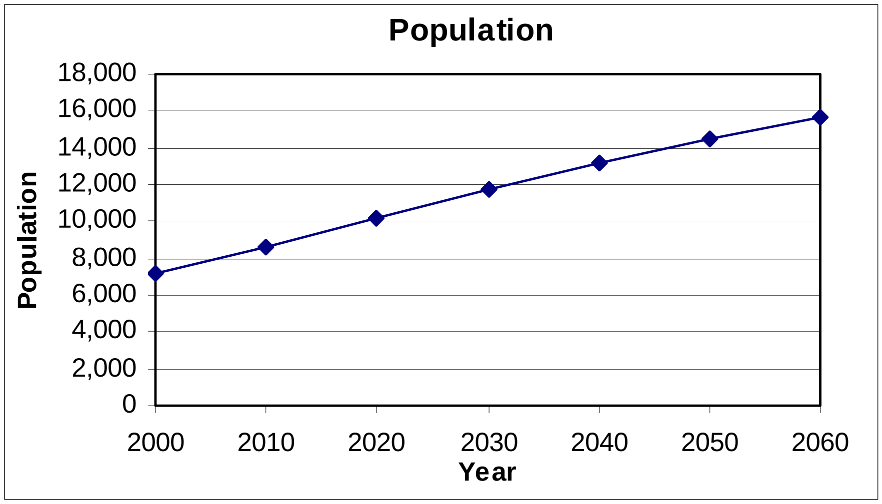
County-Other — Nueces County

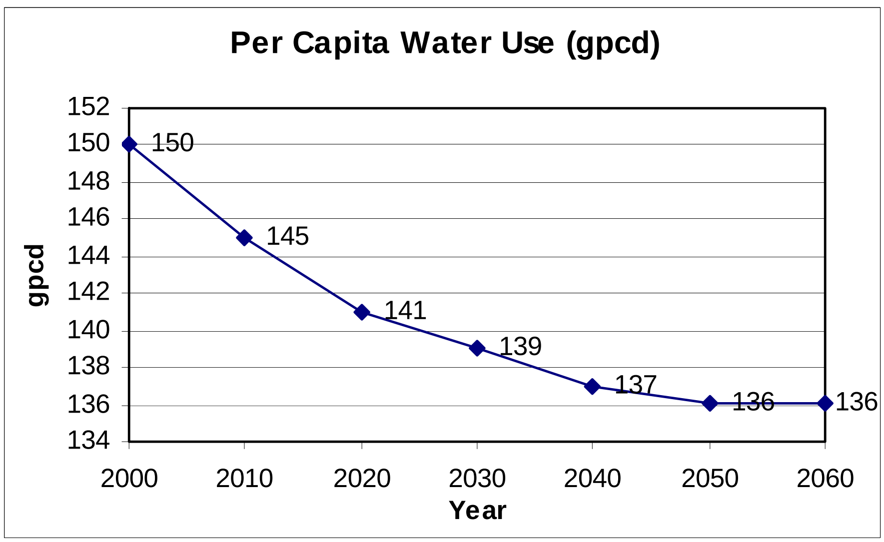


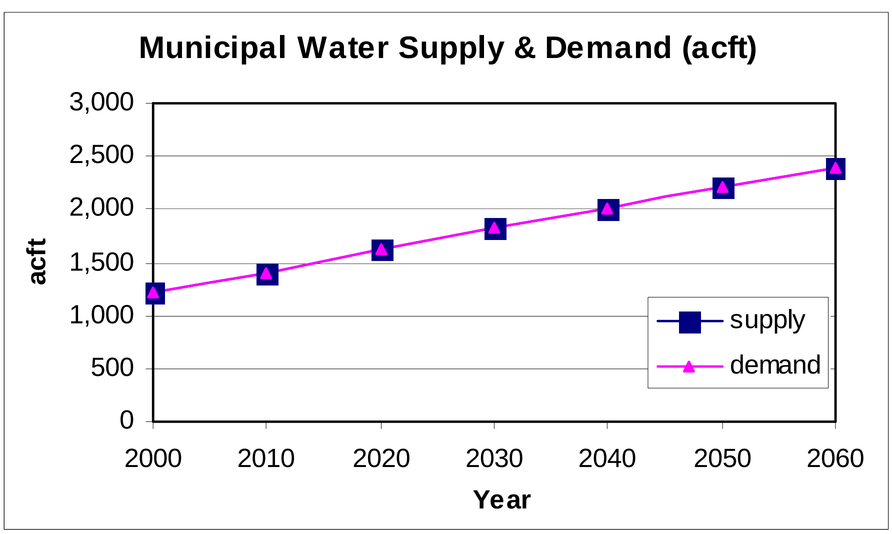




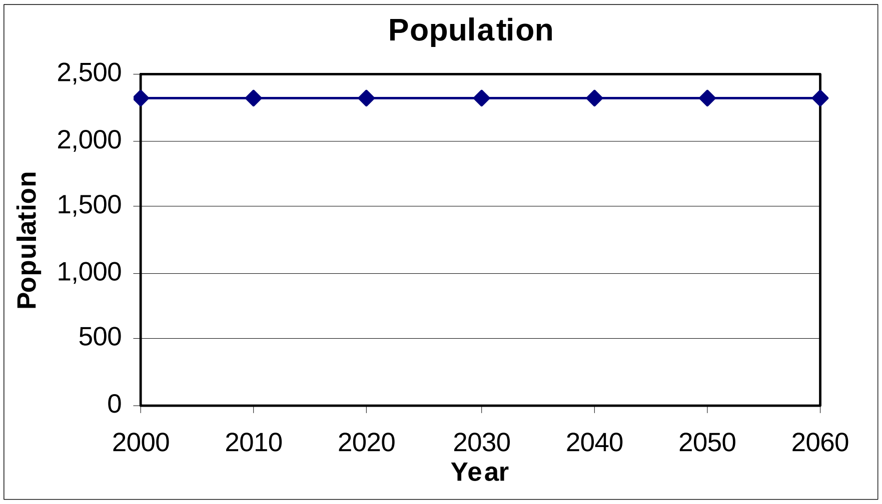
City of Aransas Pass — San Patricio County

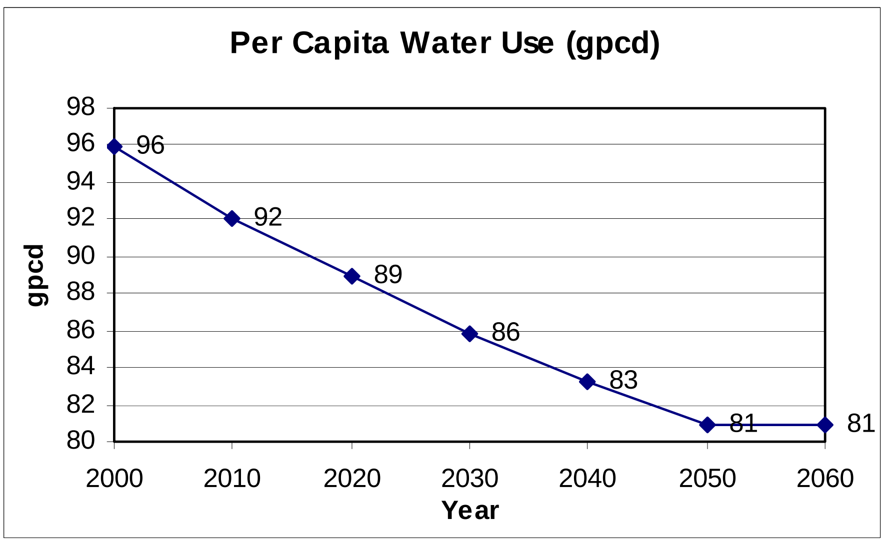


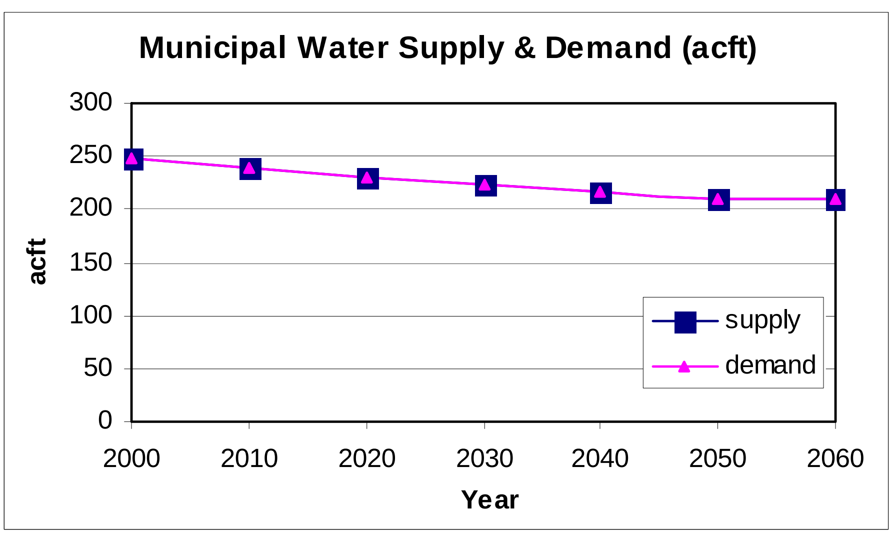




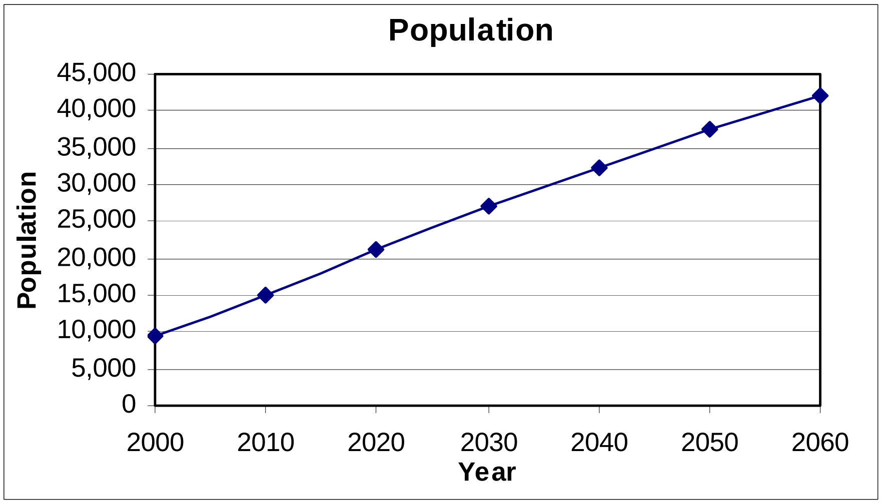
City of Gregory — San Patricio County

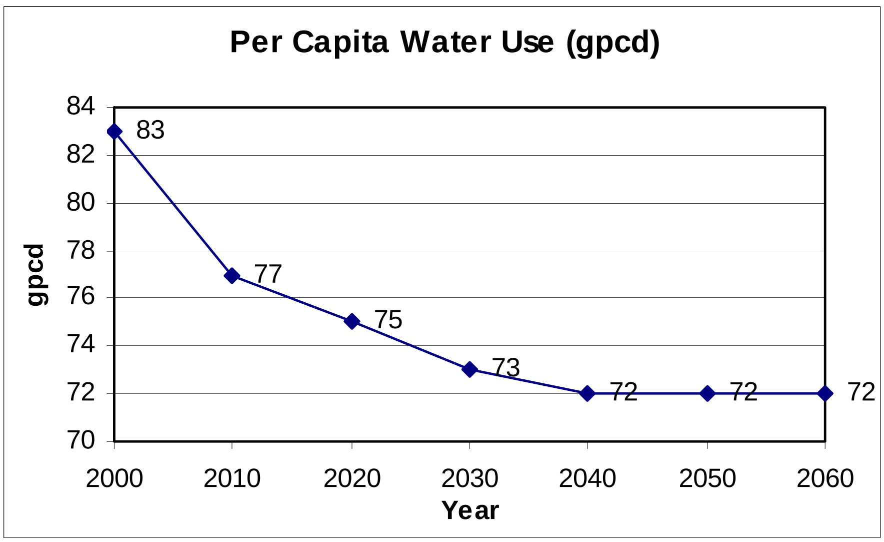


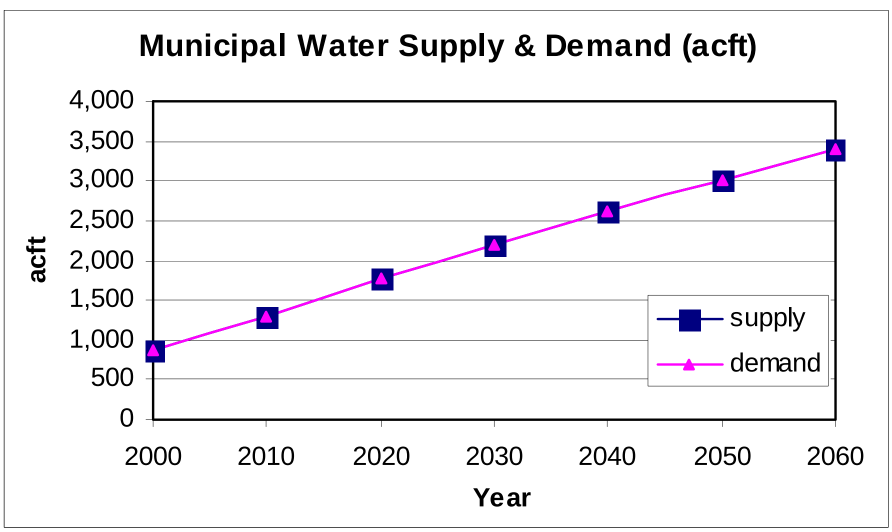




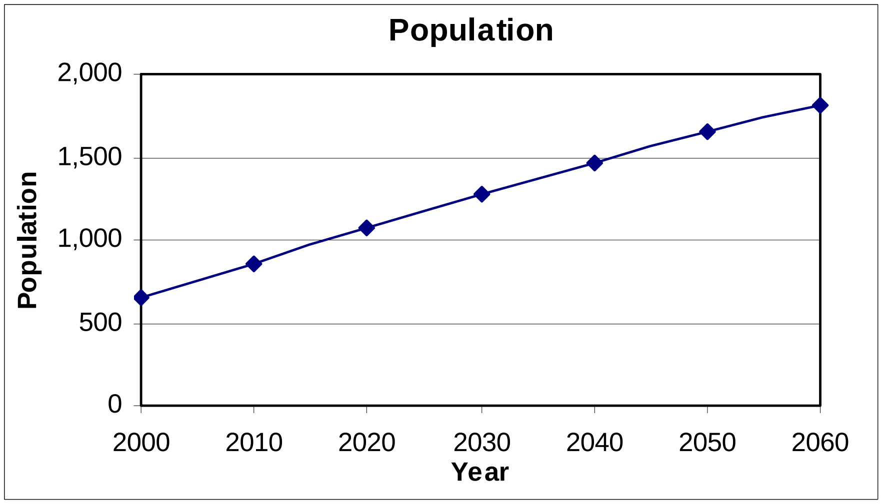
City of Ingleside — San Patricio County

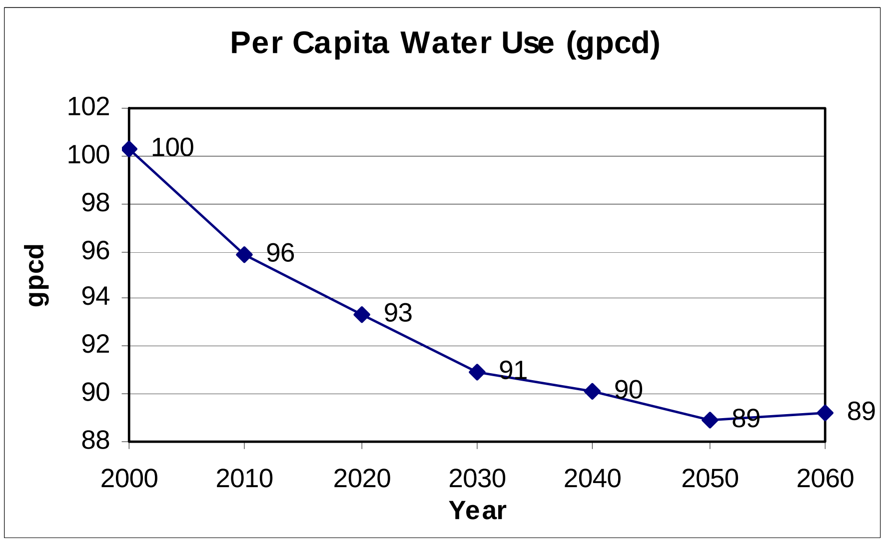


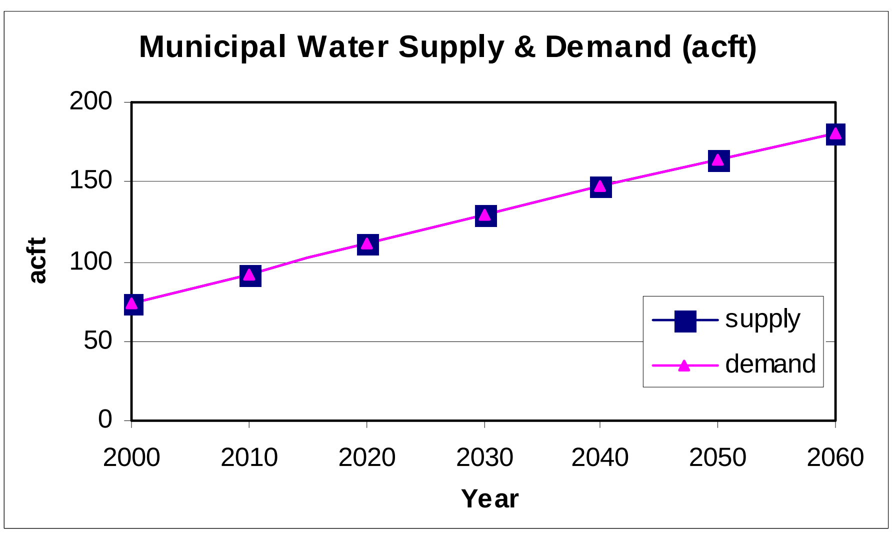




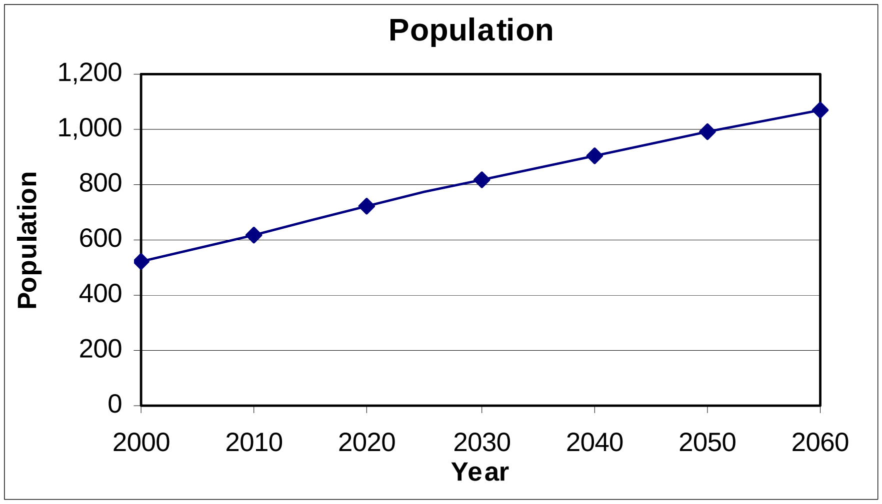
City of Ingleside On the Bay — San Patricio County

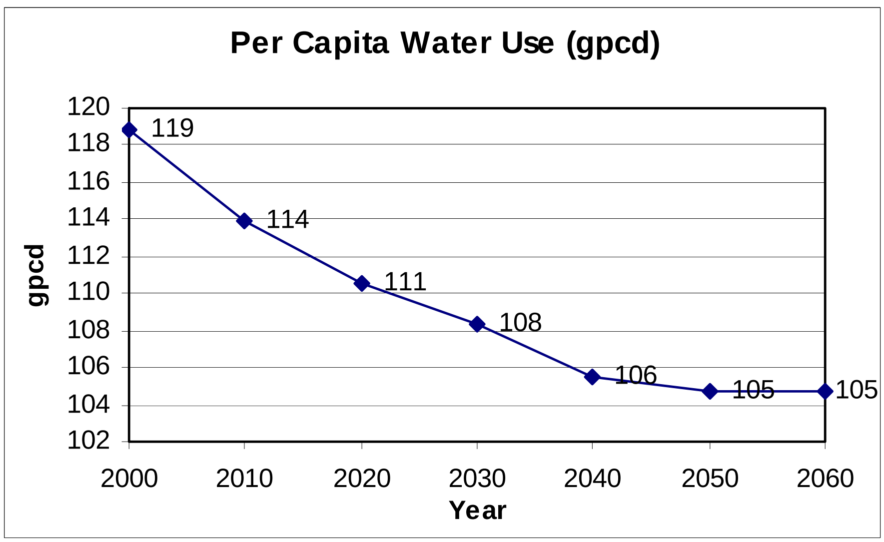


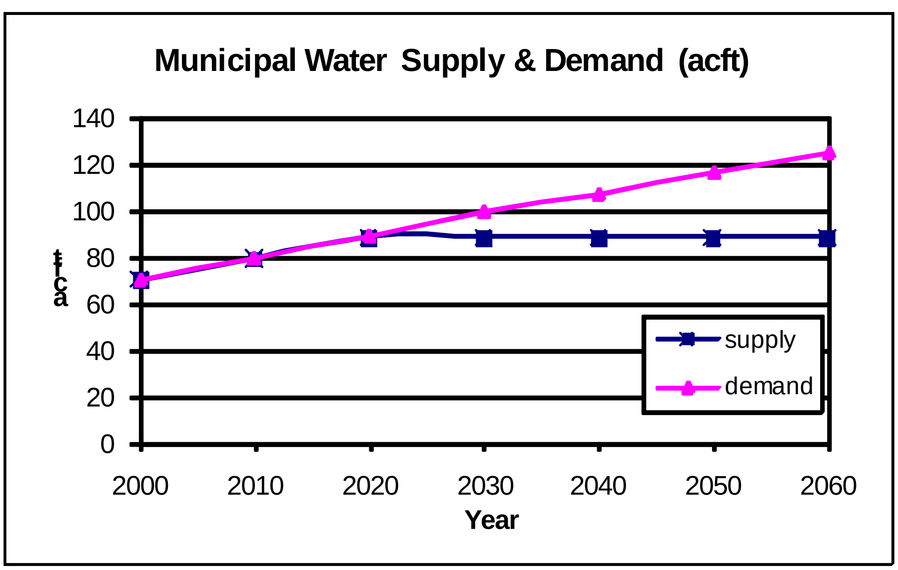




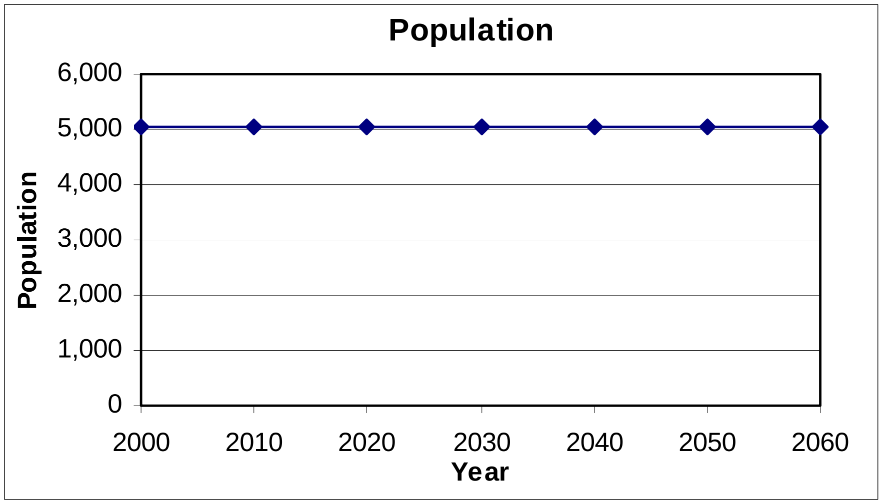
Lake City — San Patricio County

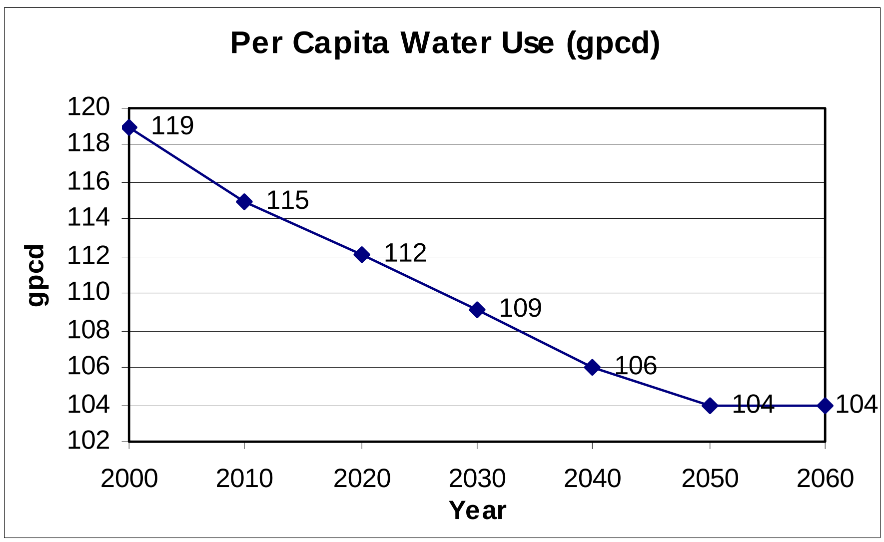


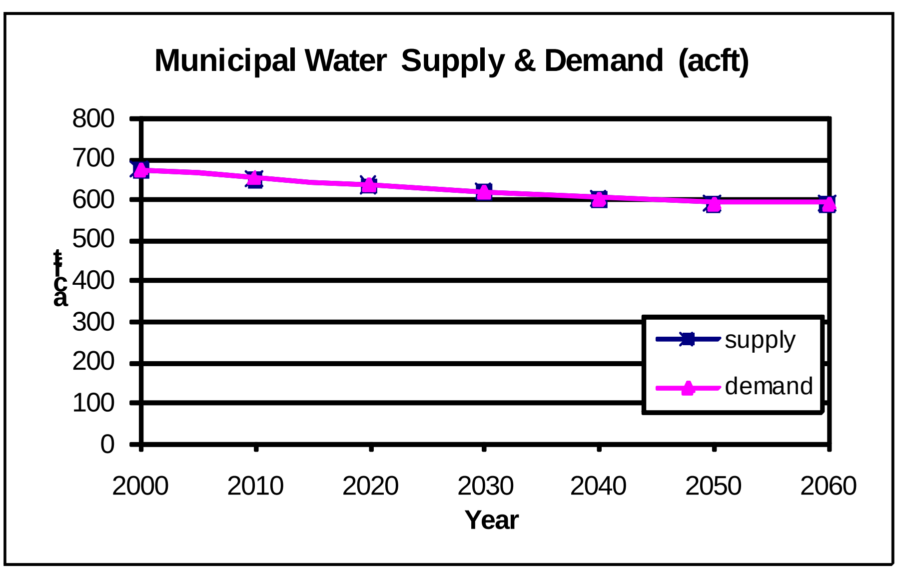




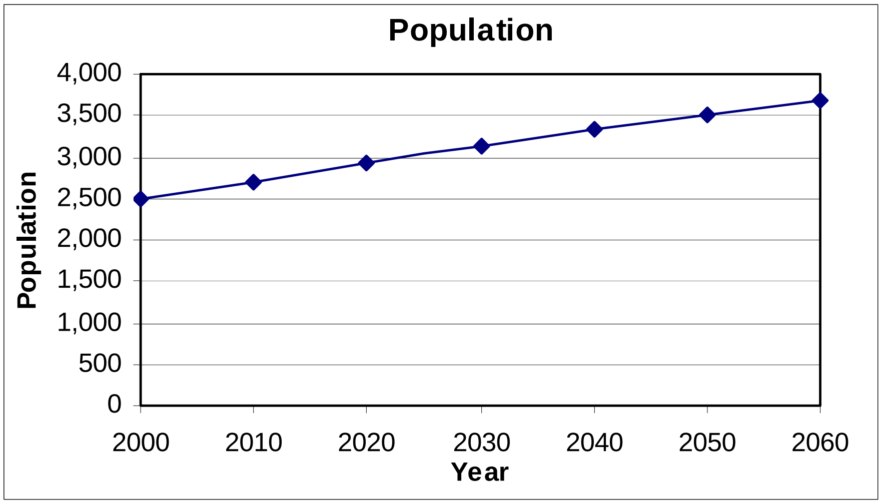
City of Mathis — San Patricio County

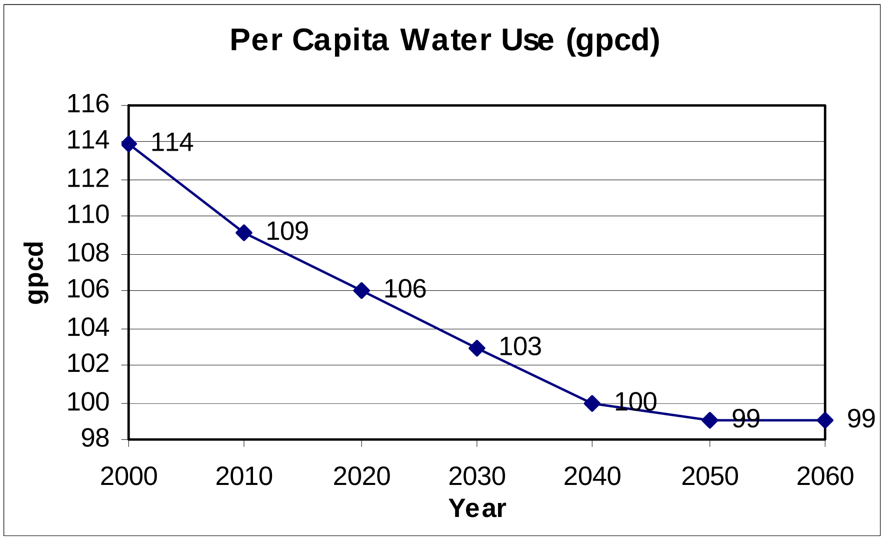


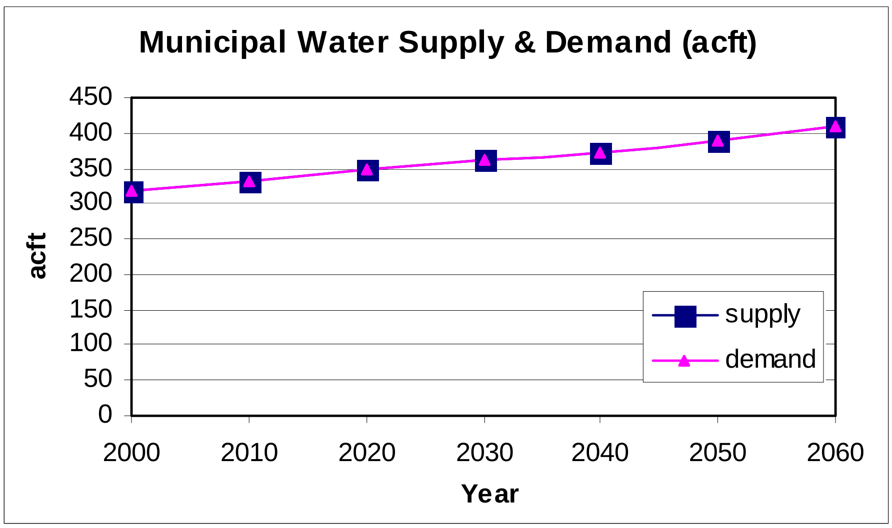




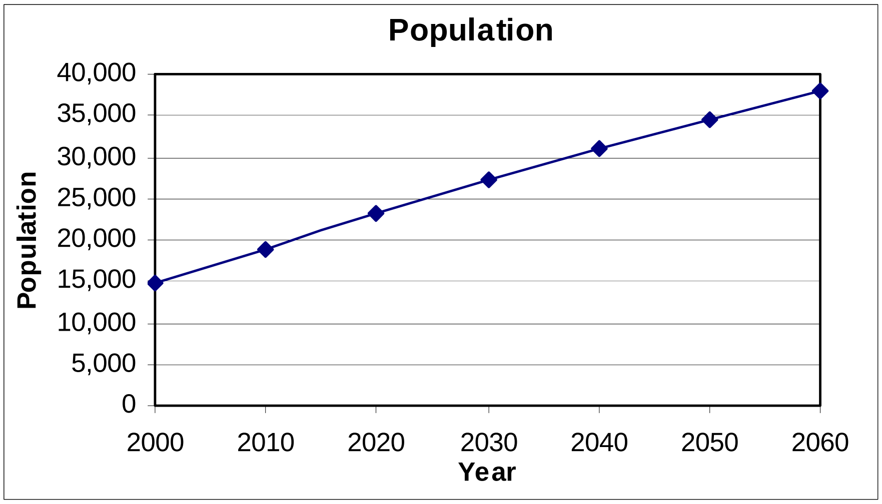
City of Odem — San Patricio County

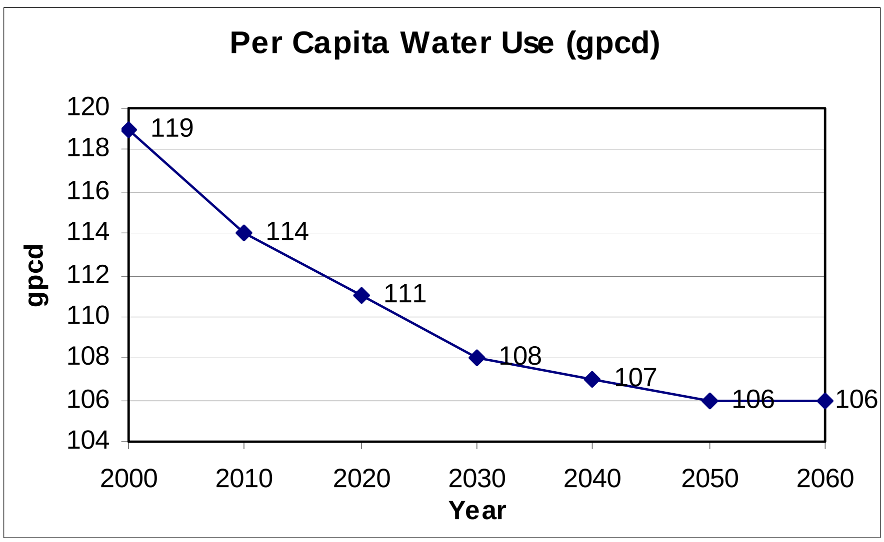


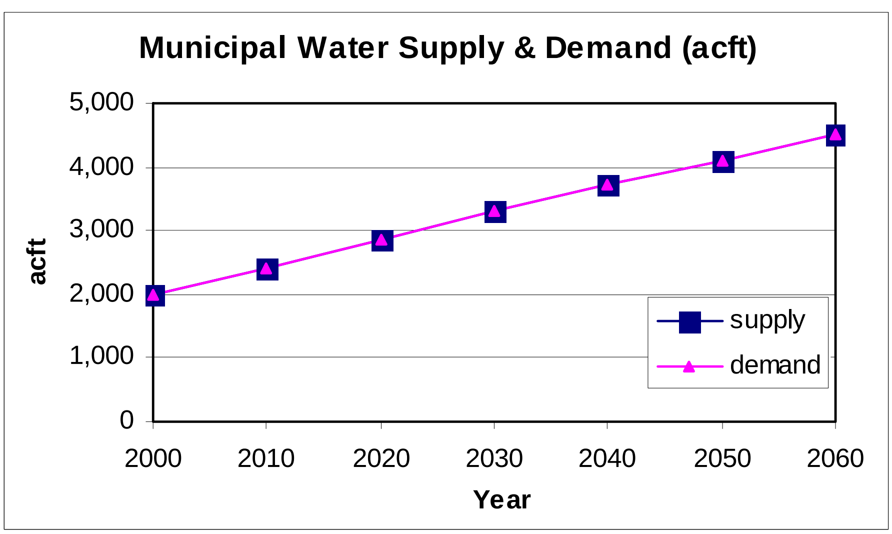




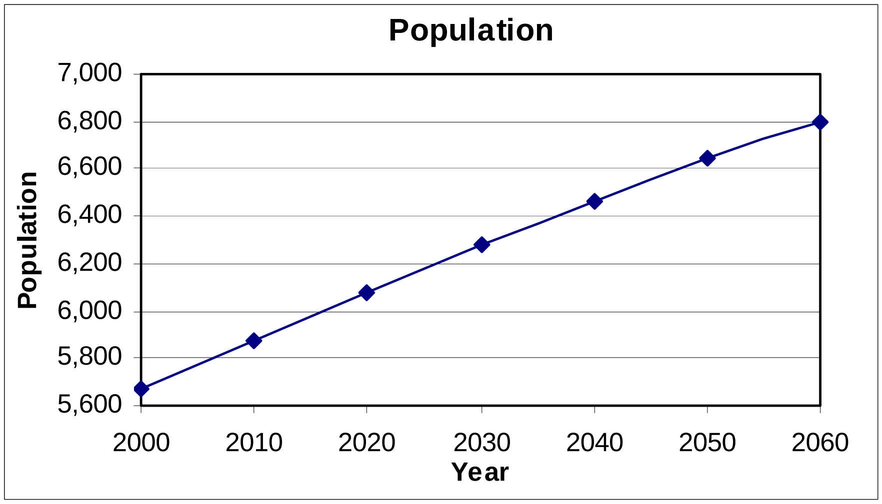
City of Portland — San Patricio County

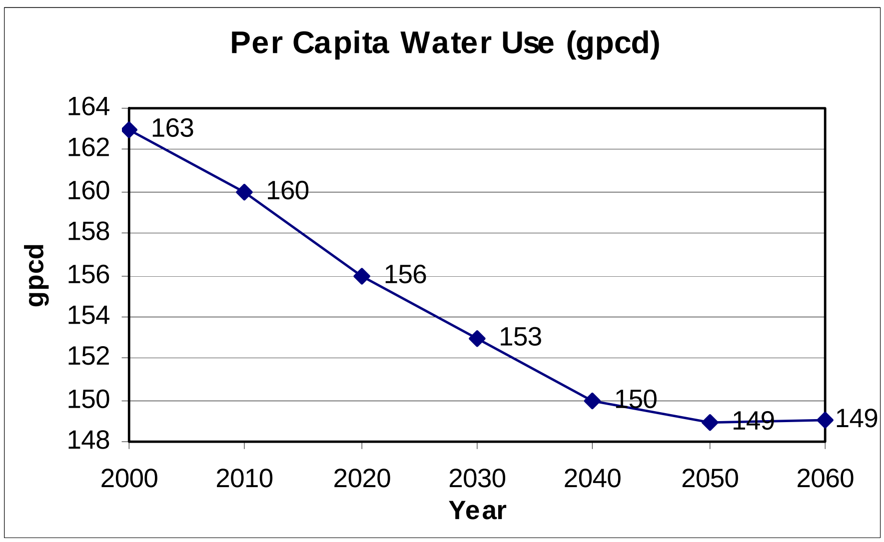


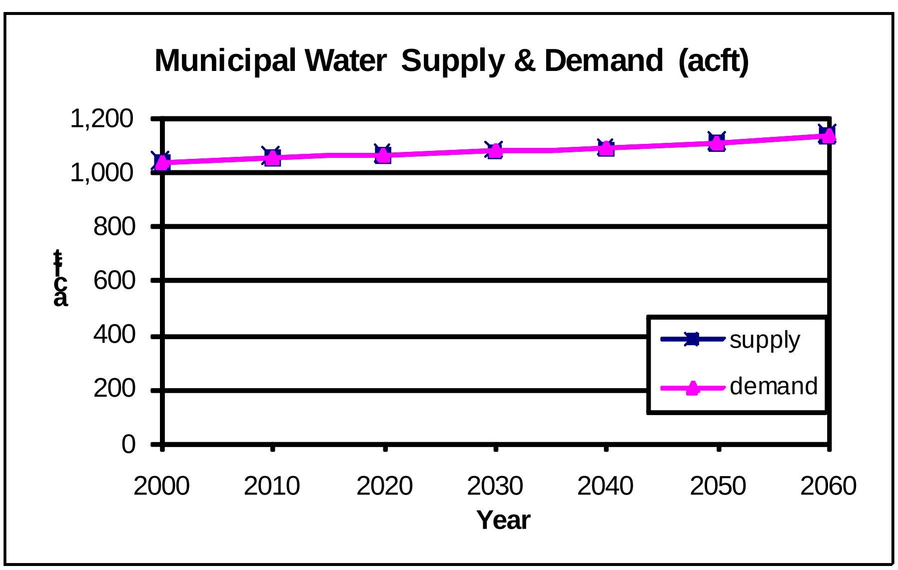




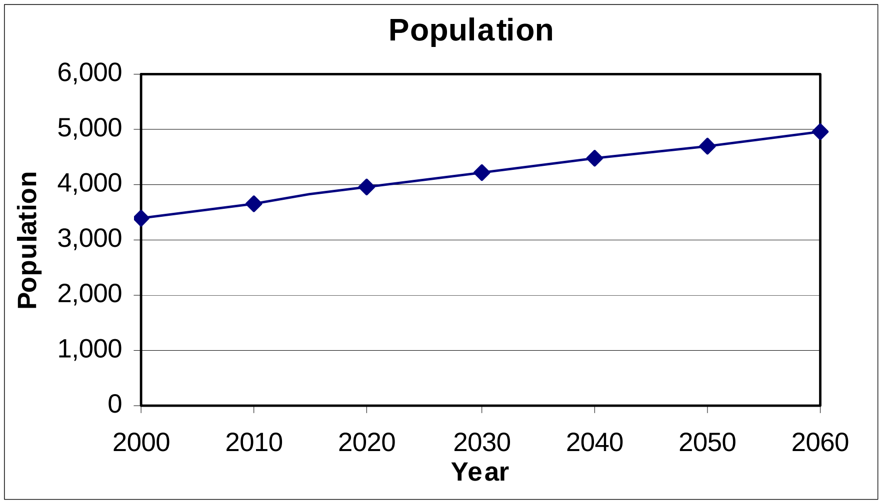
City of Sinton — San Patricio County

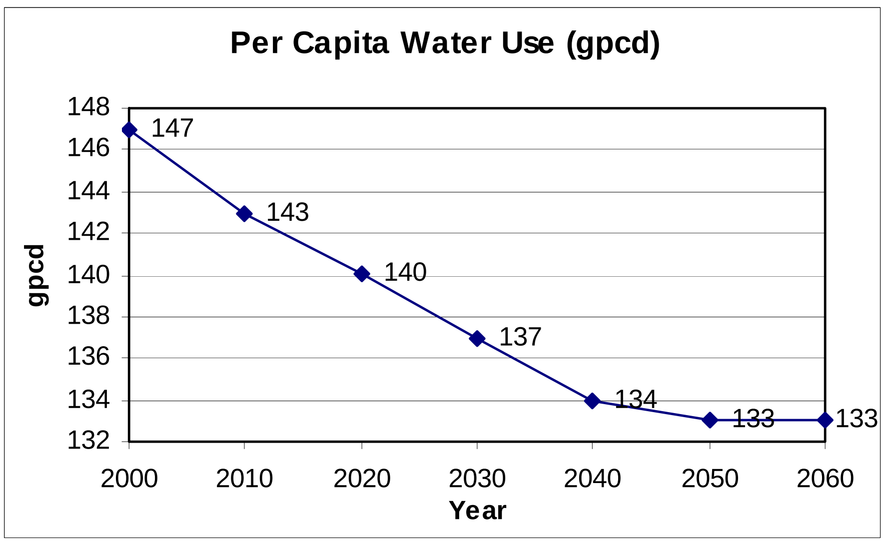


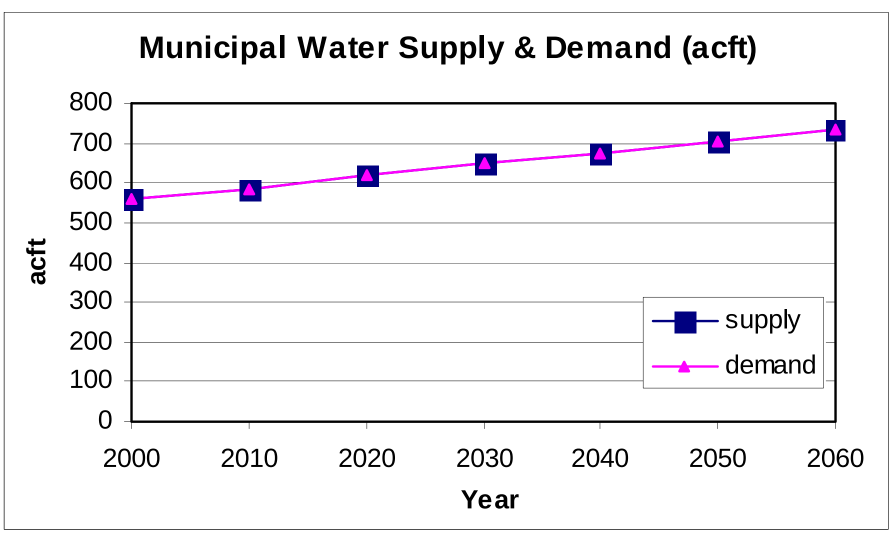




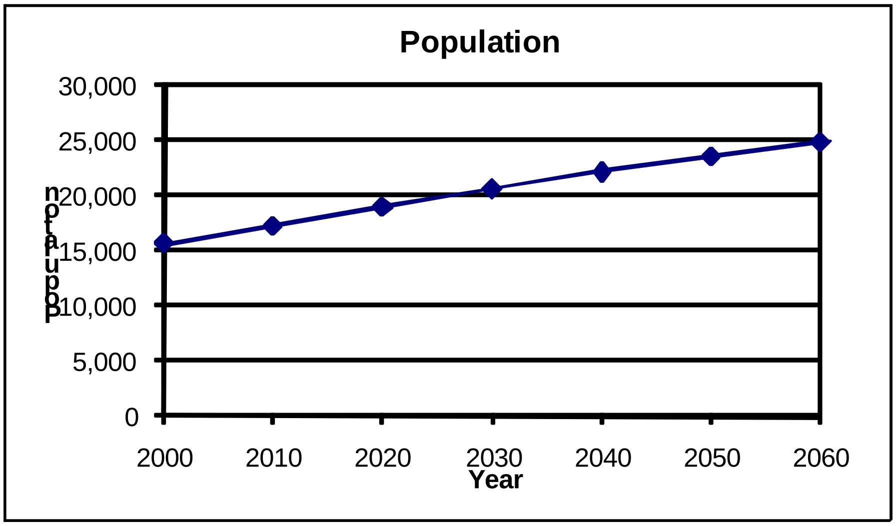
City of Taft — San Patricio County

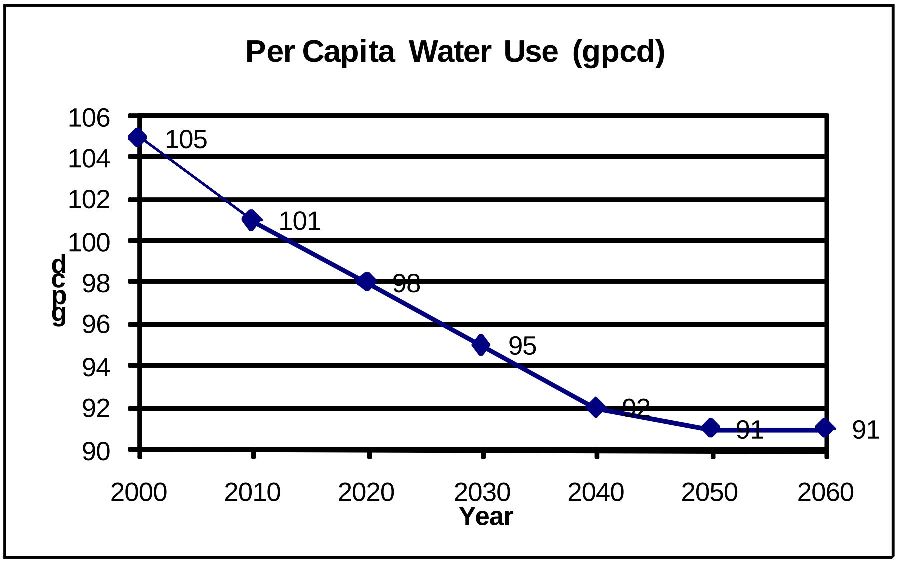


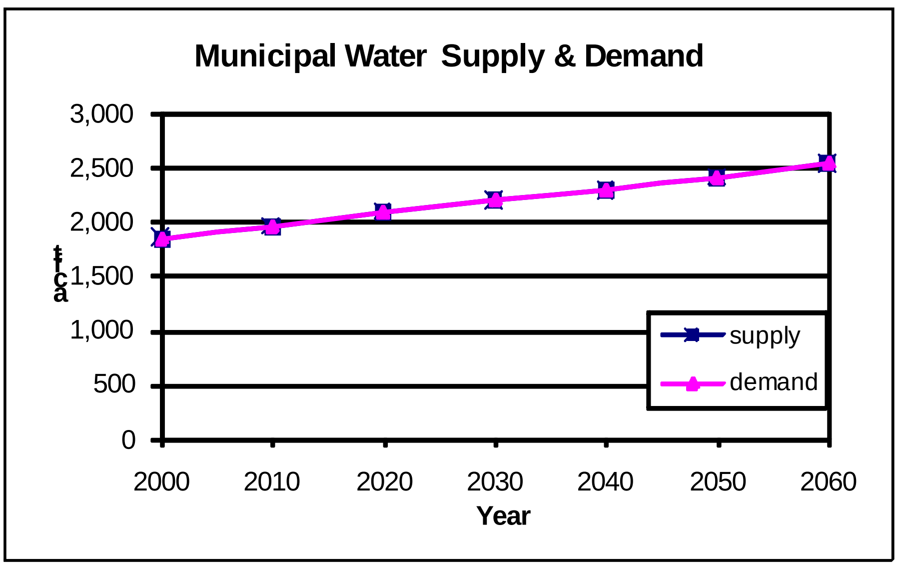




County-Other — San Patricio County







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Appendix C.2

Other Water Uses Figures (Manufacturing, Mining, Irrigation, and Livestock for each County)

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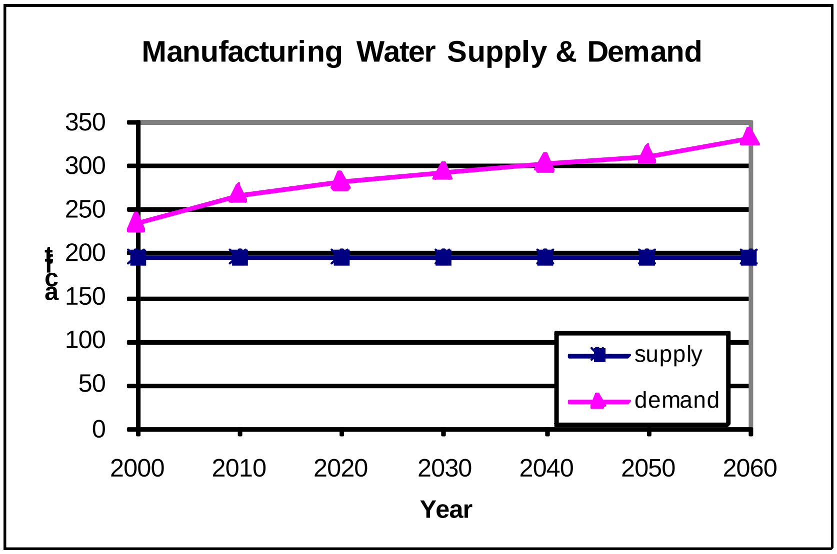
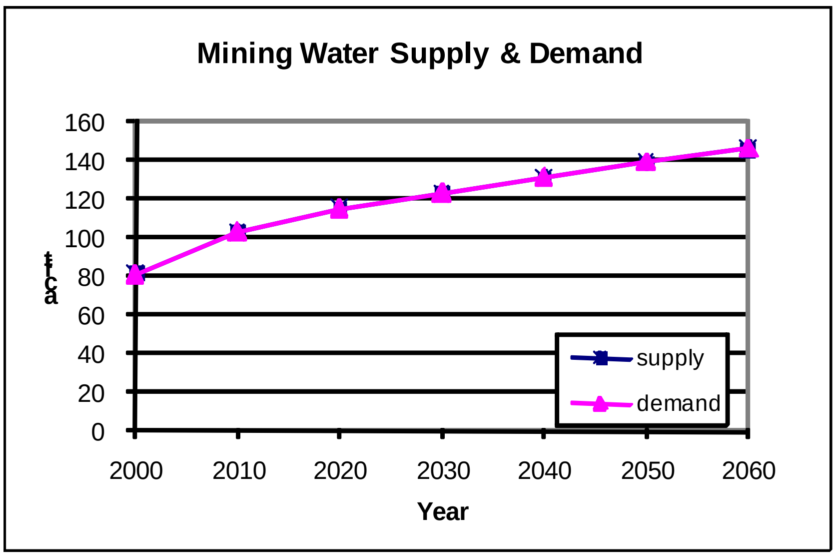
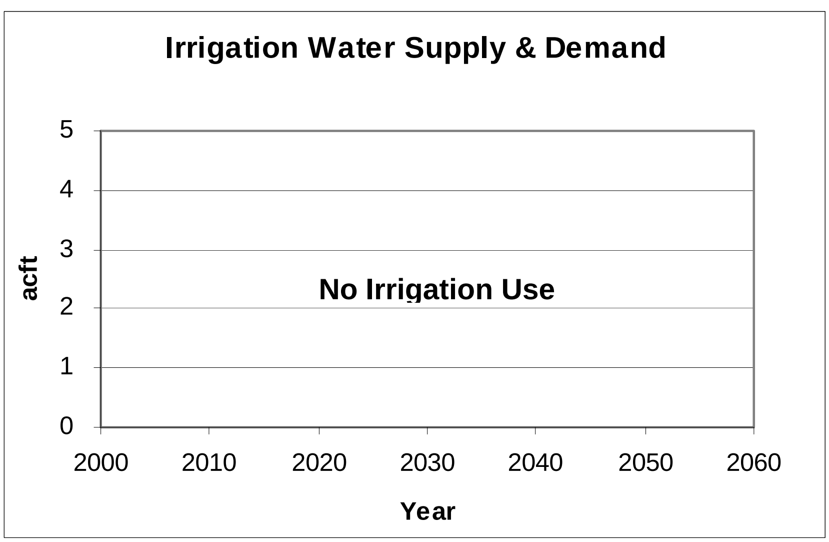
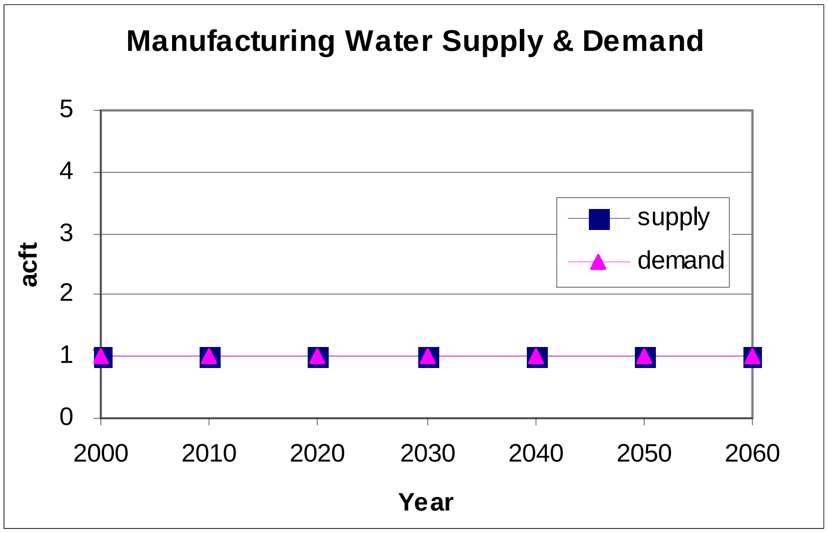
Aransas County

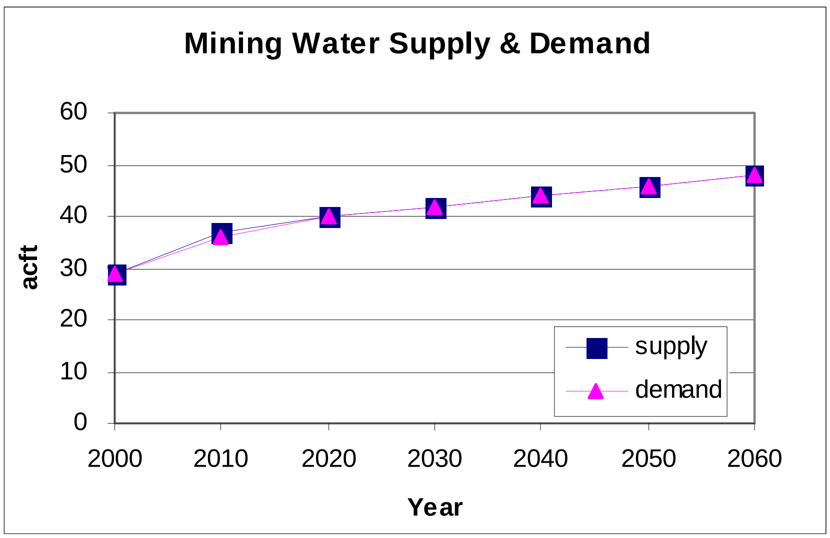


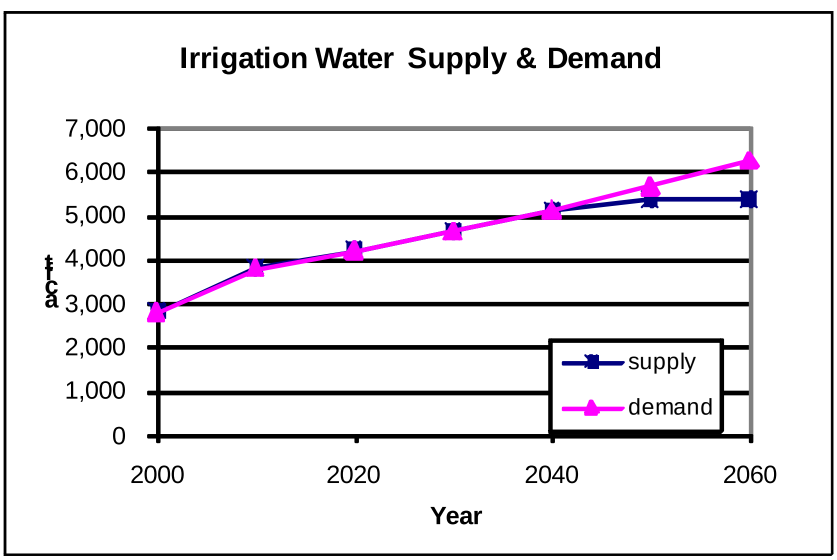




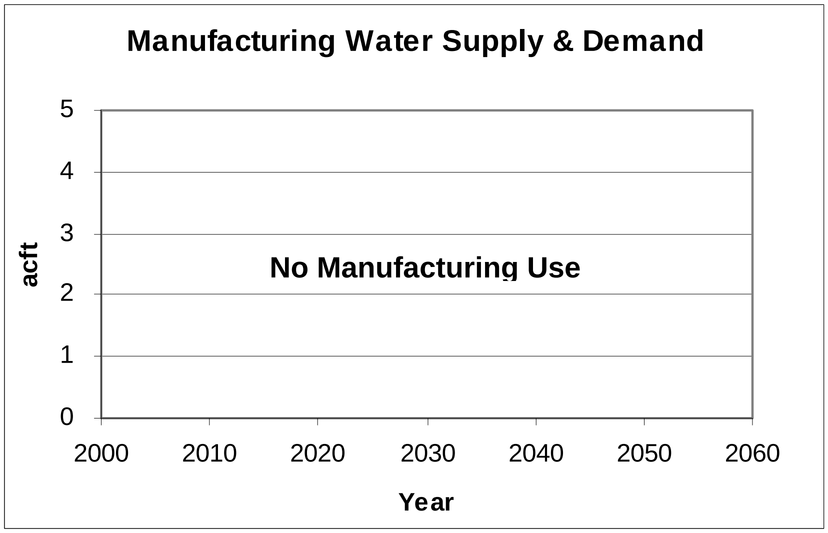
Bee County

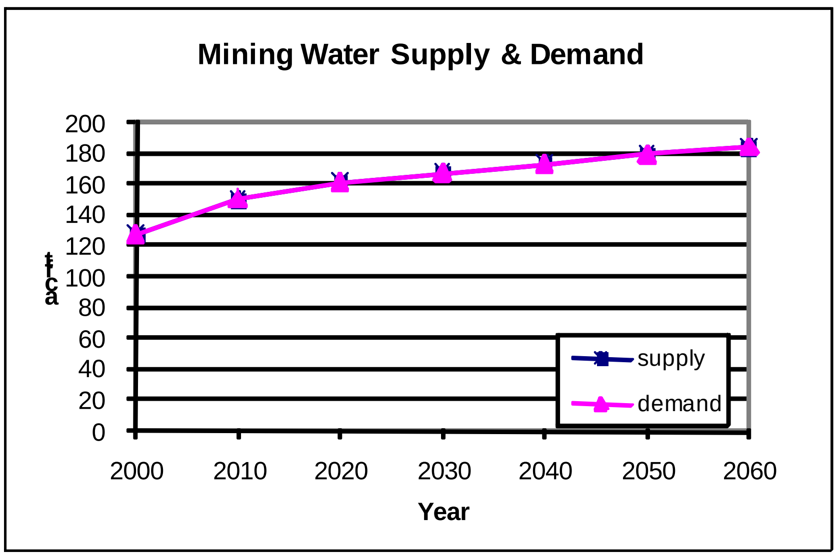

Manufacturing Water Supply & Demand
acft
5
4
3
2
1
0
2000
2010
2020
2030
2040
2050
2060
Year
supply
demand

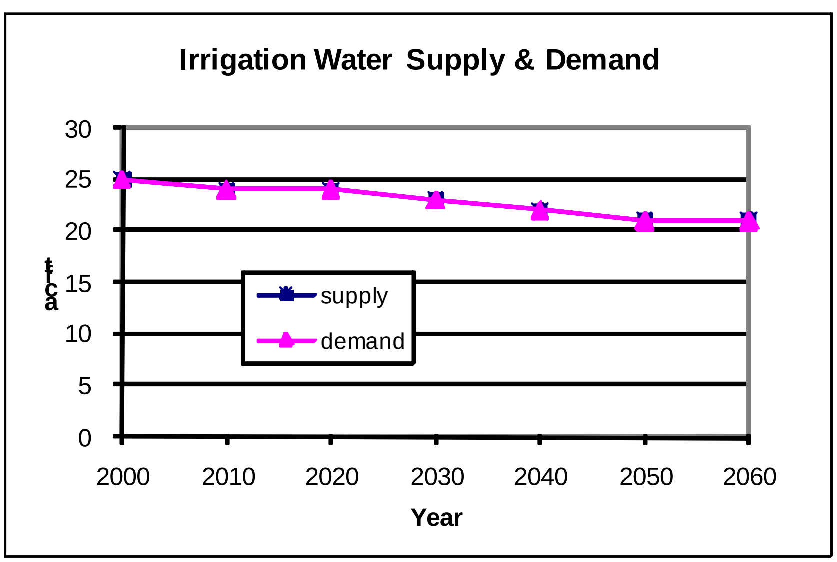

Mining Water Supply & Demand
acft
60
50
40
30
20
10
0
2000
2010
2020
2030
2040
2050
2060
Year
supply
demand


Irrigation Water Supply & Demand
acft
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
2000
2020
2040
2060
Year
supply
demand

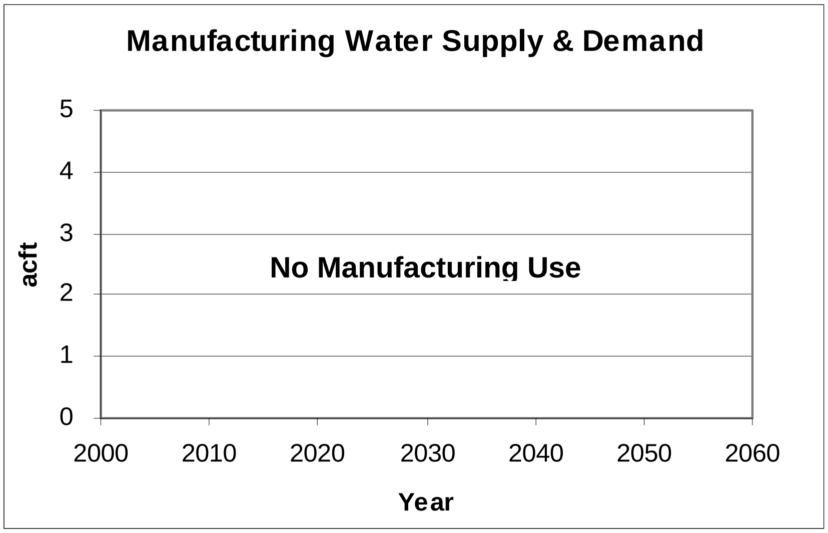
Brooks County

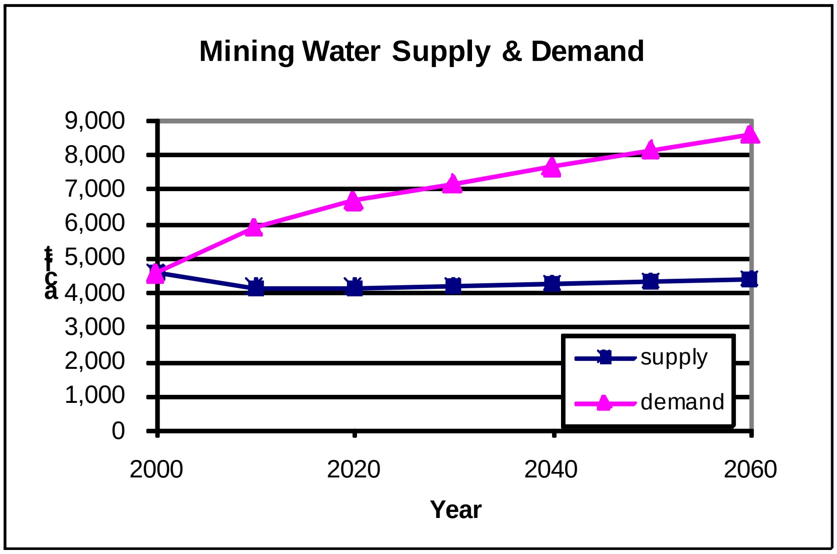


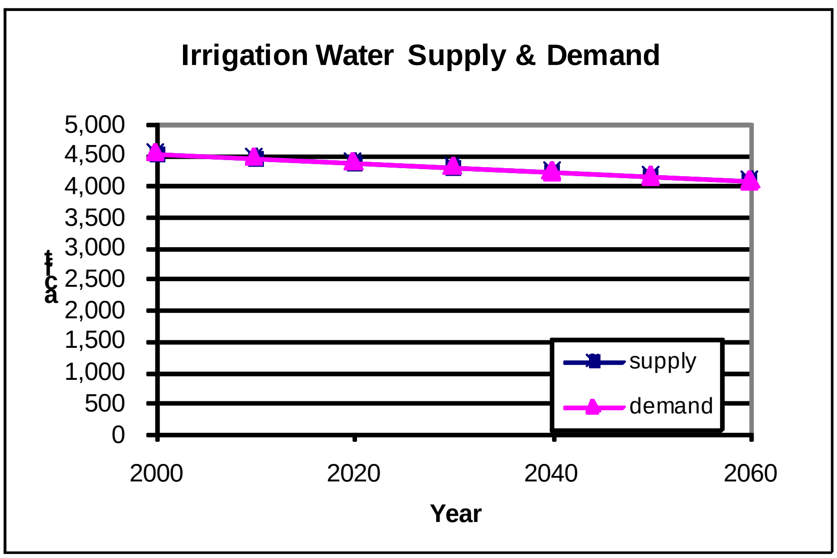




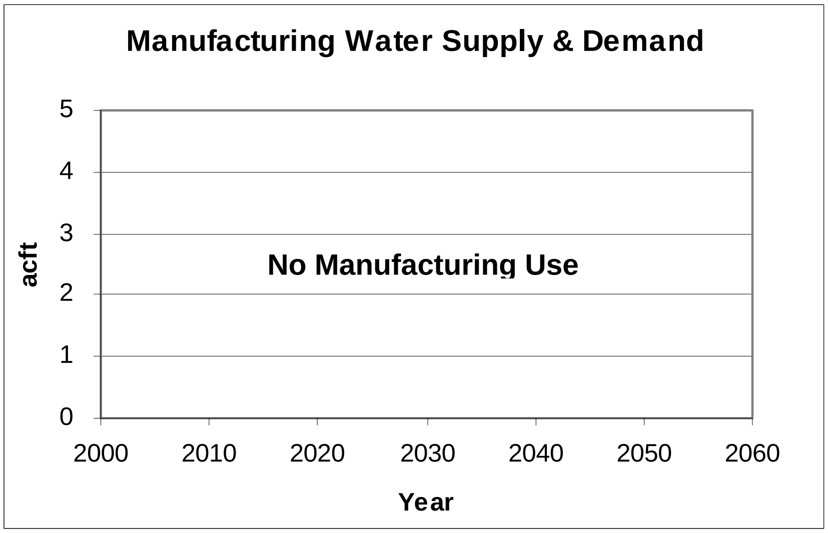
Duval County

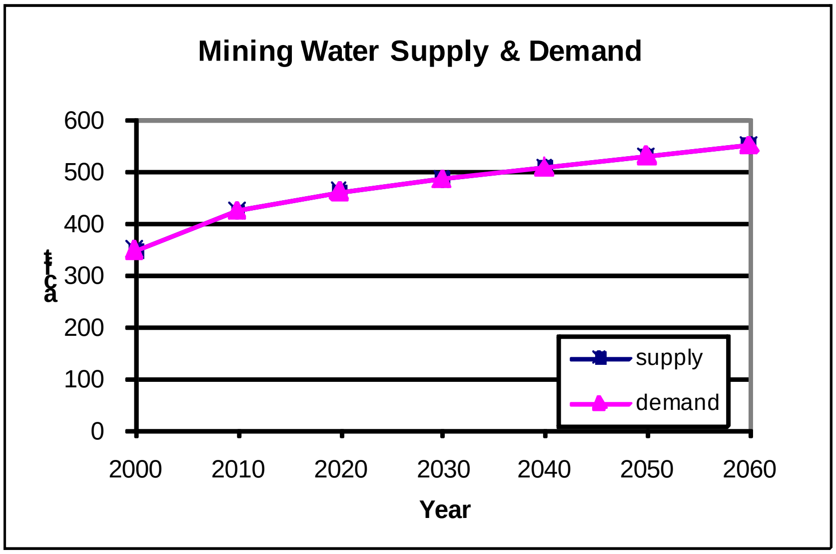


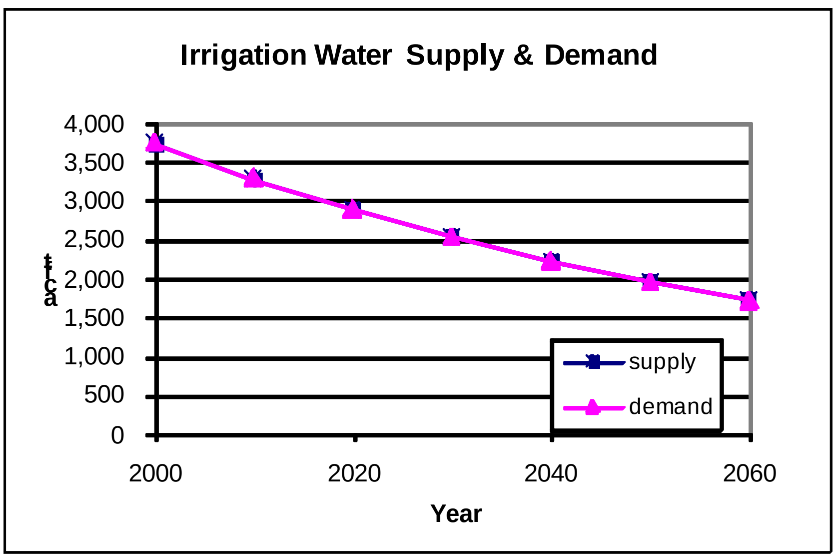




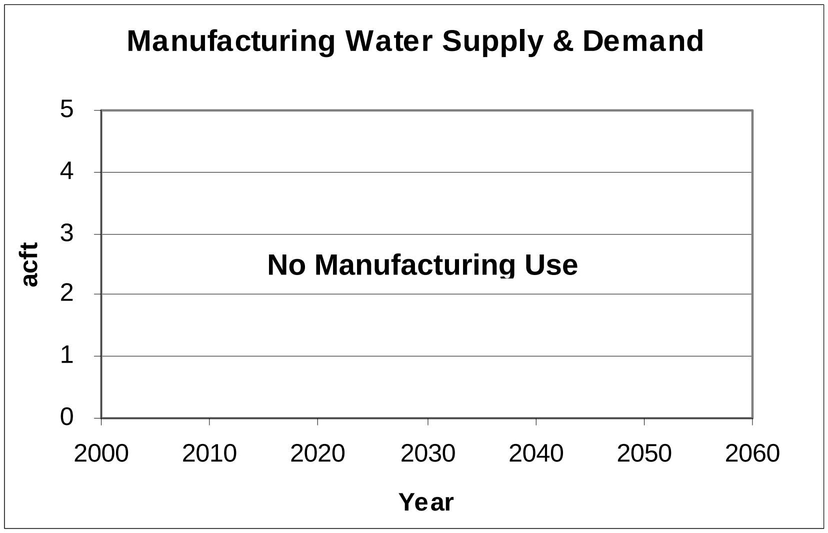
Jim Wells County

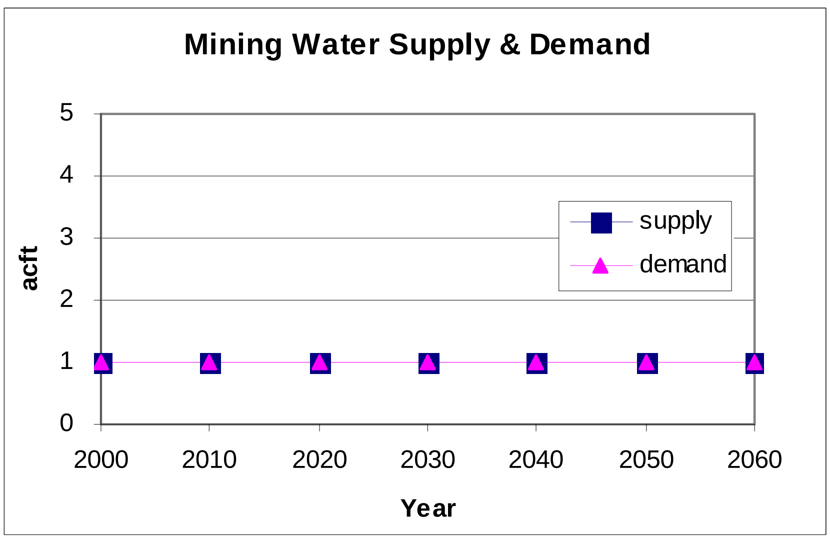


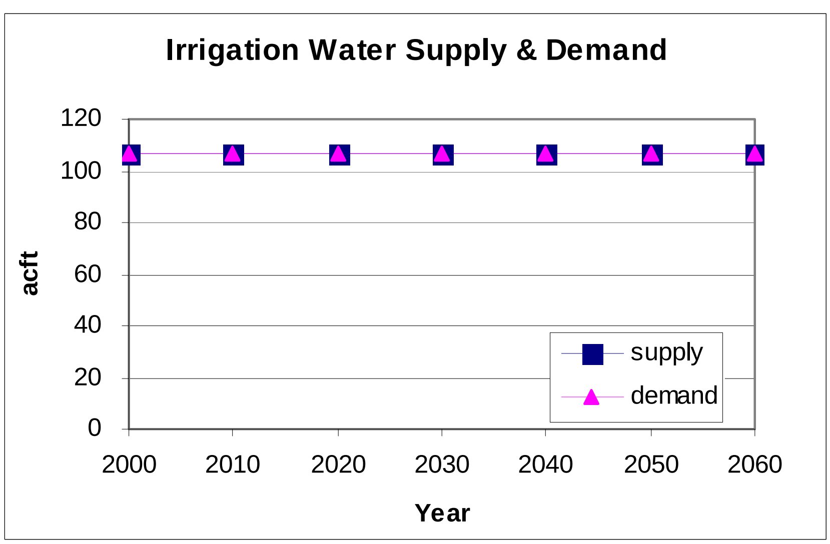




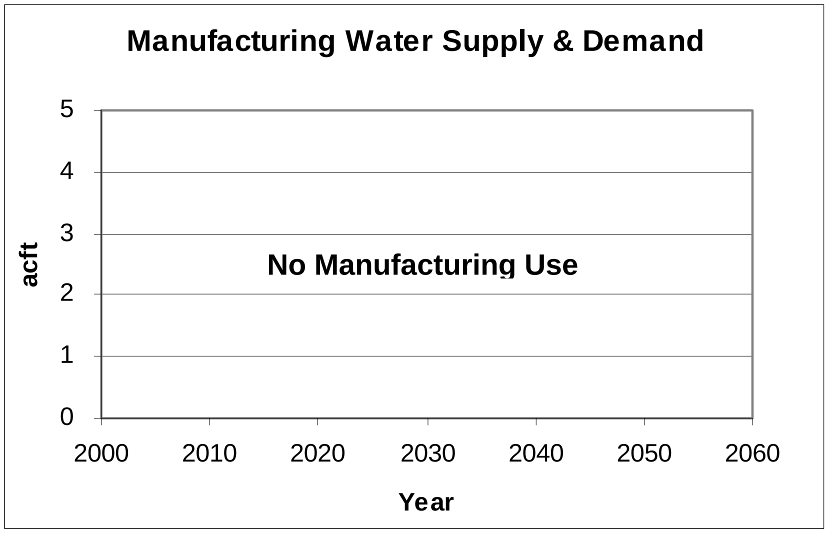
Kenedy County

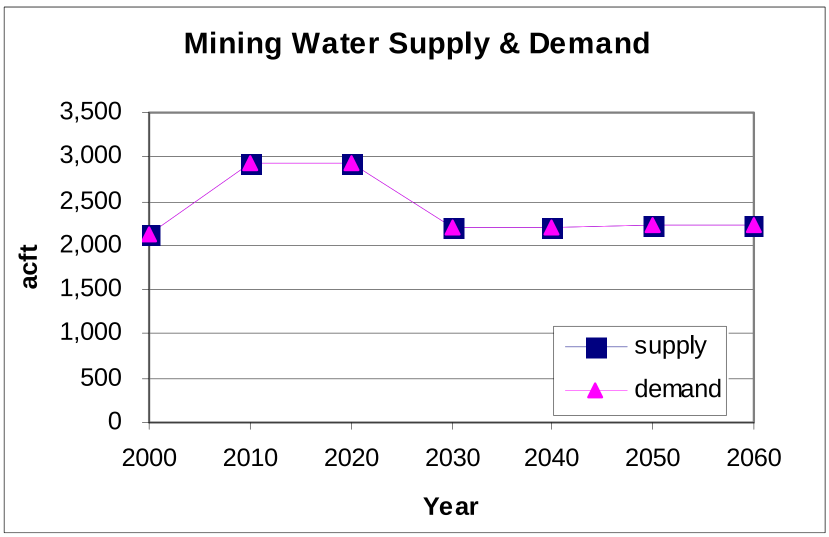


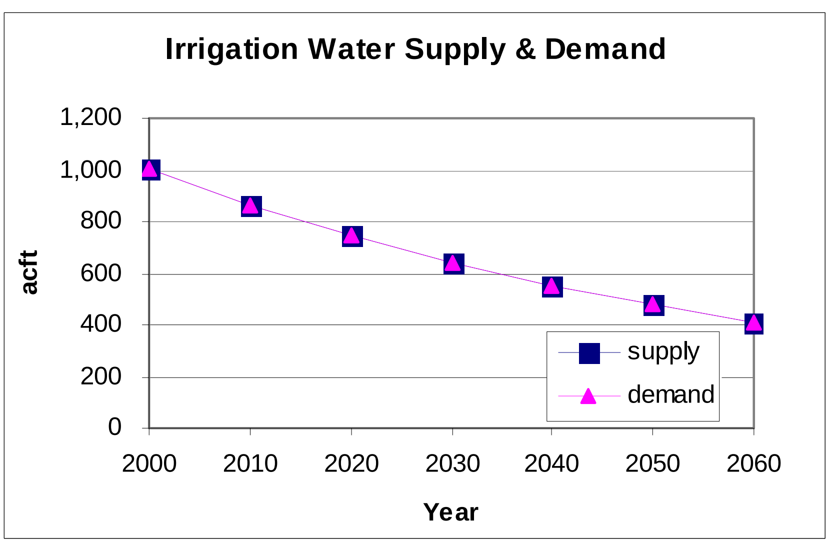




Kleberg County







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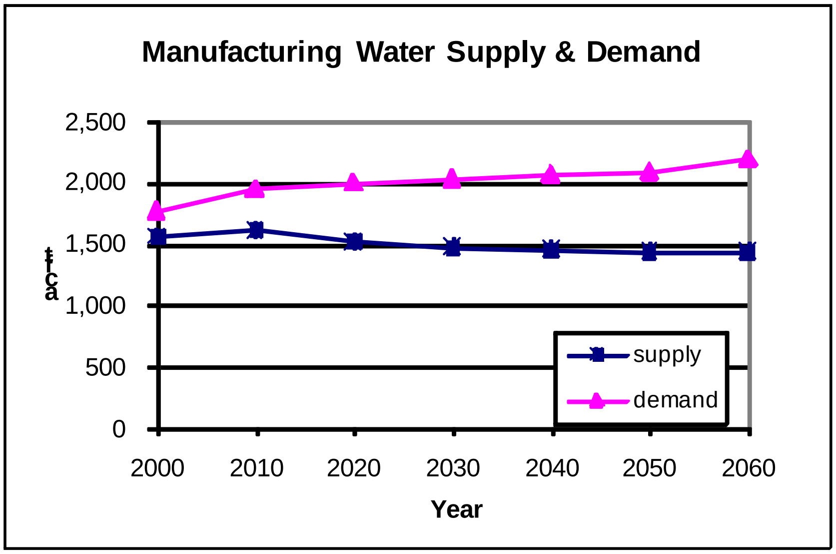
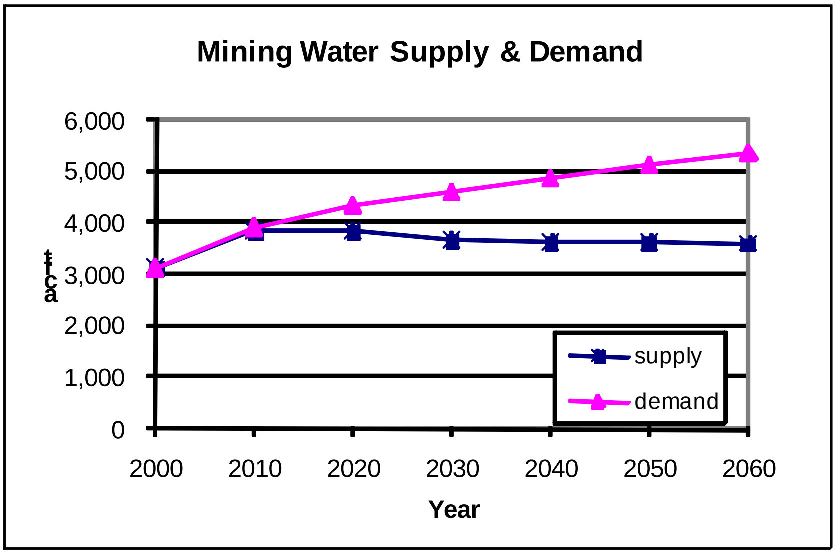
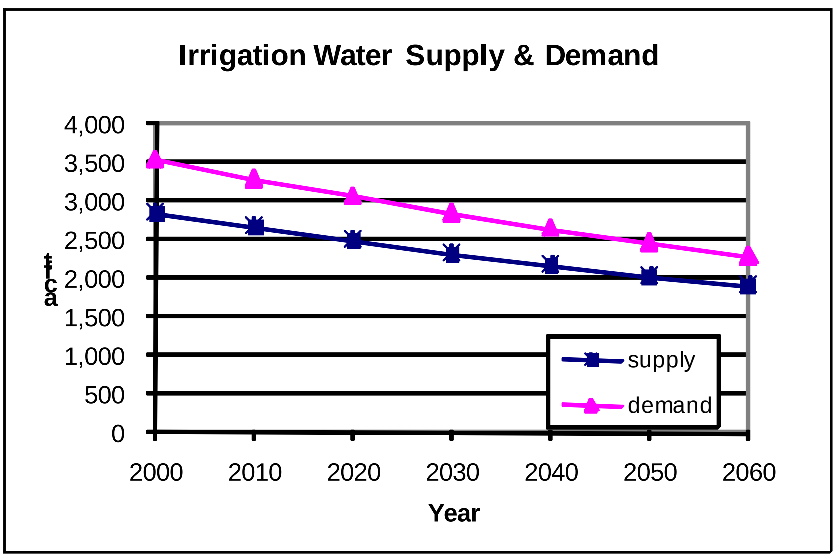
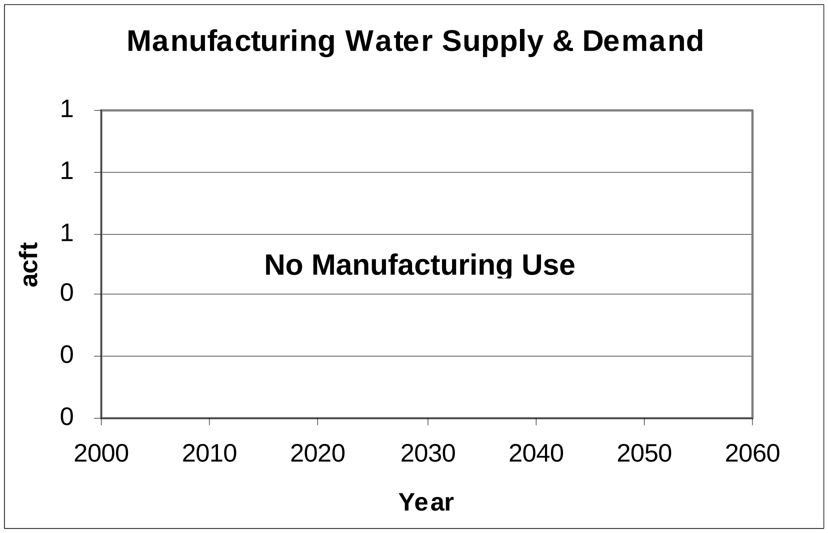
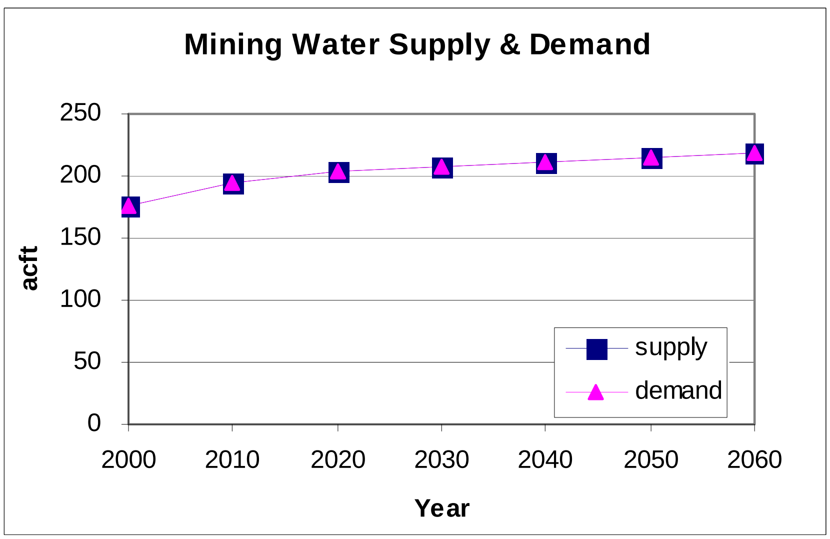


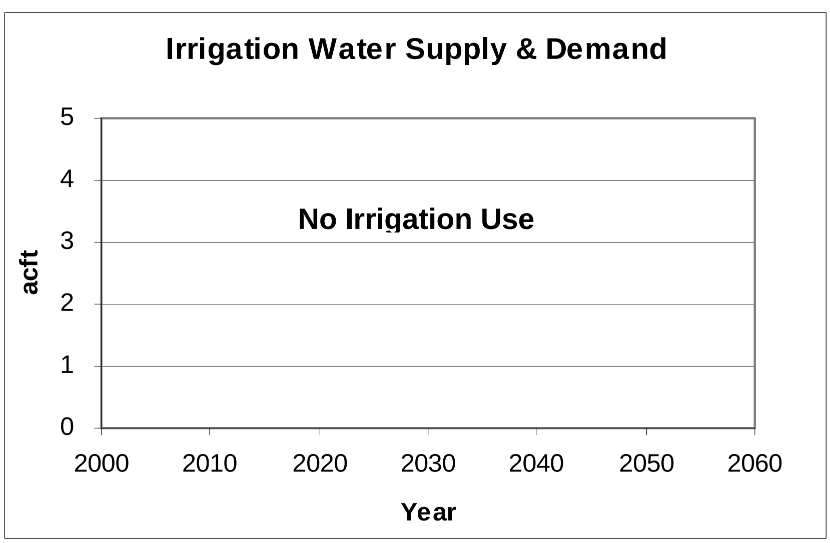




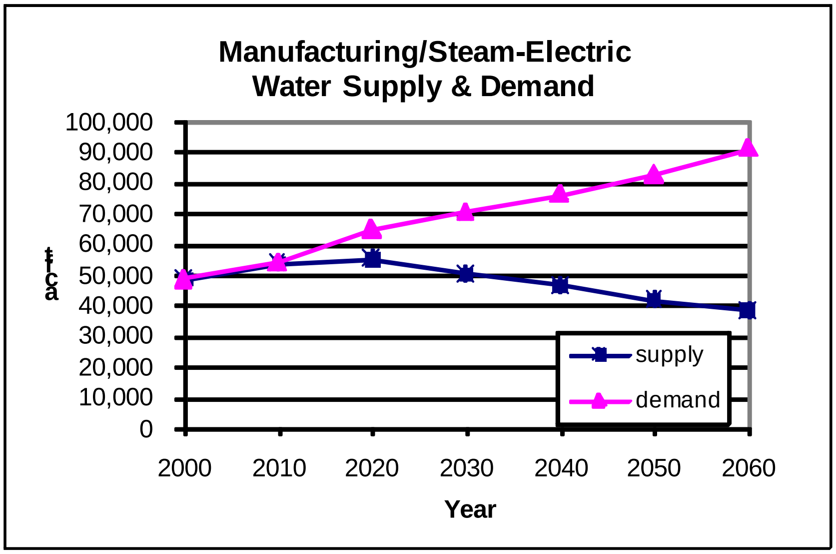
McMullen County

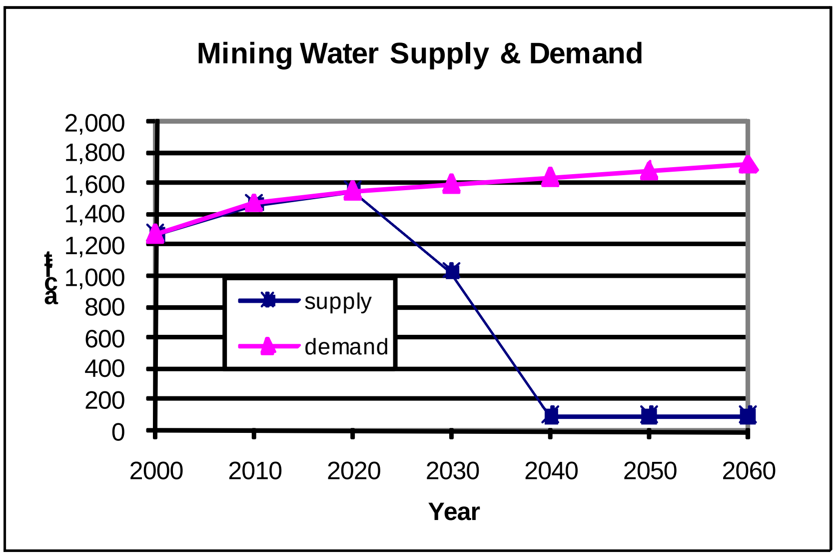


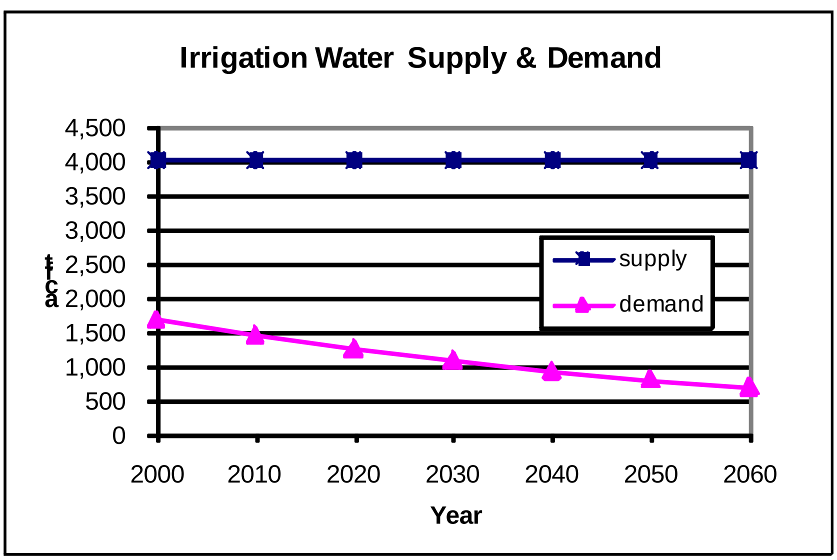




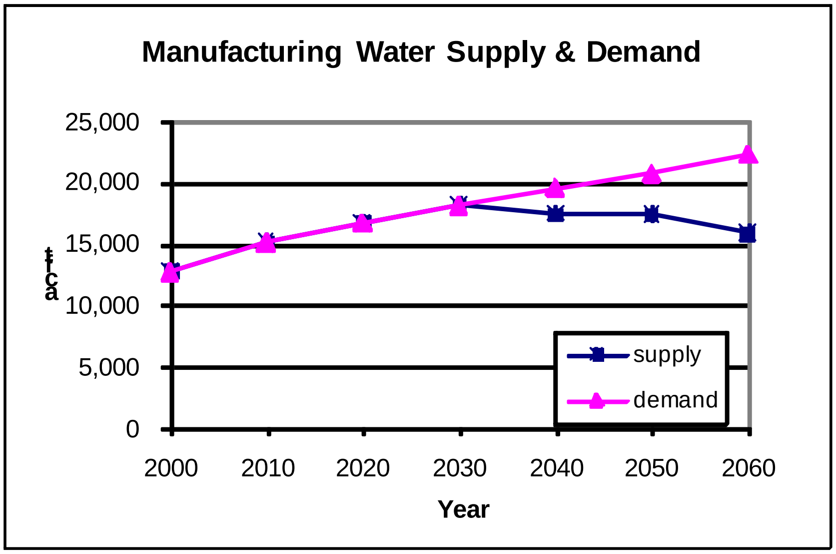
Nueces County

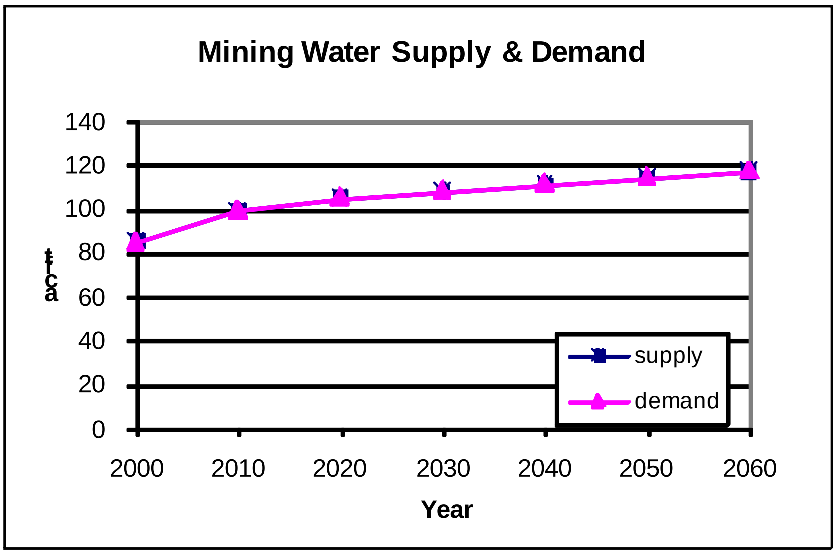


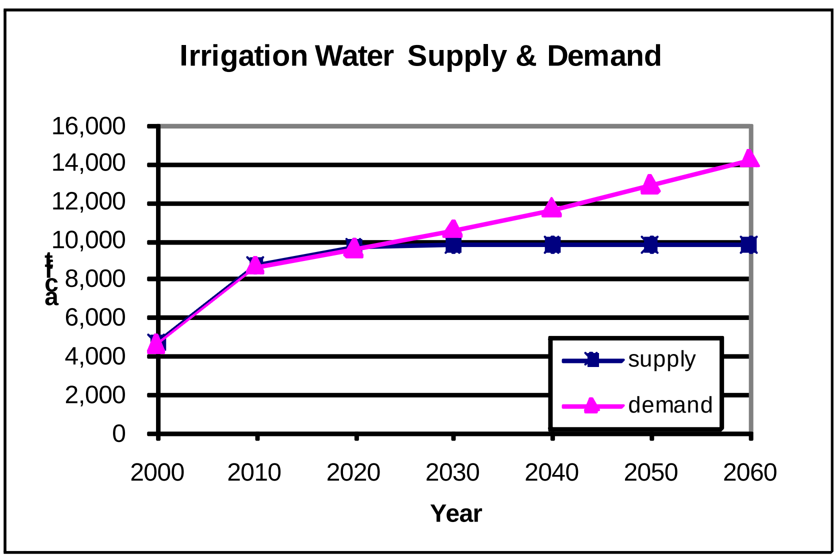




San Patricio County







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Appendix C.3

Population and Water Demands for Water User Groups by County and River Basins

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Population for Water User Groups by County and River Basin

DBWUGID	WUG ID	WUG Name	WUG RWPG	WUG County Name	WUG Basin Name	WUG Detail	P2010	P2020	P2030	P2040	P2050	P2060
2648	140808000	AGUA DULCE	N	NUECES	NUECES-RIO GRANDE	NONE	737	737	737	737	737	737
2649	140006000	ALICE	N	JIM WELLS	NUECES-RIO GRANDE	NONE	20512	21899	22792	23181	23017	22524
2650	140023000	ARANSAS PASS	N	ARANSAS	SAN ANTONIO-NUECES	NONE	1035	1179	1255	1241	1172	1110
2651	140023000	ARANSAS PASS	N	NUECES	SAN ANTONIO-NUECES	NONE	163	259	343	417	482	534
2652	140023000	ARANSAS PASS	N	SAN PATRICIO	SAN ANTONIO-NUECES	NONE	8653	10225	11739	13134	14447	15660
2653	140045000	BEEVILLE	N	BEE	SAN ANTONIO-NUECES	NONE	13916	14646	15092	15252	15255	14885
2654	140050000	BENAVIDES	N	DUVAL	NUECES-RIO GRANDE	NONE	1784	1867	1912	1925	1872	1776
2655	140059000	BISHOP	N	NUECES	NUECES-RIO GRANDE	NONE	3305	3305	3305	3305	3305	3305
3781	144055000	CHOKE CANYON WS	N	LIVE OAK	NUECES	NONE	2511	2729	2812	2745	2524	2271
3782	144055000	CHOKE CANYON WS	N	MCMULLEN	NUECES	NONE	270	281	270	254	246	233
2656	140135000	CORPUS CHRISTI	N	NUECES	NUECES	NONE	25872	29152	32013	34525	36745	38517
2657	140135000	CORPUS CHRISTI	N	NUECES	NUECES-RIO GRANDE	NONE	290186	326971	359064	387236	412134	432006
2684	140757004	COUNTY-OTHER	N	ARANSAS	SAN ANTONIO-NUECES	NONE	15156	17266	18369	18167	17163	16243
2686	140757013	COUNTY-OTHER	N	BEE	NUECES	NONE	199	210	216	218	218	213
2685	140757013	COUNTY-OTHER	N	BEE	SAN ANTONIO-NUECES	NONE	19844	20886	21522	21749	21753	21225
2687	140757024	COUNTY-OTHER	N	BROOKS	NUECES-RIO GRANDE	NONE	1626	987	599	364	221	134
2688	140757066	COUNTY-OTHER	N	DUVAL	NUECES	NONE	424	443	455	457	446	422
2689	140757066	COUNTY-OTHER	N	DUVAL	NUECES-RIO GRANDE	NONE	4088	4279	4383	4411	4290	4070
2690	140757125	COUNTY-OTHER	N	JIM WELLS	NUECES	NONE	2448	2613	2720	2766	2747	2688
2691	140757125	COUNTY-OTHER	N	JIM WELLS	NUECES-RIO GRANDE	NONE	14203	15164	15781	16051	15937	15596
2692	140757131	COUNTY-OTHER	N	KENEDY	NUECES-RIO GRANDE	NONE	467	495	523	527	529	537
2693	140757137	COUNTY-OTHER	N	KLEBERG	NUECES-RIO GRANDE	NONE	4428	4971	5323	5549	5846	5859
2694	140757149	COUNTY-OTHER	N	LIVE OAK	NUECES	NONE	4702	5111	5268	5143	4727	4253
2695	140757156	COUNTY-OTHER	N	MCMULLEN	NUECES	NONE	650	676	648	612	591	560
2697	140757178	COUNTY-OTHER	N	NUECES	NUECES	NONE	1389	974	684	480	336	236
2698	140757178	COUNTY-OTHER	N	NUECES	NUECES-RIO GRANDE	NONE	3863	2586	1731	1157	771	513
2700	140757205	COUNTY-OTHER	N	SAN PATRICIO	NUECES	NONE	4340	4773	5190	5575	5937	6271
2699	140757205	COUNTY-OTHER	N	SAN PATRICIO	SAN ANTONIO-NUECES	NONE	12860	14145	15381	16520	17591	18582
2658	140859000	DRISCOLL	N	NUECES	NUECES-RIO GRANDE	NONE	1090	1364	1603	1813	1999	2147

Population for Water User Groups by County and River Basin (Continued)

DBWUGID	WUG ID	WUG Name	WUG RWPG	WUG County Name	WUG Basin Name	WUG Detail	P2010	P2020	P2030	P2040	P2050	P2060
3783	144104000	EL OSO WSC	N	BEE	NUECES	NONE	299	315	324	328	328	320
3784	144104000	EL OSO WSC	N	BEE	SAN ANTONIO-NUECES	NONE	40	42	44	44	44	43
3785	144104000	EL OSO WSC	N	LIVE OAK	NUECES	NONE	1116	1213	1250	1220	1122	1009
2659	140197000	FALFURRIAS	N	BROOKS	NUECES-RIO GRANDE	NONE	6981	8316	9310	9924	10178	10215
2660	140218000	FREER	N	DUVAL	NUECES	NONE	3429	3589	3676	3699	3598	3414
2661	140870000	FULTON	N	ARANSAS	SAN ANTONIO-NUECES	NONE	1854	2113	2248	2223	2100	1987
2662	140234000	GEORGE WEST	N	LIVE OAK	NUECES	NONE	2816	3061	3155	3079	2831	2548
2663	140251000	GREGORY	N	SAN PATRICIO	SAN ANTONIO-NUECES	NONE	2318	2318	2318	2318	2318	2318
2664	140296000	INGLESIDE	N	SAN PATRICIO	SAN ANTONIO-NUECES	NONE	15003	21080	26933	32327	37402	42090
3779	141027000	INGLESIDE ON THE BAY	N	SAN PATRICIO	SAN ANTONIO-NUECES	NONE	857	1071	1277	1467	1646	1811
2665	140323000	KINGSVILLE	N	KLEBERG	NUECES-RIO GRANDE	NONE	26844	27756	28347	28727	29226	29248
3780	141035000	LAKE CITY	N	SAN PATRICIO	NUECES	NONE	619	719	816	905	989	1066
2666	140392000	MATHIS	N	SAN PATRICIO	NUECES	NONE	5034	5034	5034	5034	5034	5034
3786	144250000	MCCOY WSC	N	LIVE OAK	NUECES	NONE	494	537	554	540	497	447
3787	144289000	NUECES COUNTY WCID #4	N	NUECES	NUECES-RIO GRANDE	NONE	9434	14385	18704	22496	25847	28521
2668	140437000	ODEM	N	SAN PATRICIO	SAN ANTONIO-NUECES	NONE	2701	2920	3131	3325	3508	3677
2669	140444000	ORANGE GROVE	N	JIM WELLS	NUECES-RIO GRANDE	NONE	1390	1484	1544	1571	1559	1526
2671	140475000	PORT ARANSAS	N	NUECES	NUECES-RIO GRANDE	NONE	5565	7843	9830	11575	13117	14348
2672	140478000	PORTLAND	N	SAN PATRICIO	SAN ANTONIO-NUECES	NONE	18786	23071	27197	31000	34578	37884
2673	140486000	PREMONT	N	JIM WELLS	NUECES-RIO GRANDE	NONE	2991	3193	3323	3380	3356	3284
3788	144316000	RICARDO WSC	N	KLEBERG	NUECES-RIO GRANDE	NONE	5687	8122	9700	10713	12046	12105
3789	144320000	RIVER ACRES WSC	N	NUECES	NUECES	NONE	3947	5189	6273	7224	8065	8736
2674	140508000	ROBSTOWN	N	NUECES	NUECES-RIO GRANDE	NONE	12727	12727	12727	12727	12727	12727
2675	140511000	ROCKPORT	N	ARANSAS	SAN ANTONIO-NUECES	NONE	8818	10046	10688	10570	9987	9451
2676	140534000	SAN DIEGO	N	DUVAL	NUECES-RIO GRANDE	NONE	4156	4350	4456	4484	4361	4137
2677	140534000	SAN DIEGO	N	JIM WELLS	NUECES-RIO GRANDE	NONE	890	950	989	1006	999	978
2679	140562000	SINTON	N	SAN PATRICIO	SAN ANTONIO-NUECES	NONE	5869	6078	6279	6465	6640	6801
2680	140592000	TAFT	N	SAN PATRICIO	SAN ANTONIO-NUECES	NONE	3661	3947	4223	4477	4716	4937
2682	140604000	THREE RIVERS	N	LIVE OAK	NUECES	NONE	2096	2278	2347	2291	2107	1896

Water Demands for Water User Groups by County and River Basin

DBWUG ID	WUG ID	WUG Name	WUG RWPG	WUG County Name	WUG Basin Name	WUG Detail	CNWD2010	CNWD2020	CNWD2030	CNWD2040	CNWD2050	CNWD2060
2648	140808000	AGUA DULCE	N	NUECES	NUECES-RIO GRANDE	NONE	112	110	107	105	103	103
2649	140006000	ALICE	N	JIM WELLS	NUECES-RIO GRANDE	NONE	5606	5912	6076	6102	6033	5904
2650	140023000	ARANSAS PASS	N	ARANSAS	SAN ANTONIO-NUECES	NONE	168	186	195	190	179	169
2651	140023000	ARANSAS PASS	N	NUECES	SAN ANTONIO-NUECES	NONE	26	41	53	64	73	81
2652	140023000	ARANSAS PASS	N	SAN PATRICIO	SAN ANTONIO-NUECES	NONE	1405	1615	1828	2015	2201	2386
2653	140045000	BEEVILLE	N	BEE	SAN ANTONIO-NUECES	NONE	2619	2690	2722	2699	2683	2618
2654	140050000	BENAVIDES	N	DUVAL	NUECES-RIO GRANDE	NONE	326	333	334	330	319	302
2655	140059000	BISHOP	N	NUECES	NUECES-RIO GRANDE	NONE	444	433	422	411	404	404
3781	144055000	CHOKE CANYON WS	N	LIVE OAK	NUECES	NONE	397	425	435	421	384	346
3782	144055000	CHOKE CANYON WS	N	MCMULLEN	NUECES	NONE	43	44	42	39	37	35
2656	140135000	CORPUS CHRISTI	N	NUECES	NUECES	NONE	5071	5584	6024	6420	6791	7119
2657	140135000	CORPUS CHRISTI	N	NUECES	NUECES-RIO GRANDE	NONE	56882	62628	67568	72002	76170	79843
2684	140757004	COUNTY-OTHER	N	ARANSAS	SAN ANTONIO-NUECES	NONE	1766	1953	2016	1954	1826	1728
2686	140757013	COUNTY-OTHER	N	BEE	NUECES	NONE	16	17	17	17	16	16
2685	140757013	COUNTY-OTHER	N	BEE	SAN ANTONIO-NUECES	NONE	1645	1684	1687	1657	1633	1593
2687	140757024	COUNTY-OTHER	N	BROOKS	NUECES-RIO GRANDE	NONE	180	106	62	37	22	13
2688	140757066	COUNTY-OTHER	N	DUVAL	NUECES	NONE	89	92	93	92	89	84
2689	140757066	COUNTY-OTHER	N	DUVAL	NUECES-RIO GRANDE	NONE	861	887	894	884	855	811
2690	140757125	COUNTY-OTHER	N	JIM WELLS	NUECES	NONE	313	325	329	325	320	313
2691	140757125	COUNTY-OTHER	N	JIM WELLS	NUECES-RIO GRANDE	NONE	1814	1885	1909	1888	1857	1817
2692	140757131	COUNTY-OTHER	N	KENEDY	NUECES-RIO GRANDE	NONE	50	52	53	53	52	53
2693	140757137	COUNTY-OTHER	N	KLEBERG	NUECES-RIO GRANDE	NONE	799	880	930	957	1002	1004
2694	140757149	COUNTY-OTHER	N	LIVE OAK	NUECES	NONE	748	796	808	778	709	638
2695	140757156	COUNTY-OTHER	N	MCMULLEN	NUECES	NONE	143	146	138	129	123	117
2697	140757178	COUNTY-OTHER	N	NUECES	NUECES	NONE	236	163	112	77	53	37
2698	140757178	COUNTY-OTHER	N	NUECES	NUECES-RIO GRANDE	NONE	658	432	283	185	122	81
2700	140757205	COUNTY-OTHER	N	SAN PATRICIO	NUECES	NONE	491	524	552	575	605	639
2699	140757205	COUNTY-OTHER	N	SAN PATRICIO	SAN ANTONIO-NUECES	NONE	1455	1553	1637	1702	1793	1894
2658	140859000	DRISCOLL	N	NUECES	NUECES-RIO GRANDE	NONE	122	148	171	191	208	224
3783	144104000	EL OSO WSC	N	BEE	NUECES	NONE	55	57	58	58	57	56
3784	144104000	EL OSO WSC	N	BEE	SAN ANTONIO-NUECES	NONE	7	8	8	8	8	8
3785	144104000	EL OSO WSC	N	LIVE OAK	NUECES	NONE	206	220	223	215	196	176
2659	140197000	FALFURRIAS	N	BROOKS	NUECES-RIO GRANDE	NONE	2135	2515	2795	2957	3021	3032

Water Demands for Water User Groups by County and River Basin (Continued)

DBWUG ID	WUG ID	WUG Name	WUG RWPG	WUG County Name	WUG Basin Name	WUG Detail	CNWD2010	CNWD2020	CNWD2030	CNWD2040	CNWD2050	CNWD2060
2660	140218000	FREER	N	DUVAL	NUECES	NONE	645	659	663	655	633	600
2661	140870000	FULTON	N	ARANSAS	SAN ANTONIO-NUECES	NONE	307	346	365	359	336	318
2662	140234000	GEORGE WEST	N	LIVE OAK	NUECES	NONE	703	754	767	738	675	608
2663	140251000	GREGORY	N	SAN PATRICIO	SAN ANTONIO-NUECES	NONE	239	231	223	216	210	210
2664	140296000	INGLESIDE	N	SAN PATRICIO	SAN ANTONIO-NUECES	NONE	1294	1771	2202	2607	3016	3394
3779	141027000	INGLESIDE ON THE BAY	N	SAN PATRICIO	SAN ANTONIO-NUECES	NONE	92	112	130	148	164	181
3823	141004013	IRRIGATION	N	BEE	NUECES	NONE	380	419	463	513	564	622
2728	141004013	IRRIGATION	N	BEE	SAN ANTONIO-NUECES	NONE	3416	3774	4169	4603	5088	5621
2729	141004024	IRRIGATION	N	BROOKS	NUECES-RIO GRANDE	NONE	24	24	23	22	21	21
2730	141004066	IRRIGATION	N	DUVAL	NUECES-RIO GRANDE	NONE	4444	4365	4289	4212	4138	4064
2731	141004125	IRRIGATION	N	JIM WELLS	NUECES	NONE	1180	1036	910	799	703	618
2732	141004125	IRRIGATION	N	JIM WELLS	NUECES-RIO GRANDE	NONE	2098	1842	1618	1422	1250	1099
3824	141004131	IRRIGATION	N	KENEDY	NUECES-RIO GRANDE	NONE	107	107	107	107	107	107
2733	141004137	IRRIGATION	N	KLEBERG	NUECES-RIO GRANDE	NONE	866	745	644	555	477	410
2734	141004149	IRRIGATION	N	LIVE OAK	NUECES	NONE	3289	3056	2840	2639	2451	2277
2735	141004178	IRRIGATION	N	NUECES	NUECES	NONE	1402	1210	1042	898	775	670
2736	141004178	IRRIGATION	N	NUECES	NUECES-RIO GRANDE	NONE	47	40	35	30	26	22
2738	141004205	IRRIGATION	N	SAN PATRICIO	NUECES	NONE	346	383	424	467	515	567
2737	141004205	IRRIGATION	N	SAN PATRICIO	SAN ANTONIO-NUECES	NONE	8285	9151	10107	11166	12335	13628
2665	140323000	KINGSVILLE	N	KLEBERG	NUECES-RIO GRANDE	NONE	4570	4601	4604	4569	4616	4619
3780	141035000	LAKE CITY	N	SAN PATRICIO	NUECES	NONE	79	89	99	107	116	125
2739	141005004	LIVESTOCK	N	ARANSAS	SAN ANTONIO-NUECES	NONE	23	23	23	23	23	23
2741	141005013	LIVESTOCK	N	BEE	NUECES	NONE	119	119	119	119	119	119
2740	141005013	LIVESTOCK	N	BEE	SAN ANTONIO-NUECES	NONE	876	876	876	876	876	876
2742	141005024	LIVESTOCK	N	BROOKS	NUECES-RIO GRANDE	NONE	747	747	747	747	747	747
2743	141005066	LIVESTOCK	N	DUVAL	NUECES	NONE	210	210	210	210	210	210
2744	141005066	LIVESTOCK	N	DUVAL	NUECES-RIO GRANDE	NONE	663	663	663	663	663	663
2745	141005125	LIVESTOCK	N	JIM WELLS	NUECES	NONE	181	181	181	181	181	181
2746	141005125	LIVESTOCK	N	JIM WELLS	NUECES-RIO GRANDE	NONE	883	883	883	883	883	883
2747	141005131	LIVESTOCK	N	KENEDY	NUECES-RIO GRANDE	NONE	901	901	901	901	901	901
2748	141005137	LIVESTOCK	N	KLEBERG	NUECES-RIO GRANDE	NONE	1900	1900	1900	1900	1900	1900
2749	141005149	LIVESTOCK	N	LIVE OAK	NUECES	NONE	833	833	833	833	833	833

Water Demands for Water User Groups by County and River Basin (Continued)

DBWUG ID	WUG ID	WUG Name	WUG RWPG	WUG County Name	WUG Basin Name	WUG Detail	CNWD2010	CNWD2020	CNWD2030	CNWD2040	CNWD2050	CNWD2060
2750	141005156	LIVESTOCK	N	MCMULLEN	NUECES	NONE	659	659	659	659	659	659
2751	141005178	LIVESTOCK	N	NUECES	NUECES	NONE	31	31	31	31	31	31
2752	141005178	LIVESTOCK	N	NUECES	NUECES-RIO GRANDE	NONE	248	248	248	248	248	248
2754	141005205	LIVESTOCK	N	SAN PATRICIO	NUECES	NONE	186	186	186	186	186	186
2753	141005205	LIVESTOCK	N	SAN PATRICIO	SAN ANTONIO-NUECES	NONE	378	378	378	378	378	378
2701	141001004	MANUFACTURING	N	ARANSAS	SAN ANTONIO-NUECES	NONE	267	281	292	302	311	331
2702	141001013	MANUFACTURING	N	BEE	SAN ANTONIO-NUECES	NONE	1	1	1	1	1	1
2703	141001149	MANUFACTURING	N	LIVE OAK	NUECES	NONE	1946	1998	2032	2063	2088	2194
2705	141001178	MANUFACTURING	N	NUECES	NUECES	NONE	1494	1615	1716	1815	1900	2033
2706	141001178	MANUFACTURING	N	NUECES	NUECES-RIO GRANDE	NONE	45016	48661	51709	54685	57250	61280
2708	141001205	MANUFACTURING	N	SAN PATRICIO	NUECES	NONE	8491	9393	10187	10971	11662	12534
2707	141001205	MANUFACTURING	N	SAN PATRICIO	SAN ANTONIO-NUECES	NONE	6605	7306	7924	8534	9071	9749
2666	140392000	MATHIS	N	SAN PATRICIO	NUECES	NONE	648	632	615	598	586	586
3786	144250000	MCCOY WSC	N	LIVE OAK	NUECES	NONE	54	57	58	56	51	46
2711	141003004	MINING	N	ARANSAS	SAN ANTONIO-NUECES	NONE	103	115	123	131	139	146
2713	141003013	MINING	N	BEE	NUECES	NONE	16	18	19	20	21	22
2712	141003013	MINING	N	BEE	SAN ANTONIO-NUECES	NONE	20	22	23	24	25	26
2714	141003024	MINING	N	BROOKS	NUECES-RIO GRANDE	NONE	150	161	167	173	179	184
2715	141003066	MINING	N	DUVAL	NUECES	NONE	2009	2273	2441	2609	2780	2933
2716	141003066	MINING	N	DUVAL	NUECES-RIO GRANDE	NONE	3851	4357	4678	5001	5328	5620
2717	141003125	MINING	N	JIM WELLS	NUECES	NONE	200	218	229	240	250	260
2718	141003125	MINING	N	JIM WELLS	NUECES-RIO GRANDE	NONE	223	243	255	267	280	290
2719	141003131	MINING	N	KENEDY	NUECES-RIO GRANDE	NONE	1	1	1	1	1	1
2720	141003137	MINING	N	KLEBERG	NUECES-RIO GRANDE	NONE	2917	2934	2207	2216	2225	2232
2721	141003149	MINING	N	LIVE OAK	NUECES	NONE	3894	4319	4583	4845	5108	5341
2722	141003156	MINING	N	MCMULLEN	NUECES	NONE	195	203	207	211	215	218
2724	141003178	MINING	N	NUECES	NUECES	NONE	11	11	12	12	12	12
2725	141003178	MINING	N	NUECES	NUECES-RIO GRANDE	NONE	521	551	566	581	596	611
2723	141003178	MINING	N	NUECES	SAN ANTONIO-NUECES	NONE	940	993	1021	1048	1074	1101
2727	141003205	MINING	N	SAN PATRICIO	NUECES	NONE	24	26	27	27	28	29
2726	141003205	MINING	N	SAN PATRICIO	SAN ANTONIO-NUECES	NONE	75	79	81	84	86	88
3787	144289000	NUECES COUNTY WCID #4	N	NUECES	NUECES-RIO GRANDE	NONE	1913	2884	3729	4460	5124	5655

Water Demands for Water User Groups by County and River Basin (Concluded)

DBWUG ID	WUG ID	WUG Name	WUG RWPG	WUG County Name	WUG Basin Name	WUG Detail	CNWD2010	CNWD2020	CNWD2030	CNWD2040	CNWD2050	CNWD2060
2668	140437000	ODEM	N	SAN PATRICIO	SAN ANTONIO-NUECES	NONE	330	347	361	372	389	408
2669	140444000	ORANGE GROVE	N	JIM WELLS	NUECES-RIO GRANDE	NONE	374	394	405	406	402	393
2671	140475000	PORT ARANSAS	N	NUECES	NUECES-RIO GRANDE	NONE	2606	3655	4558	5355	6068	6637
2672	140478000	PORTLAND	N	SAN PATRICIO	SAN ANTONIO-NUECES	NONE	2399	2868	3290	3715	4106	4498
2673	140486000	PREMONT	N	JIM WELLS	NUECES-RIO GRANDE	NONE	858	905	931	935	925	905
3788	144316000	RICARDO WSC	N	KLEBERG	NUECES-RIO GRANDE	NONE	682	955	1130	1236	1390	1397
3789	144320000	RIVER ACRES WSC	N	NUECES	NUECES	NONE	429	546	646	736	813	881
2674	140508000	ROBSTOWN	N	NUECES	NUECES-RIO GRANDE	NONE	2110	2067	2024	1982	1953	1953
2675	140511000	ROCKPORT	N	ARANSAS	SAN ANTONIO-NUECES	NONE	1590	1778	1868	1823	1712	1620
2676	140534000	SAN DIEGO	N	DUVAL	NUECES-RIO GRANDE	NONE	479	482	479	467	449	426
2677	140534000	SAN DIEGO	N	JIM WELLS	NUECES-RIO GRANDE	NONE	103	105	106	105	103	101
2679	140562000	SINTON	N	SAN PATRICIO	SAN ANTONIO-NUECES	NONE	1052	1062	1076	1086	1108	1135
2709	141002178	STEAM ELECTRIC POWER	N	NUECES	NUECES	NONE	3133	10977	12834	15097	17855	21218
2710	141002178	STEAM ELECTRIC POWER	N	NUECES	NUECES-RIO GRANDE	NONE	4183	3335	3899	4586	5425	6446
2680	140592000	TAFT	N	SAN PATRICIO	SAN ANTONIO-NUECES	NONE	586	619	648	672	703	735
2682	140604000	THREE RIVERS	N	LIVE OAK	NUECES	NONE	465	498	505	485	444	399

Appendix C.4

Water Demands and Water Use for Wholesale Water Providers by County and River Basins

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Water Demands for Wholesale Water Provides by County and River Basin

WWP ID	WWP Name	WWP RWPG	Recipient Name	WUG Name	WUG County Name	WUG Basin Name	WD2010	WD2020	WD2030	WD2040	WD2050	WD2060
140114147	CORPUS CHRISTI CITY OF	N	ALICE	ALICE	JIM WELLS	NUECES-RIO GRANDE	5606	5912	6076	6102	6033	5904
140114147	CORPUS CHRISTI CITY OF	N	BEEVILLE	BEEVILLE	BEE	SAN ANTONIO-NUECES	2619	2691	2722	2699	2683	2618
140114147	CORPUS CHRISTI CITY OF	N	CORPUS CHRISTI	CORPUS CHRISTI	NUECES	NUECES	5071	5584	6024	6420	6791	7119
140114147	CORPUS CHRISTI CITY OF	N	CORPUS CHRISTI	CORPUS CHRISTI	NUECES	NUECES-RIO GRANDE	56882	62628	67568	72002	76170	79843
140114147	CORPUS CHRISTI CITY OF	N	MANUFACTURING	MANUFACTURING	NUECES	NUECES	1467	1588	1689	1788	1873	2006
140114147	CORPUS CHRISTI CITY OF	N	MANUFACTURING	MANUFACTURING	NUECES	NUECES-RIO GRANDE	43906	47459	50430	53331	55831	59759
140114147	CORPUS CHRISTI CITY OF	N	MATHIS	MATHIS	SAN PATRICIO	NUECES	648	632	615	598	586	586
140114147	CORPUS CHRISTI CITY OF	N	MINING	MINING	NUECES	NUECES	11	11	9	9	9	9
140114147	CORPUS CHRISTI CITY OF	N	MINING	MINING	NUECES	NUECES-RIO GRANDE	501	530	544	558	572	586
140114147	CORPUS CHRISTI CITY OF	N	MINING	MINING	NUECES	SAN ANTONIO-NUECES	875	924	959	988	1012	1038
140114147	CORPUS CHRISTI CITY OF	N	NUECES COUNTY WCID #4	COUNTY-OTHER	NUECES	NUECES-RIO GRANDE	1913	2884	3729	4460	5124	5655
140114147	CORPUS CHRISTI CITY OF	N	SAN PATRICIO MWD	COUNTY-OTHER	SAN PATRICIO	NUECES	40000	40000	40000	40000	40000	40000
140114147	CORPUS CHRISTI CITY OF	N	SOUTH TEXAS WATER AUTHORITY	COUNTY-OTHER	KLEBERG	NUECES-RIO GRANDE	2619	2867	3011	3065	3236	3260
140114147	CORPUS CHRISTI CITY OF	N	STEAM-ELECTRIC	STEAM ELECTRIC POWER	NUECES	NUECES	3133	10977	12834	15097	17855	21218
140114147	CORPUS CHRISTI CITY OF	N	STEAM-ELECTRIC	STEAM ELECTRIC POWER	NUECES	NUECES-RIO GRANDE	4183	3335	3899	4586	5425	6446
140114147	CORPUS CHRISTI CITY OF	N	THREE RIVERS	THREE RIVERS	LIVE OAK	NUECES	3363	3363	3363	3363	3363	3363
140114147	CORPUS CHRISTI CITY OF	N	VIOLET WSC	COUNTY-OTHER	NUECES	NUECES-RIO GRANDE	116	116	116	116	116	116
110114183	NUECES COUNTY WCID #3	N	COUNTY-OTHER	COUNTY-OTHER	NUECES	NUECES-RIO GRANDE	155	155	155	155	155	155
110114183	NUECES COUNTY WCID #3	N	IRRIGATION	IRRIGATION	NUECES	NUECES	1449	1250	1077	928	801	692
110114183	NUECES COUNTY WCID #3	N	REMAINING WATER RIGHT YIELD	COUNTY-OTHER	NUECES	NUECES	0	0	0	0	0	0
110114183	NUECES COUNTY WCID #3	N	RIVER ACRES WSC	RIVER ACRES WSC	NUECES	NUECES	291	291	291	291	291	291
110114183	NUECES COUNTY WCID #3	N	ROBSTOWN	ROBSTOWN	NUECES	NUECES-RIO GRANDE	2110	2067	2024	1982	1953	1953
110914148	SAN PATRICIO MWD	N	ARANSAS PASS	ARANSAS PASS	ARANSAS	SAN ANTONIO-NUECES	168	186	195	190	179	169
110914148	SAN PATRICIO MWD	N	ARANSAS PASS	ARANSAS PASS	NUECES	SAN ANTONIO-NUECES	26	41	53	64	73	81
110914148	SAN PATRICIO MWD	N	ARANSAS PASS	ARANSAS PASS	SAN PATRICIO	SAN ANTONIO-NUECES	1405	1615	1828	2016	2201	2386
110914148	SAN PATRICIO MWD	N	COUNTY-OTHER	COUNTY-OTHER	ARANSAS	SAN ANTONIO-NUECES	1524	1686	1740	1687	1576	1491
110914148	SAN PATRICIO MWD	N	COUNTY-OTHER	COUNTY-OTHER	SAN PATRICIO	NUECES	0	0	20	43	73	107
110914148	SAN PATRICIO MWD	N	COUNTY-OTHER	COUNTY-OTHER	SAN PATRICIO	SAN ANTONIO-NUECES	1033	1103	1143	1166	1201	1238
110914148	SAN PATRICIO MWD	N	FULTON	FULTON	ARANSAS	SAN ANTONIO-NUECES	307	346	365	359	336	318
110914148	SAN PATRICIO MWD	N	GREGORY	GREGORY	SAN PATRICIO	SAN ANTONIO-NUECES	239	231	223	216	210	210
110914148	SAN PATRICIO MWD	N	INGLESIDE	INGLESIDE	SAN PATRICIO	SAN ANTONIO-NUECES	1294	1771	2202	2607	3016	3395
110914148	SAN PATRICIO MWD	N	INGLESIDE ON THE BAY	INGLESIDE ON THE BAY	SAN PATRICIO	SAN ANTONIO-NUECES	92	112	130	148	164	181
110914148	SAN PATRICIO MWD	N	MANUFACTURING	MANUFACTURING	SAN PATRICIO	NUECES	8491	9393	10187	10971	11662	12534
110914148	SAN PATRICIO MWD	N	MANUFACTURING	MANUFACTURING	SAN PATRICIO	SAN ANTONIO-NUECES	6594	7294	7911	8520	9056	9733
110914148	SAN PATRICIO MWD	N	NUECES COUNTY WCID #4	COUNTY-OTHER	NUECES	NUECES-RIO GRANDE	2606	3655	4558	5355	6068	6637
110914148	SAN PATRICIO MWD	N	ODEM	ODEM	SAN PATRICIO	SAN ANTONIO-NUECES	330	347	361	372	389	408
110914148	SAN PATRICIO MWD	N	PORTLAND	PORTLAND	SAN PATRICIO	SAN ANTONIO-NUECES	2399	2869	3290	3716	4106	4498

Water Demands for Wholesale Water Provides by County and River Basin (Concluded)

WWP ID	WWP Name	WWP RWPG	Recipient Name	WUG Name	WUG County Name	WUG Basin Name	WD2010	WD2020	WD2030	WD2040	WD2050	WD2060
110914148	SAN PATRICIO MWD	N	REMAINING YIELD FROM CONTRACT WITH CC	COUNTY-OTHER	SAN PATRICIO	SAN ANTONIO-NUECES	0	0	0	0	0	0
110914148	SAN PATRICIO MWD	N	ROCKPORT	ROCKPORT	ARANSAS	SAN ANTONIO-NUECES	1590	1778	1868	1823	1712	1620
110914148	SAN PATRICIO MWD	N	TAFT	TAFT	SAN PATRICIO	SAN ANTONIO-NUECES	586	619	648	672	703	736
120214149	SOUTH TEXAS WATER AUTHORITY	N	AGUA DULCE	AGUA DULCE	NUECES	NUECES-RIO GRANDE	112	110	107	105	103	103
120214149	SOUTH TEXAS WATER AUTHORITY	N	BISHOP	BISHOP	NUECES	NUECES-RIO GRANDE	317	309	301	294	289	289
120214149	SOUTH TEXAS WATER AUTHORITY	N	COUNTY-OTHER	COUNTY-OTHER	NUECES	NUECES-RIO GRANDE	213	213	213	213	213	213
120214149	SOUTH TEXAS WATER AUTHORITY	N	DRISCOLL	DRISCOLL	NUECES	NUECES-RIO GRANDE	122	148	171	191	208	224
120214149	SOUTH TEXAS WATER AUTHORITY	N	KINGSVILLE	KINGSVILLE	KLEBERG	NUECES-RIO GRANDE	1352	1382	1385	1350	1397	1400
120214149	SOUTH TEXAS WATER AUTHORITY	N	RICARDO WSC	RICARDO WSC	KLEBERG	NUECES-RIO GRANDE	503	705	834	912	1026	1031

Water Use for Wholesale Water Providers by County and River Basin

WWP ID	WWP Name	WWP RWPG	Recipient Name	WUG Name	WUG County Name	WUG Basin Name	SRC Name	SRC Type	WPS2010	WPS2020	WPS2030	WPS2040	WPS2050	WPS2060
140114147	CORPUS CHRISTI CITY OF	N	ALICE	ALICE	JIM WELLS	NUECES-RIO GRANDE	CC-CCL/RS*	SW	5606	5912	6076	6102	6033	5904
140114147	CORPUS CHRISTI CITY OF	N	BEEVILLE	BEEVILLE	BEE	SAN ANTONIO-NUECES	CC-CCL/RS*	SW	2619	2691	2722	2699	2683	2618
140114147	CORPUS CHRISTI CITY OF	N	CORPUS CHRISTI	CORPUS CHRISTI	NUECES	NUECES	CC-CCL/RS*	SW	3071	3584	4024	4420	4791	5119
140114147	CORPUS CHRISTI CITY OF	N	CORPUS CHRISTI	CORPUS CHRISTI	NUECES	NUECES	TEXANA LAKE/RESERVOIR	SW	2000	2000	2000	2000	2000	2000
140114147	CORPUS CHRISTI CITY OF	N	CORPUS CHRISTI	CORPUS CHRISTI	NUECES	NUECES-RIO GRANDE	CC-CCL/RS*	SW	26343	22788	27728	32162	36330	40003
140114147	CORPUS CHRISTI CITY OF	N	CORPUS CHRISTI	CORPUS CHRISTI	NUECES	NUECES-RIO GRANDE	TEXANA LAKE/RESERVOIR	SW	39840	39840	39840	39840	39840	39840
140114147	CORPUS CHRISTI CITY OF	N	MANUFACTURING	MANUFACTURING	NUECES	NUECES	CC-CCL/RS*	SW	1467	1588	1689	1788	1873	2006
140114147	CORPUS CHRISTI CITY OF	N	MANUFACTURING	MANUFACTURING	NUECES	NUECES-RIO GRANDE	CC-CCL/RS*	SW	43906	40048	35227	30953	25271	20209
140114147	CORPUS CHRISTI CITY OF	N	MATHIS	MATHIS	SAN PATRICIO	NUECES	CC-CCL/RS*	SW	648	632	615	598	586	586
140114147	CORPUS CHRISTI CITY OF	N	MINING	MINING	NUECES	NUECES	CC-CCL/RS*	SW	11	11	9	0	0	0
140114147	CORPUS CHRISTI CITY OF	N	MINING	MINING	NUECES	NUECES-RIO GRANDE	CC-CCL/RS*	SW	501	530	337	0	0	0
140114147	CORPUS CHRISTI CITY OF	N	MINING	MINING	NUECES	SAN ANTONIO-NUECES	CC-CCL/RS*	SW	875	924	590	0	0	0
140114147	CORPUS CHRISTI CITY OF	N	NUECES COUNTY WCID #4	COUNTY-OTHER	NUECES	NUECES-RIO GRANDE	CC-CCL/RS*	SW	1913	2884	3729	4460	5124	5655
140114147	CORPUS CHRISTI CITY OF	N	SAN PATRICIO MWD	COUNTY-OTHER	SAN PATRICIO	NUECES	CC-CCL/RS*	SW	40000	40000	40000	40000	40000	40000
140114147	CORPUS CHRISTI CITY OF	N	SOUTH TEXAS WATER AUTHORITY	COUNTY-OTHER	KLEBERG	NUECES-RIO GRANDE	CC-CCL/RS*	SW	2619	2867	3011	3065	3236	3260
140114147	CORPUS CHRISTI CITY OF	N	STEAM-ELECTRIC	STEAM ELECTRIC POWER	NUECES	NUECES	CC-CCL/RS*	SW	3133	8995	8079	7638	7668	8035
140114147	CORPUS CHRISTI CITY OF	N	STEAM-ELECTRIC	STEAM ELECTRIC POWER	NUECES	NUECES-RIO GRANDE	CC-CCL/RS*	SW	4183	3335	3899	4586	5425	6446
140114147	CORPUS CHRISTI CITY OF	N	THREE RIVERS	THREE RIVERS	LIVE OAK	NUECES	CC-CCL/RS*	SW	3363	3363	3363	3363	3363	3363
140114147	CORPUS CHRISTI CITY OF	N	VIOLET WSC	COUNTY-OTHER	NUECES	NUECES-RIO GRANDE	CC-CCL/RS*	SW	116	116	116	116	116	116
110114183	NUECES COUNTY WCID #3	N	COUNTY-OTHER	COUNTY-OTHER	NUECES	NUECES-RIO GRANDE	NUECES RIVER RUN-OF-RIVER	SW	155	155	155	155	155	155
110114183	NUECES COUNTY WCID #3	N	IRRIGATION	IRRIGATION	NUECES	NUECES	NUECES RIVER RUN-OF-RIVER	SW	1449	1250	1077	928	801	692
110114183	NUECES COUNTY WCID #3	N	REMAINING WATER RIGHT YIELD	COUNTY-OTHER	NUECES	NUECES	NUECES RIVER RUN-OF-RIVER	SW	3098	3340	3556	3747	3903	4012
11011418 3	NUECES COUNTY WCID #3	N	RIVER ACRES WSC	RIVER ACRES WSC	NUECES	NUECES	NUECES RIVER RUN-OF-RIVER	SW	291	291	291	291	291	291
110114183	NUECES COUNTY WCID #3	N	ROBSTOWN	ROBSTOWN	NUECES	NUECES-RIO GRANDE	NUECES RIVER RUN-OF-RIVER	SW	2110	2067	2024	1982	1953	1953
110914148	SAN PATRICIO MWD	N	ARANSAS PASS	ARANSAS PASS	ARANSAS	SAN ANTONIO-NUECES	CC-CCL/RS*	SW	168	186	195	190	179	169
110914148	SAN PATRICIO MWD	N	ARANSAS PASS	ARANSAS PASS	NUECES	SAN ANTONIO-NUECES	CC-CCL/RS*	SW	26	41	53	64	73	81
110914148	SAN PATRICIO MWD	N	ARANSAS PASS	ARANSAS PASS	SAN PATRICIO	SAN ANTONIO-NUECES	CC-CCL/RS*	SW	1405	1615	1828	2016	2201	2386
110914148	SAN PATRICIO MWD	N	COUNTY-OTHER	COUNTY-OTHER	ARANSAS	SAN ANTONIO-NUECES	CC-CCL/RS*	SW	1524	1686	1740	1687	49	49
110914148	SAN PATRICIO MWD	N	COUNTY-OTHER	COUNTY-OTHER	SAN PATRICIO	NUECES	CC-CCL/RS*	SW	0	0	20	43	73	107
110914148	SAN PATRICIO MWD	N	COUNTY-OTHER	COUNTY-OTHER	SAN PATRICIO	SAN ANTONIO-NUECES	CC-CCL/RS*	SW	1033	1103	1143	1166	1201	1238
110914148	SAN PATRICIO MWD	N	FULTON	FULTON	ARANSAS	SAN ANTONIO-NUECES	CC-CCL/RS*	SW	307	346	365	359	336	318
110914148	SAN PATRICIO MWD	N	GREGORY	GREGORY	SAN PATRICIO	SAN ANTONIO-NUECES	CC-CCL/RS*	SW	239	231	223	216	210	210
110914148	SAN PATRICIO MWD	N	INGLESIDE	INGLESIDE	SAN PATRICIO	SAN ANTONIO-NUECES	CC-CCL/RS*	SW	1294	1771	2202	2607	3016	3395
110914148	SAN PATRICIO MWD	N	INGLESIDE ON THE BAY	INGLESIDE ON THE BAY	SAN PATRICIO	SAN ANTONIO-NUECES	CC-CCL/RS*	SW	92	112	130	148	164	181
110914148	SAN PATRICIO MWD	N	MANUFACTURING	MANUFACTURING	SAN PATRICIO	NUECES	CC-CCL/RS*	SW	8491	9393	10187	8890	8309	6079
110914148	SAN PATRICIO MWD	N	MANUFACTURING	MANUFACTURING	SAN PATRICIO	SAN ANTONIO-NUECES	CC-CCL/RS*	SW	6594	7294	7911	8520	9056	9733
110914148	SAN PATRICIO MWD	N	NUECES COUNTY WCID #4	COUNTY-OTHER	NUECES	NUECES-RIO GRANDE	CC-CCL/RS*	SW	2606	3655	4558	5355	6068	6637
110914148	SAN PATRICIO MWD	N	ODEM	ODEM	SAN PATRICIO	SAN ANTONIO-NUECES	CC-CCL/RS*	SW	330	347	361	372	389	408
110914148	SAN PATRICIO MWD	N	PORTLAND	PORTLAND	SAN PATRICIO	SAN ANTONIO-NUECES	CC-CCL/RS*	SW	2399	2869	3290	3716	4106	4498
110914148	SAN PATRICIO MWD	N	REMAINING YIELD FROM CONTRACT WITH CC	COUNTY-OTHER	SAN PATRICIO	SAN ANTONIO-NUECES	CC-CCL/RS*	SW	11316	6954	3278	2156	2155	2155
110914148	SAN PATRICIO MWD	N	ROCKPORT	ROCKPORT	ARANSAS	SAN ANTONIO-NUECES	CC-CCL/RS*	SW	1590	1778	1868	1823	1712	1620
110914148	SAN PATRICIO MWD	N	TAFT	TAFT	SAN PATRICIO	SAN ANTONIO-NUECES	CC-CCL/RS*	SW	586	619	648	672	703	736
120214149	SOUTH TEXAS WATER AUTHORITY	N	AGUA DULCE	AGUA DULCE	NUECES	NUECES-RIO GRANDE	CC-CCL/RS*	SW	112	110	107	105	103	103

Water Use for Wholesale Water Providers by County and River Basin (Concluded)

WWP ID	WWP Name	WWP RWPG	Recipient Name	WUG Name	WUG County Name	WUG Basin Name	SRC Name	SRC Type	WPS2010	WPS2020	WPS2030	WPS2040	WPS2050	WPS2060
120214149	SOUTH TEXAS WATER AUTHORITY	N	BISHOP	BISHOP	NUECES	NUECES-RIO GRANDE	CC-CCL/RS*	SW	317	309	301	294	289	289
120214149	SOUTH TEXAS WATER AUTHORITY	N	COUNTY-OTHER	COUNTY-OTHER	NUECES	NUECES-RIO GRANDE	CC-CCL/RS*	SW	213	213	213	213	213	213
120214149	SOUTH TEXAS WATER AUTHORITY	N	DRISCOLL	DRISCOLL	NUECES	NUECES-RIO GRANDE	CC-CCL/RS*	SW	122	148	171	191	208	224
120214149	SOUTH TEXAS WATER AUTHORITY	N	KINGSVILLE	KINGSVILLE	KLEBERG	NUECES-RIO GRANDE	CC-CCL/RS*	SW	1352	1382	1385	1350	1397	1400
120214149	SOUTH TEXAS WATER AUTHORITY	N	RICARDO WSC	RICARDO WSC	KLEBERG	NUECES-RIO GRANDE	CC-CCL/RS*	SW	503	705	834	912	1026	1031

*CC-CCL/RS = Corpus Christi-Choke Canyon Lake/Reservoir System

Appendix C.5

Surface and Groundwater Availability by Counties and River Basins

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Surface and Groundwater Availability by County and River Basin

DBSO ID	SRC Name	SRC Type	SRC RWPG	SRC County Name	SRC Basin Name	SRC ID	MAG	TA2010	TA2020	TA2030	TA2040	TA2050	TA2060	Methodology
1752	CARRIZO-WILCOX AQUIFER	GW	N	BEE	NUECES	01310	N	394	394	394	394	394	394	TWDB ESTIMATE
1757	CARRIZO-WILCOX AQUIFER	GW	N	LIVE OAK	NUECES	14910	N	2399	2399	2399	2399	2399	2399	TWDB ESTIMATE
1760	CARRIZO-WILCOX AQUIFER	GW	N	MCMULLEN	NUECES	15610	N	7909	7909	7909	7909	7909	7909	TWDB ESTIMATE
844	CORPUS CHRISTI-CHOKE CANYON LAKE/RESERVOIR SYSTEM	SW	N	RESERVOIR	NUECES	210A1	N	165000	164000	163000	162000	161000	160000	WAM
1748	GULF COAST AQUIFER	GW	N	ARANSAS	SAN ANTONIO-NUECES	00415	N	796	796	796	796	796	796	GAM
1753	GULF COAST AQUIFER	GW	N	BEE	NUECES	01315	N	334	334	334	334	334	334	GAM
1749	GULF COAST AQUIFER	GW	N	BEE	SAN ANTONIO-NUECES	01315	N	17497	17497	17497	17497	17497	17497	GAM
1764	GULF COAST AQUIFER	GW	N	BROOKS	NUECES-RIO GRANDE	02415	N	3325	3325	3325	3325	3325	3325	GAM
1754	GULF COAST AQUIFER	GW	N	DUVAL	NUECES	06615	N	3638	3638	3638	3638	3638	3638	GAM
1765	GULF COAST AQUIFER	GW	N	DUVAL	NUECES-RIO GRANDE	06615	N	11290	11290	11290	11290	11290	11290	GAM
1755	GULF COAST AQUIFER	GW	N	JIM WELLS	NUECES	12515	N	1712	1598	1486	1383	1292	1210	GAM
1766	GULF COAST AQUIFER	GW	N	JIM WELLS	NUECES-RIO GRANDE	12515	N	5853	5684	5509	5330	5157	4987	GAM
1767	GULF COAST AQUIFER	GW	N	KENEDY	NUECES-RIO GRANDE	13115	N	12700	12700	12700	12700	12700	12700	GAM
1768	GULF COAST AQUIFER	GW	N	KLEBERG	NUECES-RIO GRANDE	13715	N	9700	9700	9700	9700	9700	9700	GAM
1756	GULF COAST AQUIFER	GW	N	LIVE OAK	NUECES	14915	N	10598	10496	10120	10080	10060	10051	GAM
1759	GULF COAST AQUIFER	GW	N	MCMULLEN	NUECES	15615	N	1200	1200	1200	1200	1200	1200	GAM
1762	GULF COAST AQUIFER	GW	N	NUECES	NUECES	17815	N	194	156	152	152	152	152	GAM
1769	GULF COAST AQUIFER	GW	N	NUECES	NUECES-RIO GRANDE	17815	N	1877	1877	1877	1877	1877	1877	GAM
1750	GULF COAST AQUIFER	GW	N	NUECES	SAN ANTONIO-NUECES	17815	N	75	75	75	75	75	75	GAM
1763	GULF COAST AQUIFER	GW	N	SAN PATRICIO	NUECES	20515	N	1501	1501	1501	1501	1501	1501	GAM
1751	GULF COAST AQUIFER	GW	N	SAN PATRICIO	SAN ANTONIO-NUECES	20515	N	28879	28879	28879	28879	28879	28879	GAM
832	LIVESTOCK LOCAL SUPPLY	SW	N	ARANSAS	SAN ANTONIO-NUECES	99720004	N	21	21	21	21	21	21	HISTORICAL USE
835	LIVESTOCK LOCAL SUPPLY	SW	N	BEE	NUECES	99721013	N	107	107	107	107	107	107	HISTORICAL USE
833	LIVESTOCK LOCAL SUPPLY	SW	N	BEE	SAN ANTONIO-NUECES	99720013	N	800	800	800	800	800	800	HISTORICAL USE
845	LIVESTOCK LOCAL SUPPLY	SW	N	BROOKS	NUECES-RIO GRANDE	99722024	N	672	672	672	672	672	672	HISTORICAL USE
836	LIVESTOCK LOCAL SUPPLY	SW	N	DUVAL	NUECES	99721066	N	189	189	189	189	189	189	HISTORICAL USE
846	LIVESTOCK LOCAL SUPPLY	SW	N	DUVAL	NUECES-RIO GRANDE	99722066	N	597	597	597	597	597	597	HISTORICAL USE
837	LIVESTOCK LOCAL SUPPLY	SW	N	JIM WELLS	NUECES	99721125	N	163	163	163	163	163	163	HISTORICAL USE
847	LIVESTOCK LOCAL SUPPLY	SW	N	JIM WELLS	NUECES-RIO GRANDE	99722125	N	795	795	795	795	795	795	HISTORICAL USE
4004	LIVESTOCK LOCAL SUPPLY	SW	N	KENEDY	NUECES-RIO GRANDE	99722131	N	811	811	811	811	811	811	HISTORICAL USE
848	LIVESTOCK LOCAL SUPPLY	SW	N	KLEBERG	NUECES-RIO GRANDE	99722137	N	1710	1710	1710	1710	1710	1710	HISTORICAL USE
839	LIVESTOCK LOCAL SUPPLY	SW	N	LIVE OAK	NUECES	99721149	N	416	416	416	416	416	416	HISTORICAL USE
4005	LIVESTOCK LOCAL SUPPLY	SW	N	MCMULLEN	NUECES	99721156	N	593	593	593	593	593	593	HISTORICAL USE
842	LIVESTOCK LOCAL SUPPLY	SW	N	NUECES	NUECES	99721178	N	19	19	19	19	19	19	HISTORICAL USE
849	LIVESTOCK LOCAL SUPPLY	SW	N	NUECES	NUECES-RIO GRANDE	99722178	N	180	180	180	180	180	180	HISTORICAL USE
843	LIVESTOCK LOCAL SUPPLY	SW	N	SAN PATRICIO	NUECES	99721205	N	167	167	167	167	167	167	HISTORICAL USE
834	LIVESTOCK LOCAL SUPPLY	SW	N	SAN PATRICIO	SAN ANTONIO-NUECES	99720205	N	340	340	340	340	340	340	HISTORICAL USE

Surface and Groundwater Availability by County and River Basin (Concuded)

DBSO ID	SRC Name	SRC Type	SRC RWPG	SRC County Name	SRC Basin Name	SRC ID	MAG	TA2010	TA2020	TA2030	TA2040	TA2050	TA2060	Methodology
4017	NUECES RIVER COMBINED RUN-OF-RIVER IRRIGATION	SW	N	LIVE OAK	NUECES	3421130	N	200	200	200	200	200	200	WAM
838	NUECES RIVER RUN-OF-RIVER	SW	N	LIVE OAK	NUECES	3462103215A	N	1500	1500	1500	1500	1500	1500	WAM
840	NUECES RIVER RUN-OF-RIVER	SW	N	MCMULLEN	NUECES	3462103142	N	6	6	6	6	6	6	WAM
841	NUECES RIVER RUN-OF-RIVER	SW	N	NUECES	NUECES	3462102466	N	7104	7104	7104	7104	7104	7104	WAM
4008	NUECES-RIO GRANDE RIVER COMBINED RUN-OF-RIVER IRRIGATION	SW	N	NUECES	NUECES-RIO GRANDE	3422010	N	569	569	569	569	569	569	WAM
1758	QUEEN CITY AQUIFER	GW	N	MCMULLEN	NUECES	15624	N	1105	1105	1105	1105	1105	1105	TWDB ESTIMATE
4006	SAN ANTONIO-NUECES RIVER COMBINED RUN-OF-RIVER IRRIGATION	SW	N	BEE	SAN ANTONIO-NUECES	3420010	N	42	42	42	42	42	42	WAM
4007	SAN ANTONIO-NUECES RIVER COMBINED RUN-OF-RIVER IRRIGATION	SW	N	SAN PATRICIO	SAN ANTONIO-NUECES	3420020	N	83	83	83	83	83	83	WAM
1761	SPARTA AQUIFER	GW	N	MCMULLEN	NUECES	15627	N	600	600	600	600	600	600	TWDB ESTIMATE

Appendix C.6

Water Management Strategies (Supplies and Costs) for WUGs by County

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Water Management Strategy Supplies for Water User Groups by County

WMS Project ID	Project Name	SRC Basin Name	WUG Name	WUG County Name	SS2010	SS2020	SS2030	SS2040	SS2050	SS2060
N1	MUNICIPAL WATER CO NSERVATION	NUECES-RIO GRANDE	FALFURRIAS	BROOKS	1	38	95	156	228	309
N1	MUNICIPAL WATER CONSERVATION	NUECES	COUNTY-OTHER	DUVAL	3	7	11	14	22	32
N1	MUNICIPAL WATER CONSERVATION	NUECES-RIO GRANDE	ALICE	JIM WELLS	50	133	219	306	438	585
N1	MUNICIPAL WATER CONS ERVATION	NUECES-RIO GRANDE	ORANGE GROVE	JIM WELLS	3	8	14	18	28	38
N1	MUNICIPAL WATER CONSERVATION	NUECES-RIO GRANDE	PREMONT	JIM WELLS	9	22	36	49	70	92
N1	MUNICIPAL WATER CONSERVATION	NUECES	GEORGE WEST	LIVE OAK	5	14	25	33	45	57
N1	MUNICIPAL WATER CONSER VATION	NUECES	THREE RIVERS	LIVE OAK	3	8	14	18	27	34
N1	MUNICIPAL WATER CONSERVATION	NUECES	COUNTY-OTHER	MCMULLEN	1	2	3	5	7	10
N1	MUNICIPAL WATER CONSERVATION	NUECES-RIO GRANDE	COUNTY-OTHER	DUVAL	3	6	10	13	22	31
N1	MUNICIPAL WATER CONSERVATION	NUECES-RIO GRANDE	NUECES COUNTY WCID #4	NUECES	0	0	56	135	261	384
N1	MUNICIPAL WATER CONSERVATION	NUECES-RIO GRANDE	PORT ARANSAS	NUECES	28	115	238	406	615	843
N10	PIPELINE FROM CHOKE CANYON RESERVOIR TO LAKE CORPUS CHRISTI	NUECES	MANUFACTURING	NUECES	0	0	0	7303	7303	7303
N10	PIPELINE FROM CHOKE CANYON RESERVOIR TO LAKE CORPUS CHRISTI	NUECES	MINING	NUECES	0	0	0	7301	7301	7301
N10	PIPELINE FROM CHOKE CANYON RESERVOIR TO LAKE CORPUS CHRISTI	NUECES	STEAM ELECTRIC POWER	NUECES	0	0	0	7301	7301	7301
N11	OFF-CHANNEL RESERVOIR NEAR LAKE CORPUS CHRISTI	NUECES	MANUFACTURING	NUECES	0	0	10114	10114	10114	10114
N11	OFF-CHANNEL RESERVOIR NEAR LAKE CORPUS CHRISTI	NUECES	MANUFACTURING	SAN PATRICIO	0	0	5056	5056	5056	5056
N11	OFF-CHANNEL RESERVOIR NEAR LAKE CORPUS CHRISTI	NUECES	MINING	NUECES	0	0	5057	5057	5057	5057
N11	OFF-CHANNEL RESERVOIR NEAR LAKE CORPUS CHRISTI	NUECES	STEAM ELECTRIC POWER	NUECES	0	0	10113	10113	10113	10113
N14	GARWOOD PIPELINE AND OFF-CHANNEL RESERVOIR STORAGE	COLORADO	MANUFACTURING	NUECES	0	11667	11667	11667	11667	11667
N14	GARWOOD PIPELINE AND OFF-CHANNEL RESERVOIR STORAGE	COLORADO	MANUFACTURING	SAN PATRICIO	0	5498	5498	5498	5498	5498
N14	GARWOOD PIPELINE AND OFF-CHANNEL RESERVOIR STORAGE	COLORADO	MINING	NUECES	0	700	700	700	700	700
N14	GARWOOD PIPELINE AND OFF-CHANNEL RESERVOIR STORAGE	COLORADO	MINING	NUECES	0	5498	5498	5498	5498	5498
N14	GARWOOD PIPELINE AND OFF-CHANNEL RESERVOIR STORAGE	COLORADO	STEAM ELECTRIC POWER	NUECES	0	11667	11667	11667	11667	11667
N15	VOLUNTARY REDISTRIBUTION	NUECES	COUNTY-OTHER	ARANSAS	0	0	0	0	1527	1443
N15	VOLUNTARY REDISTRIBUTION	NUECES	COUNTY-OTHER	NUECES	261	0	0	0	0	0
N15	VOLUNTARY REDISTRIBUTION	NUECES	MANUFACTURING	LIVE OAK	337	483	559	615	657	764
N15	VOLUNTARY REDISTRIBUTION	NUECES	RIVER ACRES WSC	NUECES	138	255	355	445	522	590
N17	DESALINATION	GULF	MANUFACTURING	NUECES	0	0	0	9334	9334	9334
N17	DESALINATION	GULF	MINING	NUECES	0	0	0	9333	9333	9333
N17	DESALINATION	GULF	STEAM ELECTRIC POWER	NUECES	0	0	0	9333	9333	9333
N19	O.N. STEVENS WATER TREATMENT PLANT IMPROVE MENTS	NUECES	MANUFACTURING	NUECES	13968	13215	12573	12000	11489	10888
N19	O.N. STEVENS WATER TREATMENT PLANT IMPROVEMENTS	NUECES	MANUFACTURING	SAN PATRICIO	6984	6607	6286	6000	5744	5444
N19	O.N. STEVENS WATER TREATMENT PLANT IMPROVEMENTS	NUECES	MINING	NUECES	6984	6608	6287	6000	5745	5444
N19	O.N. STEVENS WATER TREATMENT PLANT IMPROVEMENTS	NUECES	STEAM ELECTRIC POWER	NUECES	13968	13215	12573	12000	11489	10888
N2	IRRIGATION WATER CONSERVATION	NUECES	IRRIGATION	LIVE OAK	17	52	103	169	248	342
N20	BRACKISH GROUNDWATER DESALINATION	NUECES	MANUFACTURING	NUECES	0	0	0	6000	6000	6000

Water Management Strategy Supplies for Water User Groups by County (Concluded)

WMS Project ID	Project Name	SRC Basin Name	WUG Name	WUG County Name	SS2010	SS2020	SS2030	SS2040	SS2050	SS2060
N20	BRACKISH GROUNDWATER DESALINATION	NUECES	MINING	NUECES	0	0	0	6000	6000	6000
N20	BRACKISH GROUNDWATER DESALINATION	NUECES	STEAM ELECTRIC POWER	NUECES	0	0	0	6000	6000	6000
N3	MANUFACTURING WATER CONSERVATION	NUECES-RIO GRANDE	MANUFACTURING	NUECES	1260	1418	1576	1734	1892	2050
N4	MINING WATER CONSERVATION	NUECES	MINING	DUVAL	53	120	192	274	365	462
N4	MINING WATER CONSERVATION	NUECES-RIO GRANDE	MINING	DUVAL	94	212	342	487	649	821
N4	MINING WATER CONSERVATION	NUECES	MINING	LIVE OAK	97	216	344	485	639	801
N4	MINING WATER CONSERVATION	NUECES-RIO GRANDE	MINING	NUECES	0	0	60	123	189	259
N5	RECLAIMED WASTEWATER SUPPLIES	NUECES	MANUFACTURING	NUECES	84	84	84	84	84	84
N5	RECLAIMED WASTEWATER SUPPLIES	NUECES	MINING	NUECES	83	83	83	83	83	83
N5	RECLAIMED WASTEWATER SUPPLIES	NUECES	STEAM ELECTRIC POWER	NUECES	83	83	83	83	83	83
N7	GULF COAST AQUIFER SUPPLIES	SAN ANTONIO-NUECES	MANUFACTURING	ARANSAS	200	200	200	200	200	200
N7	GULF COAST AQUIFER SUPPLIES	SAN ANTONIO-NUECES	IRRIGATION	BEE	0	0	0	0	2016	2016
N7	GULF COAST AQUIFER SUPPLIES	NUECES-RIO GRANDE	COUNTY-OTHER	JIM WELLS	565	565	565	565	565	565
N7	GULF COAST AQUIFER SUPPLIES	NUECES-RIO GRANDE	COUNTY-OTHER	KLEBERG	0	400	400	400	400	400
N7	GULF COAST AQUIFER SUPPLIES	NUECES	COUNTY-OTHER	LIVE OAK	0	80	80	80	80	80
N7	GULF COAST AQUIFER SUPPLIES	NUECES	IRRIGATION	LIVE OAK	1210	1210	1210	1210	1210	1210
N7	GULF COAST AQUIFER SUPPLIES	NUECES	IRRIGATION	SAN PATRICIO	0	0	365	365	365	365
N7	GULF COAST AQUIFER SUPPLIES	NUECES	LAKE CITY	SAN PATRICIO	0	80	80	80	80	80
N7	GULF COAST AQUIFER SUPPLIES	SAN ANTONIO-NUECES	IRRIGATION	SAN PATRICIO	0	0	8635	8635	8635	8635
N7.1	GULF COAST AQUIFER SUPPLIES (REGIONAL)	SAN ANTONIO-NUECES	MANUFACTURING	SAN PATRICIO	0	0	5500	5500	5500	9000
N7.1	GULF COAST AQUIFER SUPPLIES (REGIONAL)	SAN ANTONIO-NUECES	MANUFACTURING	SAN PATRICIO	0	0	5500	5500	5500	9000

Water Management Strategy Costs for Water User Groups by County

WMS Project ID	Project Name	SRC Basin Name	WUG Name	WUG County Name	Capital Cost	AC2010	AC2020	AC2030	AC2040	AC2050	AC2060
N1	MUNICIPAL WATER CONSERVATION	NUECES-RIO GRANDE	FALFURRIAS	BROOKS	0	283	15955	40021	66129	96639	130882
N1	MUNICIPAL WATER CONSERVATION	NUECES	COUNTY-OTHER	DUVAL	0	1216	2840	4408	5759	9233	13233
N1	MUNICIPAL WATER CONSERVATION	NUECES-RIO GRANDE	ALICE	JIM WELLS	0	21240	56111	92762	129589	185382	247695
N1	MUNICIPAL WATER CONSERVATION	NUECES-RIO GRANDE	ORANGE GROVE	JIM WELLS	0	1087	3224	5744	7826	11905	15869
N1	MUNICIPAL WATER CONSERVATION	NUECES-RIO GRANDE	PREMONT	JIM WELLS	0	3813	9272	15294	20901	29665	39077
N1	MUNICIPAL WATER CONSERVATION	NUECES	GEORGE WEST	LIVE OAK	0	1961	6068	10446	14026	19008	24166
N1	MUNICIPAL WATER CONSERVATION	NUECES	THREE RIVERS	LIVE OAK	0	1068	3492	5797	7779	11332	14508
N1	MUNICIPAL WATER CONSERVATION	NUECES	COUNTY-OTHER	MCMULLEN	0	272	739	1421	2232	2894	4264
N1	MUNICIPAL WATER CONSERVATION	NUECES-RIO GRANDE	COUNTY-OTHER	DUVAL	0	1215	2840	4419	5759	9233	13234
N1	MUNICIPAL WATER CONSERVATION	NUECES-RIO GRANDE	NUECES COUNTY WCID #4	NUECES	0	0	0	25130	60508	117026	171880
N1	MUNICIPAL WATER CONSERVATION	NUECES-RIO GRANDE	PORT ARANSAS	NUECES	0	12682	51653	106749	181858	275709	377720
N10	PIPELINE FROM CHOKE CANYON RESERVOIR TO LAKE CORPUS CHRISTI	NUECES	MANUFACTURING	NUECES	0	0	0	0	4247093	4247093	4247093
N10	PIPELINE FROM CHOKE CANYON RESERVOIR TO LAKE CORPUS CHRISTI	NUECES	MINING	NUECES	0	0	0	0	4247093	4247093	4247093
N10	PIPELINE FROM CHOKE CANYON RESERVOIR TO LAKE CORPUS CHRISTI	NUECES	STEAM ELECTRIC POWER	NUECES	0	0	0	0	4247093	4247093	4247093
N11	OFF-CHANNEL RESERVOIR NEAR LAKE CORPUS CHRISTI	NUECES	MANUFACTURING	NUECES	0	0	0	7159944	7159944	7159944	5787045
N11	OFF-CHANNEL RESERVOIR NEAR LAKE CORPUS CHRISTI	NUECES	MANUFACTURING	SAN PATRICIO	0	0	0	3579972	3579972	3579972	2893522
N11	OFF-CHANNEL RESERVOIR NEAR LAKE CORPUS CHRISTI	NUECES	MINING	NUECES	0	0	0	3579972	3579972	3579972	2893522
N11	OFF-CHANNEL RESERVOIR NEAR LAKE CORPUS CHRISTI	NUECES	STEAM ELECTRIC POWER	NUECES	0	0	0	7159944	7159944	7159944	5787045
N14	GARWOOD PIPELINE AND OFF-CHANNEL RESERVOIR STORAGE	COLORADO	MANUFACTURING	NUECES	0	0	3716125	3716125	3716125	2180850	2180850
N14	GARWOOD PIPELINE AND OFF-CHANNEL RESERVOIR STORAGE	COLORADO	MANUFACTURING	SAN PATRICIO	0	0	7906140	7906140	7906140	4637820	4637820
N14	GARWOOD PIPELINE AND OFF-CHANNEL RESERVOIR STORAGE	COLORADO	MINING	NUECES	0	0	3716125	3716125	3716125	2180850	2180850
N14	GARWOOD PIPELINE AND OFF-CHANNEL RESERVOIR STORAGE	COLORADO	STEAM ELECTRIC POWER	NUECES	0	0	7906140	7906140	7906140	4637820	4637820
N15	VOLUNTARY REDISTRIBUTION	NUECES	COUNTY-OTHER	NUECES	0	0	0	0	0	674900	629100
N15	VOLUNTARY REDISTRIBUTION	NUECES	COUNTY-OTHER	ARANSAS	0	170200	0	0	0	0	0
N15	VOLUNTARY REDISTRIBUTION	NUECES	MANUFACTURING	NUECES	0	230800	330900	382900	421300	450000	523300
N15	VOLUNTARY REDISTRIBUTION	NUECES	RIVER ACRES WSC	LIVE OAK	0	110200	203500	283300	355200	416600	470900
N17	DESALINATION	GULF	MANUFACTURING	NUECES	0	0	0	0	1567340	1567340	1567340
N17	DESALINATION	GULF	MINING	NUECES	0	0	0	0	1567340	1567340	1567340
N17	DESALINATION	GULF	STEAM ELECTRIC POWER	NUECES	0	0	0	0	1567340	1567340	1567340
N19	O.N. STEVENS WATER TREATMENT PLANT IMPROVEMENTS	NUECES	MANUFACTURING	NUECES	0	2492820	2492820	2492820	1591590	1591590	1591590

Water Management Strategy Costs for Water User Groups by County (Concluded)

WMS Project ID	Project Name	SRC Basin Name	WUG Name	WUG County Name	Capital Cost	AC2010	AC2020	AC2030	AC2040	AC2050	AC2060
N19	O.N. STEVENS WATER TREATMENT PLANT IMPROVEMENTS	NUECES	MANUFACTURING	NUECES	0	1246410	1246410	1246410	795795	795795	795795
N19	O.N. STEVENS WATER TREATMENT PLANT IMPROVEMENTS	NUECES	MINING	SAN PATRICIO	0	1246410	1246410	1246410	795795	795795	795795
N19	O.N. STEVENS WATER TREATMENT PLANT IMPROVEMENTS	NUECES	STEAM ELECTRIC POWER	NUECES	0	2492820	2492820	2492820	1591590	1591590	1591590
N2	IRRIGATION WATER CONSERVATION	NUECES	IRRIGATION	NUECES	0	3900	11900	23500	38500	56500	78000
N20	BRACKISH GROUNDWATER DESALINATION	NUECES	MANUFACTURING	LIVE OAK	0	0	0	0	5802720	5802720	5802720
N20	BRACKISH GROUNDWATER DESALINATION	NUECES	MINING	NUECES	0	0	0	0	5802720	5802720	5802720
N20	BRACKISH GROUNDWATER DESALINATION	NUECES	STEAM ELECTRIC POWER	NUECES	0	0	0	0	5802720	5802720	5802720
N3	MANUFACTURING WATER CONSERVATION	NUECES-RIO GRANDE	MANUFACTURING	NUECES	0	0	0	0	0	0	0
N4	MINING WATER CONSERVATION	NUECES	MINING	NUECES	0	0	0	0	0	0	0
N4	MINING WATER CONSERVATION	NUECES-RIO GRANDE	MINING	DUVAL	0	0	0	0	0	0	0
N4	MINING WATER CONSERVATION	NUECES	MINING	DUVAL	0	0	0	0	0	0	0
N4	MINING WATER CONSERVATION	NUECES-RIO GRANDE	MINING	LIVE OAK	0	0	0	0	0	0	0
N5	RECLAIMED WASTEWATER SUPPLIES	NUECES	MANUFACTURING	NUECES	0	68145	68145	68145	68145	68145	68145
N5	RECLAIMED WASTEWATER SUPPLIES	NUECES	MINING	NUECES	0	68145	68145	68145	68145	68145	68145
N5	RECLAIMED WASTEWATER SUPPLIES	NUECES	STEAM ELECTRIC POWER	NUECES	0	68145	68145	68145	68145	68145	68145
N7	GULF COAST AQUIFER SUPPLIES	SAN ANTONIO-NUECES	MANUFACTURING	NUECES	257000	27000	27000	27000	5000	5000	5000
N7	GULF COAST AQUIFER SUPPLIES	SAN ANTONIO-NUECES	IRRIGATION	ARANSAS	1763000	0	0	0	0	202000	202000
N7	GULF COAST AQUIFER SUPPLIES	NUECES-RIO GRANDE	COUNTY-OTHER	BEE	980000	120000	120000	120000	35000	35000	35000
N7	GULF COAST AQUIFER SUPPLIES	NUECES-RIO GRANDE	COUNTY-OTHER	JIM WELLS	587000	0	74000	74000	74000	23000	23000
N7	GULF COAST AQUIFER SUPPLIES	NUECES	COUNTY-OTHER	KLEBERG	315000	0	35000	35000	35000	8000	8000
N7	GULF COAST AQUIFER SUPPLIES	NUECES	IRRIGATION	LIVE OAK	1058000	121000	121000	121000	29000	29000	29000
N7	GULF COAST AQUIFER SUPPLIES	NUECES	IRRIGATION	LIVE OAK	328883	0	0	37511	37511	37511	8841
N7	GULF COAST AQUIFER SUPPLIES	NUECES	LAKE CITY	SAN PATRICIO	343000	0	36000	36000	36000	6000	6000
N7	GULF COAST AQUIFER SUPPLIES	SAN ANTONIO-NUECES	IRRIGATION	SAN PATRICIO	7781117	0	0	887489	887489	887489	209160
N7.1	GULF COAST AQUIFER SUPPLIES (REGIONAL)	SAN ANTONIO-NUECES	MANUFACTURING	SAN PATRICIO	0	0	0	4691500	4691500	4691500	5094000
N7.1	GULF COAST AQUIFER SUPPLIES (REGIONAL)	SAN ANTONIO-NUECES	MANUFACTURING	SAN PATRICIO	0	0	0	4691500	4691500	4691500	5094000

Appendix D
Projected Groundwater Availability
through 2060 using the
Central Gulf Coast Groundwater Availability Model

D.1 Description of the Central Gulf Coast Aquifer

The Gulf Coast Aquifer underlies all or parts of eleven counties within the Coastal Bend Region and yields moderate to large amounts of fresh to slightly saline water. The Gulf Coast Aquifer, extending from Northern Mexico to Florida, is comprised of four water-bearing formations: Catahoula, Jasper, Evangeline, and Chicot. The Evangeline and Chicot Aquifers are the uppermost water-bearing formations, are the most productive and, consequently, are the formations utilized most commonly. The Evangeline Aquifer of the Gulf Coast Aquifer System features the highly transmissive Goliad Sands. The Chicot Aquifer is comprised of many different geologic formations, including the Beaumont and Lissie Formations, which are predominant in the Coastal Bend area. The Catahoula and Jasper are comparatively thin formations that are not extensively developed.

D.2 Description of the Central Gulf Coast Groundwater Availability Model

The Texas Water Development Board (TWDB) has sponsored the development of Groundwater Availability Models (GAMs) for all major and minor aquifers in the state of Texas. The GAM that was utilized to support the Coastal Bend Regional Water Planning activities is the Central Gulf Coast GAM (CGCGAM), which extends from Wharton and Colorado Counties in the northeast to Hidalgo and Starr Counties in the southwest. The model has four layers which thicken and dip toward the Gulf of Mexico. Layer 1 represents the Chicot Aquifer, Layer 2 represents the Evangeline Aquifer, Layer 3 represents the Burkeville confining unit, and Layer 4 represents the Jasper Aquifer (Figure D-1). The Catahoula Formation is not represented in the GAM Model.

Due to technical problems encountered by the TWDB and the GAM contractors during the development of the CGCGAM, there are currently two differing versions of the model available from TWDB. Each version is appropriate for evaluating predictive scenarios with different purposes. The two versions of the CGCGAM are called the Partially-Penetrating version[1] and the best-calibrated, Fully-Penetrating version.[2] These are the best models currently available to use as tools to calculate the regional effects of local and project pumping on the Gulf

[1] Chowdhury, A., Wade, S., Mace, R., and Ridgeway, C., *Groundwater Availability of the Central Gulf Coast Aquifer System: Numerical Simulations through 1999,* Texas Water Development Board, September 27, 2004.
[2] Chowdhury, A., *GAM run 05-04*, Texas Water Development Board, January 23, 2005.

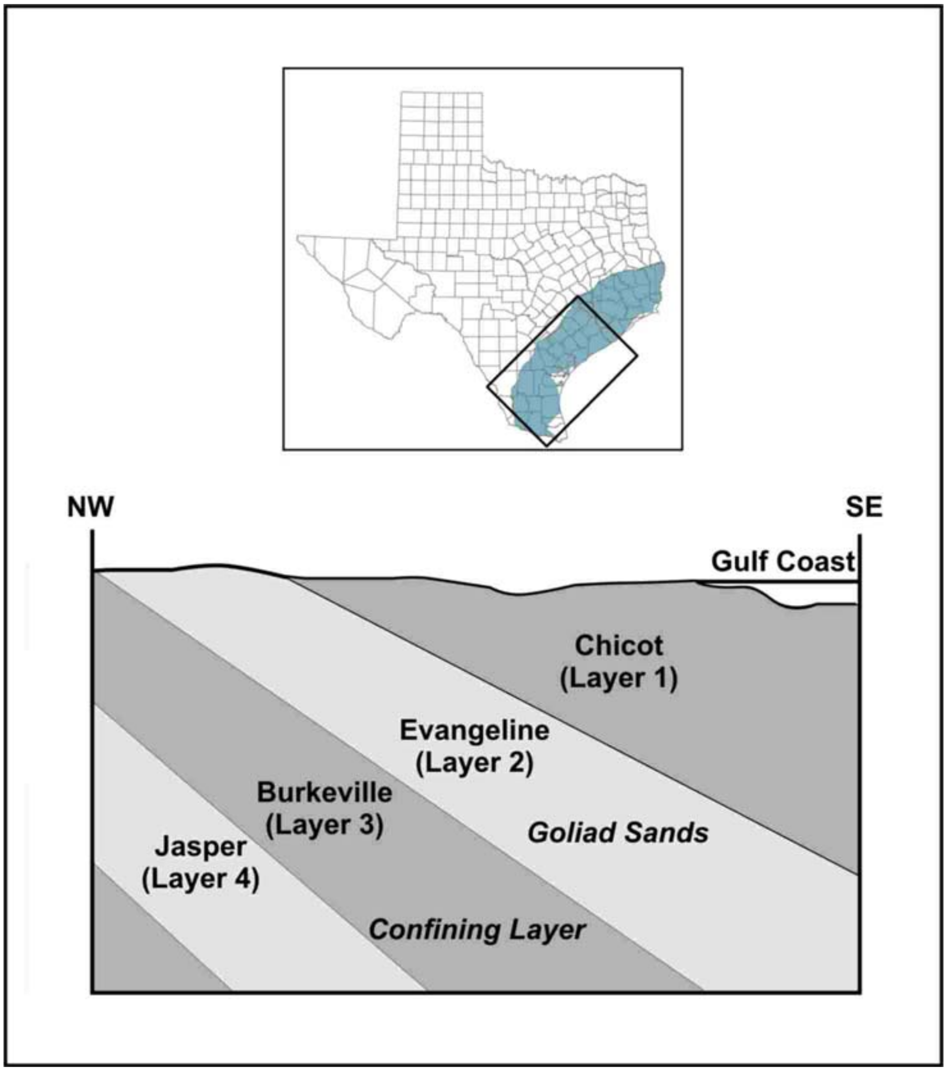

Figure D-1. Central Gulf Coast Groundwater Availability Model Boundaries and Layers

Coast Aquifer. These models are essentially identical for most aquifer parameters, with one important difference. They differ in the representation of the hydraulic conductivity (and therefore transmissivity, which is hydraulic conductivity multiplied by thickness) of Layer 2, the Evangeline Aquifer. The hydraulic conductivity differences between the models are shown in Figure D-2. Use of the Partially-Penetrating model is appropriate when modeling local groundwater demands in which existing wells in the Evangeline Aquifer are screened only in the upper portion of the aquifer; in other words, the wells only partially penetrate the aquifer. Use of the Fully-Penetrating model is appropriate when modeling major project groundwater demands in which wells are expected to fully penetrate the entire thickness of the aquifer. The Central Gulf Coast Aquifer was modeled with local groundwater demands and project-related groundwater demands for each water user group using the two publicly-released versions of the CGCGAM. The cumulative effects are the sum of the drawdowns calculated in two models.

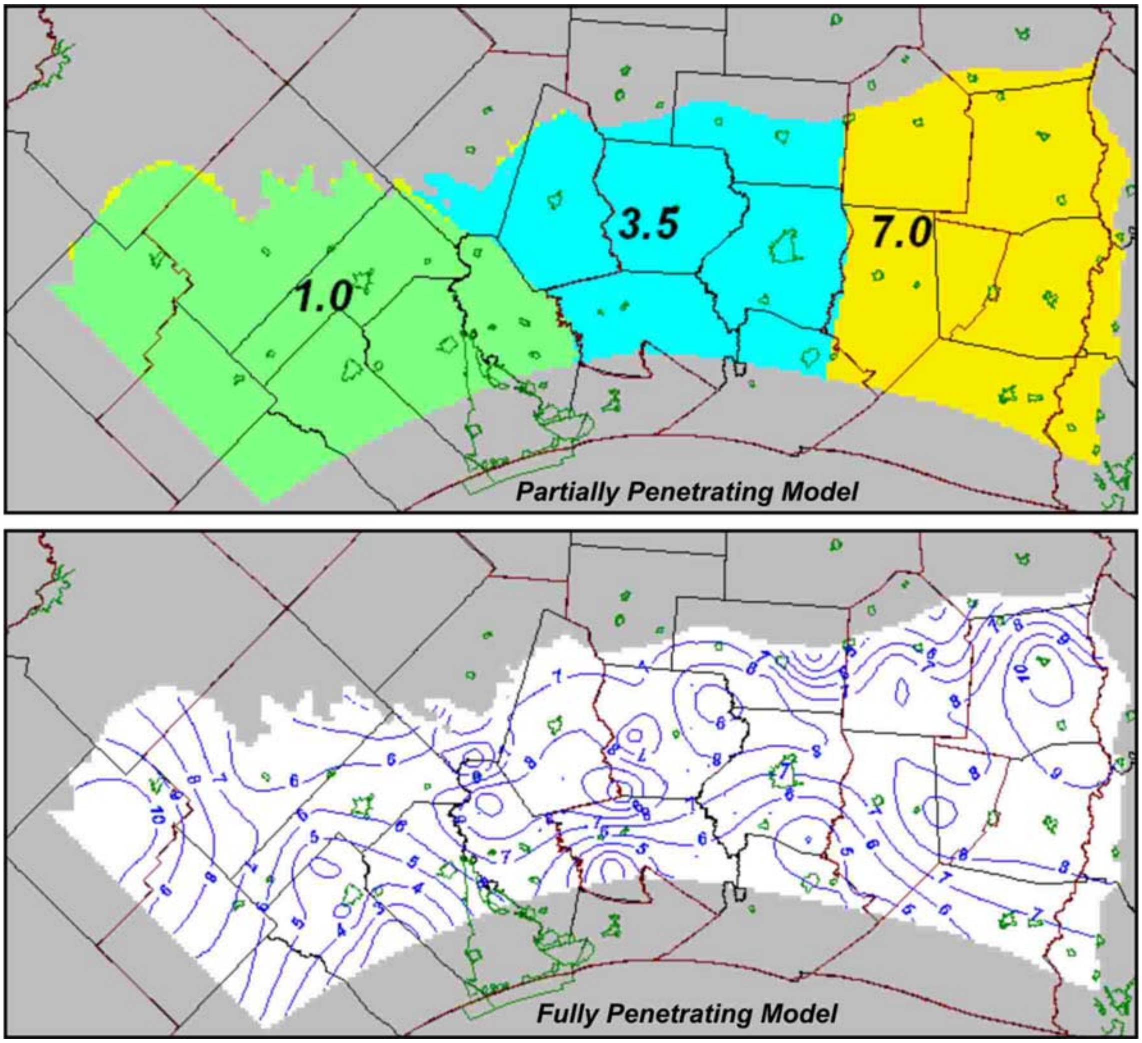

Figure D-2. Evangeline Aquifer Hydraulic Conductivity in the Partially-Penetrating Model (a) and the Fully-Penetrating Model (b) (ft/day)

The TWDB released a steady-state (pre-development) and a historical transient (1980 to 1999) version of the CGCGAM, reflective of the partially-penetrating conceptual approach. The historical transient model contained a variable time series of values for recharge, streamflow, pumping, and evapotranspiration. For predictive analysis, a clearer assessment can be made of the effects of pumpage if the other time-variant parameters are held at a constant value. For this reason, the predictive CGCGAM Model used by HDR to evaluate regional effects of pumping in Region N for both the Partially-Penetrating version and the Fully-Penetrating version used these constant value parameters from the TWDB steady-state model. The predictive simulations represent the period from 2000 to 2060 with 61 annual stress periods. The steady-state recharge values were used in the predictive models; however, they were modified to include a 6-year drought, with recharge based on the percentage of reported annual precipitation as a portion of average annual precipitation during the drought of record in 1951 to 1956 in the region.[3] The storage and specific yield values from the historical transient model were used in the predictive models. The final heads from the TWDB historical transient model, representative of conditions in the year 1999, were used as the initial starting heads for the Partially-Penetrating model so that the historical pumping would be represented prior to starting the predictive simulation. The TWDB steady-state model (with the fully-penetrating hydraulic conductivity) heads were used as the initial starting heads for the Fully-Penetrating model; thus, these simulations only calculate drawdown estimates specifically associated with the described development projects.

Since there are two versions of the CGCGAM, the Partially-Penetrating version and the Fully-Penetrating version, there will be drawdown results and output from both models. In order to calculate total drawdown effects of the aquifer system from both models, the drawdown from each simulation was added to calculate total drawdown, as shown in Figure D-3.

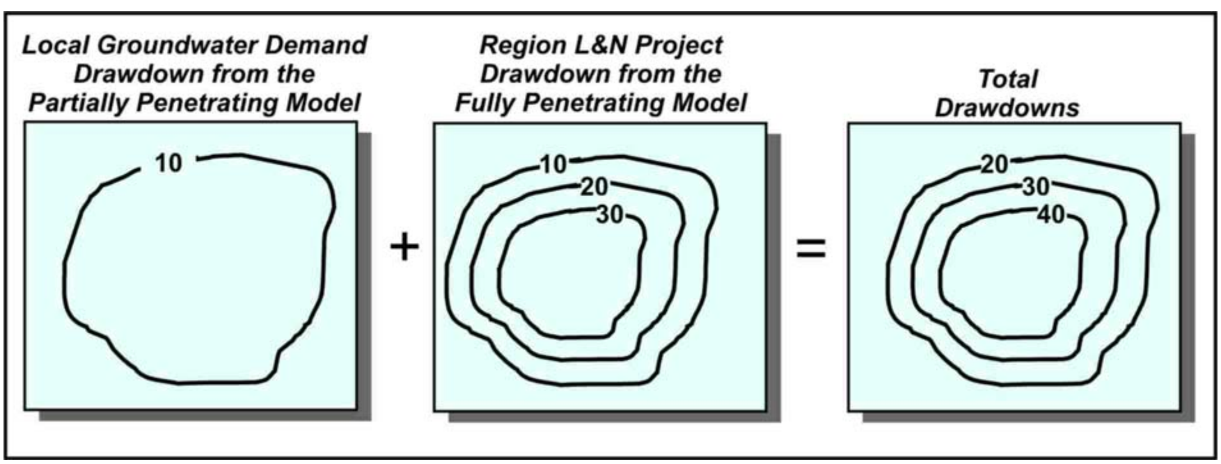

Figure D-3: Calculating Total Drawdown

[3] Chowdhury, personal communication, 2005.

D.3 Description of the CGCGAM Predictive Pumpage Data Sets

The Central Gulf Coast Model covers six Regional Water Planning Group boundaries as shown in Figure D-4. Predictive pumping data for Regions M, P, K, and H were obtained from the TWDB and are consistent with the 2002 Regional Water Plan. The 2002 pumping dataset includes water management strategies per the 2002 Regional Water Plan. Pumping data in Regions N and Region L were updated to reflect the 2006 Regional Water Plan.

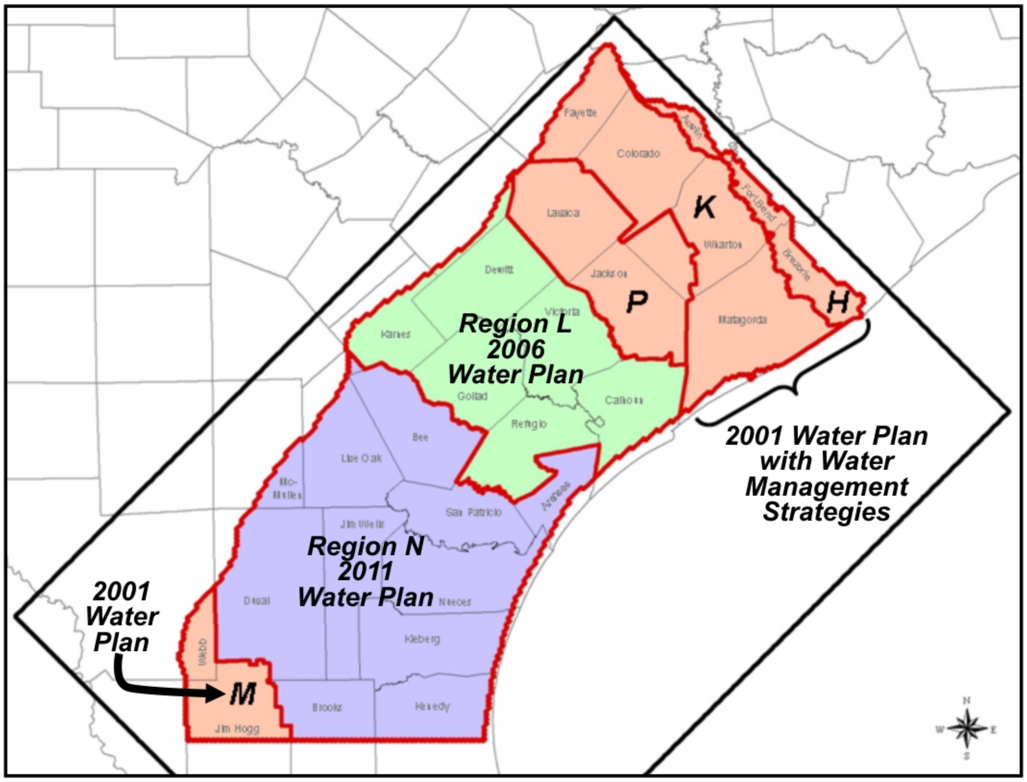

Figure D-4: Groundwater Pumping Data Sources for the Partially Penetrating Model

Region N and Region L developed estimates of total pumpage by county for each of the defined water user groups (municipal, irrigation, manufacturing, steam-electric, livestock, and rural/county-other). The method used to distribute Region L and Region N ground water pumpage data to cells in the partially-penetrating model included apportioning the pumping between *point-source* and *diffuse* use types. Point source use types include pumping that can be attributed to a particular location. The TWDB has identified locations of municipalities, mines, power plants, and manufacturing facilities and the utilized aquifers. The point source pumping data was distributed to these identified locations and aquifers in the partially-penetrating model.

In general, diffuse use types include irrigation, livestock, rural, and any point source pumping use type with a demand of less than 250 acft/yr. A methodology for assigning a spatial distribution to diffuse pumping has been developed by the TWDB,[4] and was used to assign pumpage in the historical transient version of the CGCGAM. When developing the predictive pumpage data sets, HDR maintained the spatial distribution of diffuse pumpage in each county that was represented for the year 1999, which was the final year of the historical transient simulation. The model extends to south approximately midway through Jim Hogg, Brooks, and Kenedy Counties. Other than the City of Falfurrias, water user groups identified by the TWDB for Brooks and Kenedy County were provided on a county basis. Falfurrias is located in north Brooks County and was therefore evaluated as a point source demand. Estimated groundwater pumping for county-defined water user groups were apportioned in a diffuse pattern across the active model area (ie. northern portions of Brooks and Kenedy counties). The maximum predictive pumping for Brooks and Kenedy counties did not violate the drawdown criteria adopted by the Coastal Bend Region.

The predictive annual pumping per county for local supply in Region N that was used in the Partially-Penetrating model is presented in Table D-1. Figures D-5 through D-15 display the 1981 to 1999 historical and predictive annual pumping per county and aquifer for Aransas, Bee, Brooks, Duval, Jim Wells, Kenedy, Kleberg, Live Oak, McMullen, Nueces, and San Patricio Counties, respectively. Drawdown from 2000 to 2060 was calculated by the CGCGAM. After the groundwater demands for local supply were simulated, the resulting water levels were compared to water levels simulated in the steady-state version of the CGCGAM which are representative of pre-development conditions. If drawdown from pre-development conditions exceeded any of the criteria adopted by the RWPG, these locations are noted. Drawdown for the Chicot and Evangeline Aquifers are presented in Figures D-16 and D-17. A more detailed discussion of CGCGAM modeling results is included in Section 4C.7.

All counties in the Coastal Bend Region show a consistent trend through the planning period, either increasing or decreasing with time. Exceptions to this trend exist in Region L pumpage. The City of Victoria is pursuing a strategy to switch from groundwater to surface water supply, and is simulated to have variable groundwater demand in the predictive simulations based on surface water availability modeling. The annual pumping for local supply in Goliad County (Region L) is predicted to increase from 1,920 acre-ft/yr in 2000 to 2,501 acre-ft/yr in 2060. The annual pumping for local supply in Refugio County (Region L) is expected to decline from 2,358 acre-ft/yr in 2000 to 1,690 acre-ft/yr by 2060.[5] Graphs that include the projected pumping trend by aquifer for each Region L county can be found in the Region L Plan.

Table D-1.
Predictive Annual Pumping per County for Local Supply used for the Partially-Penetrating Model

County	2000	2010	2020	2030	2040	2050	2060
Aransas	530	614	665	693	702	702	715
Bee	4,607	5,645	6,088	12,033	12,489	13,001	17,053
Brooks	2,197	2,564	2,881	3,122	3,264	3,318	3,325
Duval	10,854	10,408	10,358	10,322	10,296	10,236	10,122
Jim Wells	7,465	7,269	7,059	6,798	6,494	6,196	5,902
Kenedy	244	248	250	251	251	250	251
Kleberg	7,295	8,170	8,218	7,486	7,461	7,477	7,421
Live Oak	9,323	9,981	9,773	9,353	9,014	8,647	8,295
McMullen	34	34	34	34	34	34	34
Nueces	1,567	1,670	1,719	1,763	1,817	1,867	1,963
San Patricio	6,683	10,841	11,833	18,410	19,575	20,884	25,832

Note: This table includes pumping associated with recommended water management strategies. The drawdown criteria were exceeded for point-source pumping in Live Oak County for manufacturing and mining uses and Duval County for mining uses when considering groundwater supplies to fully meet projected demands for these entities. The pumping was prorated back as described in Section 3.4.1 and Section 4C-7.2.2. The amount shown in the tables reflects the amount of pumping without exceeding drawdown criteria.

[4] GAM Technical Memo 02-02, Cindy Ridgeway, TWDB, August 1, 2002.
[5] HDR, South Central Texas Regional Water Initially Prepared Plan, June 2005.

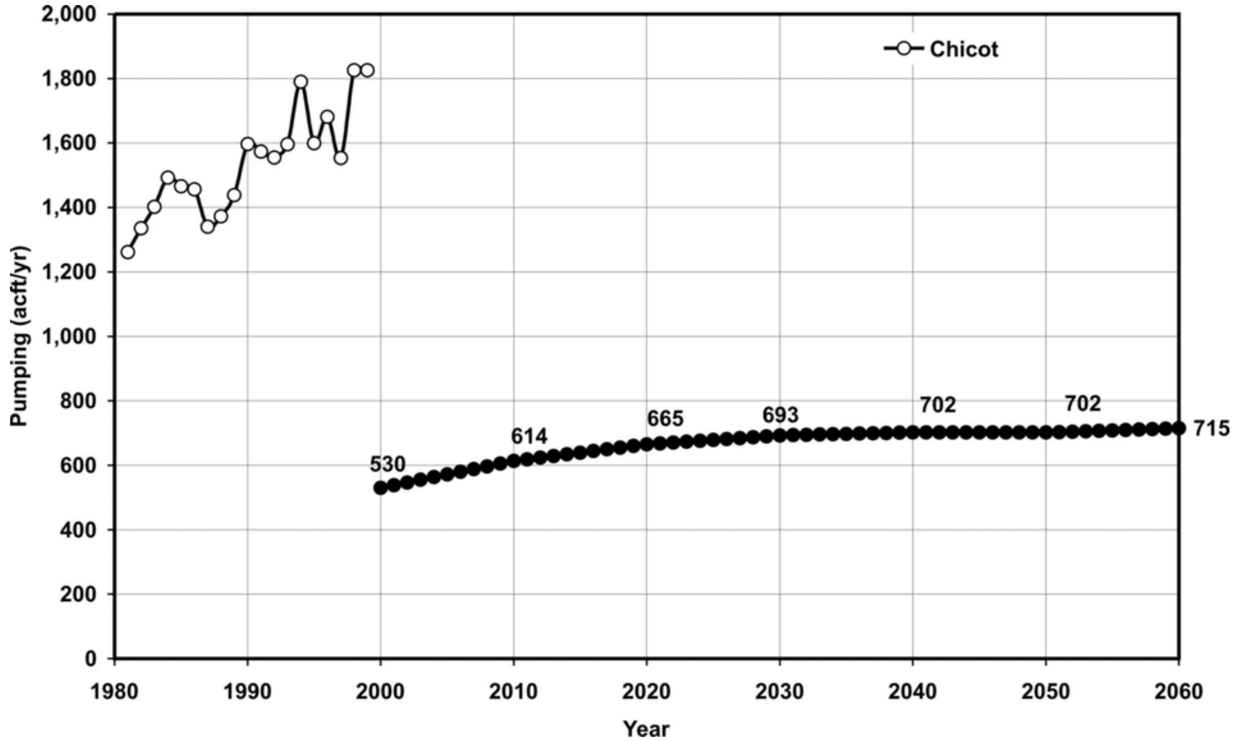

Figure D-5: Partially-Penetrating Model Historical and Predictive Pumping in Aransas County

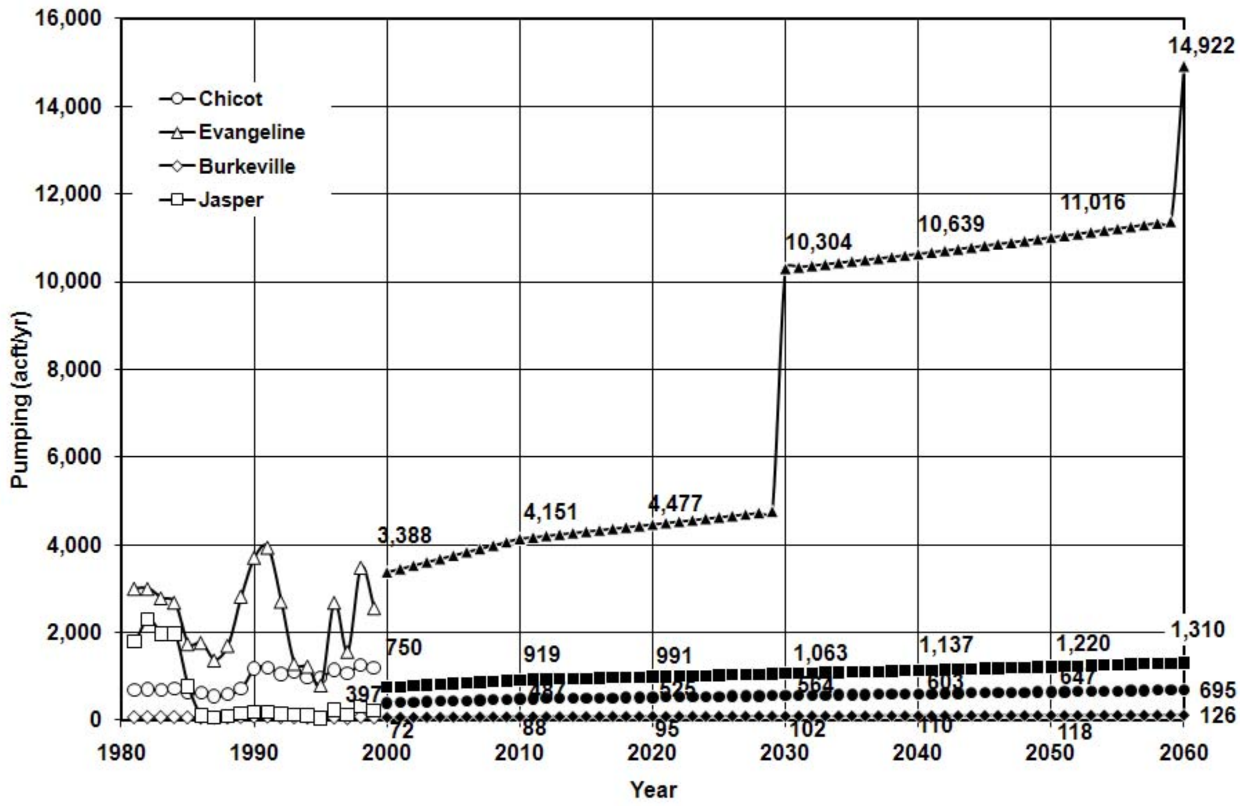

Figure D-6: Local Supply Historical and Predictive Pumping in Bee County

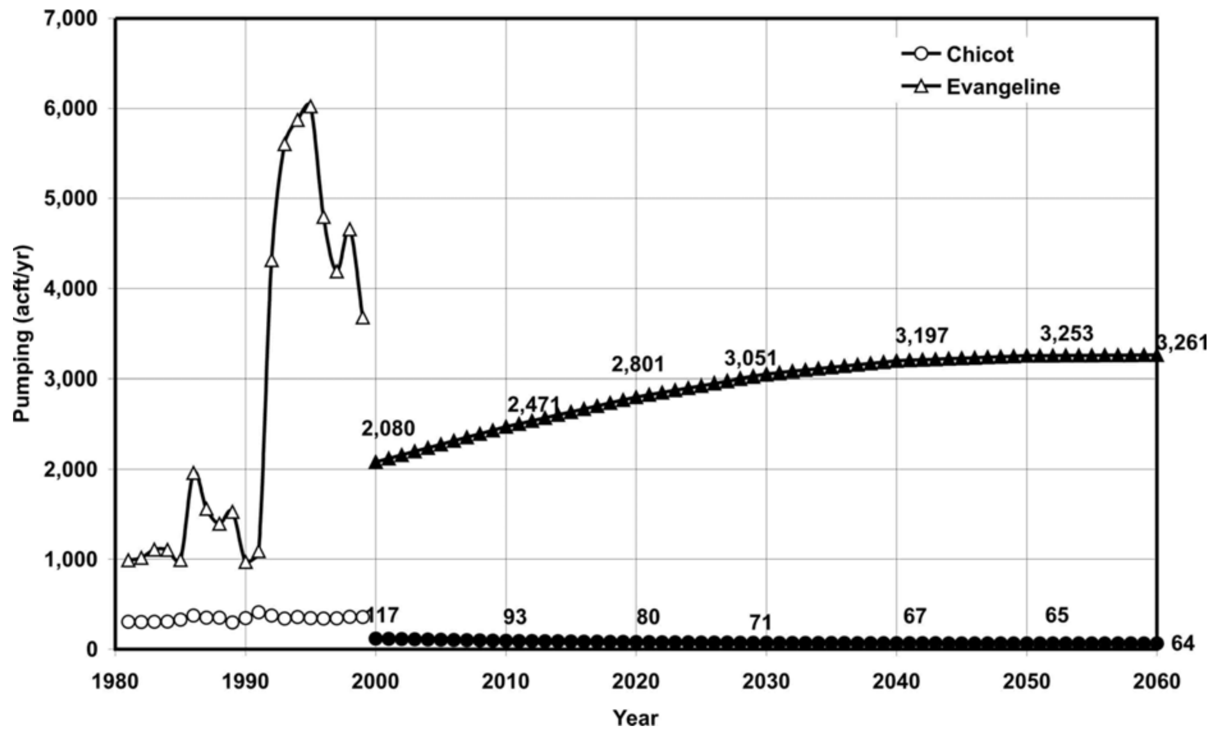

Figure D-7: Local Supply Historical and Predictive Pumping in Brooks County

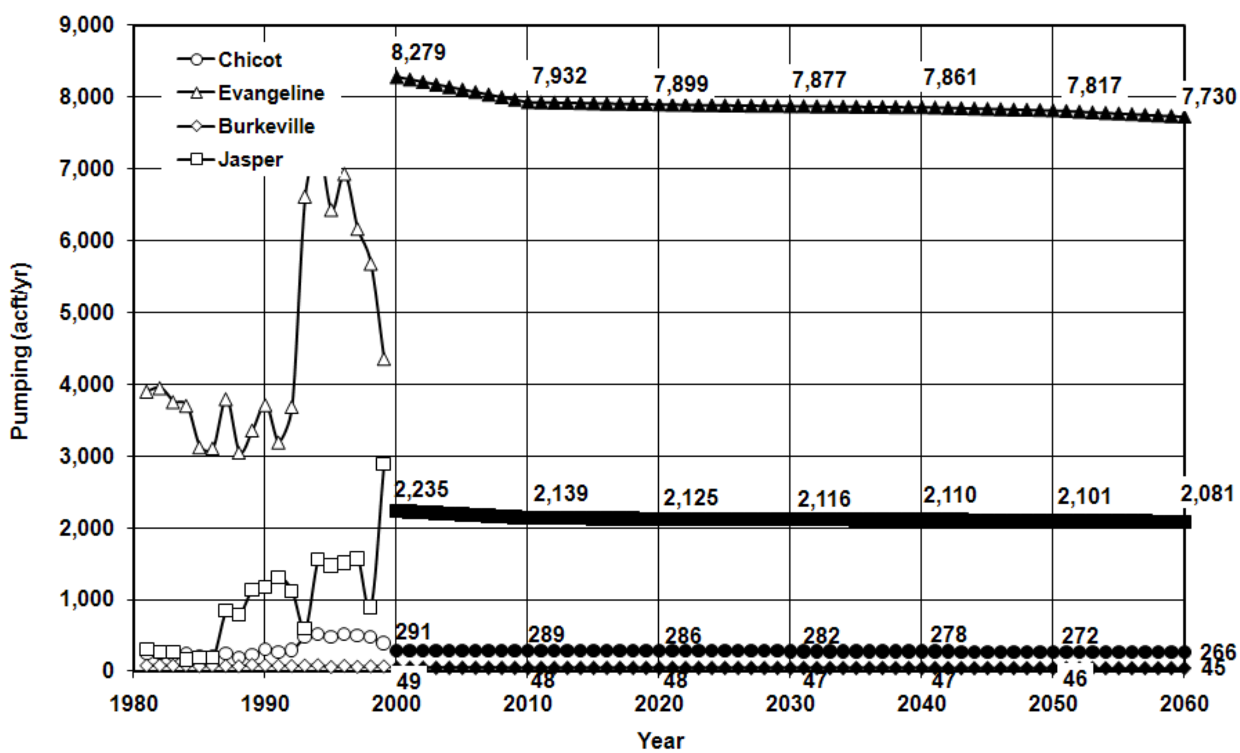

Figure D-8: Local Supply Historical and Predictive Pumping in Duval County

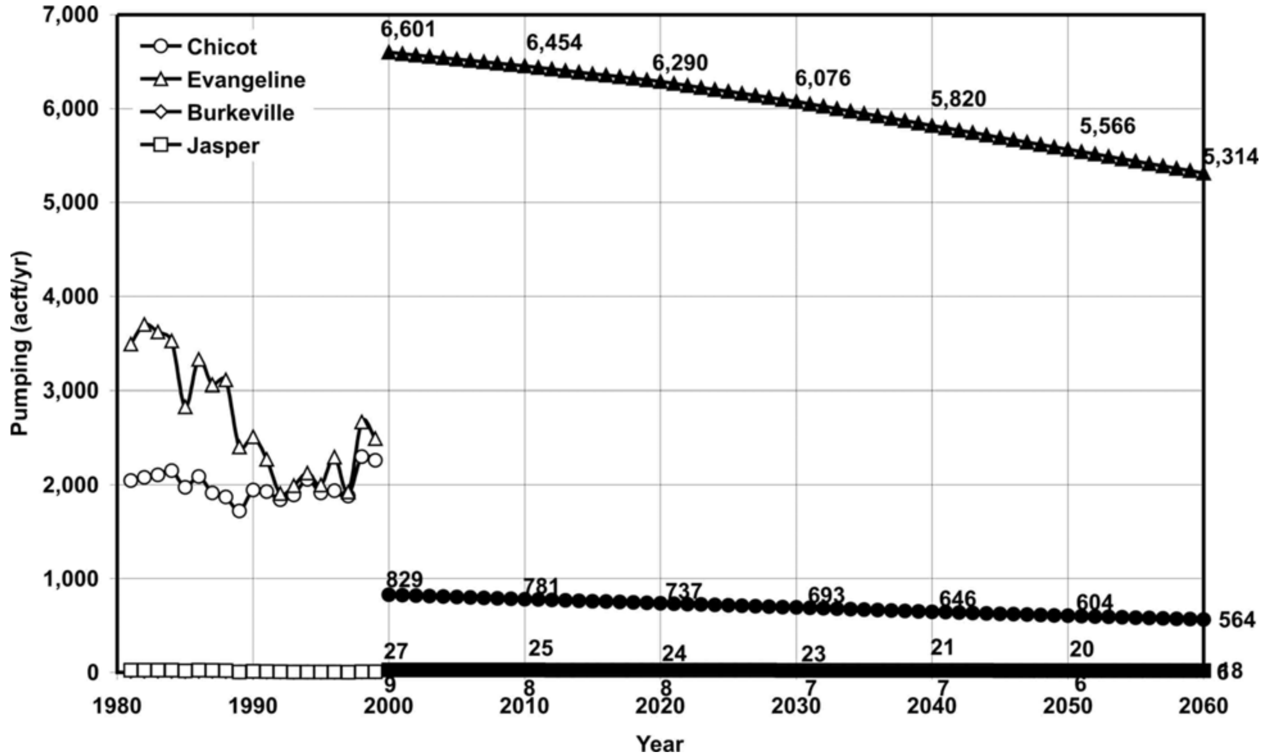

Figure D-9: Local Supply Historical and Predictive Pumping in Jim Wells County

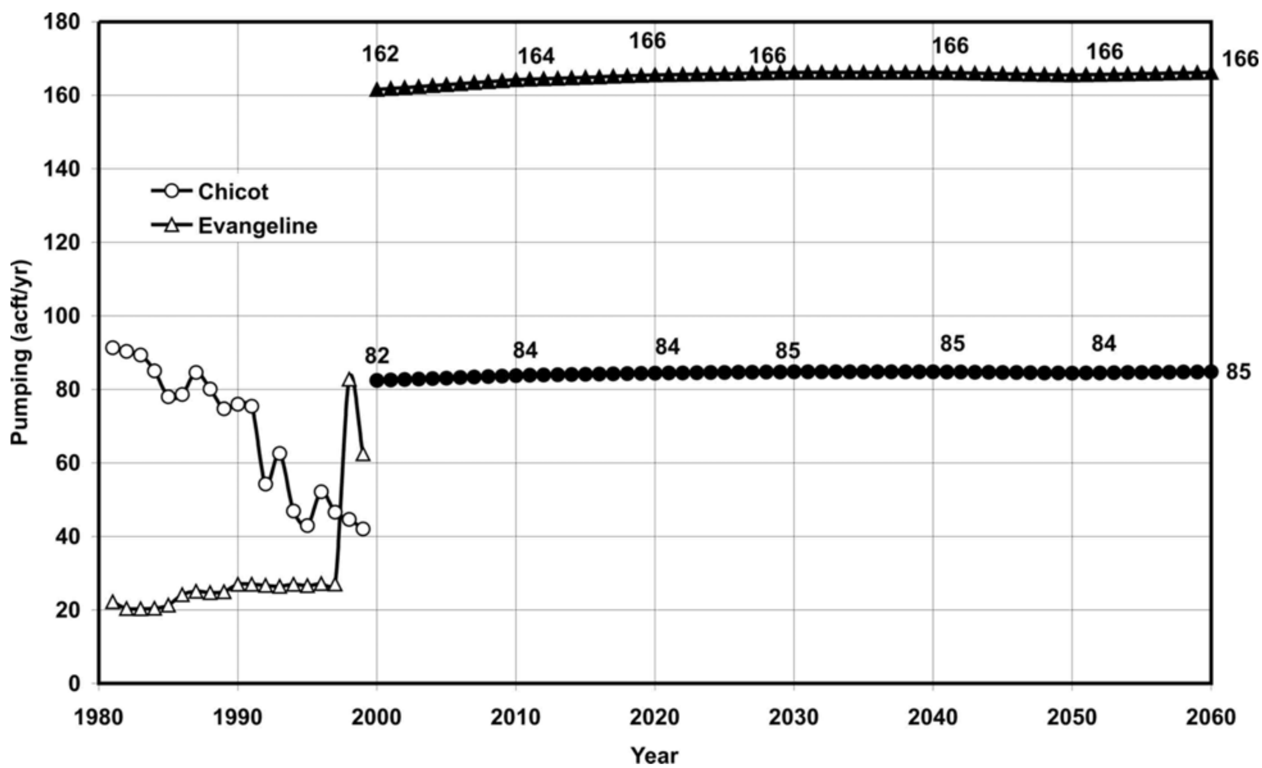

Figure D-10: Local Supply Historical and Predictive Pumping in Kenedy County

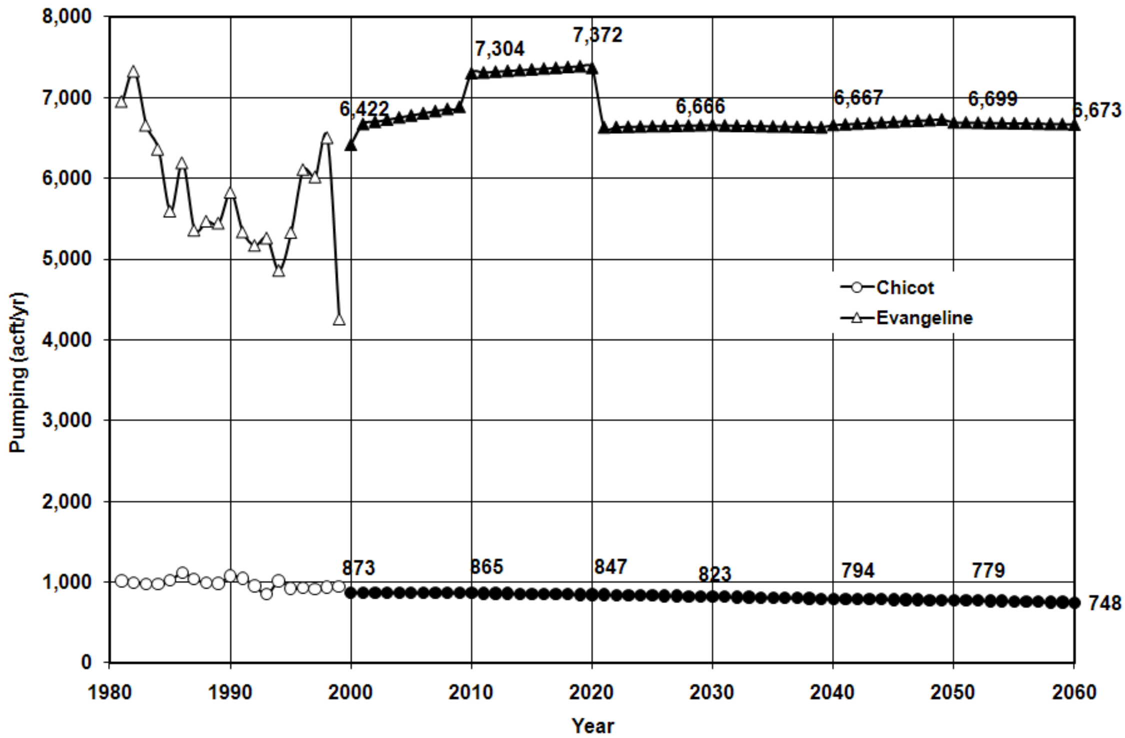

Figure D-11: Local Supply Historical and Predictive Pumping in Kleberg County

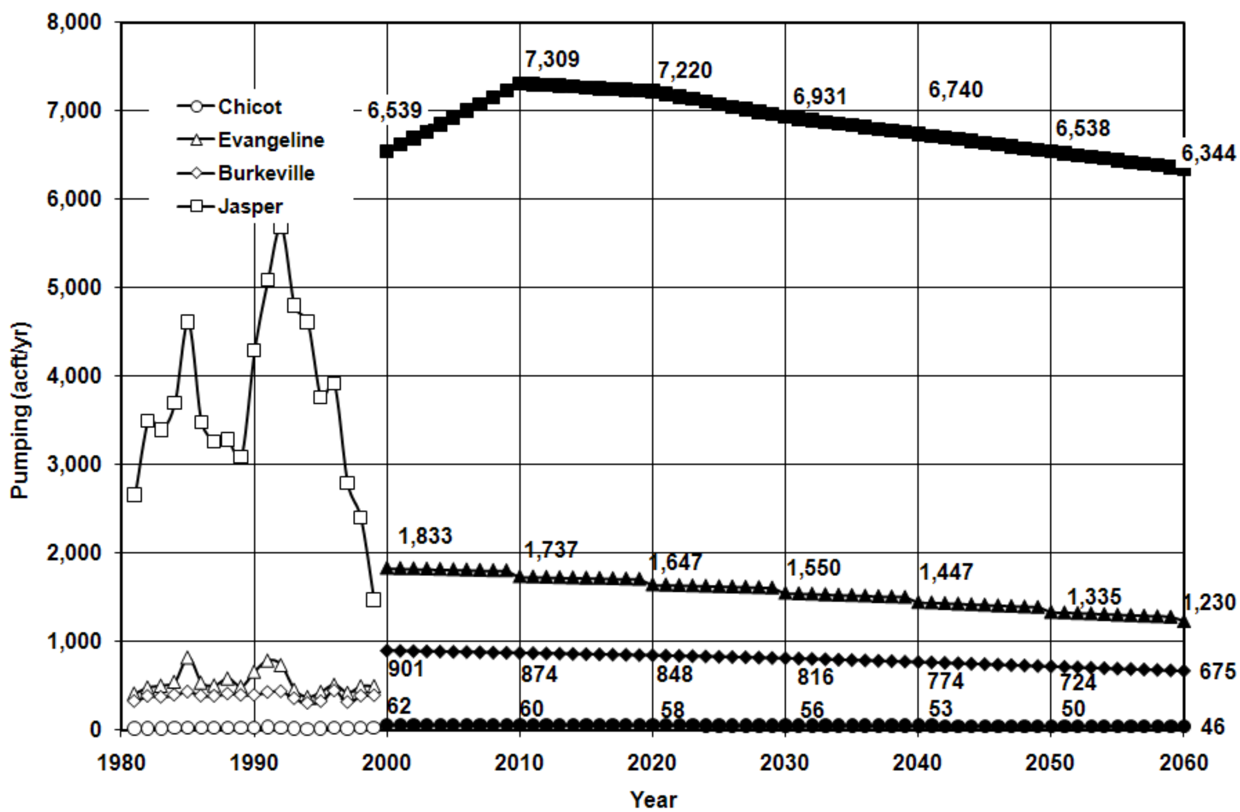

Figure D-12: Local Supply Historical and Predictive Pumping in Live Oak County

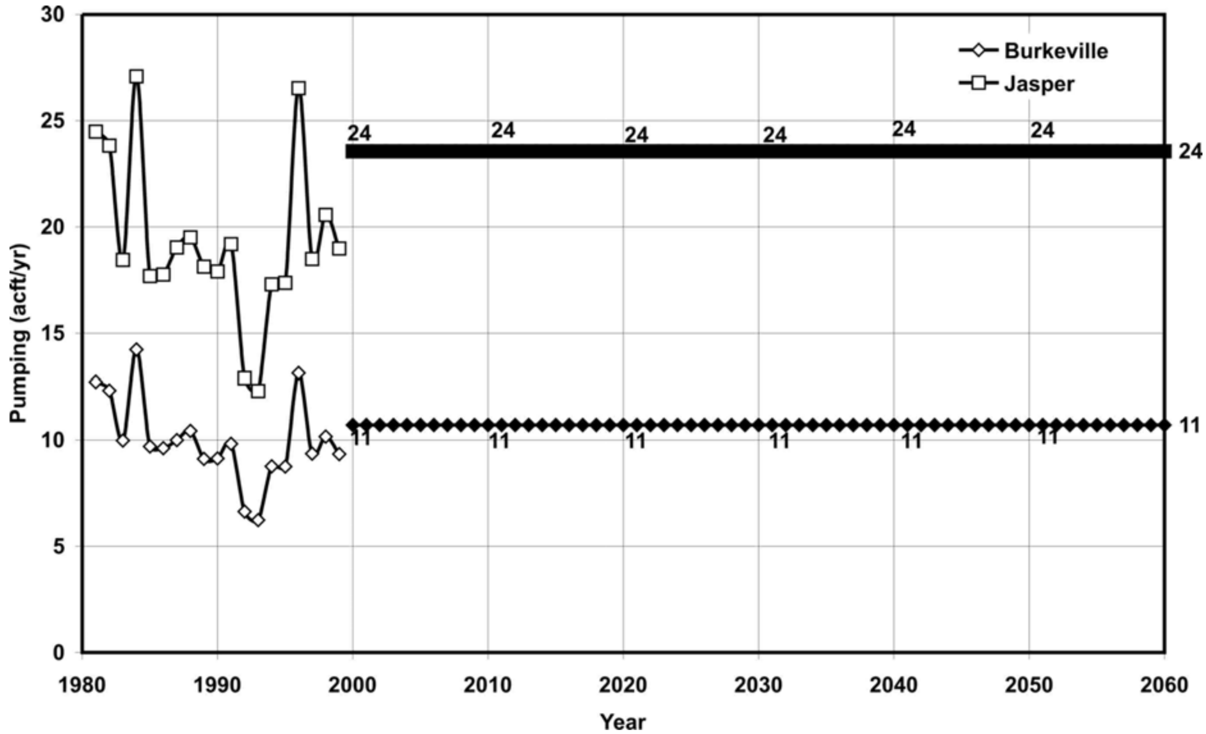

Figure D-13: Local Supply Historical and Predictive Pumping in McMullen County

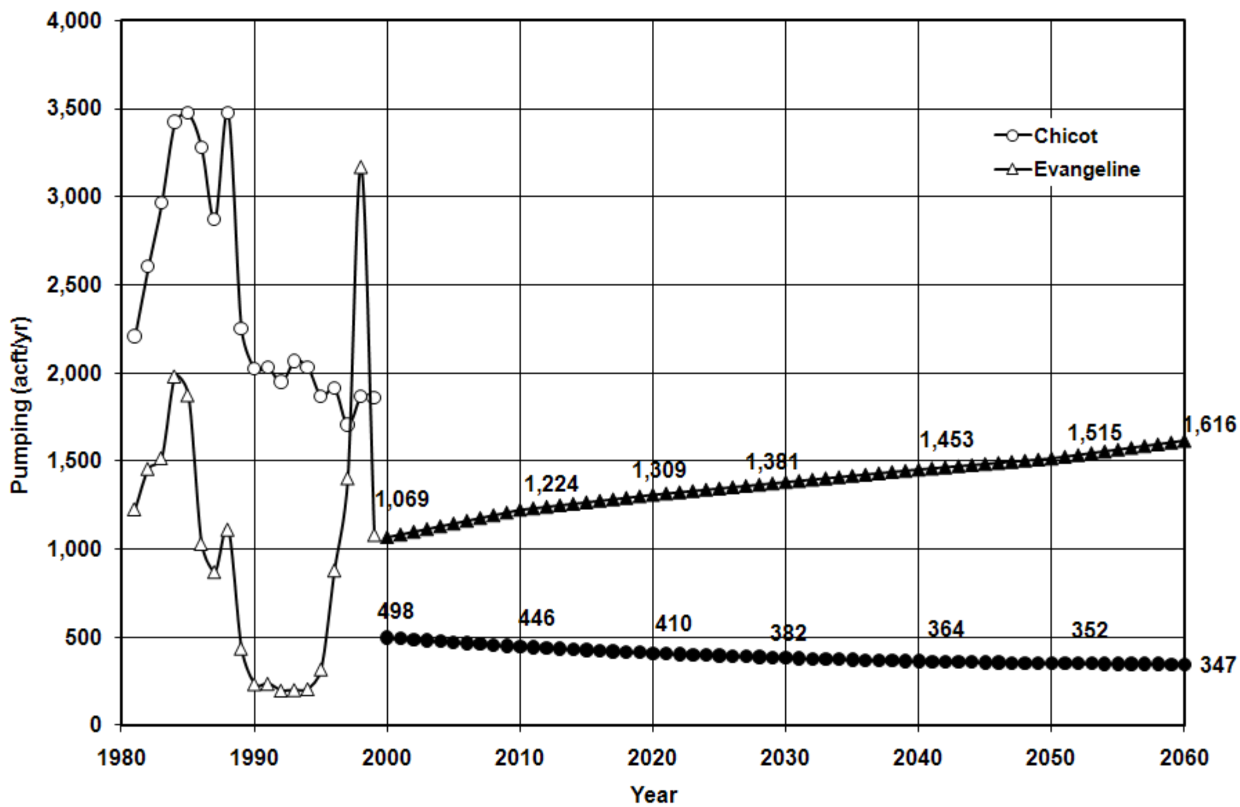

Figure D-14: Local Supply Historical and Predictive Pumping in Nueces County

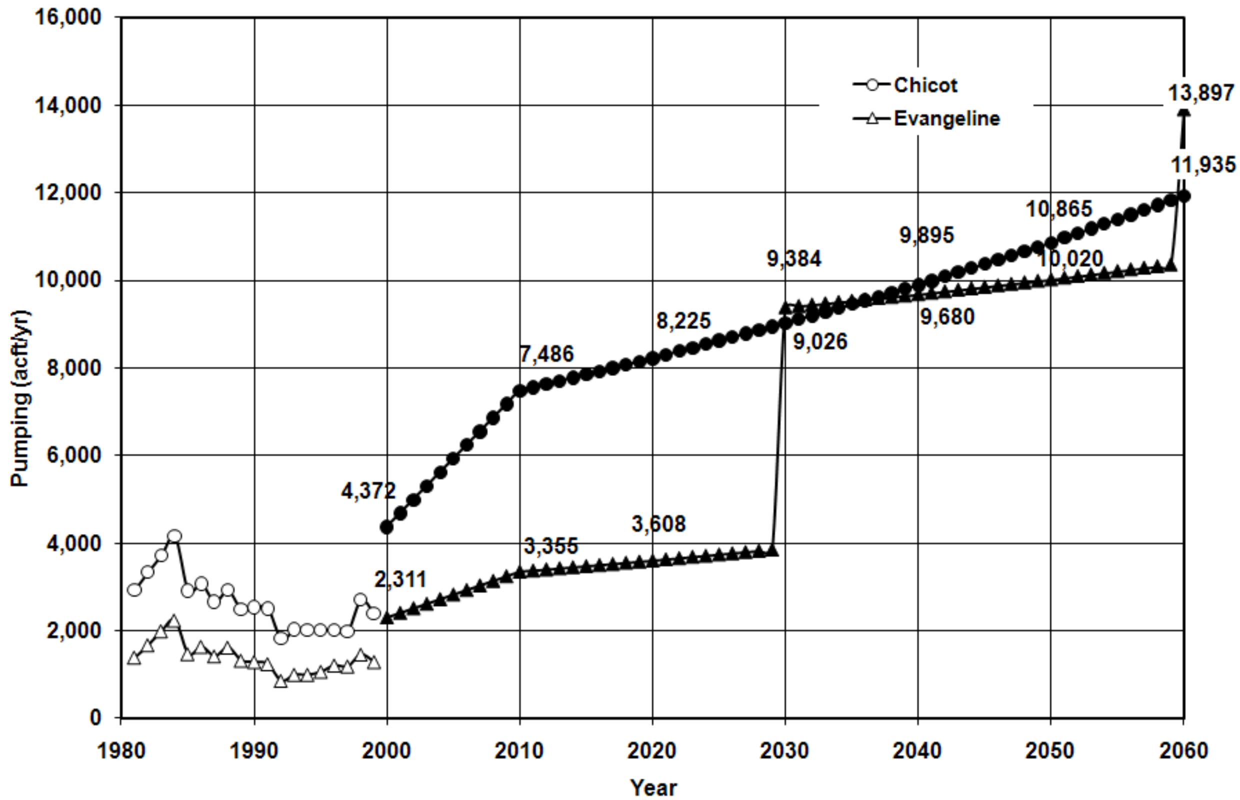

Figure D-15: Local Supply Historical and Predictive Pumping in San Patricio County

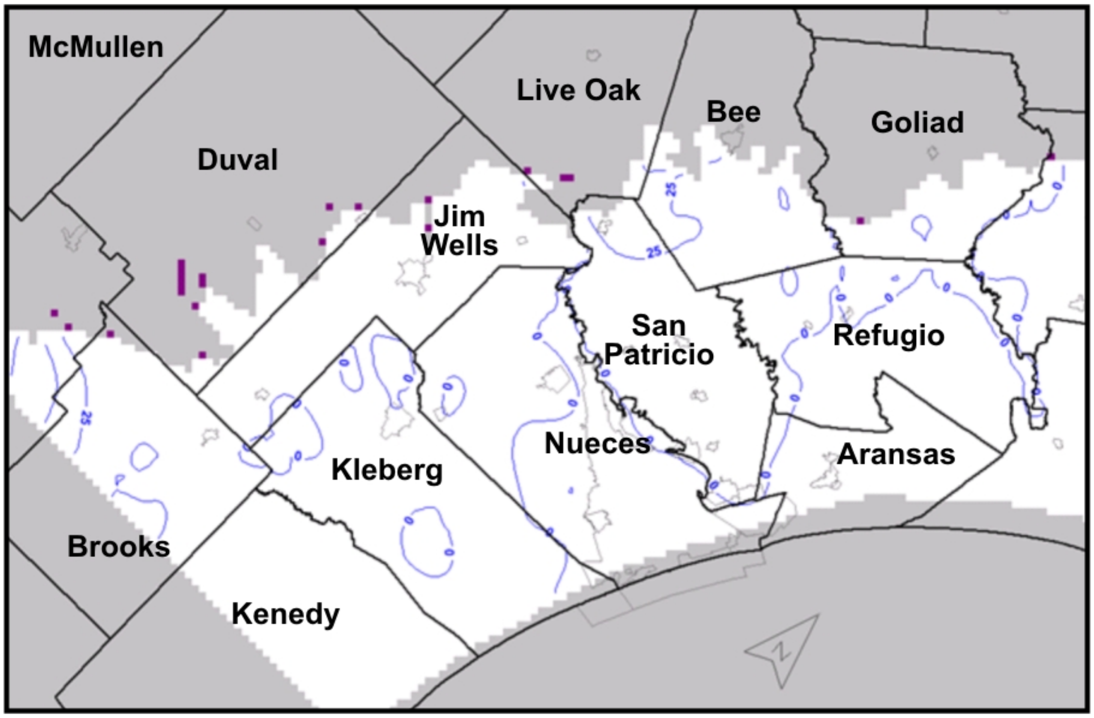

Figure D-16. 2000 to 2060 Chicot Drawdown

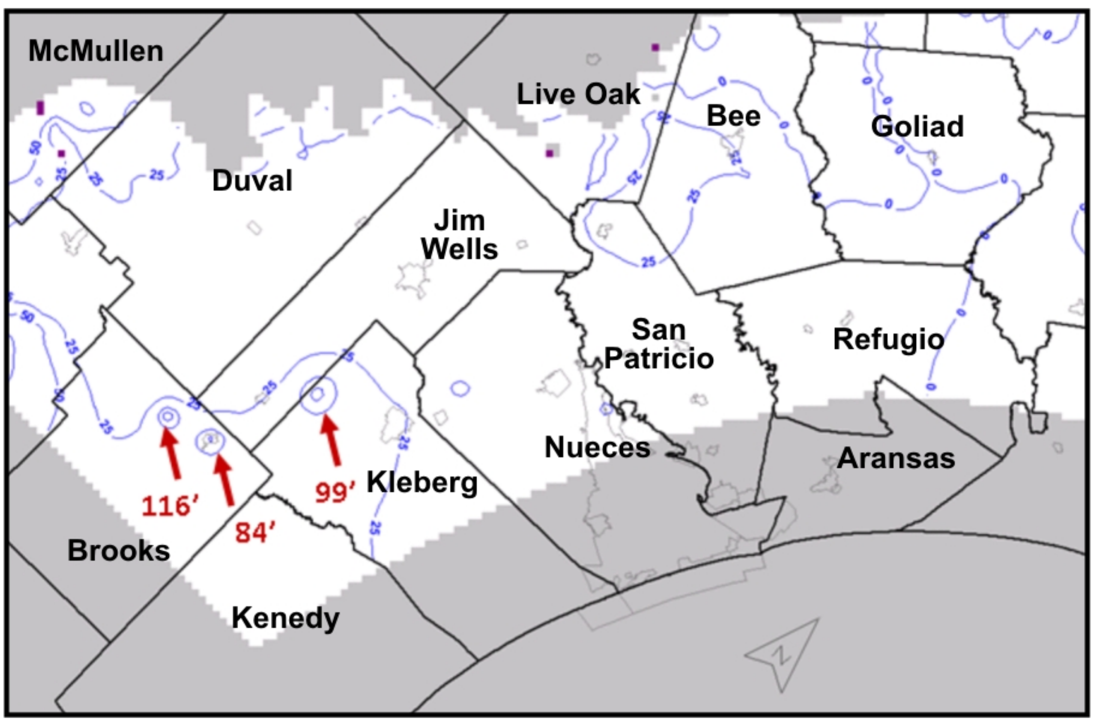

Figure D-17. 2000 to 2060 Evangeline Drawdown

D.4 Region N Project Pumping

Region N projects were also modeled in the Fully-Penetrating model. The San Patricio well field project includes two well fields in Bee and San Patricio Counties, each producing 5,500 acft/yr for a total of 11,000 acft/yr at a constant annual rate starting in 2030. The total pumping for both welllfields is 18,000 acft/yr in 2060. The Bee County well field has four 1,350-gpm wells and the San Patricio County well field also has four 1,350-gpm wells.

Region N project pumping associated with 18,000 acft/yr groundwater project in Bee and San Patricio County using the Fully-Penetrating model is shown in Figure D-18.

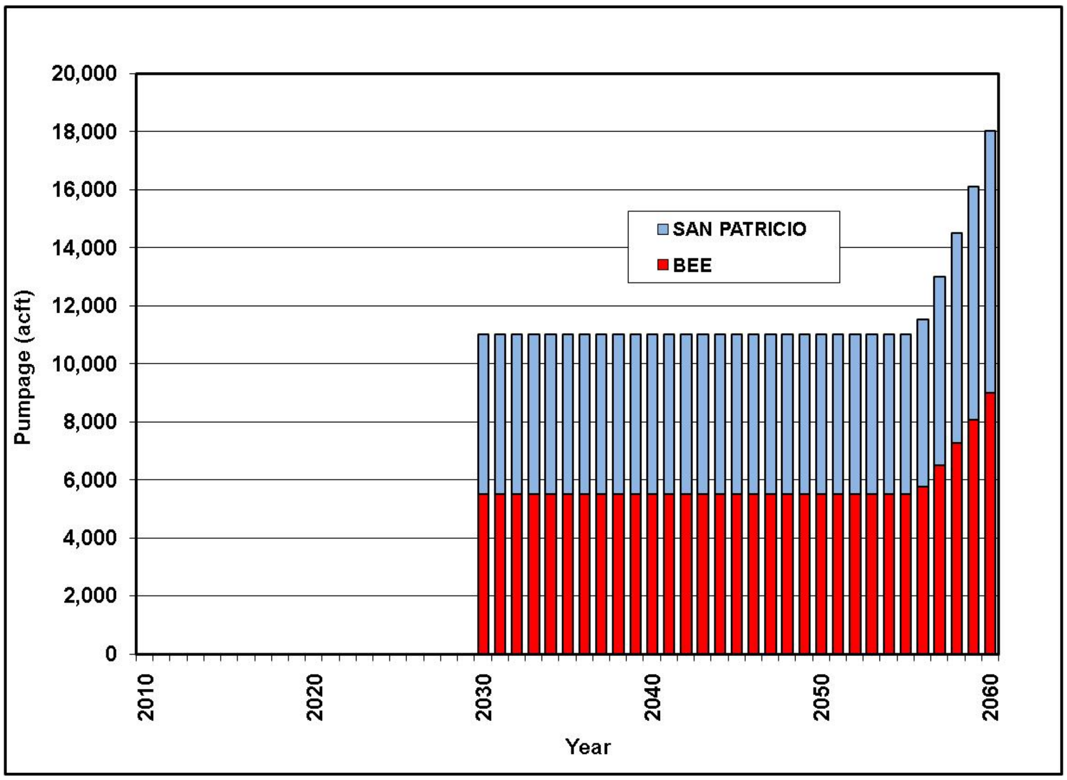

Figure D-18. Fully-Penetrating Model Predictive Pumping per Project

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Appendix E

Model Water Conservation and Drought Contingency Plans for the Coastal Bend Region

Contents

Appendix E.1

Texas Commission on Environmental Quality

Model

Municipal Water Conservation Plan

Utility Profile and Water Conservation Plan Requirements for Municipal Water Use by Public Water Suppliers

Web Sites for Information:
www.tceq.state.tx.us/permitting/water_supply/water_rights/conserve.html#forms
www.twdb.state.tx.us/assistance/conservation/Municipal/Plans/CPlans.asp
www.twdb.state.tx.us/assistance/conservation/TaskForceDocs/WCITFBMPGuide.pdf

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Texas Commission on Environmental Quality

UTILITY PROFILE & WATER CONSERVATION PLAN REQUIREMENTS FOR MUNICIPAL WATER USE BY PUBLIC WATER SUPPLIERS

This form is provided to assist entities in water conservation plan development for municipal water use by a retail public water supplier. Information from this form should be included within a water conservation plan for municipal use. If you need assistance in completing this form or in developing your plan, please contact the conservation staff of the Resource Protection Team in the Water Supply Division at (512) 239-4691.

Name of Entity: ____

Address & Zip: ____

Telephone Number: ______________________________ **Fax:** ____________________

Form Completed By:____

Title: ____

Signature: ______________________________ **Date:** ___________________

Name and Phone Number of Person/Department responsible for implementing a water conservation program: ____

UTILITY PROFILE

I. POPULATION AND CUSTOMER DATA

A. Population and Service Area Data

1. Attach a copy of your service-area map and, if applicable, a copy of your Certificate of Convenience and Necessity (CCN).

2. Service area size (square miles): ________________________________

3. Current population of service area: ______________________________

4. Current population served:

a. water ______________________
b. wastewater ______________________

5. Population served by water utility for the previous five years:

Year	Population
________	_________
________	_________
________	_________
________	_________
________	_________

6. Projected population for service area in the following decades:

Year	Population
2010	_________
2020	_________
2030	_________
2040	_________
2050	_________

7. List source/method for the calculation of current and projected population:

____
____
____
____

B. Active Connections

1. Current number of active connections. Check whether multi-family service is counted as Residential _____ or Commercial _____

Treated water users:	Metered	Not-metered	Total
Residential	________	__________	______
Commercial	________	__________	______
Industrial	________	__________	______
Other	________	__________	______

2. List the net number of new connections per year for most recent three years:

Year	________	________	________
Residential	________	________	________
Commercial	________	________	________
Industrial	________	________	________
Other	________	________	________

C. High Volume Customers

List annual water use for the five highest volume customers
(indicate if treated or raw water delivery)

	Customer	Use (1,000gal./yr.)	Treated/Raw Water
(1)	________	________	________
(2)	________	________	________
(3)	________	________	________
(4)	________	________	________
(5)	________	________	________

II. WATER USE DATA FOR SERVICE AREA

A. Water Accounting Data

1. Amount of water use for previous five years (in 1,000 gal.):
Please indicate : Diverted Water ________________
Treated Water ________________

Year	________	________	________	________	________
January	________	________	________	________	________
February	________	________	________	________	________
March	________	________	________	________	________

April	______	______	______	______	______
May	______	______	______	______	______
June	______	______	______	______	______
July	______	______	______	______	______
August	______	______	______	______	______
September	______	______	______	______	______
October	______	______	______	______	______
November	______	______	______	______	______
December	______	______	______	______	______
Total	______	______	______	______	______

Indicate how the above figures were determined (e.g., from a master meter located at the point of a diversion from the source or located at a point where raw water enters the treatment plant, or from water sales).

____

____

____

2. Amount of water (in 1,000 gallons) delivered (sold) as recorded by the following account types for the past five years.

Year	Residential	Commercial	Industrial	Wholesale	Other	Total Sold
____	______	______	______	______	____	______
____	______	______	______	______	____	______
____	______	______	______	______	____	______
____	______	______	______	______	____	______
____	______	______	______	______	____	______

3. List previous five years records for water loss (the difference between water diverted (or treated) and water delivered (or sold))

Year	Amount (gal.)	%
____	__________	____
____	__________	____
____	__________	____
____	__________	____
____	__________	____

4. Municipal water use for previous five years:

Year	Population	Total Water Diverted or Pumped for Treatment (1,000 gal.)
	______________	________________
	______________	________________
	______________	________________
	______________	________________
	______________	________________

B. Projected Water Demands

If applicable, attach projected water supply demands for the next ten years using information such as population trends, historical water use, and economic growth in the service area over the next ten years and any additional water supply requirement from such growth.

III. WATER SUPPLY SYSTEM DATA

A. Water Supply Sources

List all current water supply sources and the amounts authorized with each:

	Source	Amount Authorized
Surface Water:	______________________________	____________ acre-feet
Groundwater:	______________________________	____________ acre-feet
Contracts:	______________________________	____________ acre-feet
Other:	______________________________	____________ acre-feet

B. Treatment and Distribution System

1. Design daily capacity of system: ______________ MGD

2. Storage Capacity: Elevated ________ MGD, Ground _______ MGD

3. If surface water, do you recycle filter backwash to the head of the plant? Yes ______ No ______. If yes, approximately ________ MGD.

4. Please attach a description of the water system. Include the number of

treatment plants, wells, and storage tanks. If possible, include a sketch of the system layout.

IV. WASTEWATER SYSTEM DATA

A. Wastewater System Data

1. Design capacity of wastewater treatment plant(s): ___________ MGD

2. Is treated effluent used for irrigation on-site _____, off-site _____, plant washdown _____, or chlorination/dechlorination ______?
   If yes, approximately ________ gallons per month.

3. Briefly describe the wastewater system(s) of the area serviced by the water utility. Describe how treated wastewater is disposed of. Where applicable, identify treatment plant(s) with the TCEQ name and number, the operator, owner, and, if wastewater is discharged, the receiving stream. If possible, attach a sketch or map which locates the plant(s) and discharge points or disposal sites.

B. Wastewater Data for Service Area

1. Percent of water service area served by wastewater system: ______%

2. Monthly volume treated for previous three years (in 1,000 gallons):

Year			
January			
February			
March			
April			
May			
June			
July			
August			
September			
October			
November			
December			
Total			

REQUIREMENTS FOR WATER CONSERVATION PLANS FOR MUNICIPAL WATER USE BY PUBLIC WATER SUPPLIERS

In addition to the utility profile, a water conservation plan for municipal use by a public water supplier must include, at a minimum, additional information as required by Title 30, Texas Administrative Code, §288.2. Note: If the water conservation plan does not provide information for each requirement, an explanation must be included as to why the requirement is not applicable.

Specific, Quantified 5 & 10-Year Targets

The water conservation plan must include specific, quantified five-year and ten-year targets for water savings to include goals for water loss programs and goals for ***municipal use in gallons per capita per day*** (see Appendix A). Note that the goals established by a public water supplier under this subparagraph are not enforceable.

Metering Devices

The water conservation plan must include a statement about the water supplier's metering device(s), within an accuracy of plus or minus 5.0% in order to measure and account for the amount of water diverted from the source of supply.

Universal Metering

The water conservation plan must include and a program for universal metering of both customer and public uses of water, for meter testing and repair, and for periodic meter replacement.

Unaccounted-For Water Use

The water conservation plan must include measures to determine and control unaccounted-for uses of water (for example, periodic visual inspections along distribution lines; annual or monthly audit of the water system to determine illegal connections; abandoned services; etc.).

Continuing Public Education & Information

The water conservation plan must include a description of the program of continuing public education and information regarding water conservation by the water supplier.

Non-Promotional Water Rate Structure

The water supplier must have a water rate structure which is not "promotional," i.e., a rate structure which is cost-based and which does not encourage the excessive use of water. This rate structure must be listed in the water conservation plan.

Reservoir Systems Operations Plan

The water conservation plan must include a reservoir systems operations plan, if applicable, providing for the coordinated operation of reservoirs owned by the applicant within a common watershed or river basin in order to optimize available water supplies.

Enforcement Procedure & Plan Adoption

The water conservation plan must include a means of implementation and enforcement which shall be evidenced by 1) a copy of the ordinance, resolution, or tariff indicating **official adoption** of the water conservation plan by the water supplier; and 2) a description of the authority by which the water supplier will implement and enforce the conservation plan.

Coordination with the Regional Water Planning Group(s)

The water conservation plan must include documentation of coordination with the regional water planning group(s) for the service area of the public water supplier in order to ensure consistency with the appropriate approved regional water plans.

Example statement to be included within the water conservation plan:

The service area of the _____________ (name of water supplier) is located within the ___________ (name of regional water planning area or areas) and ___________ (name of water supplier) has provided a copy of this water conservation plan to the ____________ (name of regional water planning group or groups).

Additional Requirements:

required of suppliers serving population of 5,000 or more or a projected population of 5,000 or more within ten years)

1. Program for Leak Detection, Repair, and Water Loss Accounting

The plan must include a description of the program of leak detection, repair, and water loss accounting for the water transmission, delivery, and distribution system in order to control unaccounted-for uses of water.

2. Record Management System

The plan must include a record management system to record water pumped, water deliveries, water sales, and water losses which allows for the desegregation of water sales and uses into the following user classes (residential; commercial; public and institutional; and industrial.

Plan Review and Update

Beginning May 1, 2005, a public water supplier for municipal use shall review and update its water conservation plan, as appropriate, based on an assessment of previous five-year and ten-year targets and any other new or updated information. The public water supplier for municipal use shall review and update the next revision of its water conservation plan not later than May 1, 2009, and every five years after that date to coincide with the regional water planning group. The revised plan must also include an implementation report.

Best Management Practices Guide

On November 2004, the Texas Water Development Board's (TWDB) Report 362 was completed by the Water Conservation Implementation Task Force. Report 362 is the Water Conservation Best Management Practices (BMP) Guide. The BMP Guide is a voluntary list of management practices that water users may implement in addition to the required components of Title 30, Texas Administrative Code, Chapter 288. The BMP Guide is available on the TWDB's website at the link below or by calling (512) 463-7847.

http://www.twdb.state.tx.us/assistance/conservation/TaskForceDocs/WCITFBMPGuide.pdf

Appendix A

Definitions of Commonly Used Terms

Conservation – Those practices, techniques, and technologies that reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or increase the recycling and reuse of water so that a water supply is made available for future or alternative uses.

Industrial use – The use of water in processes designed to convert materials of a lower order of value into forms having greater usability and commercial value, commercial fish production, and the development of power by means other than hydroelectric, but does not include agricultural use.

Irrigation – The agricultural use of water for the irrigation of crops, trees, and pastureland, including, but not limited to, golf courses and parks which do not receive water through a municipal distribution system.

Municipal per capita water use – The sum total of water diverted into a water supply system for residential, commercial, and public and institutional uses divided by actual population served.

Municipal use – The use of potable water within or outside a municipality and its environs whether supplied by a person, privately owned utility, political subdivision, or other entity as well as the use of sewage effluent for certain purposes, including the use of treated water for domestic purposes, fighting fires, sprinkling streets, flushing sewers and drains, watering parks and parkways, and recreational purposes, including public and private swimming pools, the use of potable water in industrial and commercial enterprises supplied by a municipal distribution system without special construction to meet its demands, and for the watering of lawns and family gardens.

Municipal use in gallons per capita per day – The total average daily amount of water diverted or pumped for treatment for potable use by a public water supply system. The calculation is made by dividing the water diverted or pumped for treatment for potable use by population served. Indirect reuse volumes shall be credited against total diversion volumes for the purpose of calculating gallons per capita per day for targets and goals.

Pollution – The alteration of the physical, thermal, chemical, or biological quality of, or the contamination of, any water in the state that renders the water harmful, detrimental, or injurious to humans, animal life, vegetation, or property, or to the public health, safety, or welfare, or impairs the usefulness or the public enjoyment of the water for any lawful or reasonable purpose.

Public water supplier – An individual or entity that supplies water to the public for human consumption.

Regional water planning group – A group established by the Texas Water Development Board to prepare a regional water plan under Texas Water Code, §16.053.

Retail public water supplier – An individual or entity that for compensation supplies water to the public for human consumption. The term does not include an individual or entity that supplies water to itself or its employees or tenants when that water is not resold to or used by others.

Reuse – The authorized use for one or more beneficial purposes of use of water that remains unconsumed after the water is used for the original purpose of use and before that water is either disposed of or discharged or otherwise allowed to flow into a watercourse, lake, or other body of state-owned water.

Water conservation plan – A strategy or combination of strategies for reducing the volume of water withdrawn from a water supply source, for reducing the loss or waste of water, for maintaining or improving the efficiency in the use of water, for increasing the recycling and reuse of water, and for preventing the pollution of water. A water conservation plan may be a separate document identified as such or may be contained within another water management document(s).

Water loss - The difference between water diverted or treated and water delivered (sold). Water loss can result from:

1. inaccurate or incomplete record keeping;
2. meter error;
3. unmetered uses such as firefighting, line flushing, and water for public buildings and water treatment plants;
4. leaks; and
5. water theft and unauthorized use.

Wholesale public water supplier – An individual or entity that for compensation supplies water to another for resale to the public for human consumption. The term does not include an individual or entity that supplies water to itself or its employees or tenants as an incident of that employee service or tenancy when that water is not resold to or used by others, or an individual or entity that conveys water to another individual or entity, but does not own the right to the water which is conveyed, whether or not for a delivery fee.

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Appendix E.2

Texas Commission on Environmental Quality

Model
Municipal Drought Contingency Plan

Drought Contingency Plan Requirements for
Municipal Retail Public Water Suppliers

Web Site for Information:
www.tnrcc.state.tx.us/permitting/waterperm/wrpa/contingency.html

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DROUGHT CONTINGENCY PLAN
FOR THE
(name of retail public water supplier)
(date)

Section I: Declaration of Policy, Purpose, and Intent

In order to conserve the available water supply and protect the integrity of water supply facilities, with particular regard for domestic water use, sanitation, and fire protection, and to protect and preserve public health, welfare, and safety and minimize the adverse impacts of water supply shortage or other water supply emergency conditions, the ___________________ (name of water supplier) hereby adopts the following regulations and restrictions on the delivery and consumption of water through an ordinance/or resolution (see Appendix C for an example).

Water uses regulated or prohibited under this Drought Contingency Plan (the Plan) are considered to be non-essential and continuation of such uses during times of water shortage or other emergency water supply condition are deemed to constitute a waste of water which subjects the offender(s) to penalties as defined in Section XI of this Plan.

Section II: Public Involvement

Opportunity for the public to provide input into the preparation of the Plan was provided by the ______________ (name of water supplier) by means of ________________ (describe methods used to inform the public about the preparation of the plan and provide opportunities for input; for example, scheduling and providing public notice of a public meeting to accept input on the Plan).

Section III: Public Education

The _________ (name of water supplier) will periodically provide the public with information about the Plan, including information about the conditions under which each stage of the Plan is to be initiated or terminated and the drought response measures to be implemented in each stage. This information will be provided by means of __________________ (describe methods to be used to provide information to the public about the Plan; for example, public events, press releases or utility bill inserts).

Section IV: Coordination with Regional Water Planning Groups

The service area of the _____________ (name of water supplier) is located within the ____________ (name of regional water planning area or areas) and ___________ (name of water supplier) has provided a copy of this Plan to the ____________ (name of regional water planning group or groups).

Section V: Authorization

The ___________________ (designated official; for example, the mayor, city manager, utility director, general manager, etc.), or his/her designee is hereby authorized and directed to implement the applicable provisions of this Plan upon determination that such implementation is necessary to protect public health, safety, and welfare. The _______________, (designated official) or his/her designee, shall have the authority to initiate or terminate drought or other water supply emergency response measures as described in this Plan.

Section VI: Application

The provisions of this Plan shall apply to all persons, customers, and property utilizing water provided by the ___________________ (name of supplier). The terms "person" and "customer" as used in the Plan include individuals, corporations, partnerships, associations, and all other legal entities.

Section VII: Definitions

For the purposes of this Plan**,** the following definitions shall apply:

<u>Aesthetic water use</u>: water use for ornamental or decorative purposes such as fountains, reflecting pools, and water gardens.

<u>Commercial and institutional water use</u>: water use which is integral to the operations of commercial and non-profit establishments and governmental entities such as retail establishments, hotels and motels, restaurants, and office buildings.

<u>Conservation</u>: those practices, techniques, and technologies that reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water or increase the recycling and reuse of water so that a supply is conserved and made available for future or alternative uses.

<u>Customer</u>: any person, company, or organization using water supplied by __________________ (name of water supplier).

<u>Domestic water use</u>: water use for personal needs or for household or sanitary purposes such as drinking, bathing, heating, cooking, sanitation, or for cleaning a residence, business, industry, or institution.

<u>Even number address</u>: street addresses, box numbers, or rural postal route numbers ending in 0, 2, 4, 6, or 8 and locations without addresses.

<u>Industrial water use</u>: the use of water in processes designed to convert materials of lower value into forms having greater usability and value.

<u>Landscape irrigation use</u>: water used for the irrigation and maintenance of landscaped areas, whether publicly or privately owned, including residential and commercial lawns, gardens, golf courses, parks, and rights-of-way and medians.

<u>Non-essential water use</u>: water uses that are not essential nor required for the protection of public, health, safety, and welfare, including:

(a) irrigation of landscape areas, including parks, athletic fields, and golf courses, except otherwise provided under this Plan;
(b) use of water to wash any motor vehicle, motorbike, boat, trailer, airplane or other vehicle;

(c) use of water to wash down any sidewalks, walkways, driveways, parking lots, tennis courts, or other hard-surfaced areas;
(d) use of water to wash down buildings or structures for purposes other than immediate fire protection;
(e) flushing gutters or permitting water to run or accumulate in any gutter or street;
(f) use of water to fill, refill, or add to any indoor or outdoor swimming pools or jacuzzi-type pools;
(g) use of water in a fountain or pond for aesthetic or scenic purposes except where necessary to support aquatic life;
(h) failure to repair a controllable leak(s) within a reasonable period after having been given notice directing the repair of such leak(s); and
(i) use of water from hydrants for construction purposes or any other purposes other than fire fighting.

Odd numbered address: street addresses, box numbers, or rural postal route numbers ending in 1, 3, 5, 7, or 9.

Section VIII: Criteria for Initiation and Termination of Drought Response Stages

The ____________ (designated official) or his/her designee shall monitor water supply and/or demand conditions on a _____ (*e.g., daily, weekly, monthly*) basis and shall determine when conditions warrant initiation or termination of each stage of the Plan, that is, when the specified "triggers" are reached.

The triggering criteria described below are based on ______________________________________
____
(*provide a brief description of the rationale for the triggering criteria; for example, triggering criteria / trigger levels based on a statistical analysis of the vulnerability of the water source under drought of record conditions, or based on known system capacity limits*).

Stage 1 Triggers -- MILD Water Shortage Conditions

Requirements for initiation
Customers shall be requested to voluntarily conserve water and adhere to the prescribed restrictions on certain water uses, defined in Section VII–Definitions, when
____
(*describe triggering criteria / trigger levels; see examples below*).

> *Following are examples of the types of triggering criteria that might be used in one or more successive stages of a drought contingency plan. One or a combination of such criteria must be defined for each drought response stage, but usually not all will apply. Select those appropriate to your system:*
>
> *Example 1:* *Annually, beginning on May 1 through September 30.*
>
> *Example 2:* *When the water supply available to the ____________ (name of water supplier) is equal to or less than _______ (acre-feet, percentage of storage, etc.).*

Example 3: *When, pursuant to requirements specified in the ____________(name of water supplier) wholesale water purchase contract with ____________ (name of wholesale water supplier), notification is received requesting initiation of Stage 1 of the Drought Contingency Plan.*

Example 4: *When flows in the _______ (name of stream or river) are equal to or less than ____cubic feet per second.*

Example 5: *When the static water level in the ____________(name of water supplier) well(s) is equal to or less than _____ feet above/below mean sea level.*

Example 6: *When the specific capacity of the __________________(name of water supplier) well(s) is equal to or less than _____ percent of the well's original specific capacity.*

Example 7: *When total daily water demand equals or exceeds ______ million gallons for ___consecutive days of ____ million gallons on a single day (e.g., based on the "safe" operating capacity of water supply facilities).*

Example 8: *Continually falling treated water reservoir levels which do not refill above __ percent overnight (e.g., based on an evaluation of minimum treated water storage required to avoid system outage).*

The public water supplier may devise other triggering criteria which are tailored to its system.

<u>Requirements for termination</u>
Stage 1 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of ___ (e.g. 3) consecutive days.

Stage 2 Triggers -- MODERATE Water Shortage Conditions

<u>Requirements for initiation</u>
Customers shall be required to comply with the requirements and restrictions on certain non-essential water uses provided in Section IX of this Plan when ____________ (*describe triggering criteria; see examples in Stage 1*).

<u>Requirements for termination</u>
Stage 2 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of ___ (e.g., 3) consecutive days. Upon termination of Stage 2, Stage 1 becomes operative.

Stage 3 Triggers – SEVERE Water Shortage Conditions

<u>Requirements for initiation</u>

Customers shall be required to comply with the requirements and restrictions on certain non-essential water uses for Stage 3 of this Plan when **____________** (*describe triggering criteria; see examples in Stage 1*).

<u>Requirements for termination</u>
Stage 3 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of ___ (e.g., 3) consecutive days. Upon termination of Stage 3, Stage 2 becomes operative.

Stage 4 Triggers -- CRITICAL Water Shortage Conditions

<u>Requirements for initiation</u>
Customers shall be required to comply with the requirements and restrictions on certain non-essential water uses for Stage 4 of this Plan when **____________** (*describe triggering criteria; see examples in Stage 1*).

<u>Requirements for termination</u>
Stage 4 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of ___ (e.g., 3) consecutive days. Upon termination of Stage 4, Stage 3 becomes operative.

Stage 5 Triggers -- EMERGENCY Water Shortage Conditions

<u>Requirements for initiation</u>
Customers shall be required to comply with the requirements and restrictions for Stage 5 of this Plan when **____________** (designated official), or his/her designee, determines that a water supply emergency exists based on:

1. Major water line breaks, or pump or system failures occur, which cause unprecedented loss of capability to provide water service; **or**

2. Natural or man-made contamination of the water supply source(s).

<u>Requirements for termination</u>
Stage 5 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of ___ (e.g., 3) consecutive days.

Stage 6 Triggers -- WATER ALLOCATION

<u>Requirements for initiation</u>
Customers shall be required to comply with the water allocation plan prescribed in Section IX of this Plan and comply with the requirements and restrictions for Stage 5 of this Plan when **__________________________** (*describe triggering criteria, see examples in Stage 1*).

Requirements for termination - Water allocation may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of ___ (e.g., 3) consecutive days.

Note: The inclusion of WATER ALLOCATION as part of a drought contingency plan may not be required in all cases. For example, for a given water supplier, an analysis of water supply availability under drought of record conditions may indicate that there is essentially no risk of water supply shortage. Hence, a drought contingency plan for such a water supplier might only address facility capacity limitations and emergency conditions (e.g., supply source contamination and system capacity limitations).

Section IX: Drought Response Stages

The _________ (designated official), or his/her designee, shall monitor water supply and/or demand conditions on a daily basis and, in accordance with the triggering criteria set forth in Section VIII of this Plan, shall determine that a mild, moderate, severe, critical, emergency or water shortage condition exists and shall implement the following notification procedures:

Notification

Notification of the Public:
The ____________ (designated official) or his/ here designee shall notify the public by means of:
Examples:
publication in a newspaper of general circulation,
direct mail to each customer,
public service announcements,
signs posted in public places
take-home fliers at schools.

Additional Notification:
The ___________ (designated official) or his/ her designee shall notify directly, or cause to be notified directly, the following individuals and entities:
Examples:
Mayor / Chairman and members of the City Council / Utility Board
Fire Chief(s)
City and/or County Emergency Management Coordinator(s)
County Judge & Commissioner(s)
State Disaster District / Department of Public Safety
TCEQ *(required when* mandatory *restrictions are imposed)*
Major water users
Critical water users, i.e. hospitals
Parks / street superintendents & public facilities managers

Note: The plan should specify direct notice only as appropriate to respective drought stages.

Stage 1 Response -- MILD Water Shortage Conditions

Target: Achieve a voluntary ___ percent reduction in _________ (e.g., total water use, daily water demand, etc.).

Best Management Practices for Supply Management:

Describe measures, if any, to be implemented directly by (name of water supplier) to manage limited water supplies and/or reduce water demand. Examples include: reduced or discontinued flushing of water mains, activation and use of an alternative supply source(s); use of reclaimed water for non-potable purposes.

Voluntary Water Use Restrictions for Reducing Demand :

(a) Water customers are requested to voluntarily limit the irrigation of landscaped areas to Sundays and Thursdays for customers with a street address ending in an even number (0, 2, 4, 6 or 8), and Saturdays and Wednesdays for water customers with a street address ending in an odd number (1, 3, 5, 7 or 9), and to irrigate landscapes only between the hours of midnight and 10:00 a.m. and 8:00 p.m to midnight on designated watering days.

(b) All operations of the _____________ (name of water supplier) shall adhere to water use restrictions prescribed for Stage 2 of the Plan.

(c) Water customers are requested to practice water conservation and to minimize or discontinue water use for non-essential purposes.

Stage 2 Response -- MODERATE Water Shortage Conditions

Target: Achieve a ___ percent reduction in _________ (e.g., total water use, daily water demand, etc.).

Best Management Practices for Supply Management:

Describe measures, if any, to be implemented directly by ___________ (name of water supplier) to manage limited water supplies and/or reduce water demand. Examples include: reduced or discontinued flushing of water mains, reduced or discontinued irrigation of public landscaped areas; use of an alternative supply source(s); use of reclaimed water for non-potable purposes.

Water Use Restrictions for Demand Reduction:
Under threat of penalty for violation, the following water use restrictions shall apply to all persons:

(a) Irrigation of landscaped areas with hose-end sprinklers or automatic irrigation systems shall be limited to Sundays and Thursdays for customers with a street address ending in an even number (0, 2, 4, 6 or 8), and Saturdays and Wednesdays for water customers with a street address ending in an odd number (1, 3, 5, 7 or 9), and irrigation of landscaped areas is further limited to the hours of 12:00 midnight until 10:00 a.m. and between 8:00 p.m. and 12:00 midnight on designated watering days. However, irrigation of landscaped areas is permitted at anytime if it is by means of a hand-held hose, a faucet filled bucket or watering can of five (5) gallons or less, or drip irrigation system.

(b) Use of water to wash any motor vehicle, motorbike, boat, trailer, airplane or other vehicle is prohibited except on designated watering days between the hours of 12:00 midnight and 10:00 a.m. and between 8:00 p.m. and 12:00 midnight. Such washing, when allowed, shall be done with a hand-held bucket or a hand-held hose equipped with a positive shutoff nozzle for quick rises. Vehicle washing may be done at any time on the immediate premises of a commercial car wash or commercial service station. Further, such washing may be exempted from these regulations if the health, safety, and welfare of the public is contingent upon frequent vehicle cleansing, such as garbage trucks and vehicles used to transport food and perishables.

(c) Use of water to fill, refill, or add to any indoor or outdoor swimming pools, wading pools, or jacuzzi-type pools is prohibited except on designated watering days between the hours of 12:00 midnight and 10:00 a.m. and between 8 p.m. and 12:00 midnight.

(d) Operation of any ornamental fountain or pond for aesthetic or scenic purposes is prohibited except where necessary to support aquatic life or where such fountains or ponds are equipped with a recirculation system.

(e) Use of water from hydrants shall be limited to fire fighting, related activities, or other activities necessary to maintain public health, safety, and welfare, except that use of water from designated fire hydrants for construction purposes may be allowed under special permit from the ___________________ (name of water supplier).

(f) Use of water for the irrigation of golf course greens, tees, and fairways is prohibited except on designated watering days between the hours 12:00 midnight and 10:00 a.m. and between 8 p.m. and 12:00 midnight. However, if the golf course utilizes a water source other than that provided by the _______________ (name of water supplier), the facility shall not be subject to these regulations.

(g) All restaurants are prohibited from serving water to patrons except upon request of the patron.

(h) The following uses of water are defined as non-essential and are prohibited:

1. wash down of any sidewalks, walkways, driveways, parking lots, tennis courts, or other hard-surfaced areas;
2. use of water to wash down buildings or structures for purposes other than immediate fire protection;
3. use of water for dust control;
4. flushing gutters or permitting water to run or accumulate in any gutter or street; and
5. failure to repair a controllable leak(s) within a reasonable period after having been given notice directing the repair of such leak(s).

Stage 3 Response -- SEVERE Water Shortage Conditions

<u>Target</u>: Achieve a ___ percent reduction in __________ (e.g., total water use, daily water demand, etc.).

<u>Best Management Practices for Supply Management</u>:

Describe measures, if any, to be implemented directly by ____________ (name of water supplier) to manage limited water supplies and/or reduce water demand. Examples include: reduced or discontinued flushing of water mains, reduced or discontinued irrigation of public landscaped areas; use of an alternative supply source(s); use of reclaimed water for non-potable purposes.

<u>Water Use Restrictions for Demand Reduction</u>:
All requirements of Stage 2 shall remain in effect during Stage 3 except:

(a) Irrigation of landscaped areas shall be limited to designated watering days between the hours of 12:00 midnight and 10:00 a.m. and between 8 p.m. and 12:00 midnight and shall be by means of hand-held hoses, hand-held buckets, drip irrigation, or permanently installed automatic sprinkler system only. The use of hose-end sprinklers is prohibited at all times.

(b) The watering of golf course tees is prohibited unless the golf course utilizes a water source other than that provided by the ____________________ (name of water supplier).

(c) The use of water for construction purposes from designated fire hydrants under special permit is to be discontinued.

Stage 4 Response -- CRITICAL Water Shortage Conditions

<u>Target</u>: Achieve a ___ percent reduction in __________ (e.g., total water use, daily water demand, etc.).

<u>Best Management Practices for Supply Management</u>:

Describe measures, if any, to be implemented directly by ____________ (name of water supplier) to manage limited water supplies and/or reduce water demand. Examples include: reduced or discontinued flushing of water mains, reduced or discontinued irrigation of public landscaped areas; use of an alternative supply source(s); use of reclaimed water for non-potable purposes.

<u>Water Use Restrictions for Reducing Demand:</u>. All requirements of Stage 2 and 3 shall remain in effect during Stage 4 except:

(a) Irrigation of landscaped areas shall be limited to designated watering days between the hours of 6:00 a.m. and 10:00 a.m. and between 8:00 p.m. and 12:00 midnight and shall be by means of hand-held hoses, hand-held buckets, or drip irrigation only. The use of hose-end sprinklers or permanently installed automatic sprinkler systems are prohibited at all times.

(b) Use of water to wash any motor vehicle, motorbike, boat, trailer, airplane or other vehicle not occurring on the premises of a commercial car wash and commercial service stations and not in the immediate interest of public health, safety, and welfare is prohibited. Further, such vehicle washing at commercial car washes and commercial service stations shall occur only between the hours of 6:00 a.m. and 10:00 a.m. and between 6:00 p.m. and 10 p.m.

(c) The filling, refilling, or adding of water to swimming pools, wading pools, and jacuzzi-type pools is prohibited.

(d) Operation of any ornamental fountain or pond for aesthetic or scenic purposes is prohibited except where necessary to support aquatic life or where such fountains or ponds are equipped with a recirculation system.

(e) No application for new, additional, expanded, or increased-in-size water service connections, meters, service lines, pipeline extensions, mains, or water service facilities of any kind shall be approved, and time limits for approval of such applications are hereby suspended for such time as this drought response stage or a higher-numbered stage shall be in effect.

Stage 5 Response -- EMERGENCY Water Shortage Conditions

<u>Target</u>: Achieve a ___ percent reduction in _________ (e.g., total water use, daily water demand, etc.).

<u>Best Management Practices for Supply Management</u>:

Describe measures, if any, to be implemented directly by ___________ (name of water supplier) to manage limited water supplies and/or reduce water demand. Examples include: reduced or discontinued flushing of water mains, reduced or discontinued irrigation of public landscaped areas; use of an alternative supply source(s); use of reclaimed water for non-potable purposes.

<u>Water Use Restrictions for Reducing Demand</u>. All requirements of Stage 2, 3, and 4 shall remain in effect during Stage 5 except:

(a) Irrigation of landscaped areas is absolutely prohibited.

(b) Use of water to wash any motor vehicle, motorbike, boat, trailer, airplane or other vehicle is absolutely prohibited.

Stage 6 Response -- WATER ALLOCATION

In the event that water shortage conditions threaten public health, safety, and welfare, the ____________ (designated official) is hereby authorized to allocate water according to the following water allocation plan:

Single-Family Residential Customers

The allocation to residential water customers residing in a single-family dwelling shall be as follows:

Persons per Household	Gallons per Month
1 or 2	6,000
3 or 4	7,000
5 or 6	8,000
7 or 8	9,000
9 or 10	10,000
11 or more	12,000

"Household" means the residential premises served by the customer's meter. "Persons per household" includes only those persons currently physically residing at the premises and expected to reside there for the entire billing period. It shall be assumed that a particular customer's household is comprised of two (2) persons unless the customer notifies the ____________ (name of water supplier) of a greater number of persons per household on a form prescribed by the _________ (designated official). The _________ (designated official) shall give his/her best effort to see that such forms are mailed, otherwise provided, or made available to every residential customer. If, however, a customer does not receive such a form, it shall be the customer's responsibility to go to the ____________ (name of water supplier) offices to complete and sign the form claiming more than two (2) persons per household. New customers may claim more persons per household at the time of applying for water service on the form prescribed by the __________ (designated official). When the number of persons per household increases so as to place the customer in a different allocation category, the customer may notify the _________ (name of water supplier) on such form and the change will be implemented in the next practicable billing period. If the number of persons in a household is reduced, the customer shall notify the _________(name of water supplier) in writing within two (2) days. In prescribing the method for claiming more than two (2) persons per household, the _________ (designated official) shall adopt methods to insure the accuracy of the claim. Any person who knowingly, recklessly, or with criminal negligence falsely reports the number of persons in a household or fails to timely notify the ____________ (name of water supplier) of a reduction in the number of person in a household shall be fined not less than $________.

Residential water customers shall pay the following surcharges:

$____ for the first 1,000 gallons over allocation.
$____ for the second 1,000 gallons over allocation.
$____ for the third 1,000 gallons over allocation.

$____ for each additional 1,000 gallons over allocation.

Surcharges shall be cumulative.

Master-Metered Multi-Family Residential Customers

The allocation to a customer billed from a master meter which jointly measures water to multiple permanent residential dwelling units (e.g., apartments, mobile homes) shall be allocated 6,000 gallons per month for each dwelling unit. It shall be assumed that such a customer's meter serves two dwelling units unless the customer notifies the ____________ (name of water supplier) of a greater number on a form prescribed by the __________ (designated official). The _________ (designated official) shall give his/her best effort to see that such forms are mailed, otherwise provided, or made available to every such customer. If, however, a customer does not receive such a form, it shall be the customer's responsibility to go to the ____________ (name of water supplier) offices to complete and sign the form claiming more than two (2) dwellings. A dwelling unit may be claimed under this provision whether it is occupied or not. New customers may claim more dwelling units at the time of applying for water service on the form prescribed by the __________ (designated official). If the number of dwelling units served by a master meter is reduced, the customer shall notify the _________(name of water supplier) in writing within two (2) days. In prescribing the method for claiming more than two (2) dwelling units, the _________ (designated official) shall adopt methods to insure the accuracy of the claim. Any person who knowingly, recklessly, or with criminal negligence falsely reports the number of dwelling units served by a master meter or fails to timely notify the ____________ (name of water supplier) of a reduction in the number of person in a household shall be fined not less than $________. Customers billed from a master meter under this provision shall pay the following monthly surcharges:

$____ for 1,000 gallons over allocation up through 1,000 gallons for each dwelling unit.
$____, thereafter, for each additional 1,000 gallons over allocation up through a second 1,000 gallons for each dwelling unit.
$____, thereafter, for each additional 1,000 gallons over allocation up through a third 1,000 gallons for each dwelling unit.
$____, thereafter for each additional 1,000 gallons over allocation.

Surcharges shall be cumulative.

Commercial Customers

A monthly water allocation shall be established by the __________ (designated official), or his/her designee, for each nonresidential commercial customer other than an industrial customer who uses water for processing purposes. The non-residential customer's allocation shall be approximately __ (e.g. 75%) percent of the customer's usage for corresponding month's billing period for the previous 12 months. If the customer's billing history is shorter than 12 months, the monthly average for the period for which there is a record shall be used for any monthly period for which no history exists. Provided, however, a customer, __ percent of whose monthly usage is less than ____ gallons, shall be allocated ____ gallons. The _________ (designated official) shall give his/her best effort to see that notice of each non-residential customer's allocation is mailed to such customer. If, however, a customer does not receive such notice, it shall be the customer's responsibility to contact the ____________ (name of water supplier) to determine the allocation. Upon request of the customer or at the initiative of the ___________ (designated official), the allocation may be reduced or increased if, (1) the designated period does not accurately reflect the customer's normal water usage, (2) one nonresidential customer agrees to transfer part of its allocation to another nonresidential customer, or (3) other objective evidence demonstrates that the designated allocation is inaccurate under present conditions. A customer may appeal an allocation established hereunder to the ___________ (designated official or alternatively, a special water allocation review committee). Nonresidential commercial customers shall pay the following surcharges:

Customers whose allocation is _____ gallons through ______ gallons per month:

$____ per thousand gallons for the first 1,000 gallons over allocation.
$____ per thousand gallons for the second 1,000 gallons over allocation.
$____ per thousand gallons for the third 1,000 gallons over allocation.
$____ per thousand gallons for each additional 1,000 gallons over allocation.

Customers whose allocation is ______ gallons per month or more:

___ times the block rate for each 1,000 gallons in excess of the allocation up through 5 percent above allocation.
___ times the block rate for each 1,000 gallons from 5 percent through 10 percent above allocation.
___ times the block rate for each 1,000 gallons from 10 percent through 15 percent above allocation.
___ times the block rate for each 1,000 gallons more than 15 percent above allocation.

The surcharges shall be cumulative. As used herein, "block rate" means the charge to the customer per 1,000 gallons at the regular water rate schedule at the level of the customer's allocation.

Industrial Customers

A monthly water allocation shall be established by the __________ (designated official), or his/her designee, for each industrial customer, which uses water for processing purposes. The industrial customer's allocation shall be approximately __ (e.g., 90%) percent of the customer's water usage baseline. Ninety (90) days after the initial imposition of the allocation for industrial customers, the industrial customer's allocation shall be further reduced to __ (e.g., 85%) percent of the customer's water usage baseline. The industrial customer's water use baseline will be computed on the average water use for the ______ month period ending prior to the date of implementation of Stage 2 of the Plan. If the industrial water customer's billing history is shorter than ___ months, the monthly average for the period for which there is a record shall be used for any monthly period for which no billing history exists. The _________ (designated official) shall give his/her best effort to see that notice of each industrial customer's allocation is mailed to such customer. If, however, a customer does not receive such notice, it shall be the customer's responsibility to contact the ____________ (name of water supplier) to determine the allocation, and the allocation shall be fully effective notwithstanding the lack of receipt of written notice. Upon request of the customer or at the initiative of the ___________ (designated official), the allocation may be reduced or increased, (1) if the designated period does not accurately reflect the customer's normal water use because the customer had shutdown a major processing unit for repair or overhaul during the period, (2) the customer has added or is in the process of adding significant additional processing capacity, (3) the customer has shutdown or significantly reduced the production of a major processing unit, (4) the customer has previously implemented significant permanent water conservation measures such that the ability to further reduce water use is limited, (5) the customer agrees to transfer part of its allocation to another industrial customer, or (6) if other objective evidence demonstrates that the designated allocation is inaccurate under present conditions. A customer may appeal an allocation established hereunder to the ___________ (designated official or alternatively, a special water allocation review committee). Industrial customers shall pay the following surcharges:

Customers whose allocation is _____ gallons through _______ gallons per month:

> $____ per thousand gallons for the first 1,000 gallons over allocation.
> $____ per thousand gallons for the second 1,000 gallons over allocation.
> $____ per thousand gallons for the third 1,000 gallons over allocation.
> $____ per thousand gallons for each additional 1,000 gallons over allocation.

Customers whose allocation is ______ gallons per month or more:

> ___ times the block rate for each 1,000 gallons in excess of the allocation up through 5 percent above allocation.
> ___ times the block rate for each 1,000 gallons from 5 percent through 10 percent above allocation.
>
> ___ times the block rate for each 1,000 gallons from 10 percent through 15 percent above allocation.
> ___ times the block rate for each 1,000 gallons more than 15 percent above allocation.

The surcharges shall be cumulative. As used herein, "block rate" means the charge to the customer per 1,000 gallons at the regular water rate schedule at the level of the customer's allocation.

Section X: Enforcement

(a) No person shall knowingly or intentionally allow the use of water from the __________________ (name of water supplier) for residential, commercial, industrial, agricultural, governmental, or any other purpose in a manner contrary to any provision of this Plan, or in an amount in excess of that permitted by the drought response stage in effect at the time pursuant to action taken by _____________ (designated official), or his/her designee, in accordance with provisions of this

Plan.

(b) Any person who violates this Plan is guilty of a misdemeanor and, upon conviction shall be punished by a fine of not less than _______ dollars ($__) and not more than ______ dollars ($__). Each day that one or more of the provisions in this Plan is violated shall constitute a separate offense. If a person is convicted of three or more distinct violations of this Plan, the _____________ (designated official) shall, upon due notice to the customer, be authorized to discontinue water service to the premises where such violations occur. Services discontinued under such circumstances shall be restored only upon payment of a re-connection charge, hereby established at $______, and any other costs incurred by the ___________________ (name of water supplier) in discontinuing service. In addition, suitable assurance must be given to the ________________ (designated official) that the same action shall not be repeated while the Plan is in effect. Compliance with this plan may also be sought through injunctive relief in the district court.

(c) Any person, including a person classified as a water customer of the ______________ (name of water supplier), in apparent control of the property where a violation occurs or originates shall be presumed to be the violator, and proof that the violation occurred on the person's property shall constitute a rebuttable presumption that the person in apparent control of the property committed the violation, but any such person shall have the right to show that he/she did not commit the violation. Parents shall be presumed to be responsible for violations of their minor children and proof that a violation, committed by a child, occurred on property within the parents' control shall constitute a rebuttable presumption that the parent committed the violation, but any such parent may be excused if he/she proves that he/she had previously directed the child not to use the water as it was used in violation of this Plan and that the parent could not have reasonably known of the violation.

(d) Any employee of the _______________ (name of water supplier), police officer, or other _____ employee designated by the ___________ (designated official), may issue a citation to a person he/she reasonably believes to be in violation of this Ordinance. The citation shall be prepared in duplicate and shall contain the name and address of the alleged violator, if known, the offense charged, and shall direct him/her to appear in the _____________ (e.g., municipal court) on the date shown on the citation for which the date shall not be less than 3 days nor more than 5 days from the date the citation was issued. The alleged violator shall be served a copy of the citation. Service of the citation shall be complete upon delivery of the citation to the alleged violator, to an agent or employee of a violator, or to a person over 14 years of age who is a member of the violator's immediate family or is a resident of the violator's residence. The alleged violator shall appear in _________ (e.g., municipal court) to enter a plea of guilty or not guilty for the violation of this Plan. If the alleged violator fails to appear in __________ (e.g., municipal court), a warrant for his/her arrest may be issued. A summons to appear may be issued in lieu of an arrest warrant. These cases shall be expedited and given preferential setting in __________ (e.g., municipal court) before all other cases.

Section XI: Variances

The ________________ (designated official), or his/her designee, may, in writing, grant temporary variance for existing water uses otherwise prohibited under this Plan if it is determined that failure to grant such variance would cause an emergency condition adversely affecting the health, sanitation, or fire protection for the public or the person requesting such variance and if one or more of the following conditions are met:

(a) Compliance with this Plan cannot be technically accomplished during the duration of the water supply shortage or other condition for which the Plan is in effect.
(b) Alternative methods can be implemented which will achieve the same level of reduction in water use.

Persons requesting an exemption from the provisions of this Ordinance shall file a petition for variance with the _________________ (name of water supplier) within 5 days after the Plan or a particular drought response stage has been invoked. All petitions for variances shall be reviewed by the __________ (designated official), or his/her designee, and shall include the following:

(a) Name and address of the petitioner(s).
(b) Purpose of water use.
(c) Specific provision(s) of the Plan from which the petitioner is requesting relief.
(d) Detailed statement as to how the specific provision of the Plan adversely affects the petitioner or what damage or harm will occur to the petitioner or others if petitioner complies with this Ordinance.
(e) Description of the relief requested.
(f) Period of time for which the variance is sought.
(g) Alternative water use restrictions or other measures the petitioner is taking or proposes to take to meet the intent of this Plan and the compliance date.
(h) Other pertinent information.

Variances granted by the ___________________ (name of water supplier) shall be subject to the following conditions, unless waived or modified by the ____________ (designated official) or his/her designee:

(a) Variances granted shall include a timetable for compliance.
(b) Variances granted shall expire when the Plan is no longer in effect, unless the petitioner has failed to meet specified requirements.

No variance shall be retroactive or otherwise justify any violation of this Plan occurring prior to the issuance of the variance.

EXAMPLE ORDINANCE FOR ADOPTION OF A DROUGHT CONTINGENCY PLAN

ORDINANCE NO. __________

AN ORDINANCE OF THE CITY OF ____________________, TEXAS, ADOPTING A DROUGHT CONTINGENCY PLAN; ESTABLISHING CRITERIA FOR THE INITIATION AND TERMINATION OF DROUGHT RESPONSE STAGES; ESTABLISHING RESTRICTIONS ON CERTAIN WATER USES; ESTABLISHING PENALTIES FOR THE VIOLATION OF AND PROVISIONS FOR ENFORCEMENT OF THESE RESTRICTIONS; ESTABLISHING PROCEDURES FOR GRANTING VARIANCES; AND PROVIDING SEVERABILITY AND AN EFFECTIVE DATE.

WHEREAS, the City of _________________, Texas recognizes that the amount of water available to the City and its water utility customers is limited and subject to depletion during periods of extended drought;

WHEREAS, the City recognizes that natural limitations due to drought conditions and other acts of God cannot guarantee an uninterrupted water supply for all purposes;

WHEREAS, Section 11.1272 of the Texas Water Code and applicable rules of the Texas Commission on Environmental Quality require all public water supply systems in Texas to prepare a drought contingency plan; and

WHEREAS, as authorized under law, and in the best interests of the citizens of _____________, Texas, the ________________ (governing body) deems it expedient and necessary to establish certain rules and policies for the orderly and efficient management of limited water supplies during drought and other water supply emergencies;

NOW THEREFORE, BE IT ORDAINED BY THE CITY OF ____________, TEXAS:

SECTION 1.

That the City of ____________, Texas Drought Contingency Plan attached hereto as Exhibit “A” and made part hereof for all purposes be, and the same is hereby, adopted as the official policy of the City.

SECTION 2.

That all ordinances that are in conflict with the provisions of this ordinance be, and the same are hereby, repealed and all other ordinances of the City not in conflict with the provisions of this ordinance shall remain in full force and effect.

SECTION 3.

Should any paragraph, sentence, subdivision, clause, phrase, or section of this ordinance be adjudged or held to be unconstitutional, illegal or invalid, the same shall not affect the validity of this ordinance as a whole or any part or provision thereof, other than the part so declared to be invalid, illegal or unconstitutional.

SECTION 4.

This ordinance shall take effect immediately from and after its passage and the publication of the caption, as the law in such cases provides.

DULY PASSED BY THE CITY OF _______________, TEXAS, on the ___________ day of ______________, 20__.

APPROVED:

____
MAYOR

ATTESTED TO:

____
CITY SECRETARY

APPROVED AS TO FORM:

____
CITY ATTORNEY

EXAMPLE RESOLUTION FOR ADOPTION OF A DROUGHT CONTINGENCY PLAN

RESOLUTION NO. __________

A RESOLUTION OF THE BOARD OF DIRECTORS OF THE ___________________ (name of water supplier) ADOPTING A DROUGHT CONTINGENCY PLAN.

WHEREAS, the Board recognizes that the amount of water available to the ____________ (name of water supplier) and its water utility customers is limited and subject to depletion during periods of extended drought;

WHEREAS, the Board recognizes that natural limitations due to drought conditions and other acts of God cannot guarantee an uninterrupted water supply for all purposes;

WHEREAS, Section 11.1272 of the Texas Water Code and applicable rules of the Texas Commission on Environmental Quality require all public water supply systems in Texas to prepare a drought contingency plan; and

WHEREAS, as authorized under law, and in the best interests of the customers of the _________________(name of water supply system), the Board deems it expedient and necessary to establish certain rules and policies for the orderly and efficient management of limited water supplies during drought and other water supply emergencies;

NOW THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF THE _________________ (name of water supplier):

SECTION 1. That the Drought Contingency Plan attached hereto as Exhibit AA@ and made part hereof for all purposes be, and the same is hereby, adopted as the official policy of the ________________ (name of water supplier).

SECTION 2. That the _______________ (e.g., general manager) is hereby directed to implement, administer, and enforce the Drought Contingency Plan.

SECTION 3. That this resolution shall take effect immediately upon its passage.

DULY PASSED BY THE BOARD OF DIRECTORS OF THE _______________, ON THIS __ day of ______________, 20__.

____
President, Board of Directors

ATTESTED TO:

____
Secretary, Board of Directors

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Appendix E.3

Lavaca-Navidad River Authority Drought Contingency Plan

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LAVACA-NAVIDAD RIVER AUTHORITY

Drought Contingency Plan

As Revised August 24, 2005

LNRA
MANAGE CONSERVE PROTECT

LAVACA-NAVIDAD RIVER AUTHORITY

DROUGHT CONTINGENCY PLAN

MAY 2005

(Revised August 24, 2005)

DROUGHT CONTINGENCY PLAN

1.0 INTRODUCTION

Droughts and other uncontrollable circumstances can disrupt the normal availability of water supplies from either ground or surface sources. During drought periods, consumer demand is typically 15 to 25 percent higher than under normal conditions. Limitations on the supply of either ground or surface water, or on facilities to pump, treat, store, or distribute water can also present a public water supply utility with an emergency demand management situation.

The Drought Contingency Plan (DCP) establishes temporary methods designed to be used as long as the emergency exists. The purpose of the DCP is to specify how LNRA will contract and supply stored water supplies during a repetition of the critical drought of record. Consistent with Texas Commission on Environmental Quality (TCEQ) regulations, the LNRA has recommended that, as appropriate, its wholesale water customers consider adoption of drought contingency measures to be implemented in response to LNRA trigger conditions. As a provision of their respective water supply contracts, all LNRA customers have drought contingency plans on file with the TCEQ.

LNRA's DCP includes the following measures:

a. Trigger conditions signaling the start of an emergency period;
b. Designation of drought contingency measures;
c. Public information and education; and
d. Notification actions for drought termination

2.0 TRIGGERING CONDITIONS

As a wholesale water supply utility and a water resource manager, the LNRA will initiate drought contingency measures upon occurrence of the following conditions:

Condition One:	Compromised Reservoir Condition One Reservoir elevation is at or below elevation 43.00 msl
Condition Two:	Compromised Reservoir Condition Two Reservoir elevation is at or below elevation 40.15 msl
Condition Three:	Severe Local Drought Condition -- Compromised Groundwater Supply Reduction of local groundwater supplies to critical levels.

3.0 DROUGHT CONTINGENCY MEASURES

The following actions should be taken when trigger conditions are met. As a wholesale water supplier, the LNRA continuously monitors Lake Texana water levels and communicates with local communities as to the condition of water supplies in the Lavaca River Basin.

Condition One: Compromised Reservoir Condition One

A trigger condition has been established by an agreement between the LNRA and specified water rights permit holders upstream of Lake Texana using surface water for irrigation purposes. Trigger condition one impacts permit holders upstream of Lake Texana who divert water for irrigation purposes. Diversions for irrigation purposes are limited to times that Lake Texana is at or above elevation 43.00 msl. Prior to any initiating diversions, permittees must confirm the level of Lake Texana with either the LNRA or the TCEQ Watermaster. Diversions must cease within 24 hours following the time when the reservoir level drops below elevation 43.00 msl. The goal for water use reduction under Condition One is a 3% percent reduction of the use that would have occurred in the absence of drought contingency measures.

Upon reaching Condition One, LNRA will implement the following relevant actions:

a. Notify the TCEQ Watermaster of reservoir condition.
b. Inform public, giving notice of reservoir condition to the customers served by the LNRA system and upstream water rights permit holders.
c. Through the news media, the public should be advised of the trigger condition situation. Include in the information to the public a recommendation that water users look for ways to conserve water.

Resumption of normal operation and termination of Condition One should occur when reservoir levels are equal to or greater than elevation 43.00 msl.

Condition Two: Compromised Reservoir Condition Two

A trigger condition has been established by an agreement between LNRA, Texas Parks and Wildlife Department and Texas Water Development Board, whereby upon Lake Texana reaches elevation 40.15 or roughly 78% of the reservoir capacity, LNRA may reduce the volume of freshwater releases to bays and estuaries to 5 cubic feet per second. The goal for water use reduction under Condition Two is a 5% percent reduction of the use that would have occurred in the absence of drought contingency measures.

Upon reaching Condition Two, the LNRA will implement the following relevant actions:

a. Notify the TCEQ Watermaster of reservoir condition.
b. Inform public, giving notice of reservoir condition to the customers served by the LNRA system and include in the information recommendations for water conservation.

Resumption of normal operation and termination of Condition Two should occur when reservoir levels are equal to or greater than elevation 40.15 msl.

Condition Three: Severe Local Drought Condition- Compromised Groundwater Supply

All communities in the Lavaca River Basin use groundwater as their primary water supply source. Lowering of groundwater supplies to critical levels in these communities will impact the health and safety of the public. The water sales contract between the LNRA and the City of Corpus Christi allows for the return of 10,400 acre-feet for meeting the needs of Jackson County. The goal for water use reduction under Condition Three is a 7% percent reduction of the use that would have occurred in the absence of drought contingency measures.

Upon reaching Condition Three, the LNRA will implement the following relevant actions:

a. Notify the TCEQ Watermaster of the compromised condition.
b. The affected community(s) should continue implementation of relevant DCP and water conservation actions
c. Upon authorization by the TCEQ Watermaster, the LNRA will enact contractual provisions and assist the affected community as appropriate
d. Certain industrial and commercial water uses which are not essential to the health and safety of the community should be prohibited; and
e. Through the news media, the public should be advised daily of the trigger conditions.

4.0 INFORMATION AND EDUCATION

Once trigger conditions have been reached for the LNRA system, LNRA will notify the TCEQ Watermaster and its customers, whereby customers should notify the public within their jurisdictions of conditions and measures to be taken. The process for notifying the public should include:

a. Posting the Notice of Drought conditions at City Hall, County Courthouse, Post Office, Public Library, Senior Citizens Center, and Major Supermarkets;
b. Copy of notice to newspapers and hold press conferences; and
c. Copy of notice to local radio and television stations.

5.0 TERMINATION NOTIFICATION

Termination of the drought contingency measures should take place when the trigger conditions that initiated the drought contingency measures have subsided, and an emergency situation no longer exists. LNRA will notify the TCEQ Watermaster and its customers. Customers should notify the public within their jurisdiction of termination of the drought contingency measures in the same manner they were informed of initiation of the drought contingency measures through the city officials in charge.

6.0 LNRA ENVIRONMENTAL ASSURANCE PROGRAM

LNRA participates in the TCEQ sponsored Texas Clean Rivers Program, conducting water quality assessments of the Lavaca River Basin. The purpose of the water quality assessment is to identify issues affecting water quality in the Lavaca River Basin, and to develop solution techniques for improving water quality. The assessment program is divided into two phases. LNRA's Clean Rivers Program involves collecting, reviewing, and analyzing past and present water quality data, addressing public opinion, and identifying areas of potential pollution. The program has required the implementation of a comprehensive data management system, the establishment of a water quality monitoring network, and the identification of specific water quality concerns throughout the Lavaca River Basin. LNRA is providing water quality and water conservation information to citizens throughout the Lavaca River Basin as a means of public education. The LNRA Clean Rivers Program will assist in the protection of the water resources in the Lavaca River Basin.

7.0 PUBLIC INVOLVEMENT AND CUSTOMER COORDINATION

LNRA's wholesale water supply contracts are based on allocations from firm yield and are governed by and are enforceable in all respects in accordance with the laws of the State of Texas.

LNRA's water customers are required to prepare and submit Water Conservation and/or Drought Contingency Plans to the TCEQ. LNRA works closely and coordinates with its customers and recommends that each develop plans consistent with LNRA's DCP and conditions as established herein.

As a means of actively informing the public and to provide opportunity for input in the preparation of the DCP, and to inform LNRA's customers of the plan, information concerning drought management will be provided to the customers and the public by means of annual customer meetings, public board meetings, mail, telephone, and the news media, as appropriate.

8.0 PRO RATA WATER ALLOCATION

In the event that a) the triggering criteria specified herein have been met and b) the General Manager, or his designee, deems it necessary, LNRA, in coordination with the South Texas Watermaster, will allocate water supplies on a pro rata basis in accordance with Texas Water Code, § 11.039.

9.0 ENFORCEMENT

This DCP and all plans developed hereunder are incorporated by reference into all LNRA water supply contracts. Violation of this DCP is a violation of the contract and will be treated as such.

10.0 VARIANCES

The General Manager, or his designee, may grant a temporary variance to the pro rata water allocation policies provided by this DCP if it is determined that failure to grant such variance would cause an emergency condition adversely affecting the public health, welfare, or safety and if one or more of the following conditions are met:

a. Compliance with this DCP cannot be technically accomplished during the duration of the water supply shortage or other conditions for which the DCP is in effect.

b. Alternative methods can be implemented which will achieve the same level of reduction in water use.

11.0 PLAN UPDATE

LNRA shall review and update, as appropriate, this DCP at least every five (5) years, based on new or updated information, such as adoption or revision of a regional water plan.

APPENDIX A

Texas Administrative Code, Section 288.22

APPENDIX A

Texas Commission on Environmental Quality Rules on Drought Contingency Plans for Wholesale Water Suppliers

TITLE 30	ENVIRONMENTAL QUALITY
PART 1	TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
CHAPTER 288	WATER CONSERVATION PLANS, DROUGHT CONTINGENCY PLANS, GUIDELINES AND REQUIREMENTS
SUBCHAPTER B	DROUGHT CONTINGENCY PLANS
RULE § 288.22	**Drought Contingency Plans for Wholesale Water Suppliers**

(a) A drought contingency plan for a wholesale water supplier must include the following minimum elements.

(1) Preparation of the plan shall include provisions to actively inform the public and to affirmatively provide opportunity for user input in the preparation of the plan and for informing wholesale customers about the plan. Such acts may include, but are not limited to, having a public meeting at a time and location convenient to the public and providing written notice to the public concerning the proposed plan and meeting.

(2) The drought contingency plan must document coordination with the regional water planning groups for the service area of the wholesale public water supplier to ensure consistency with the appropriate approved regional water plans.

(3) The drought contingency plan must include a description of the information to be monitored by the water supplier and specific criteria for the initiation and termination of drought response stages, accompanied by an explanation of the rationale or basis for such triggering criteria.

(4) The drought contingency plan must include a minimum of three drought or emergency response stages providing for the implementation of measures in response to water supply conditions during a repeat of the drought-of-record.

(5) The drought contingency plan must include the procedures to be followed for the initiation or termination of drought response stages, including procedures for notification of wholesale customers regarding the initiation or termination of drought response stages.

(6) The drought contingency plan must include specific, quantified targets for water use reductions to be achieved during periods of water shortage and drought. The entity preparing the plan shall establish the targets. The goals established by the entity under this paragraph are not enforceable.

(7) The drought contingency plan must include the specific water supply or water demand management measures to be implemented during each stage of the plan including, but not limited to, the following:

(A) A pro rata curtailment of water deliveries to or diversions by wholesale water customers as provided in Texas Water Code, § 11.039; and

(B) utilization of alternative water sources with the prior approval of the executive director as appropriate (e.g., interconnection with another water system, temporary use of a non-municipal water supply, use of reclaimed water for non-potable purposes, etc.).

(8) The drought contingency plan must include a provision in every wholesale water contract entered into or renewed after adoption of the plan, including contract extensions, that in case of a shortage of water resulting from drought, the water to be distributed shall be divided in accordance with Texas Water Code, § 11.039.

(9) The drought contingency plan must include procedures for granting variances to the plan.

(10) The drought contingency plan must include procedures for the enforcement of any mandatory water use restrictions including specification of penalties (e.g., liquidated damages, water rate surcharges, discontinuation of service) for violations of such restrictions.

(b) The wholesale public water supplier shall notify the executive director within five business days of the implementation of any mandatory provisions of the drought contingency plan.

(c) The wholesale public water supplier shall review and update, as appropriate, the drought contingency plan, at least every five years, based on new or updated information, such as adoption or revision of the regional water plan.

Source Note: The provisions of this § 288.22 adopted to be effective February 21, 1999, 24 TexReg 949; amended to be effective April 27, 2000, 25 TexReg 3544; amended to be effective October 7, 2004, 29 TexReg 9384.

APPENDIX B

Letter to Customers

APPENDIX B
Example Letter to Wholesale Water Customers

Date

[Customer]
[Address]

Dear [Customer]:

The Lavaca-Navidad River Authority has prepared a draft Drought Contingency Plan which, when adopted by the Board of Directors of the Lavaca-Navidad River Authority, will be used by the Authority as a component of its Water Management Plan. As a wholesale water customer of the Authority, we are seeking your input and comments on the draft Drought Contingency Plan. I have enclosed a copy of the Plan for your review.

Public comments regarding the draft Drought Contingency Plan may be made at the Public Meeting to be held by the Lavaca-Navidad River Authority Board of Directors on April 20, 2005. Written comments on the draft Drought Contingency Plan will be accepted through close of business on Tuesday, April 19, 2005.

We appreciate your input and interest in the water resources in the Lavaca River Basin.

Sincerely,

Patrick Brzozowski
General Manager
Lavaca-Navidad River Authority

APPENDIX C

Letter to Regional Water Planning Groups

APPENDIX C
Example Letter to Regional Water Planning Groups
[Planning Groups P and N]

Date

[Chairman]
Chair, Region__ Water Planning Group
[Address]

Dear [Chairman]:

Enclosed please find a copy of the draft Drought Contingency Plan for the Lavaca-Navidad River Authority. I am submitting a copy of this plan to the Region __ Water Planning Group in accordance with the Texas Water Development Board and Texas Commission on Environmental Quality rules.

Please review the draft plan for consistency with the approved Regional Water Plan. Public comments regarding the draft Drought Contingency Plan may be made at the Public Meeting to be held by the Lavaca-Navidad River Authority Board of Directors on April 20, 2005. Written comments on the draft Drought Contingency Plan will be accepted through close of business on Tuesday, April 19, 2005.

Sincerely,

Patrick Brzozowski
General Manager
Lavaca-Navidad River Authority

APPENDIX D

Texas Water Code, Section 11.039

APPENDIX D

Texas Water Code Section 11.039

§ 11.039. Distribution of Water During Shortage

(a) If a shortage of water in a water supply not covered by a water conservation plan prepared in compliance with Texas Natural Resource Conservation Commission or Texas Water Development Board rules results from drought, accident, or other cause, the water to be distributed shall be divided among all customers pro rata, according to the amount each may be entitled to, so that preference is given to no one and everyone suffers alike.

(b) If a shortage of water in a water supply covered by a water conservation plan prepared in compliance with Texas Natural Resource Conservation Commission or Texas Water Development Board rules results from drought, accident, or other cause, the person, association of persons, or corporation owning or controlling the water shall divide the water to be distributed among all customers pro rata, according to:

(1) the amount of water to which each customer may be entitled; or

(2) the amount of water to which each customer may be entitled, less the amount of water the customer would have saved if the customer had operated its water system in compliance with the water conservation plan.

(c) Nothing in Subsection (a) or (b) precludes the person, association of persons, or corporation owning or controlling the water from supplying water to a person who has a prior vested right to the water under the laws of this state.

Amended by Acts 1977, 65th Leg., p. 2207, ch. 870, § 1, eff. Sept. 1, 1977.

Amended by Acts 2001, 77th Leg., ch. 1126, § 1, eff. June 15, 2001.

APPENDIX E

Board Resolution to Adopt the Drought Contingency Plan

Lavaca-Navidad River Authority
Resolution No. 2005-002
Board Resolution Adopting the Drought Contingency Plan

Resolution Adopting a Drought Contingency Plan for the Lavaca-Navidad River Authority, Authorizing Submittal of the Drought Contingency Plan to the Texas Commission on Environmental Quality and the Texas Water Development Board for Approval, and Authorizing Incorporation of Provisions into All Water Sales Contracts used by the Lavaca-Navidad River Authority

BE IT RESOLVED by the Board of Directors of the Lavaca-Navidad River Authority that a Drought Contingency Plan attached hereto as Exhibit A, prepared in conformance with the requirements of the Texas Commission on Environmental Quality (TCEQ) and the Texas Water Development Board (TWDB) is hereby adopted;

BE IT FURTHER RESOLVED by the Board of Directors of the Lavaca-Navidad River Authority that the General Manager is directed to submit the adopted Lavaca-Navidad River Authority Drought Contingency Plan to TCEQ and TWDB and for their approval; and

BE IT FURTHER RESOLVED by the Board of Directors of the Lavaca-Navidad River Authority that the General Manager, in accordance with state law, is directed to incorporate provisions into all water sales contracts used by the Lavaca-Navidad River Authority to require purchasers of water from the Lavaca-Navidad River Authority to implement water conservation and demand reduction measures in accordance with the adopted Lavaca-Navidad River Authority Drought Contingency Plan.

Passed and approved this 20th day of April, 2005.

Vee Strauss
Vée Strauss, President
Board of Directors
Lavaca-Navidad River Authority

ATTEST:

Willard Ulbricht
Willard Ulbricht, Secretary-Treasurer
Board of Directors
Lavaca-Navidad River Authority

Appendix E.4

City of Corpus Christi
Water Conservation and
Drought Contingency Plan
(Amended April 28, 2009)

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City of Corpus Christi
Water Conservation and Drought Contingency Plan

April 28, 2009

AN ORDINANCE

AMENDING SECTION 55-151(a), CODE OF ORDINANCES, CITY OF CORPUS CHRISTI REGARDING THE ADOPTION OF THE 2009 CORPUS CHRISTI WATER CONSERVATION AND DROUGHT CONTINGENCY PLAN; PROVIDING FOR SEVERANCE; AND PROVIDING FOR PUBLICATION.

BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF CORPUS CHRISTI, TEXAS, THAT:

SECTION 1. Section 55-151(a), Code of Ordinances is revised to read as follows:

"Sec. 55-151. Water conservation and drought contingency plan.

"(a) The City of Corpus Christi Water Conservation and Drought Contingency Plan ~~2005~~ 2009, dated April ~~26, 2005, as amended on November 15, 2005~~ 28, 2009, a true copy of which is on file in the office of the city secretary, is adopted, and shall be followed in matters concerning water conservation, drought management, and water supply enhancement programs."

* * * * *

SECTION 2. If for any reason any section, paragraph, subdivision, clause, phrase, word or provision of this ordinance shall be held invalid or unconstitutional by final judgment of a court of competent jurisdiction, it shall not affect any other section, paragraph, subdivision, clause, phrase, word, or provision of this ordinance, for it is the definite intent of this City Council that every section, paragraph, subdivision, clause, phrase, word or provision of this ordinance be given full force and effect for its purpose.

SECTION 3. Publication shall be made in the official publication of the City of Corpus Christi as required by the City Charter of the City of Corpus Christi.

SECTION 4. That upon written request of the Mayor or five Council members, copy attached, the City Council (1) finds and declares an emergency due to the need for immediate action necessary for the efficient and effective administration of City affairs and (2) suspends the Charter rule that requires consideration of and voting upon ordinances at two regular meetings so that this ordinance is passed and takes effect upon first reading as an emergency measure on this the 28th day of April, 2009.

028141

ATTEST:

Armando Chapa
City Secretary

THE CITY OF CORPUS CHRISTI

Henry Garrett
Mayor

APPROVED: This 17th day of April, 2009:

R. Jay Reining
First Assistant City Attorney
For City Attorney

Corpus Christi, Texas
28th day of April, 2009

TO THE MEMBERS OF THE CITY COUNCIL

Corpus Christi, Texas

For the reasons set forth in the emergency clause of the foregoing ordinance an emergency exists requiring suspension of the Charter rule as to consideration and voting upon ordinances at two regular meetings: I/we, therefore, request that you suspend said Charter rule and pass this ordinance finally on the date it is introduced, or at the present meeting of the City Council.

Respectfully,

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Council Members

Respectfully,

Henry Garrett

Henry Garrett
Mayor

The above ordinance was passed by the following vote:

Henry Garrett	Aye
Melody Cooper	Aye
Larry Elizondo, Sr.	Aye
Mike Hummell	Aye
Bill Kelly	Aye
Priscilla G. Leal	Aye
John E. Marez	Aye
Nelda Martinez	Aye
Michael McCutchon	Aye

028141

Executive Summary

The City of Corpus Christi has had a nationally recognized water conservation program for the past 19 years. The City was first in the state to create a Drought Contingency Plan in 1986 which served as a guide for state officials. Corpus Christi understands the seriousness of maintaining an active water conservation and drought contingency plan based on historic drought conditions.

Since 1988, the City's Water Department assigned duties to a conservation coordinator to develop outreach programs. The building of the Xeriscape Learning Center and Design Garden has set precedence in commercial landscape ordinance requirements. Development of educational programs such as Toby Globy Eco-Action, Major Rivers and the Learning to be Water Wise programs are delivered to local classrooms. These efforts have resulted in measurable water savings. Total water consumption per person has dropped from 259 gallons per day in 1988 to 233 gallons per day in 2008.

The City has also worked with its wholesale customers to promote water conservation and to coordinate efforts during times of water shortage as during the mid-1990s and 2006. This document contains all of the provisions required in Title 30, Texas Administrative Code Chapter 288.2 for public water suppliers, wholesale providers, and for a drought contingency plan. The document is divided into chapters that contain the major elements essential to each of the regulatory requirements, and appendices that contain legal ordinances enacting the Drought Contingency and Conservation Plan and water rates, as well as the utility profile and reservoir operations plan.

Chapter One summarizes the reservoir operating systems that supply the City of Corpus Christi and its wholesale customers with raw and treated water. Chapter Two presents the demand profiles and quantifiable targets and goals for the City, indicating that water use is tracked by customer class, and that the City has related its metered data to its conservation aims. For example, the City's largest retail customer class is single-family residential at 89 percent of customers, while the largest customer class by consumption per connection is industrial at 15 million gallons per month. The City projects a 1 percent per year drop in per capita consumption over the next 10 years, and has a goal to keep system water loss below 10 percent.

Chapter Three includes the 11 conservation best management practices that make up the City's Conservation Program. Mandatory elements, like metering, systems water audits, and conservation pricing are addressed, as well as voluntary practices like park conservation and water reuse. The City's conservation program is best known for its educational initiatives including efforts which target both adults and children. The Xeriscape Learning Center and Design Garden at the Museum of Science and History has attracted interest from horticultural and conservation specialists from around the state and the nation, as well as serving as a resource for school children and adults in Corpus Christi.

Chapter Four includes the provision addressing the wholesale customers, including a summary of contractual requirements to conserve during water shortages, and targets and goals section for wholesale customers. Chapter Five includes a summary of the drought plan provisions which were enacted by ordinance in 2001, and the water use reduction targets for the drought plan.

Chapter 1
Introduction

The City of Corpus Christi Water Department serves nearly 500,000 citizens of Corpus Christi and the Coastal Bend. Its mission is to effectively manage the City's water supply, production, and distribution system in order to meet water supply needs and to provide safe drinking water that meets state and federal regulations; to review the design and construction of water facilities to ensure the adequacy of the water system to meet projected growth requirements; and to identify and meet consumer needs and expectations.

The City of Corpus Christi Water Department supplies water for municipal and industrial use in a seven-county service area covering 140 square miles. Major raw water customers include Alice Water Authority, Beeville Water Supply District, City of Mathis, San Patricio Municipal Water District, Celanese, and Flint Hills Resources. Treated water customers include Nueces County Water Improvement District No. 4 (Port Aransas), San Patricio Municipal Water District, South Texas Water Authority, and the Violet Water Supply Corporation. The primary supply of water comes from surface water resources. The Frio River supplies water to Choke Canyon Reservoir. Lake Corpus Christi receives inflow from Choke Canyon Reservoir, the Atascosa and the Nueces Rivers, all within the Nueces River Basin. Water drawn from Lake Texana is pumped through the Mary Rhodes Pipeline and enters the O. N. Stevens Water Treatment Plant.

Lake Corpus Christi has a capacity of 242,241 acre-feet of water. Wesley Seale Dam was dedicated April 26, 1958. Choke Canyon Reservoir has the capacity of 695,271 acre-feet of water. The United States Bureau of Reclamation financed, designed, and built the reservoir, which was dedicated on June 8, 1982. The City operates and maintains the facility.

During 1993 to 1996, Nueces River Basin stream flows were the lowest recorded — even lower than the much-remembered 1950s Drought. The Regional Water Supply Task Force determined that additional water resources were needed for the Coastal Bend. In 1993, the City entered into a contract with the Lavaca-Navidad River Authority to purchase 41,840 acre-feet of water per year. The City of Corpus Christi, along with the Nueces River Authority, the Port of Corpus Christi and the Lavaca-Navidad River Authority worked together to deliver water via a new pipeline from Lake Texana. The 101-mile-long pipeline was named for the late Mary Rhodes, mayor of Corpus Christi from 1991 to 1997, in recognition of her special contribution to the development of water resources for the residents and industries of the Coastal Bend. Water is pumped through a 64-inch pipeline from Lake Texana near Edna, Texas. The pipeline came on line in September 1998. Approximately 50 percent to 70 percent of the water delivered to homes in Corpus Christi comes from Lake Texana.

Another Water Department function includes operation of the O. N. Stevens Water Treatment Plant. The City diverts raw water from the Nueces River and Lake Texana into the plant to be treated to Texas Commission on Environmental Quality (TCEQ) drinking water standards. Water is drawn from the Nueces River, and passes through screens to remove large floating objects. The water is pumped from the Nueces River to the treatment plant junction box, where it is blended with Lake Texana water. From there, the water is treated to remove suspended particles and disinfected for human consumption. Large master pumps help to distribute water into the City and to its wholesale water customers.

Approximately 25 billion gallons of water are treated each year. The O. N. Stevens Water Treatment Plant has a rated capacity of 167 million gallons per day, well above the peak summer demand of 98 million gallons per day. The Water Department operates five pumping stations and four elevated storage tanks, and maintains 1,600 miles of pipeline.

The Water Department operates in full compliance with all state and federal requirements. The Water Department also maintains a water laboratory and water maintenance activity that oversees the repair and replacement of transmission and distribution service water lines.

To meet the demand of a growing community, the City has taken steps to assure a future water supply. In 1999, the City purchased senior water rights to 35,000 acre-feet of water per year in the Colorado River. This water will be transported to Corpus Christi via a pipeline that will be constructed in the future from the Colorado River to the Mary Rhodes Pipeline at Lake Texana.

The City has explored the feasibility of desalination — the process of removing salt from seawater. The Padre Island Desalination Plant Feasibility Analysis and Siting Plan studied the feasibility and costs of building a reverse osmosis (RO) desalination facility (up to five million gallons per day (mgd)), increasing water storage at Padre Island, and using a technology that stores water underground for future use known as aquifer storage and recovery (ASR) in the Chicot Aquifer. The City also participated in a U.S. Army Corps of Engineers feasibility study to assess the potential for desalination as a water supply source for the region. This study was jointly sponsored by the San Antonio Water System, San Antonio River Authority, and Guadalupe Blanco River Authority.

The Water Department has a long-standing commitment to promoting water conservation in the community. Its public education and communications functions promote community awareness of water resources, the importance of using water wisely, and techniques for efficient use of water. The Department provides free water-related educational materials to local school districts, public outreach, free water saving devices and an extensive year around media campaign. The long-term focus of the Plan is to stretch existing and planned expansions to the water systems by reducing per capita water consumption. Long-term conservation programs include conservation pricing, residential and commercial, and institutional water education designed to help customers reduce per capita water use by one percent per year over the next decade. Increased usage of reuse water and aquifer storage and recovery will also help manage the demand profile and use water more efficiently.

The service area of the City of Corpus Christi is located within the Coastal Bend, designated as Region N Planning area, and the City has provided a copy of its Water Conservation Plan to the Coastal Bend Regional Water Planning Group (RWPG). The Region N Planning Group was initially appointed by the Texas Water Development Board (TWDB), under the authority of Senate Bill 1, and includes representatives from 12 interests including the public, counties, municipalities, industries, agriculture, the environment, small businesses, electric-generating utilities, port authorities, river authorities, water districts, and water utilities from across the region. This Plan is consistent with the City's role as a leader in water supply planning in Region N, and meets the standards for water conservation planning in TAC Chapter 288. The Water Department has coordinated with the RWPG through the following measures:

1. A City Council member sits on the planning group;
2. The City delivered the 2009 Corpus Christi Water Conservation and Drought Contingency Plan to the Region N Water Planning Group;
3. City staff members (in addition to RWPG representative) attend Planning Group meetings on a regular basis;

4. City staff has made formal comments (at meetings and in writing) at various times regarding issues with population and water demand projections and with selection of water management strategies; and

5. The City has held numerous meetings with the RWPG consultant to address issues related to Corpus Christi and the regional planning process.

Chapter 2
Demand Profile, Targets, and Goals

2.1 Demand Profile

The City of Corpus Christi serves both wholesale and retail customers. Of the wholesale customers, five receive treated water, and six receive raw water from the City. Surface waters from the Nueces and Frio Rivers are impounded in Choke Canyon Reservoir and Lake Corpus Christi, while water from the Navidad River is impounded in Lake Texana.

Of the 120,259 acre-feet of raw water withdrawn in 2008, 21,441 acre-feet, or 31.4 percent, was delivered to the four wholesale and two retail customers on the Choke Canyon/Lake Corpus Christi (CCR/LCC) reservoir system, and 9,510 acre-feet was delivered to one wholesale customer on the Lake Texana side. Raw water customers include Alice Water Authority, Beeville Water Supply District, City of Mathis, San Patricio Municipal Water District, Celanese, and Flint Hills Resources. San Patricio Municipal Water District receives raw water from both the CCR/LCC system and Lake Texana. The remaining 82,916 acre-feet of raw water in 2008 was delivered to the O. N. Stevens Water Treatment Plant (WTP) for treatment and serves as retail and wholesale water supply of potable water. Figure 1, Corpus Christi Water Source Flow Chart 2008, as shown on the following page, reflect the amounts of water delivered to major customers from the two principle surface water sources, from raw water to the WTP, and then on to treated water customers.

The overall water demand by the City of Corpus Christi Water Department customers in the year 2008 was 37.0 billion gallons, including sales to wholesale treated and raw water customers. In 2008, 48.9 percent of the raw water entered the WTP from the combined CCR/LCC system on the Nueces River. The remaining 51.1 percent of the raw water was withdrawn from Lake Texana on the Navidad River. Of the 27.0 billion gallons of raw water delivered to the O. N. Stevens WTP, 24 billion gallons were delivered to wholesale and retail customers.

Figure 1

Corpus Christi, Texas

Water Source Flow Chart for 2008
(Million Gallons)

Water Drawn from Choke Canyon/ Lake Corpus Christi Reservoir System	
Alice	2,245
Beeville	982
Mathis	250
Celanese	470
Flint Hills Resources	1,613
San Patricio MWD	3,509
Corpus Christi	13,459
Total	22,528

Water Drawn from Lake Texana	
San Patricio MWD Raw	3,099
Corpus Christi	14,008
Total	17,107

O. N. Stevens Water Treatment Plant	
Raw Water Entering O. N. Stevens WTP	27,467
Treated Water Leaving O. N. Stevens WTP	23,979
UBO Billed Water Consumption	25,347

Treated Water Customers	
Naval Air Station	342
NCWCID #4	474
San Patricio MWD-Treated	1,072
South Texas Water Authority	507
Violet Water Supply Corp.	58
Corpus Christi	22,894
Total	25,347

Retail industrial and single-family residential customers were the two highest demand sectors in 2008 for treated water at 36 percent and 29 percent respectively (see Figure 2, 2008 Treated Water Use by Customer Class (wholesale customers included)). They were followed by commercial customers at 21 percent and wholesale customers at 8 percent. City and State accounts, which include City parks, municipal buildings and State highway irrigation, represents 1 percent of overall consumption. Multi-family accounts represented approximately 5 percent of demand. Multi-family accounts include residential accounts with up to four housing units per meter. Apartments, condominiums, and domiciles with five or more units per meter are included in the commercial demand segment.

Figure 2

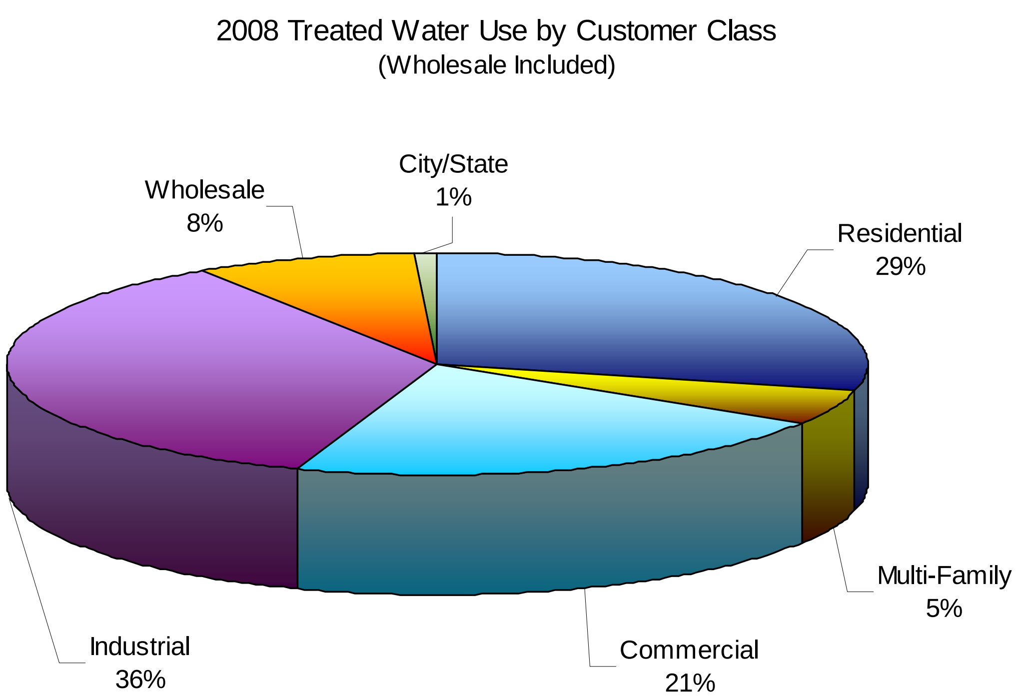
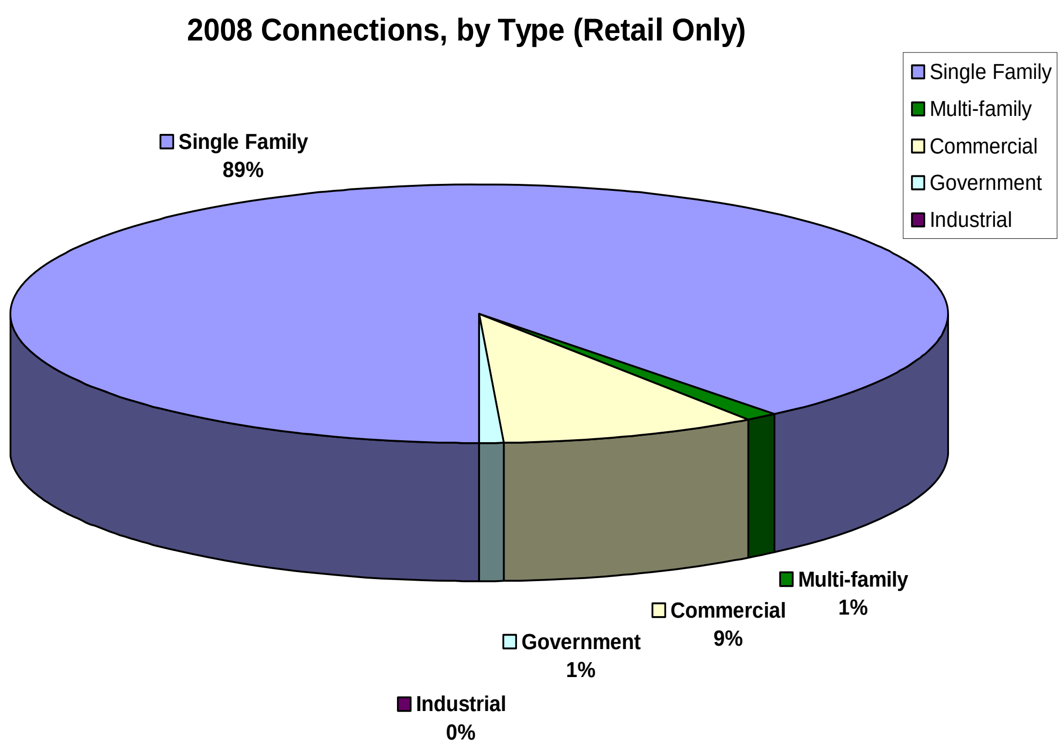


Figure 3, 2008 Connections by Type (Retail Only), shows the breakdown of retail treated water customers by connection. In 2008 the City served an average of 87,277 connections per month. The figure indicates that residential accounts represent the largest number of accounts at 89 percent of all retail connections. Commercial customers account for the next largest number of customers at 9 percent of all accounts. City and State accounts represent 1 percent of all connections; and industrial accounts with 31 connections were less than one-tenth of 1 percent of the total. Wholesale customers represent far less than 1 percent of connections, and are not included in Figure 3.

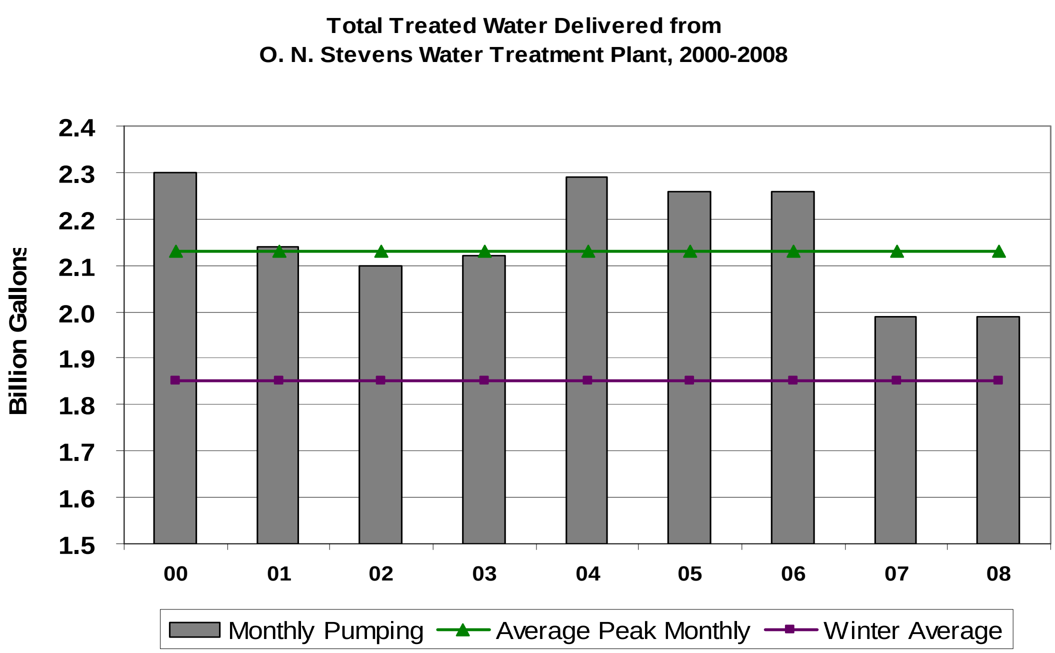
Figure 3



System Efficiency
The Water Department summary showed an unaccounted for water rate of 9 percent in 2008. The City's unaccounted for water rates are kept below 10 percent through an aggressive leak detection and repair program, timely meter testing and replacement, tracking of system pressures, and water use for construction and other purposes. Detailed descriptions of water loss reduction efforts are found in Chapter 3.

Seasonal Demand
The City's demand profile shows the summer peaks typical of Texas cities. Summer demand has averaged 2.3 billion gallons (for the period of 2005 to 2008) as compared to 2.5 billion gallons (for the period of 2000 to 2004) for a difference of 2.4 million gallons. The winter average demand was approximately 1.88 billion gallons per month, decreased slightly from 1.89 to 1.76 billion gallons (Figure 4, Total Pumping 2000-2008). A reduction in winter average from 1.9 billion gallons per month to 1.7 was seen in 2008. Average summer time peak dropped from 2.5 bgm to 2.3 bgm when comparing the periods of 2000 to 2004 and 2005 to 2008. This reduction can be attributed to the combined effects rainfall events has had on reduced irrigation usages; and public education over the past several years.

Figure 4



Source: Surface Water Monthly operating reports; TNRCC Form No. 0102c (1/05/09).

2.2 Goals

The City of Corpus Christi water conservation plan focuses on two efficiency goals. The first and most immediate goal is to reduce summertime peak pumping. The second goal is to reduce overall per capita consumption over the next several decades by 1 percent per year from the City's consumption of 259 gallons per capita per day (gpcd) in 1988. The goals are designed to assist the City with challenges to water supply constraints due to weather, and to ensure that the system is run with the optimum efficiency. The City carefully balances revenue needs and conservation programming to ensure that the system is fiscally sound.

The City has a long history of progressive regional water resource planning. In keeping with that tradition, and to ensure that future generations will have adequate water supplies, the City will promote water conservation as an alternative water supply. Conserving existing supplies is less expensive and has less environmental impact than attempting to build new reservoirs. In order to reduce per capita demand over the next several decades, the City has embarked on a water conservation program designed to educate citizens on the benefits of efficiency, and to provide incentives for reduced water use through changes in behavior and installation of water saving devices.

The City must maintain a balance between conservation and water quality based on the requirement to flush the City's 2,000 dead-end main fire hydrants annually to comply with TCEQ requirements.

Table 2, Water Consumption Goals, shows recent gpcd consumption and the goal of 1 percent per year reduction over the next 10 years based upon the City's pre-conservation consumption rate. Actual consumption for 2008 indicates that the City gpcd at 233. The projected gpcd target goals are shown at 5 and 10 year increments as required by House Bill 2660. These targets and goals have been updated as part of the 2009 Water Conservation Plan. Per capita consumption is a result of a combination of conservation efforts, including public education and behavioral water use patterns, implemented as part of the City's conservation plan and weather patterns.

Table 2
Water Consumption Goals Based on Gallons Per Capita Per Day (gpcd)[1]

		Actual			Target Goals		
					Annual	5 & 10 Year Goals	
Year	**1988**	**2004**	**2006**	**2008**	**2008**	**2013**	**2018**
Total gpcd [2]	**259**	**218**	**243**	**233**	**234**	**223**	**212**

[1] Wholesale customers are excluded.
[2] Total gpcd represents total volume of raw water entering the O. N. Stevens Water Treatment Plant, excluding water sold to treated wholesale water customers, divided by population of 297,467, divided by 365 days.

The City's gallon per capita per day (gpcd) consumption is higher than most Texas cities based on the large volume users such as refineries that consume 40 percent of treated water. Texas Commission on Environmental Quality recommends a minimum one percent reduction in per capita use per year.

In addition to traditional water conservation methods that focus on changes in customer consumption patterns, the Water Department plans to promote demand management techniques that provide the most efficient use of water resources. Demand management programs will be investigated in the next planning time frame to include reuse, aquifer storage and recovery, and conjunctive use of surface and groundwater resources.

Current efforts in reducing water losses focus on a percentage of unaccounted-for water, or the difference between billed water consumption and total water production. The City's goal is to keep the water loss rate below 10 percent. In 2008, the City's water loss was 9 percent.

The City has completed a water system audit for the year ending 2008. The document was developed based on the Texas Water Development Board (TWDB) guidelines and with the use of the American Water Works Association (AWWA) water system audit procedures. The City will evaluate moving to the leakage index method articulated in the System Water Audit and Loss Best Management Practice (BMP) identified in Chapter 3.

2.3 Utility Profile Survey

A detailed summary of the City's water and wastewater systems is included in Appendix A. The survey includes the Texas Commission on Environmental Quality – Water Conservation Implementation Report including the City of Corpus Christi Utility Profile.

Chapter 3
Best Management Practices

3.1 Introduction

Water consumption in the City of Corpus Christi is driven by a wide variety of domestic, commercial, industrial, and institutional needs. Best Management Practices (BMPs) have been developed to improve water use efficiency for the City of Corpus Christi Water Department and for programs to assist the City's water customers in efficient water use. Ten BMPs have been implemented as part of the City's ongoing water conservation effort, which began in 1988. The BMPs are described briefly in the next paragraph, and in greater detail in the remaining sections of this chapter. Each BMP has five sections; description, implementation, schedule, documentation, and water savings information. A new BMP has been added: Plumbing Assistance.

The System Water Audits and Water Loss BMP allow the Water Department to reliably track water uses and provide the information to address unnecessary water and revenue losses. The Metering of All New Connections and Retrofit of Existing Connections BMP have been established to create equity among customers, reduce water waste, and reduce flows to wastewater facilities. The Water Conservation Pricing BMP is designed to discourage the waste of water while assuring the fiscal obligations of the system are met.

Additionally, the City has initiated an Automatic Meter Reading (AMR) Program to accurately record usage and integrate data into our billing system. More than 65 percent of the City's water meters have been installed with the innovative technology, benefiting the city with improved meter accuracy.

The Water Conservation Pricing BMP is designed to discourage the waste of water while assuring the fiscal obligations of the system are met. The Prohibition on Wasting Water BMP is aimed at customers who continue to waste water despite Water Department efforts to educate customers to reduce waste of water. The Conservation Coordinator BMP provides an effective method of ensuring that the City's water conservation programs are well administered and effective.

The Public Information BMP affects water consumption through changes in behavior as customers learn about water resources, the wise use of water, and the conservation program. The Water-Wise Landscape Design Program BMP saves water through the installation of water-wise landscape materials supplemented with subsequent education to ensure efficient irrigation of the new landscapes. The Park Conservation BMP will save water through the implementation of regulations in existing BMPs and use of reclaimed water in the City's two golf courses, two large City-wide parks, five recreation centers, several decorative fountains, nine public swimming pools, and more than 200 neighborhood parks.

3.2 System Water Audit and Water Loss

A. Description

The City of Corpus Christi performs a regular estimate of system water efficiency by comparing water delivered to the treatment plant, potable water produced, and water sold. In accordance with the requirements of House Bill 3338, the City will increase the level of detail of water-use accounting by adding several categories of water-use tracking over the next year. The Water Department already tracks numerous leak detection and repair activities and is able to evaluate its success using the asset management software to compile and track work orders. Potential refinements for the future will include: leak repair summaries, average pressures, meter accuracy test, meter change-out summary, permitted fire hydrant use, and other records that may be kept on water theft and unmetered uses such as street cleaning. The City's top-down water audit, using existing records and some estimation, will provide a more detailed overall picture of water losses within the next calendar year, and will be maintained annually thereafter.

B. Implementation

A working group will be formed with representatives from the following work areas: management, distribution, operations, production, customer service, finance, and conservation. Each of these work areas has an essential role to play in implementing this BMP. Initially, the working group will focus on gathering relevant data and identifying current practices listed below in Step 1 that form the basis for the top-down audit.

Step 1. The top-down audit will be performed using readily available information compiled annually in the Water Department's response to the Texas Commission on Environmental Quality's Utility Profile; with the worksheets provided by the TWDB's water planning division in response to HB 3338; and with plans to incorporate methods recommended by the American Water Works Association (AWWA) in the M36 Water Audit and Leak Detection Manual update.

Step 2. The second step of the audit, the bottom-up approach, will involve a more detailed review of utility policies and practices that affect water losses. This review will be performed at least once every five years per the requirements of HB 3338. The Water Department will be able to better incorporate information from utility practices including leak reporting, whether by customers or by City staff, and repairing. Systems pressure tracking, especially analysis of high-end users' effects on systems pressures, will be accomplished through the use of Supervisory Control and Data Acquisition (SCADA) technology. The Water Department will also explore methods for developing better estimates of water use by the fire department and for line flushing and street cleaning. The City will also evaluate night flow and zonal analysis to better estimate leakage; analyze leakage repair records for length of time from reporting to repair of the leak; and analyze pressure throughout the system. The installation of Automatic Meter Readers (AMR) meters will facilitate this effort.

Using the AWWA M36 Water Audits and Leak Detection Manual recommended methodology, the City will review and consider incorporating the relevant elements in the water loss control program. Potential elements of the future Water Loss Program will be evaluated including:

1. Using a water loss modeling program;
2. Metering individual pressure zones;
3. Establishing district metering areas (DMA) and measuring daily, weekly, or monthly flows with portable or permanently installed metering equipment;
4. Continuous or intermittent night-flow measurement;

5. Reducing repair time on leaks; and
6. Limiting surges in pressure.

To reduce the potential for leaks on the service lines between the main and the meter, all new construction is required to use Type K copper tubing and a single compression fitting. No splices are allowed in these lines.

C. Schedule

Initial elements to reduce water losses and account for water use and loss were implemented in 1970s.

1. The Water Department will gather the necessary information for conducting the top-down audit, develop the procedures, and complete the audit by May 1, 2008.
2. The Water Department will review the new M36 manual and begin implementing the bottom-up refinements indicated by the TWDB's new guidelines for water audits before March 31, 2009.
3. After such review, the Water Department will propose new water audit standards based upon keeping real water losses below a specific percentage or to achieve an infrastructure leakage index (ILI) below 3.
4. A bottom-up audit will be performed no less than once every five years; and more often if the internal water audit standard is not achieved.

D. Documentation

To track this BMP, the Department will collect and maintain the following documentation:

1. A copy of each annual system audit, the ILI and percentage losses for each year, and a list of actions taken in response to audit recommendations;
2. Annual leak detection and repair report, including number and sizes of leaks repaired;
3. Number of customer service line leaks identified and actions taken to repair these leaks;
4. Pressure reduction actions taken, if any; and
5. Estimated annual revenue increased through reducing apparent losses.

E. Determination of Water Savings

Potential water savings are an integral part of the system water audit process and will be contained in the audit report. Based on the results of the audit, goals will be set for reducing losses. Documentation is maintained through the City's Maximo software.

3.3 Metering of All Connections

A. Description

The purpose of this BMP is to ensure that all aspects of meter installation, replacement testing, and repair are managed optimally for water use efficiency. The City has fully implemented this BMP.

The meter program has several elements:

1. Required metering of all connections.
2. A policy for installation of adequate, proper-sized meters as determined by a customer's current water use patterns.
3. Direct utility metering of each duplex, triplex, and four-plex unit, whether each is on its own separate lot or there are multiple buildings on a single commercial lot.
4. Metering of all utility and publicly owned facilities.
5. Use of construction meters and access keys to account for water used in new construction.
6. Implementation of the State requirements in HB 2404, passed by the 77th Legislature Regular Session and implemented through Texas Water Code 13.502, which requires all new apartments be either directly metered by the utility or submetered by the owner.
7. Annual testing and maintenance of all meters larger than two inches. Regular replacement of five-eighth- and three-quarter-inch meters in service for 15 years of service.
8. An accounting of water savings and revenue gains through the implementation of the Water Department's meter repair and replacement procedures.
9. An accounting of water savings and revenue gains through the implementation of the Water Department's meter repair and replacement procedures.

B. Implementation

The Water Department ensures the high quality of metering is maintained through the regular review of metered data and revision of metering policies to ensure that the maximum amount of water consumption is accounted for.

The City will continue to conduct a meter repair and replacement procedures following the methodology and frequency currently recommended in industry practices and recommended by the AWWA. This includes:

1. Maintaining a proactive meter-testing program, and repair identified meters; and
2. Notifying customers when it appears that leaks exist on the customer's side of the meter.

C. Schedule

The City has already implemented this BMP, and continues to maintain the practice on an ongoing basis.

D. Documentation

To track the effectiveness of the Metering BMP the Water Department gathers the following documentation:

1. Copy of meter installation guidelines based upon customer usage levels;
2. Copy of meter repair and replacement policy;
3. Records of number and size of meters repaired annually;
4. Report on the method used to determine meter replacement and testing intervals for each meter size; and
5. Estimate of water savings achieved through meter repair and replacement program.

E. Determination of Water Savings

Each year the Water Department will estimate its annual water saving from the BMP. Savings can be estimated based upon a statistical sample analyzed as part of the meter repair and replacement program.

The City maintains a meter replacement policy based upon a customer's concern on the accuracy of the meter. Records of meters replaced annually are maintained through the City's Maximo software. Meter replacement takes dominance over meter repair due to the cost of repairing old meters. With the conversion of standard meters to automated meter reading (AMR), the City has improved efficiency to purge old meters and eliminate water loss. The determination of water savings is difficult to assess.

3.4 Water Conservation Pricing

A. Description

The City has an increasing block rate structure for residential customers. A copy of the current water rate structure is attached as Appendix D**.** The basic rate structure is designed to recover the cost of providing service and billing for water, storm water and wastewater service based on actual metered water use. The rates include a consumption charge based upon actual gallons metered so that increasing water consumption results in a larger bill for the customer. Conservation such as an increasing block structure helps to decrease water use by targeting the highest use rates with highest prices.

B. Implementation

A utility rate study, as prepared by HDR Consultants, was completed in 2008 creating a new rate structure for all customer classes, but specifically eliminated the declining rate structure for industrial accounts. The existing increasing block for residents was retained and additional conservation pricing structures will be examined, such as the following:

1. Seasonal rates to reduce peak demands during summer months.
2. Increasing block rates for other customer classes. Rates for single-family residential and other customer classes may be set differently to reflect the different demand patterns of the classes.
3. Restructuring of commercial rate structure to an increasing block rate.

Successful adoption of a new rate structure included public input process to educate the community about the new rate structure. The City's rate structure adheres to all applicable regulatory procedures and constraints.

At least annually, the Water Department staff will annually review consumption patterns (including seasonal use) and the income and expense levels to determine if the conservation rates are effective, and make appropriate, regular rate structure adjustments as needed.
In the 2005 Water Conservation Plan, the City identified the possibility of adopting service rules to authorize the use of commercial, industrial and residential customers to install separate irrigation meters. The City has followed through with authorizing 166 irrigation accounts that consume approximately 3,500 gallons per month.

Public involvement in the development and implementation of conservation rates help to assure that the goals of the conservation pricing initiatives are met and accepted by local constituents. Public meetings, advisory groups, and public announcements are among ways to generate public involvement.

The City's priority is a rate design that sends the appropriate price signal to customers to reduce discretionary water use. To remain effective, the rates need to be adjusted periodically to take inflation into account, as well as future increases in operating costs.

C. Schedule

Water rate schedule was adopted August 1, 2008. The City is considering the adoption of a new storm water rate fee.

D. Documentation

To track this BMP, the Water Department maintains the following documentation:

1. A copy of its rate ordinance;
2. Billing and customer records that include annual revenues by customer class and revenue derived from commodity charges by customer class for the reporting period;
3. Monthly customer numbers and water consumption by customer class; and
4. A copy of the education materials on the conservation rate sent to customers for each calendar year this BMP is in effect.

E. Determination of Water Savings

Elasticity studies have shown an average reduction in water use of 1 to 3 percent for every 10 percent increase in the average monthly water bill. In implementing a conservation pricing structure, consideration will be given to the factors that influence whether the new structure results in a reduction in water use. The *Water Price Elasticities for Single Family Homes* (TWDB, 1998) study included the City of Corpus Christi among the study subjects. The study found long-term price elasticities of -0.20 for the City, which translates into a reduction of 2 percent in water use for a 10 percent increase in price.

3.5 Prohibition on Wasting Water

A. Description

Water Waste Prohibition measures are enforceable actions and measures that prohibit specific wasteful activities. Under this BMP, ordinances have been enacted and enforced to prohibit wasteful activities. No person may:

1. Allow water to run off yards or plants into gutters or streets.
2. Permit or maintain defective plumbing in a home, business establishment or any location where water is used on the premises. Defective plumbing includes out-of-repair water closets, underground leaks, defective or leaking faucets and taps.
3. Allow water to flow constantly through a tap, hydrant, valve, or otherwise by any use of water connected to the City water system.
4. Use non-recycling decorative water fountain.

Water waste during irrigation includes:

1. Water running along the curb of the street;
2. Irrigation heads or sprinklers spraying directly on paved surfaces such as driveways, parking lots, and sidewalks in public right-of-ways;
3. Operation of an irrigation system with misting heads caused by water pressure higher than recommended design pressure for the heads, or operation with broken heads;
4. City Manager is authorized to prohibit spray irrigation during summer months between the hours of 10 a.m. and 6 p.m. if conditions warrant.
5. The Water Department is exploring the potential for introducing ordinances requiring rain sensors and/or evapotranspiration (ET) controllers on automatic irrigation systems in the future.

B. Implementation

This BMP is implemented by the regular operating personnel of the Water Department, and leaks on the water system distribution lines are repaired by crews that are available 24 hours a day. Through visual detection of leaks reported by the public or Department staff, and audible detection of leaks by storm water crews, leaks are detected and scheduled for repair.

C. Schedule

The initial water waste provisions on Corpus Christi's City ordinances were introduced in 1986 as part of the Drought Contingency Plan. The drought contingency and water conservation ordinances have been amended numerous times.

Future water waste ordinances, such as rain sensors or ET controllers, will be considered for introduction to the City Council in the 2009-2010 time period.

D. Documentation

To track this BMP, the Water Department maintains the following documentation:

1. Copy of City's Plumbing Code, Section 612 Lawn Irrigation Systems;
2. Copy of compliance or enforcement procedures implemented by the Code Enforcement and Water Department; and
3. Records of enforcement actions including public complaints of violations and responses from Code Enforcement and Water Department.

E. Determination of Water Savings

Total water savings for this BMP can be estimated from each water-wasting measure eliminated through the actions taken under this BMP. The Water Department will develop new tracking methods to determine overall water saved through the water waste prohibition efforts in future years. The City has taken the practice of sending a letter to bring attention to water-wasting activity. Typically, neighbors report such occurrences to the Water Conservation Office or the City's Call Center. Field crews make site visits to address the action and to bring the customer to eliminate the waste. The Utility Business office frequently sees homeowners who clearly have a leak or spike in water use visible through high water consumption readings. Low income customers are referred to City's Neighborhood Improvement Program to qualify for a grant for plumbing improvements. The Water Department in conjunction with the Utilities Business Office is teaming up to develop a Plumber to People Program during 2008. The program will provide financial assistance to low income homeowners to repair leaks in plumbing devices.

3.6 Conservation Coordinator

A. Description

The City's Water Public Relations and Marketing Coordinator oversees and coordinates conservation efforts within the Water Department's service area for retail customers and assists in conservation efforts of wholesale customers.

The Coordinator is responsible for effecting water conservation practices and measures within the Water Department's service area by promotion of water conservation programs, development of marketing strategies for conservation programs, and coordination with other Department staff and program partners. The coordinator also promotes the value of conservation programs within the Department.

Water conservation programs are directed to primary grade school children through the schools and through public events, and to the general public through media awareness campaigns, demonstration gardens, public events, and partnership with other entities such as Texas AgriLife Service, Nueces County Master Gardeners and local school districts.

Other duties include preparation of the annual conservation budget; preparation and implementation of the water conservation and drought contingency plans; preparation and submittal of annual conservation status reports to Water Department management; implementation of the Water Department's conservation program; and management of the conservation staff, consultants, and contractors, when appropriate.

B. Implementation

Coordinator and support staff duties include the following:

1. Manage and oversee conservation programs and implementation;
2. Document water conservation program implementation status as it relates to state requirements and water conservation BMPs adopted by the Water Department;
3. Communicate and promote water conservation to Water Department management;
4. Communication and promote water conservation to wholesale customers;
5. Coordinate Water Department conservation programs with operations and planning staff;
6. Prepare annual conservation budget;
7. Manage consultants and contractors assisting in implementing the water conservation program;
8. Coordinate with partnering agencies, such as Texas Cooperative Extension, Texas A&M University – Corpus Christi;
9. Assist in preparing presentations to the Water Resource Advisory Committee and Corpus Christi Community Advisory Council;
10. Develop public outreach and marketing strategies for water conservation; and
11. Serve as media contact and public information spokesperson for the Water Department on conservation issues.

The water conservation plan's budget includes public school education programs, media campaigns, and public event participation and materials.

C. Schedule

The Water Department first hired a conservation coordinator in 1987. The Water Department employs the Public Relations and Marketing Coordinator, assisted by support staff, on an ongoing basis.

D. Documentation

The Water Department gathers the following documentation:

1. Description of the Public Relations and Marketing Coordinator position;
2. Annual or more frequent reports on progress of water conservation program implementation, costs and water savings; and
3. Effectiveness of programs of wholesale customers in terms of water savings.

E. Determination of Water Savings

The Coordinator assists in the implementation of other BMPs. This effort can be considered as essential to the savings accrued by the implementation of the whole range of conservation programs that are offered by the Water Department.

3.7 Public Information

A. Description

The Water Department employs several types of media resources and modes of mass communication to present a compelling and consistent message about the importance of water use efficiency to managing and sustaining existing water supplies and delaying the need to build new treatment facilities. The overall goal of the public information program is to raise awareness among customers and citizens of the overall picture of regional water resources and the importance of conservation.

B. Implementation

The Water Department employs the following methods to bring the water resources awareness and to instill the importance of conservation in the community:

1. Multi-tiered media campaign. A budget of $76,700 funds annual television, radio, and print campaigns promoting water use efficiency. Agreements with radio and television stations provide for matching airtime for each ad purchased by the City.

2. Billboard advertisement. Ads on two billboards and 5 bus benches were obtained at a discount to promote the City's water conservation campaign, "Make Saving Water a Life Long Habit." The City has also initiated a campaign to address the City's 20007 water quality issues. A budget of $13,000 out of the $76,700 is reserved for billboard advertisement,

3. Website. The Water Conservation Department's website includes tips on outdoor and indoor conservation, an on-line version of the Xeriscape-to-Go brochure (the City's plumbing ordinance requiring drip or soaker hose irrigation on landscaped strips narrower than five feet), and information on the Xeriscape Coalition.

4. Printed brochures. Printed brochures available to the public are explained in the Water-Wise Landscape Design and Conversation Program:
    a. Xeriscape To-Go: Planning and Designing a Gardener's Dream,
    b. Xeriscape: Landscape with Less Water, and
    c. Purple Water-Wise Plant Labels.

5. School Education. Programs targeted to grade school children are explained in the School Education section. A budget of $33,000 is dedicated for school education.

6. Xeriscape Learning Center and Design Garden. As part of the Corpus Christi Museum of Science and History, the Xeriscape Corpus Christi Steering Committee, in partnership with the City, maintains a Xeriscape demonstration garden with more than 100 plant varieties. Within the garden an educational gazebo, The Water Story Exhibit, showcases and 8-foot interactive topographic map of the Nueces River Basin. A second gazebo named the Learning Center features practical landscape ideas and photographs. Educational Walk 'n' Talk Tours are held annually to enhance public education.

7. City Call Center. The City's Call Center was created to encourage customers to report water line breaks, service calls and water conservation information. Customers utilize a dedicated telephone line to request water conservation kits and other information. In addition, a screen message is shown daily on the City's public access station Channel 20 that encourages customers to call for a free water saving kit. The message rotates continuously 24/7/365.

C. Schedule

1. The Xeriscape Learning Center and Design Garden at the Museum of Science and History premiered in 1994 and continues as an ongoing effort.

2. The multi-tiered media campaign was initiated in 1994, and continues as an ongoing effort.

3. The Call Center was developed in 2004 and replaces the Water Hotline. The Call Center offers a live person to receive customer calls.

4. Xeriscape-to-Go in both print and on-line versions was developed and printed in 1999.

5. The City's Water Conservation website is continually updated.

D. Documentation

To track the progress of this BMP, the Water Department gathers the following documentation:

1. Number of activities, pieces of information distributed, and number of customers at that activity;
2. Number and schedule of activities or information pieces related to promoting specific BMPs adopted by the Water Department;
3. Number of public school children divided by grade level who received instruction in water resources or water conservation;
4. Number of news programs or advertisements that featured the water conservation message and how many customers had the opportunity to receive each message;
5. Total population in the service area;
6. Total budget by category for public information; and
7. Results of annual or biannual customer survey and/or focus groups to determine the reach and impact of the program.

E. Determination of Water Savings

Water savings due to public information efforts are difficult to quantify. Water savings for other public information programs that result in specific actions by customers such as changes in irrigation scheduling or reduction in water waste occurrences may be quantified through surveys or analysis of water waste reporting in future years.

The City tracks the number of presentations made to schools or organizations. The number of community activities are documented such as the Xeriscape Symposium (60 attendees), World of Water Celebration (700), Earth Day (3,000), American Diabetes / City Job Fair (90), school campuses - science extravaganzas (1,200), AgriLife workshops (75), Del Mar College presentations (75), Home and Garden shows (2,500), etc.

Presentations have been made to Barnes, Fannin, Kostoryz, Houston, Cunningham, Los Encinos, Meadowbrook, Yeager, Moore, Evans, Sanders, Garcia and Moore Elementary. School district officials post information in their newsletters to teachers extending the opportunity to have a guest speaker from the Water Department. In addition, teachers are sent an email with a personal invitation from the Water Conservation Coordinator. Teachers welcome the opportunity to have a presenter.

3.8 School Education

A. Description

School education programs, which may not result in quantifiable water saving, nevertheless enhance a utility's public image, contribute to the attainment of Texas state education goals by students, increase customer goodwill, and increase the viability of its overall water conservation efforts. The message conveyed by students to their families based upon greater knowledge of water sources and conservation can result in behavioral changes resulting in both short- and long-term water savings.

B. Implementation

The City of Corpus Christi Water Department offers the following school educational programs.

- ***Major Rivers***. Piloted in 1991, the self-contained *Major Rivers* curriculum, incorporated into the 4th grade curriculum, meets or exceeds the requirements of Texas Essential Knowledge and Skills (TEKS). The program educates students on water conservation, supply, treatment, distribution and conservation. The self-contained program offers academic and hands-on activities in math, language arts, science, and social studies, with teacher's guide geared to the interdisciplinary curriculum, as well as an introductory video and home information leaflets. The program includes pre- and post-test evaluations. In addition, teachers receive continuing education credits for participating in *Major Rivers* workshops. The program is funded by the City at a base price of $45 per classroom.

- ***Toby Globy Eco- Action*.** Introduced to school children in grades pre-kinder to second grade with classroom and special event visits by mascot Toby Globy, this locally produced bilingual program brings the environmental awareness to primary grade school children in sing-along song and coloring books, a compact disc of recorded music in English and Spanish, environment-oriented classroom activities, posters, and a pictorial instruction booklet introducing solid waste, and recycling, in addition to water conservation.

- ***Learning to be Water Wise***. A program is used in 5th grade classrooms to associate science, math, language arts, and social studies to water conservation activities. Boxed kits, which include a toilet water displacement bag, toilet leak detector tablets, showerhead and faucet aerators, and instructions for repairing common toilet leaks, are given to each student. This program, has been shown to produce an estimated savings of 8,900 gallons per year in homes in which the water-saving fixtures have been installed (*Learning to Be Waterwise, City of Corpus Christi 2001-2002 Program Summary Report,* Prepared for City of Corpus Christi, Dave Munk, 2002.)

• **Workshop for Daycare Teachers*.*** In a half-day-long workshop, Pre-kinder to second grade teachers were introduced to age-appropriate water resources teaching aids, including the educational program "Toby Globy Eco Action Team and coloring books with a water-conservation message.

• ***Water Source Book.*** The *Water Source Book*, developed by the Water Environment Federation, reinforces water resource issues with hands-on classroom activities and experiments for grades 6 through 8. The classroom activities feature water, wastewater, and storm water experiments. This book is provided by the City to all local school resource libraries. Continuing education workshops, introduce local classroom teachers to the *Water Source Book.* Teachers can utilize this teaching aid to satisfy certain TEKS objectives as established by the Texas Education Agency.

• **Coastal Bend Teacher Resource Extravaganza.** The City Water Department has participated in the Coastal Bend Informal Educators (CBIE), to offer valuable opportunities and resources for teachers, students and the general public at the annual event. The City Water Department sponsors the event which brings environmental resources to teachers throughout Texas Education Agency Region 2 area.

• **Museum of Science and History.** The Corpus Christi Museum of Science and History offers guided tours to school groups. In addition, educational gazebos, targeted to children, features various showcases an 8-foot interactive topographic map of the Nueces River Basin. The touch of a button activates lights and sound to explain the area's water resources. Displays throughout the Xeriscape Learning Center and Design Garden are used as teaching tools for children and adults.

• **Other educational materials.** The Water Department of the City of Corpus Christi also provides age-appropriate water resources teaching materials at public events. Materials include *Splash Activity Book*, *My Book About Water and How to Use it Wisely*, and *The Story of Drinking Water.* Spanish material is also available upon request.

• **Water IQ.** By 2010, the City plans to adopt the Texas Water Development Boards new educational program to target middle grade students.

C. Schedule

The Water Department of the City of Corpus Christi will continue to offer existing age- and grade-level-appropriate educational programs in the classroom as detailed above.

D. Documentation

To track the progress of this BMP, the utility should gather and have available the following documentation:

1. Number of school presentations made during reporting period:
Fourteen presentations were made to elementary and middle grade schools during 2008.

2. Number and type of curriculum materials developed and/or provided by water supplier: All elementary campuses within the Corpus Christi Independent School Districts received a copy of Major Rivers and Toby Globy Eco Action program kits. Major Rivers – 160 program kits; Toby Globy Eco Action – 192 Teacher Lesson Plan Kits; and Learning to be Water Wise – 322.

3. Number and percent of students reached by presentations and by curriculum;

A total of 2,711 students were reached.

4. Number of students reached outside the utility service area:
Educational materials and literature given to teachers outside the City utility service area; however, the numbers were not quantified. The City also works with neighboring communities by offering them the opportunity to use the City's water conservation literature.

5. Number of in-service presentations or teacher's workshops conducted during reporting period:
One teacher workshop was held in conjunction with the Texas Education Agency, Region 2 relating to the Toby Globy Eco Action.

6. Results of evaluation tools used, such as pre- and posttests, student surveys, teacher surveys: Teachers attending the workshop completed a survey providing useful feedback. Major Rivers pre and post tests survey results are typically not submitted back to the City.

7. Copies of program marketing and educational materials:
A sample packet of materials distributed to schools is attached.

8. Annual budget for school education programs related to conservation.
The Water Department reserves approximately $30,000 for school education programs per fiscal year.

E. Determination of Water Savings

Water savings for school education programs are difficult to quantify. The retrofit kit included with the *Learning to be Water Wise* has been shown to reduce domestic water use by 8,885 gallons per year per household.

3.9 Water-Wise Landscape Design and Conservation Program

A. Description

The City will decrease both summertime water consumption peaks and overall water use by the installation of water-wise landscapes at residential properties and subsequent education to ensure efficient irrigation of the new landscapes. Water-wise landscaping involves not only plant selection, but continued attention to appropriate irrigation and landscape maintenance.

In addition, a public education and outreach campaign through the media, Water Department-produced brochures, partnership with the Nueces County Master Gardeners and Texas Cooperative Extension, plant labeling at commercial nurseries, and installation of public demonstration gardens will create a multi-faceted program bringing water-wise landscape design to residential and commercial customers.

The City has adopted a Landscape Ordinance as part of its Zoning Ordinance. This ordinance requires landscape plantings within commercial developments to enhance the beauty of the City. The ordinance assigns points to the various plant materials. To encourage the use of water-wise landscaping, drought-tolerant and low-water-use species are assigned a higher point value. To comply, a landscape design must surpass an established threshold number of points, which is achieved more easily with the water wise and drought-tolerant plants.

B. Implementation

The implementation of this BMP involves continual public education campaigns, including media partnering with groups such as Nueces County Master Gardeners for outreach.

The City will continue existing public outreach measures and existing educational and outreach campaigns:

1. ***Xeriscape To-Go: Planning and Designing a Gardener's Dream***. A new brochure, both in print and online, designed to educate local residents on the benefits of Xeriscape landscaping, features a plant list suitable for the Coastal Bend and an explanation of the seven principles of Xeriscaping. The choice of vegetation and the Xeriscape gardening techniques save water and reduce maintenance requirements.

2. ***Xeriscape: Landscape with Less Water.*** A brochure detailing the seven principles of Xeriscape.

3. ***Purple Water-Wise Plant Labels***. A brochure produced in cooperation with the non-profit Xeriscape Corpus Christi, commercial nurseries, and Texas AgriLife Service to bring to public awareness lists of plants that are proven performers in the Coastal Bend. Also, the City's landscape ordinance assigns points to the various plant materials; drought-tolerant species are assigned a higher point value. Water-wise plants are labeled with purple tags at commercial nurseries for easy identification. Purple labels are affixed to water-wise and drought-tolerant plants offered at retail nurseries.

4. **Multi-Tier Media Campaign.** The City will continue local television and radio stations ads, with stations offering to match ad for ad, or provide a rate discount to the City. A television commercial featuring Texas Cooperative Extension horticulture agents will promote water-wise landscaping.

5. **Xeriscape Corpus Christi**. A steering committee established to develop an educational garden teaching the seven principles of Xeriscape. The garden was built at the Museum of Science and History. The steering committee's members include the City of Corpus Christi Water Department, Storm Water Department, and Park and Recreation Department, Corpus Christi Museum of Science and History, Friends of the Museum, Mayor's Water Conservation Advisory Committee, Nueces County Master Gardeners, and Texas AgriLife Service of Nueces County.

6. **Xeriscape Design Garden and Learning Center**. The demonstration garden at the Museum of Science and History exhibits over 100 plant varieties. One educational

gazebo, The Water Story Exhibit, showcases an 8-foot interactive topographic map of the Nueces River Basin. The touch of a button activates lights and sound to explain the area's water resources. The second gazebo, redesigned and renamed Learning Center, features various wall exhibits. Other exhibits feature South Texas' hardiest plants, a mulch exhibit, and a classroom exhibit, as well as a feature on South Texas' hardiest plants. Garden works days are held bi-annually and the public are invited to participate. Tours are provided to schools and civic organizations upon request.

7. **Rain Sensors.** The Water Department will evaluate the potential for greater savings by adoption of a rain sensor ordinance requiring the use of rain sensors on all automated irrigation systems.

8. **Evapotranspiration (ET) Controllers*.*** The Water Department will explore the possibility of requiring ET Controllers on new and refurbished irrigation systems. These controllers may also be purchased for use with City property as demonstration project.

In addition, vegetation on each island at the **Xeriscape Design Garden and Learning Center** is grouped based upon water needs. Each island is separately metered, and the individual meters are read monthly. They are watered on average one-quarter inch to one-third inch per week. Rain sensors on the automatic sprinkler systems help reduce water use by running equipment only when water is needed. Landscaping at Water Department properties and some park properties survives on rainfall alone.

C. Schedule

This BMP was initially implemented in 1991 with the initiation of the multi-faceted media campaign to increase public awareness of Xeriscaping. A number of activities listed above have been initiated over the years, and are planned for ongoing implementation, including:

1. Public outreach and educational campaigns and partnership with Nueces County Master Gardeners, Texas AgriLife Extension of Nueces County, and retail plant nurseries since 1993;

2. Plant labeling for water-wise and drought-characteristics at commercial plant nurseries since 2004 and remains active into 2009; and

3. The City's Commercial Landscape Ordinance was amended in 2007 to promote water conservation measures.

Over the next five years, the City will perform evaluations of its ongoing programs to determine the effectiveness of each effort. The City will also determine the feasibility of ordinances requiring ET-controller and rain sensor installation on automated sprinkler systems by the end of the 2014.

D. Documentation

To track the effectiveness of Water-Wise Landscape Design and Conversion Programs, the Water Department will gather the following documentation:

1. Number of dedicated irrigation meter accounts;

2. Estimated landscape area converted;

3. Estimated water savings based on customer billing records;

4. Customer water use records prior to and after conversion of the landscape. This data is best compared in years of similar rainfall and after the landscape has been installed a sufficient time to establish itself; and

5. Number of rain sensors and ET-controllers on automatic sprinkler systems and customer records prior to and after installation of such devices. This data is best compared in years of similar rainfall and after the landscape has been installed a sufficient time to establish itself.

E. Determination of Water Savings

Water savings will be determined from analysis of actual customer-metered water use before and after landscape conversion and/or installation of rain sensors or ET-controllers.

In addition, the effectiveness of educational and public outreach campaigns will be assessed by analysis of peak and annual water volumes per customer class.

The City currently has 166 irrigation accounts with an average consumption of 3,500 gallons each per month. The City hopes to initiate a landscape design and conversion program before 2014 to effectively monitor conversion of landscape areas, water savings, and incorporate the use of rain sensors.

3.10 Park Conservation

A. Description

The City of Corpus Christi Parks and Recreation Department manages two golf courses; two large City-wide parks; five recreation centers; several decorative fountains; nine public swimming pools; and more than 200 neighborhood parks, some with irrigated athletic fields. At these facilities, the visible use of water often comes under scrutiny by the public and water resource managers both because of large water demand to maintain a park and because of the perception that the water use may be excessive.

Conservation of water at parks will be achieved through the BMPs on Prohibition on Wasting Water; Water-Wise Landscape Design; Retrofit of Existing Connections and Metering of New Connections; and System Water Audit and Loss Program.

The Water Department will also explore the potential and feasibility of expanding irrigation of golf courses with reclaimed wastewater. At present, between 2 and 3 percent of treated wastewater is reclaimed to irrigate golf courses and a baseball field.

B. Implementation

1. Parks properties will be included in the Water Department’s System Water Audit and Loss programs identified in Section 3.2.

2. The Parks Department voluntarily adopts Landscape Ordinance provisions of the Corpus Christi Zoning Ordinance, Article 27B.

3. In compliance with Corpus Christi Plumbing Code, Section 612 Lawn Irrigation Systems.

C. Schedule

To accomplish this BMP, the Water Department will:

1. Ensure park properties' landscapes are planted and irrigated in compliance with City ordinances and plumbing codes within the next five years;
2. Continue the use of reclaimed wastewater for irrigation started in 1987;
3. Beginning in 2005, include park properties in the System Water Audit and Loss programs; and
4. Ensure that other BMPs promoting efficient use of water are followed at park properties.

D. Documentation

To track the progress of this BMP, the Water Department will gather and have available the following documentation:

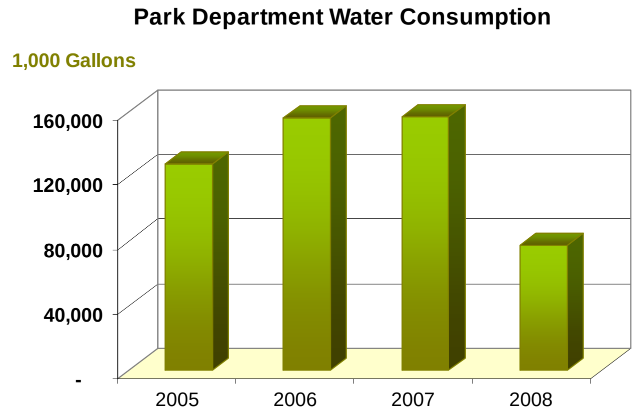
1. Water savings due to offset of potable water use by irrigation with reclaimed waste water;
2. Water savings attributable to repairs of leaks;
3. Changes to irrigation systems, retrofits, or upgrades, regular leak detection, maintenance policies, and estimated water savings from conservation practices;
4. Estimated water savings attributable to changes implemented; and
5. Costs of repairs, equipment upgrades, or new equipment installed.

The Water Department will compare monthly data for irrigation water consumption from irrigation meter readings at park properties on an annual basis or more frequently during times of water shortage. Special emphasis will be placed upon evaluating data from sites before and after significant irrigation system changes or upgrades. City maintains performance measure software to monitor the progress of leaks repaired. The Maximo software will identify individual categories to estimate the volume of water savings attributable to repairs of leaks.

E. Determination of Water Savings

The Water Department compiles monthly data for irrigation water consumption from irrigation meter readings at park properties on an annual basis or more frequently during times of water shortage. Special emphasis will be placed upon evaluating data from sites before and after significant irrigation system changes or upgrades. Figure 5 identifies water consumption dropped 49 percent at park properties during calendar year 2008.

Figure 5



3.11 Reuse of Reclaimed Water

A. Description

The Certificate of Adjudication for Choke Canyon Reservoir required the City of Corpus Christi to provide no less than 151,000 acre feet of water per annum for the estuaries by a combination of releases and spills from Lake Corpus Christi and by way of return flows to the Nueces and Corpus Christi Bays and other receiving estuaries. Subsequent amendments to the City's Certificate of Adjudication refined the freshwater inflow requirements to Nueces Bay by calculating target inflows as a percentage of system storage; however the balance of effluent that can be utilized for reuse purposes by City was determined in the February 2001 TCEQ Agreed Order. The City of Corpus Christi currently has six reclaimed water use customers and recognizes that the direct use of reclaimed water is an effective method of reducing potable water usage. Reclaimed water is defined as, "Domestic or municipal wastewater which has been treated to a quality suitable for a beneficial use, pursuant to the provisions of this chapter and other applicable rules and permits" (30 TAC §210.3(24)). Corpus Christi reclaimed water is primarily used for irrigating recreational tracts and maintaining the Nueces Estuary.

B. Implementation

To facilitate expansion of its reuse program, the Corpus Christi Water Department will identify and rank industrial, commercial, and institutional (ICI) customers according to volume of water use, and investigate the feasibility using reclaimed water. The Water Department will also investigate reuse opportunities within its own accounts or with third parties outside its service area. The City owns several public areas that are candidates for reuse.

Historically, Corpus Christi began its reuse program in the early 1960s when it began delivering reclaimed effluent to its first customer, the Gabe Lozano Golf Course. Over the next several decades, the City acquired five additional reuse customers including two more golf courses, a country club, a softball complex and the landscape median of Park Road 22. The remaining two golf courses within the City recently entered into an agreement with the City for the supply of reclaimed water. Approximately 2.5 percent of the City's overall effluent flows are reused as reclaimed water.

C. Schedule

The Water Department will continue to deliver reclaimed water to its six customers and investigate a possible expansion of the reuse program.

D. Documentation

To track this BMP, the Water Department will gather the following documentation:

1. Description of wastewater treatment facilities and reclaimed water distribution systems.
2. Documentation of its efforts to find reuse opportunities within it customer base, including lists of potential users.
3. Number of gallons or acre-feet of previous potable water use replaced by reuse water since implementation of this BMP.

E. Determination of Water Savings

Water savings are estimated at up to 100 percent of total amount of potable water replaced by reclaimed water. Changes in operating parameters or water balance calculations which depend upon water quality parameters, such as the impact of total dissolved solids (TDS) in irrigation water, may require different quantities of reuse water to be applied for same end uses.

For the period of 2006 through 2008, 876 million gallons of wastewater effluent was applied to four golf courses and baseball parks. Additional details are shown in the attached Utility Profile Report.

3.12 Plumbing Assistance

A. Description

The Water Department is developing an affordability program to provide plumbing assistance to low-income residential customers seeking to repair plumbing fixtures in their homes. The Utility Business Office reports that low-income residents often find themselves with high water consumption resulting from leaky plumbing devices for which they cannot afford to repair. The intent of the program is two-fold: (1) to eliminate the cycle of uncollected high water bills resulting from water leaks; (2) to promote water conservation.

B. Implementation

Persons eligible for the program must meet the following criteria.

- City of Corpus Christi water customer
- Homeowner and occupant
- Meet the eligibility requirements established by the City of Corpus Christi Neighborhood Improvement Office income requirements which are similar to those for most government assistance programs as identified under the 2009 income limits.

Individuals must contact the Utility Business Office (UBO) to identify their eligibility to determine the individual's income limits and need for assistance. The UBO representative will contact the plumber who is responsible to contact customer. The plumber will be given the homeowner's name, address, phone number and a brief description of the problem. Licensed and bonded plumbing companies will conduct a free estimate of repairs and notify City officials on the probability of repairing the leak. Only plumbers under contract will be authorized to make repairs. If the homeowner makes repairs, they will not be eligible for reimbursement under the program.

C. Schedule

The Water Department will implement the program during Fiscal Year 2009-2010 which begins August 1, 2009.

D. Documentation

To track this BMP, the Water Department and the Utilities Business Office will gather the following documentation:

1. Documentation the number of homeowners who qualify for the program based on eligibility requirements and history of high water use due to leaks.
2. Initiate contract with reputable plumbing companies who agree to repair plumbing leaks
3. Account for the number of gallons saved after repairs are made to the plumbing devices.

E. Determination of Water Savings

To determine water savings, a comparison will be made of previous water consumption data to that of consumption after repairs. An evaluation of plumbing leaks can be made by the plumber to determine the estimated waste of water by the defective plumbing device.

Chapter 4
Wholesale Customer Conservation

4.1 Summary

As part of the 2008 Water Conservation Planning Process, wholesale customers have been reviewed to determine conformance with the water conservation goals of the Plan.

Communication will be maintained with wholesale customers to ensure that the City's retail and wholesale customers are being treated in an equitable fashion, and for optimum implementation of the Plan. The City offers wholesale customers the opportunity to cosponsor conservation education and information activities.

4.2 Wholesale Customer Targets and Goals

The City of Corpus Christi serves five wholesale customers with treated water and six wholesale customers with raw water. The raw water is delivered to Corpus Christi's four municipal and two industrial customers. The water demands for these customers are summarized in Chapter 2, Demand Profile, Targets, and Goals, and are further detailed in the Water Utility Profile in Appendix A. Due to the fact that the City's wholesale customers have other sources of water in addition to the water provided by the City, the total gpcd provided in Table 2, Wholesale Customer Targets and Goals below, is based upon the Water Resource Planning information from the TWDB.

4.3 Metering, Monitoring, and Records Management

The City meters all water diverted from the raw water supply to its wholesale customers. The City also meters all treated water delivered to its wholesale customers. By contract these meters are calibrated on a semiannual basis, and must be accurate within 2 percent. The meters are read on a monthly basis for billing purposes.

A summary report is prepared, which aggregates all meter readings from wholesale raw water meters, wholesale treated water meters, and all retail customers, as well as the readings from the meters at the intake to the O. N. Stevens Water Treatment.

4.4 Leak Detection and Repair

The treated water wholesale customers are supplied from portions of the City's distribution system. The meter location is the point of sale after which the water enters the customer's system, which is the customer's responsibility to operate and maintain. The portions of the City's distribution system that serve these wholesale customers is subject to the same leak detection and repair program described in Chapter 3, Section 3.2 System Water Audit and Water Loss.

All raw water delivery systems to the wholesale customers are owned and operated by those customers. Therefore, they are responsible for any leak detection and repair programs as well as for unaccounted-for water. Wholesale customers are encouraged to voluntarily report their results to the City in order to promote cooperative efficiency efforts.

4.5 Contractual Requirements

The City has in place valid contracts with various wholesale customers including raw water contracts with municipal water suppliers, Alice Water Authority, Beeville Water Supply District, City of Mathis, and San Patricio Municipal Water District. Treated water customers include Nueces County Water Improvement District No. 4 (Port Aransas), San Patricio Municipal Water District, South Texas Water Authority, and the Violet Water Supply Corporation. Industrial wholesale customers, include Celanese, and Flint Hills Resources. All of these contracts contain language relating to water use restrictions in drought situations. Each contract has a section requiring the customer to accept shortages in supply, should natural or unforeseen circumstances prevent the City from delivering the water. With the exceptions of the Beeville Water Supply District and San Patricio Municipal Water District contracts, the contracts further stipulate that should there be a shortage in the basic supply of water which requires the restriction or curtailing of any consumer of water within the city limits of Corpus Christi that the wholesale customer limit and restrict all of its customers to the same extent.

In the most recent contract, with San Patricio Municipal Water District, language concerning water conservation year-round is included. As the need to renegotiate other contracts arises, the City will include contract language requiring conformance with applicable state and federal regulations concerning water conservation.

The Beeville Water Supply District requires the district to reduce its average raw water consumption by specific percentages whenever the City declares water shortage conditions. The district is required to reduce its average raw water consumption by 10% when the reservoirs fall below 50% (Condition I), 20% when the reservoirs fall below 40% (Condition II), 30% when the reservoirs fall below 30% (Condition III), and to cease raw water withdrawals when reservoir storage levels drop below 20% (Condition IV). In exchange the District is excused from contract minimum payments during the time of shortage; and it has the discretion to supplement river water with groundwater in lieu of imposing water use restrictions on its customers.

The San Patricio Municipal Water District has the discretion to either implement water conservation and drought measures similar to those imposed by the City or to reduce the water it takes from the City's water supply system. If the district elects to reduce the amount of water it takes from the City's water supply system the reductions are based on the average deliveries for the same month of the year over the three previous years. The percent of the reduction is based on the available water in the City's reservoir system. The required decrease in the amount of water that can be taken is 10% when the reservoirs fall below 50% (Condition I), 20% when the reservoirs fall below 40% (Condition II), 30% when the reservoirs fall below 30% (Condition III), and 60% when the reservoirs fall below 20% (Condition IV).

4.6 Targets and Goals

The City has no enforcement mechanism to impose conservation targets and goals upon its wholesale customers at this time. Achieving these goals must be through cooperative efforts to maintain and improve system efficiencies, to educate customers to the importance of conservation, and to enforce existing plumbing regulations within the municipal boundaries of each entity. To assist in meeting these goals, the City plays an active role in Region N water resource planning, working with wholesale customers on a voluntary basis on water conservation programs like those described in Sections 3.7, Public Information; 3.8, School Education; and 3.9, Water-Wise Landscape Design and Conversion Program. Wholesale customers may voluntarily report their progress on water conservation activities on an annual basis.

The Region N Water Resource Planning Group has projected water conservation from plumbing fixture replacements which are listed in Table 3, Wholesale Customer Municipal gpcd. The City will assist its wholesale customers in voluntarily meeting these goals through cooperative efforts like those mentioned above.

Table 3
Wholesale Customer Municipal GPCD

Customer Name	**GPCD 2000**	**GPCD 2010**	**GPCD 2020**
Alice Water Authority	248	244	241
Beeville Water Supply District	172	168	164
City of Mathis	119	115	112
Nueces County Water Control and Improvement District 4 / Port Aransas	187	181	179
San Patricio Municipal Water District	118	111	107
South Texas Water Authority	155	152	148
Violet Water Supply Corporation	151	148	145
GPCD - Weighted Average	**151**	**145**	**141**

Source: 2003 Population and Demand Projections for Region N, TWDB, 2003.

Of the wholesale customers served by the City, six have per capita consumption higher than the statewide goal of 140 gpcd recommended by the Water Conservation implementation Task Force, while two has per capita use rates lower than 140. The aggregate per capita use rates, weighted by population show that the overall per capita for the City’s wholesale customers will drop to around 141 gpcd by 2020. The 5- and 10-year targets are 146 gpcd and 143 gpcd. The gpcd targets are not relevant as conservation targets for industrial wholesale customers. Wholesale customers will be encouraged to operate efficiently and to keep water loss rates below 10 percent.

4.7 Reservoir System Operating Plan

The Reservoir System Operating plan is discussed in Chapter 1. A copy of the plan is attached in Appendix C.

Chapter 5
Drought Contingency Plan

5.1 Summary

A drought contingency plan is designed to address drought emergencies or uncontrollable circumstances that can disrupt the normal availability of water supply. The plan identifies water supply sources as well as measures to reduce water use. The plan may be implemented in other than drought emergencies such as system failures or weather-related events such as hurricanes. The City of Corpus Christi has had a Drought Contingency Plan in effect since 1987.

This chapter summarizes the City's Drought Contingency Plan. Emergency contingency planning is not the same as conservation planning. While water conservation involves implementing permanent water use efficiencies, an emergency contingency plan establishes temporary methods or techniques designed to be used only as long as the emergency exists.

The City's Drought Contingency Plan includes the following elements:

A) Trigger conditions signaling the start of an emergency period;

B) Emergency contingency measures;

C) Education and information;

D) Initiation procedures;

E) Termination notification actions; and

F) Implementation.

In addition, under the City's agreed order with the Texas Commission on Environmental Quality under Certificate of Adjudication No. 21-3214, the City is required to implement certain measures when specific trigger conditions are met, if the City elects to reduce the amount of water that is passed through its reservoir system to the Nueces bay and estuary.

The Plan is found codified in ordinance Sections 55-150 to 55-159, and is attached as Appendix B to this Water Conservation and Drought Contingency Plan 2005.

5.2 Procedure – Implementation

The City has automatic measures that are triggered at certain reservoir levels. In addition the City Manager may implement any or all of the water use restriction measures, as appropriate. The City Manager shall notify the members of the City Council before implementing any measures. Criminal penalties do not apply during the time of voluntary conservation.

5.3 Procedure – Notification

When trigger conditions and potential emergency contingency measures appear to be necessary, the City Manager shall publish notice in a daily newspaper of general circulation in

Nueces County when each water use restriction measure takes effect. Copies of the notices published by the City Manager under this section shall be filed with the City Secretary who shall send a copy of the notice to each member of the City Council and a certified copy of the notice to the judges of the Municipal Court.

5.4 Plan Applicability

The Drought Contingency Plan applies to all persons and premises receiving retail water from the City of Corpus Christi Water System. Wholesale customers are also subject to the plan under their contracts with the city. Specific restrictions based upon trigger levels and types of water use are detailed in the codified ordinance.

5.5 Enforcement

The City Manager has the authority to designate the enforcement authority of the Drought Contingency Plan. The City may serve a person or user in violation of this Drought Contingency Plan with a written notice stating the nature of the violation and giving a time limit for compliance. This notice may be in the form of a door hanger or written citation. Penalties are set forth in the ordinance. Any police officer, or other City employee designated by the City Manager, may issue a citation to a person s/he reasonably believes to be in violation of this article.

5.6 Emergency Criteria

Emergency criteria triggering the implementation of various stages of the Drought Contingency Plan include, but are not limited to, the following:

A) Voluntary announcement when combined storage in the Choke Canyon/Lake Corpus Christi Reservoir System (Reservoir System Storage) falls below 50 percent of the Reservoir System Storage capacity;

B) Automatic announcement of restrictions when combined storage falls below 40 percent of the Reservoir System Storage capacity;

C) General or geographical emergency; and

D) Water system failures/emergencies (i.e., pressure zone deficiencies, chemical spills, broken water mains, power outages, electrical failures, failures of storage tanks or other equipment, treatment plant breakdown, and/or water contamination).

5.7 Descriptions of Trigger Conditions

Upon the occurrence of an emergency, the City Manager may exercise his or her discretion to request special voluntary water use restrictions and/or to initiate mandatory restrictions. Public information concerning these stages is codified in ordinance and contained in Sections 55-150 to 55-159 inclusive, and attached as Appendix B to this Plan.

The City Manager may consider additional conservation measures that benefit specific water use restrictions as identified in the City's Drought Contingency Plan, Section 55-153, including:

- Restricting the use of water for watering foundations.
- Restricting use of water for washing of automobiles, trucks, trailers, boats, airplanes and any other type of mobile equipment.
- Prohibiting the washing of building exteriors and interiors, trailers, trailer houses and railroad cars with potable water.
- Restricting the use of water for recreational uses, such as playing in sprinklers.
- Restricting the use of fire hydrants for any purpose other than firefighting.
- Prohibiting the use of potable water in ornamental fountains or in artificial waterfalls.
- Prohibiting the use of potable water to wash down any sidewalks, walkways, driveways, parking lots, tennis courts, or other hard-surfaced area, or building or structure.
- Prohibiting the use of potable water for dust control.
- Limiting the use of potable water to irrigate golf courses.
- Prohibiting new service connections to the city's water system.
- Prohibiting the use of potable water to put new agricultural land into production.
- Denying applications for new, additional, further expanded, or increased-in-size water service connections, meters, service lines, pipeline extensions, mains, or other water service facilities of any kind.
- Establishing allocations of water use to industrial and commercial customers in amounts, after consultation with the allocation and review committee.
- Establishing the maximum monthly use for a residential customer with revised rate schedules and penalties approved by the city council, based on recommendations by the allocation and review committee.

5.8 Target Goals

The Corpus Christi Drought Management Ordinance is designed to reduce water demand through the imposition of specific water use restrictions including the use of bill surcharges and mandatory limits on consumption. As conditions worsen, automatic measures are mandated and additional discretionary measures may be implemented. It is the goal of this Water Conservation and Drought Contingency Plan to achieve specific, quantified targets for water use reductions during periods of water shortage and drought. These targets are summarized in Table 4 Water Reduction Targets below.

5.9 Wholesale Water Contracts

Every wholesale water contract entered into, renewed or modified shall include language relating to the City of Corpus Christi Water Conservation and Drought Contingency Plan, adopted under Section 55-151 of the Code of Ordinances to impose similar restrictions, surcharges or rationing measures on their customers. The City requires that any contract for the resale of water furnished to wholesale water contractors shall contain a similar condition. In addition, every wholesale water contract entered into or renewed after adoption of the plan (April 26, 2005), including contract extensions, must include a provision that in case of a shortage of water resulting from drought, the water to be distributed shall be divided in accordance with Texas Water Code, §11.039.

Table 4
Water Use Reduction Targets
during Periods of Water Shortage and Drought

Reservoir Storage Level	Target Demand Reduction Levels
<50%	1%
<40%	5%
<30%	10%
<20%	15%

Glossary:

Best Management Practice (BMP) – A conservation measure or system of business procedures that is beneficial, empirically proven, cost-effective, and widely accepted in the professional community.

Conservation – Those practices, techniques, and technologies that reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or increase the recycling and reuse of water so that a water supply is made available for future or alternative uses.

Industrial use – The use of water in processes designed to convert materials of a lower order of value into forms having greater usability and commercial value, commercial fish production, and the development of power by means other than hydroelectric, but does not include agricultural use.

Irrigation – The agricultural use of water for the irrigation of crops, trees, and pastureland, including, but not limited to, golf courses and parks which do not receive water through a municipal distribution system.

Municipal per capita water use – The sum total of water diverted into a water supply system for residential, commercial, and public and institutional uses divided by actual population served.

Municipal use – The use of potable water within or outside a municipality and its environs whether supplied by a person, privately owned utility, political subdivision, or other entity as well as the use of sewage effluent for certain purposes, including the use of treated water for domestic purposes, fighting fires, sprinkling streets, flushing sewers and drains, watering parks and parkways, and recreational purposes, including public and private swimming pools, the use of potable water in industrial and commercial enterprises supplied by a municipal distribution system without special construction to meet its demands, and for the watering of lawns and family gardens.

Municipal use in gallons per capita per day – The total average daily amount of water diverted or pumped for treatment for potable use by a public water supply system. The calculation is made by dividing the water diverted or pumped for treatment for potable use by population served. Indirect reuse volumes shall be credited against total diversion volumes for the purpose of calculating gallons per capita per day for targets and goals.

Pollution – The alteration of the physical, thermal, chemical, or biological quality of, or the contamination of, any water in the state that renders the water harmful, detrimental, or injurious to humans, animal life, vegetation, or property, or to the public health, safety, or welfare, or impairs the usefulness or the public enjoyment of the water for any lawful or reasonable purpose.

Public water supplier – An individual or entity that supplies water to the public for human consumption.

Regional water planning group – A group established by the Texas Water Development Board to prepare a regional water plan under Texas Water Code, §16.053.

Retail public water supplier – An individual or entity that for compensation supplies water to the public for human consumption. The term does not include an individual or entity that supplies water to itself or its employees or tenants when that water is not resold to or used by others.

Reuse – The authorized use for one or more beneficial purposes of use of water that remains unconsumed after the water is used for the original purpose of use and before that water is either disposed of or discharged or otherwise allowed to flow into a watercourse, lake, or other body of state-owned water.

Single Family Residential gpcd – Total annual single-family residential consumption divided by total population divided by 365.

Total gpcd – Total annual water delivered to treatment plant minus sales to wholesale customers and then divided by total population and divided by 365.

Water conservation plan – A strategy or combination of strategies for reducing the volume of water withdrawn from a water supply source, for reducing the loss or waste of water, for maintaining or improving the efficiency in the use of water, for increasing the recycling and reuse of water, and for preventing the pollution of water. A water conservation plan may be a separate document identified as such or may be contained within another water management document(s).

Water loss - The difference between water diverted or treated and water delivered (sold). Water loss can result from:

1. Inaccurate or incomplete record keeping;
2. Meter error;
3. Unmetered uses such as firefighting, line flushing, and water for public buildings and water treatment plants;
4. Leaks; and
5. Water theft and unauthorized use.

Wholesale public water supplier – An individual or entity that for compensation supplies water to another for resale to the public for human consumption. The term does not include an individual or entity that supplies water to itself or its employees or tenants as an incident of that employee service or tenancy when that water is not resold to or used by others, or an individual or entity that conveys water to another individual or entity, but does not own the right to the water which is conveyed, whether or not for a delivery fee.

APPENDIX A

Texas Commission on Environmental Quality
Water Conservation Implementation Report

Submitting Entity

City of Corpus Christi Water Department
P. O. Box 9277
Corpus Christi, Texas 78469-9277
(361) 826.1879 Fax: (361) 826-1889

Gus Gonzalez, P.E., Water Director, P.E.

Person responsible for implementing the water conservation program:
Yolanda R. Marruffo 361.826-1689 or 361.826-1879

UTILITY PROFILE
Appendix A to 2009 Water Conservation Plan

I. POPULATION AND CUSTOMER DATA

A. Population and Service Area Data

1. Attach a copy of your service-area map and, if applicable, a copy of your Certificate of Convenience and Necessity (CCN).

2. Service area size (square miles): 140 Sq. Miles

3. Current population of service area: 287,0000
4. Current population served:

   a. water 286,000
   b. wastewater 295,478

5. Population served by water utility for the previous five years:

Year	Population
2000	277,454
2002	277,773
2004	281,055
2006	285,267
2007	Est. 286,000

6. Projected population for service area in the following decades:

Year	Population
2010	316,058
2020	359,123
2030	391,077
2040	421,761
2050	448,879

7. List source/method for the calculation of current and projected population:

2006 Coastal Bend Regional Water Plan Report – HDR Consultants

____

____

B. Active Connections

1. Current number of active connections. Check whether multi-family service is counted as Residential _____ or Commercial __X___

Treated water users:	Metered		Not-metered	Total
	Inside City Limit	Outside City Limit		
Residential	78,124	80	0	78,204
Commercial	7,717	144	0	7,861
Industrial	0	23	0	23
Other - Government	577	0	0	577
Wholesale Treated	0	3	0	3
Wholesale- Raw	0	6	0	6

2. List the net number of new connections per year for most recent three years:

Year	2006	2007	2008
Residential	6,202	1,366	1,033
Commercial	501	(196)	(188)
Industrial	6	19	(17)
Other-Govt	36	(21)	5

C. High Volume Customers

List annual water use for the five highest volume customers
(indicate if treated or raw water delivery)

	Customer	Use (1,000/gal/yr)	Treated/Raw Water
1)	Valero Refining Co	4,006,077	Treated
2)	Lyondell Chemical Co	1,835,532	Treated
3)	Citgo Refining & Chemical	1,825,247	Treated
4)	San Patricio Municipal Water Dist.	1,114,640	Raw
5)	Calphine	519,869	Treated

II. WATER USE DATA FOR SERVICE AREA

A. Water Accounting Data

1. Amount of water use for previous five years (in 1,000 gal.):
   Please indicate: **Diverted Water**
   Treated Water

Year	2004	2005	2006	2007	2008
Jan	1,882,397	1,867,904	2,065,462	1,824,706	2,082,875
Feb	1,763,767	1,763,073	1,925,016	1,766,269	1,901,593
Mar	1,918,633	2,052,753	2,397,652	2,058,545	2,117,479
April	1,972,131	2,206,407	2,536,984	2,026,587	2,342,233
May	2,136,634	2,364,457	2,672,502	2,220,607	2,493,687
June	2,268,248	2,530,623	2,488,754	2,015,564	2,764,538
July	2,451,343	2,784,833	2,348,403	2,143,344	2,474,715
Aug	2,689,916	3,020,168	2,760,172	2,472,774	2,438,666
Sept	2,262,579	2,444,212	2,315,515	2,406,879	2,275,944
Oct	2,209,922	2,298,221	2,083,087	2,341,622	2,377,773
Nov	2,008,512	2,116,271	2,060,730	2,210,498	2,073,703
Dec	1,983,486	2,064,495	1,999,952	2,060,021	2,124,581
Total	**25,547,568**	**27,513,417**	**27,654,229**	**25,547,416**	**27,467,786**

Indicate how the above figures were determined (e.g., from a master meter located at the point of a diversion from the source or located at a point where raw water enters the treatment plant, or from water sales).

Water measurements originate at the point where raw water enters the O. N. Stevens Water Treatment Plant

2. Amount of water (in 1,000 gallons) delivered (sold) as recorded by the following account types for the past five years.

City of Corpus Christi also sells wholesale raw water which is reported in the Utility Profile – Water Conservation Plan for Wholesale Suppliers.

Year	Residential	Commercial	Industrial	Wholesale-Treated	Other	Total Sold
2004	5,930,732	5,460,068	8,466,442	2,144,717	549,773	22,551,732
2005	6,830,252	5,956,064	8,903,128	2,192,921	534,228	24,416,593
2006	7,031,163	6,108,953	7,794,876	2,238,574	618,574	23,792,140
2007	5,974,437	5,625,743	7,874,791	2,074,039	629,458	22,178,468
2008	7,267,154	5,634,055	9,203,674	2,053,795	789,616	24,948,294

3. List previous five years records for water loss (the difference between water diverted (or treated) and water delivered (or sold).

Year	Amount (1, 000 Gallons)	Percentage
2004	2,995,836	11.73%
2005	3,096,824	12.12%
2006	3,862,089	13.97%
2007	4,025,838	15.76%
2008	2,519,493	7.07%

4. Municipal water use for previous five years:

Year Population Total Water Diverted or <u>Pumped for Treatment</u> (1,000 gal.)

Year	Population *	Total Water Diverted or Pumped for Treatment (1,000 Gals)
2004	379,955	25,547,568
2005	383,437	27,513,417
2006	386,960	27,654,229
2007	390,525	25,547,416
2008	394,132	27,467,786

* Population based on Regional Water Planning Group growth projections, including Corpus Christi, San Patricio MWD, South Texas Water Authority, Nueces County WCID#4.

B. Projected Water Demands

If applicable, attach projected water supply demands for the next ten years using information such as population trends, historical water use, and economic growth in the service area over the next ten years and any additional water supply requirement from such growth.

As the primary provider of surface water to the Coastal Bend Region, the City of Corpus Christi is the major wholesale water provider in the region. Corpus Christi has 200,000 acre feet in available safe yield supply in 2060 through its own water right in the Choke Canyon Reservoir and Lake Corpus Christi Reservoir System and a contract with Lavaca Navidad River Authority from Lake Texana. This availability constitutes 93 percent of the total surface water availability in the region. Additionally, the City has a permit to divert up to 35,000 acre-feet/year run-of-river water under its inter-basin transfer permit on the Colorado River (via the Garwood Irrigation Co.). While the City owns the water right on the Colorado River, it currently does not have the facilities to divert and convey this water to the City; therefore, the 35,000 acre-feet is not included in the existing surface water availability in the region.

The City provides treated and raw water from the Choke Canyon/Lake Corpus Christi/Lake Texana System to the water user group. Based on the 2005 Regional Water Plan, Corpus Christi has a projected demand of 61,953 acre feet in 2010; 73,592 acre feet in 2030; and 86,962 acre feet in 2060. Corpus Christi is not projected to have a shortage of water supplies through the year 2060.

III. WATER SUPPLY SYSTEM DATA

A. Water Supply Sources

List all current water supply sources and the amounts authorized with each:

	Source	Amount Authorized	
Surface Water:	1) Lake Corpus Christi 2) Choke Canyon Reservoir	257,260 695,271	Acre-feet/yr Acre-feet/yr
Groundwater:	Aquifer Storage Recovery Groundwater Conservation District	Pending	Acre-feet/yr
Contracts:	1) Garwood Irrigation Company – Colorado River	35,000	Acre-feet/yr
	2) Lavaca Navidad River Authority – Lake Texana	41,840 12,000*	Acre-feet/yr Acre-feet/yr

* Contract with the Lavaca Navidad River Authority provides for 12,000 af/yr on an interruptible basis.

B. Treatment and Distribution System

1. Design daily capacity of system: ___167_________ MGD

2. Storage Capacity: Elevated _3.5__ MGD, Ground __70.1_ MGD

3. If surface water, do you recycle filter backwash to the head of the plant? Yes _X___ No ______. If yes, approximately ___6____ MGD.

4. Please attach a description of the water system. Include the number of treatment plants, wells, and storage tanks. If possible, include a sketch of the system layout.

Corpus Christi, Texas
Water Source Flow Chart for 2008
(Million Gallons)

CHOKE CANYON RESERVOIR

LAKE CORPUS CHRISTI

LAKE TEXANA

Water Drawn from Choke Canyon/ Lake Corpus Christi Reservoir System	
Alice	2,245
Beeville	982
Mathis	250
Celanese	470
Flint Hills Resources	1,613
San Patricio MWD	3,509
Corpus Christi	13,459
Total	22,113

Water Drawn from Lake Texana	
San Patricio MWD Raw	3,099
Corpus Christi	14,008
Total	16,904

O. N. Stevens Water Treatment Plant	
Raw Water Entering O. N. Stevens WTP	27,467
Treated Water Leaving O. N. Stevens WTP	23,979
UBO Billed Water Consumption	24,948

Treated Water Customers	
Naval Air Station	342
NCWCID #4	474
San Patricio MWD-Treated	1,072
South Texas Water Authority	507
Violet Water Supply Corp.	58
Corpus Christi	22,894
Total	24,948

IV. WASTEWATER SYSTEM DATA

A. Wastewater System Data

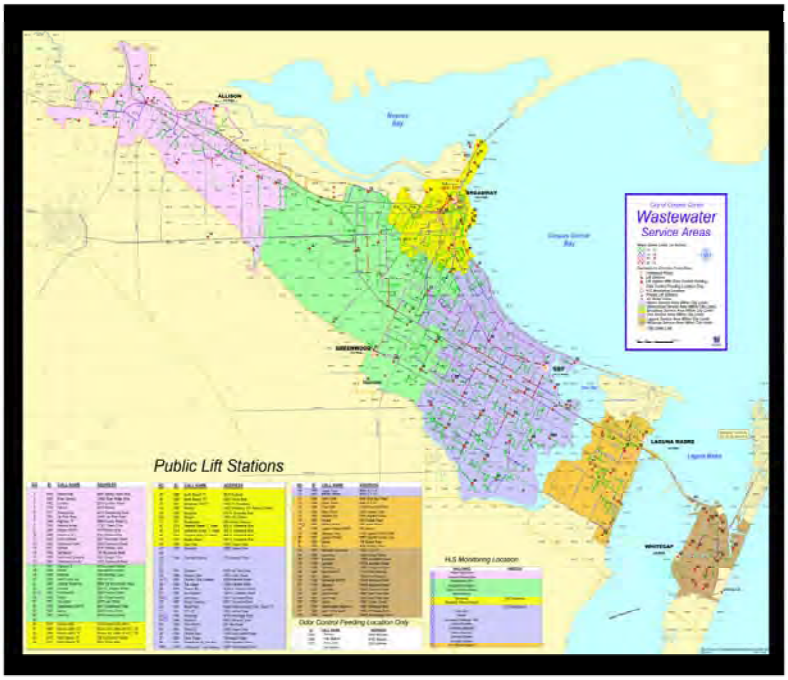
1. Design capacity of wastewater treatment plant(s): 44.7 MGD

2. Is treated effluent used for irrigation on-site Yes , off-site Yes , plant wash down Yes , or chlorination/dechlorination Yes
   If yes, approximately 26,248,000 gallons per month.

3. Briefly describe the wastewater system(s) of the area serviced by the water utility. Describe how treated wastewater is disposed of. Where applicable, identify treatment plant(s) with the TCEQ name and number, the operator, owner, and, if wastewater is discharged, the receiving stream. If possible, attach a sketch or map which locates the plant(s) and discharge points or disposal sites.

4. CITY OF CORPUS CHRISTI WASTEWATER TREATMENT PLANTS

PLANT	ADDRESS	TPDES PERMIT	RECEIVING STREAM	PROCESS TYPE	DESIGN CAPACITY
ALLISON	4101 ALLISON DR. CORPUS CHRISTI, TX 78410	WQ0010401-006 TX0047082	NUECES RIVER SEGMENT 2482	ACTIVATED SLUDGE COMPLETE MIX	5 MGD
BROADWAY	1402 W BROADWAY CORPUS CHRISTI, TX 78401	WQ0010401-005 TX0047066	CC INNER HARBOR SEGMENT2484	TRICKLING FILTER	10 MGD
GREENWOOD	6541 GREENWOOD CORPUS CHRISTI, TX 78415	WQ0010401-003 TX0047074	OSO CREEK SEGMENT 2485	ACTIVATED SLUDGE COMPLETE MIX	8 MGD
LAGUNA MADRE	201 JESTER CORPUS CHRISTI, TX 78418	WQ0010401-008 TX0047104	LAGUNA MADRE SEGMENT 2491	ACTIVATED SLUDGE CONTACT STABILIZATION	3 MGD
OSO	601 NILE DR. CORPUS CHRISTI, TX 78412	TX0047058	WQ0010401-004 SEGMENT 2485	OSO BAY CONTACT STABILIZATION	ACTIVATED SLUDGE
WHITECAP	13409 WHITECAP BLVD. CORPUS CHRISTI, TX 78418	WQ0010401-009 TX0047121	LAGUNA MADRE SEGMENT 2491	ACTIVATED SLUDGE COMPLETE MIX	2.5 MGD



B. Wastewater Data for Service Area

1. Percent of water service area served by wastewater system: 99 %
2. Monthly volume treated for previous three years (in 1,000 gallons):

Year	2006	2007	2008
January	25,075	32,298	27,251
February	25,653	27,453	26,462
March	27,006	29,129	27,290
April	26,750	28,172	27,865
May	27,816	28,645	27,569
June	29,556	29,066	27,158
July	32,214	45,158	31,183
August	28,015	31,691	30,083
September	31,028	32,260	28,838
October	30,984	30,239	27,267
November	27,469	29,018	26,299
December	26,362	26,660	25,921
Total	337,928	369,789	333,186

2006 IRRIGATION FLOWS MILLION GALLONS						
	OSO PLANT		GREENWOOD PLANT		WHITECAP PLANT	
MONTH	PHARAOH VALLEY	OSO	GABE LOZANO	GRANDSTANDS	PADRE ISLES	TOTAL
JANUARY	1.292	1.629	0.104	0.252	4.689	7.966
FEBRUARY	2.099	3.353	5.351	0.070	7.738	18.611
MARCH	2.452	4.724	8.755	0.288	8.234	24.453
APRIL	4.846	6.472	3.785	0.177	14.277	29.558
MAY	2.731	7.177	7.090	0.722	21.597	39.317
JUNE	4.298	5.095	7.471	0.239	23.082	40.185
JULY	2.333	3.157	1.414	0.077	12.746	19.727
AUGUST	6.118	10.596	13.057	0.411	22.943	53.125
SEPTEMBER	0.861	6.204	5.374	0.160	16.758	29.357
OCTOBER	0.484	2.545	5.157	0.000	6.194	14.380
NOVEMBER	2.519	6.612	8.574	0.327	12.183	30.215
DECEMBER	0.133	1.742	4.152	0.126	4.997	11.150
TOTAL	30.166	59.305	70.284	2.850	155.438	318.043

2007 IRRIGATION FLOWS MILLION GALLONS						
	OSO PLANT		GREENWOOD PLANT		WHITECAP PLANT	
MONTH	PHARAOH VALLEY	OSO	GABE LOZANO	GRANDSTANDS	PADRE ISLES	TOTAL
JANUARY	0.000	0.793	0.000	0.000	0.000	0.793
FEBRUARY	0.000	1.565	1.752	0.129	1.029	4.475
MARCH	2.039	7.030	7.208	0.165	5.455	21.897
APRIL	2.455	10.871	5.098	0.046	6.715	25.185
MAY	3.308	8.303	8.510	0.328	11.235	31.684
JUNE	1.950	6.365	8.818	0.119	13.913	31.165
JULY	0.716	2.295	2.212	0.012	0.982	6.217
AUGUST	1.235	3.982	9.992	0.000	5.452	20.661
SEPTEMBER	2.932	4.623	10.057	0.005	7.572	25.189
OCTOBER	1.569	2.091	4.905	0.002	6.187	14.754
NOVEMBER	1.780	4.728	6.495	0.114	20.514	33.631
DECEMBER	1.850	3.374	9.383	0.203	12.598	27.408
TOTAL	19.834	56.020	74.430	1.122	91.652	243.058

2008 IRRIGATION FLOWS MILLION GALLONS						
MONTH	OSO PLANT		GREENWOOD PLANT		WHITECAP PLANT	TOTAL
	PHARAOH VALLEY	OSO	GABE LOZANO	GRANDSTANDS	PADRE ISLES	
JANUARY	0.713	1.419	7.351	0.066	5.638	15.187
FEBRUARY	1.583	2.438	8.381	0.125	8.853	21.380
MARCH	1.133	3.817	4.118	0.114	6.650	15.832
APRIL	2.560	5.767	11.527	0.317	9.562	29.733
MAY	2.028	8.039	4.681	0.277	7.929	22.954
JUNE	5.537	10.466	13.518	0.050	24.001	53.572
JULY	1.427	4.373	1.670	0.060	20.200	27.730
AUGUST	1.854	4.646	5.978	0.008	25.644	38.130
SEPTEMBER	1.964	4.400	0.000	0.000	25.831	32.195
OCTOBER	2.738	5.938	0.000	0.090	15.162	23.928
NOVEMBER	1.537	4.584	0.000	0.063	14.720	20.904
DECEMBER	1.495	3.699	0.000	0.053	8.180	13.427
TOTAL	24.569	59.586	57.224	1.223	172.370	314.972

APPENDIX B

ARTICLE XII. WATER CONSERVATION

Sec. 55-150. Scope, purpose and authorization.

(a) *Scope.* There is hereby established a City of Corpus Christi Water Conservation Plan.

(b) *Declaration of policy.*

(1) It is hereby declared that the general welfare requires that the water resources available to the city be put to the maximum beneficial use to the extent to which they are capable, and that the waste or unreasonable use, or unreasonable method of use of water be prevented, and the conservation of such water is to be extended with a view to the reasonable and beneficial use thereof in the interests of the people of the area served by the city's water resources and for the public welfare.

(2) In making decisions under this article concerning the allocation of water between conflicting interests, highest priority will be given to allocation necessary to support human life and health; i.e., the minimum amount of water necessary for drinking, prevention of disease, and the like. Second highest priority will be given to allocations, which will result in the least loss of employment to persons whose income is essential to their families.

(c) *Authorization.* The City Manager, or his designee, upon the recommendation of the Assistant City Manager, Public Works and Utilities, is hereby authorized and directed to implement the applicable provisions of this article upon their determination that such implementation is necessary to protect the public welfare and safety.

Sec. 55-151. Water conservation and drought contingency plan.

(a) The Water Conservation and Drought Contingency Plan for Corpus Christi, dated August 24, 1999, a true copy of which is on file in the office of the city secretary, is adopted, and shall be followed in matters concerning water conservation, drought management, and water supply enhancement programs.

(b) The city manager shall pursue a water well leasing program to obtain and maintain sufficient leased acreage to produce at least sixty million (60,000,000) gallons per day of groundwater to supplement surface supplies, as needed.

Sec. 55-152. Automatic water conservation measures.

(a) When combined storage in the Choke Canyon/Lake Corpus Christi Reservoir System (Reservoir System Storage) falls below 50% of Reservoir System Storage capacity:

(1) The City Manager shall issue a public notice informing water users of the Corpus Christi water supply region of voluntary conservation measures that are requested immediately and required drought management measures that must be taken if the amount of water in the reservoirs falls to under 40% of Reservoir System Storage capacity and when the amount of water in the reservoirs falls to under 30% of Reservoir System Storage capacity.

(2) No person may:

A. Allow water to run off yards or plants into gutters or streets.

B. Permit or maintain defective plumbing in a home, business establishment or any location where water is used on the premises. Defective plumbing includes out-of-repair water closets, underground leaks, defective or leaking faucets and taps.

C. Allow water to flow constantly through a tap, hydrant, valve, or otherwise by any user of water connected to the City system.

(b) To the extent of the City's legal authority, the City Manager shall require the City's wholesale customers to issue public notice advising their water customers of voluntary conservation measures that are requested immediately and required drought management measures that must be taken if the amount of water in the reservoirs falls to under 40% of the Reservoir System Storage capacity and when the amount of water in the reservoirs falls to under 30% of the Reservoir System Storage capacity.

(c) When combined storage in the Choke Canyon/Lake Corpus Christi Reservoir System (Reservoir System Storage) falls below 40% of Reservoir System Storage capacity, the City Manager shall publish a public notice in a daily newspaper of general circulation in Nueces County when the City Manager determines that the amount of water in storage has fallen below 40% of Reservoir System Storage capacity. From the date of publication of the notice until the date the notice is rescinded by the City Manager, no person may use water for irrigation of vegetation between the hours or 10:00 a.m. and 6:00 p.m.

(d) It shall be a defense to prosecution of a violation under subsection (c) of this section that the use of water was for one of the following purposes and the City Manager had specifically authorized the use of water for the purpose on the date of the violation:

(1) The water was used, at the minimum rate necessary, for the establishment and maintenance of commercial nursery stock and applied using:

a. A hand held hose equipped with a positive shutoff nozzle.

b. A sprinkler system.

c. A drip irrigation system equipped with an automatic shutoff device. A soaker hose, which does not spray water into the air, equipped with an automatic shutoff device.

e. A root feeder equipped with an automatic shutoff device.

f. A hand held bucket or watering can.

(2) Wastewater treatment plant effluent, graywater, well water (which is not mixed with any water from the City's water supply), or other water not obtained from the City water system was used, if a permit was obtained from the City Manager and a sign was posted stating that the water used for irrigation is wastewater effluent, graywater, water from a permitted private well, or water that was not obtained from the City's water supply.

(3) The water was used for short periods of time for testing related to the installation, maintenance, and repair of sprinkler systems.

(4) The water was used for irrigation of vegetation on a large parcel of land or unique botanical institution, such as the Corpus Christi Botanical Gardens and Blucher Nature Center, in conformance with a special watering plan, specifically approved for that parcel by an official designated by the City Manager. The official approving any special watering plan shall ensure that the plan achieves similar water conservation goals to the mandatory conservation measures applicable to other customers under this subsection.

(e) When combined storage in the Choke Canyon/Lake Corpus Christi Reservoir System (Reservoir System Storage) falls below 30% of Reservoir System Storage capacity, the City Manager shall publish notice in a daily newspaper of general circulation in Nueces County when the City Manager determines that the amount of water in reservoirs has fallen below 30% Reservoir System storage capacity and publish a lawn watering plan that allows customers to water lawns no more often than every five days, while maintaining the prohibition on using water for irrigation between 10:00 a.m. to 6:00 p.m.

(f) From the date of publication of the notice and plan, until the date the notice and plan are rescinded by the City Manager, no person may use water for irrigation of a lawn, except on a day lawn water is authorized under the lawn watering plan.

(g) It shall be a defense to prosecution of a violation under subsection (f) of this section that the use of water was for one of the following purposes and the City Manager had specifically authorized the use of water for the purpose on the date of the violation:

(1) The water was used, other than during the hours between 10:00 a.m. and 6:00 p.m., for irrigation, at the minimum rate necessary, for the establishment of newly planted lawns within thirty (30) days of planting.

(2) Wastewater treatment plant effluent, graywater, well water (which is not mixed with any water from the City's water supply), or other water not obtained from the City water system was used, if a permit is obtained from the City Manager and a sign is posted stating that the water used for irrigation is wastewater effluent, graywater, water from a permitted private well, or water that was not obtained from the City's water supply.

(3) The water was used, other than during the hours between 10:00 a.m. and 6:00 p.m., for irrigation, at the minimum rate necessary, for maintenance of golf course greens and tee boxes.

(4) The water was used for irrigation on a large parcel of land or unique botanical institution, such as the Corpus Christi Botanical Gardens and Blucher Nature Center, in conformance with a special watering plan, specifically approved for that parcel by an official designated by the City Manager. The official approving any special watering plan shall ensure that the plan achieves similar water conservation goals to the mandatory conservation measures applicable to other customers under this subsection.

(h) This section shall only be effective at any time the City is entitled, under to Order of the Texas Natural Resource Conservation Commission under Certificate of Adjudication No. 21-3214, to (1) reduce targeted inflows of water to Nueces Bay to 1200 acre feet when Reservoir System Storage falls below 40% of capacity, and (2) suspend targeted inflows below 30% of capacity.

(i) Copies of the notices published by the City Manager under this section shall be filed with the City Secretary. The City Secretary shall send a copy of the notice to each member of the City Council and a certified copy of the notice to the judges of the Municipal Court.

(j) Courts shall take judicial notice of the notices published by the City Manager under this section, and the notices may be read into evidence without pleading or proof.

Sec. 55-153. Water conservation measures.

(a) The City Manager shall develop guidelines, based upon the recommendations of the Water Superintendent and Assistant City Manager for Public Works and Utilities, which shall set forth the criteria for determining when particular water conservation measures should be implemented and terminated based on water available in the City's reservoir system, other available water resources, the needs of customers, human life and health concerns, the effect water conservation measures on the jobs of residents of the area, and the effect on the long term viability of local businesses and industries.

(1) The guidelines shall be updated when, in the opinion of the City Manager, the conditions of the water system have changed so as to necessitate such update.

(2) The guidelines shall be published and filed in the office of the City Secretary.

(b) The City Manager, in the exercise of the City Manager's discretion may implement any or all of the water conservation measures the City Manager deems necessary at any particular time.

(1) The City Manager shall notify the members of the City Council before implementing any measures under this section.

(2) The City Manager shall publish notice in a daily newspaper of general circulation in Nueces County when each water conservation measure takes effect.

(3) Copies of the notices published by the City Manager under this section shall be filed with the City Secretary. The City Secretary shall send a copy of the notice to each member of the City Council and a certified copy of the notice to the judges of the Municipal Court.

(c) The use or withdrawal of water from the water supply system of the city for the following purposes or uses is hereby regulated during any period of water shortage commencing with the promulgation and implementation of water conservation guidelines by the City Manager and continuing until such water conservation measures are no longer deemed necessary by the City Manager in accordance with the guidelines.

(d) The following water conservation measures may be included in the implementation guidelines developed by the City Manager and implemented by the City Manager.

(1) Request customers of the water system of the City of Corpus Christi through the news media announcements and utility bill inserts to voluntarily conserve and limit their use of water and notify them that they must comply with the implemented restrictions on the use of water for irrigation of vegetation.

(2) Place municipal operations on mandatory conservation.

(3) Prohibit the use of water for irrigation of lawns or lawns and other vegetation between the hours of 10:00 a.m. and 6:00 p.m.

(4) Restrict the use of water for irrigation of lawns or lawns and other vegetation, other than between the hours of 10:00 a.m. and 6:00 p.m., to specific dates or frequencies based on street numbers, as may be designated by the city manager.

a. However, any person may raise as a defense to prosecution for violation of this section the fact that the use of water for the following purposes had been specifically authorized by the City Manager, if the City Manager had actually authorized the use of water for that purpose on the date of the violation:

1. The water was used, other than during the hours between 10:00 a.m. and 6:00 p.m., for irrigation, at the minimum rate necessary, for the establishment and maintenance of flower gardens, vegetable gardens, fruit gardens, trees, and shrubs, or plants in containers, and applied using:

i. A hand held hose equipped with a positive shutoff nozzle.

ii. A drip irrigation system equipped with an automatic shutoff device.

iii. A soaker hose, which does not spray water into the air, equipped with an automatic shutoff device.

iv. A root feeder equipped with an automatic shutoff device.

v. A hand held bucket or watering can.

2. The water was used at any hour for irrigation, at the minimum rate necessary, for the establishment and maintenance of commercial nursery stock and applied using:

i. A hand held hose equipped with a positive shutoff nozzle.

ii. A sprinkler system.

iii. A drip irrigation system equipped with an automatic shutoff device.

iv. A soaker hose, which does not spray water into the air, equipped with an automatic shutoff device.

v. A root feeder equipped with an automatic shutoff device.

vi. A hand held bucket or watering can.

3. The water was used, other than during the hours between 10:00 am. and 6:00 p.m., for irrigation, at the minimum rate necessary, for the establishment of newly planted lawns and plant materials within thirty (30) days of planting. Water used for this purpose may be applied by any means.

4. Wastewater treatment plant effluent, graywater, well water (which is not mixed with any water from the City's water supply), or other water not obtained from the City water system was used, may be used at any hour, if a permit is obtained from the City Manager and a sign is posted stating that the water used for irrigation is

wastewater effluent, graywater, water from a permitted private well, or water that was not obtained from the City's water supply.

5. The water was used, other than during the hours between 10:00 a.m. and 6:00 p.m., for irrigation, at the minimum rate necessary, for maintenance, of golf course greens and tee boxes.

6. The water was used at any hour for short periods of time for testing related to the installation, maintenance, and repair of sprinkler systems.

7. The water was used for irrigation of vegetation on a large parcel of land or unique botanical institutions, such as the Corpus Christi Botanical Gardens and Blucher Nature Center, in conformance with a special watering plan, specifically approved for that parcel by an official designated by the City Manager. The official approving any special watering plan shall ensure that the plan achieves similar water conservation goals to the mandatory conservation measures applicable to other customers under this section.

b. In the event the premises have no number, application shall be made to the city building official for the assignment of a number to such premises and such premises shall thereafter bear the number so assigned. Such day or days may be changed by further directive of the city manager. In the event any premises do not have a number at the time of the occurrence of any violation under this article, the premises shall be in the category of premises with street numbers ending in zero. No person or customer shall cause or permit water to run or waste in any gutter or otherwise.

(5) Restrict the use of water for watering foundations during specific hours, specific dates, or specific frequencies based on street numbers, as may be designated by the city manager.

(6) Prohibit the washing of automobiles, trucks, trailers, boats, airplanes and any other type of mobile equipment, except that individuals and filling stations may wash cars or boats if they use a bucket, pail, or other receptacles not larger than of 5 gallon capacity; however, an individual or filling station, before or after such washing, shall be permitted to rinse the car or boat off with a hose using only a reasonable amount of water in so doing. Commercial or automatic car wash establishment shall use minimum practical water settings.

(7) Prohibit the washing of building exteriors and interiors, trailers, trailer houses and railroad cars with potable water, except by a professional power washing contractor or that in the interest of public health the Director of Public Health may permit limited use of the water as the case may be, including allowing the use of water for the removal of graffiti.

(8) Restrict the use of water for recreational uses, such as playing in sprinklers, except during times when the use of water for irrigating lawns is permitted, operating water toys such as "slip & slides", or operating sprayers on pool slides.

(9) Restrict the use of fire hydrants for any purpose other than firefighting; except that the City Manager may permit the use of metered fire hydrant water by the City or by commercial operators using jet rodding equipment to clear and clean sanitary and storm sewers.

(10) Prohibit the use of potable water in ornamental fountains or in artificial waterfalls is prohibited where the water is not reused or recirculated in any manner.

(11) Prohibit the use of potable water to wash down any sidewalks, walkways, driveways, parking lots, tennis courts, or other hard-surfaced area, or building or structure, except by a professional power washing contractor.

(12) Prohibit the use of potable water for dust control.

(13) Prohibit the use of potable water by a golf course to irrigate any portion of its grounds, except those areas designated as tees and greens may be watered between the hours of 6 a.m. and 10 a.m. on Mondays, Wednesdays, Fridays, and Sundays.

(14) Prohibit the use of water to serve a customer in a restaurant, unless requested by the customer.

(15) Prohibit new service connections to the City's water system where some other source independent of the City's water system is existing and in use at the time this element of Condition III is implemented.

(16) Reserved.

(17) Impose mandatory limit of normal water use by customers without use penalty, in amounts as determined by the City Manager in accordance with guidelines established by the City Council.

> a. In connection with the enforcement of this subdivision, the City Manager shall request the City Council establish a maximum limit beyond which water service will be terminated.
>
> b. Concurrently with the implementation of this conservation measure, the City Manager shall request the appointment of an Allocation and Review Committee by City Council, for the purpose of reviewing water conservation policies and establishing exemptions.

(18) Prohibit the use of potable water (water obtained from the City's water utility) for scenic and recreational ponds and lakes.

(19) Prohibit the use of potable water to put new agricultural land into production.

(20) Deny applications for new, additional, further expanded, or increased-in-size water service connections, meters, service lines, pipeline extensions, mains, or other water service facilities of any kind, except as approved by the Allocation and Review Committee.

(21) Establish allocations of water use to industrial and commercial customers in amounts, after consultation with the Allocation and Review Committee.

(22) Establish the maximum monthly use for a residential customer with revised rate schedules and penalties approved by the City Council, based on recommendations by the Allocation and Review Committee.

(e) The City Council and City Manager shall take any additional actions deemed necessary to meet the conditions resulting from the emergency.

(f) Any use of water in violation of this Section or any measure implemented by the City Manager under this Section is deemed a waste of water.

(g) No person may use water in violation of this Section or any measure implemented by the City Manager under this Section.

(h) Proof that a particular premises has a water meter connection registered in the name of the defendant named in the complaint, shall constitute in evidence a prima facie presumption that the person in whose name the water connection was registered was the person who permitted or caused the act of waste charged to occur on the premises.

(i) Courts shall take judicial notice of the notices published by the City Manager under this section, and the notices may be read into evidence without pleading or proof.

Sec. 55-154. Allocation and Review Committee, establishment, composition, powers, and duties.

(a) The Allocation and Review Committee shall be composed of six (6) members, the Assistant City Manager for Public Works and Utilities, the Director of Public Health, a representative of industry, a representative of business and commerce, a homemaker-citizen, and a citizen of the city.

(1) The industry, business, homemaker, and citizen members shall be appointed by the Mayor and Council and shall serve at the pleasure of the City Council.

(2) In addition, six (6) alternate members shall be appointed. Each alternate shall serve in place of his/her respective regular Committee member whenever that regular Committee member is unavailable to participate.

(3) The City Manager shall appoint alternates for the Assistant City Manger for Public Works and Utilities and the Director of Public Health.

(4) The Mayor and Council shall appoint alternates for the industry, business, homemaker, and citizen members of the Committee. Alternates appointed shall have qualifications similar to those of their respective regular member.

(5) An alternate serving in place of a regular Committee member shall exercise the same powers and have the same duties as a regular member.

(b) The Committee shall consider requests of water users for special consideration to be given as to their respective particular circumstances and the Committee shall hear and decide such requests and is hereby authorized to, in special cases, grant such variance from the terms of this plan as will not be contrary to the public interest, where, owing to special conditions, a literal enforcement of the provisions of this plan will result in unnecessary hardship, and so that the spirit of this plan shall be observed and substantial justice done.

(1) Should a permit for special exception be granted by such Committee, it shall be in effect from the time of granting; provided, that the permit is prominently posted on the premises within two (2) feet of the street number located on the premises.

(2) Should protest be received after the granting of any such special permit, the Committee shall consider the revocation of such permit and shall reconsider the granting of such permit at a public hearing, notice of which shall have been given at least one (1) day prior to the holding of such hearing.

(2) After the conclusion of such hearing, the Committee shall take such action by way of revocation of such permit, or refusal to revoke the same, or modification of such permit as the Committee may deem proper under the circumstances.

Sec. 55-155. Violations, penalties, and enforcement.

(a) Any person that intentionally, knowingly, recklessly, or with criminal negligence violates any provision of this Article shall be deemed guilty of a misdemeanor and, upon conviction, shall, upon conviction, be guilty of a misdemeanor, punishable by a fine of not more than five hundred dollars ($500.00) per violation per day.

(b) The commission of a violation of each provision, and each separate violation thereof, shall be deemed a separate offense, in and upon conviction thereof, shall be fined as hereinabove provided.

(c) If any person or a second person in the same household or premises, is found guilty of a second violation of this plan, the Water Superintendent shall be authorized to discontinue water service to the premises where such violation occurs.

(d) Any police officer, or other city employee designated by the city manager, may issue a citation to a person he reasonably believes to be in violation of this article.

(e) The citation shall be prepared in duplicate and shall contain the name and address of the alleged violator, if known, the offense charged, and shall direct him to appear in the Corpus Christi Municipal Court no sooner than ten (10) days and no later than twenty one (21) days of service of the citation.

(1) The alleged violator shall be requested to sign the citation, and shall be served a copy of the citation.

(2) Service of the citation shall be complete upon the attempt to give it to the alleged violator, to an agent or employee of a violator, or to a person over fourteen (14) years of age who is a member of the violator's immediate family or is a resident at the violator's residence.

(f) The alleged violator shall appear in municipal court to make his plea no sooner than ten (10) days and no later than twenty one (21) days of service of the citation, and failure to so appear shall be a violation of this article.

(g) A police officer may arrest for any offense under this article where permitted by state arrest law.

(h) Cases filed under this section shall be expedited and given preferential setting in municipal court before all other cases.

(i) A person in apparent control of the property where the violation occurs or originates shall be presumed to be the violator, and proof of facts showing apparent control by such person of the premises and proof that the violation occurred on the premises shall constitute prima facie evidence that said person committed the violation, but said person shall have the right to show that he did not commit the violation.

(j) Any person whose name is on file with the Utilities Billing Office as the customer on the water account for the property where the violation occurs or originates shall be presumed to be the violator, and proof that the violation occurred on said premises shall constitute prima facie evidence that the customer committed the violation, but said customer shall have the right to show that he did not commit the violation.

(k) Parents shall be presumed to be responsible for violations of their minor children, and proof that a child committed a violation on property within the parent' s control shall constitute prima facie evidence that said parent committed the violation, but said parent may be excused if he proves that he had previously directed the child not to use the water as it was used in the violation and that the parent could not have reasonably known of the violation.

(l) If any person fails to respond to a citation or summons issued for a violation of this Article within the time allowed, upon receipt of notice from the Director or a judge of the Municipal Courts, the Water Superintendent is authorized to discontinue water service to the premises where such violation occurs.

Sec. 55-156. Reserved (Proposed excess usage charge).

Sec. 55-157. Surcharges and termination of service.

(a) *General.*

(1) This section is provided to implement and enforce the mandatory limits on water usage called for in Condition III and IV of this drought contingency plan.

(2) The surcharges established herein are solely intended to regulate and deter the use of water during a period of serious drought in order to achieve necessary water conservation.

(3) The City Council expressly finds that the drought poses a serious and immediate threat to the public and economic health and general welfare of this community, and that the surcharges and other measures adopted herein are essential to protect said public health and welfare.

(4) This section, and the surcharges and measures adopted herein are purely an exercise of the City's regulatory and police power, and the surcharges and connection fees herein are in no way to be considered rates for production of revenue.

(5) All monies collected from surcharges shall be placed in a special fund to be used for research and development of alternative or expanded water sources for the City of Corpus Christi and its water customers.

(b) *Residential water customers, who are not billed through a master water meter.*

(1) Residential water customers, who are billed through a master water meter, shall pay the following surcharges:

a. $5.00 for the first 1,000 gallons over allocation.

b. $8.00 for the second 1,000 gallons over allocation.

c. $16.00 for the third 1,000 gallons over allocation.

d. $40.00 for each additional 1,000 gallons over allocation.

e. The surcharges shall be cumulative.

(2) When the combined reservoir capacity is less than 20% of total capacity, the allocation to residential customers shall be as follows:

Persons Per Household	Gallons Per Month
1 or 2	6,000
3 or 4	7,000
5 or 6	8,000
7 or 8	9,000
9 or 10	10,000
11 or more	12,000

(3) In this subsection:

"Household" means the residential premises served by the customer's meter.

"Persons per household" includes only those persons currently physically residing at the premises and expected to reside there for the entire billing period.

(4) Size of households.

a. It shall be assumed that a particular customer's household is comprised of two (2) persons unless the customer notifies the City of a greater number, on a form prescribed by the City Manager.

1. The City Manager shall give his best effort to see that such forms are mailed to every residential customer.

2. If, however, a customer does not receive such a form, it shall be the customer's responsibility to go to the City's Utility Billing Office and sign the form if the customer desires to claim more than two (2) persons.

3. New customers may claim more persons at the time of applying for their water service on the form prescribed by the City Manager.

4. When the number of persons in a household increases so as to place the customer in a different category, the customer may notify the City of the change on such form, and the change will be implemented in the next practicable billing period.

5. If the number of persons in a household is reduced, the customer shall notify the City in writing within two days.

6. In prescribing the method for claiming more than two (2) persons, the City Manager shall adopt methods to insure the accuracy of the claim.

7. Any person who knowingly, recklessly, or with criminal negligence falsely reports the number of persons in a household or fails to timely notify the City of a reduction in the number of persons in a household shall be fined not less than $200.

(c) *Residential customers who are billed from a master water meter.*

(1) When the combined reservoir capacity is less than 20% of total capacity, a residential customer billed from a master water meter, which jointly measures water to multiple permanent residential dwelling units (for example, apartments, mobile homes), shall be allocated 6,000 gallons for each dwelling unit.

(2) Number of dwelling units assigned to a master water meter.

a. It shall be assumed that such a customer's meter serves two dwelling units unless the customer notifies the City of a greater number, on a form prescribed by the City Manager.

b. The City Manager shall give his best effort to see that such forms are mailed to every such customer.

c. If, however, such customer does not receive such a form, it shall be the customer's responsibility to go to the City's Utility Billing Office and sign the form if the customer desires to claim more than two dwellings.

d. A dwelling unit may be claimed under this provision whether it is occupied or not. New customers may claim more dwelling units at the time of applying for their water service on the form prescribed by the City Manager.

e. If the number of dwelling units served by a master meter is reduced, the customer shall notify the City in writing within two days.

f. In prescribing the method for claiming more than two dwelling units, the City Manager shall adopt methods to insure the accuracy of the claim.

g. Any person who knowingly, recklessly, or with criminal negligence falsely reports the number of dwelling units on a meter or fails to notify the City of a reduction in the number of dwelling units on a meter shall be fined not less than $200.

(3) In this subsection, "person" includes individuals, partnerships, associations, corporations, and all other legal entities.

(4) Residential customers billed from a master meter under this provision shall pay the following monthly surcharges:

1. $5.00 for each 1,000 gallons over allocation up through 1,000 gallons for each dwelling unit.

2. $8.00, thereafter, for each additional 1,000 gallons over allocation up through a second 1,000 gallons for each dwelling unit.

3. $16.00, thereafter, for each additional 1,000 gallons over allocation up through a third 1,000 gallons for each dwelling unit.

4. $40.00, thereafter, for each additional 1,000 gallons over allocation.

Examples of applications of the surcharge formula are as follows:

Apartment complex contains 100 units. Allocation is 600,000 gallons (hypothetically):

Usage is 610,000 gallons. Surcharge is $50.00, computed as follows: 10 thousands of gallons at $5.00 each.

Usage is 710,000 gallons. Surcharge is $580, computed as follows: 100 thousands of gallons at $5.00 each plus 10 thousands of gallons at $8.00 each.

Usage is 910,000 gallons. Surcharge is $3,300, computed as follows: 100 thousands of gallons at $5.00 each, plus 100 thousands of gallons at $8.00 each, plus 100 thousands of gallons at $16.00 each, plus 10 thousands of gallons at $40.00 each.

(d) *Nonresidential commercial customer, other than an industrial customer, who uses water for processing.*

(1) A monthly water usage allocation shall be established by the City Manager or his designee for each nonresidential commercial customer, other than an industrial customer, who uses water for processing.

(2) Method of establishing allocation.

a. When the combined reservoir capacity is less than 20% of total capacity, the nonresidential commercial customer's allocation shall be approximately 75 percent of the customer's usage for the corresponding month's billing period during previous 12 months.

b. If the customer's billing history is shorter than 12 months, the monthly average for the period for which there is a record shall be used for any monthly period for which no history exists.

c. Provided, however, a customer, 75 percent of whose monthly usage is less than 6,000 gallons, shall be allocated 6,000 gallons.

d. The City Manager shall give his best effort to see that notice of each nonresidential commercial customer's allocation is mailed to such customer.

e. If, however, the customer does not receive such notice, it shall be the customer's responsibility to contact the City' Utilities Billing Office to determine the allocation, and the allocation shall be fully effective notwithstanding lack of receipt of written notice.

f. Upon request of the customer or at the initiative of the City Manager, the allocation may be reduced or increased,

(1) if the designated period does not accurately reflect the customer's normal water usage,

(2) if one nonresidential customer agrees to transfer part of its allocation to another nonresidential customer, or

(3) if other objective evidence demonstrates that the designated allocation is inaccurate under present conditions.

g. A customer may appeal an allocation established hereunder to the Water Allocation and Review Committee on grounds of unnecessary hardship.

(e) Industrial customers, who use water for processing.

(1) A monthly water usage allocation shall be established by the City Manager or his designee for each an industrial customer, which uses water for processing (e.g., an industrial customer).

(2) Method of establishing allocation.

a. When the combined reservoir capacity is less than 20% of total capacity, the industrial customer allocation shall be 90 percent of the customer' s water usage baseline.

b. Three months after the initial imposition of the allocation for industrial customers, the industrial customer's allocation shall be further reduced to 85% of the customer's water usage baseline.

c. The customer's water usage baseline will be computed on the average water usage for the thirty six month period ending prior to the date of implementation of Condition II.

d. If the customer's billing history is shorter than 36 months, the monthly average for the period for which there is a record shall be used for any monthly period for which no history exists.

e. The City Manager shall give his best effort to see that notice of each industrial customer's allocation is mailed to such customer.

f. If, however, the customer does not receive such notice, it shall be the customer's responsibility to contact the City Utilities Billing Office to determine the allocation, and the allocation shall be fully effective notwithstanding lack of receipt of written notice.

g. Upon request of the customer or at the initiative of the City Manager, the allocation may be reduced or increased, if:

1. The designated period does not accurately reflect the customer's normal water usage because customer had shutdown a major processing unit for overhaul during the period.

2. The customer has added or is in the process of adding significant additional processing capacity. Only additional capacity that was under contract and publicly announced prior to the implementation of Condition II should be considered.

3. The customer has shutdown or significantly reduced the production of a major processing unit.

4. The customer has previously implemented significant permanent water conservation measures.

5. The customer agrees to transfer part of its allocation to another industrial customer.

6. Other objective evidence demonstrates that the designated allocation is inaccurate under present conditions.

h. A customer may appeal an allocation established under this provision to the Water Allocation and Review Committee on grounds of unnecessary hardship.

(f) Nonresidential commercial and industrial customers shall pay the following surcharges:

(1) Customers whose allocation is 6,000 gallons through 20,000 gallons per month:

a. $5.00 per 1,000 gallons for the first 1,000 gallons over allocation.

b. $8.00 per 1,000 gallons for the second 1,000 gallons over allocation.

c. $16.00 per 1,000 gallons for the third 1,000 gallons over allocation.

d. $40.00 for each additional 1,000 gallons over allocation.

e. The surcharges shall be cumulative.

2. Customers whose allocation is 21,000 gallons per month or more:

a. One times the block rate for each 1,000 gallons in excess of the allocation up through 5 percent above allocation.

b. Three times the block rate for each 1,000 gallons from 5 percent through 10 percent above allocation.

c. Five times the block rate for each 1,000 gallons from 10 percent through 15 percent above allocation.

d. Ten times the block rate for each 1,000 gallons more than 15 percent above allocation.

e. The surcharges shall be cumulative.

f. As used herein, "block rate" means the charge to the customer per 1,000 gallons at the regular water rate schedule at the level of the customer's allocation.

(g) *Nonresidential customer is billed from a master meter*.

(1) When a nonresidential customer is billed from a master meter which jointly measures water to multiple residential dwelling units (for example: apartments, mobile homes), the customer may pass along any surcharges assessed under this plan to the tenants or occupants, provided that:

a. The customer notifies each tenant in writing:

1. That the surcharge will be passed along.

2. How the surcharge will be apportioned.

3. That the landlord must be notified immediately of any plumbing leaks.

4. Of methods to conserve water (which shall be obtained from the City).

b. The customer diligently maintains the plumbing system to prevent leaks.

c. The customer installs water saving devices and measures (ideas for which are available from the City) to the extent reasonable and practical under the circumstances.

d. The surcharge shall be passed along, where permissible, to dwelling units in proportion to the rent or price charged for each dwelling unit.

(h) Water service to the customer may be terminated under the following conditions:

(1) Monthly residential water usage exceeds allocation by 4,000 gallons or more two or more times (which need not be consecutive months).

(2) Monthly water usage on a master meter which jointly measures water usage to multiple residential dwelling units exceeds allocation by 4,000 gallons times the number of dwelling units or more two or more times (which need not be consecutive months).

(3) Monthly nonresidential water usage for a customer whose allocation is 6,000 gallons through 20,000 gallons exceeds its allocation by 7,000 gallons or more two or more times (which need not be consecutive months).

(4) Monthly nonresidential water usage for a customer whose allocation is 21,000 gallons or more exceeds its allocation by 15 percent or more two or more times (which need not be consecutive months).

(5) For residential customers and nonresidential customers whose allocation does not exceed 20,000 gallons, after the first disconnection water service shall be restored upon request for a fee of $50.

(6) For such customers, after the second disconnection, water service shall be restored within 24 hours of the request for a fee of $500.

(7) If water service is disconnected a third time for such customer, water service shall not be restored until the City re-enters a level of water conservation less than Condition III.

(8) For master meter customers, the service restoration fees shall be the same as above times the number of dwelling units.

(9) For nonresidential customers whose allocation is 21,000 gallons per month or more.

a. After the first disconnection water service shall be restored upon request for a fee in the amount of "X" in the following formula:

$$X = \frac{\$50 \times \text{Customer's Allocation in gallons}}{20{,}000 \text{ gallons}}$$

b. After the second disconnection for said customers, water service shall be restored within 24 hours of the request for a fee of 10 times "X".

c. If water service is disconnected a third time for such customer, water service shall not be restored until the City re-enters a level of water conservation less than Condition III.

d. The City Manager is directed to institute written guidelines for disconnection of water service under this provision, which will satisfy minimum due process requirements, if any.

(l) It shall be a defense to imposition of a surcharge hereunder, or to termination of service, that water used over allocation resulted from loss of water through no fault of the customer (for example, a major water line break).

(1) The customer shall have the burden to prove such defense by objective evidence (for example, a written certification of the circumstances by a plumber).

(2) A sworn statement may be required of the customer.

(3) This defense shall not apply if the customer failed to take reasonable steps for upkeep of the plumbing system, failed to reasonably inspect the system and discover the leak, failed to take immediate steps to correct the leak after discovered, or was in any other way negligent in causing or permitting the loss of water.

(j) When this section refers to allocation or water usage periods as "month," "monthly," "billing period," and the like, such references shall mean the period in the City's ordinary billing cycle which commences with the reading of a meter one month and commences with the next reading of that meter which is usually the next month.

(1) The goal for the length of such period is 30 days, but a variance of two days, more or less, will necessarily exist as to particular meters.

(2) If a meter reader is prevented from timely reading a meter by a dog or any other obstacle which is attributable to the customer, the original allocation shall apply to the longer period without modification.

Sec. 55-158. Effluent distribution; permit and regulations.

(a) Upon implementation of the City of Corpus Christi Water Conservation Plan as provided in this section, the City may make available effluent water discharged from its sewage treatment plants for the purpose of watering lawns, grass, and other plants, dust control and similar uses.

(1) Such effluent water shall be made available only under the terms and conditions herein provided and only to such persons as are duly permitted as distributors as provided in this section.

(2) The City shall be under no obligation to provide such effluent and reserves the right to discontinue such service at any time and to limit the volume and to establish or alter loading procedures and/or locations as necessary for the efficient administration of the Wastewater Division.

(b) No Effluent Distribution Permit shall be issued except upon application filed with the Wastewater Division of the City. Every such application shall contain the following information:

(1) Name of applicant.

(2) Name of authorized representative (e.g. president of corporation; partner; etc.) if applicant is other than an individual.

(3) Business address and phone number.

(4) Residence address and phone number of authorized individual representative.

(5) Description of each vehicle and container unit to be used in the transportation or distribution of effluent water, including the make, year, model, type, weight and gross vehicle weight, container capacity in gallons, vehicle registration number, and the State safety inspection certificate number and expiration date.

(6) Names and driver's license number of every proposed driver of such vehicles.

(7) Statement of previous use of container units and any proposed use after or concurrently with such units use for effluent distribution.

(8) Statement of the proposed uses of any effluent water, including whether the use is proposed for residential, commercial, or industrial purpose.

(c) Upon the filing of the required application, and payment of the permit fee specified herein for each container unit, the Wastewater Superintendent, or the Superintendent's designee, shall upon his determination that the applicant and vehicles and container units are in compliance with all applicable provisions of this article, issue a permit for each such container unit.

(1) The permit shall identify the particular unit for which it is issued and shall be displayed in a prominent place upon the unit.

(2) Each unit shall be separately permitted.

(d) The Permit Fee shall be fifty dollars ($50.00) per month for each unit plus five dollars ($5) per month for each unit per 1,000 gallons of capacity (or portion thereof) over the first 1,000 gallons of capacity.

(e) Permits shall be issued on a quarterly basis from the effective date of this plan; fee proration shall be on a monthly basis.

(f) Notwithstanding subsection (g) of this section, a resident of the City of Corpus Christi may obtain effluent at no charge from a wastewater treatment plant, designated by the Wastewater Superintendent, for the irrigation of vegetation, dust control, or watering a foundation at the individual's personal residence.

(1) Any effluent received under this subsection may not be sold or transferred to another individual or used for commercial purposes.

a. Before receiving effluent the resident must obtain a permit from the Wastewater Superintendent or the Superintendent's designee.

b. Prior to receiving a permit, the resident must complete a course of instruction on the handling of wastewater effluent that has been developed by the City's Health Department.

c. Any container used to receive and transport effluent must have a lid or cap, be watertight, and be properly secured to the vehicle.

d. All containers are subject to inspection and approval of the City Health Department or Wastewater Department.

e. Any effluent received under this subsection must be immediately transported to the personal residence of the individual receiving the effluent and used for the irrigation of vegetation, dust control, or watering a foundation.

f. The effluent may not be stored for future use.

g. A resident using effluent for the irrigation of vegetation or dust control must post a sign on the property legible from the street stating that effluent is being used on the property.

h. Every resident obtaining effluent under this subsection must either:

1. Provide proof of and maintain in force a property liability insurance policy (homeowner/renter) in the amount of three hundred thousand dollars ($300,000.00) per occurrence. Or

2. Sign a form provided by the Superintendent that releases the City of Corpus Christi from any liability resulting from the resident's improper use or transportation of the effluent and agree to hold the City harmless, including reimbursing the City for the costs of defending itself.

(g) Every Effluent Distribution Permit shall be subject to the following terms and conditions and no person shall receive or distribute effluent water except in compliance herewith:

(1) Container units or tanks shall have a minimum capacity of 500 gallons; shall be capable of being closed water tight and shall be so closed during transport of effluent water; and shall be maintained in a leak-proof condition; provided, however, that special permits may be issued for container units with a capacity of less than 500 gallons upon the determination by the Wastewater Division Superintendent that all other container unit specifications herein required have been met and that the particular container unit does not create an increased risk to the public health and safety.

(2) No vehicle may be used in connection herewith which has not been reported on the application and approved for such use.

(3) Every driver or handler must be certified by the Wastewater Division prior to receiving any effluent water from the City.

a. The Wastewater Division may certify a driver or handler who has completed a course of instruction on the handling of wastewater effluent that has been developed by the City's Health Department.

(4) Effluent water shall be used as soon as possible to prevent regrowth of bacteria.

a. Permittees shall check effluent water in their units not less than every four (4) hours for chlorine residual, except for effluent stored in fixed-site containers which shall be checked not less than every eight (8) hours.

(5) Chlorine residuals shall be maintained at one milligram per liter (parts per million) [1 mg/l (ppm)], consistent throughout the effluent container.

(6) The minimum quality of the effluent must not exceed conditions on the use of effluent set out in any permits or authorizations issued to the City by a federal or state regulatory agency or the applicable regulations of a federal or state regulatory agency.

(7) Effluent containers, including those used for storage, shall be subject to inspection and approval of the City Health Department or wastewater division, whose inspectors are hereby authorized to prohibit the use of any container or effluent water which is determined to be outside the parameters established in this section or is otherwise determined to present a danger to public health.

(8) Every permittee shall provide proof of and shall maintain in force a policy of comprehensive general liability insurance in the amount specified by the City's Risk Manager under Sec. 17-15; or shall maintain a policy of general business liability insurance in the same or greater amount with a contractual liability endorsement; and shall maintain a policy of automobile liability insurance in the minimum amounts set by state law. The City shall be named as an additional insured on the general liability insurance policies.

(9) By acceptance of a permit under this section and/or receipt of effluent water from the City system, the permittee and/or recipient of such effluent agree to fully indemnify, save and hold harmless, the City of Corpus Christi, Texas, its agents and employees, from and against all claims and actions, and all expenses incidental to the investigation and defense thereof, based upon or arising out of damages or injuries to person or property in any way related to or in connection with the use or distribution of effluent water under this section.

(10) Permittees shall provide a written notice to every person to whom effluent is furnished which shall state in not less than ten point type, substantially as follows:

"CAUTION”

> "You are hereby advised that effluent water is the discharged water from a sewage treatment plant. The Director of Public Health has determined that improper use or handling could be harmful and recommends the following precautions:
>
> "1. Do not use effluent water for drinking, bathing, or personal hygiene purposes.
>
> "2. Do not use effluent water for washing autos, clothes, or other personal contact items.

"3. Do not use effluent water in swimming pools or for similar recreational uses.

"4. Do not allow children to play on grass wet with effluent water, wait until it dries.

"5. Do not use effluent which has been stored for more than four (4) hours unless the chlorine residual level has been tested and is not less than one part per million [1 mg/1(p.m.)].

"6. Application of effluent shall be by coarse stream and shall not be by fine spray."

(h) Violation of any of the cautions set forth in subsection (g)(10) of this section, by any person, is a violation of this section.

(i) Violation of any of the provisions of this section, in addition to the general penalties provided in this particle, shall result in denial or revocation of any such violator's Effluent Distribution Permit.

Sec. 55-159. Operations plan for reservoir system.

To maximize the amount of water reliably available to the City and its water customers, the City Manager shall operate the Lake Corpus Christi/Choke Canyon Reservoir System as follows:

1. A minimum of 2,000 acre-feet per month will be released from Choke Canyon Reservoir to meet conditions of the release agreement between the City of Corpus Christi and the Texas Parks and Wildlife Department.

2. In order to provide maximum dependable yield from the two reservoirs, the water level in Lake Corpus Christi will be allowed to drop to elevation 74 feet before water is released from Choke Canyon Reservoir in excess of the 2,000 acre-feet per month requirement.

APPENDIX C

CITY COUNCIL AGENDA MEMORANDUM

March 9, 2001

AGENDA ITEM:

(1) Resolution supporting "A Proposal for Implementing the Rincon Bayou Diversions and Amending the 1995 Agreed Order on Freshwater Inflows to the Nueces Estuary;" requesting the Texas Natural Resource Conservation Commission to approve necessary amendments to the 1995 Agreed Order; and expressing appreciation for efforts of the Nueces Estuary Advisory Council.

(2) Ordinance amending the Code of Ordinances, City of Corpus Christi, by revising Article XII, Water Conservation, of Chapter 55, Utilities, to establish automatic water conservation measures, to codify the rules governing drought contingencies and establishing permanent water conservation measures, and to direct an operations plan for the reservoir system; amending the Water Conservation and Drought Contingency Plan by deleting the references to specific reservoir levels in section 2.1 of the Drought Contingency Plan; amending the Water Conservation and Drought Contingency Plan by repealing Section 2.2 of the Drought Contingency Plan; revising and clarifying certain other provisions of Article XII of Chapter 55; providing for penalties; providing for severance; and providing for publication.

(3) Motion authorizing the City Manager to retain HDR Engineering to provide engineering services for design and bidding services related to re-opening the Rincon Overflow Channel at a price not to exceed $40,000, to provide construction services for the Rincon Channel project at a price to be negotiated, and to provide services related to construction of a pipeline from the Calallen Reservoir to the Nueces Delta at a price to be negotiated.

ISSUE: Late last year the Council authorized staff to explore whether agreement could be reached among the City and other interested parties for the City to re-open the channel to continue the Rincon Project (proven environmentally beneficial to the Nueces Estuary by the Bureau of Reclamation) in return for reduced pass-through requirements from the reservoir system. The Nueces Estuary Advisory Council ("NEAC") met on the City's proposal and appointed a Working Group to evaluate the proposal. The Working Group reached consensus on the outlines of a modified proposal. The Council authorized staff to proceed to finalize an amendment to the Agreed Order for pass-throughs consistent with the modified proposal.

Subsequent meetings with the Working Group fleshed out details of the Plan. On March 6, the full NEAC considered that Plan and, after due deliberation, approved the proposal by consensus.

The Plan will economically supplement our water supply by increasing reservoir system firm yield by 3,200 acre-feet annually. This will be accomplished by automatically reducing the City's obligation to pass through water to 1,200 acre-feet when system storage is less than 40%

of capacity, and suspending the obligation entirely when supplies go below 30% of capacity. This relief from pass-throughs will be effective immediately upon action by TNRCC and will remain in effect if the City meets two specific deadlines noted below.

In consideration, the City will: 1) reopen the Rincon Overflow channel by the end of this year, 2) construct a pipeline and pumps to deliver up to 3,000 acre-feet per month of pass-throughs to the Upper Nueces Delta by the end of 2002; and 3) implement a monitoring program to evaluate the benefits. Capitol costs are estimated to be around $5.5 million. In addition, the City will automatically implement conservation measures as follows: 1) when system supply goes below 50% of capacity, initiate enhanced communications to the public on water conservation and the importance of estuaries, 2) when supply goes below 40%, prohibit outdoor watering of vegetation from 10:00 a.m. to 6:00 p.m., and 3) when supply goes below 30%, prohibit lawn watering more often than every five days.

The plan contemplates that the City will continue its present policy of maximum use of Lake Texana water and operating the Lake Corpus Christi/Choke Canyon Reservoir System to maximize system yield.

The Plan, as finalized, would have these benefits to the City:

1) It would increase firm yield at a reasonable cost per acre-foot.
2) The decision when to implement drought measures is left completely to the judgment of future councils, prudently weighing all economic, human and other factors at that time.
3) The automatic measures at 50%, 40%, and 30% are targeted for demand reduction in watering grass and plants, and are supportable as good, routine conservation measures.
4) The health of the Nueces Estuary would be enhanced, with consequent benefits to the area.

Implementation of the Plan requires approval of the Texas Natural Resource Commission. A meeting of that agency is being scheduled for April 4.

Two action items are submitted for Council approval. First is a resolution supporting the proposal, requesting TNRCC approval, and expressing appreciation for NEAC's efforts. Second is an ordinance enacting the automatic water conservation measures in the proposal, subject to TNRCC approval. The ordinance also: a) removes references in the present water conservation plan to specific reservoir levels corresponding to particular drought conditions (thus leaving discretion as to implementation of any specific condition), b) continues operation of the reservoir system to maximize water supply, with Lake Corpus Christi allowed to go down to 74 feet mean sea level before releases from Choke, and c) codifies the water conservation plan for easier reference and makes other clean-up and clarifying changes.

In order to meet the short timeline for the re-opening of the Rincon Overflow Channel, it is necessary to immediately procure engineering services for the design and bid phase. HDR Engineering has been previously hired to assist the Project and they are very knowledgeable of its requirements. Their scope of services for the required design and bid phase is attached. The services are proposed at a cost of $28,000 for the design phase and $12,000 for the bidding phase.

Attached are: 1) the Resolution; 2) Exhibit A to the Resolution which is the final Proposal; 3) Exhibit B to the Resolution which is proposed Amended Order which has been submitted to the TNRCC; 4) maps, charts and graphs prepared by HDR Engineering related to the Proposal; 5) the Ordinance; and 6) scope of services proposal of HDR Engineering.

RECOMMENDATION: Approval of resolution and ordinance as submitted.

Ron Massey

Ron Massey, Assistant City Manager

by JRB

Jim Bray

Jimmy Bray, City Attorney

RESOLUTION

SUPPORTING "A PROPOSAL FOR IMPLEMENTING THE RINCON BAYOU DIVERSIONS AND AMENDING THE 1995 AGREED ORDER ON FRESHWATER INFLOWS TO THE NUECES ESTUARY;" REQUESTING THE TEXAS NATURAL RESOURCE CONSERVATION COMMISSION TO APROVE NECESSARY AMENDMENTS TO THE 1995 AGREED ORDER; AND EXPRESSING APPRECIATION FOR EFFORTS OF THE NUECES ESTUARY ADVISORY COUNCIL

WHEREAS, on April 28, 1995, the Texas Natural Resource Conservation Commission issued an Agreed Order (the "Agreed Order") amending the operational procedures and continuing an Advisory Council pertaining to Special Condition 5.B., Certificate of Adjudication No. 21-3214; and

WHEREAS, from 1995 to 1999 the United States Bureau of Reclamation operated the Rincon Bayou Demonstration Project to evaluate the feasibility of increasing water exchange between the Nueces River tidal segment and the Upper Rincon Bayou, and the Bureau's Concluding Report documented positive effects on the Rincon Bayou and Upper Nueces River Delta; and

WHEREAS, the Rincon Bayou Demonstration Project and evidence from other studies over the years suggested an opportunity to: (1) better manage the limited resources of the Nueces River Basin for the benefit of the Nueces Estuary, and (2) at the same time supplement municipal and industrial water supplies for the Corpus Christi area by increasing the annual firm yield of the Lake Corpus Christi/Choke Canyon Reservoir System; and

WHEREAS, on January 17, 2001, the City of Corpus Christi and the Nueces River Authority presented a proposal to the Nueces Estuary Advisory Council to accomplish said purposes of benefitting the estuary and increasing water supplies; and

WHEREAS, the Nueces Estuary Advisory Council appointed a Working Group to oversee development of a detailed implementation plan for the proposal, including representatives of the City of Corpus Christi, the Nueces River Authority, the Coastal Bend Bays and Estuaries Program; the Coastal Bend Bays Foundation, the Sierra Club, the Center for Coastal Studies of Texas A&M University - Corpus Christi, Environmental Defense, the Port Industries of Corpus Christi, and the Texas Parks and Wildlife Department; and

WHEREAS, after several meetings and much deliberation, the Working Group reached consensus on an implementation plan (the "Implementation Plan") to be accomplished through amendment to the Agreed Order; and

WHEREAS, on March 6, 2001, the full Nueces Estuary Advisory Council considered the

Implementation Plan developed by the Working Group and reached consensus in favor of said Plan.

NOW, THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF CORPUS CHRISTI, TEXAS, THAT:

SECTION 1. The City of Corpus Christi supports "A Proposal for Implementing the Rincon Bayou Diversions and Amending the 1995 Agreed Order on Freshwater Inflows to the Nueces Estuary," a true copy of which is attached hereto as Exhibit A and incorporated herein by reference.

SECTION 2. The City of Corpus Christi requests the Texas Natural Resource Conservation Commission to approve, in all material aspects, the Amended Agreed Order, attached hereto as Exhibit B and incorporated herein by reference.

SECTION 3. The City of Corpus Christi recognizes and appreciates the cooperative and constructive efforts of the members of the Nueces Estuary Advisory Council in reaching consensus on the Implementation Plan.

1jrb4501009.wpd

ATTEST:	**CITY OF CORPUS CHRISTI**
Armando Chapa, City Secretary	Samuel L. Neal, Jr., Mayor

Legal Form Approved March 9, 2001
James R. Bray, Jr.
City Attorney

By: J. R. Bray

A PROPOSAL FOR IMPLEMENTING THE "RINCON BAYOU DIVERSIONS" AND AMENDING THE 1995 AGREED ORDER ON FRESHWATER INFLOWS TO THE NUECES ESTUARY

Submitted to the
Texas Natural Resource Conservation Commission

By:
The City of Corpus Christi and the Nueces River Authority
With the Consensus of the
Nueces Estuary Advisory Council

SUMMARY

The City of Corpus Christi (City) and the Nueces River Authority (NRA) propose to implement the "Rincon Bayou Diversions" to enhance the exchange of water from the Nueces River into the Upper Rincon Bayou in order to improve the ecological productivity of the Nueces Delta/Nueces Estuary system. In consideration for committing to the attached "Implementation Plan and Timetable" for constructing, operating and maintaining these diversion facilities as permanent projects, the City and NRA also propose to amend the 1995 Agreed Order on Freshwater Inflows to the Nueces Estuary (1995 Agreed Order) to immediately modify the level of drought management measures required to be implemented in order to obtain the reductions in monthly inflow targets now available under the 1995 Agreed Order when reservoir storage levels fall below 40 percent of reservoir system capacity.

PROCESS FOR IMPLEMENTING THE RINCON BAYOU DIVERSIONS AND AMENDING THE 1995 AGREED ORDER

The Texas Natural Resouce Conservation Commission (TNRCC) is the state agency that regulates water rights in Texas, and therefore administers provisions of Certificate of Adjudication No. 21-3214 (Certificate), jointly held by the City and NRA, which authorizes the impoundment and diversion of waters of the state from the Frio River at Choke Canyon Reservoir. Beginning in 1990, TNRCC and its predecessor agencies have issued a series of orders governing the operations of the Choke Canyon/Lake Corpus Christi Reservoir System (Reservoir System) with respect to freshwater inflows to the Nueces Estuary as required under Special Condition 5.B. of the Certificate.

In 1992, TNRCC, by effect of the "Interim Agreed Order" on freshwater inflows to the Nueces Estuary, established the Nueces Estuary Advisory Council (NEAC) as the designated body of stakeholders charged with reviewing proposed changes to the freshwater inflow operating plan for the Nueces Estuary. Later amendments to the 1992 Agreed Order (the "1995 Agreed Order") continued to authorize NEAC to review any proposed changes to the new "pass-through" operating plan for freshwater inflows.

EXHIBIT

A

At a NEAC meeting on January 17, 2001, the City and NRA presented an initial proposal for the Rincon Bayou Diversion improvements and associated amendments to the 1995 Agreed Order. NEAC members agreed to establish a working group, or steering committee, of principal stakeholders to oversee the development of a detailed implementation plan for this proposed project. This working group, facilitated by the TNRCC, includes representatives of the following entities and organizations: the Cityi; NRA; Coastal Bend Bays and Estuaries Program; Coastal Bend Bays Foundation; Sierra Club; Center for Coastal Studies, Texas A&M University - Corpus Christi; Environmental Defense; Port Industries of Corpus Christi; and Texas Parks and Wildlife Department.

The working group met several times over the past month to consider the City/NRA proposal for the Rincon Bayou Diversions and amendments to the 1995 Agreed Order. After considerable deliberation, the group reached consensus on an implementation plan for the Rincon Diversions and the proposed amendment to the 1995 Agreed Order. The following proposal and work plan was developed with the consensus of the working group. It defines the measures of relief from the pass-through requirements that would be available and how this relief would be contingent upon implementation of certain discrete elements of the City of Corpus Christi's Water Conservation and Drought Management Plan and timely implementation of specific elements of the Rincon Bayou Diversion project.

This proposal was presented to NEAC for consideration and approval on March 6, 2001. Based on there being consensus among members of NEAC regarding the proposal, the City, NRA and Three Rivers will file a motion to amend the 1995 Agreed Order, seeking to have the motion scheduled for consideration by the TNRCC on April 4, 2001.

BACKGROUND

Certificate of Adjudication No. 21-3214 authorizes the City and NRA to impound waters of the Frio River in Choke Canyon Reservoir, and to divert and use up to 139,000 acre-feet per year of water for municipal and industrial water supply purposes. Choke Canyon Reservoir is also authorized to be operated in conjunction with Lake Corpus Christi, located downstream on the Nueces River, to produce a combined system yield of 252,000 acre-feet per year.

During permitting, the construction of Choke Canyon Reservoir and its operation in conjunction with Lake Corpus Christi, there were concerns regarding the protection of freshwater inflows to the Nueces Estuary, including reductions in the amount of freshwater flooding occurring in the upper Nueces Delta. A provision for minimum freshwater inflow amounts to the Nueces Estuary was addressed in Special Condition 5.B. of Certificate of Adjudication No. 21-3214. This provision was implemented by a series of freshwater inflow operating orders issued by the TNRCC beginning in 1990. The matter of delivering desirable and useful quantities of freshwater inflows into the Nueces Delta continues to be studied.

Numerous studies (Bureau of Reclamation 1975, U.S. Fish and Wildlife Service 1980, Texas Department of Water Resources 1981, Espey, Huston and Associates 1981, U.S. Fish and Wildlife Service 1984, HDR, *et al.* 1991, HDR *et al.* 1993) have suggested that a superior alternative to sending freshwater inflows to Nueces Bay is to deliver additional quantities of freshwater into the Nueces Delta either by breaching the banks of the Nueces River at some point(s) below the Calallen Saltwater Barrier Dam and/or by diverting treated wastewater effluent via pipelines. The potential benefits of freshwater diversions to the Nueces Delta are :

- Restoration of more "natural" salinity gradients in the upper Nueces Delta, where, historically, periodic flooding events had flushed out salts concentrated in the soils and the water column during low flow conditions;
- Restoration of typical delta/estuarine ecological functions, which had been lost largely to the hypersaline conditions and lack of nutrient inputs, both of which limit primary productivity and cause loss of habitat; and
- Restoration of hydrologic functions which transport nutrients and detritus into and out of the wetlands within the delta complex, making these materials available to various trophic levels within both the delta and the larger estuarine ecosystem.

By the early 1990's, efforts to test the feasibility of these diversion projects were implemented. Eventually, two separate diversion demonstration projects evolved:

- The City authorized and implemented the Allison Wastewater Diversion Demonstration Project, which re-routes approximately two million gallons per day (2 MGD) of treated effluent from its historical discharge location in the Nueces River tidal segment to a new discharge point adjacent to "South Lake," a tidal pond in the Nueces Delta. Construction on the project was completed in 1997 and treated wastewater discharges were initiated in 1998. Project monitoring began prior to construction and has continued through the first two years of operation. Initial data indicate positive benefits and the City continues to operate and support the project.
- The U.S. Bureau of Reclamation (BuRec) authorized and constructed the Rincon Bayou Demonstration Project, designed to evaluate the feasibility of increasing water exchange between the Nueces River tidal segment and the Upper Rincon Bayou. This demonstration project involved excavating both a "Nueces Overflow Channel" at a point just downstream of the I-37 bridge, where the upper Rincon Bayou had historically connected to the Nueces River, and a "Rincon Overflow Channel" connecting the upper Rincon Bayou with an area of tidal flats in the northern portion of the Nueces Delta. Baseline monitoring for the project began in October 1994. Excavation of the overflow channels was completed in October 1995. Monitoring continued through December 1999, and the demonstration project terminated with the backfilling of the Nueces Overflow Channel in September 2000.

The Concluding Report for the Rincon Bayou Demonstration Project documents the effects of the project on the hydrography and ecology of Rincon Bayou and the upper Nueces Delta. In terms of hydrography (or hydrology), the breaching of the river bank at the upper end of the Rincon Bayou increased "the opportunity for larger, more frequent diversions of fresh water" (BuRec 2000). The report noted that there were three types of resulting diversion events: positive flow events -- infrequent, large volume flows from the Nueces River into Rincon Bayou; tidal flat inundation events -- very large positive flow events resulting in flow through the Rincon Overflow Channel and general inundation of the tidal flats areas of the upper delta; and exchange events -- more frequent, smaller flows that resulted from daily differences in water level elevations between Rincon Bayou and Nueces Bay or Nueces River. In the relatively short duration of the demonstration project, these diversion events helped to restore a more natural salinity regime in the Rincon Bayou portion of the Nueces Delta.

As a result of the various diversion events, "(A) significant degree of ecological function was returned to the Nueces Delta and Nueces Estuary ecosystems" (BuRec 2000). The Concluding Report documents positive responses in terms of:

- an increase in the primary productivity in the water column (phytoplankton) and on the surface of the sediments (microphytobenthos);

- an increase in the number and size of benthic organisms, as well as an increase in the number of benthic species; and

- an increase in the amount of plant cover and a corresponding decrease in the amount of bare areas in the emergent wetlands areas.

The report recommends that the demonstration project features be incorporated into a permanent diversion project and that changes in the current operating plan for freshwater inflows to the Nueces Estuary (1995 Agreed Order) be designed to better facilitate the diversion of freshwater "pass-throughs" from the Choke Canyon/Lake Corpus Christi reservoir system through the project and into the upper Nueces Delta. With permanent diversion facilities in place, and continued monitoring, the Rincon Bayou Diversion Project could provide opportunities for "adaptive management" -- the process of monitoring and evaluating ecological responses to changes in freshwater inflows and incorporating this information into subsequent decisions on how to most effectively utilize the limited freshwater resources available to the estuarine environment.

PROPOSAL TO IMPLEMENT THE "RINCON BAYOU DIVERSION PROJECTS" AND TO AMEND THE 1995 AGREED ORDER

The water resource management goals of this proposal are to (1) provide better management of the limited freshwater resources of the Nueces River Basin for the benefit of the Nueces Estuary and (2) to supplement municipal and industrial water supplies for the Coastal Bend area by increasing the firm annual yield of the reservoir system. The specific environmental management goals of the proposed projects are to enhance the salinity conditions and ecological functions of the Nueces Delta by providing increased freshwater inflows to the upper Nueces Delta, through both the Rincon Bayou Overflow Channel and a conveyance system to deliver water from the Calallen Pool directly into Upper Rincon Bayou.

By this proposal, the City and NRA, joint holders of Certificate of Adjudication No. 21-3214 and parties to the 1995 Agreed Order, agree to:

(1) acquire either easements or ownership of properties necessary to re-open the Nueces River Overflow Channel and make the Nueces River Overflow Channel and the Rincon Bayou Overflow Channel permanent features of the Rincon Bayou Diversion;

(2) construct and operate a conveyance facility to deliver up to 3,000 acre-feet per month of required Reservoir System "pass-throughs" directly from the Calallen Pool into the Upper Rincon Bayou; and

(3) implement an ongoing monitoring and assessment program designed to develop information on how the diversion of freshwater into the Upper Rincon Bayou affects the ecological function of various trophic levels within the Rincon Bayou/Nueces Delta system, as well as the Nueces River Tidal Segment. The monitoring data will be assessed and reported on an annual basis, with the annual monitoring cycle beginning on September 1 of each year and ending on August 31 of the following year, with the annual report due within 6 months, or by the end of February following the monitoring year end. Such monitoring data should, when integrated with other information (such as fisheries data) collected by various entities, help to facilitate an ongoing "adaptive management" program for freshwater inflows into the Nueces Estuary.

In anticipation of the environmental enhancements to the Nueces Estuary that may accrue from these projects being proposed by the City and NRA, the NEAC agrees to support amendments to the 1995 Agreed Order that would increase the reservoir system yield and provide greater flexibility in the implementation of the City of Corpus Christi's Drought Management Plan. The proposed amendments to the 1995 Agreed Order would provide that:

(1) When the combined storage in the Choke Canyon/Lake Corpus Christi reservoir system (Reservoir System Storage) falls below 50% of the total system storage capacity, the City of Corpus Christi shall issue public notice advising and informing the water users in the region of potential drought conditions, as well as outlining voluntary conservation measures that are requested immediately and required drought management measures to be taken should the Reservoir System Storage fall to under 40 percent and/or 30 percent of total system storage capacity. To the extent of its legal authority, the City of Corpus Christi shall require its wholesale customers to issue public notice advising and informing the water users in the region of potential drought conditions, as well as outlining voluntary conservation measures that are requested immediately and required drought management measures to be taken should the Reservoir System Storage fall to under 40 percent and/or 30 percent of total system storage capacity. (When the combined reservoir system storage falls to 50% of total storage capacity, the City will immediately provide notification to the public by placing advertising in the *Corpus Christi Caller-Times*; in addition, the informational content of the City's ongoing public information/education programs on water conservation -- conducted via both print and electronic media -- will be revised to emphasize additional water demand reduction measures that can be implemented to protect both the water supplies in the Choke Canyon/Lake Corpus Christi Reservoir System and freshwater inflows to the Nueces Estuary. Advertising and information will be designed to encourage voluntary reductions in both indoor and outdoor water use and will include

information educating the public about the importance of the Nueces Estuary to the regional economy, environment and quality of life.

(2) In any month when Reservoir System Storage is less than 40 percent, but equal to or greater than 30 percent of total system storage capacity, the City of Corpus Christi shall implement time of day outdoor watering restrictions and shall reduce targeted inflows to Nueces Bay to 1,200 acre-feet per month (1,200 acre-feet per month represents the quantity of water that is the median inflow into Lake Corpus Christi during the drought of record.). Time of day outdoor watering restrictions prohibit lawn watering between the hours of 10 am and 6 pm and are subject to additional conditions as described in the City of Corpus Christi's "Water Conservation and Drought Contingency Plan" ("Plan"). To the extent of its legal authority, the City of Corpus Christi shall require its wholesale customers to implement time of day outdoor watering restrictions similar to those of the City.

(3) In any month when Reservoir System Storage is less than 30 percent of total system storage capacity, the City of Corpus Christi shall implement a five-day lawn watering schedule in addition to time of day outdoor watering restrictions (see 2.b.(2)) and shall suspend the passage of inflow from the Reservoir System for targeted inflows to Nueces Bay. However, return flows directed into Nueces Bay and/or the Nueces Delta shall continue. The five-day lawn watering schedule shall allow customers to water lawns once every five days, subject to the time of day restrictions described in 2.b.(2) and any additional conditions as described in the City's Plan.

(4) Certificate Holders' rights to obtain whole or partial suspension of the passage of inflow through the Reservoir System is contingent upon the City implementing, and requiring its wholesale customers to implement, water conservation and drought management measures at the diminished Reservoir System levels, as set forth in subparagraphs 2.b.(2) and 2.b.(3), and enforcement of such requirements using the authority provided in City ordinances and codes to levy fines and penalties for violations of these particular provisions of the City's Water Conservation and Drought Management Plan and various wholesale water contracts.

Recognizing that the restoration of the Nueces River Overflow Channel and the construction of a system to convey water from the Calallen Pool to the Upper Rincon Bayou area are significant undertakings, the NEAC Working Group has developed an Implementation Plan and Timetable (see Attachment A) for the Rincon Bayou Diversions. Initial elements of this plan are already underway, including the preliminary engineering and property acquisition efforts.

However, while proceeding at an accelerated pace, full completion of these two components of the Rincon Bayou Diversions involves a number of steps that will likely depend on decisions and actions by other entities besides the project sponsors – i.e., issuance of permits for diversion of state water (TNRCC) and for construction in navigable waters (U.S. Army Corps of Engineers). The NEAC Working Group agrees, and requests that the full membership of NEAC recommend to TNRCC, that the proposed amendments to the 1995 Agreed Order be effective immediately upon approval by TNRCC and continue to be available to the City so long as the progress on the implementation of the required projects follows as outlined in the timetable below.

If in the event that the City fails to meet the final deadlines in this timetable, the NEAC Working Group would review the options for completing the projects and recommend additional amendments to the Agreed Order to address the situation at that time. During the intervening time, however, the freshwater inflow operating rules would revert to the conditions of the 1995 Agreed Order.

LITERATURE CITED

Bureau of Reclamation, "Environmental Impact Statement for Choke Canyon Reservoir," December 1975.

Bureau of Reclamation, "Concluding Report: Rincon Bayou Demonstration Project. Volume I: Executive Summary," United States Department of the Interior, Bureau of Reclamation, Oklahoma-Texas Area Office, Austin, Texas. 2000.

Espey, Huston and Associates, "Enhancement Potential Determination for the Nueces River/Deltaic Marsh System Study," 1981.

HDR, *et al.*, "Nueces Estuary Regional Wastewater Planning Study, Phase 1," City of Corpus Christi, *et al.*, November 1991.

HDR, *et al.*, "Nueces Estuary Regional Wastewater Planning Study, Phase 2," City of Corpus Christi, *et al.*, March 1993.

Texas Department of Water Resources, "Nueces and Mission-Aransas Estuaries: A Study of the Influence of Freshwater Inflows," January 1981.

U.S. Fish and Wildlife Service, "Phase 4 Report - Studies of freshwater Needs of Fish and Wildlife Resources in Nueces-Corpus Christi Bay Area, Texas," August 1980.

U.S. Fish and Wildlife Service, "Supplemental Fish and Wildlife Coordination Act Report, Choke Canyon Dam and Reservoir, Nueces River Project, Texas," 1984.

ATTACHMENT A:

IMPLEMENTATION PLAN AND TIMETABLE FOR THE RINCON BAYOU DIVERSIONS

Submitted to the
Texas Natural Resource Conservation Commission

Submitted by the
City of Corpus Christi
and the
Nueces River Authority

February 28, 2001

SCOPE OF WORK

Nueces River Overflow Channel Project

Preliminary Engineering:

- Review the Bureau of Reclamation's original design for the construction of the Nueces River Overflow Channel and compare with the "as-built" specifications of the project to assess design changes that might be required or desired.
- Identify the areal extent of inundation that the design channel would provide in order to define easement/property acquisition requirements for downstream properties.
- Develop preliminary cost estimates.
- Prepare information for permitting process.

Permitting:

- Develop and submit application for state water right associated with diversion of water from the Nueces River into the Rincon Bayou/Nueces Delta area.
- Identify and apply for permits necessary for construction and operation of the overflow channels, O&M on project facilities, etc.

Land Acquisition:

- Identify extent of land impacted by project construction and operation.
- Identify land ownership by tract in impacted areas; conduct title research.
- Evaluate most appropriate strategy for securing rights to access, develop and inundate impacted properties.
- Appraise value of various properties/easements.
- Contact landowners and make offers.
- Follow up and conclude necessary transactions.

Final Engineering Design:

- Prepare final plans and specifications for Nueces River Overflow Channel construction, and ancillary construction in other portions of the project area.
- Prepare detailed cost estimates.

Bidding and Construction:

- Commit/appropriate requisite funding for project construction based on engineering cost estimates
- Advertise for Bids; Accept Bids; Evaluate Bids and Identify Low Bid
- Negotiate and Award Construction Contract(s)
- Establish and implement construction oversight process, including permit compliance measures
- Construct project elements by no later than December 31, 2001

Calallen Pool to Rincon Bayou Water Conveyance Project

Preliminary Engineering:

- Identify diversion and discharge locations.
- Identify pipeline/canal alignment and routing.
- Develop preliminary cost estimates and evaluate alternatives.
- Prepare information for permitting process.

Permitting:

- Develop and submit application for state water right associated with diversion of water from the Nueces River into the Rincon Bayou/Nueces Delta area.
- Identify and apply for permits necessary for construction and operation of the diversion, conveyance and discharge structures, O&M on project facilities, etc. (i.e., Section 404 permit?)

Land Acquisition:

- Identify land ownership at diversion site,along conveyance route and at dishcarge site; conduct title research.
- Evaluate most appropriate strategy for securing rights to construct, operate and maintain project facilities
- Appraise value of various properties/easements.
- Contact landowners and make offers.
- Follow up and conclude necessary transactions.

Final Engineering Design:

- Prepare final plans and specifications for constructionof diversion facilities, pump station, pipeline or canal, and discharge structures, as well as ancillary construction in other portions of the project area.
- Prepare detailed cost estimates.

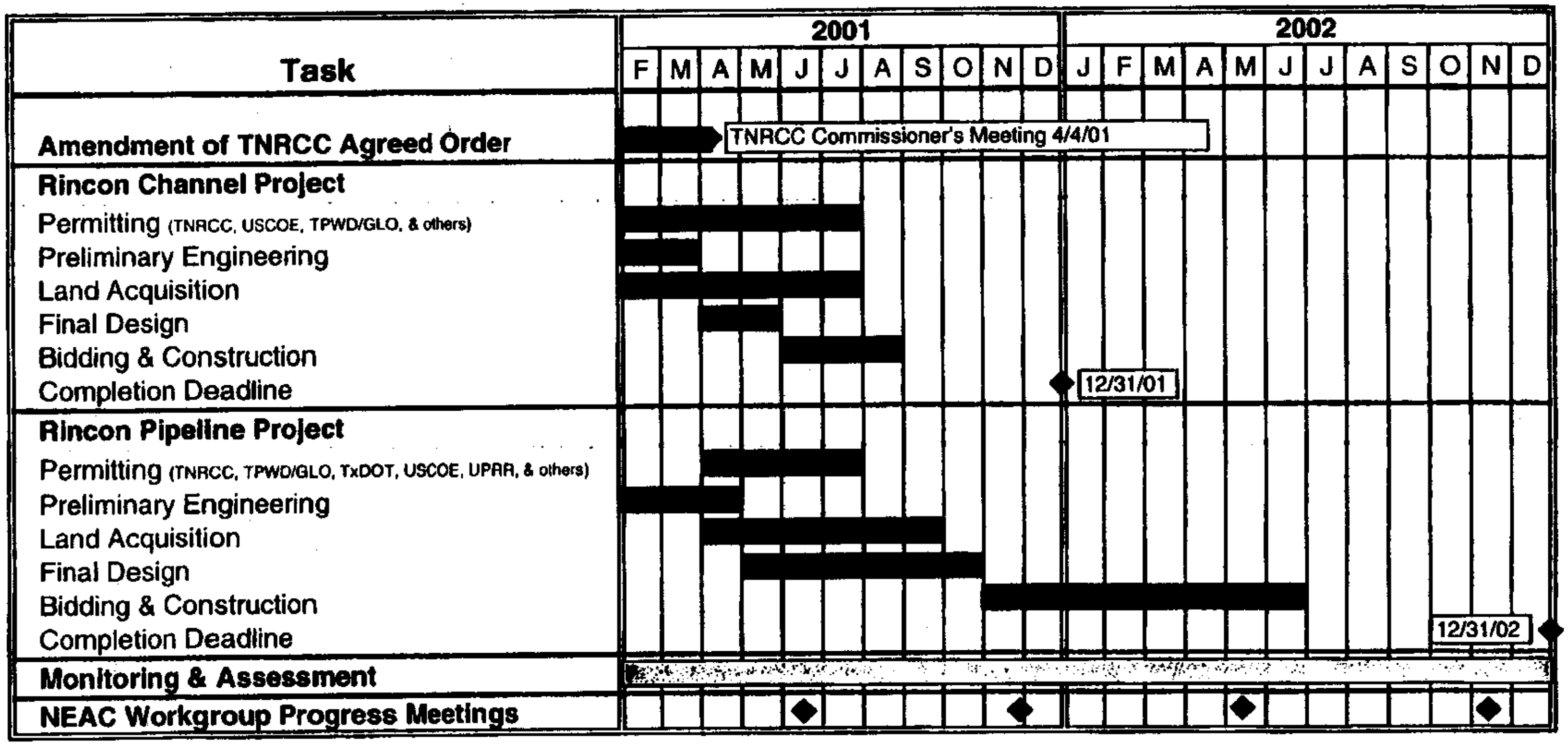
Bidding and Construction:

- Commit/appropriate requisite funding for project construction based on engineering cost estimates
- Advertise for Bids; Accept Bids; Evaluate Bids and Identify Low Bid
- Negotiate and Award Construction Contract(s)
- Establish and implement construction oversight process, including permit compliance measures
- Construct project elements and begin operation no later than December 31, 2002

Project Monitoring and Assessment:

- Establish goals and objectives for long-term monitoring of the Rincon Bayou Diversions
- Design monitoring plan
- Coordinate monitoring program for the Rincon Bayou Diversions, in connection with existing monitoring efforts in the Nueces Delta (i.e., ongoing monitoring for the City of Corpus Christi Allison Wastewater Diversion Project, Texas Parks and Wildlife routine and targeted monitoring, TNRCC routine and targeted monitoring, Clean Rivers Program targeted monitoring, and special studies conducted by the Coastal Bend Bays & Estuaries program)
- Implement monitoring by September 1, 2001
- Provide annual reports, due within six months of the end of each monitoring year (September 1 through August 31 of each year); annual reports will include an assessment of monitoring data and a review of the monitoring program in the context of other monitoring activities, and will provide recommendations regarding "adaptive management" measures designed to better integrate project facilities with the freshwater inflow operating policies

Schedule for Implementation of Rincon Bayou Diversion Projects



HDR Engineering, Inc.

Rincon Bayou Diversion Projects
Project Facilities

0 1000 2000 3000 Feet

February 28th, 2001

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

DOCKET NUMBER: 95-0616-WR

IN RE: AGREED ORDER ESTABLISHING OPERATIONAL PROCEDURES PERTAINING TO SPECIAL CONDITION 5.B., CERTIFICATE OF ADJUDICATION NO. 21-3214, HELD BY THE CITY OF CORPUS CHRISTI, NUECES RIVER AUTHORITY, AND THE CITY OF THREE RIVERS	§ § § § § § § § §	BEFORE THE TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

AN AGREED ORDER amending the operational procedures and continuing an Advisory Council pertaining to Special Condition 5.B., Certificate of Adjudication No. 21-3214

On ________________, came to be considered before the Texas Natural Resource Conservation Commission ("Commission") the Motion by the City of Corpus Christi and Nueces River Authority for the adoption of an amendment to the Agreed Order issued April 28, 1995, establishing operating procedures pertaining to Special Condition 5.B., Certificate of Adjudication No. 21-3214, held by the City of Corpus Christi, the Nueces River Authority, and the City of Three Rivers" (the two cities and river authority shall be referred to herein as "Certificate Holders").

After hearing and considering the proposed operational procedures and the presentations of the parties, the Commission finds that it has authority to establish operational procedures under Special Condition 5.B. of Certificate of Adjudication No. 21-3214, and that operational procedures previously established should be amended. The Commission finds that, because of the need to continue to monitor the ecological environment and health of related living marine resources of the estuaries to assess the effectiveness of freshwater inflows provided by requirements contained in this Agreed Order relating to releases and spills from Choke Canyon Reservoir and Lake Corpus Christi (collectively referred to as the Reservoir System), as well as return flows, and to evaluate potential impacts which may occur to the reservoirs as well as to the availability of water to meet the needs of the Certificate Holders and their customers which may result from those operational procedures, the existing advisory council should be maintained to consider such additional information and related issues and to formulate recommendations for the Commission's review.

The Commission additionally finds that based on the preliminary application of the Texas Water Development Board's Mathematical Programming Optimization Model, (GRG-2),

EXHIBIT

B

inflows to Nueces Bay and/or the Nueces Delta shall be in the acre-foot amounts as follow:

January	2,500	July	6,500
February	2,500	August	6,500
March	3,500	September	28,500
April	3,500	October	20,000
May	25,500	November	9,000
June	25,500	December	4,500

It is expressly provided, however, that releases from Reservoir System storage shall not be required to satisfy the above targeted inflow amounts, as calculated in Subparagraph d.

c. When water impounded in the Reservoir System is less than 70 percent but greater than or equal to 40 percent of storage capacity, a targeted amount of 97,000 acre-feet is to be delivered to Nueces Bay and/or the Nueces Delta by a combination of releases and spills from the Reservoir System as well as diversions and return flows. In accordance with the monthly schedule and except as provided otherwise in this Agreed Order, target inflows to Nueces Bay and/or the Nueces Delta shall be in the acre-foot amounts as follows:

January	2,500	July	4,500
February	2,500	August	5,000
March	3,500	September	11,500
April	3,500	October	9,000
May	23,500	November	4,000
June	23,000	December	4,500

It is expressly provided, however, that releases from Reservoir System storage shall not be required to satisfy the above targeted inflow amounts as calculated in Subparagraph d.

d. The amounts of water required in subparagraphs 1.b. and 1.c. will consist of return flows, and intentional diversions, as well as spills and releases from the Reservoir System as defined in this subparagraph. For purposes of compliance with monthly targeted amounts prescribed above, the spills and releases described in this paragraph shall be measured at the U.S. Geological Survey stream monitoring station on the Nueces River at Calallen, Texas (USGS Station No. 08211500). Any inflows, including measured wastewater effluent and rainfall runoff meeting lawful discharge standards which are intentionally diverted to the upper Nueces Delta region, shall be credited toward the total inflow amount delivered to Nueces Bay and/or the Nueces Delta. Inflow passage from the Reservoir System for the purpose of compliance with the monthly targeted amounts prescribed in subparagraphs 1.b. and 1.c. shall in no case exceed the estimated inflow to

Lake Corpus Christi as if there were no impoundment of inflows at Choke Canyon Reservoir. The estimated inflow to Lake Corpus Christi as if there were no impoundment of inflows at Choke Canyon Reservoir shall be computed as the sum of the flows measured at the U.S. Geological Survey (USGS) STREAMFLOW GAGING STATIONS ON THE Nueces River near Three Rivers (USGS No. 08210000), Froi River at Tilden, Texas (USGS No. 08206600), and San Miguel Creek near Tilden, Texas (USGS No. 08206700) less computed releases and spills from Choke Canyon Reservoir.

into the Nueces Bay/Nueces Delta Area - For purposes of compliance with monthly targeted amounts prescribed above, the spills and releases described in this paragraph shall be measured at the U. S. Geological Survey stream monitoring station on the Nueces River at Calallen, Texas (USGS Station No. 08211500).

e. The passage of inflow necessary to meet the monthly targeted allocations may be distributed over the calendar month in a manner to be determined by the City. Relief from the above requirements shall be available under subparagraphs (1) or (2) below and Section 2.(b) and 3.(c) at the option of the City of Corpus Christi. However, passage of inflow may only be reduced under one of those subparagraphs below, for any given month.

(1) Inflows to Nueces Bay and/or the Nueces Delta in excess of the required monthly targeted amount may be credited for up to fifty (50) percent of the targeted requirement for the following month, based on the amount received.

(2) When the mean salinity in Upper Nueces Bay (Lat. 27°51'02", Long. 97°28'52") for a 10-day period, ending at any time during the calendar month for which the reduction of the passage of inflow is sought, is below the SUB*, pass through of inflow from the reservoir system for that same calendar month may be reduced as follows:

(a) For any month other than May, June, September and October, if 5 ppt below the SUB for the month, a reduction of 25% of the current month's targeted Nueces Bay inflow;

(b) If 10 ppt below the SUB for the month, a reduction of 50 % of the current month's targeted Nueces Bay inflow except that credit under this provision is limited to 25 % during the months of May, June. September and October;

* "SUB" means "salinity upper bounds" as set forth more specifically in Section 3.b.

(c) If 15 ppt below the SUB for that month, a reduction of 75% of the current month's targeted Nueces Bay inflow.

f. The City of Corpus Christi shall submit monthly reports to the Commission containing daily inflow amounts provided to the Nueces Estuary in accordance with this Agreed Order through releases, spills, return flows and other freshwater inflows.

2. a. Certificate holders are to provide in any future contracts or any amendments, modifications or changes to existing contracts the condition that all wholesale customers and any subsequent wholesale customers shall develop and have in effect a water conservation and drought management plan consistent with Commission rule. The City of Corpus Christi shall solicit from its customers and report to the Commission annually the result of conservation under the City's plan, the customers' plans, and the feasibility of implementing conservation plans and programs for all users of water from the reservoir system. This report shall be submitted with the Certificate Holder's annual water use report as provided by 31 T.A.C. §295.202.

b. The Certificate Holders may obtain relief from targeted Nueces Bay inflows during times of prolonged drought in accordance with this subparagraph ~~subparagraphs 2.b.(1) - 2.b.(3)~~.

2. b. (1) When the combined storage in the Choke Canyon/Lake Corpus Christi reservoir system (Reservoir System Storage) falls below 50% of the total system storage capacity, the City of Corpus Christi shall issue public notice advising and informing the water users of the region of voluntary conservation measures that are requested immediately and required drought management measures to be taken should the Reservoir System Storage fall to under 40% and/or 30% of total system storage capacity. To the extent of its legal authority, the City of Corpus Christi shall require its wholesale customers to issue public notice advising and informing the water users of the region of voluntary conservation measures that are requested immediately and required drought management measures to be taken should the Reservoir System Storage fall to under 40% and/or 30% of total system storage capacity.

~~In any month when water impounded in the Reservoir System is less than 40 percent but equal to or greater than 30 percent of storage capacity, the City of Corpus Christi may reduce targeted inflows to Nueces Bay to 1,200 acre-feet per month (1,200 acre-feet per month represents the quantity of water that is the median inflow into Lake Corpus Christi during the drought of record.), when the City has implemented and required its customers to implement Condition II - Drought Watch as described in the City of Corpus Christi's "Water Conservation and Drought Contingency Plan" ("Plan").~~

(2) In any month when Reservoir System Storage is less than 40%, but equal to or greater than 30% of total system storage capacity, the City of Corpus Christi shall implement time of day outdoor watering restrictions and shall reduce targeted inflows to Nueces

Bay to 1,200 acre-feet per month (1,200 acre-feet per month represents the quantity of water that is the median inflow into Lake Corpus Christi during the drought of record). Time of day outdoor watering restrictions prohibit lawn watering between the hours of 10:00 o'clock a.m. and 6:00 o'clock p.m. and are subject to additional conditions as described in the City of Corpus Christi's approved "Water Conservation and Drought Contingency Plan ("Plan")." To the extent of its legal authority, the City of Corpus Christi shall require its wholesale customers to implement time of day outdoor watering restrictions similar to those of the City.

~~In any month when water impounded in the Reservoir System is less than 30 percent of the storage capacity, the City of Corpus Christi may suspend the passage of inflow from the Reservoir System for targeted inflow purposes to Nueces Bay, when the City has implemented and required its customers to implement Condition III - Drought Warning as described in the Plan. However, return flows directed into Nueces Bay and/or the Nueces Delta shall continue to be made.~~

(3) In any month when Reservoir System Storage is less than 30% of total system storage capacity, the City of Corpus Christi shall implement a lawn watering schedule in addition to time of day outdoor watering restrictions (see subparagraph 2.b.(2)) and shall suspend the passage of inflow from the Reservoir System for targeted inflows to Nueces Bay. However, return flows directed into Nueces Bay and/or the Nueces Delta shall continue. The lawn watering schedule shall allow customers to water lawns no oftener than every five days, subject to the time of day restrictions described in subparagraph 2.b.(2) and any additional conditions as described in the City's Plan.

(4) Certificate Holders' rights to obtain whole or partial suspension of the passage of inflow through the reservoir is contingent upon the City implementing, and requiring its customers to implement, water conservation and drought management measures at ~~and levels of drought management, and~~ diminished Reservoir System levels, as set forth in subparagraphs b.(2) and b.(3) ~~b.(1) and b.(2)~~. ~~However, the decision whether to avail itself of relief from inflow passage, through the initiation of drought management levels, is solely that of the Certificate Holders.~~

~~The initiation of drought management levels set forth in subparagraph 2.b.(1) shall not be a prerequisite to the Certificate Holders' rights to avail themselves of complete suspension of inflow passage as provided for in subparagraph 2.b.(2).~~

~~However, suspension of inflow passage pursuant to subparagraph 2.b.(2) shall not be available unless Condition III is implemented during the month water impounded in the Reservoir System drops below 30 percent.~~

c. For purposes of this Agreed Order, Reservoir System storage capacity shall be determined by the most recently completed bathymetric survey of each reservoir. As of 2001, completed bathymetric surveys of each reservoir reports conservation storage capacities of 695,271 acre-feet (below 220.5 feet mean sea level) for Choke Canyon Reservoir (Volumetric Survey of Choke Canyon Reservoir, TWDB September 23, 1993) and 241, 241 acre-feet (below 94 feet mean sea level) for Lake Corpus Christi (Regional Water Supply Planning Study-Phase I Nueces River Basin, HDR, December, 1990). ~~figures contained in the "Regional Water Supply Planning Study - Phase I Nueces River Basin (December 1990)" by HDR and based on 1990 sedimentation conditions. According to the Study, the storage capacity for Choke Canyon Reservoir is 689,314 acre-feet (220.5 feet mean sea level) and the storage capacity for Lake Corpus Christi is 237,473 acre-feet (94 feet mean sea level) making total Reservoir System storage capacity equal to 926,787 acre-feet.~~

d. Percentage of the Reservoir System capacity shall be determined on a daily basis and shall govern, in part, the inflow to be passed through the reservoir during the remaining days of the month.

e. Within the first ten days of each month, the City of Corpus Christi shall submit to the Commission a monthly report containing the daily capacity of the Reservoir System in percentages and mean sea levels as recorded for the previous month as well as reservoir surface areas and estimated inflows to Lake Corpus Christi assuming no impoundment of inflows at Choke Canyon Reservoir. The report shall indicate which gages or measuring devices were used to determine Reservoir System capacity and estimate inflows to Lake Corpus Christi.

f. To gain the benefits of subparagraphs 2.b.(1) through 2.b.(3), the City shall:

1. Acquire ownership of properties necessary to re-open the Nueces River Overflow Channel and make the Nueces River Overflow Channel and Rincon Bayou Overflow Channel permanent features of the Rincon Bayou Diversion;

2. Construct and operate a conveyance facility to deliver up to 3,000 acre-feet per month of required Reservoir System "pass-throughs" directly from the Calallen Pool into the Upper Rincon Bayou; and

3. Implement an on-going monitoring and assessment program designed to facilitate an "adaptive management" program for freshwater inflows into the Nueces Estuary.

(Some additional clarification should provided regarding the monitoring and assessment program.)

4. Construction necessary to implement subparagraph 2.f.1.shall be accomplished by December 31, 2001 and work necessary to accomplish subparagraph 2.f.2. shall be accomplished by December 31, 2002.

5. In the event the City fails to timely complete the work set forth in subparagraphs 2.f.1. and 2.f.2., the provisions of the Agreed Order of April 28, 1995 shall become operative despite this amendment, unless the Executive Director grants a modification after considering the recommendations of the Nueces Estuary Advisory Council.

g. The executive Director is delegated authority to make modifications to subparagraph 2.f., after considering the recommendations of the Nueces Estuary Advisory Council. However, changes may be made through this process only with the City's consent if the changes result in increased costs to the City.

3. a. The City of Corpus Christi, with the assistance and/or participation of federal, state and local entities, shall maintain a monitoring program to assess the effect of this operating plan on Nueces Bay. The cornerstone of this program is the development of a salinity monitoring program. The program shall include at least two monitoring stations, one in upper Nueces Bay (Lat. 27°51'02", Long. 97°28'52") and one in mid Nueces Bay (Lat. 27°51'25", Long. 97°25'28") with the capability of providing continuous salinity and/or conductivity data, temperature, pH, and dissolved oxygen levels. Additional stations may be established at the recommendation of the Advisory Council (continued by paragraph 4 of this Agreed Order) to assess inflow effects throughout the estuarine system, but the City shall not be obligated to establish such additional stations except to the extent authorized by its City Council.

b. The City of Corpus Christi or its designated representatives shall monitor salinity levels in Upper and Mid-Nueces Bay. The lower (SLB) and upper (SUB) salinity bounds (in parts per thousand-ppt) developed for application of the Texas Estuarine Mathematical Programming Model and considered appropriate for use herein, are as follows:

	SLB	SUB		SLB	SUB
January	5	30	July	2	25
February	5	30	August	2	25
March	5	30	September	5	20
April	5	30	October	5	30
May	1	20	November	5	30
June	1	20	December	5	30

c. When the average salinity for the third week (the third week includes the seven days from the 15th through 21st) of any month is at or below the subsequent month's established SLB for upper Nueces Bay (Lat. 27°51'02", Long. 97°28'52"), no releases from the

Reservoir System to satisfy targeted Nueces Bay inflow mounts shall be required for that subsequent month.

d. All data collected as a result of the monitoring program required by paragraph 3 of this Agreed Order shall be submitted monthly to the Commission within the first ten days of the immediately following month. The Nueces Estuary Advisory Council shall study the feasibility of developing a method of granting credits for inflows which exceed the required amounts to replace the credits that are set out in subparagraph 1.e.(l) and make recommendations to the Commission for possible implementation. That method shall have as its goal the maintenance of the proper ecological environment and health of related living marine resources and the provision of maximum reasonable credits towards monthly inflow requirements.

4. a. To assist the Commission in monitoring implementation of this Order and making recommendations to the Commission relating to any changes to this Agreed Order and the establishment of future operating procedures, the Nueces Estuary Advisory Council shall be continued. Its members shall include, but are not limited to a qualified representative chosen by each of the following entities or groups: the Executive Director of the Texas Natural Resource Conservation Commission, whose representative shall serve as chair; the Texas Water Development Board; the Texas Parks and Wildlife Department; the Texas Department of Health; the General Land Office; the holders of Certificate of Adjudication No. 21-3214 (the Cities of Corpus Christi and Three Rivers and the Nueces River Authority; the University of Texas Marine Science Institute; Texas A&M University - Corpus Christi; Save Lake Corpus Christi; Corpus Christi Chamber of Commerce ~~Bay Area Business Alliance~~; the City of Mathis; Coastal Bend Bays and Estuaries Program, Inc.; a commercial bay fishing group; a conservation group (e.g. the Sierra Club and ~~or~~ the Coastal Bend Bays Foundation); wholesale water suppliers who are customers of the Certificate Holders (e.g., the South Texas Water Authority and the San Patricio Municipal Water District); the Port of Corpus Christi Authority; and a representative of industry. The representatives should have experience and knowledge relating to current or future water use and management or environmental and economic needs of the Coastal Bend area.

b. No modification shall be made to this Order without the unanimous consent of the Certificate Holders, except to the extent provided by law.

c. Matters to be studied by the Nueces Estuary Advisory Council and upon which the Executive Director shall certify recommendations to the Commission shall include, but are not limited to:

(1) the effectiveness of the inflow requirements contained in this Agreed Order on Nueces Estuary and any recommended changes;

(2) the effect of the releases from the Reservoir System upon the aquatic and wildlife habitat and other beneficial and recreational uses of Choke Canyon Reservoir and Lake Corpus Christi;

(3) the development and implementation of a short and long-term regional water management plan for the Coastal Bend Area;

(4) the salinity level to be applied in Paragraphs 1.e. and 3.c., at which targeted inflows m the subsequent month may be suspended;

(5) the feasibility of discharges at locations where the increased biological productivity justifies an inflow credit computed by multiplying the amount of discharge by a number greater than one; and development of a methodology for granting credits for inflows which exceed the required amount to replace the credits that are set out in subparagraph 1.e. That methodology shall have as its goal the maintenance of the proper ecological environment and health of related living marine resources and the provision of maximum reasonable credits towards monthly inflow requirements; and,

(6) any other matter pertinent to the conditions contained in this Agreed Order.

5. This Agreed Order shall remain in effect until amended or superseded by the Commission.

Issued date: TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

____

L:\Clients\Corpus\Choke\Corpus.Choke 1995 TNRCC ORDER rev 2-23-01 .wpd

Technical Information Regarding

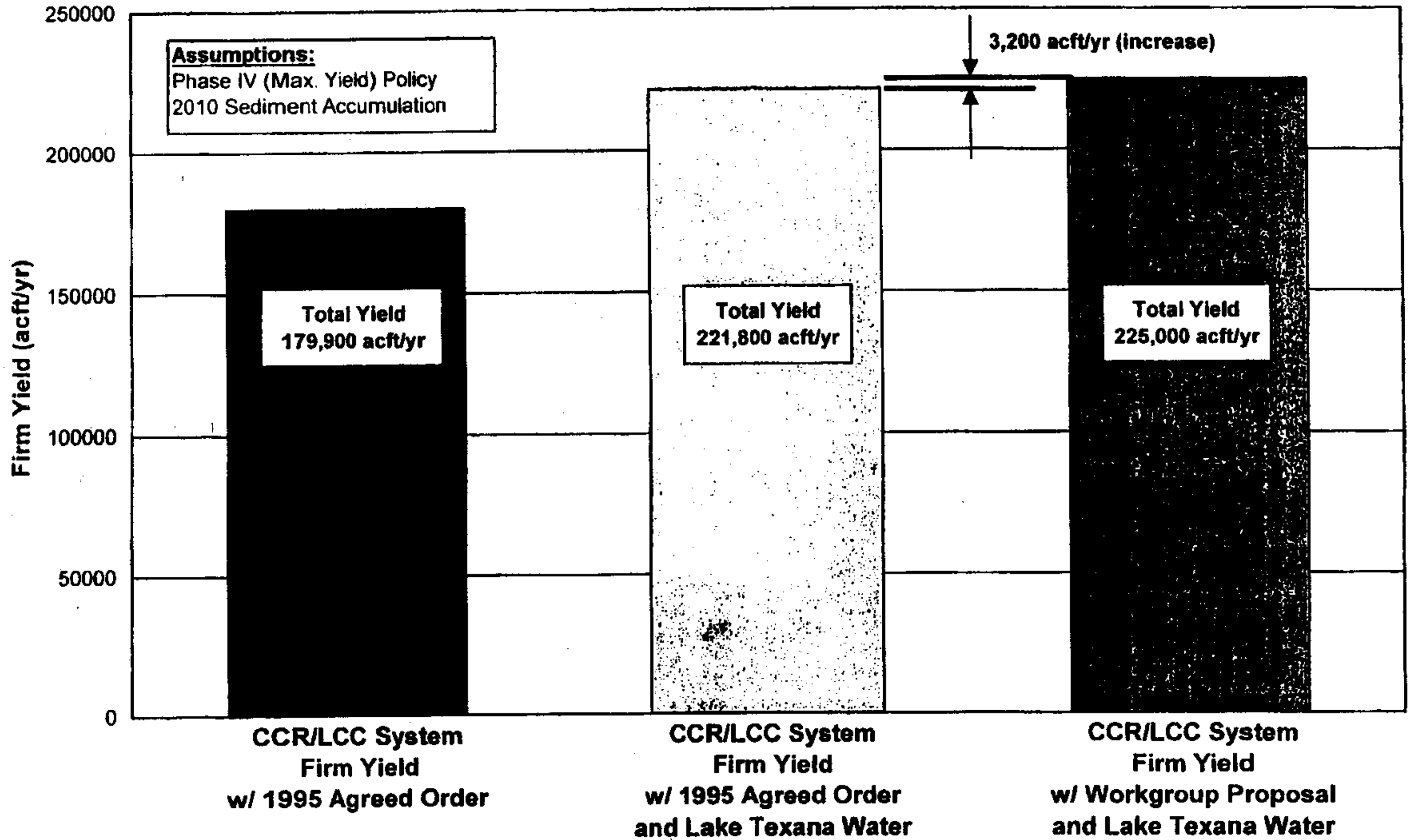
City of Corpus Christi Water Supply
and
Freshwater Inflows to the Nueces Estuary

Prepared for

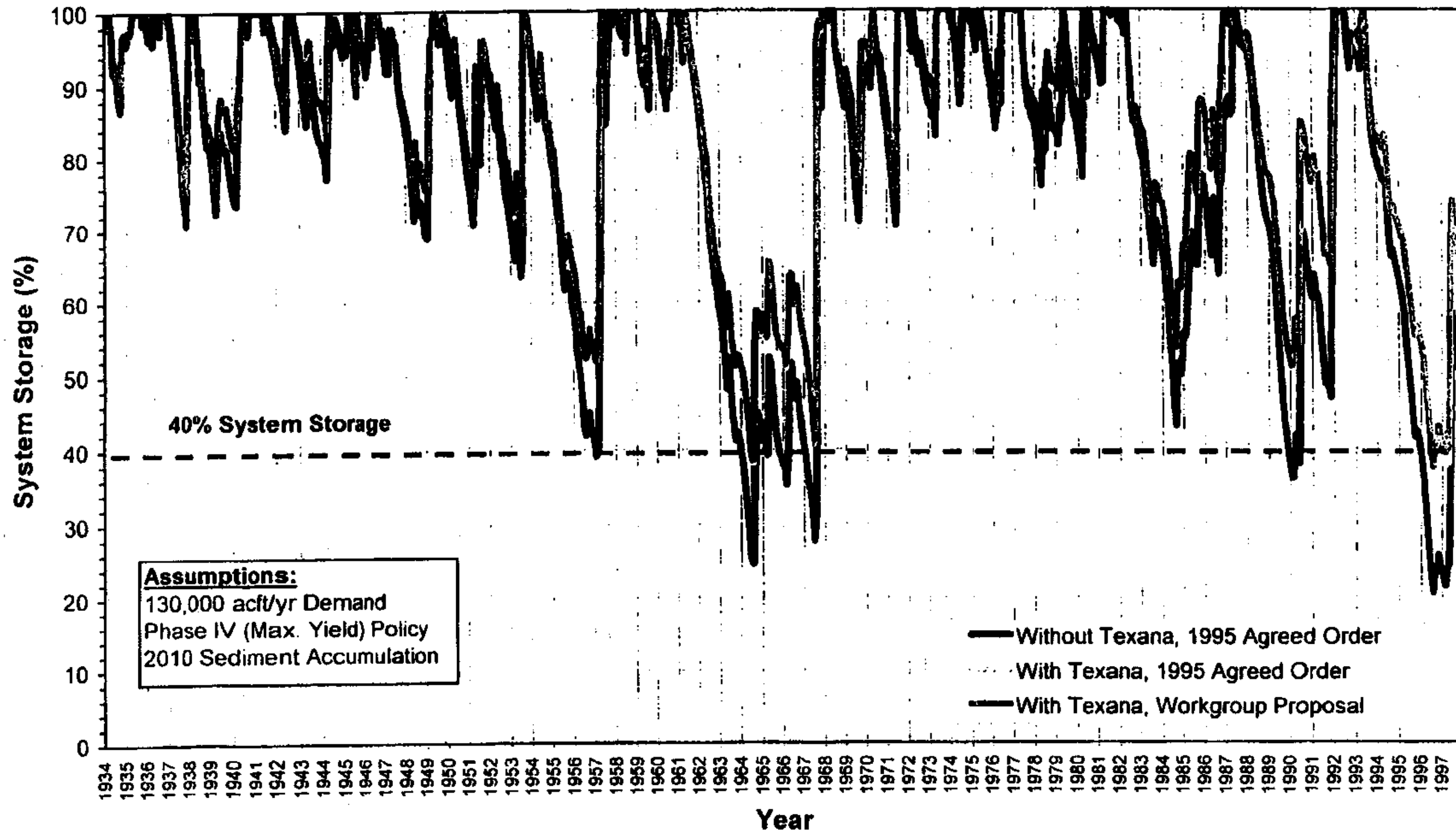
Nueces Estuary Advisory Council

HDR Engineering, Inc.
March 6, 2001

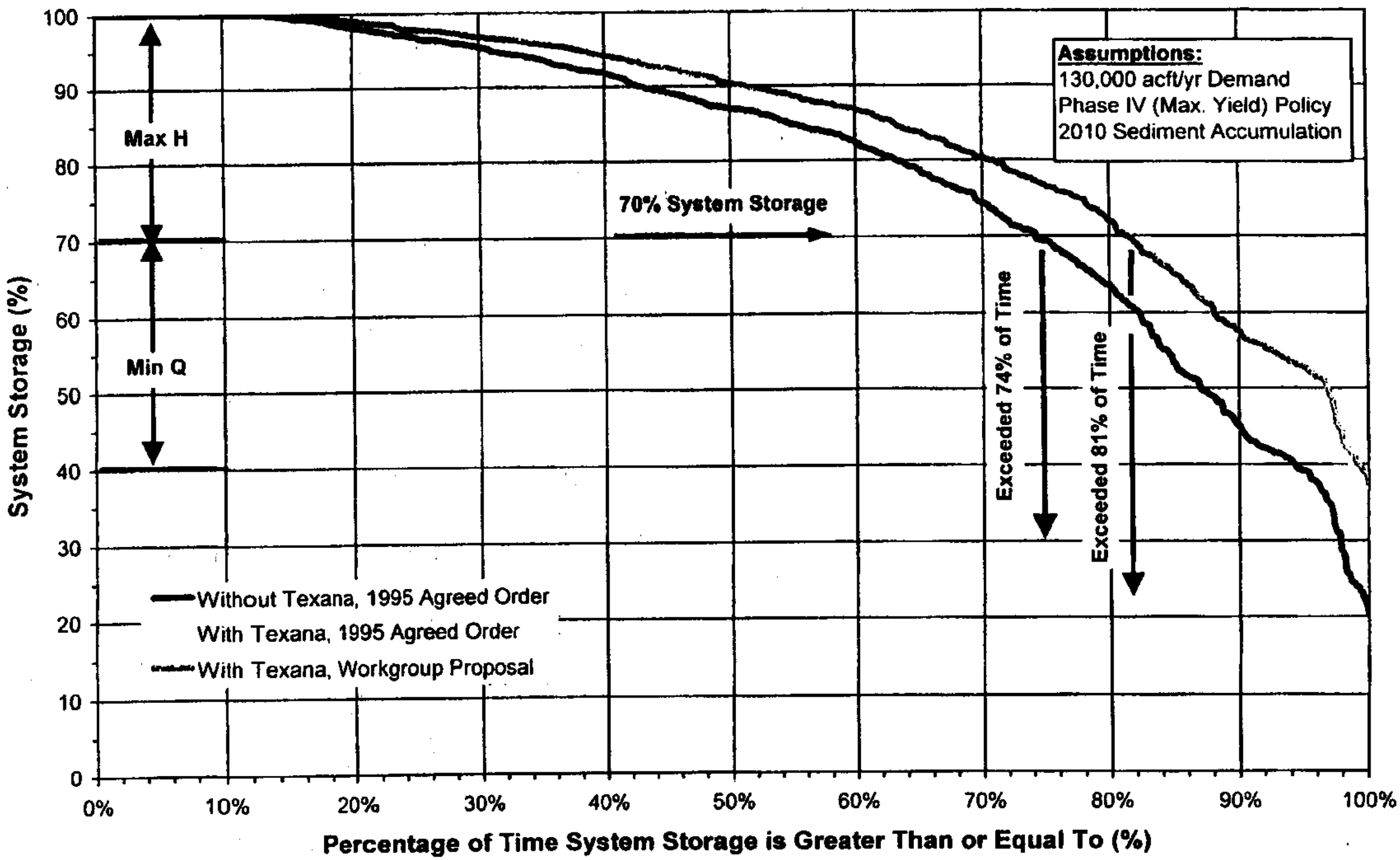
City of Corpus Christi's Firm Water Supply Summary with Workgroup Proposal



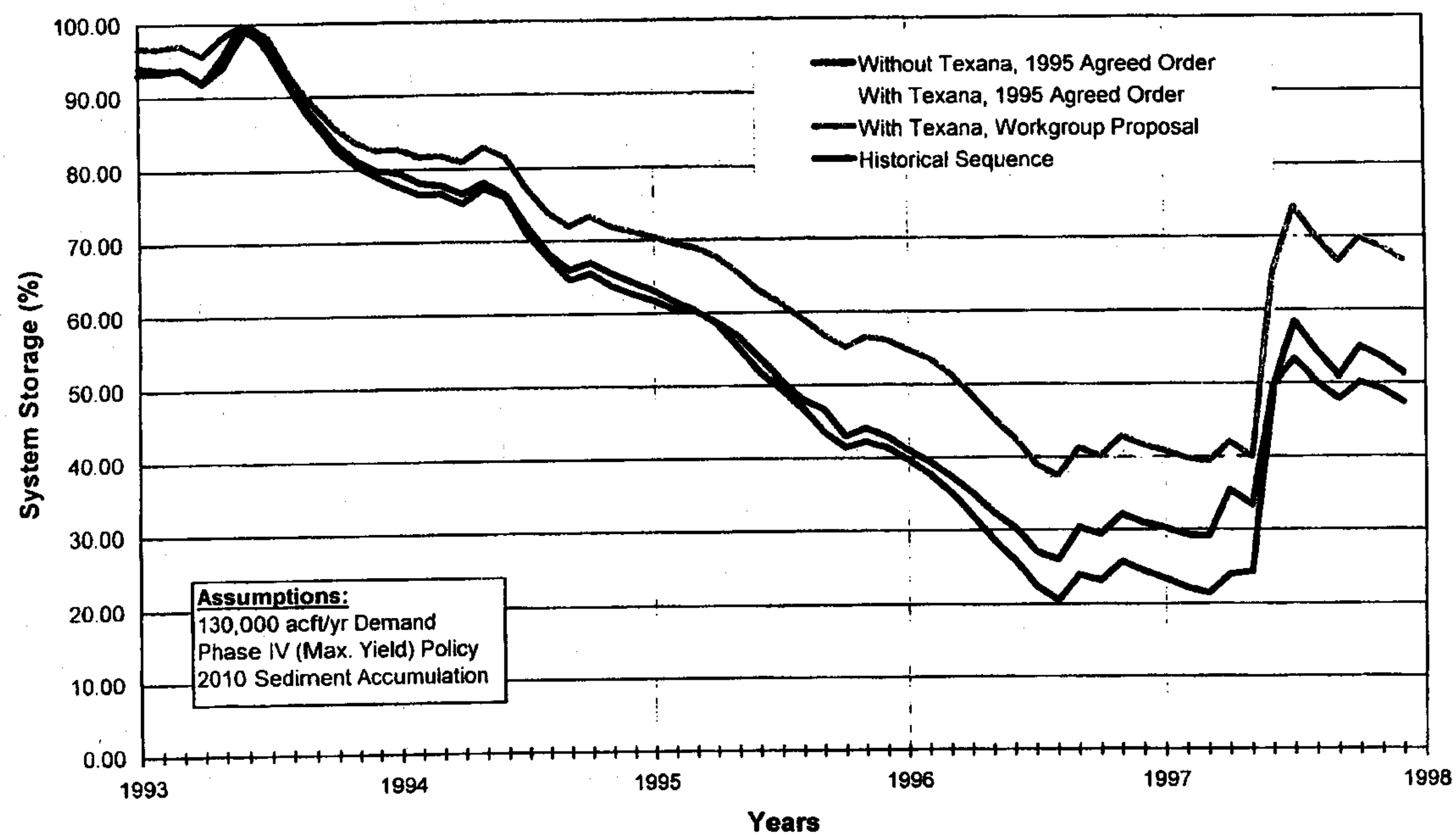
Comparison of CCR/LCC System Storage
1934 to 1997 Period of Record



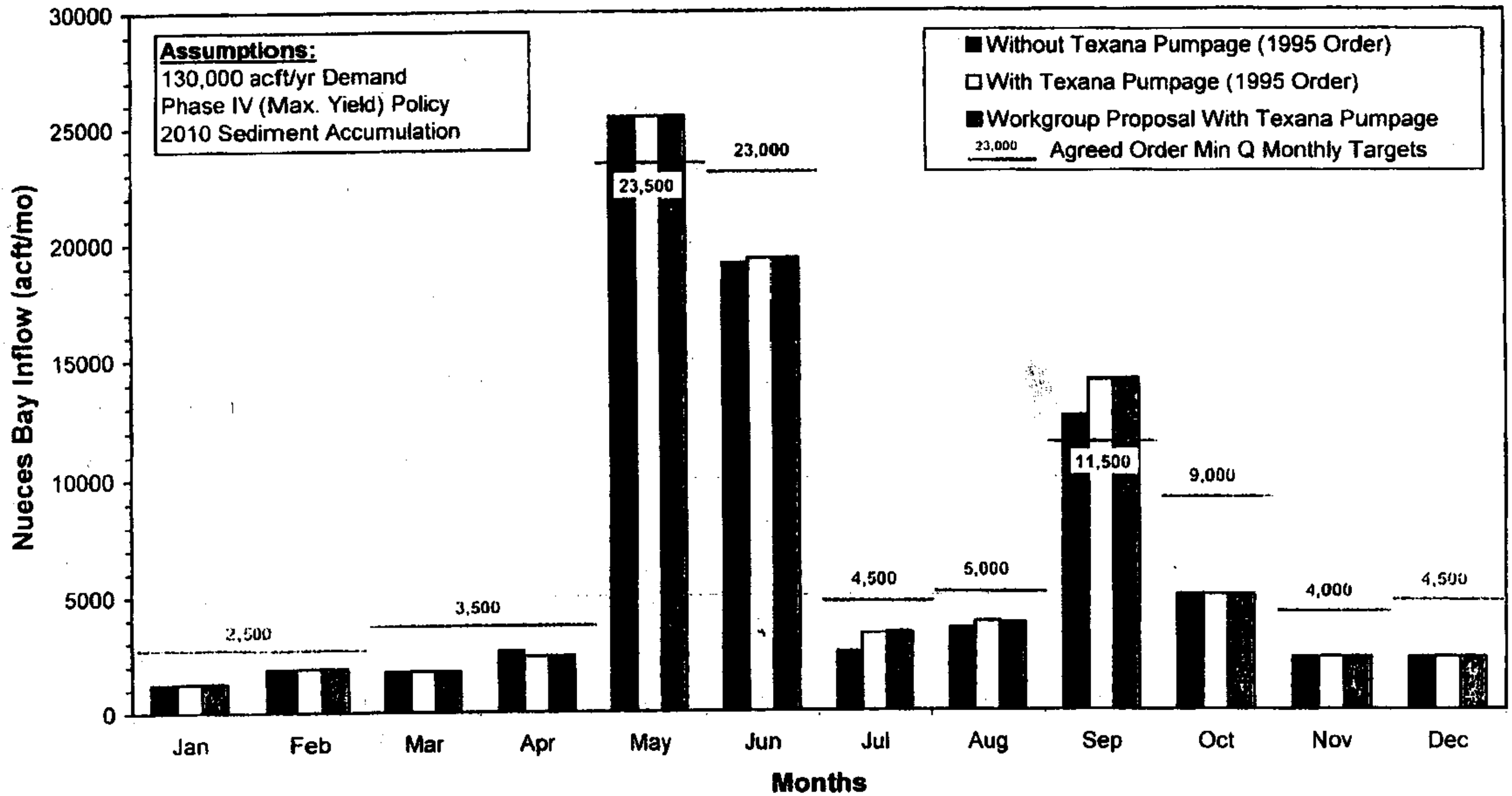
CCR/LCC System Storage Frequency



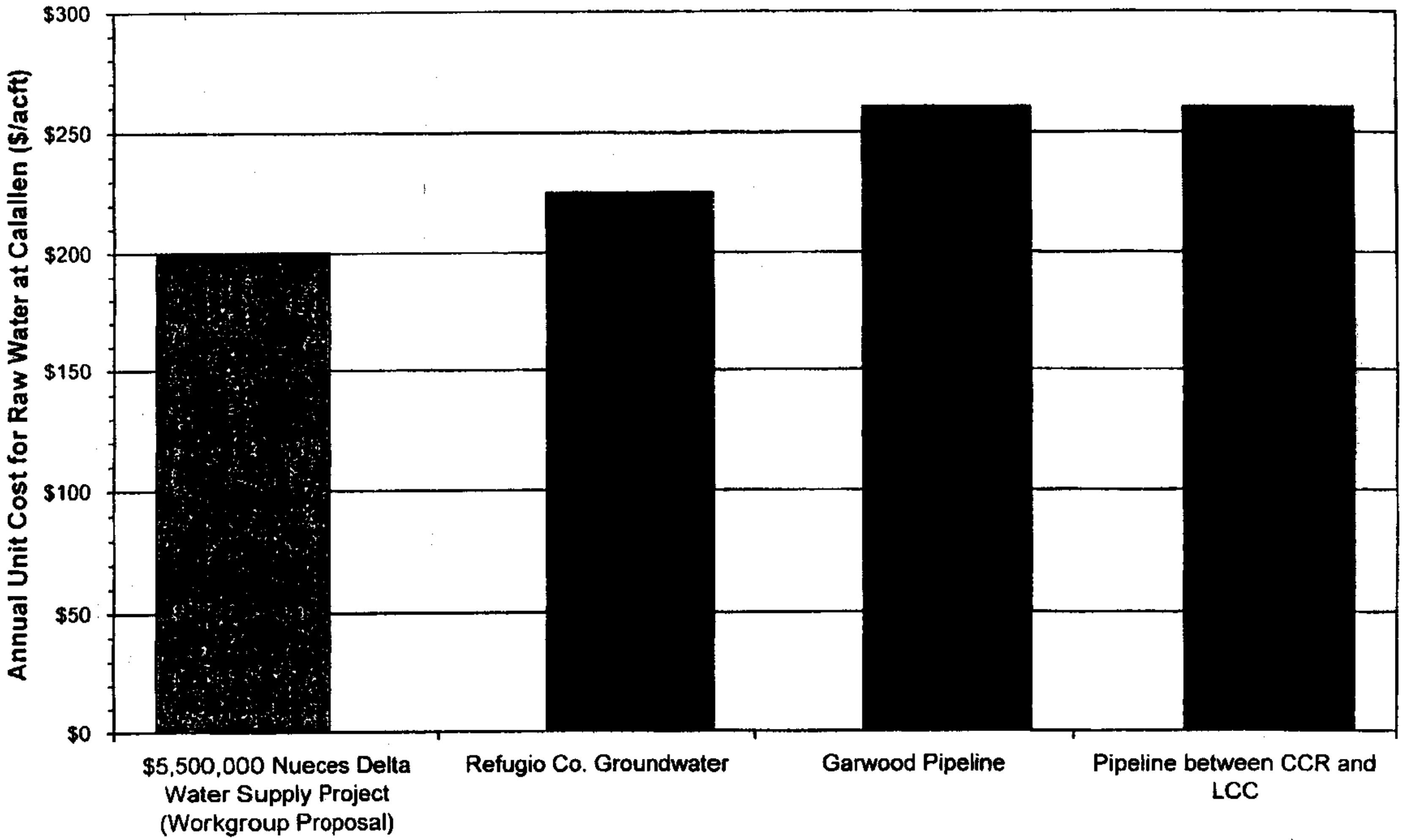
CCR/LCC System Storage Trace
1990's Drought



Median Monthly Nueces Bay Inflow
With Workgroup Proposal



Comparison of City of Corpus Christi Raw Water Supply Options



APPENDIX D

CITY OF CORPUS CHRISTI
UTILITIES BUSINESS OFFICE
U T I L I T Y   R A T E   S C H E D U L E
MONTHLY CHARGE FOR WATER SERVICE
Effective August 1, 2008

MINIMUM MONTHLY CHARGE (FOR FIRST 2,000 GALLONS)

INSIDE CITY LIMITS:

Meter Size			Minimum
5/8" x 3/4"	Residential	$	8.550
5/8" x 3/4"	Commercial		12.330
1"	. . . .		18.500
1 1/2"	. . . .		30.840
2"	. . . .		61.670
3"	. . . .		98.670
4"	. . . .		197.340
6"	. . . .		308.350
8" or larger	. . . .		616.700

OUTSIDE CITY LIMITS:

Meter Size			Minimum
5/8" x 3/4"	Residential	$	10.260
5/8" x 3/4"	Commercial		14.800
1"	. . . .		22.200
1 1/2"	. . . .		37.000
2"	. . . .		74.000
3"	. . . .		118.410
4"	. . . .		236.810
6"	. . . .		370.020
8" or larger	. . . .		740.040

MONTHLY VOLUME CHARGES PER 1,000 GALLONS (above the minimum level)

INSIDE THE CITY LIMITS:
PER 1000/GALLONS

Residential

First 2,000	Gallons		Minimum
Next 4,000	. . . .	$	2.795
Next 4,000	. . . .		3.493
Next 5,000	. . . .		4.017
Next 15,000	. . . .		4.891
Next 20,000	…………….		5.939
Next 50,000	…………….		6.463
Over 100,000	………………		6.987

Commercial

First 2,000	Gallons		Minimum
Over 2,000	. . . .	$	3.493

Large Volume-

Minimum			Minimum
First 10,000,000	Gallons	$	16,028.000
Over 10,000,000	. . . .		1.647

OUTSIDE THE CITY LIMITS:
PER 1000/GALLONS

Residential

First 2,000	Gallons		Minimum
Next 4,000	. . . .	$	1.501
Next 4,000	. . . .		1.876
Next 5,000	. . . .		2.157
Next 15,000	. . . .		2.626
Next 20,000	…………….		3.189
Next 50,000	…………….		3.471
Over 100,000	…………….		3.752

Commercial

First 2,000	Gallons		Minimum
Over 2,000	. . . .	$	1.876

Large Volume-

Minimum			Minimum
First 10,000,000	Gallons	$	26,744.000
Over 10,000,00(	. . . .		1.506

Agency for Resale

Metered at the site of treatment

First 2,000	Gallons		Minimum
Over 2,000	. . . .	$	0.877

Agency for Resale

Water delivered through City facilities					
First	2,000	Gallons		Minimum	
Over 2,000		. . . .	$		1.506

Raw water cost rate payers inside city limit $0.899/TGAL

Raw water cost rate payers outside city limits, delivered through City facilities $1.017/TGAL

Raw water cost rate payers outside city limits, return on equity not applied, metered at site of treatment $0.899/TGAL

Untreated Raw water cost outside city limits, delivered through City facilities $1.068/TGAL

Untreated Raw water, outside city limits, return on equity not applied, metered at site $0.950/TGAL

APPENDIX E

Texas Commission on Environmental Quality
Water Conservation Implementation Report

Submitting Entity

City of Corpus Christi Water Department
P. O. Box 9277
Corpus Christi, Texas 78469-9277
(361) 826.1879 Fax: (361) 826-1889

____
Gus Gonzalez, P.E., Director of Water Operations

I. WATER USES

Indicate the type(s) of water uses (example: municipal, industrial, or agricultural).

___municipal____ Use

___industrial____ Use

II. WATER CONSERVATION MEASURES IMPLEMENTED

Provide the water conservation measures and the dates the measures were implemented.

A. SYSTEM WATER AUDIT AND WATER LOSS

The City of Corpus Christi maintains accountability of system water efficiency by comparing water entering the treatment plant, treated water leaving the treatment plant and all metered water sold. The accountability of non-revenue water includes in-plant return wash water, internal plant use, basin and clear well seepage, evaporation, fire fighting, fire hydrant flushing, etc.

The utilization of Maximo software helps to compile and track work orders such leak repair summaries and meter change-out summary. Potential refinements include average pressures, meter accuracy test, permitted fire hydrant use, and other records that may be kept on water theft and unmetered uses such as street cleaning and wastewater vactor water tank fill-ups.

The City is in the process of developing a top-down water audit, using existing records to provide a detailed view of water losses within a calendar year.

Date Implemented: The City has always maintained accountability of water use and water loss.

B. METERING OF ALL CONNECTIONS

The meter installation, replacement testing, and repairs are managed optimally for water use efficiency. The meter program has several elements:

1. Require metering of all connections.
2. A policy for installation of adequate, proper-sized meters as determined by a customer's current water use patterns.
3. Direct utility metering of each duplex, triplex, and four-plex unit, whether each is on its own separate lot or there are multiple buildings on a single commercial lot.
4. Metering of all utility and publicly owned facilities.
5. Use of construction meters and access keys to account for water used in new construction.
6. Implementation of the State requirements in HB 2404, passed by the 77th Legislature Regular Session and implemented through Texas Water Code 13.502, which requires all new apartments be either directly metered by the utility or submetered by the owner.
7. Annual testing and maintenance of all meters larger than two inches. Crews regularly replace five-eighth and three-quarter-inch meters that have been in service for 15 years.
8. An effective monthly meter-reading program in which readings are estimated only in cases of inoperable meters or other extenuating circumstances. Broken meters are replaced within five working days.

Date Implemented: <u>The City has always maintained accountability of water use and water loss.</u>

The Water Department acquires high quality meters and maintains them through the regular review of metered data and revision of metering policies to ensure that the maximum amount of water consumption is accounted for. The City maintains procedures for meter repair and replacement following the methodology and frequency currently recommended in industry practices and recommended by the AWWA to include a proactive meter-testing program, and repair identified meters; and notifying customers when it appears that leaks exist on the customer's side of the meter.

Each year the Water Department will estimate its annual water saving from the BMP. Savings can be estimated based upon a statistical sample analyzed as part of the meter repair and replacement program.

The City maintains a meter replacement policy based upon a customer's concern on the accuracy of the meter. Records of meters replaced annually are maintained through the City's Maximo software. Meter replacement takes dominance over meter repair due to the cost of repairing old meters. With the conversion of standard meters to automated meter reading (AMR), the City has improved efficiency to purge old meters and eliminate water loss. The determination of water savings is difficult to assess. The City estimates 100 percent accuracy in meters based on the utilization of Automated Meter Reading Program.

C. WATER CONSERVATION PRICING

A utility rate study, as prepared by HDR Consultants, was completed in 2008 creating a new rate structure for all customer classes that specifically eliminated the declining rate structure for industrial accounts. The existing increasing block for residents was retained and additional conservation pricing structures will be examined, such as the following:

1. Seasonal rates to reduce peak demands during summer months.
2. Increasing block rates for other customer classes. Rates for single-family residential and other customer classes may be set differently to reflect the different demand patterns of the classes.

Successful adoption of a new rate structure included public input process to educate the community about the new rate structure. The City's rate structure adheres to all applicable regulatory procedures and constraints.

At least annually, the Water Department staff will annually review consumption patterns (including seasonal use) and the income and expense levels to determine if the conservation rates are effective, and make appropriate, regular rate structure adjustments as needed.

In the 2005 Water Conservation Plan, the City identified the possibility of adopting service rules to authorize the use of commercial, industrial and residential customers to install separate irrigation meters. The City has followed through with authorizing 166 irrigation accounts that consume approximately 3,500 gallons per month.

Public involvement in the development and implementation of conservation rates help to assure that the goals of the conservation pricing initiatives are met and accepted by local constituents. Public meetings, advisory groups, and public announcements are among ways to generate public involvement.

The City's priority is a rate design that sends the appropriate price signal to customers to reduce discretionary water use. To remain effective, the rates need to be adjusted periodically to take inflation into account, as well as future increases in operating costs.

Date Implemented: August 2008

Below is a copy of the revised water rate structure effective August 1, 2008.

CITY OF CORPUS CHRISTI

UTILITIES BUSINESS OFFICE

U T I L I T Y   R A T E   S C H E D U L E

MONTHLY CHARGE FOR WATER SERVICE

Effective August 1, 2008

MINIMUM MONTHLY CHARGE (FOR FIRST 2,000 GALLONS)

INSIDE CITY LIMITS:				OUTSIDE CITY LIMITS:			
Meter Size			Minimum	Meter Size			Minimum
5/8" x 3/4"	Residential	$	8.550	5/8" x 3/4"	Residential	$	10.260
5/8" x 3/4"	Commercial		12.330	5/8" x 3/4"	Commercial		14.800
1"	....		18.500	1"	....		22.200
1 1/2"	....		30.840	1 1/2"	....		37.000
2"	....		61.670	2"	....		74.000
3"	....		98.670	3"	....		118.410
4"	....		197.340	4"	....		236.810
6"	....		308.350	6"	....		370.020
8" or larger	....		616.700	8" or larger	....		740.040

MONTHLY VOLUME CHARGES PER 1,000 GALLONS (above the minimum level)

INSIDE THE CITY LIMITS: PER 1000/GALLONS Residential				OUTSIDE THE CITY LIMITS: PER 1000/GALLONS Residential			
First 2,000	Gallons		Minimum	First 2,000	Gallons		Minimum
Next 4,000	....	$	2.795	Next 4,000	....	$	1.501
Next 4,000	....		3.493	Next 4,000	....		1.876
Next 5,000	....		4.017	Next 5,000	....		2.157
Next 15,000	....		4.891	Next 15,000	....		2.626
Next 20,000	....		5.939	Next 20,000	....		3.189
Next 50,000	....		6.463	Next 50,000	....		3.471
Over 100,000	....		6.987	Over 100,000	....		3.752

Commercial				Commercial			
First 2,000	Gallons		Minimum	First 2,000	Gallons		Minimum
Over 2,000	....	$	3.493	Over 2,000	....	$	1.876

Large Volume-				Large Volume-			
Minimum			Minimum	Minimum			Minimum
First 10,000,000	Gallons	$	16,028.000	First 10,000,000	Gallons	$	26,744.000
Over 10,000,000	....		1.647	Over 10,000,00(	....		1.506

Agency for Resale			
Metered at the site of treatment			
First 2,000	Gallons		Minimum
Over 2,000	....	$	0.877

Agency for Resale

Water delivered through City facilities				
First	2,000	Gallons	Minimum	
Over 2,000		.... $		1.506

Raw water cost rate payers inside city limit $0.899/TGAL

Raw water cost rate payers outside city limits, delivered through City facilities $1.017/TGAL

Raw water cost rate payers outside city limits, return on equity not applied, metered at site of treatment $0.899/TGAL

Untreated Raw water cost outside city limits, delivered through City facilities $1.068/TGAL

Untreated Raw water, outside city limits, return on equity not applied, metered at site $0.950/TGAL

D. PROHIBITION OF WASTING WATER

Water waste prohibition measures are enforceable actions and measures that prohibit specific wasteful activities.

Under this BMP, ordinances have been enacted and enforced to prohibit wasteful activities. No person may:

1. Allow water to run off yards or plants into gutters or streets.
2. Permit or maintain defective plumbing in a home, business establishment or any location where water is used on the premises. Defective plumbing includes out-of-repair water closets, underground leaks, defective or leaking faucets and taps.
3. Allow water to flow constantly through a tap, hydrant, valve, or otherwise by any use of water connected to the City water system.
4. Use non-recycling decorative water fountain.

Water waste during irrigation includes:

1. Water running along the curb of the street;
2. Irrigation heads or sprinklers spraying directly on paved surfaces such as driveways, parking lots, and sidewalks in public right-of-ways;
3. Operation of an irrigation system with misting heads caused by water pressure higher than recommended design pressure for the heads, or operation with broken heads;
4. Prohibit spray irrigation during summer months between the hours of 10 a.m. and 6 p.m. as authorized by the City Manager and if conditions warrant.
5. The Water Department is exploring the potential for introducing ordinances requiring rain sensors and/or evapotranspiration (ET) controllers on automatic irrigation systems in the future.

Date Implemented: Ongoing

Total water savings for this BMP can be estimated from each water-wasting measure eliminated through the actions taken under this BMP. The Water Department will develop new tracking methods to determine overall water saved through the water waste prohibition efforts in future years. The City has taken the practice of sending a letter to bring attention to water-wasting activity. Typically, neighbors report such occurrences to the Water Conservation Office or the City's Call Center. Field crews make site visits to address the action and to bring the customer to eliminate the waste. The Utility Business office frequently sees homeowners who clearly have a leak or spike in water use visible through high water consumption readings. Low income customers are referred to City's Neighborhood Improvement Program to qualify for a grant for plumbing improvements. The Water Department in conjunction with the Utilities Business Office is teaming up to develop a Plumber to People Program during 2009. The program will provide financial assistance to low income homeowners to repair leaks in plumbing devices.

E. PUBLIC INFORMATION

The Water Department employs several types of media resources and modes of mass communication to present persuasive messages on the importance of water use efficiency to managing and sustaining existing water supplies and delaying the need to build new treatment facilities. The overall goal of the public information program is to raise awareness among customers and citizens of the overall picture of regional water resources and the importance of conservation.

The Water Department employs the following methods to bring the water resources awareness and to instill the importance of conservation in the community:

1. Multi-tiered media campaign. A budget of $76,700 funds annual television, radio, and print campaigns promoting water use efficiency. Agreements with radio and television stations provide for matching airtime for each ad purchased by the City.

2. Billboard advertisement. Ads on two billboards and 10 bus benches were obtained at a discount to promote the City's water conservation campaign, "Make Saving Water a Life Long Habit." The City has also initiated a campaign to address the City's 2007 water quality issues. A budget of $13,000 out of the $76,700 is reserved for billboard advertisement,

3. Website. The Water Conservation Department's website includes tips on outdoor and indoor conservation, an on-line version of the *Xeriscape-to-Go* brochure (the City's plumbing ordinance requiring drip or soaker hose irrigation on landscaped strips narrower than five feet), and information on the Xeriscape Coalition. The web link can be accessed through www.cctexas.com or www.corpuschristiwater.com

4. Printed brochures. Printed brochures available to the public are explained in the Water-Wise Landscape Design and Conversation Program:

   a. *Xeriscape To-Go: Planning and Designing a Gardener's Dream*,

   b. *Xeriscape: Landscape with Less Water*, and

   c. *Purple Water-Wise Plant Labels.*

5. School Education. Programs targeted to grade school children are explained in the School Education section. A budget of $33,000 is dedicated for school education.

6. Xeriscape Learning Center and Design Garden. As part of the Corpus Christi Museum of Science and History, the Xeriscape Corpus Christi Steering Committee, in partnership with the City Water Department, maintains a Xeriscape demonstration garden with more than 100 plant varieties. Within the garden an educational gazebo, The Water Story Exhibit, showcases and 8-foot interactive topographic map of the Nueces River Basin. A second gazebo named The Learning Center features practical landscape ideas and photographs. Educational Walk 'n' Talk Tours are held annually to enhance public education. The Xeriscape Corpus Christi Steering Committee sponsors an annual Xeriscape Symposium, free of charge.

7. City Call Center. The City's Call Center was created to encourage customers to report water line breaks, service calls and water conservation information. Customers utilize a dedicated telephone line to request water conservation kits and other information. In addition, a screen message is shown daily on the City's public access station Channel 20 that encourages customers to call for a free water saving kit. The message rotates continuously 24/7/365.

Date Implemented: Ongoing, since 1989

Water savings due to public information efforts are difficult to quantify. Water savings for other public information programs that result in specific actions by customers such as changes in irrigation scheduling or reduction in water waste occurrences may be quantified through surveys or analysis of water waste reporting in future years.

The City tracks the number of presentations made to schools or organizations. The number of community activities are documented such as the Xeriscape Symposium (60 attendees), World of Water Celebration (700), Earth Day (3,000), American Diabetes / City Job Fair (90), school campuses - science extravaganzas (1,200), AgriLife workshops (75), Del Mar College presentations (75), Home and Garden shows (1,500), etc.

Presentations have been made to Barnes, Fannin, Kostoryz, Houston, Cunningham, Los Encinos, Meadowbrook, Yeager, Moore, Evans, Sanders, Garcia and Moore Elementary. School district officials post information in their newsletters to teachers extending the opportunity to have a guest speaker from the Water Department. In addition, teachers are sent an email with a personal invitation from the Water Conservation Coordinator. Teachers welcome the opportunity to have a presenter.

Since 2006, water meters were installed at the Xeriscape garden to monitor the efficiency of water use. Meters were installed at each of the nine different irrigation zones. The application of water consumption is measured in total gallons per square foot per day and gallons per square foot per week. In order to exemplify the concept of Xeriscape, water use has gradually been decreased over several years to promote the possibility of how plant material can be lush with minimal water use. Average water use per square foot/inch ranges from 0.15 to 1.0. Leaks in the irrigation system are easily identified when water use increases above 1.0 inch per square foot.
See **Attachment B** for 2007 and 2008 for a water use summary.

F. SCHOOL EDUCATION PROGRAMS

The City of Corpus Christi Water Department offers quality educational programs to public, parochial and private schools.

- *Major Rivers*. Piloted in 1991, the self-contained *Major Rivers* curriculum, incorporated into the 4th grade curriculum, meets or exceeds the requirements of Texas Essential Knowledge and Skills (TEKS). The program educates students on water conservation, supply, treatment, distribution and conservation. The self-contained program offers academic and hands-on activities in math, language arts, science, and social studies, with teacher's guide geared to the interdisciplinary curriculum, as well as an introductory video and home information leaflets. The program includes pre- and post-test evaluations. In addition, teachers receive continuing education credits for participating in *Major Rivers* workshops. The program is funded by the City at a base price of $45 per classroom.

- *Toby Globy Eco- Action*. Introduced to school children in grades pre-kinder to second grade with classroom and special event visits by mascot Toby Globy, this locally produced bilingual program brings the environmental awareness to primary grade school children in sing-along song and coloring books, a compact disc of recorded music in English and Spanish, environment-oriented classroom activities, posters, and a pictorial instruction booklet introducing solid waste, and recycling, in addition to water conservation.

- *Learning to be Water Wise*. A program is used in 5th grade classrooms to associate science, math, language arts, and social studies to water conservation activities. Boxed kits, which include a toilet water displacement bag, toilet leak detector tablets, showerhead and faucet aerators, and instructions for repairing common toilet leaks, are given to each student. This program, has been shown to produce an estimated savings of 8,900 gallons per year in homes in which the water-saving fixtures have been installed (*Learning to Be Waterwise, City of Corpus Christi 2001-2002 Program Summary Report,* Prepared for City of Corpus Christi, Dave Munk, 2002.)

• Workshop for Daycare Teachers*.* In a half-day-long workshop, Pre-kinder to second grade teachers were introduced to age-appropriate water resources teaching aids, including the educational program "Toby Globy Eco Action Team and coloring books with a water-conservation message.

• *Water Source Book.* The *Water Source Book*, developed by the Water Environment Federation, reinforces water resource issues with hands-on classroom activities and experiments for grades 6 through 8. The classroom activities feature water, wastewater, and storm water experiments. This book is provided by the City to all local school resource libraries. Continuing education workshops, introduce local classroom teachers to the *Water Source Book.* Teachers can utilize this teaching aid to satisfy certain TEKS objectives as established by the Texas Education Agency.

• Coastal Bend Teacher Resource Extravaganza. The City Water Department has participated in the Coastal Bend Informal Educators (CBIE), to offer valuable opportunities and resources for teachers, students and the general public at the annual event. The City Water Department sponsors the event which brings environmental resources to teachers throughout Texas Education Agency Region 2 area.

• Museum of Science and History. The Corpus Christi Museum of Science and History offers guided tours to school groups. In addition, educational gazebos, targeted to children, features various showcases an 8-foot interactive topographic map of the Nueces River Basin. The touch of a button activates lights and sound to explain the area's water resources. Displays throughout the Xeriscape Learning Center and Design Garden are used as teaching tools for children and adults.

• Other educational materials. The Water Department of the City of Corpus Christi also provides age-appropriate water resources teaching materials at public events. Materials include *Splash Activity Book*, *My Book About Water and How to Use it Wisely*, and *The Story of Drinking Water.* Spanish material is also available upon request.

• Water IQ. By 2010, the City plans to adopt the Texas Water Development Boards new educational program to target middle grade students.

• Tour of the Water Treatment Plant. Student groups of all levels and community organizations have the opportunity to tour the O. N. Stevens Water Treatment Plant.

Date Implemented: _Ongoing_______________

To track the progress of this BMP, the utility should gather and have available the following documentation:

1. Number of school presentations made during reporting period:
Fourteen presentations were made to elementary and middle grade schools during 2008.

2. Number and type of curriculum materials developed and/or provided by water supplier: All elementary campuses within the Corpus Christi Independent School Districts received a copy of Major Rivers and Toby Globy Eco Action program kits. Major Rivers – 160 program kits; Toby Globy Eco Action – 192 Teacher Lesson Plan Kits; and Learning to be Water Wise – 322.

3. Number and percent of students reached by presentations and by curriculum;

A total of 2,711 students were reached through classroom presentations.

4. Number of students reached outside the utility service area:
Educational materials and literature given to teachers outside the City utility service area; however, the numbers were not quantified. The City also works with neighboring communities by offering them the opportunity to use the City's water conservation literature.

5. Number of in-service presentations or teacher's workshops conducted during reporting period:
One teacher workshop was held in conjunction with the Texas Education Agency, Region 2 relating to the Toby Globy Eco Action. A Major Rivers workshop was provided by the Texas Water Development Board.

6. Results of evaluation tools used, such as pre- and posttests, student surveys, teacher surveys:
Teachers attending the workshop completed a survey providing useful feedback. Major Rivers pre- and posttests survey results are typically not submitted back to the City.

7. Copies of program marketing and educational materials.
A sample packet of materials distributed to schools is attached.

8. Annual budget for school education programs related to conservation.
The Water Department reserves approximately $30,000 for school education programs per fiscal year.

G. WATER WISE LANDSCAPE DESIGN

The implementation of this BMP involves continual public education campaigns, including media partnering with groups such as Nueces County Master Gardeners for outreach.

The City will continue existing public outreach measures and existing educational and outreach campaigns:

1. *Xeriscape To-Go: Planning and Designing a Gardener's Dream*. A new brochure, both in print and online, designed to educate local residents on the benefits of Xeriscape landscaping, features a plant list suitable for the Coastal Bend and an explanation of the seven principles of Xeriscaping. The choice of vegetation and the Xeriscape gardening techniques save water and reduce maintenance requirements.

2. *Xeriscape: Landscape with Less Water.* A brochure describing the seven principles of Xeriscape.

3. *Purple Water-Wise Plant Labels*. A brochure produced in cooperation with the non-profit Xeriscape Corpus Christi, commercial nurseries, and Texas AgriLife Service to bring to public awareness lists of plants that are proven performers in the Coastal Bend. Also, the City's landscape ordinance assigns points to the various plant materials; drought-tolerant species are assigned a higher point value. Water-wise plants are labeled with purple tags at commercial nurseries for easy identification. Purple labels are affixed to water-wise and drought-tolerant plants offered at retail nurseries.

4. Multi-Tier Media Campaign. The City will continue local television and radio stations ads, with stations offering to match ad for ad, or provide a rate discount to the City. A television commercial featuring Texas Cooperative Extension horticulture agents will promote water-wise landscaping.

5. Xeriscape Corpus Christi. A steering committee established to develop an educational garden teaching the seven principles of Xeriscape. The garden was built at the Museum of Science and History. The steering committee's members include the City of Corpus Christi Water Department, Storm Water Department, and Park and Recreation Department, Corpus Christi Museum of Science and History, Friends of the Museum, Mayor's Water Conservation Advisory Committee,

Nueces County Master Gardeners, and Texas AgriLife Service of Nueces County.

6. Xeriscape Design Garden and Learning Center. The demonstration garden at the Museum of Science and History exhibits over 100 plant varieties. One educational gazebo, The Water Story Exhibit, showcases an 8 -foot interactive topographic map of the Nueces River Basin. The touch of a button activates lights and sound to explain the area's water resources. The second gazebo, redesigned and renamed Learning Center, features various wall exhibits. Other exhibits feature South Texas' hardiest plants, a mulch exhibit, and a classroom exhibit, as well as a feature on South Texas' hardiest plants. Garden works days are held bi- annually and the public are invited to participate. Tours are provided to schools and civic organizations upon request.

7. Rain Sensors. The Water Department will evaluate the potential for greater savings by adoption of a rain sensor ordinance requiring the use of rain sensors on all automated irrigation systems.

Evapotranspiration (ET) Controllers. The Water Department will explore the possibility of requiring ET Controllers on new and refurbished irrigation systems. These controllers may also be purchased for use with City property as demonstration project.

In addition, vegetation on each island at the Xeriscape Design Garden and Learning Center is grouped based upon water needs. Each island is separately metered, and the individual meters are read monthly. They are watered on average one-quarter inch to one-third inch per week. Rain sensors on the automatic sprinkler systems help reduce water use by running equipment only when water is needed. Landscaping at Water Department properties and some park properties survives on rainfall alone.

Date Implemented: <u>The implementation of this BMP is continual through public education campaigns.</u>

Water savings will be determined from analysis of actual customer-metered water use before and after landscape conversion and/or installation of rain sensors or ET-controllers.

In addition, the effectiveness of educational and public outreach campaigns will be assessed by analysis of peak and annual water volumes per customer class.

The City currently has 166 irrigation accounts with an average consumption of 3,500 gallons per month. The City hopes to initiate a landscape design and conversion program before 2014 to effectively monitor conversion of landscape areas, water savings, and incorporate the use of rain sensors.

H. PARK CONSERVATION

The City of Corpus Christi Parks and Recreation Department manages two golf courses; two large City-wide parks; five recreation centers; several decorative fountains; nine public swimming pools; and more than 200 neighborhood parks.

Conservation of water at parks is achieved through the prohibition on wasting water; utilizing water-wise landscape design; and metering all park connections. Field maintenance crews are required to attend training sessions that address water conservation.

Water previously flushed to storm drain inlets, as part of the City's fire hydrant flushing program, is now used to irrigate city parks in near proximity. This procedure does not completely replace the use of sprinkler irrigation at the sites. Most neighborhood parks are sustained by natural rainfall.

1. Parks properties will be included in the Water Department's System Water Audit and Loss programs identified in Section 3.2.

2. The Parks Department voluntarily adopts Landscape Ordinance provisions of the Corpus Christi Zoning Ordinance, Article 27B.

3. In compliance with Corpus Christi Plumbing Code, Section 612 Lawn Irrigation Systems.

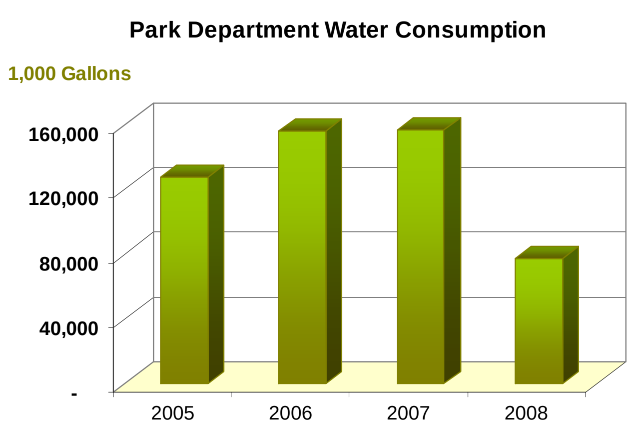
To accomplish this BMP, the Water Department will:

1. Ensure park property landscapes are planted and irrigated in compliance with City ordinances and plumbing codes within the next five years;

2. Continue the use of reclaimed wastewater for irrigation as started in 1987;

3. Beginning in 2005, include park properties in the System Water Audit and Loss programs; and

4. Ensure that other BMPs promoting efficient use of water are followed at park properties.



Date Implemented: _____On-going___________________

The Water Department compiles monthly data for irrigation water consumption from irrigation meter readings at park properties on an annual basis or more frequently during times of water shortage. Special emphasis will be placed upon evaluating data from sites before and after significant irrigation system changes or upgrades. Figure 5 identifies water consumption dropped 49 percent at park properties during calendar year 2008.

I. Reuse of Reclaimed Water

The Certificate of Adjudication for Choke Canyon Reservoir requires the City of Corpus Christi to provide no less than 151,000 acre feet of water per annum for the estuaries by a combination of releases and spills from Lake Corpus Christi and by way of return flows to the Nueces and Corpus Christi Bays and other receiving estuaries. Subsequent amendments to the City's Certificate of Adjudication refined the freshwater inflow requirements to Nueces Bay by calculating target inflows as a percentage of system storage; however the balance of effluent that can be utilized for reuse purposes by City was determined in the February 2001 TCEQ Agreed Order. The City of Corpus Christi currently has six reclaimed water use customers and recognizes that the direct use of reclaimed water is an effective method of reducing potable water usage. Reclaimed water is defined as, "Domestic or municipal wastewater which has been treated to a quality suitable for a beneficial use, pursuant to the provisions of this chapter and other applicable rules and permits" (30 TAC §210.3(24)). Corpus Christi reclaimed water is primarily used for irrigating recreational tracts and maintaining the Nueces Estuary.

To facilitate expansion of the reuse program, the Corpus Christi Water Department will identify and rank industrial, commercial, and institutional (ICI) customers according to volume of water use, and investigate the feasibility of replacing some of their potable water uses with reclaimed water. The Water Department will also investigate reuse opportunities within its own accounts or with third parties outside its service area. The City owns several public areas that are candidates for reuse.

Historically, Corpus Christi began its reuse program in the early 1960s when it began delivering reclaimed effluent to its first customer, the Gabe Lozano Golf Course. Over the next several decades, the City acquired five additional reuse customers including two more golf courses, a country club, a softball complex and the landscape median of Park Road 22. The remaining two golf courses within the City recently entered into an agreement with the City for the supply of reclaimed water. Approximately 2.5 percent of the City's overall effluent flows are reused as reclaimed water.

The Water Department will continue to deliver reclaimed water to its six customers and investigate a possible expansion of the reuse program.

In its effort to find additional reuse opportunities, the City Wastewater Department is working with the Naval Air Station to provide effluent water to its golf course. Presently, two to three percent of treated wastewater is reclaimed to irrigate golf courses and a baseball field.

Attached is a description of wastewater treatment facilities and reclaimed water distribution systems.

Date Implemented: Program started 1960's; remains on-going

Water savings are estimated at up to 100 percent of total amount of potable water replaced by reclaimed water. Changes in operating parameters or water balance calculations which depend upon water quality parameters, such as the impact of total dissolved solids (TDS) in irrigation water, may require different quantities of reuse water to be applied for same end uses.

For the period of 2006 through 2008, 876 million gallons of wastewater effluent was applied to four golf courses and baseball parks. Additional details are shown in the attached Utility Profile Report.

J. Plumbing Assistance

The Water Department plans to develop an affordability program to provide plumbing assistance to low-income homeowners. The Utility Business Office reports that low-income residents often find themselves with high water consumption resulting from leaky plumbing devices for which they cannot afford to repair. The intent of the program is two-fold: (1) to eliminate the cycle of uncollected high water bills resulting from water leaks; (2) to promote water conservation.

Date Implemented: ____Fiscal Year 2009-2010________________

To determine water savings, a comparison will be made based on previous water consumption data to that of consumption data after repairs are made. An evaluation of plumbing leaks can be made by the plumber to determine the estimated waste of water by the defective plumbing device.

III. TARGETS

A. Provide the **specific and quantified five and ten-year targets** as listed in water conservation plan for previous planning period.

5-Year Specific/Quantified Target: ___234 gpcd / 233 gpcd________________________

Date to achieve target: _________Year 2008____________________________________

10-Year Specific/Quantified Target: ___223 gpcd_______________________________

Date to achieve target: ____Year 2013_______________________________________

B. State if these targets in the water conservation plan are being met.

___The City of Corpus Christi Water Department anticipated per capita goal for 2008 was set at of 234 gpcd. Actual calculations indicate that we met that goal with 233 gpcd.__________

C. List the **actual amount of water saved.**

D. If the targets are not being met, provide an explanation as to why, including any progress on the targets.

___Target was met_

If you have any questions on how to fill out this form or about the Water Conservation program, please contact us at 512/239-4691.
Individuals are entitled to request and review their personal information that the agency gathers on its forms. They may also have any errors in their information corrected. To review such information, contact us at 512-239-3282.

APPENDIX E

Texas Commission on Environmental Quality
Water Conservation Implementation Report

Submitting Entity

City of Corpus Christi Water Department
P. O. Box 9277
Corpus Christi, Texas 78469-9277
(361) 826.1689 Fax: (361) 826-1889

____
Gus Gonzalez, P.E., Director of Water Operations

I. WATER USES

Indicate the type(s) of water uses (example: municipal, industrial, or agricultural).

___municipal____ Use

___industrial____ Use

II. WATER CONSERVATION MEASURES IMPLEMENTED

Provide the water conservation measures and the dates the measures were implemented.

A. SYSTEM WATER AUDIT AND WATER LOSS

The City of Corpus Christi maintains accountability for the efficiency of its system water by comparing raw water entering the treatment plant, treated water leaving the facility and accounting for all metered water sold. The accountability of non-revenue water includes in-plant return wash water, internal plant use, basin and clear well seepage, evaporation, fire fighting, fire hydrant flushing, etc.

The utilization of Maximo software helps to compile and track work orders such leak repair summaries and meter change-out summary. Potential refinements include average pressures, meter accuracy test, permitted fire hydrant use, and other records that may be kept on water theft and unmetered uses such as street cleaning and wastewater vactor water tank fill-ups.

The City is in the process of developing a top-down water audit, using existing records to provide a detailed view of water losses within a calendar year.

Date Implemented: The City has always maintained accountability of water use and water loss.

B. METERING OF ALL CONNECTIONS

The meter installation, replacement testing, and repairs are managed optimally for water use efficiency. The meter program has several elements:

1. Require metering of all connections.
2. A policy for installation of adequate, proper-sized meters as determined by a customer's current water use patterns.
3. Direct utility metering of each duplex, triplex, and four-plex unit, whether each is on its own separate lot or there are multiple buildings on a single commercial lot.
4. Metering of all utility and publicly owned facilities.
5. Use of construction meters and access keys to account for water used in new construction.
6. Implementation of the State requirements in HB 2404, passed by the 77th Legislature Regular Session and implemented through Texas Water Code 13.502, which requires all new apartments be either directly metered by the utility or submetered by the owner.
7. Annual testing and maintenance of all meters larger than two inches. Crews regularly replace five-eighth and three-quarter-inch meters that have been in service for 15 years.
8. An effective monthly meter-reading program in which readings are estimated only in cases of inoperable meters or other extenuating circumstances. Broken meters are replaced within five working days.

Date Implemented: <u>The City has always maintained accountability of water use and water loss.</u>

The Water Department acquires high quality meters and maintains them through the regular review of metered data and revision of metering policies to ensure that the maximum amount of water consumption is accounted for. The City maintains procedures for meter repair and replacement following the methodology and frequency currently recommended in industry practices and recommended by the AWWA to include a proactive meter-testing program, and repair identified meters; and notifying customers when it appears that leaks exist on the customer's side of the meter.

Each year the Water Department will estimate its annual water saving from the BMP. Savings can be estimated based upon a statistical sample analyzed as part of the meter repair and replacement program.

The City maintains a meter replacement policy based upon a customer's concern on the accuracy of the meter. Records of meters replaced annually are maintained through the City's Maximo software. Meter replacement takes dominance over meter repair due to the cost of repairing old meters. With the conversion of standard meters to automated meter reading (AMR), the City has improved efficiency to purge old meters and eliminate water loss. The determination of water savings is difficult to assess. The City estimates 100 percent accuracy in meters based on the utilization of Automated Meter Reading Program.

C. WATER CONSERVATION PRICING

A utility rate study, as prepared by HDR Consultants, was completed in 2008 creating a new rate structure for all customer classes that specifically eliminated the declining rate structure for industrial accounts. The existing increasing block for residents was retained and additional conservation pricing structures will be examined, such as the following:

1. Seasonal rates to reduce peak demands during summer months.
2. Increasing block rates for other customer classes. Rates for single-family residential
and other customer classes may be set differently to reflect the different demand patterns of the classes.

Successful adoption of a new rate structure included public input process to educate the community about the new rate structure. The City's rate structure adheres to all applicable regulatory procedures and constraints.

At least annually, the Water Department staff will annually review consumption patterns (including seasonal use) and the income and expense levels to determine if the conservation rates are effective, and make appropriate, regular rate structure adjustments as needed.

In the 2005 Water Conservation Plan, the City identified the possibility of adopting service rules to authorize the use of commercial, industrial and residential customers to install separate irrigation meters. The City has followed through with authorizing 166 irrigation accounts that consume approximately 3,500 gallons per month.

Public involvement in the development and implementation of conservation rates help to assure that the goals of the conservation pricing initiatives are met and accepted by local constituents. Public meetings, advisory groups, and public announcements are among ways to generate public involvement.

The City's priority is a rate design that sends the appropriate price signal to customers to reduce discretionary water use. To remain effective, the rates need to be adjusted periodically to take inflation into account, as well as future increases in operating costs.

Date Implemented: August 2008

Below is a copy of the revised water rate structure effective August 1, 2008.

CITY OF CORPUS CHRISTI
UTILITIES BUSINESS OFFICE
UTILITY RATE SCHEDULE
MONTHLY CHARGE FOR WATER SERVICE
Effective August 1, 2008

MINIMUM MONTHLY CHARGE (FOR FIRST 2,000 GALLONS)

INSIDE CITY LIMITS:			OUTSIDE CITY LIMITS:		
Meter Size		Minimum	Meter Size		Minimum
5/8" x 3/4"	Residential $	8.550	5/8" x 3/4"	Residential $	10.260
5/8" x 3/4"	Commercial	12.330	5/8" x 3/4"	Commercial	14.800
1"	....	18.500	1"	....	22.200
1 1/2"	....	30.840	1 1/2"	....	37.000
2"	....	61.670	2"	....	74.000
3"	....	98.670	3"	....	118.410
4"	....	197.340	4"	....	236.810
6"	....	308.350	6"	....	370.020
8" or larger	....	616.700	8" or larger	....	740.040

MONTHLY VOLUME CHARGES PER 1,000 GALLONS (above the minimum level)

INSIDE THE CITY LIMITS: PER 1000/GALLONS			OUTSIDE THE CITY LIMITS: PER 1000/GALLONS		
Residential			Residential		
First 2,000	Gallons	Minimum	First 2,000	Gallons	Minimum
Next 4,000	.... $	2.795	Next 4,000	.... $	1.501
Next 4,000	....	3.493	Next 4,000	....	1.876
Next 5,000	....	4.017	Next 5,000	....	2.157
Next 15,000	....	4.891	Next 15,000	....	2.626
Next 20,000	....	5.939	Next 20,000	....	3.189
Next 50,000	....	6.463	Next 50,000	....	3.471
Over 100,000	....	6.987	Over 100,000	....	3.752
Commercial			Commercial		
First 2,000	Gallons	Minimum	First 2,000	Gallons	Minimum
Over 2,000	.... $	3.493	Over 2,000	.... $	1.876

Large Volume-			Large Volume-		
Minimum		Minimum	Minimum		Minimum
First 10,000,000	Gallons $	16,028.000	First 10,000,000	Gallons $	26,744.000
Over 10,000,000	....	1.647	Over 10,000,00(	....	1.506

Agency for Resale		
Metered at the site of treatment		
First 2,000	Gallons	Minimum
Over 2,000	.... $	0.877

Agency for Resale

Water delivered through City facilities	
First 2,000 Gallons	Minimum
Over 2,000	$1.506

Raw water cost rate payers inside city limit $0.899/TGAL
Raw water cost rate payers outside city limits, delivered through City facilities $1.017/TGAL
Raw water cost rate payers outside4 city limits, return on equity not applied, metered at site of treatment $0.899/TGAL
Untreated raw water cost outside city limits, delivered through City facilities $1.068/TGAL
Untreated raw water, outside city limits, return on equity not applied, metered at site $0.950/TGL

D. PROHIBITION OF WASTING WATER

Water waste prohibition measures are enforceable actions and measures that prohibit specific wasteful activities.

Under this BMP, ordinances have been enacted and enforced to prohibit wasteful activities. No person may:

1. Allow water to run off yards or plants into gutters or streets.
2. Permit or maintain defective plumbing in a home, business establishment or any location where water is used on the premises. Defective plumbing includes out-of-repair water closets, underground leaks, defective or leaking faucets and taps.
3. Allow water to flow constantly through a tap, hydrant, valve, or otherwise by any use of water connected to the City water system.
4. Use non-recycling decorative water fountain.

Water waste during irrigation includes:

1. Water running along the curb of the street;
2. Irrigation heads or sprinklers spraying directly on paved surfaces such as driveways, parking lots, and sidewalks in public right-of-ways;
3. Operation of an irrigation system with misting heads caused by water pressure higher than recommended design pressure for the heads, or operation with broken heads;
4. Prohibit spray irrigation during summer months between the hours of 10 a.m. and 6 p.m. as authorized by the City Manager and if conditions warrant.
5. The Water Department is exploring the potential for introducing ordinances requiring rain sensors and/or evapotranspiration (ET) controllers on automatic irrigation systems in the future.

Date Implemented: Ongoing

Total water savings for this BMP can be estimated from each water-wasting measure eliminated through the actions taken under this BMP. The Water Department will develop new tracking methods to determine overall water saved through the water waste prohibition efforts in future years. The City has taken the practice of sending a letter to bring attention to water-wasting activity. Typically, neighbors report such occurrences to the Water Conservation Office or the City's Call Center. Field crews make site visits to address the action and to bring the customer to eliminate the waste. The Utility Business office frequently sees homeowners who clearly have a leak or spike in water use visible through high water consumption readings. Low income customers are referred to City's Neighborhood Improvement Program to qualify for a grant for plumbing improvements. The Water Department in conjunction with the Utilities Business Office is teaming up to develop a Plumber to People Program during 2009. The program will provide financial assistance to low income homeowners to repair leaks in plumbing devices.

E. PUBLIC INFORMATION

The Water Department employs several types of media resources and modes of mass communication to present persuasive messages on the importance of water use efficiency to managing and sustaining existing water supplies and delaying the need to build new treatment facilities. The overall goal of the public information program is to raise awareness among customers and citizens of the overall picture of regional water resources and the importance of conservation.

The Water Department employs the following methods to bring the water resources awareness and to instill the importance of conservation in the community:

1. Multi-tiered media campaign. A budget of $76,700 funds annual television, radio, and print campaigns promoting water use efficiency. Agreements with radio and television stations provide for matching airtime for each ad purchased by the City.

2. Billboard advertisement. Ads on two billboards and 10 bus benches were obtained at a discount to promote the City's water conservation campaign, "Make Saving Water a Life Long Habit." The City has also initiated a campaign to address the City's 2007 water quality issues. A budget of $13,000 out of the $76,700 is reserved for billboard advertisement,

3. Website. The Water Conservation Department's website includes tips on outdoor and indoor conservation, an on-line version of the *Xeriscape-to-Go* brochure (the City's plumbing ordinance requiring drip or soaker hose irrigation on landscaped strips narrower than five feet), and information on the Xeriscape Coalition. The web link can be accessed through www.cctexas.com or www.corpuschristiwater.com

4. Printed brochures. Printed brochures available to the public are explained in the Water-Wise Landscape Design and Conversation Program:

   a. *Xeriscape To-Go: Planning and Designing a Gardener's Dream*,

   b. *Xeriscape: Landscape with Less Water*, and

   c. *Purple Water-Wise Plant Labels.*

5. School Education. Programs targeted to grade school children are explained in the School Education section. A budget of $33,000 is dedicated for school education.

6. Xeriscape Learning Center and Design Garden. As part of the Corpus Christi Museum of Science and History, the Xeriscape Corpus Christi Steering Committee, in partnership with the City Water Department, maintains a Xeriscape demonstration garden with more than 100 plant varieties. Within the garden an educational gazebo, The Water Story Exhibit, showcases and 8-foot interactive topographic map of the Nueces River Basin. A second gazebo named The Learning Center features practical landscape ideas and photographs. Educational Walk 'n' Talk Tours are held annually to enhance public education. The Xeriscape Corpus Christi Steering Committee sponsors an annual Xeriscape Symposium, free of charge.

7. City Call Center. The City's Call Center was created to encourage customers to report water line breaks, service calls and water conservation information. Customers utilize a dedicated telephone line to request water conservation kits and other information. In addition, a screen message is shown daily on the City's public access station Channel 20 that encourages customers to call for a free water saving kit. The message rotates continuously 24/7/365.

Date Implemented: Ongoing, since 1989

Water savings due to public information efforts are difficult to quantify. Water savings for other public information programs that result in specific actions by customers such as changes in irrigation scheduling or reduction in water waste occurrences may be quantified through surveys or analysis of water waste reporting in future years.

The City tracks the number of presentations made to schools or organizations. The number of community activities are documented such as the Xeriscape Symposium (60 attendees), World of Water Celebration (700), Earth Day (3,000), American Diabetes / City Job Fair (90), school campuses - science extravaganzas (1,200), AgriLife Extension workshops (75), Del Mar College presentations (75), Home and Garden shows (1,500), etc.

Presentations have been made to Barnes, Fannin, Kostoryz, Houston, Cunningham, Los Encinos, Meadowbrook, Yeager, Moore, Evans, Sanders, Garcia and Moore Elementary. School district officials post information in their newsletters to teachers extending the opportunity to have a guest speaker from the Water Department. In addition, teachers are sent an email with a personal invitation from the Water Conservation Coordinator. Teachers welcome the opportunity to have a presenter.

Since 2006, water meters were installed at the Xeriscape garden to monitor the efficiency of water use. Meters were installed at each of the nine different irrigation zones. The application of water consumption is measured in total gallons per square foot per day and gallons per square foot per week. In order to exemplify the concept of Xeriscape, water use has gradually been decreased over several years to promote the possibility of how plant material can be lush with minimal water use. Average water use per square foot/inch ranges from 0.15 to 1.0. Leaks in the irrigation system are easily identified when water use increases above 1.0 inch per square foot. See **Attachment B** for 2007 and 2008 for a water use summary.

F. SCHOOL EDUCATION PROGRAMS

The City of Corpus Christi Water Department offers quality educational programs to public, parochial and private schools.

- *Major Rivers*. Piloted in 1991, the self-contained *Major Rivers* curriculum, incorporated into the 4^{th} grade curriculum, meets or exceeds the requirements of Texas Essential Knowledge and Skills (TEKS). The program educates students on water conservation, supply, treatment, distribution and conservation. The self-contained program offers academic and hands-on activities in math, language arts, science, and social studies, with teacher's guide geared to the interdisciplinary curriculum, as well as an introductory video and home information leaflets. The program includes pre- and post-test evaluations. In addition, teachers receive continuing education credits for participating in *Major Rivers* workshops. The program is funded by the City at a base price of $45 per classroom.

- *Toby Globy Eco- Action*. Introduced to school children in grades pre-kinder to second grade with classroom and special event visits by mascot Toby Globy, this locally produced bilingual program brings the environmental awareness to primary grade school children in sing-along song and coloring books, a compact disc of recorded music in English and Spanish, environment-oriented classroom activities, posters, and a pictorial instruction booklet introducing solid waste, and recycling, in addition to water conservation.

- *Learning to be Water Wise*. A program is used in 5th grade classrooms to associate science, math, language arts, and social studies to water conservation activities. Boxed kits, which include a toilet water displacement bag, toilet leak detector tablets, showerhead and faucet aerators, and instructions for repairing common toilet leaks, are given to each student. This program, has been shown to produce an estimated savings of 8,900 gallons per year in homes in which the water-saving fixtures have been installed (*Learning to Be WaterWise, City of Corpus Christi 2001-2002 Program Summary Report,* Prepared for City of Corpus Christi, Dave Munk, 2002.)

• Workshop for Daycare Teachers*.* In a half-day-long workshop, Pre-kinder to second grade teachers were introduced to age-appropriate water resources teaching aids, including the educational program "Toby Globy Eco Action Team and coloring books with a water-conservation message.

• *Water Source Book.* The *Water Source Book*, developed by the Water Environment Federation, reinforces water resource issues with hands-on classroom activities and experiments for grades 6 through 8. The classroom activities feature water, wastewater, and storm water experiments. This book is provided by the City to all local school resource libraries. Continuing education workshops, introduce local classroom teachers to the *Water Source Book.* Teachers can utilize this teaching aid to satisfy certain TEKS objectives as established by the Texas Education Agency.

• Coastal Bend Teacher Resource Extravaganza. The City Water Department has participated in the Coastal Bend Informal Educators (CBIE), to offer valuable opportunities and resources for teachers, students and the general public at the annual event. The City Water Department sponsors the event which brings environmental resources to teachers throughout Texas Education Agency Region 2 area.

• Museum of Science and History. The Corpus Christi Museum of Science and History offers guided tours to school groups. In addition, educational gazebos, targeted to children, features various showcases an 8-foot interactive topographic map of the Nueces River Basin. The touch of a button activates lights and sound to explain the area's water resources. Displays throughout the Xeriscape Learning Center and Design Garden are used as teaching tools for children and adults.

• Other educational materials. The Water Department of the City of Corpus Christi also provides age-appropriate water resources teaching materials at public events. Materials include *Splash Activity Book*, *My Book About Water and How to Use it Wisely*, and *the Story of Drinking Water.* Spanish material is also available upon request.

• Water IQ. By 2010, the City plans to adopt the Texas Water Development Boards new educational program to target middle grade students.

• Tour of the Water Treatment Plant. Student groups of all levels and community organizations have the opportunity to tour the O. N. Stevens Water Treatment Plant.

Date Implemented: __Ongoing________________

To track the progress of this BMP, the utility should gather and have available the following documentation:

1. Number of school presentations made during reporting period:
Fourteen presentations were made to elementary and middle grade schools during 2008.

2. Number and type of curriculum materials developed and/or provided by water supplier: All elementary campuses within the Corpus Christi Independent School Districts received a copy of Major Rivers and Toby Globy Eco Action program kits. Major Rivers – 160 program kits; Toby Globy Eco Action – 192 Teacher Lesson Plan Kits; and Learning to be Water Wise – 322.

3. Number and percent of students reached by presentations and by curriculum;

A total of 2,711 students were reached through classroom presentations.

4. Number of students reached outside the utility service area:
Educational materials and literature given to teachers outside the City utility service area; however, the numbers were not quantified. The City also works with neighboring communities by offering them the opportunity to use the City's water conservation literature.

5. Number of in-service presentations or teacher's workshops conducted during reporting period:
One teacher workshop was held in conjunction with the Texas Education Agency, Region 2 relating to the Toby Globy Eco Action. A Major Rivers workshop was provided by the Texas Water Development Board.

6. Results of evaluation tools used, such as pre- and posttests, student surveys, teacher surveys:
Teachers attending the workshop completed a survey providing useful feedback. Major Rivers pre- and posttests survey results are typically not submitted back to the City.

7. Copies of program marketing and educational materials.
A sample packet of materials distributed to schools is attached.

8. Annual budget for school education programs related to conservation.
The Water Department reserves approximately $30,000 for school education programs per fiscal year.

G. WATER WISE LANDSCAPE DESIGN

The implementation of this BMP involves continual public education campaigns, including media partnering with groups such as Nueces County Master Gardeners for outreach.

The City will continue existing public outreach measures and existing educational and outreach campaigns:

1. *Xeriscape To-Go: Planning and Designing a Gardener's Dream*. A new brochure, both in print and online, designed to educate local residents on the benefits of Xeriscape landscaping, features a plant list suitable for the Coastal Bend and an explanation of the seven principles of Xeriscape. The choice of vegetation and the Xeriscape gardening techniques save water and reduce maintenance requirements.

2. *Xeriscape: Landscape with Less Water.* A brochure describing the seven principles of Xeriscape.

3. *Purple Water-Wise Plant Labels*. A brochure produced in cooperation with the non-profit Xeriscape Corpus Christi, commercial nurseries, and Texas AgriLife Extension to bring to public awareness lists of plants that are proven performers in the Coastal Bend. Also, the City's landscape ordinance assigns points to the various plant materials; drought-tolerant species are assigned a higher point value. Water-wise plants are labeled with purple tags at commercial nurseries for easy identification. Purple labels are affixed to water-wise and drought-tolerant plants offered at retail nurseries.

4. Multi-Tier Media Campaign. The City will continue local television and radio stations ads, with stations offering to match ad for ad, or provide a rate discount to the City. A television commercial featuring Texas Cooperative Extension horticulture agents will promote water-wise landscaping.

5. Xeriscape Corpus Christi. A steering committee established to develop an educational garden teaching the seven principles of Xeriscape. The garden was built at the Museum of Science and History. The steering committee's members include the City of Corpus Christi Water Department, Storm Water Department, and Park and Recreation Department, Corpus Christi Museum of Science and History, Friends of the Museum, Mayor's Water Conservation Advisory Committee,

Nueces County Master Gardeners, and Texas AgriLife Extension of Nueces County.

6. Xeriscape Design Garden and Learning Center. The demonstration garden at the Museum of Science and History exhibits over 100 plant varieties. One educational gazebo, The Water Story Exhibit, showcases an 8 -foot interactive topographic map of the Nueces River Basin. The touch of a button activates lights and sound to explain the area's water resources. The second gazebo, redesigned and renamed Learning Center, features various wall exhibits. Other exhibits feature South Texas' hardiest plants, a mulch exhibit, and a classroom exhibit, as well as a feature on South Texas' hardiest plants. Garden works days are held bi- annually and the public are invited to participate. Tours are provided to schools and civic organizations upon request.

7. Rain Sensors. The Water Department will evaluate the potential for greater savings by adoption of a rain sensor ordinance requiring the use of rain sensors on all automated irrigation systems.

Evapotranspiration (ET) Controllers*.* The Water Department will explore the possibility of requiring ET Controllers on new and refurbished irrigation systems. These controllers may also be purchased for use with City property as demonstration project.

In addition, vegetation on each island at the Xeriscape Design Garden and Learning Center is grouped based upon water needs. Each island is separately metered, and the individual meters are read monthly. They are watered on average one-quarter inch to one-third inch per week. Rain sensors on the automatic sprinkler systems help reduce water use by running equipment only when water is needed. Landscaping at Water Department properties and some park properties survives on rainfall alone.

Date Implemented: The implementation of this BMP is continual through public education campaigns.

Water savings will be determined from analysis of actual customer-metered water use before and after landscape conversion and/or installation of rain sensors or ET-controllers.

In addition, the effectiveness of educational and public outreach campaigns will be assessed by analysis of peak and annual water volumes per customer class.

The City currently has 166 irrigation accounts with an average consumption of 3,500 gallons per month. The City hopes to initiate a landscape design and conversion program before 2014 to effectively monitor conversion of landscape areas, water savings, and incorporate the use of rain sensors.

H. PARK CONSERVATION

The City of Corpus Christi Parks and Recreation Department manages two golf courses; two large City-wide parks; five recreation centers; several decorative fountains; nine public swimming pools; and more than 200 neighborhood parks.

Conservation of water at parks is achieved through the prohibition on wasting water; utilizing water-wise landscape design; and metering all park connections. Field maintenance crews are required to attend training sessions that address water conservation.

Water previously flushed to storm drain inlets, as part of the City's fire hydrant flushing program, is now used to irrigate city parks in near proximity. This procedure does not completely replace the use of sprinkler irrigation at the sites. Most neighborhood parks are sustained by natural rainfall.

1. Parks properties will be included in the Water Department's System Water Audit and Loss programs identified in Section 3.2.

2. The Parks Department voluntarily adopts Landscape Ordinance provisions of the Corpus Christi Zoning Ordinance, Article 27B.

3. In compliance with Corpus Christi Plumbing Code, Section 612 Lawn Irrigation Systems.

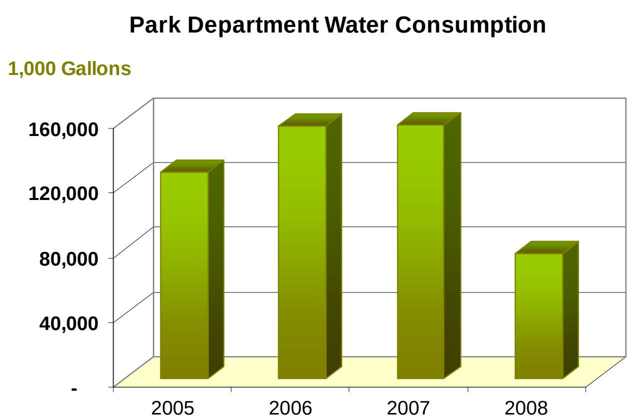
To accomplish this BMP, the Water Department will:

1. Ensure park property landscapes are planted and irrigated in compliance with City ordinances and plumbing codes within the next five years;

2. Continue the use of reclaimed wastewater for irrigation as started in 1987;

3. Beginning in 2005, include park properties in the System Water Audit and Loss programs; and

4. Ensure that other BMPs promoting efficient use of water are followed at park properties.



Date Implemented: ______On-going___________________

The Water Department compiles monthly data for irrigation water consumption from irrigation meter readings at park properties on an annual basis or more frequently during times of water shortage. Special emphasis will be placed upon evaluating data from sites before and after significant irrigation system changes or upgrades. Figure 5 identifies water consumption dropped 49 percent at park properties during calendar year 2008.

I. Reuse of Reclaimed Water

The Certificate of Adjudication for Choke Canyon Reservoir requires the City of Corpus Christi to provide no less than 151,000 acre feet of water per annum for the estuaries by a combination of releases and spills from Lake Corpus Christi and by way of return flows to the Nueces and Corpus Christi Bays and other receiving estuaries. Subsequent amendments to the City's Certificate of Adjudication refined the freshwater inflow requirements to Nueces Bay by calculating target inflows as a percentage of system storage; however the balance of effluent that can be utilized for reuse purposes by City was determined in the February 2001 TCEQ Agreed Order. The City of Corpus Christi currently has six reclaimed water use customers and recognizes that the direct use of reclaimed water is an effective method of reducing potable water usage. Reclaimed water is defined as, "Domestic or municipal wastewater which has been treated to a quality suitable for a beneficial use, pursuant to the provisions of this chapter and other applicable rules and permits" (30 TAC §210.3(24)). Corpus Christi reclaimed water is primarily used for irrigating recreational tracts and maintaining the Nueces Estuary.

To facilitate expansion of the reuse program, the Corpus Christi Water Department will identify and rank industrial, commercial, and institutional (ICI) customers according to volume of water use, and investigate the feasibility of replacing some of their potable water uses with reclaimed water. The Water Department will also investigate reuse opportunities within its own accounts or with third parties outside its service area. The City owns several public areas that are candidates for reuse.

Historically, Corpus Christi began its reuse program in the early 1960s when it began delivering reclaimed effluent to its first customer, the Gabe Lozano Golf Course. Over the next several decades, the City acquired five additional reuse customers including two more golf courses, a country club, a softball complex and the landscape median of Park Road 22. The remaining two golf courses within the City recently entered into an agreement with the City for the supply of reclaimed water. Approximately 2.5 percent of the City's overall effluent flows are reused as reclaimed water.

The Water Department will continue to deliver reclaimed water to its six customers and investigate a possible expansion of the reuse program.

In its effort to find additional reuse opportunities, the City Wastewater Department is working with the Naval Air Station to provide effluent water to its golf course. Presently, two to three percent of treated wastewater is reclaimed to irrigate golf courses and a baseball field.

Attached is a description of wastewater treatment facilities and reclaimed water distribution systems.

Date Implemented: <u>Program started 1960's; remains on-going</u>

Water savings are estimated at up to 100 percent of total amount of potable water replaced by reclaimed water. Changes in operating parameters or water balance calculations which depend upon water quality parameters, such as the impact of total dissolved solids (TDS) in irrigation water, may require different quantities of reuse water to be applied for same end uses.

For the period of 2006 through 2008, 876 million gallons of wastewater effluent was applied to four golf courses and baseball parks. Additional details are shown in the attached Utility Profile Report.

J. Plumbing Assistance

The Water Department plans to develop an affordability program to provide plumbing assistance to low-income homeowners. The Utility Business Office reports that low-income residents often find themselves with high water consumption resulting from leaky plumbing devices for which they cannot afford to repair. The intent of the program is two-fold: (1) to eliminate the cycle of uncollected high water bills resulting from water leaks; (2) to promote water conservation.

Date Implemented: ____Fiscal Year 2009-2010________________

To determine water savings, a comparison will be made based on previous water consumption data to that of consumption data after repairs are made. An evaluation of plumbing leaks can be made by the plumber to determine the estimated waste of water by the defective plumbing device.

III. TARGETS

A. Provide the **specific and quantified five and ten-year targets** as listed in water conservation plan for previous planning period.

5-Year Specific/Quantified Target: ___234 gpcd / 233 gpcd________________

Date to achieve target: _________Year 2008_____________________________

10-Year Specific/Quantified Target: ___223 gpcd__________________________

Date to achieve target: ____Year 2013___________________________________

B. State if these targets in the water conservation plan are being met.

___The City of Corpus Christi Water Department anticipated per capita goal for 2008 was set at of 234 gpcd. Actual calculations indicate that we met that goal with 233 gpcd._____

____

C. List the actual amount of water saved.

The City of Corpus Christi System Water Audit reflects a total real loss of 716 million gallons for 2008. The containment of water loss remains a high priority for the department. The continuous reduction of water loss equates to water saved.

The annual testing and maintenance of meters larger than two inches cannot be effectively identified as actual water saved; however, the prevention of miscalibrated meters contributes to the City's on-going effort to accountability.

The City's progressive move to utilize Automated Meter Reading equipment contributes to accountability and efficiency. The actual mount of water saved is difficult to quantify.

The implementation of the increasing block rate for commercial customers will be assessed within the next five years to determine water saved.

Water savings achieved through the prohibition of wasting water are difficult to determine. Customers are alerted to discontinue their wasteful behavior.

Media relations, public education, etc are extremely difficult to quantify. Long term assessment and survey help to assess the public's awareness to such public relation efforts. A survey placed on the City Water Department web site helps customers provide comments.

Water savings that can be quantified include the irrigation of the Xeriscape Learning Center and Design Garden where the nine irrigation zones are measured based on the gallons applied per square foot. A total of 86,872 and 224,164 gallons were used in 2007 and 2008, respectively. The 2008 figure of 224,164 reflects the large volume of leaks that occurred at the garden. In comparison to the recommended irrigation standards, where one inch of water should be applied per one square foot per week or 32.4 gallons per square foot per year. Quantified water savings amount to 24.3 gallons per square foot per year and 11.5 gallons per square foot per year.

The City Park Department focused on water conservation during 2008 to help reduce consumption. Average water consumption for the period of 2005 through 2008 was 97,477 gallons. During 2008, consumption dropped to 77,154 or a difference of 20,323 gallons of water saved.

A total of 875 million gallons were reclaimed from wastewater effluent and reutilized for golf course irrigation.

Since 2003, the City Water Department has distributed 7,388 showerheads and 15,335 water conservation kits to school students and the general public. Due to the inability to trace the installation of each unit, quantifiable water savings are unavailable.

D. If the targets are not being met, provide an explanation as to why, including any progress on the targets.

___Target was met.____

If you have any questions on how to fill out this form or about the Water Conservation program, please contact us at 512/239-4691. Individuals are entitled to request and review their personal information that the agency gathers on its forms. They may also have any errors in their information corrected. To review such information, contact us at 512-239-3282.

APPENDIX F

Texas Water Development Board
Water Audit Worksheet

A. Water Utility General Information

1. Water Utility Name: City of Corpus Christi Water Department
2. Contact: Name Gustavo Gonzalez, P.E., Director of Water Operations

   Telephone# (361) 826-1681 Email Address gustavog@cctexas.com
3. Reporting Period: From 01 / 01 / 2008 to 12 / 31 / 2008
4. Source Water Utilization, percentage: Surface Water 100% % Groundwater 0 %
5. Population Served:

   a. Retail Population Served 296,897

   b. Wholesale Population Served ______

		Assessment Scale
6. Utility's Length of Main Lines, miles	1,583	______
7. Number of Wholesale Connections Served	4	
8. Number of Retail Service Connections Served	86,637	
9. Service Connection Density *(Number of retail service connections/Miles of main lines)*	55	
10. Average Yearly System Operating Pressure (psi)	45	______

11. Volume Units of Measure (check one):
    _____ acre-ft _____ million gallons X thousand gallons _____ gallons

B. System Input Volume

12. Water Volume from own Sources	27,467,786	______
13. Production Meter Accuracy (enter percentage)	97 %	______
14. Corrected Input Volume	28,317,305	
15. Wholesale Water Imported	______	______
16. Wholesale Water Exported	2,112,162	______
17. **System Input Volume** *(Corrected input volume, plus imported water, minus exported water)*	26,205,143	

		Assessment Scale
C. Authorized Consumption		
18. Billed Metered	24,648,391	____
19. Billed Unmetered	0	____
20. Unbilled Metered	190,407	____
21. Unbilled Unmetered	400,908	____
22. Total Authorized Consumption	25,239,706	
D. Water Losses		
23. Water Losses *(Line 17 minus Line 22)*	965,437	
E. Apparent Losses		
24. Average Customer Meter Accuracy *(Enter percentage)*	100 %	____
25. Customer Meter Accuracy Loss	0	
26. Systematic Data Handling Discrepancy	248,388	____
27. Unauthorized Consumption	71	____
28. Total Apparent Losses	248,459	
F. Real Losses		
29. Reported Breaks and Leaks *(Estimated volume of leaks and breaks repaired during the audit period)*	500,000	____
30. Unreported Loss *(Includes all unknown water loss)*	216,978	____
31. Total Real Losses *(Line 29, plus Line 30)*	716,978	
32. Water Losses (Apparent + Real) *(Line 28 plus Line 31) = Line 23*	965,437	
33. Non-revenue Water (Water Losses + Unbilled Authorized Consumption) *(Line 32, plus Line 20, plus Line 21)*	1,556,752	

Assessment Scale

G. Technical Performance Indicator for Apparent Loss

34. Apparent Losses Normalized (Apparent Loss Volume/# of Retail Service Connections/365) 0.008

H. Technical Performance Indicators for Real Loss

35. Real Loss Volume *(Line 31)* 716,978

36. Unavoidable Annual Real Losses, volume (calculated) 970

37. Infrastructure Leakage Index (calculated) 739
(Equals real loss volume divided by unavoidable annual real losses)

38. Real Losses Normalized
(Real Loss Volume/# of Service Connections/365) 0.023
(This indicator applies if service connection density is greater than 32/mile)

39. Real Losses Normalized
(Real Loss Volume/Miles of Main Lines/365) 0
(This indicator applies if service connection density is less than 32/mile)
Use this calculation if service connection density is less than 32 per mile.

I. Financial Performance Indicators

40. Total Apparent Losses *(Line 28)* 248,459

41. Retail Price of Water 3.79 ______

42. Cost of Apparent Losses $941,660
(Apparent loss volume multiplied by retail cost of water, Line 40 x Line 41)

43. Total Real Losses *(Line 31)* 716,978

44. Variable Production Cost of Water* .55 ______
*(*Note: In case of water shortage, real losses might be valued at the retail price of water instead of the variable production cost.)*

45. Cost of Real Losses $394,338
(Real loss multiplied by variable production cost of water, Line 43 x Line 44)

46. Total Assessment Score ______

47. Total Cost Impact of Apparent and Real Losses $1,335,998

Appendix E.5

San Patricio Municipal Water District Water Conservation and Drought Contingency Plan

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WATER CONSERVATION PLAN
FOR THE
SAN PATRICIO MUNICIPAL WATER DISTRICT
May 1999
Amended May 10, 2005

Section I: Declaration of Policy, Purpose and Intent

In order to conserve the available water supply and/or to protect the integrity of water supply facilities, with particular regard for domestic water use, sanitation, and fire protection, and to protect and preserve public health, welfare, and safety and minimize the occurrence of water supply shortage or other water supply emergency conditions, the San Patricio Municipal Water District (District) by action of its Board of Directors (Board) adopts the following Water Conservation Plan (the Plan).

Section II: Goals

The Water Conservation goals of the District are:

(a) to maintain in effect a water conservation plan and a separate drought contingency plan providing the information and direction required by the Texas Administrative Code, Title 30, Environmental Quality, Chapter 288, as these regulations may be amended or modified

(b) to work with the Region "N" Water Planning Group to complete development of the regional water plan

(c) to work with the City of Corpus Christi as regional water supplier to continue development of the specifics of the regional water conservation plan and drought contingency plan

(d) to assist District customers in development and continuing implementation of water conservation plans consistent with the regional plan

(e) to assure that the per capita and per production unit water use by District municipal and industrial customers remain at least 10% below previous 5-year State average values

(f) to limit unaccounted-for water from District transmission and storage facilities to no more than 3% of the volume of water delivered

III. Description of District Service Area and Wholesale Customers

The District, in accordance with its enabling legislation, can operate in San Patricio, Aransas and Refugio counties. Present operations and facilities are all located in San Patricio County. Figure 1 presents information on wholesale customers and their wastewater practices. Figure 2 presents information on the water use of wholesale customers. Appendix "A" gives information on the District's water supply system.

IV. Amount of Diversion from Sources of Supply

The present (2005) source of supply for all water sold by the District is the City of Corpus Christi regional supply. Water diverted from this source is measured by standard water meters complying contractual requirements and with American Water Works Association specifications, including accuracy. Raw water is pumped from the Nueces River at Calallen and raw water is taken from the Lake Texana supply at a tap on the Mary Rhodes Memorial Pipeline south of Sinton. A record of all diversions is kept by the District in its Water Accounting Records, and also is kept by the City of Corpus Christi.

V. Water Deliveries, Metering and Losses

All water delivered to customers will be metered through standard meters having an accuracy of plus or minus 2% of flow rate. The District will maintain a set of Water Accounting Records which that will record amounts of water received by the District and sold to its customers. These records will include the billing records and the SCADA records from the delivery meters. Summaries showing monthly and yearly totals, losses, distribution between customers and other information will be prepared yearly. These records will be available to management personnel through the local PC network a yearly report will be prepared each year and will be available to all District customers, the District's water supplier, regulatory agencies and the public. Each District wholesale customer will receive summary information pertaining to its water use for the previous year.

VI. Leak Detection and Repair

The District system is a transmission system. District customers provide distribution of water delivered to them. Major leaks will be detected by changes in pressure and flow values reported to the operator by the SCADA system, (24-hour per day operation), or by area residents or property owners near the District facilities. Pipeline alignments, storage tanks, pump stations and raw water storage reservoirs will be inspected on a daily basis, combined with meter reading and maintenance functions. Pipeline easements crossing range or brush land will be mowed on a regular basis, with personnel observing for indication of leaks. Repairs will be initiated on discovery of a leak.

VII. Contractual Water Conservation Requirements

All contracts with wholesale customers will include the requirement that each successive wholesale customer develop and implement a water conservation plan or water conservation measures using the applicable elements of Chapter 288 previously cited.

VIII. Water Rates

The District will use uniform or increasing block rate schedules for all classes of water customers.

IX. Water Conservation and Reuse and Recycling of Wastewater

The District will continue implementation of an active water conservation education program. The District will actively pursue potentially feasible reuse or recycling options within its service area. This will specifically include reuse of municipal wastewater effluent and select industrial effluent streams. The District will also work with existing and new water customers to prevent, where possible, contamination of wastewater streams with substances that might preclude the feasibility of reuse of the stream. Specific programs include:

1. Work with new industrial customers at the pre-design stage to assure that potential water conservation elements are included in the final plant process design, where feasible.
2. Reuse all backwash streams at the treatment plants site and maintain "zero discharge".
3. Continued operation and maintenance of the Aransas Pass/Sherwin/Alcoa reclaimed water project
4. Improved use of water treatment plant residual solids for land reclamation.
5. Cooperative programs with school districts addressing specific educational programs.
6. Working with public entities on Xeriscape projects.
7. Working with Earth Day, Coastal Bend Bays and Estuaries Foundation, Informal Science Educators and other similar organizations.

X. Aquifer Storage and Recovery

The District will investigate the use of aquifer storage and recovery techniques within its service area to reduce seasonal peak supply facility demands and to provide storage for accomplishing this without associated evaporative losses.

XI. Implementation, Enforcement and Coordination with Regional Water Planning Groups and Regional Water Supplier

Copies of the Water Conservation Plan and the Drought Contingency Plan, including the dates of adoption by the Board of Directors, will be furnished to all District wholesale customers, the regional water supplier and the Region "N" Water Planning Group. The District will implement and enforce the plans by the means available to it, including Pro Rata Water Allocation during Severe Water Shortage Conditions or Emergency Water Supply Conditions.

DROUGHT CONTINGENCY PLAN
FOR THE
SAN PATRICIO MUNICIPAL WATER DISTRICT
May 1999
Amended May 10, 2005

Section I: Declaration of Policy, Purpose and Intent

In order to conserve the available water supply and/or to protect the integrity of water supply facilities, with particular regard for domestic water use, sanitation, and fire protection, and to protect and preserve public health, welfare, and safety and minimize the adverse impacts of water supply shortage or other water supply emergency conditions, the San Patricio Municipal Water District (District) by action of its Board of Directors (Board) adopts the following Drought Contingency Plan (the Plan).

Section II: Public Involvement

Opportunity for the public and wholesale water customers to provide input into the preparation of the Plans was provided by the District by means of a public hearing. Notice of the meeting and copies of the proposed plans were mailed to each District wholesale customer and notices of the hearing were published in papers with circulation in San Patricio and Aransas counties.

Section III: Wholesale Water Customer Education

The District will periodically provide wholesale water customers with information about the Plan, including information about the conditions under which each stage of the Plan is to be initiated or terminated and the drought response measures to be implemented in each stage. Copies of the Plan will be provided to each wholesale customer, with information about Stages of the Plan and appropriate actions communicated at appropriate times.

Section IV: Coordination with Regional Water Planning Groups

The water service area of the District is located within the Region "N" Water Planning Area and the District has provided a copy of the Plan to the Region "N" Planning Group.

Section V: Authorization

The District Manager, or his/her designee, is hereby authorized and directed to implement the applicable provisions of the Plan upon determination that such implementation is necessary to protect public health, safety, and welfare. The District Manager, or his/her designee, shall have the authority to initiate or terminate drought or other water supply emergency response measures as described in the Plan.

Section VI: Application

The provisions of the Plan shall apply to all customers utilizing water provided by the District. The terms "person" and "customer" as used in the Plan included individuals, corporations, partnerships, associations, and all other legal entities.

Section VII: Triggering Criteria for Initiation and Termination of Drought Response Stages

The Manager, or his/her designee, shall monitor water supply and demand conditions on a weekly basis and shall maintain contact with the City of Corpus Christi as regional water supplier. Triggering criteria for initiation and termination of drought response stages relating to basic regional water supply shall be determined by the City of Corpus Christi. Triggering conditions for emergency water supply conditions not relating to basic regional water supply shall be determined by the District Board. The District will notify all of its customers when conditions warrant initiation or termination of each stage of the Plan. Customer notification of the initiation or termination of drought response stages will be made by mail or telephone. All of these activities will be coordinated with the City of Corpus Christi to assure that all water customers in the regional area receive the same supply condition message at the same time.

Section VIII: Drought Response Stages

The District will encourage all of its customers to adopt similar demand management measures to those adopted by the City of Corpus Christi for each Water Supply Condition Stage. The District will work with all of its wholesale customers to initiate voluntary and mandatory measures, as appropriate for each Stage, to reduce non-essential water use.

Section IX: Pro Rata Water Allocation

In the event that the triggering criteria for Severe Water Shortage Conditions or Emergency Water Supply Conditions have been met, the Manager is hereby authorized to initiate allocation of water supplies on a pro rata basis in accordance with Texas Water Code Section 11.039 and according to the following procedures.

The Manager, or his/her designee, will maintain a monthly water usage baseline for each wholesale customer. The wholesale customer's water usage baseline will be computed on the average water usage by month for the previous five calendar year period. If the wholesale water customer's billing history is less than five years, the monthly average for the period for which there is a record shall be used for any monthly period for which no billing history exists.

A wholesale customer's monthly allocation shall be a percentage of the customer's water usage baseline. The percentage will be set by resolution of the Board based on the Manager's assessment of the severity of the water shortage condition and the need to curtail water deliveries and may be adjusted periodically by resolution of the Board as conditions warrant. Once pro rata allocation is in effect, water deliveries to each wholesale customer shall be limited to the allocation established for each month.

The Manager shall provide notice, by certified mail, to each wholesale customer informing them of their monthly water usage allocations and shall notify the news media and the executive director of the Texas Natural Resource Conservation Commission upon initiation of pro rata water allocation.

Upon request of the customer or at the initiative of the Manager, the allocation may be reduced or increased if objective evidence demonstrates that the designated allocation is inaccurate under present conditions. A customer may appeal an allocation established hereunder to the Board.

Section X: Enforcement

During any period when pro rata allocation of available water supplies is in effect, delivery of water to wholesale customers shall be limited to the amount per day which will produce the monthly water usage allocation. Daily deliveries to each wholesale customer will be in as equal an amount as is possible, with each day's delivery target being the amount required to bring the running total delivery for the month to the running total allocation for the month.

Section XI: Variances

The Manager, or his/her designee, may, in writing, grant a temporary variance to the pro rata water allocation policies provided by the Plan if it is determined that failure to grant such variance would cause an emergency condition adversely affecting the public health, welfare, or safety and if one or more of the following conditions are met:

(a) Compliance with this Plan cannot be technically accomplished during the duration of the water supply shortage or other condition for which the Plan is in effect.
(b) Alternative methods can be implemented which will achieve the same level of reduction in water use.

District customers requesting an exemption from the provisions of this Plan shall file a petition for variance with the Manager within 10 days after pro rata allocation has been invoked. All petitions for variances shall be reviewed by the District Board, and shall include the following:

(a) Name and address of petitioner(s)
(b) Detailed statement with supporting data and information as to how the pro rata allocation of water under the policies and procedures established in the Plan adversely affects the petitioner or what damage or harm will occur to the petitioner or others if petitioner complies with this Plan.
(c) Description of the relief requested
(d) Period of time for which the variance is sought
(e) Alternative measures the petitioner is taking or proposed to take to meet the intent of this Plan and the compliance date.
(f) Other pertinent information.

No variance shall be retroactive or otherwise justify any violation of this Plan occurring prior to the issuance of the variance.

Section XII: Severability

It is hereby declared to be the intention of the Board that the sections, paragraphs, sentences, clauses, and phrases of this Plan are severable and, if any phrase, clause, sentence, paragraph, or section of this Plan shall be declared unconstitutional by the valid judgment or decree of any court of competent jurisdiction, such unconstitutionality shall not affect any of the remaining phrases, clauses, sentences, paragraphs, and sections of this Plan, since the same would not have been enacted by the Board without the incorporation into this Plan of any such unconstitutional phrase, clause, sentence, paragraph, or section.

FIGURE I: (See Spreadsheet File CONSERV1.wk4)
FIGURE II: (See Spreadsheet File CONSERV2.wk4)

APPENDIX "A"
MAJOR WATER FACILITIES OF THE
SAN PATRICIO MUNICIPAL WATER DISTICT

I: General

The District purchases both untreated and potable water from City of Corpus Christi. This water is either resold directly by the District or its quality is modified in treatment facilities and the product sold to District customers. The District is a "Wholesale" water supplier, selling water in large quantities to municipalities and water supply corporations having their own storage, pumping and distribution systems or to industries, which treat and/or distribute the water within their facilities to meet the various process and sanitary needs. Their are several small "single meter" customers which were connected to District facilities, (or transmission facilities which the District later purchased). prior to 1983. Policy does not permit additional connections of this type and existing connections are moved to distribution systems as they become available in the area.

II: Raw Water Facilities

Raw water is received by the District at two points, (1) the Nueces River channel near Calallen, just upstream from the salt water barrier dam, and (2) a connection to the Mary Rhodes Memorial Pipeline at a point just south of the city of Sinton. Water from the Nueces River is pumped from the river channel at the 4-pump W. A. Edwards Pumping Station and flows easterly in a 36" diameter concrete steel cylinder pipeline which terminates at the District water treatment plants site between Gregory and Ingleside. There is a booster pumping station located on the pipeline approximately 3 miles southeast of Odem. The maximum capacity of this facility is approximately 24 million gallons per day peak rate. Raw water from this line is delivered directly to District customers or to the 192 million gallon raw water storage reservoir at the plants site.

Raw water is also received from the Mary Rhodes Pipeline through a 24" valve and meter installation. This water flows easterly in a 36" diameter pipeline to a blending station southeast of Taft, where it is blended with water from the Nueces River. From there the blended water flows easterly in a 42" diameter concrete steel cylinder pipeline to the 192 million gallon raw water storage reservoir located approximately 1000 feet northwesterly from the treatment plants site.

An existing raw water storage reservoir on the treatment plants site has a capacity of 12 million gallons and presently (2005) furnishes raw water to DuPont, Air Liquide and Plant "B". The 192 million gallon raw water storage reservoir at the plants site provides preliminary settling. Water from this reservoir is delivered to Plants "A", "B" and "C" and to Ingleside Cogeneration and Sherwin Alumina.

III: Potable Water Facilities

Potable water treated at the City of Corpus Christi O. N. Stevens Water Treatment Plant is received by the District through a meter located near the Nueces River at Calallen, on the site of the Cunningham Treatment Plant, (no longer in use). This water is conveyed easterly to the District treatment plants site in a 24" diameter concrete steel cylinder and PVC pipeline. There is a booster pumping station located near Odem. The cities of Odem, Taft, Gregory and Portland are served with potable water at metering stations on this line, as are the Seaboard Water Supply Corporation and the Rincon Water Supply Corporation. The capacity of this facility is approximately 7.2 million gallons per day but is presently reduced because of deterioration of portions of the line.

The District owns, operates and maintains two potable water treatment facilities, Plant "A", with a capacity of 9 million gallons per day and Plant "C" with a capacity of 4.6 million gallons per day. Raw water for both plants is taken from both the Nueces and Texana sources. There are transmission lines to the cities of Taft, Gregory, Portland, Ingleside, Aransas Pass and to the Aransas County Conservation and Reclamation District (serving the Rockport/Fulton area) and the Nueces County Water Control and Improvement District (serving the Port Aransas area). A total of 6.25 million gallons of potable water storage is a part of the system, as are pumping stations and metering stations.

IV: Clarified Water Facilities

The District owns, operates and maintains two clarified water treatment facilities, Plant "B", with a capacity of 5.7 million gallons per day and Plant "C" with a capacity of 3.2 million gallons per day. Water from Plant "B" is delivered to Occidental Chemical for their use. Water from Plant "C" is delivered to Ingleside Cogeneration LP for their use.

V. Reclaimed Water Facilities

The District owns. operates and maintains a reclaimed water facility which takes treated wastewater effluent and excess biosolids from the City of Aransas Pass and delivers them to Alcoa for their process and plant use. The facility includes a pump station, metering and transmission line, and delivers approximately 0.7 million gallons per day.

FIGURE I: SERVICE AREA AND CUSTOMER DATA
WATER CONSERVATION PLAN
San Patricio Municipal Water District
May 2005 File: CONSERV1.wk4

Customer	Water Type	Del.Pts , #	Wastewater Information
Rockport/Fulton	Potable	1	Municipal treatment plant, effluent used for watering golf course
Aransas Pass	Potable	2	Municipal treatment plant, effluent reclaimed for use at Sherwin Alumina (90%) and municipal park use (10%)
NCWCID No.4	Potable	1	Municipal treatment plant, discharge to wetlands area and Corpus Christi Bay
Ingleside	Potable	2	Municipal treatment plant, discharge to Kinney Bayou
Gregory	Potable	1	Municipal treatment plant, discharge to Green Lake (drainage) with reuse for golf course irrigation
Portland	Potable	2	Municipal treatment plant, discharge to Nueces Bay
Taft	Potable	1	Municipal treatment plant, discharge to local ditch, Copano Bay
Odem	Potable	1	Municipal treatment plant, discharge to Peters Swale, new plant will divert effluent to Rincon Bayou
Sherwin Alumina	Raw & Pot.	4	Small sanitary waste treatment plant, effluent recycled. All other water, including direct rainfall, reused - no discharge
Ingleside Cogeneration	MF Clarified	1	Cooperative with Dupont and Occidental Chemical
Dupont	Raw & Pot.	2	Industrial treatment plant, discharge to Corpus Christi Bay
Air Liquide	Raw & Pot.	2	Cooperative with Dupont and Occidental Chemical
Gregory Power Partners	Raw & Pot.	2	Industrial treatment plant, effluent reclaimed for use at Sherwin Alumina
Rural	Potable		Individual treatment and disposal
Water Corporations	Potable		Individual treatment and disposal
Other Raw	Raw		None

NOTES;

(1) NCWCID No.4 is Mustang/Padre Island area, which also has service from the City of Corpus Christi

(2) Types of water sold by the District are potable (drinking water), clarified (not disinfected), MF clarified (not disinfected), reclaimed and raw (untreated)

FIGURE II WATER USE DATA

WATER CONSERVATION PLAN

San Patricio Municipal Water District

May 10, 2005

Customer	Total Delivery - M Gals.	Population	Per Capita Use, Gal/Day
Rockport	917,264,000	10,096	248.9
Aransas Pass	562,624,000	8,134	189.5
DuPont	339,747,000		
Gregory	112,265,000	2318	132.7
Ingleside	358,017,700	9388	104.5
NCWCID #4	157,005,000		
Occidental Chem	1,404,474		
Odem	119,644,000	2499	131.2
Portland	552,930,900	17,489	86.6
Sherwin Alum. - Raw	1,058,447,000		
Sherwin Alum. - Pot.	363,240,000		
Taft	161,605,000	5,014	88.3
Rural	32,565,000		
Water Corps.	106,986,000		
Other Raw	1,227,000		

NOTES

(1) NCWCID # 4 includes Mustang/Padre Island Area - also served by City of Corpus Christi
(2) Types of water sold by the District are potable (drinking water), clarified (not disinfected) and raw (untreated)
(3) Total Delivery, Mgals, does not include reclaimed water delivered to Sherwin Alumina
(4) Population data is from US Census 2000
(5) Population data for Rockport does not include total service area
(6) Population data for Taft includes residential area south of Taft

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Appendix E.6

South Texas Water Authority Water Conservation and Drought Contingency Plan (Amended April 2009)

South Texas Water Authority
Water Conservation and Drought Contingency Plan

PART I—WATER CONSERVATION PLAN

Introduction:

The South Texas Water Authority provides wholesale, treated water supplies to approximately 35,000 citizens. Its mission is to:

- provide a high quality, safe, and potable supply of water that meets all federal and state requirements to communities, residents, and entities in central Kleberg County and western Nueces County,
- insure a dependable, abundant supply is available to our customers and
- utilize a regional approach that minimizes adverse cost of service based on entity size.

South Texas Water Authority does not provide wastewater service.

Service Area:

South Texas Water Authority supplies water to ten (10) entities. The following information is the latest population data (2010 Census data is not yet available) and information for the last five (5) Fiscal Years. South Texas Water Authority does not provide wastewater service.

Table 1

Entity	Population	Service Connections	5 Year Average (annual)	Monthly Peak Demand (last 5 years)
City of Agua Dulce	735	330	30,761,230	3,667,160
City of Bishop	3,305	1,277	70,074,200[2]	9,190,000
City of Driscoll	825	254	29,538,240	3,526,000
City of Kingsville	25,575	7,476	170,393,400	52,522,000
Nueces Water Supply Corp.	2,289[1]	763	88,263,710	12,820,660
Ricardo Water Supply Corp.	2,538[1]	846	102,045,140[4]	13,182,500[3]
Nueces County Water Control & Improvement District #5	810	270	33,281,540	4,017,000
Coastal Bend Youth City/Teen Challenge	N/A	1	1,547,625	463,400
Coastal Acres, LLC	N/A	1	670,132	188,130
LCS Corrections Services, Inc.	N/A	1	254,377[4]	181,900

[1] Nueces and Ricardo Water Supply Corporations' population is estimated at 3 times their service connections.

[2] Bishop's average annual usage includes periods of 100% surface use and periods of blending—well usage data is not included.

[3] Ricardo WSC annual average and monthly peak include total demand from all sources—surface and ground water

[4] LCS Corrections Services, Inc.'s usage is from April 2007 to September 2008

All customers are located within the Authority's district with the exception of the Nueces County Water Control and Improvement District #5 (Banquete), which is served as an Out-of-District customer.

The Authority's facilities were designed and constructed to serve four original customers, Kingsville, Bishop, Driscoll and Agua Dulce with 100% of their needs. At the time of construction in 1983, it was anticipated that these entities would initially require between 5 MGD and 7 MGD. The system was designed to meet a 50-year planning period; therefore, the delivery capacity of the system is 17 MGD.

South Texas Water Authority purchases treated water from the City of Corpus Christi. Supplies are transported approximately thirty (30) miles south from the O.N. Stevens Treatment Plant to the City of Kingsville via a 42" steel reinforced concrete cylinder water line (P-303). Coastal Acres LLC, Coastal Bend Youth City (Teen Challenge), the City of Driscoll, the City of Bishop and a portion of the Nueces Water Supply Corporation customers are serviced along the route of the 42" transmission line. A smaller asbestos concrete spur line (14-inch and 12-inch) supplies customers in Agua Dulce, Banquete, the remainder of the Nueces Water Supply Corporation's customers and LCS Corrections Services, Inc.. Water service to the Ricardo Water Supply Corporation is provided via a pass-through agreement between the Authority and the City of Kingsville for a portion of the distance. Water is transported the remainder of the distance through the Authority's 12" ductile iron line to the Corporation's three pump stations. In addition, construction of the system included pump station and storage facilities designed to provide a full day's supply during peak periods.

According to the City of Corpus Christi, the Authority purchased approximately 507 million gallons from the City of Corpus Christi in the year 2008. The Authority's Fiscal Year records (October 2007 through September 2008) indicate a purchase of 530 million gallons. In the past 20 years, however, the largest potential customer, Kingsville, has opted to continue using groundwater wells for the majority of its needs. Therefore, on average the Authority provides less than 2 MGD to its ten customers. During extremely dry conditions, water demand has exceeded 3 MGD.

Water purchased from the City of Corpus Christi is from Lake Corpus Christi, which stores 242,241 acre-feet of water, Choke Canyon Reservoir which stores 695,271 acre-feet of water and the 101-mile-long Mary Rhodes Pipeline which transports water through a 64-inch pipeline from Lake Texana near Edna, Texas. In 1993, the City of Corpus Christi entered into a contract with the Lavaca-Navidad River Authority to purchase 41,840 acre-feet of water per year. According to the City, approximately 50 percent to 70 percent of the water treated at the O.N. Stevens Treatment Plant is transported from Lake Texana.

The O.N. Stevens Water Treatment Plant has a rated capacity of 167 million gallons per day, well above the peak summer demand of 110 million gallons per day. According to the City's Conservation and Drought Contingency Plan, the City's Water Department operates in full compliance with all state and federal requirements.

In addition to the above mentioned supplies, in 1999 the City of Corpus Christi acquired senior water rights to 35,000 acre-feet of water per year in the Navidad River. At this time, the City is also exploring the feasibility of desalination. In 2003, the City was one of three sites awarded a $500,000 state grant to conduct a study as part of Governor Rick Perry's initiative to assess the potential desalination of seawater to help meet the state's regional water needs. The City is also participating in a U.S. Army Corps of Engineers feasibility study to assess the potential for desalination as a water supply source for the region. This study is jointly sponsored by the San Antonio Water System, San Antonio River Authority, and Guadalupe Blanco River Authority.

South Texas Water Authority's district is located within the Region N Planning area and the Authority will be providing a copy of this Plan to the Region N Planning Group. South Texas Water Authority stays abreast of City of Corpus Christi and regional water issues through the Executive Director's participation in the following:

1. as the co-chair of the Coastal Bend Regional Water Planning Group;
2. as the chair of the Corpus Christi Water Resource Advisory Committee;
3. as a member of the Coastal Bend Bay and Estuary Program's Bay Council and chair of the Bay Council Coordination Team; and
4. as a member of the Nueces Estuary Advisory Committee.

Measurement/Accounting and Monitoring/Record Management of Water:

All water is metered through a 16-inch meter as it leaves the O.N. Stevens Plant and enters the Authority's Regional System. Water is metered again as it enters the ground storage tanks servicing the Authority's ten (10) wholesale customers. Meters are read on the first day of the month by field personnel, and meter readings and flow volumes are recorded daily via a Supervisory Control and Data Acquisition system. A water loss report is calculated Monday through Friday by comparing recordings from the O.N. Stevens Plant against the cumulative of the Authority's wholesale customers. On average, the monthly water loss is less than two percent (2%). The Authority's goal is to keep the water loss rate below that level. Readings taken on the first of the month are used to prepare monthly invoices for the volumes of water sold to the Authority's wholesale customers.

Leak Detection and Repair:

As mentioned in the previous section, all water is metered as it leaves the O.N. Stevens Plant and enters the Authority's Regional System, which is a transmission system, not a distribution system. Water is metered again as it enters the ground storage tanks servicing the Authority's ten (10) wholesale customers. Meters are read on the first day of the month by field personnel, and meter readings and flow volumes are recorded daily via a Supervisory Control and Data Acquisition system. A water loss report is calculated Monday through Friday by comparing recordings from the O.N. Stevens Plant against the cumulative of the Authority's wholesale customers. In addition to the daily water loss report and daily metering, the Authority periodically drives out the route of the line. A major portion of the Authority's Regional System's waterlines are located in rural farmlands; therefore, leaks that are not detected by employees are reported by landowners or tenant farmers. For those areas that are not located in cultivated fields, the Authority clears its right-of-way using leased equipment.

In addition, leaks have been located as part of the Authority's cathodic protection program, which involves excavating the 42" transmission line to install sacrificial zinc anodes every 100 lineal feet. Master meters are tested annually by an outside company specializing in testing larger meters. For deviations from 100% greater or less than 2%, the meter is re-calibrated. Meters are also tested prior to the annual test date in the event the meter is exhibiting a slow down in registering. Ground storage and elevated tanks are inspected annually. Cathodic protection systems are installed in the two welded steel tanks located in Kingsville and Bishop; however, the Bishop tank is being replaced by a new prestressed concrete tank. Tanks are refurbished every five years, or as needed, by interior and exterior cleaning, spot painting, or in certain instances completely repainting of the tank.

Reservoir Systems Operations Plan:

South Texas Water Authority does not own or operate any reservoir systems. The water wholesaled by STWA is purchased from the City of Corpus Christi, the responsible entity overseeing those tasks.

Five-year and Ten-year targets:

According to the City of Corpus Christi's Water Conservation Plan, the South Texas Water Authority daily per capita use is 155. The City's Plan cites the Texas Water Development Board as the source of the information. A goal of 1 percent reduction per year would result in a gcpd of 145 in the year 2010 and a gpcd of 141 in the year 2020.[1]

It is important to note that the cities of Kingsville and Bishop use groundwater wells in addition to the water provided by the Authority. In addition, Ricardo WSC's well is no longer in service as of March 2008. The remainder of the Authority's customers utilize the Authority for 100% of their needs. Coastal Bend Youth City/Teen Challenge, Coastal Acres, LLC and LCS Corrections Services, Inc. do not provide retail service. Table 2 provides specific numbers on these retail service providers. These figures include residential, commercial, and industrial use.

Table 2

Entity	FY 2008 Purchased Volume	FY 2008 Self-supplied Volume	FY 2008 Total	FY 2008 Population	FY 2008 Current Per Capita
Agua Dulce	28,883,090	0	28,883,090	735	107.66
Bishop[1]	73,602,000	59,574,000	134,720,000	3,305	111.68
Driscoll	28,019,300	0	28,019,300	825	93.05
Kingsville[2]	154,787,000	1,108,983,000	1,263,770,000	25,575	135.38
Nueces WSC	101,888,270	0	101,888,270	2,289	121.95
NCWC&ID#5	33,181,540	0	33,181,540	810	112.23
Ricardo WSC[3]	104,805,000	462,300	105,267,300	2,538	113.63

[1] The City of Corpus Christi is in the process of updating its Conservation Plan at this time and the latest information is not yet available. This section will be updated once the City's Plan is received.

[1] Bishop's well usage is from October 2007 through September 2008 from readings taken by STWA staff.
[2] Kingsville's well usage is from October 2007 through September 2008 from information provided by the City.
[3] Ricardo WSC well usage is from October 2008 through March 2008 from readings taken by STWA staff.

Table 2A			
Unaccounted-for Water			
Fiscal Year	Gallons Purchased	Gallons Sold	Unaccounted-for Gallons
2004	616,983,000	718,014,340	101,031,340
2005	471,775,000	569,431,860	97,656,860
2006	561,591,000	661,424,170	99,833,170
2007	487,804,000	584,731,370	96,927,370
2008	529,970,360	634,870,750	104,900,390
Average for 2004-2008			100,069,826

The Authority has no enforcement mechanism to impose conservation targets and goals upon its wholesale customers.

Conservation Strategies:

(A) Conservation-Oriented Water Rates— South Texas Water Authority has negotiated contracts with its customers using a water rate which includes a Handling Charge to recoup fixed costs, and a variable cost component to cover the cost of water purchased from Corpus Christi and other variable expenses.
(B) South Texas Water Authority does not sell water to any agricultural customers; therefore, the Authority does not have any programs to assist agricultural customers in the development of conservation pollution prevention and abatement plans.
(C) South Texas Water Authority does not provide wastewater service therefore, it does not have any programs for reuse and/or recycling of wastewater and/or graywater.

The Authority recognizes that there are numerous factors involved in achieving these goals including educating customers, adoption of conservation oriented rates, and proper maintenance of infrastructure. As such, the Authority is actively involved in the Coastal Bend Regional Water Planning Group, the Nueces Estuary Advisory Council, the Coastal Bend Bay and Estuary Program, the City of Corpus Christi Water Resource Advisory Committee, and the recently formed Uranium Resource Incorporated Citizens Advisory Board. The Authority will continue to assist its wholesale customers through the following voluntary programs:

- Major Rivers
- Issuance and administration of Contract Revenue Bonds
- Providing financial data for grant/loan applications
- Providing brochure and templates for conservation information

In addition, the Authority makes use of water-wise vegetation and crushed limestone landscaping and grounds keeping. The Authority will request that wholesale customers voluntarily report their progress on water conservation activities on an annual basis.

Water Supply Contracts:

South Texas Water Authority recognizes that a requirement in every water supply contract entered into or renewed after official adoption of the water conservation plan, and including any contract extension, stipulates that each successive wholesale customer develop and implement a water conservation plan or water conservation measures. In addition, the Authority recognizes that should the customer intend to resell the water, then the contract between the initial supplier and customer must provide that the contract for the resale of the water must have water conservation requirements so that each successive customer in the resale of the water will be required to implement water conservation measures. Current contract and future contracts or contract extensions will include those stipulations.

Implementation And Enforcement:

Enclosed is a copy of the resolution adopted by the South Texas Water Authority Board of Directors adopting The Water Conservation And Drought Contingency Plan attached as Appendix A.

Coordination With The Regional Water Planning Group:

Enclosed is a copy of the cover letter sent to the Nueces River Authority, administrator of the Coastal Bend Regional Water Planning Group attached as Appendix B.

Review And Update:

Beginning May 1, 2009, the South Texas Water Authority shall review and update its Water Conservation And Drought Contingency Plan, as appropriate, based on an assessment of previous five-year and ten-year targets and any other new or updated information. Therefore, the next review shall not occur later than May 1, 2014, and every five years after that date.

PART II—DROUGHT CONTINGENCY PLAN

The following Part II of the Water Conservation and Drought Contingency Plan is South Texas Water Authority's Drought Contingency Plan adopted by Board resolution on August 26, 1999.

Section I: Declaration of Policy, Purpose and Intent

In order to conserve the available water supply and/or to protect the integrity of water supply facilities, with particular regard for domestic water use, sanitation, and fire protection, and to protect and preserve public health, welfare, and safety and minimize the adverse impacts of water supply shortage or other water supply emergency conditions, the South Texas Water Authority adopts the following Drought Contingency Plan, hereinafter referred to as the "Plan."

It is the intent that the Plan will:

a) maintain in effect a drought contingency plan providing the information and direction required by the Texas Administrative Code, Title 30, Environmental Quality, Chapter 288, as these regulations may be amended or modified;
b) facilitate the development of the specifics of a regional drought contingency plan in conjunction with the Coastal Bend Regional Water Planning Group and the regional water supplier, the City of Corpus Christi;
c) assist District customers in development and implementation of plans.

Section II: Public Involvement

Opportunity for the public and wholesale water customers to provide input into the preparation of the Plan was provided by South Texas Water Authority by means of notice of public meeting and certified letter to wholesale customers.

Section III: Wholesale Water Customer Education

The South Texas Water Authority will periodically provide wholesale water customers with information about the Plan, including information about the conditions under which each stage of the Plan is to be initiated or terminated and the drought response measures to be implemented in each stage. This information will be provided by means of certified letter.

The South Texas Water Authority currently wholesales water to the cities of Agua Dulce, Bishop, Driscoll, Kingsville and the Nueces County Water Control and Improvement District #5 (Banquete), the Nueces Water Supply Corporation, Ricardo Water Supply Corporation, Teen Challenge, Coastal Acres LLC and LCS Corrections Services, Inc. The District is located in western Nueces County and northern Kleberg County.

Section IV: Coordination with Regional Water Planning Groups

The water service area of the South Texas Water Authority is located within Region N and the South Texas Water Authority has provided a copy of the Plan to the Coastal Bend Regional Water Planning Group.

Section V: Authorization

The Executive Director, or his/her designee, is hereby authorized and directed to implement the applicable provisions of this Plan upon determination that such implementation is necessary to protect public health, safety, and welfare. The Executive Director, or his/her designee, shall have the authority to initiate or terminate drought or other water supply emergency response measures as described in this Plan.

Section VI: Application

The provisions of this Plan shall apply to all customers utilizing water provided by the South Texas Water Authority. The terms person and customer as used in the Plan include individuals, corporations, partnerships, associations, and all other legal entities.

Section VII: Triggering Criteria for Initiation and Termination of Drought Response Stages

The Executive Director or his/her designee shall monitor water supply and/or demand conditions on a **weekly** basis and shall determine when conditions warrant initiation or termination of each stage of the Plan. Coordination with the City of Corpus Christi, the regional water supplier, will be required. Customer notification of the initiation or termination of drought response stages will be made by mail or telephone. The news media will also be informed.

The triggering criteria described below are based on limits as adopted by the City Council of the City of Corpus Christi.

(a) Stage 1 – Mild Water Shortage Conditions

Requirements for initiation – The South Texas Water Authority will recognize that a mild water shortage condition exists when combined water stored in the reservoirs is estimated to be forty percent (40%) of total storage capacity or the percentage established by the City of Corpus Christi, the regional water supplier.

Requirements for termination – Stage 1 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of thirty (30) consecutive days. The South Texas Water Authority will notify its wholesale customers and the media of the termination of Stage 1 in the same manner as the notification of initiation of Stage 1 of the Plan.

b) Stage 2 – Moderate Water Shortage Conditions

Requirements for initiation – The South Texas Water Authority will recognize that a moderate water shortage condition exists when combined water supply in the City of Corpus Christi's reservoirs is less than 40% but greater than 30% of total storage capacity, or the percentage established by the City of Corpus Christi, and the City Manager directs implementation in order to protect reservoir storage levels.

Requirements for termination – Stage 2 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of thirty (30) consecutive days. Upon termination of Stage 2, Stage 1 becomes operative, unless the combined water supply has exceeded the 40% level. The South Texas Water Authority will notify its wholesale customers and the media of the termination of Stage 2 in the same manner as the notification of initiation of Stage 1 of the Plan, if applicable.

c) Stage 3 – Severe Water Shortage Conditions

Requirements for initiation – The South Texas Water Authority will recognize that a severe water shortage condition exists when combined water storage in the City of Corpus Christi's reservoir system is equal to or less than 30% of total storage capacity, or the percentage established by the City of Corpus Christi, and the City Manager directs implementation in order to protect reservoir storage levels.

Requirements for termination – Stage 3 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of thirty (30) consecutive days. Upon termination of Stage 3, Stage 2 becomes operative, unless the combined water supply has exceeded the 30% level. The South Texas Water Authority will notify its wholesale customers and the media of the termination of Stage 3 in the same manner as the notification of initiation of Stage 2 of the Plan, if applicable.

(d) Stage 4 – Emergency Water Shortage Conditions

Requirements for initiation - The South Texas Water Authority will recognize that an emergency water shortage condition exists when:

a) Water supply in the City of Corpus Christi's reservoirs is estimated to be less than 65,000 acre feet, or a level established by the City of Corpus Christi, or
b) Major water line breaks or pump station failures which cause unprecedented loss of capability to provide water service, or
c) Natural or man-made contamination of the water supply source(s).

Requirements for termination – Stage 4 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of fifteen (15) consecutive days or earliest and safest time period possible. The South Texas Water Authority will notify its wholesale customers and the media of the termination of Stage 4.

Section VIII: Drought Response Stages

The Executive Director, or his/her designee, shall monitor water supply and/or demand conditions and, in accordance with the triggering criteria set forth in Section VII, shall determine that mild, moderate, or severe water shortage conditions exist, as established by the City of Corpus Christi, or that an emergency condition exists and shall implement the following actions:

Stage 1 – Mild Water Shortage Conditions

1. Goal: achieve a comparable percent reduction as requested by the City of Corpus Christi.
2. Supply Management Measures. Request wholesale customers and assist in the effort to organize a committee of business, industrial, and residential representatives to make recommendations for the necessary regulations and prohibitions which may include, but are not limited to, the following:

    a) Restrict outdoor use of water for both residential and commercial use: car washing, dust control, watering of lawns and vegetation, and washing building exteriors, sidewalk and driveways.
    b) Prohibit unnecessary waste of water due to defective plumbing including out-of-repair toilets and faucets, underground leaks, leaking hydrants or valves.
    c) Prohibit use of ornamental fountains.
    d) Restrict use of golf course irrigation.
    e) Use of fire hydrants restricted to only fire fighting.
    f) Schedule meetings with large water users, industrial and commercial, to determine any necessary allocation structures and exchange information regarding methods of saving water.
    g) Schedule meetings with utility divisions to review budgets and short and long-term effects of drought restrictions.

3. Demand Management Measures:

    a) The Executive Director, or his/her designee(s), will contact wholesale water customers to discuss water supply and/or demand conditions and will request that wholesale water customers initiate voluntary measures to reduce water use.
    b) The Executive Director, or his/her designee(s), will provide a weekly report to news media with information regarding current water supply and/or demand conditions, projected water supply and demand conditions if drought conditions persist, and consumer information on water conservation measures and practices.
    c) The Executive Director, or his/her designee(s), will initiate preparations for the implementation of pro rata curtailment of water diversions and/or deliveries by preparing a monthly water usage allocation baseline for each

wholesale customer according to the procedures specified in Section IX of the Plan.

d) The Executive Director, or his/her designee(s), will provide a weekly report to the City of Corpus Christi with information regarding current wholesale customer usage.

Stage 2 – Moderate Water Shortage Conditions

1. Goal: achieve a comparable percent reduction as requested by the City of Corpus Christi.

2. Supply Management Measures. Request wholesale customers continue in full force with conditions set in Mild Water Shortage Conditions. In addition, request that wholesale customers consider implementation of the following <u>additional</u> regulations or prohibitions:

   a) Limit new connections to distribution system if other service source is available.
   b) Set a mandatory limit of water use for customers with termination limits for excessive use.
   c) Service of water in restaurants only at request of customer.
   d) Prohibit water use for expansion of commercial nurseries.
   e) Prohibit water use for scenic and recreational ponds and lakes.
   f) Prohibit water use for swimming pools, wading pools, jacuzzi pools, hot tubs and like or similar uses owned either privately, municipally, commercially (including businesses) or owned by a neighborhood, subdivision, club, or fraternal organization.
   g) Prohibit the use of water for the purpose of placing additional land into agricultural use.
   h) Prohibit new residential, commercial, business, or industrial landscaping or planting.
   i) Devise penalties for violations of any instituted restrictions.

3. Demand Management Measures:

   a) The Executive Director, or his/her designee(s) will initiate weekly contact with wholesale water customers to discuss water supply and/or demand conditions and the possibility of pro rata curtailment of water diversions and/or deliveries.
   b) The Executive Director, or his/her designee(s), will request wholesale water customers to initiate mandatory measures to reduce non-essential water use.
   c) The Executive Director, or his/her designee(s), will initiate preparations for the implementation of pro rata curtailment of water diversions and/or deliveries by <u>preparing a monthly water usage allocation baseline</u> for each

wholesale customer according to the procedures specified in Section IX of the Plan.

d) The Executive Director, or his/her designee(s), will provide a weekly report to the City of Corpus Christi with information regarding current wholesale customer usage.

Stage 3 – Severe Water Shortage Conditions

1. Goal: achieve a comparable percent reduction as requested by the City of Corpus Christi.

2. Supply Management Measures. Request wholesale customers to continue in full force with restrictions set forth in previous condition. In addition, request that wholesale customers consider implementation of the following additional regulations or prohibitions:

   a) Applications for new, additional, expanded, or increased size connections, meters, service lines, pipelines, mains or other water service facilities of any kind should not be approved except by review and approval of the majority of the governing body.
   b) Revise allocations to commercial and industrial users.
   c) Establish revised allocations and rates to residential customers based on family size, average historical use, etc.

3. The Executive Director, or his/her designee(s), will provide a weekly report to the City of Corpus Christi with information regarding current wholesale customer usage.

Stage 4 – Emergency Water Shortage Conditions

Whenever emergency water shortage conditions exist as defined in Section VII of the Plan, the Executive Director shall:

1) Assess the severity of the problem and identify the actions needed and time required to solve the problem.

2) Inform the utility director or other responsible official of each wholesale water customer by telephone or in person and suggest actions, as appropriate, to alleviate problems.

3) If appropriate, notify city, county, and/or state emergency response officials for assistance.

4) Undertake necessary actions, including repairs and/or cleanup as needed.

5) Prepare a post-event assessment report on the incident and critique of emergency response procedures and action.

Section IX: Pro Rata Water Allocation

In the event that the triggering criteria specified in Section VII of the Plan for Stage 3 – Severe Water Shortage Conditions have been met, the Executive Director is hereby authorized to initiate allocation of water supplies on a pro rata basis in accordance with Texas Water Code Section 11.039 and according to the following water allocation policies and procedures:

(a) A wholesale customer's monthly allocation shall be a percentage of the customer's water usage baseline. The percentage will be set by resolution of the Board of Directors based on the Executive Director's assessment of the severity of the water shortage condition and the need to curtail water diversions and/or deliveries and may be adjusted periodically by resolution of the Board of Directors as conditions warrant. Once pro rata allocation is in effect, water diversions by or deliveries to each wholesale customer shall be limited to the allocation established for each month.

(b) A monthly water usage allocation shall be established by the Executive Director, or his/her designee, for each wholesale customer. The wholesale customer's water usage baseline will be computed on the average water usage by month for the last five (5) year period as shown in the example given below. If the wholesale water customer's billing history is less than five (5) years, the monthly average for the period for which there is a record shall be used for any monthly period for which no billing history exists.

Example Calculation of Monthly Allocation for a Hypothetical Wholesale Water Customer

	2004	2005	2006	2007	2008	SUM	AVE	Allocation Percentage	Monthly Allocation
Jan	133	137	146	148	156	719	144	75%	108
Feb	115	122	133	133	147	650	130	75%	98
Mar	130	150	146	149	159	734	147	75%	110
Apr	130	167	168	157	187	808	162	75%	122
May	160	152	179	183	171	845	169	75%	127
June	226	184	172	205	249	1,035	207	75%	155
July	235	274	232	314	246	1,301	260	75%	195
Aug	222	203	206	337	309	1,277	255	75%	191
Sep	199	160	196	229	198	982	196	75%	147
Oct	165	172	197	165	185	884	177	75%	133
Nov	139	142	149	153	162	745	149	75%	112
Dec	142	143	150	156	165	755	151	75%	113
Total	1,995	2,006	2,072	2,330	2,333		2,333		

* UNITS IN 1,000 gallons

(c) The Executive Director shall provide notice, by certified mail, to each wholesale customer informing them of their monthly water usage allocations and shall notify the City of Corpus Christi and the executive director of the Texas Commission on Environmental Quality upon initiation of pro rata water allocation.

(d) Upon request of the customer or at the initiative of the Executive Director, the allocation may be reduced or increased if, (1) the designated period does not accurately reflect the wholesale customer's normal water usage; (2) the customer agrees to transfer part of its allocation to another wholesale customer; or (3) other objective evidence demonstrates that the designated allocation is inaccurate under present conditions. A customer may appeal an allocation established hereunder to the Board of Directors of the South Texas Water Authority.

Section X: Enforcement

During any period when pro rata allocation of available water supplies is in effect, wholesale customers shall pay their pro rata share of any surcharges that the City of Corpus Christi collects from the South Texas Water Authority. Daily volumes will be provided to each customer to insure they are aware of their monthly allotment standing.

Section XI: Variances

The Executive Director, or his/her designee, may, in writing, grant a temporary variance to the pro rata water allocation policies provided by this Plan if it is determined that failure to grant such variance would cause an emergency condition adversely affecting the public health, welfare, or safety and if one or more of the following conditions are met:

(a) Compliance with this Plan cannot be technically accomplished during the duration of the water supply shortage or other condition for which the Plan is in effect.

(b) Alternative methods can be implemented which will achieve the same level of reduction in water use.

Persons requesting an exemption from the provisions of this Plan shall file a petition for variance with the Executive Director within five (5) days after pro rata allocation has been invoked. All petitions for variances shall be reviewed by the Board of Directors, and shall include the following:

(a) Name and address of the petitioner(s).

(b) Detailed statement with supporting data and information as to how the pro rata allocation of water under the policies and procedures established in the Plan adversely affects the petition or what damage or harm will occur to the petitioner or others if petitioner complies with this Ordinance.

(c) Description of the relief requested.

(d) Period of time for which the variance is sought.

(e) Alternative measures the petitioner is taking or proposes to take to meet the intent of this Plan and the compliance date.

(f) Other pertinent information.

Variances granted by the Board of Directors shall be subject to the following conditions, unless waived or modified by the Board of Directors or its designee:

(a) Variances granted shall include a timetable for compliance.

(b) Variances granted shall expire when the Plan is no longer in effect, unless the petitioner has failed to meet specified requirements.

No variance shall be retroactive or otherwise justify any violation of this Plan occurring prior to the issuance of the variance.

Section XII: Severability

It is hereby declared to be the intention of the Board of Directors that the sections, paragraphs, sentences, clauses, and phrases of this Plan are severable and, if any phrase, clause, sentence, paragraph, or section of this Plan shall be declared unconstitutional by the valid judgment or decree of any court of competent jurisdiction, such unconstitutionality shall not affect any of the remaining phrases, clauses, sentences, paragraphs, and sections of this Plan, since the same would not have been enacted by the Board of Directors without the incorporation into this Plan of any such unconstitutional phrase, clause, sentence, paragraph, or section.

APPENDIX A

SOUTH TEXAS WATER AUTHORITY

Resolution 09-08

RESOLUTION OF THE BOARD OF DIRECTORS ADOPTING A WATER CONSERVATION AND DROUGHT CONTINGENCY PLAN FOR THE SOUTH TEXAS WATER AUTHORITY.

WHEREAS, the Board recognizes that the importance of water and its availability to the South Texas Water Authority and to its wholesale water customers; and

WHEREAS, the Board recognizes that water resources are not a limitless resource and are subject to depletion during periods of extended drought;

WHEREAS, the South Texas Water Authority recognizes that natural limitations due to drought conditions and other acts of God cannot guarantee an uninterrupted water supply for all purposes; and

WHEREAS, the Texas Commission on Environmental Quality requires all public water supply systems in Texas to prepare a Water Conservation and Drought Contingency Plan; and

WHEREAS, the Texas Water Code Section 11.039 authorizes water suppliers to distribute available water supplies on a pro rata basis during times of water supply shortage; and

WHEREAS, as authorized under law, and in the best interests of the customers of the South Texas Water Authority, the Board deems it expedient and necessary to establish certain rules and policies for the orderly and efficient management of limited water supplies on an ongoing basis as well as during drought and other water supply emergencies.

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF THE SOUTH TEXAS WATER AUTHORITY:

SECTION 1. That the Water Conservation and Drought Contingency Plan is attached hereto as Exhibit "A" and hereby adopted as the official policy of the South Texas Water Authority.

SECTION 2. That the Executive Director is hereby directed to implement, administer, and enforce the Water Conservation and Drought Contingency Plan.

SECTION 3. That this resolution shall take effect immediately upon its passage.

Duly adopted by the Board of Directors of the South Texas Water Authority on this 21st day of April, 2009.

Kathleen Lowman

KATHLEEN LOWMAN, PRESIDENT

ATTEST:

ALICIA J. BLACK, SECRETARY/TREASURER

Appendix F
TWDB Socioeconomic Impacts of Projected Water Shortages for the Coastal Bend Regional Water Planning Area
(Draft January 2010)

Socioeconomic Impacts of Projected Water Shortages for the Coastal Bend Regional Water Planning Area

Prepared in Support of the 2011 Coastal Bend Regional Water Plan

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February, 2010

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Introduction

Water shortages during drought would likely curtail or eliminate economic activity in business and industries reliant on water. For example, without water farmers cannot irrigate; refineries cannot produce gasoline, and paper mills cannot make paper. Unreliable water supplies would not only have an immediate and real impact on existing businesses and industry, but they could also adversely affect economic development in Texas. From a social perspective, water supply reliability is critical as well. Shortages would disrupt activity in homes, schools and government and could adversely affect public health and safety. For all of the above reasons, it is important to analyze and understand how restricted water supplies during drought could affect communities throughout the state.

Administrative rules require that regional water planning groups evaluate the impacts of not meeting water needs as part of the regional water planning process, and rules direct TWDB staff to provide technical assistance: "*The executive administrator shall provide available technical assistance to the regional water planning groups, upon request, on water supply and demand analysis, including methods to evaluate the social and economic impacts of not meeting needs*" [(§357.7 (4)(A)]. Staff of the TWDB's Water Resources Planning Division designed and conducted this report in support of the Coastal Bend Regional Water Planning Group (Region N).

This document summarizes the results of our analysis and discusses the methodology used to generate the results. Section 1 outlines the overall methodology and discusses approaches and assumptions specific to each water use category (i.e., irrigation, livestock, mining, steam-electric, municipal and manufacturing). Section 2 presents the results for each category where shortages are reported at the regional planning area level and river basin level. Results for individual water user groups are not presented, but are available upon request.

1. Methodology

Section 1 provides a general overview of how economic and social impacts were measured. In addition, it summarizes important clarifications, assumptions and limitations of the study.

1.1 Economic Impacts of Water Shortages

1.1.1 General Approach

Economic analysis as it relates to water resources planning generally falls into two broad areas. Supply side analysis focuses on costs and alternatives of developing new water supplies or implementing programs that provide additional water from current supplies. Demand side analysis concentrates on impacts or benefits of providing water to people, businesses and the environment. Analysis in this report focuses strictly on demand side impacts. When analyzing the economic impacts of water shortages as defined in Texas water planning, three potential scenarios are possible:

1) Scenario 1 involves situations where there are physical shortages of raw surface or groundwater due to drought of record conditions. For example, City A relies on a reservoir with average conservation storage of 500 acre-feet per year and a firm yield of 100 acre feet. In 2010, the city uses about 50 acre-feet per year, but by 2030 their demands are expected to increase to 200 acre-feet. Thus, in 2030 the reservoir would not have enough water to meet the city's demands,

and people would experience a shortage of 100 acre-feet assuming drought of record conditions. Under normal or average climatic conditions, the reservoir would likely be able to provide reliable water supplies well beyond 2030.

2) Scenario 2 is a situation where despite drought of record conditions, water supply sources can meet existing use requirements; however, limitations in water infrastructure would preclude future water user groups from accessing these water supplies. For example, City B relies on a river that can provide 500 acre-feet per year during drought of record conditions and other constraints as dictated by planning assumptions. In 2010, the city is expected to use an estimated 100 acre-feet per year and by 2060 it would require no more than 400 acre-feet. But the intake and pipeline that currently transfers water from the river to the city's treatment plant has a capacity of only 200 acre-feet of water per year. Thus, the city's water supplies are adequate even under the most restrictive planning assumptions, but their conveyance system is too small. This implies that at some point – perhaps around 2030 - infrastructure limitations would constrain future population growth and any associated economic activity or impacts.

3) Scenario 3 involves water user groups that rely primarily on aquifers that are being depleted. In this scenario, projected and in some cases existing demands may be unsustainable as groundwater levels decline. Areas that rely on the Ogallala aquifer are a good example. In some communities in the Panhandle region, irrigated agriculture forms a major base of the regional economy. With less irrigation water from the Ogallala, population and economic activity in the region could decline significantly assuming there are no offsetting developments.

Assessing the social and economic effects of each of the above scenarios requires various levels and methods of analysis and would generate substantially different results for a number of reasons; the most important of which has to do with the time frame of each scenario. Scenario 1 falls into the general category of static analysis. This means that models would measure impacts for a small interval of time such as a drought. Scenarios 2 and 3, on the other hand imply a dynamic analysis meaning that models are concerned with changes over a much longer time period.

Since administrative rules specify that planning analysis be evaluated under drought of record conditions (a static and random event), socioeconomic impact analysis developed by the TWDB for the state water plan is based on assumptions of Scenario 1. Estimated impacts under scenario 1 are point estimates for years in which needs are reported (2010, 2020, 2030, 2040, 2050 and 2060). They are independent and distinct "what if" scenarios for a particular year and shortages are assumed to be temporary events resulting from drought of record conditions. Estimated impacts measure what would happen if water user groups experience water shortages for a period of one year.

The TWDB recognize that dynamic models may be more appropriate for some water user groups; however, combining approaches on a statewide basis poses several problems. For one, it would require a complex array of analyses and models, and might require developing supply and demand forecasts under "normal" climatic conditions as opposed to drought of record conditions. Equally important is the notion that combining the approaches would produce inconsistent results across regions resulting in a so-called "apples to oranges" comparison.

A variety tools are available to estimate economic impacts, but by far, the most widely used today are input-output models (IO models) combined with social accounting matrices (SAMs). Referred to as IO/SAM models, these tools formed the basis for estimating economic impacts for agriculture (irrigation and livestock water uses) and industry (manufacturing, mining, steam-electric and commercial business activity for municipal water uses).

Since the planning horizon extends through 2060, economic variables in the baseline are adjusted in accordance with projected changes in demographic and economic activity. Growth rates for municipal water use sectors (i.e., commercial, residential and institutional) are based on TWDB population forecasts. Future values for manufacturing, agriculture, and mining and steam-electric activity are based on the same underlying economic forecasts used to estimate future water use for each category.

The following steps outline the overall process.

Step 1*: Generate IO/SAM Models and Develop Economic Baseline*

IO/SAM models were estimated using propriety software known as IMPLAN PRO™ (Impact for Planning Analysis). IMPLAN is a modeling system originally developed by the U.S. Forestry Service in the late 1970s. Today, the Minnesota IMPLAN Group (MIG Inc.) owns the copyright and distributes data and software. It is probably the most widely used economic impact model in existence. IMPLAN comes with databases containing the most recently available economic data from a variety of sources.[1] Using IMPLAN software and data, transaction tables conceptually similar to the one discussed previously were estimated for each county in the region and for the region as a whole. Each transaction table contains 528 economic sectors and allows one to estimate a variety of economic statistics including:

- **total sales -** total production measured by sales revenues;
- **intermediate sales -** sales to other businesses and industries within a given region;
- **final sales –** sales to end users in a region and exports out of a region**;**
- **employment -** number of full and part-time jobs (annual average) required by a given industry including self-employment;
- **regional income -** total payroll costs (wages and salaries plus benefits) paid by industries, corporate income, rental income and interest payments; and
- **business taxes -** sales, excise, fees, licenses and other taxes paid during normal operation of an industry (does not include income taxes).

TWDB analysts developed an economic baseline containing each of the above variables using year 2000 data. Since the planning horizon extends through 2060, economic variables in the baseline were allowed to change in accordance with projected changes in demographic and economic activity. Growth rates for municipal water use sectors (i.e., commercial, residential and institutional) are based on TWDB population forecasts. Projections for manufacturing, agriculture, and mining and steam-electric activity are based on the same underlying economic forecasts used to estimate future water use for each category. Monetary impacts in future years are reported in constant year 2006 dollars.

It is important to stress that employment, income and business taxes are the most useful variables when comparing the relative contribution of an economic sector to a regional economy. Total sales as reported in IO/SAM models are less desirable and can be misleading because they include sales to other industries in the region for use in the production of other goods. For example, if a mill buys grain from local farmers and uses it to produce feed, sales of both the processed feed and raw corn are counted as "output" in an IO model. Thus, total sales double-count or overstate the true economic value of goods

[1]The IMPLAN database consists of national level technology matrices based on benchmark input-output accounts generated by the U.S. Bureau of Economic Analysis and estimates of final demand, final payments, industry output and employment for various economic sectors. IMPLAN regional data (i.e. states, a counties or groups of counties within a state) are divided into two basic categories: 1) data on an industry basis including value-added, output and employment, and 2) data on a commodity basis including final demands and institutional sales. State-level data are balanced to national totals using a matrix ratio allocation system and county data are balanced to state totals.

and services produced in an economy. They are not consistent with commonly used measures of output such as Gross National Product (GNP), which counts only final sales.

Another important distinction relates to terminology. Throughout this report, the term *sector* refers to economic subdivisions used in the IMPLAN database and resultant input-output models (528 individual sectors based on Standard Industrial Classification Codes). In contrast, the phrase *water use category* refers to water user groups employed in state and regional water planning including irrigation, livestock, mining, municipal, manufacturing and steam electric. Each IMPLAN sector was assigned to a specific water use category.

Step 2: *Estimate Direct and Indirect Economic Impacts of Water Needs*

Direct impacts are reductions in output by sectors experiencing water shortages. For example, without adequate cooling and process water a refinery would have to curtail or cease operation, car washes may close, or farmers may not be able to irrigate and sales revenues fall. Indirect impacts involve changes in inter-industry transactions as supplying industries respond to decreased demands for their services, and how seemingly non-related businesses are affected by decreased incomes and spending due to direct impacts. For example, if a farmer ceases operations due to a lack of irrigation water, they would likely reduce expenditures on supplies such as fertilizer, labor and equipment, and businesses that provide these goods would suffer as well.

Direct impacts accrue to immediate businesses and industries that rely on water and without water industrial processes could suffer. However, output responses may vary depending upon the severity of shortages. A small shortage relative to total water use would likely have a minimal impact, but large shortages could be critical. For example, farmers facing small shortages might fallow marginally productive acreage to save water for more valuable crops. Livestock producers might employ emergency culling strategies, or they may consider hauling water by truck to fill stock tanks. In the case of manufacturing, a good example occurred in the summer of 1999 when Toyota Motor Manufacturing experienced water shortages at a facility near Georgetown, Kentucky.[2] As water levels in the Kentucky River fell to historic lows due to drought, plant managers sought ways to curtail water use such as reducing rinse operations to a bare minimum and recycling water by funneling it from paint shops to boilers. They even considered trucking in water at a cost of 10 times what they were paying. Fortunately, rains at the end of the summer restored river levels, and Toyota managed to implement cutbacks without affecting production, but it was a close call. If rains had not replenished the river, shortages could have severely reduced output.[3]

To account for uncertainty regarding the relative magnitude of impacts to farm and business operations, the following analysis employs the concept of elasticity. Elasticity is a number that shows how a change in one variable will affect another. In this case, it measures the relationship between a percentage reduction in water availability and a percentage reduction in output. For example, an elasticity of 1.0 indicates that a 1.0 percent reduction in water availability would result in a 1.0 percent reduction in economic output. An elasticity of 0.50 would indicate that for every 1.0 percent of unavailable water, output is reduced by 0.50 percent and so on. Output elasticities used in this study are:[4]

[2] Royal, W. "*High And Dry - Industrial Centers Face Water Shortages*." in Industry Week, Sept, 2000.

[3] The efforts described above are not planned programmatic or long-term operational changes. They are emergency measures that individuals might pursue to alleviate what they consider a temporary condition. Thus, they are not characteristic of long-term management strategies designed to ensure more dependable water supplies such as capital investments in conservation technology or development of new water supplies.

[4] Elasticities are based on one of the few empirical studies that analyze potential relationships between economic output and water shortages in the United States. The study, conducted in California, showed that a significant number of industries would suffer reduced output during water shortages. Using a survey based approach researchers posed two scenarios to different industries. In

- if water needs are 0 to 5 percent of total water demand, no corresponding reduction in output is assumed;

- if water needs are 5 to 30 percent of total water demand, for each additional one percent of water need that is not met, there is a corresponding 0.50 percent reduction in output;

- if water needs are 30 to 50 percent of total water demand, for each additional one percent of water need that is not met, there is a corresponding 0.75 percent reduction in output; and

- if water needs are greater than 50 percent of total water demand, for each additional one percent of water need that is not met, there is a corresponding 1.0 percent (i.e., a proportional reduction).

In some cases, elasticities are adjusted depending upon conditions specific to a given water user group.

Once output responses to water shortages were estimated, direct impacts to total sales, employment, regional income and business taxes were derived using regional level economic multipliers estimating using IO/SAM models. The formula for a given IMPLAN sector is:

$D_{i,t} = Q_{i,t} *_{,} S_{i,t} * E_Q * RFD_i * DM_{i(Q, L, I, T)}$

where:

$D_{i,t}$ = direct economic impact to sector *i* in period *t*

$Q_{i,t}$ = total sales for sector *i* in period *t* in an affected county

$RFD_{i,}$ = ratio of final demand to total sales for sector *i* for a given region

$S_{i,t}$ = water shortage as percentage of total water use in period *t*

E_Q = elasticity of output and water use

$DM_{i(L, I, T)}$ = direct output multiplier coefficients for labor (L), income (I) and taxes (T) for sector *i*.

Secondary impacts were derived using the same formula used to estimate direct impacts; however, indirect multiplier coefficients are used. Methods and assumptions specific to each water use sector are discussed in Sections 1.1.2 through 1.1.4.

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the first scenario, they asked how a 15 percent cutback in water supply lasting one year would affect operations. In the second scenario, they asked how a 30 percent reduction lasting one year would affect plant operations. In the case of a 15 percent shortage, reported output elasticities ranged from 0.00 to 0.76 with an average value of 0.25. For a 30 percent shortage, elasticities ranged from 0.00 to 1.39 with average of 0.47. For further information, see, California Urban Water Agencies, "*Cost of Industrial Water Shortages,*" Spectrum Economics, Inc. November, 1991.

General Assumptions and Clarification of the Methodology

As with any attempt to measure and quantify human activities at a societal level, assumptions are necessary and every model has limitations. Assumptions are needed to maintain a level of generality and simplicity such that models can be applied on several geographic levels and across different economic sectors. In terms of the general approach used here several clarifications and cautions are warranted:

1. Shortages as reported by regional planning groups are the starting point for socioeconomic analyses.

2. Estimated impacts are point estimates for years in which needs are reported (i.e., 2010, 2020, 2030, 2040, 2050 and 2060).They are independent and distinct "what if" scenarios for each particular year and water shortages are assumed to be temporary events resulting from severe drought conditions combined with infrastructure limitations. In other words, growth occurs and future shocks are imposed on an economy at 10-year intervals and resultant impacts are measured. Given, that reported figures are not cumulative in nature, it is inappropriate to sum impacts over the entire planning horizon. Doing so, would imply that the analysis predicts that drought of record conditions will occur every ten years in the future, which is not the case. Similarly, authors of this report recognize that in many communities needs are driven by population growth, and in the future total population will exceed the amount of water available due to infrastructure limitations, regardless of whether or not there is a drought. This implies that infrastructure limitations would constrain economic growth. However, since needs as defined by planning rules are based upon water supply and demand under the assumption of drought of record conditions, it improper to conduct economic analysis that focuses on growth related impacts over the planning horizon. Figures generated from such an analysis would presume a 50-year drought of record, which is unrealistic. Estimating lost economic activity related to constraints on population and commercial growth due to lack of water would require developing water supply and demand forecasts under "normal" or "most likely" future climatic conditions.

3. While useful for planning purposes, this study is not a benefit-cost analysis. Benefit cost analysis is a tool widely used to evaluate the economic feasibility of specific policies or projects as opposed to estimating economic impacts of unmet water needs. Nevertheless, one could include some impacts measured in this study as part of a benefit cost study if done so properly. Since this is not a benefit cost analysis, future impacts are not weighted differently. In other words, estimates are not discounted. If used as a measure of economic benefits, one should incorporate a measure of uncertainty into the analysis. In this type of analysis, a typical method of discounting future values is to assign probabilities of the drought of record recurring again in a given year, and weight monetary impacts accordingly. This analysis assumes a probability of one.

4. IO multipliers measure the strength of backward linkages to supporting industries (i.e., those who sell inputs to an affected sector). However, multipliers say nothing about forward linkages consisting of businesses that purchase goods from an affected sector for further processing. For example, ranchers in many areas sell most of their animals to local meat packers who process animals into a form that consumers ultimately see in grocery stores and restaurants. Multipliers do not capture forward linkages to meat packers, and since meat packers sell livestock purchased from ranchers as "final sales," multipliers for the ranching sector do fully account for all losses to a region's economy. Thus, as mentioned previously, in some cases closely linked sectors were moved from one water use category to another.

5. Cautions regarding interpretations of direct and secondary impacts are warranted. IO/SAM multipliers are based on "fixed-proportion production functions," which basically means that input use - including labor - moves in lockstep fashion with changes in levels of output. In a

scenario where output (i.e., sales) declines, losses in the immediate sector or supporting sectors could be much less than predicted by an IO/SAM model for several reasons. For one, businesses will likely expect to continue operating so they might maintain spending on inputs for future use; or they may be under contractual obligations to purchase inputs for an extended period regardless of external conditions. Also, employers may not lay-off workers given that experienced labor is sometimes scarce and skilled personnel may not be readily available when water shortages subside. Lastly people who lose jobs might find other employment in the region. As a result, direct losses for employment and secondary losses in sales and employment should be considered an upper bound. Similarly, since population projections are based on reduced employment in the region, they should be considered an upper bound as well.

6. IO models are static. Models and resultant multipliers are based upon the structure of the U.S. and regional economies in 2006. In contrast, water shortages are projected to occur well into the future. Thus, the analysis assumes that the general structure of the economy remains the same over the planning horizon, and the farther out into the future we go, this assumption becomes less reliable.

7. Impacts are annual estimates. If one were to assume that conditions persisted for more than one year, figures should be adjusted to reflect the extended duration. The drought of record in most regions of Texas lasted several years.

8. Monetary figures are reported in constant year 2006 dollars.

1.1.2 Impacts to Agriculture

Irrigated Crop Production

The first step in estimating impacts to irrigation required calculating gross sales for IMPLAN crop sectors. Default IMPLAN data do not distinguish irrigated production from dry-land production. Once gross sales were known other statistics such as employment and income were derived using IMPLAN direct multiplier coefficients. Gross sales for a given crop are based on two data sources:

1) county-level statistics collected and maintained by the TWDB and the USDA Farm Services Agency (FSA) including the number of irrigated acres by crop type and water application per acre, and

2) regional-level data published by the Texas Agricultural Statistics Service (TASS) including prices received for crops (marketing year averages), crop yields and crop acreages.

Crop categories used by the TWDB differ from those used in IMPLAN datasets. To maintain consistency, sales and other statistics are reported using IMPLAN crop classifications. Table 1 shows the TWDB crops included in corresponding IMPLAN sectors, and Table 2 summarizes acreage and estimated annual water use for each crop classification (five-year average from 2003-2007). Table 3 displays average (2003-2007) gross revenues per acre for IMPLAN crop categories.

Table 1: Crop Classifications Used in TWDB Water Use Survey and Corresponding IMPLAN Crop Sectors	
IMPLAN Category	**TWDB Category**
Oilseed Farming	Soybeans and “other oil crops”
Grain Farming	Grain sorghum, corn, wheat and “other grain crops”
Vegetable and Melon Farming	“Vegetables” and potatoes
Tree Nut Farming	Pecans
Fruit Farming	Citrus, vineyard and other orchard
Cotton Farming	Cotton
Sugarcane and Sugar Beet Farming	Sugarcane and sugar beets
All “Other” Crop Farming	“Forage crops”, peanuts, alfalfa, hay and pasture, rice and “all other crops”

Table 2: Summary of Irrigated Crop Acreage and Water Demand for the Coastal Bend Regional Water Planning Area (average 2003-2007)

Sector	Acres (1000s)	Distribution of Acres	Water Use (1000s of AF)	Distribution of Water Use
Oilseed Farming	0.3	<1%	0.3	<1%
Grain Farming	8.8	30%	4.9	22%
Vegetable and Melon Farming	3.1	11%	3.4	15%
Tree Nut Farming	0.1	<1%	0.1	<1%
Fruit Farming	0.2	<1%	0.2	<1%
Cotton Farming	11.5	40%	8.1	36%
Sugarcane and Sugar Beet Farming	0.0	0%	0.0	0%
All “Other” Crop Farming	4.9	17%	5.4	24%
Total	28.9	100%	22.4	100%

Source: Water demand figures are a 5- year average (2003-2007) of the TWDB’s annual Irrigation Water Use Estimates. Statistics for irrigated crop acreage are based upon annual survey data collected by the TWDB and the Farm Service Agency. Values do not include acreage or water use for the TWDB categories classified by the Farm Services Agency as “failed acres,” “golf course” or “waste water”.

Table 3: Average Gross Sales Revenues per Acre for Irrigated Crops for the Coastal Bend Regional Water Planning Area (2003-2007)		
IMPLAN Sector	**Gross Revenues per Acre**	**Crops Included in Estimates**
Oilseed Farming	$179	Based on five-year (2003-2007) average weighted by acreage for "irrigated soybeans" and "irrigated other oil crops."
Grain Farming	$290	Based on five-year (2003-2007) average weighted by acreage for "irrigated grain sorghum," "irrigated corn", "irrigated wheat" and "irrigated 'other' grain crops."
Vegetable and Melon Farming	$5,784	Based on five-year (2003-2007) average weighted by acreage for "irrigated shallow and deep root vegetables", "irrigated Irish potatoes" and "irrigated melons."
Tree Nut Farming	$3,429	Based on five-year (2003-2007) average weighted by acreage for "irrigated pecans."
Fruit Farming	$2,297	Based on five-year (2003-2007) average weighted by acreage for "irrigated citrus", "irrigated vineyards" and "irrigated 'other' orchard."
Cotton Farming	$508	Based on five-year (2003-2007) average weighted by acreage for "irrigated cotton."
All Other Crops	$265	Irrigated figure is based on five-year (2003-2007) average weighted by acreage for "irrigated 'forage' crops", "irrigated peanuts", "irrigated alfalfa", "irrigated 'hay' and pasture" and "irrigated 'all other' crops."

*Figures are rounded. Source: Based on data from the Texas Agricultural Statistics Service, Texas Water Development Board, and Texas A&M University.

An important consideration when estimating impacts to irrigation was determining which crops are affected by water shortages. One approach is the so-called rationing model, which assumes that farmers respond to water supply cutbacks by fallowing the lowest value crops in the region first and the highest valued crops last until the amount of water saved equals the shortage.[5] For example, if farmer A grows vegetables (higher value) and farmer B grows wheat (lower value) and they both face a proportionate cutback in irrigation water, then farmer B will sell water to farmer A. Farmer B will fallow her irrigated acreage before farmer A fallows anything. Of course, this assumes that farmers can and do transfer enough water to allow this to happen. A different approach involves constructing farm-level profit maximization models that conform to widely-accepted economic theory that farmers make decisions based on marginal net returns. Such models have good predictive capability, but data requirements and complexity are high. Given that a detailed analysis for each region would require a substantial amount of farm-level data and analysis, the following investigation assumes that projected shortages are distributed equally across predominant crops in the region. Predominant in this case are crops that comprise at least one percent of total acreage in the region.

[5] The rationing model was initially proposed by researchers at the University of California at Berkeley, and was then modified for use in a study conducted by the U.S. Environmental Protection Agency that evaluated how proposed water supply cutbacks recommended to protect water quality in the Bay/Delta complex in California would affect farmers in the Central Valley. See, Zilberman, D., Howitt, R. and Sunding, D. "*Economic Impacts of Water Quality Regulations in the San Francisco Bay and Delt*a." Western Consortium for Public Health. May 1993.

The following steps outline the overall process used to estimate direct impacts to irrigated agriculture:

1. *Distribute shortages across predominant crop types in the region*. Again, unmet water needs were distributed equally across crop sectors that constitute one percent or more of irrigated acreage.

2. *Estimate associated reductions in output for affected crop sectors*. Output reductions are based on elasticities discussed previously and on estimated values per acre for different crops. Values per acre stem from the same data used to estimate output for the year 2006 baseline. Using multipliers, we then generate estimates of forgone income, jobs, and tax revenues based on reductions in gross sales and final demand.

Livestock

The approach used for the livestock sector is basically the same as that used for crop production. As is the case with crops, livestock categorizations used by the TWDB differ from those used in IMPLAN datasets, and TWDB groupings were assigned to a given IMPLAN sector (Table 4). Then we:

1) *Distribute projected water needs equally among predominant livestock sectors and estimate lost output*: As is the case with irrigation, shortages are assumed to affect all livestock sectors equally; however, the category of "other" is not included given its small size. If water needs were small relative to total demands, we assume that producers would haul in water by truck to fill stock tanks. The cost per acre-foot ($24,000) is based on 2008 rates charged by various water haulers in Texas, and assumes that the average truck load is 6,500 gallons at a hauling distance of 60 miles.

3) *Estimate reduced output in forward processors for livestock sectors*. Reductions in output for livestock sectors are assumed to have a proportional impact on forward processors in the region such as meat packers. In other words, if the cows were gone, meat-packing plants or fluid milk manufacturers) would likely have little to process. This is not an unreasonable premise. Since the 1950s, there has been a major trend towards specialized cattle feedlots, which in turn has decentralized cattle purchasing from livestock terminal markets to direct sales between producers and slaughterhouses. Today, the meat packing industry often operates large processing facilities near high concentrations of feedlots to increase capacity utilization.[6] As a result, packers are heavily dependent upon nearby feedlots. For example, a recent study by the USDA shows that on average meat packers obtain 64 percent of cattle from within 75 miles of their plant, 82 percent from within 150 miles and 92 percent from within 250 miles.[7]

[6] Ferreira, W.N. "*Analysis of the Meat Processing Industry in the United States*." Clemson University Extension Economics Report ER211, January 2003.

[7] Ward, C.E. "*Summary of Results from USDA's Meatpacking Concentration Study*." Oklahoma Cooperative Extension Service, OSU Extension Facts WF-562.

Table 4: Description of Livestock Sectors	
IMPLAN Category	**TWDB Category**
Cattle ranching and farming	Cattle, cow calf, feedlots and dairies
Poultry and egg production	Poultry production.
Other livestock	Livestock other than cattle and poultry (i.e., horses, goats, sheep, hogs)
Milk manufacturing	Fluid milk manufacturing, cheese manufacturing, ice cream manufacturing etc.
Meat packing	Meat processing present in the region from slaughter to final processing

1.1.3 Impacts to Municipal Water User Groups

Disaggregation of Municipal Water Demands

Estimating the economic impacts for the municipal water user groups is complicated for a number of reasons. For one, municipal use comprises a range of consumers including commercial businesses, institutions such as schools and government and households. However, reported water needs are not distributed among different municipal water users. In other words, how much of a municipal need is commercial and how much is residential (domestic)?

The amount of commercial water use as a percentage of total municipal demand was estimated based on "GED" coefficients (gallons per employee per day) published in secondary sources.[8] For example, if year 2006 baseline data for a given economic sector (e.g., amusement and recreation services) shows employment at 30 jobs and the GED coefficient is 200, then average daily water use by that sector is (30 x 200 = 6,000 gallons) or 6.7 acre-feet per year. Water not attributed to commercial use is considered domestic, which includes single and multi-family residential consumption, institutional uses and all use designated as "county-other." Based on our analysis, commercial water use is about 5 to 35 percent of municipal demand. Less populated rural counties occupy the lower end of the spectrum, while larger metropolitan counties are at the higher end.

After determining the distribution of domestic versus commercial water use, we developed methods for estimating impacts to the two groups.

[8] Sources for GED coefficients include: Gleick, P.H., Haasz, D., Henges-Jeck, C., Srinivasan, V., Wolff, G. Cushing, K.K., and Mann, A. "*Waste Not, Want Not*: *The Potential for Urban Water Conservation in California*." Pacific Institute. November 2003. U.S. Bureau of the Census. 1982 Census of Manufacturers: Water Use in Manufacturing. USGPO, Washington D.C. See also: "*U.S. Army Engineer Institute for Water Resources, IWR Report 88-R-6.*," Fort Belvoir, VA. See also, Joseph, E. S., 1982, "*Municipal and Industrial Water Demands of the Western United States*." Journal of the Water Resources Planning and Management Division, Proceedings of the American Society of Civil Engineers, v. 108, no. WR2, p. 204-216. See also, Baumann, D. D., Boland, J. J., and Sims, J. H., 1981, "*Evaluation of Water Conservation for Municipal and Industrial Water Supply*." U.S. Army Corps of Engineers, Institute for Water Resources, Contract no. 82-C1.

Domestic Water Uses

Input output models are not well suited for measuring impacts of shortages for domestic water uses, which make up the majority of the municipal water use category. To estimate impacts associated with domestic water uses, municipal water demand and needs are subdivided into residential, and commercial and institutional use. Shortages associated with residential water uses are valued by estimating proxy demand functions for different water user groups allowing us to estimate the marginal value of water, which would vary depending upon the level of water shortages. The more severe the water shortage, the more costly it becomes. For instance, a 2 acre-foot shortage for a group of households that use 10 acre-feet per year would not be as severe as a shortage that amounted to 8 acre-feet. In the case of a 2 acre-foot shortage, households would probably have to eliminate some or all outdoor water use, which could have implicit and explicit economic costs including losses to the horticultural and landscaping industry. In the case of an 8 acre-foot shortage, people would have to forgo all outdoor water use and most indoor water consumption. Economic impacts would be much higher in the latter case because people, and would be forced to find emergency alternatives assuming alternatives were available.

To estimate the value of domestic water uses, TWDB staff developed marginal loss functions based on constant elasticity demand curves. This is a standard and well-established method used by economists to value resources such as water that have an explicit monetary cost.

A constant price elasticity of demand is estimated using a standard equation:

$$w = kc^{(-\varepsilon)}$$

where:

- w is equal to average monthly residential water use for a given water user group measured in thousands of gallons;
- k is a constant intercept;
- c is the average cost of water per 1,000 gallons; and
- ε is the price elasticity of demand.

Price elasticities (-0.30 for indoor water use and -0.50 for outdoor use) are based on a study by Bell et al.[9] that surveyed 1,400 water utilities in Texas that serve at least 1,000 people to estimate demand elasticity for several variables including price, income, weather etc. Costs of water and average use per month per household are based on data from the Texas Municipal League's annual water and wastewater rate surveys - specifically average monthly household expenditures on water and wastewater in different communities across the state. After examining variance in costs and usage, three different categories of water user groups based on population (population less than 5,000, cities with populations ranging from 5,000 to 99,999 and cities with populations exceeding 100,000) were selected to serve as proxy values for municipal water groups that meet the criteria (Table 5).[10]

[9] Bell, D.R. and Griffin, R.C. "*Community Water Demand in Texas as a Century is Turned*." Research contract report prepared for the Texas Water Development Board. May 2006.

[10] Ideally, one would want to estimate demand functions for each individual utility in the state. However, this would require an enormous amount of time and resources. For planning purposes, we believe the values generated from aggregate data are more than sufficient.

Table 5: Water Use and Costs Parameters Used to Estimated Water Demand Functions (average monthly costs per acre-foot for delivered water and average monthly use per household)				
Community Population	**Water**	**Wastewater**	**Total Monthly Cost**	**Avg. Monthly Use (gallons)**
Less than or equal to 5,000	$1,335	$1,228	$2,563	6,204
5,000 to 100,000	$718	$1,162	$1,880	7,950
Great than or equal to 100,000	$1,047	$457	$1,504	8,409
Source: Based on annual water and wastewater rate surveys published by the Texas Municipal League.				

As an example, Table 6 shows the economic impact per acre-foot of domestic water needs for municipal water user groups with population exceeding 100,000 people. There are several important assumptions incorporated in the calculations:

1) Reported values are net of the variable costs of treatment and distribution such as expenses for chemicals and electricity since using less water involves some savings to consumers and utilities alike; and for outdoor uses we do not include any value for wastewater.

2) Outdoor and "non-essential" water uses would be eliminated before indoor water consumption was affected, which is logical because most water utilities in Texas have drought contingency plans that generally specify curtailment or elimination of outdoor water use during droughts.[11] Determining how much water is used for outdoor purposes is based on several secondary sources. The first is a major study sponsored by the American Water Works Association, which surveyed cities in states including Colorado, Oregon, Washington, California, Florida and Arizona. On average across all cities surveyed 58 percent of single family residential water use was for outdoor activities. In cities with climates comparable to large metropolitan areas of Texas, the average was 40 percent.[12] Earlier findings of the U.S. Water Resources Council showed a national average of 33 percent. Similarly, the United States Environmental Protection Agency (USEPA) estimated that landscape watering accounts for 32 percent of total residential and commercial water use on annual basis.[13] A study conducted for the California Urban Water Agencies (CUWA) calculated average annual values ranging from 25 to 35 percent.[14] Unfortunately, there does not appear to be any comprehensive research that has estimated non-agricultural outdoor water use in Texas. As an approximation, an

[11] In Texas, state law requires retail and wholesale water providers to prepare and submit plans to the Texas Commission on Environmental Quality (TCEQ). Plans must specify demand management measures for use during drought including curtailment of "non-essential water uses." Non-essential uses include, but are not limited to, landscape irrigation and water for swimming pools or fountains. For further information see the Texas Environmental Quality Code §288.20.

[12] See, Mayer, P.W., DeOreo, W.B., Opitz, E.M., Kiefer, J.C., Davis, W., Dziegielewski, D., Nelson, J.O. "*Residential End Uses of Water*." Research sponsored by the American Water Works Association and completed by Aquacraft, Inc. and Planning and Management Consultants, Ltd. (PMCL@CDM).

[13] U.S. Environmental Protection Agency. *"Cleaner Water through Conservation*." USEPA Report no. 841-B-95-002. April, 1995.

[14] Planning and Management Consultants, Ltd. "*Evaluating Urban Water Conservation Programs: A Procedures Manual*." Prepared for the California Urban Water Agencies. February 1992.

average annual value of 30 percent based on the above references was selected to serve as a rough estimate in this study.

Table 6: Economic Losses Associated with Domestic Water Shortages in Communities with Populations Exceeding 100,000 people

Water shortages as a percentage of total monthly household demands	No. of gallons remaining per household per day	No of gallons remaining per person per day	Economic loss (per acre-foot)	Economic loss (per gallon)
1%	278	93	$748	$0.00005
5%	266	89	$812	$0.0002
10%	252	84	$900	$0.0005
15%	238	79	$999	$0.0008
20%	224	75	$1,110	$0.0012
25%	210	70	$1,235	$0.0015
30%[a]	196	65	$1,699	$0.0020
35%	182	61	$3,825	$0.0085
40%	168	56	$4,181	$0.0096
45%	154	51	$4,603	$0.011
50%	140	47	$5,109	$0.012
55%	126	42	$5,727	$0.014
60%	112	37	$6,500	$0.017
65%	98	33	$7,493	$0.02
70%	84	28	$8,818	$0.02
75%	70	23	$10,672	$0.03
80%	56	19	$13,454	$0.04
85%	42	14	$18,091 ($24,000)[b]	$0.05 ($0.07)[b]
90%	28	9	$27,363 ($24,000)	$0.08 ($0.07)
95%	14	5	$55,182 ($24,000)	$0.17 ($0.07)
99%	3	0.9	$277,728 ($24,000)	$0.85 ($0.07)
99.9%	1	0.5	$2,781,377 ($24,000)	$8.53 ($0.07)
100%	0	0	Infinite ($24,000)	Infinite ($0.07)

[a] The first 30 percent of needs are assumed to be restrictions of outdoor water use; when needs reach 30 percent of total demands all outdoor water uses would be restricted. Needs greater than 30 percent include indoor use

[b] As shortages approach 100 percent the value approaches infinity assuming there are not alternatives available; however, we assume that communities would begin to have water delivered by tanker truck at an estimated cost of $24,000 per acre-foot when shortages breached 85 percent.

3) As shortages approach 100 percent values become immense and theoretically infinite at 100 percent because at that point death would result, and willingness to pay for water is immeasurable. Thus, as shortages approach 80 percent of monthly consumption, we assume that households and non-water intensive commercial businesses (those that use water only for drinking and sanitation would have water delivered by tanker truck or commercial water delivery companies. Based on reports from water companies throughout the state, we estimate that the cost of trucking in water is around $21,000 to $27,000 per acre-feet assuming a hauling distance of between 20 to 60 miles. This is not an unreasonable assumption. The practice was widespread during the 1950s drought and recently during droughts in this decade. For example, in 2000 at the heels of three consecutive drought years Electra - a small town in North Texas - was down to its last 45 days worth of reservoir water when rain replenished the lake, and the city was able to refurbish old wells to provide supplemental groundwater. At the time, residents were forced to limit water use to 1,000 gallons per person per month - less than half of what most people use - and many were having water delivered to their homes by private contractors.[15] In 2003 citizens of Ballinger, Texas, were also faced with a dwindling water supply due to prolonged drought. After three years of drought, Lake Ballinger, which supplies water to more than 4,300 residents in Ballinger and to 600 residents in nearby Rowena, was almost dry. Each day, people lined up to get water from a well in nearby City Park. Trucks hauling trailers outfitted with large plastic and metal tanks hauled water to and from City Park to Ballinger.[16]

Commercial Businesses

Effects of water shortages on commercial sectors were estimated in a fashion similar to other business sectors meaning that water shortages would affect the ability of these businesses to operate. This is particularly true for "water intensive" commercial sectors that are need large amounts of water (in addition to potable and sanitary water) to provide their services. These include:

- car-washes,
- laundry and cleaning facilities,
- sports and recreation clubs and facilities including race tracks,
- amusement and recreation services,
- hospitals and medical facilities,
- hotels and lodging places, and
- eating and drinking establishments.

A key assumption is that commercial operations would not be affected until water shortages were at least 50 percent of total municipal demand. In other words, we assume that residential water consumers would reduce water use including all non-essential uses before businesses were affected.

An example will illustrate the breakdown of municipal water needs and the overall approach to estimating impacts of municipal needs. Assume City A experiences an unexpected shortage of 50 acre-feet per year when their demands are 200 acre-feet per year. Thus, shortages are only 25 percent of total municipal use and residents of City A could eliminate needs by restricting landscape irrigation. City B, on the other hand, has a deficit of 150 acre-feet in 2020 and a projected demand of 200 acre-feet. Thus, total

[15] Zewe, C. "*Tap Threatens to Run Dry in Texas Town*." July 11, 2000. CNN Cable News Network.

[16] Associated Press, "*Ballinger Scrambles to Finish Pipeline before Lake Dries Up*." May 19, 2003.

shortages are 75 percent of total demand. Emergency outdoor and some indoor conservation measures could eliminate 50 acre-feet of projected needs, yet 50 acre-feet would still remain. To eliminate" the remaining 50 acre-feet water intensive commercial businesses would have to curtail operations or shut down completely.

Three other areas were considered when analyzing municipal water shortages: 1) lost revenues to water utilities, 2) losses to the horticultural and landscaping industries stemming for reduction in water available for landscape irrigation, and 3) lost revenues and related economic impacts associated with reduced water related recreation.

Water Utility Revenues

Estimating lost water utility revenues was straightforward. We relied on annual data from the "*Water and Wastewater Rate Survey*" published annually by the Texas Municipal League to calculate an average value per acre-foot for water and sewer. For water revenues, average retail water and sewer rates multiplied by total water needs served as a proxy. For lost wastewater, total unmet needs were adjusted for return flow factor of 0.60 and multiplied by average sewer rates for the region. Needs reported as "county-other" were excluded under the presumption that these consist primarily of self-supplied water uses. In addition, 15 percent of water demand and needs are considered non-billed or "unaccountable" water that comprises things such as leakages and water for municipal government functions (e.g., fire departments). Lost tax receipts are based on current rates for the "miscellaneous gross receipts tax, "which the state collects from utilities located in most incorporated cities or towns in Texas. We do not include lost water utility revenues when aggregating impacts of municipal water shortages to regional and state levels to prevent double counting.

Horticultural and Landscaping Industry

The horticultural and landscaping industry, also referred to as the "green Industry," consists of businesses that produce, distribute and provide services associated with ornamental plants, landscape and garden supplies and equipment. Horticultural industries often face big losses during drought. For example, the recent drought in the Southeast affecting the Carolinas and Georgia horticultural and landscaping businesses had a harsh year. Plant sales were down, plant mortality increased, and watering costs increased. Many businesses were forced to close locations, lay off employees, and even file for bankruptcy. University of Georgia economists put statewide losses for the industry at around $3.2 billion during the 3-year drought that ended in 2008.[17] Municipal restrictions on outdoor watering play a significant role. During drought, water restrictions coupled with persistent heat has a psychological effect on homeowners that reduces demands for landscaping products and services. Simply put, people were afraid to spend any money on new plants and landscaping.

In Texas, there do not appear to be readily available studies that analyze the economic effects of water shortages on the industry. However, authors of this report believe negative impacts do and would result in restricting landscape irrigation to municipal water consumers. The difficulty in measuring them is two-fold. First, as noted above, data and research for these types of impacts that focus on Texas are limited; and second, economic data provided by IMPLAN do not disaggregate different sectors of the green industry to a level that would allow for meaningful and defensible analysis.[18]

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[17] Williams, D. *"Georgia landscapers eye rebound from Southeast drought."* Atlanta Business Chronicle, Friday, June 19, 2009

[18] Economic impact analyses prepared by the TWDB for 2006 regional water plans did include estimates for the horticultural industry. However, year 2000 and prior IMPLAN data were disaggregated to a finer level. In the current

Recreational Impacts

Recreational businesses often suffer when water levels and flows in rivers, springs and reservoirs fall significantly during drought. During droughts, many boat docks and lake beaches are forced to close, leading to big losses for lakeside business owners and local communities. Communities adjacent to popular river and stream destinations such as Comal Springs and the Guadalupe River also see their business plummet when springs and rivers dry up. Although there are many examples of businesses that have suffered due to drought, dollar figures for drought-related losses to the recreation and tourism industry are not readily available, and very difficult to measure without extensive local surveys. Thus, while they are important, economic impacts are not measured in this study.

Table 7 summarizes impacts of municipal water shortages at differing levels of magnitude, and shows the ranges of economic costs or losses per acre-foot of shortage for each level.

Table 7: Impacts of Municipal Water Shortages at Different Magnitudes of Shortages

Water shortages as percent of total municipal demands	Impacts	Economic costs per acre-foot*
0-30%	✓ Lost water utility revenues ✓ Restricted landscape irrigation and non-essential water uses	$730 - $2,040
30-50%	✓ Lost water utility revenues ✓ Elimination of landscape irrigation and non-essential water uses ✓ Rationing of indoor use	$2,040 - $10,970
>50%	✓ Lost water utility revenues ✓ Elimination of landscape irrigation and non-essential water uses ✓ Rationing of indoor use ✓ Restriction or elimination of commercial water use ✓ Importing water by tanker truck	$10,979 - varies

*Figures are rounded

dataset (2006), the sector previously listed as "Landscaping and Horticultural Services" (IMPLAN Sector 27) is aggregated into "Services to Buildings and Dwellings" (IMPLAN Sector 458).

1.1.4 Industrial Water User Groups

Manufacturing

Impacts to manufacturing were estimated by distributing water shortages among industrial sectors at the county level. For example, if a planning group estimates that during a drought of record water supplies in County A would only meet 50 percent of total annual demands for manufactures in the county, we reduced output for each sector by 50 percent. Since projected manufacturing demands are based on TWDB Water Uses Survey data for each county, we only include IMPLAN sectors represented in the TWBD survey database. Some sectors in IMPLAN databases are not part of the TWDB database given that they use relatively small amounts of water - primarily for on-site sanitation and potable purposes. To maintain consistency between IMPLAN and TWDB databases, Standard Industrial Classification (SIC) codes both databases were cross referenced in county with shortages. Non-matches were excluded when calculating direct impacts.

Mining

The process of mining is very similar to that of manufacturing. We assume that within a given county, shortages would apply equally to relevant mining sectors, and IMPLAN sectors are cross referenced with TWDB data to ensure consistency.

In Texas, oil and gas extraction and sand and gravel (aggregates) operations are the primary mining industries that rely on large volumes of water. For sand and gravel, estimated output reductions are straightforward; however, oil and gas is more complicated for a number of reasons. IMPLAN does not necessarily report the physical extraction of minerals by geographic local, but rather the sales revenues reported by a particular corporation.

For example, at the state level revenues for IMPLAN sector 19 (oil and gas extraction) and sector 27 (drilling oil and gas wells) totals $257 billion. Of this, nearly $85 billion is attributed to Harris County. However, only a very small fraction (less than one percent) of actual production takes place in the county. To measure actual potential losses in well head capacity due to water shortages, we relied on county level production data from the Texas Railroad Commission (TRC) and average well-head market prices for crude and gas to estimate lost revenues in a given county. After which, we used to IMPLAN ratios to estimate resultant losses in income and employment.

Other considerations with respect to mining include:

1) Petroleum and gas extraction industry only uses water in significant amounts for secondary recovery. Known in the industry as enhanced or water flood extraction, secondary recovery involves pumping water down injection wells to increase underground pressure thereby pushing oil or gas into other wells. IMPLAN output numbers do not distinguish between secondary and non-secondary recovery. To account for the discrepancy, county-level TRC data that show the proportion of barrels produced using secondary methods were used to adjust IMPLAN data to reflect only the portion of sales attributed to secondary recovery.

2) A substantial portion of output from mining operations goes directly to businesses that are classified as manufacturing in our schema. Thus, multipliers measuring backward linkages for a given manufacturer might include impacts to a supplying mining operation. Care was taken not to double count in such situations if both a mining operation and a manufacturer were reported as having water shortages.

Steam-electric

At minimum without adequate cooling water, power plants cannot safely operate. As water availability falls below projected demands, water levels in lakes and rivers that provide cooling water would also decline. Low water levels could affect raw water intakes and outfalls at electrical generating units in several ways. For one, power plants are regulated by thermal emission guidelines that specify the maximum amount of heat that can go back into a river or lake via discharged cooling water. Low water levels could result in permit compliance issues due to reduced dilution and dispersion of heat and subsequent impacts on aquatic biota near outfalls.[19] However, the primary concern would be a loss of head (i.e., pressure) over intake structures that would decrease flows through intake tunnels. This would affect safety related pumps, increase operating costs and/or result in sustained shut-downs. Assuming plants did shutdown, they would not be able to generate electricity.

Among all water use categories steam-electric is unique and cautions are needed when applying methods used in this study. Measured changes to an economy using input-output models stem directly from changes in sales revenues. In the case of water shortages, one assumes that businesses will suffer lost output if process water is in short supply. For power generation facilities this is true as well. However, the electric services sector in IMPLAN represents a corporate entity that may own and operate several electrical generating units in a given region. If one unit became inoperable due to water shortages, plants in other areas or generation facilities that do not rely heavily on water such as gas powered turbines might be able to compensate for lost generating capacity. Utilities could also offset lost production via purchases on the spot market.[20] Thus, depending upon the severity of the shortages and conditions at a given electrical generating unit, energy supplies for local and regional communities could be maintained. But in general, without enough cooling water, utilities would have to throttle back plant operations, forcing them to buy or generate more costly power to meet customer demands.

Measuring impacts end users of electricity is not part of this study as it would require extensive local and regional level analysis of energy production and demand. To maintain consistency with other water user groups, impacts of steam-electric water shortages are measured in terms of lost revenues (and hence income) and jobs associated with shutting down electrical generating units.

1.2 Social Impacts of Water Shortages

As the name implies, the effects of water shortages can be social or economic. Distinctions between the two are both semantic and analytical in nature – more so analytic in the sense that social impacts are harder to quantify. Nevertheless, social effects associated with drought and water shortages are closely tied to economic impacts. For example, they might include:

- demographic effects such as changes in population,
- disruptions in institutional settings including activity in schools and government,

[19] Section 316 (b) of the Clean Water Act requires that thermal wastewater discharges do not harm fish and other wildlife.

[20] Today, most utilities participate in large interstate “power pools” and can buy or sell electricity “on the grid” from other utilities or power marketers. Thus, assuming power was available to buy, and assuming that no contractual or physical limitations were in place such as transmission constraints; utilities could offset lost power that resulted from waters shortages with purchases via the power grid.

- conflicts between water users such as farmers and urban consumers,
- health-related low-flow problems (e.g., cross-connection contamination, diminished sewage flows, increased pollutant concentrations),
- mental and physical stress (e.g., anxiety, depression, domestic violence),
- public safety issues from forest and range fires and reduced fire fighting capability,
- increased disease caused by wildlife concentrations,
- loss of aesthetic and property values, and
- reduced recreational opportunities.[21]

Social impacts measured in this study focus strictly on demographic effects including changes in population and school enrollment. Methods are based on demographic projection models developed by the Texas State Data Center and used by the TWDB for state and regional water planning. Basically, the social impact model uses results from the economic component of the study and assesses how changes in labor demand would affect migration patterns in a region. Declines in labor demand as measured using adjusted IMPLAN data are assumed to affect net economic migration in a given regional water planning area. Employment losses are adjusted to reflect the notion that some people would not relocate but would seek employment in the region and/or public assistance and wait for conditions to improve. Changes in school enrollment are simply the proportion of lost population between the ages of 5 and 17.

2. Results

Section 2 presents the results of the analysis at the regional level. Included are baseline economic data for each water use category, and estimated economics impacts of water shortages for water user groups with reported deficits. According to the 2011 Coastal Bend Regional Water Plan, during severe drought irrigation, municipal, manufacturing, mining and steam-electric water user groups would experience water shortages in the absence of new water management strategies.

2.1 Overview of Regional Economy

The Coastal Bend regional economy generates nearly $18.9 billion in gross state product for the state ($17.7 worth of income and $1.3. billion in business taxes) and provides almost 280,000 jobs (Table 8). Manufacturing and mining are the primary base economic sectors in the region generating nearly $5.3 billion in income for residents in the region and throughout the state and provide nearly 49,500 jobs in the region.[22] Oil and gas mining, petrochemical and petroleum refining, and construction are the largest base sectors. Municipal sectors also generate substantial amounts of income – roughly 12 billion per year. Many businesses that make up the municipal category such as restaurants and retail stores are non-basic

[21] Based on information from the website of the National Drought Mitigation Center at the University of Nebraska Lincoln. Available online at: http://www.drought.unl.edu/risk/impacts.htm. See also, Vanclay, F. "*Social Impact Assessment*." in Petts, J. (ed) International Handbook of Environmental Impact Assessment. 1999.

[22] Base industries are those that supply markets outside of the region. These industries are crucial to the local economy and are called the economic base of a region. Appendix A shows how IMPLAN's 529 sectors were allocated to water use category, and shows economic data for each sector.

industries meaning they exist to provide services to people who work would in base industries such as manufacturing, agriculture and mining.

Table 8: The Coastal Bend Regional Economy by Water User Group (monetary figures are in $millions)						
Water Use Category	**Total Sales**	**Intermediate Sales**	**Final Sales**	**Jobs**	**Income**	**Business Taxes**
Irrigation						
Vegetable and melon farming	$17.82	$1.09	$16.73	281	$7.84	$2.09
Cotton farming	$5.85	$0.12	$5.73	52	$0.74	$0.56
Grain farming	$2.55	$0.49	$2.06	70	$0.72	$0.05
All other irrigated crops	$2.11	$1.40	$0.71	$32.15	$0.57	$0.34
Total irrigation	$28.33	$3.09	$25.24	435	$9.87	$3.04
Livestock						
Animal-slaughtering	$429.14	$114.74	$314.40	1,102	$51.80	$2.88
Cattle ranching and farming	$221.70	$153.72	$67.97	3,707	$17.52	$4.66
Other livestock production	$6.64	$5.52	$1.12	210	$1.05	$0.08
Total livestock	$657.48	$273.98	$383.49	5,019	$70.36	$7.62
Manufacturing						
Petroleum refineries	$21,668.44	$8,054.17	$13,614.27	2,559	$1,215.18	$51.00
New residential construction	$1,057.67	$0.00	$1,057.67	6,773	$377.55	$5.94
Petrochemical manufacturing	$664.37	$304.39	$359.97	86	$49.33	$2.81
Commercial and institutional buildings	$613.21	$0.00	$613.21	5,905	$323.73	$3.99
Pharmaceutical manufacturing	$269.44	$49.24	$220.20	262	$90.32	$2.03
Other manufacturing	$3,479.97	$568.18	$2,911.79	16,895	$1,203.46	$20.86
Total manufacturing	$27,753.09	$8,975.98	$18,777.11	32,480	$3,259.56	$86.62
Mining						
Drilling oil and gas wells	$1,279.44	$6.39	$1,273.06	2,011	$378.81	$49.93
Oil and gas extraction	$1,159.28	$1,076.61	$82.67	1,898	$667.11	$70.02
Support activities for oil and gas	$1,092.16	$151.70	$940.46	5,417	$990.52	$44.55
Other mining	$69.32	$10.84	$58.47	316	$36.45	$2.06
Total Mining	$3,600.20	$1,245.54	$2,354.66	9,642	$2,072.89	$166.57
Steam-electric						
Power generation and supply	$349.35	$98.28	$251.07	706	$242.66	$41.32
Municipal						
Wholesale trade	$1,278.01	$611.87	$666.15	8,022	$672.57	$189.30
State & local education	$1,120.84	$0.00	$1,120.84	28,859	$1,120.84	$0.00
Food services and drinking places	$976.23	$124.66	$851.57	19,928	$407.56	$47.60
Hospitals	$941.73	$0.00	$941.73	8,203	$503.06	$6.41
Federal military	$740.61	$0.00	$740.61	7,075	$740.61	$0.00
Other municipal	$15,137.35	$4,657.89	$10,479.45	158,982	$8,588.16	$777.96
Total municipal	$20,194.78	$5,394.42	$14,800.36	231,069	$12,032.80	$1,021.27
Regional totals	$52,583.22	$15,991.30	$36,591.92	279,351	$17,688.15	$1,315.77

Based on data from the Texas Water Development Board, and year 2006 data from the Minnesota IMPLAN Group, Inc.

2.2 Impacts of Agricultural Water Shortages

According to the *2011 Coastal Bend Regional Water Plan*, during severe drought the counties of Bee, Live Oak and San Patricio would experiences shortages of irrigation water. In 2010, shortages range from about 10 to 95 percent of annual irrigation demands. In total, farmers would be short nearly 12,000 acre-feet in 2010, and about 20,000 acre-feet in 2060. Shortages of this magnitude would result in estimated incomes losses of $3.5 million dollars in 2010 and $8.8 million 2060 (Table 9). Estimated jobs losses total 65 in 2010 and 150 in 2060.

Table 9: Economic Impacts of Water Shortages for Irrigation Water User Groups (monetary figures are in $millions)

Decade	Lost Income from Reduced Economic Output [a]	Lost Business Taxes from Reduced Economic Output*	Lost Jobs from Reduced Economic Output [b]
2010	$3.52	$0.13	65
2020	$3.88	$0.14	70
2030	$4.32	$0.16	80
2040	$4.76	$0.17	90
2050	$5.27	$0.19	100
2060	$8.80	$0.30	150

[a] Changes to Income and business taxes are collectively equivalent to a decrease in Gross State Product, which is analogous to Gross Domestic Product measured at the state rather than national level.

[b] Figure are rounded.

2.3 Impacts of Municipal Water Shortages

Water shortages are projected to occur in seven municipal water user groups in the planning area. Deficits range from eight to 84 percent of total annual water use. Costs of domestic water shortages total roughly one million in 2010 and $44 million in 2060 (Table 10). Since water shortages are projected to occur in rural areas, impacts to the commercial businesses are assumed to be negligible. Lost water utility revenues are less than one million for each decade.

Table 10: Economic Impacts of Water Shortages for Municipal Water User Groups (monetary figures are in $millions)					
Decade	**Monetary Value of Domestic Water Shortages**	**Lost Income from Reduced Economic Output for Water Intensive Commercial Businesses**	**Lost Business Taxes from Reduced Economic Output**	**Lost Jobs from Reduced Economic Output**	**Lost water utility revenues**
2010	$1.35	$0.00	$0.00	0	$0.04
2020	$2.84	$0.00	$0.00	0	$0.08
2030	$4.81	$0.00	$0.00	0	$0.11
2040	$6.50	$0.00	$0.00	0	$0.14
2050	$45.33	$0.00	$0.00	0	$0.17
2060	$44.39	$0.00	$0.00	0	$0.19

2.4 Impacts of Manufacturing Water Shortages

Manufacturing water shortages in Region N are projected to occur in Aransas, Live Oak, Nueces, and San Patricio counties. The majority are reported for Nueces County, which is major base for water intensive petrochemical refining.[23] In 2010, the Region N planning group estimates that manufacturers in Nueces County would be short about 7,400 acre-feet (15 percent of annual water requirements), and by 2060 this figure increases to almost 40,000 acre-feet (62 percent of annual water requirements). In the other counties, shortages range from about 70 acre-feet in 2060 to 6,500 acre-feet in 2060. Combined shortages for each county would result in estimated incomes losses of $31 million dollars in 2010, and $7.5 billion 2060 (Table 11). Estimated jobs losses total 225 in 2010 and 54,020 in 2060.

[23] Annual revenues for petrochemical refining in Nueces County total nearly $20 billion per annum. The industry provides an estimated 2,350 jobs for the county, and indirectly supports approximately 47,000 jobs throughout Texas.

Table 11: Economic Impacts of Water Shortages for Manufacturing Water User Groups (monetary figures are in $millions)			
Decade	Lost Income from Reduced Economic Output [a]	Lost Business Taxes from Reduced Economic Output*	Lost Jobs from Reduced Economic Output [b]
2010	$31.51	$1.22	225
2020	$371.67	$15.41	2,780
2030	$1,440.56	$60.03	10,790
2040	$2,109.19	$87.89	15,700
2050	$5,554.68	$231.77	41,600
2060	$7,276.50	$303.42	54,020

[a] Changes to Income and business taxes are collectively equivalent to a decrease in Gross State Product, which is analogous to Gross Domestic Product measured at the state rather than national level.

[b] Figure are rounded.

2.5 Impacts of Mining Water Shortages

Ming water shortages in Region N are projected to occur in Duval, Live Oak, and Nueces counties, and would primarily affect the oil and gas extraction sector. Combined shortages for each county would result in estimated incomes losses of $21 million dollars in 2010, and $239 million 2060 (Table 12). Jobs losses total 140 in 2010 and 440 in 2060.

Table 12: Economic Impacts of Water Shortages for Mining Water User Groups (monetary figures are in $millions)			
Decade	Lost Income from Reduced Economic Output [a]	Lost Business Taxes from Reduced Economic Output*	Lost Jobs from Reduced Economic Output [b]
2010	$20.88	$1.49	140
2020	$31.24	$2.22	210
2030	$69.46	$4.14	255
2040	$215.83	$19.10	350
2050	$228.84	$20.06	400
2060	$239.11	$20.87	440

[a] Changes to Income and business taxes are collectively equivalent to a decrease in Gross State Product, which is analogous to Gross Domestic Product measured at the state rather than national level.

[b] Figure are rounded.

2.6 Impacts of Steam-electric Water Shortages

Water shortages for steam-electric water user groups are projected to occur in Nueces County, and would result in estimated incomes losses of $20 million dollars in 2020, and $271 million 2060 (Table 13). Jobs losses total 65 in 2010 and 415 in 2060.

Table 13: Economic Impacts of Water Shortages for Steam-electric Water User Groups (monetary figures are in $millions)

Decade	Lost Income from Reduced Economic Output [a]	Lost Business Taxes from Reduced Economic Output*	Lost Jobs from Reduced Economic Output [b]
2010	$0.00	$0.00	0
2020	$20.43	$4.19	65
2030	$98.02	$10.06	150
2040	$153.76	$15.78	235
2050	$210.00	$21.55	320
2060	$271.76	$27.89	415

[a] Changes to Income and business taxes are collectively equivalent to a decrease in Gross State Product, which is analogous to Gross Domestic Product measured at the state rather than national level.

[b] Figure are rounded.

2.7 Social Impacts of Water Shortages

As discussed previously, estimated social impacts focus changes including population loss and subsequent related in school enrollment. In Region N, water shortages in 2010 would result in estimated population losses of 520 people with a corresponding reduction in school enrollment of 130 students (Table 14). Models indicate that shortages in 2060 would cause population in the region to decline by 66,280 people and school enrollment by 10,180 students.

Table 14: Social Impacts of Water Shortages (2010-2060)

Year	Population Losses	Declines in School Enrollment
2010	520	130
2020	3,770	890
2030	13,590	2,990
2040	19,730	3,030
2050	51,100	7,840
2060	66,280	10,180

2.8 Distribution of Impacts by Major River Basin

Table 15 displays economic and social impacts by major river basin. Impacts were allocated based on distribution of water shortages by river basin. For instance, if 50 percent of water shortages in River Basin A and 50 percent occur in River Basin B then impacts were split equally among the two basins.

Table 15: Distribution of Economic and Social Impacts by Major River Basin (2010-2060, monetary figures reported in $millions)

Major River Basin	2010	2020	2030	2040	2050	2060
Nueces						
Income*	$57.26	$263.52	$838.11	$1,250.58	$2,916.31	$3,773.54
Business Taxes	$2.84	$13.46	$38.55	$61.74	$132.00	$169.64
Jobs	430	1,915	5,843	8,224	20,468	26,483
Population	520	2,310	7,043	9,909	24,656	31,900
Declines in School Enrollment	130	545	1,550	1,522	3,783	4,899
Nueces Rio Grande						
Income	$0.00	$166.54	$779.06	$1,239.46	$3,127.81	$4,067.02
Business Taxes	$0.00	$8.50	$35.84	$61.20	$141.57	$182.84
Jobs	0	1,210	5,432	8,151	21,952	28,542
Population	0	1,460	6,547	9,821	26,444	34,380
Declines in School Enrollment	0	345	1,440	1,508	4,057	5,281
San Antonio Nueces						
Income	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Business Taxes	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Jobs	0	0	0	0	0	0
Population	0	0	0	0	0	0
Declines in School Enrollment	0	0	0	0	0	0
Total						
Income	$57.26	$430.06	$1,617.17	$2,490.04	$6,044.12	$7,840.56
Business Taxes	$2.84	$21.96	$74.39	$122.94	$273.57	$352.48
Jobs	430	3,125	11,275	16,375	42,420	55,025
Population	520	3,770	13,590	19,730	51,100	66,280
Declines in School Enrollment	130	890	2,990	3,030	7,840	10,180

* Includes the estimated value of domestic water shortages, which is treated as an income effect when aggregating results across different water user groups.

Appendix: Economic Data for Individual IMPLAN Sectors for the Coastal Bend Regional Water Planning Area

Economic Data for Agricultural Water User Groups in the Coastal Bend Regional Water Planning Area (monetary figures reported in millions of dollars)

Water Use Category	IMPLAN Sector	IMPLAN Code	Total Sales	Intermediate Sales	Final Sales	Jobs	Income	Business Taxes
Irrigation	Vegetable and melon farming	3	$17.82	$1.09	$16.73	281	$7.84	$2.09
Irrigation	Cotton farming	8	$5.85	$0.12	$5.73	52	0.74	$0.56
Irrigation	Grain farming	2	$2.55	$0.49	$2.06	70	$0.72	$0.05
Irrigation	All other crop farming	10	$1.30	$1.20	$0.10	14	0.34	$0.11
Irrigation	Fruit farming	5	$0.69	$0.16	$0.53	16	$0.18	$0.22
Irrigation	Tree nut farming	4	$0.07	$0.03	$0.04	1	$0.03	$0.01
Irrigation	Oilseed farming	1	$0.05	$0.01	$0.04	1	$0.02	$0.00
Irrigation	Sugarcane and sugar beet farming	9	$0.00	$0.00	$0.00	0	0.00	$0.00
Livestock	Animal slaughtering	67	$429.14	$114.74	$314.40	1,102	$51.80	$2.88
Livestock	Cattle ranching and farming	11	$221.70	$153.72	$67.97	3,707	$17.52	$4.66
Livestock	Animal production- except cattle and poultry	13	$4.93	$4.18	$0.75	200	$0.48	$0.08
Livestock	Poultry and egg production	12	$1.70	$1.34	$0.37	10	$0.57	$0.01
	Total Agriculture	NA	$667.99	$275.99	$391.99	5,173	$72.39	$8.57

Based on year 2006 data from the Minnesota IMPLAN Group, Inc.

Economic Data for Mining and Steam-electric Water User Groups in the Coastal Bend Regional Water Planning Area (monetary figures reported in millions of dollars)								
Water Use Category	**IMPLAN Sector**	**IMPLAN Code**	**Total Sales**	**Intermediate Sales**	**Final Sales**	**Jobs**	**Income**	**Business Taxes**
Mining	Drilling oil and gas wells	27	$1,279.44	$6.39	$1,273.06	2,011	$378.81	$49.93
Mining	Oil and gas extraction	19	$1,159.28	$1,076.61	$82.67	1,898	$667.11	$70.02
Mining	Support activities for oil and gas operations	28	$1,092.16	$151.70	$940.46	5,417	$990.52	$44.55
Mining	Sand- gravel- clay- and refractory mining	25	$36.38	$3.84	$32.54	179	$21.52	$1.13
Mining	Other nonmetallic mineral mining	26	$23.87	$2.39	$21.48	91	$11.95	$0.71
Mining	Gold- silver- and other metal ore mining	23	$8.08	$4.51	$3.57	40	$2.45	$0.21
Mining	Stone mining and quarrying	24	$0.99	$0.10	$0.88	6	$0.53	$0.02
Total Mining	NA	NA	$3,600.20	$1,245.54	$2,354.66	9,642	$2,072.89	$166.57
Steam-electric	Power generation and supply	30	$349.35	$98.28	$251.07	706	$242.66	$41.32
Based on year 2006 data from the Minnesota IMPLAN Group, Inc.								

Economic Data for Manufacturing Water User Groups in the Coastal Bend Regional Water Planning Area (2006)								
Water Use Category	**IMPLAN Sector**	**IMPLAN Code**	**Total Sales**	**Intermediate Sales**	**Final Sales**	**Jobs**	**Income**	**Business Taxes**
Manufacturing	Petroleum refineries	142	$21,668.44	$8,054.17	$13,614.27	2,559	$1,215.18	$51.00
Manufacturing	New residential structures	33	$1,057.67	$0.00	$1,057.67	6,773	$377.55	$5.94
Manufacturing	Petrochemical manufacturing	147	$664.37	$304.39	$359.97	86	$49.33	$2.81
Manufacturing	Commercial and institutional buildings	38	$613.21	$0.00	$613.21	5,905	$323.73	$3.99
Manufacturing	Animal- except poultry- slaughtering	67	$429.14	$114.74	$314.40	1,102	$51.80	$2.88
Manufacturing	Pharmaceutical and medicine manufacturing	160	$269.44	$49.24	$220.20	262	$90.32	$2.03
Manufacturing	Other new construction	41	$268.89	$0.00	$268.89	2,708	$150.09	$1.18
Manufacturing	Oil and gas field machinery and equipment	261	$262.65	$9.78	$252.87	694	$72.66	$1.47
Manufacturing	Other basic inorganic chemical manufacturing	150	$186.17	$41.02	$145.15	333	$61.26	$0.70
Manufacturing	Ship building and repairing	357	$183.50	$1.06	$182.44	969	$73.23	$0.81
Manufacturing	New residential additions and alterations-all	35	$152.07	$0.00	$152.07	805	$59.87	$0.84
Manufacturing	Other basic organic chemical manufacturing	151	$141.03	$26.29	$114.73	119	$24.97	$0.98
Manufacturing	Highway- street- bridge- and tunnel construct	39	$132.05	$0.00	$132.05	1,143	$69.32	$0.88
Manufacturing	Soft drink and ice manufacturing	85	$131.91	$7.37	$124.54	212	$18.34	$0.81
Manufacturing	Other miscellaneous chemical products	171	$127.38	$66.64	$60.74	232	$38.91	$0.95
Manufacturing	Dry- condensed- and evaporated dairy products	65	$123.73	$28.97	$94.75	156	$26.01	$0.76
Manufacturing	New multifamily housing structures- all	34	$118.31	$0.00	$118.30	984	$58.23	$0.34
Manufacturing	All other electronic component manufacturing	312	$107.74	$61.74	$46.00	491	$31.48	$0.54
Manufacturing	Water- sewer- and pipeline construction	40	$95.06	$0.00	$95.06	750	$44.47	$0.64
Manufacturing	Synthetic dye and pigment manufacturing	149	$93.16	$49.61	$43.55	152	$23.79	$0.54
Manufacturing	Alumina refining	208	$88.37	$4.03	$84.35	116	$10.18	$0.92
Manufacturing	Totalizing fluid meters and counting devices	317	$88.24	$24.64	$63.60	228	$17.91	$0.43
Manufacturing	Machine shops	243	$82.78	$19.98	$62.80	612	$38.02	$0.61
Manufacturing	Bread and bakery product- except frozen	73	$82.46	$18.41	$64.05	515	$36.39	$0.57
Manufacturing	Metal window and door manufacturing	235	$70.23	$5.21	$65.02	395	$25.95	$0.40
Manufacturing	Asphalt paving mixture and blocks	143	$66.63	$59.76	$6.87	112	$7.98	$0.07
Manufacturing	Ready-mix concrete manufacturing	192	$61.81	$0.30	$61.51	263	$14.94	$0.37
Manufacturing	Manufacturing and industrial buildings	37	$48.59	$0.00	$48.59	511	$27.00	$0.29
Based on year 2006 data from the Minnesota IMPLAN Group, Inc.								

Economic Data for Manufacturing Water User Groups in the Coastal Bend Regional Water Planning Area (2006 cont.)								
Water Use Category	IMPLAN Sector	IMPLAN Code	Total Sales	Intermediate Sales	Final Sales	Jobs	Income	Business Taxes
Manufacturing	Air and gas compressor manufacturing	289	$42.72	$0.44	$42.28	91	$15.76	$0.29
Manufacturing	Watch- clock- and other measuring and control	321	$38.03	$3.66	$34.37	145	$9.58	$0.16
Manufacturing	Metal tank- heavy gauge- manufacturing	239	$37.62	$1.55	$36.07	205	$13.48	$0.19
Manufacturing	Plate work manufacturing	234	$34.20	$2.15	$32.04	139	$13.64	$0.18
Manufacturing	Agriculture and forestry support activities	18	$31.25	$17.77	$13.49	1,070	$21.86	$0.26
Manufacturing	Motor vehicle parts manufacturing	350	$27.57	$2.22	$25.36	85	$4.09	$0.07
Manufacturing	Toilet preparation manufacturing	166	$25.76	$2.78	$22.98	39	$8.70	$0.06
Manufacturing	Coffee and tea manufacturing	80	$25.35	$0.44	$24.91	45	$3.73	$0.21
Manufacturing	Plastics material and resin manufacturing	152	$24.12	$0.96	$23.16	15	$6.07	$0.20
Manufacturing	Commercial printing	139	$24.09	$11.97	$12.12	326	$16.68	$0.20
Manufacturing	Hunting and trapping	17	$23.88	$1.95	$21.93	113	$8.82	$1.63
Manufacturing	Aircraft manufacturing	351	$22.58	$1.15	$21.43	44	$4.13	$0.06
Manufacturing	Fabricated structural metal manufacturing	233	$20.49	$1.06	$19.43	69	$8.44	$0.14
Manufacturing	Gasket- packing- and sealing device	385	$20.37	$1.17	$19.20	132	$8.93	$0.06
Manufacturing	Metal heat treating	245	$17.71	$4.19	$13.52	83	$7.55	$0.13
Manufacturing	Power boiler and heat exchanger manufacturing	238	$17.40	$0.30	$17.10	82	$6.36	$0.08
Manufacturing	Industrial gas manufacturing	148	$16.31	$8.58	$7.74	21	$5.14	$0.08
Manufacturing	Surgical appliance and supplies manufacturing	376	$15.71	$3.92	$11.79	82	$6.78	$0.06
Manufacturing	Other ordnance and accessories manufacturing	251	$15.58	$0.00	$15.58	83	$8.80	$0.08
Manufacturing	Other millwork- including flooring	119	$13.48	$10.47	$3.01	85	$3.29	$0.06
Manufacturing	Plastics pipe- fittings- and profile shapes	173	$13.41	$8.25	$5.16	35	$4.14	$0.09
Manufacturing	All other transportation equipment	361	$12.73	$0.17	$12.56	24	$3.20	$0.07
Manufacturing	Manifold business forms printing	136	$12.17	$1.60	$10.57	73	$7.13	$0.11
Manufacturing	Soap and other detergent manufacturing	163	$11.71	$3.13	$8.58	14	$1.97	$0.05
Manufacturing	Iron and steel forging	224	$10.82	$0.68	$10.15	42	$4.24	$0.06
Manufacturing	Sporting and athletic goods manufacturing	381	$10.09	$0.05	$10.05	52	$2.77	$0.09
Manufacturing	Relay and industrial control manufacturing	336	$9.62	$1.40	$8.22	41	$2.14	$0.06
Manufacturing	Plastics plumbing fixtures	177	$9.59	$6.95	$2.64	48	$3.71	$0.07
Based on year 2006 data from the Minnesota IMPLAN Group, Inc.								

Economic Data for Manufacturing Water User Groups in the Coastal Bend Regional Water Planning Area (2006 cont.)								
Water Use Category	**IMPLAN Sector**	**IMPLAN Code**	**Total Sales**	**Intermediate Sales**	**Final Sales**	**Jobs**	**Income**	**Business Taxes**
Manufacturing	All other industrial machinery manufacturing	269	$9.50	$2.41	$7.09	45	$2.60	$0.02
Manufacturing	Concrete pipe manufacturing	194	$9.30	$0.05	$9.25	31	$4.23	$0.10
Manufacturing	Metal coating and non-precious engraving	246	$9.25	$2.28	$6.97	63	$2.99	$0.04
Manufacturing	Non-chocolate confectionery manufacturing	59	$7.17	$0.64	$6.53	26	$1.33	$0.03
Manufacturing	Metal valve manufacturing	248	$6.68	$0.72	$5.96	23	$3.07	$0.04
Manufacturing	Other concrete product manufacturing	195	$6.24	$0.08	$6.16	31	$2.96	$0.06
Manufacturing	Cut and sew apparel manufacturing	107	$6.20	$0.17	$6.03	47	$2.00	$0.03
Manufacturing	Overhead cranes- hoists- and monorail systems	293	$6.08	$1.29	$4.79	17	$2.18	$0.04
Manufacturing	Logging	14	$6.05	$4.52	$1.53	24	$1.62	$0.06
Manufacturing	Sign manufacturing	384	$5.33	$1.73	$3.60	64	$2.44	$0.02
Manufacturing	Aircraft engine and engine parts	352	$5.33	$1.46	$3.87	14	$1.09	$0.02
Manufacturing	Sheet metal work manufacturing	236	$4.90	$0.27	$4.63	25	$2.04	$0.03
Manufacturing	Cut stone and stone product manufacturing	199	$4.67	$3.86	$0.81	53	$1.39	$0.03
Manufacturing	Textile bag and canvas mills	101	$4.62	$0.05	$4.57	34	$1.42	$0.02
Manufacturing	Custom architectural woodwork and millwork	369	$4.52	$3.98	$0.54	42	$2.63	$0.01
Manufacturing	Mattress manufacturing	372	$4.44	$0.01	$4.43	20	$1.49	$0.01
Manufacturing	Non-upholstered wood household furniture	364	$4.41	$0.13	$4.29	37	$1.88	$0.01
Manufacturing	Meat processed from carcasses	68	$4.33	$1.28	$3.05	10	$0.51	$0.03
Manufacturing	Switchgear and switchboard apparatus	335	$4.29	$1.07	$3.22	16	$2.01	$0.03
Manufacturing	Curtain and linen mills	100	$4.18	$0.32	$3.86	23	$1.03	$0.01
Manufacturing	Other miscellaneous textile product mills	103	$4.10	$0.06	$4.04	29	$1.08	$0.02
Manufacturing	Fabricated pipe and pipe fitting	252	$3.74	$0.42	$3.32	17	$1.54	$0.02
Manufacturing	Institutional furniture manufacturing	366	$3.67	$0.18	$3.49	23	$1.92	$0.01
Manufacturing	Poultry processing	70	$3.60	$1.15	$2.45	16	$0.53	$0.02
Manufacturing	Dental laboratories	379	$3.60	$3.55	$0.05	72	$2.34	$0.02
Manufacturing	Wood kitchen cabinet and countertop	362	$3.23	$2.51	$0.71	28	$1.31	$0.02
Manufacturing	Photographic film and chemical manufacturing	170	$3.22	$0.76	$2.46	6	$1.17	$0.01
Manufacturing	Fishing	16	$3.20	$1.46	$1.74	94	$1.05	$0.03
Based on year 2006 data from the Minnesota IMPLAN Group, Inc.								

Economic Data for Manufacturing Water User Groups in the Coastal Bend Regional Water Planning Area (2006 cont.)								
Water Use Category	**IMPLAN Sector**	**IMPLAN Code**	**Total Sales**	**Intermediate Sales**	**Final Sales**	**Jobs**	**Income**	**Business Taxes**
Manufacturing	Speed changers and mechanical power transmissions	287	$2.79	$1.45	$1.34	16	$0.79	$0.01
Manufacturing	Iron and steel mills	203	$2.70	$0.19	$2.50	3	$0.58	$0.02
Manufacturing	All other food manufacturing	84	$2.45	$0.21	$2.24	9	$0.53	$0.02
Manufacturing	Tortilla manufacturing	77	$2.36	$0.25	$2.11	19	$0.40	$0.01
Manufacturing	Spring and wire product manufacturing	242	$2.05	$0.22	$1.83	12	$0.69	$0.01
Manufacturing	Electronic computer manufacturing	302	$1.78	$0.42	$1.37	1	$0.01	$0.00
Manufacturing	Adhesive manufacturing	162	$1.73	$1.33	$0.40	4	$0.34	$0.01
Manufacturing	AC- refrigeration- and forced air heating	278	$1.56	$0.00	$1.56	6	$0.24	$0.01
Manufacturing	Electroplating- anodizing- and coloring metal	247	$1.53	$0.54	$0.99	11	$0.63	$0.01
Manufacturing	Glass and glass products	190	$1.45	$0.91	$0.54	9	$0.44	$0.01
Manufacturing	Sawmill and woodworking machinery	262	$1.44	$0.45	$1.00	10	$0.29	$0.01
Manufacturing	Plastics packaging materials- film and sheet	172	$1.17	$0.63	$0.54	3	$0.38	$0.01
Manufacturing	Jewelry and silverware manufacturing	380	$1.14	$0.02	$1.12	5	$0.28	$0.01
Manufacturing	Nonferrous foundries- except aluminum	223	$1.11	$0.03	$1.08	7	$0.36	$0.01
Manufacturing	Motor and generator manufacturing	334	$1.09	$0.10	$0.98	4	$0.30	$0.01
Manufacturing	Prefabricated metal buildings and components	232	$1.06	$0.05	$1.01	4	$0.22	$0.01
Manufacturing	Manufactured home- mobile home- manufacturing	121	$0.99	$0.00	$0.99	7	$0.34	$0.00
Manufacturing	Miscellaneous fabricated metal product	255	$0.85	$0.00	$0.84	4	$0.33	$0.01
Manufacturing	Scales- balances- and miscellaneous general	301	$0.84	$0.18	$0.66	3	$0.26	$0.00
Manufacturing	Concrete block and brick manufacturing	193	$0.80	$0.00	$0.80	3	$0.34	$0.01
Manufacturing	Other leather product manufacturing	111	$0.74	$0.12	$0.62	7	$0.21	$0.00
Manufacturing	Other household and institutional furniture	367	$0.59	$0.14	$0.45	4	$0.19	$0.00
Manufacturing	Ophthalmic goods manufacturing	378	$0.54	$0.04	$0.51	6	$0.24	$0.00
Manufacturing	Boat building	358	$0.50	$0.00	$0.50	2	$0.10	$0.00
Manufacturing	Cookie and cracker manufacturing	74	$0.44	$0.05	$0.39	2	$0.06	$0.00
Manufacturing	Cement manufacturing	191	$0.39	$0.00	$0.39	1	$0.16	$0.00
Manufacturing	Fluid milk manufacturing	62	$0.37	$0.09	$0.28	1	$0.02	$0.00
Manufacturing	Ornamental and architectural metal work	237	$0.33	$0.02	$0.31	2	$0.12	$0.00
Based on year 2006 data from the Minnesota IMPLAN Group, Inc.								

Economic Data for Manufacturing Water User Groups in the Coastal Bend Regional Water Planning Area (2006 cont.)								
Water Use Category	**IMPLAN Sector**	**IMPLAN Code**	**Total Sales**	**Intermediate Sales**	**Final Sales**	**Jobs**	**Income**	**Business Taxes**
Manufacturing	Vitreous china and earthenware articles	183	$0.32	$0.03	$0.29	6	$0.14	$0.00
Manufacturing	Hand and edge tool manufacturing	229	$0.31	$0.04	$0.27	2	$0.12	$0.00
Manufacturing	Fruit and vegetable canning and drying	61	$0.30	$0.01	$0.28	1	$0.05	$0.00
Manufacturing	Tire manufacturing	179	$0.27	$0.00	$0.27	1	$0.07	$0.00
Manufacturing	Wood windows and door manufacturing	117	$0.21	$0.19	$0.02	1	$0.07	$0.00
Manufacturing	Office supplies- except paper- manufacturing	383	$0.20	$0.01	$0.19	2	$0.08	$0.00
Manufacturing	Pump and pumping equipment manufacturing	288	$0.18	$0.00	$0.18	1	$0.04	$0.00
Manufacturing	Accessories and other apparel manufacturing	108	$0.14	$0.01	$0.13	1	$0.03	$0.00
	Total Manufacturing	NA	$3,749.41	$617.42	$3,131.99	17,157	$1,293.78	$22.89
Based on year 2006 data from the Minnesota IMPLAN Group, Inc.								

Economic Data for Municipal Water User Groups in the Coastal Bend Regional Water Planning Area (2006 cont.)									
Water Use Category	**IMPLAN Sector**	**IMPLAN Code**	**Total Sales**	**Intermediate Sales**	**Final Sales**	**Jobs**	**Income**	**Business Taxes**
Municipal	Wholesale trade	390	$1,278.01	$611.87	$666.15	8,022	$672.57	$189.30
Municipal	State & Local Education	503	$1,120.84	$0.00	$1,120.84	28,859	$1,120.84	$0.00
Municipal	Food services and drinking places	481	$976.23	$124.66	$851.57	19,928	$407.56	$47.60
Municipal	Hospitals	467	$941.73	$0.00	$941.73	8,203	$503.06	$6.41
Municipal	Federal Military	505	$740.61	$0.00	$740.61	7,075	$740.61	$0.00
Municipal	Offices of physicians & dentists	465	$709.60	$0.00	$709.60	6,279	$501.58	$4.39
Municipal	Real estate	431	$555.79	$220.01	$335.78	3,440	$321.77	$68.28
Municipal	Monetary authorities and depository institutions	430	$510.75	$168.22	$342.53	2,730	$358.65	$6.53
Municipal	Motor vehicle and parts dealers	401	$487.37	$53.00	$434.37	4,613	$251.04	$71.13
Municipal	State & Local Non-Education	504	$470.77	$0.00	$470.77	8,663	$470.78	$0.00
Municipal	Architectural and engineering services	439	$470.70	$296.71	$173.99	3,791	$254.27	$2.12
Municipal	Lessors of nonfinancial intangible assets	436	$451.15	$246.03	$205.12	28	$211.62	$20.77
Municipal	Legal services	437	$369.89	$234.75	$135.14	3,261	$228.97	$7.20
Municipal	Telecommunications	422	$366.98	$126.05	$240.93	988	$153.58	$25.56
Municipal	Truck transportation	394	$359.69	$194.76	$164.93	2,786	$163.16	$3.70
Municipal	Other State and local government enterprises	499	$352.50	$114.78	$237.71	1,679	$129.64	$0.05
Municipal	Machinery and equipment rental and leasing	434	$330.80	$179.91	$150.90	1,061	$134.61	$4.70
Municipal	Owner-occupied dwellings	509	$1,602.91	$0.00	$1,602.91	0	$1,241.72	$189.54
Municipal	Insurance carriers	427	$321.05	$93.62	$227.43	1,493	$94.82	$11.70
Municipal	All other miscellaneous professional and tech	450	$307.87	$274.88	$33.00	536	$124.66	$2.50
Municipal	Food and beverage stores	405	$299.16	$40.00	$259.16	5,245	$152.24	$33.37
Municipal	Home health care services	464	$298.64	$0.00	$298.64	9,524	$172.85	$1.02
Municipal	General merchandise stores	410	$288.94	$30.45	$258.49	5,344	$129.65	$41.28
Municipal	Federal Non-Military	506	$284.85	$0.00	$284.85	1,711	$284.85	$0.00
Municipal	Business support services	455	$216.28	$101.22	$115.06	4,384	$109.83	$4.14
Municipal	Nursing and residential care facilities	468	$212.16	$0.00	$212.16	4,641	$130.61	$3.08
Municipal	Gasoline stations	407	$194.28	$29.51	$164.77	2,736	$104.98	$27.96
Based on year 2006 data from the Minnesota IMPLAN Group, Inc.									

Economic Data for Municipal Water User Groups in the Coastal Bend Regional Water Planning Area (2006 cont.)								
Water Use Category	**IMPLAN Sector**	**IMPLAN Code**	**Total Sales**	**Intermediate Sales**	**Final Sales**	**Jobs**	**Income**	**Business Taxes**
Municipal	Commercial machinery repair and maintenance	485	$193.14	$101.69	$91.46	1,476	$92.22	$6.72
Municipal	Maintenance and repair of nonresidential buildings	43	$191.90	$127.15	$64.75	1,515	$79.67	$1.48
Municipal	Hotels and motels- including casino hotels	479	$191.06	$98.43	$92.63	2,943	$103.10	$17.68
Municipal	Building material and garden supply stores	404	$190.64	$29.56	$161.07	2,288	$89.42	$27.19
Municipal	Pipeline transportation	396	$189.47	$82.86	$106.61	173	$73.07	$15.70
Municipal	Scenic and sightseeing transportation	397	$186.97	$70.14	$116.83	1,775	$127.37	$21.12
Municipal	Other ambulatory health care services	466	$174.02	$11.32	$162.70	1,345	$79.80	$1.19
Municipal	Insurance agencies- brokerages- and related	428	$149.35	$87.64	$61.71	1,660	$126.65	$0.82
Municipal	Automotive repair and maintenance- except car	483	$148.91	$35.37	$113.54	1,941	$56.69	$11.12
Municipal	Health and personal care stores	406	$148.78	$23.75	$125.04	2,183	$73.99	$21.53
Municipal	Services to buildings and dwellings	458	$146.87	$108.37	$38.50	2,837	$69.91	$2.56
Municipal	Accounting and bookkeeping services	438	$144.53	$117.37	$27.16	1,899	$63.71	$0.52
Municipal	Civic- social- professional and similar organ	493	$143.46	$50.41	$93.05	4,261	$69.81	$0.44
Municipal	Waste management and remediation services	460	$135.37	$76.09	$59.28	769	$65.92	$5.32
Municipal	Clothing and clothing accessories stores	408	$128.99	$16.15	$112.84	2,391	$66.09	$18.76
Municipal	Management consulting services	444	$126.47	$97.36	$29.12	1,040	$60.44	$0.47
Municipal	Natural gas distribution	31	$119.80	$48.02	$71.79	202	$31.10	$10.56
Municipal	Other maintenance and repair construction	45	$112.80	$39.32	$73.49	1,576	$73.37	$0.70
Municipal	Employment services	454	$105.72	$87.49	$18.22	5,152	$86.89	$0.50
Municipal	Non-depository credit intermediation institutions	425	$104.06	$63.70	$40.35	832	$57.79	$4.42
Municipal	Radio and television broadcasting	420	$98.82	$78.45	$20.37	555	$30.62	$0.39
Municipal	Water transportation	393	$95.54	$28.83	$66.71	204	$18.04	$1.35
Municipal	Other Federal Government enterprises	496	$94.26	$39.95	$54.31	3,743	$65.11	$0.00
Municipal	Securities- commodity contracts- investments	426	$91.49	$60.76	$30.73	568	$45.45	$1.32
Municipal	Grant-making and giving and social advocacy	492	$91.29	$0.00	$91.29	2,058	$35.28	$0.18
Municipal	Other amusement- gambling- and recreation	478	$82.17	$4.47	$77.70	1,438	$39.69	$5.94
Municipal	Postal service	398	$79.46	$54.10	$25.36	1,161	$63.62	$0.00
Municipal	Social assistance- except child day care	470	$79.44	$0.02	$79.43	2,360	$44.71	$0.31

Based on year 2006 data from the Minnesota IMPLAN Group, Inc.

Economic Data for Municipal Water User Groups in the Coastal Bend Regional Water Planning Area (2006 cont.)								
Water Use Category	IMPLAN Sector	IMPLAN Code	Total Sales	Intermediate Sales	Final Sales	Jobs	Income	Business Taxes
Municipal	Child day care services	469	$75.75	$0.00	$75.75	2,055	$46.50	$0.55
Municipal	Furniture and home furnishings stores	402	$75.50	$11.54	$63.96	958	$36.53	$10.78
Municipal	Miscellaneous store retailers	411	$69.71	$8.65	$61.06	2,788	$42.14	$10.19
Municipal	Environmental and other technical consulting	445	$64.92	$59.78	$5.14	399	$31.80	$0.22
Municipal	Investigation and security services	457	$62.24	$39.80	$22.44	1,687	$43.29	$1.03
Municipal	Non-store retailers	412	$61.18	$9.45	$51.73	1,854	$38.46	$6.98
Municipal	Household goods repair and maintenance	486	$59.00	$28.63	$30.37	354	$23.65	$2.05
Municipal	Newspaper publishers	413	$57.40	$38.09	$19.31	543	$30.92	$0.41
Municipal	General and consumer goods rental except vide	435	$56.35	$19.12	$37.23	706	$37.16	$0.69
Municipal	State and local government electric utilities	498	$54.00	$14.59	$39.41	155	$26.70	$0.14
Municipal	Other educational services	463	$52.49	$4.43	$48.06	1,194	$25.63	$1.46
Municipal	Maintenance and repair of farm and nonfarm residences	42	$51.81	$17.36	$34.46	360	$18.20	$0.26
Municipal	Personal care services	487	$48.92	$1.38	$47.54	1,056	$22.93	$1.72
Municipal	Veterinary services	449	$48.64	$6.46	$42.18	711	$18.04	$1.09
Municipal	Elementary and secondary schools	461	$48.63	$0.00	$48.63	1,337	$30.29	$0.00
Municipal	Rail transportation	392	$46.17	$22.32	$23.84	137	$28.06	$0.89
Municipal	Sporting goods- hobby- book and music stores	409	$45.66	$6.44	$39.22	1,005	$21.64	$6.67
Municipal	Other support services	459	$44.74	$41.93	$2.81	358	$23.90	$0.57
Municipal	Dry cleaning and laundry services	489	$43.52	$11.08	$32.44	1,138	$22.27	$2.59
Municipal	Automotive equipment rental and leasing	432	$42.56	$17.41	$25.16	293	$14.42	$0.78
Municipal	Management of companies and enterprises	451	$41.54	$39.06	$2.48	271	$20.96	$0.33
Municipal	Electronic equipment repair and maintenance	484	$40.97	$7.67	$33.30	305	$18.33	$1.38
Municipal	Motion picture and video industries	418	$40.63	$29.07	$11.56	298	$4.79	$0.17
Municipal	Private households	494	$39.66	$0.00	$39.66	4,109	$39.67	$0.00
Municipal	Electronics and appliance stores	403	$38.38	$5.08	$33.30	875	$25.89	$5.60
Municipal	Office administrative services	452	$34.22	$15.22	$18.99	242	$17.16	$0.30
Municipal	Death care services	488	$33.64	$0.00	$33.64	510	$16.75	$2.51
Based on year 2006 data from the Minnesota IMPLAN Group, Inc.								

Economic Data for Municipal Water User Groups in the Coastal Bend Regional Water Planning Area (2006 cont.)								
Water Use Category	**IMPLAN Sector**	**IMPLAN Code**	**Total Sales**	**Intermediate Sales**	**Final Sales**	**Jobs**	**Income**	**Business Taxes**
Municipal	Couriers and messengers	399	$32.92	$29.93	$2.99	416	$21.38	$0.50
Municipal	Video tape and disc rental	433	$30.39	$0.16	$30.23	511	$13.47	$1.29
Municipal	Maintenance and repair of highways- streets-	44	$30.25	$0.00	$30.25	336	$17.11	$0.23
Municipal	Fitness and recreational sports centers	476	$28.51	$7.95	$20.56	1,032	$12.94	$1.51
Municipal	Air transportation	391	$27.37	$3.05	$24.32	154	$4.50	$0.58
Municipal	Information services	423	$26.80	$6.52	$20.28	104	$7.97	$0.19
Municipal	Custom computer programming services	441	$25.87	$2.16	$23.71	428	$21.89	$0.13
Municipal	Funds- trusts- and other financial vehicles	429	$23.60	$0.45	$23.16	86	$3.92	$0.16
Municipal	Advertising and related services	447	$23.32	$21.74	$1.58	218	$7.95	$0.13
Municipal	Computer systems design services	442	$22.15	$13.48	$8.67	286	$18.79	$0.46
Municipal	Colleges- universities- and junior colleges	462	$21.50	$1.14	$20.36	448	$9.96	$0.00
Municipal	Other personal services	490	$21.25	$1.80	$19.45	136	$7.68	$0.88
Municipal	Promoters of performing arts and sports and a	474	$21.12	$6.92	$14.20	413	$13.70	$0.87
Municipal	State and local government passenger transit	497	$20.71	$5.40	$15.31	330	$7.18	$0.00
Municipal	Other computer related services- including fa	443	$19.56	$11.76	$7.80	102	$14.40	$0.18
Municipal	Photographic services	448	$19.50	$6.44	$13.07	283	$6.95	$0.52
Municipal	Car washes	482	$17.14	$3.38	$13.76	460	$8.49	$0.97
Municipal	Facilities support services	453	$16.77	$3.95	$12.82	361	$10.46	$0.05
Municipal	Software publishers	417	$14.02	$1.61	$12.41	38	$7.92	$0.12
Municipal	Independent artists- writers- and performers	473	$12.57	$12.21	$0.36	195	$3.55	$0.08
Municipal	Warehousing and storage	400	$11.95	$10.99	$0.96	133	$9.00	$0.06
Municipal	Other accommodations	480	$11.87	$0.17	$11.70	145	$3.81	$0.34
Municipal	Transit and ground passenger transportation	395	$11.80	$3.08	$8.73	168	$7.29	$0.29
Municipal	Data processing services	424	$10.59	$2.17	$8.42	67	$4.25	$0.05
Municipal	Specialized design services	440	$10.58	$9.95	$0.63	98	$3.33	$0.09
Municipal	Travel arrangement and reservation services	456	$10.30	$7.30	$3.00	98	$3.56	$0.14
Based on year 2006 data from the Minnesota IMPLAN Group, Inc.								

Economic Data for Municipal Water User Groups in the Coastal Bend Regional Water Planning Area (2006 cont.)								
Water Use Category	**IMPLAN Sector**	**IMPLAN Code**	**Total Sales**	**Intermediate Sales**	**Final Sales**	**Jobs**	**Income**	**Business Taxes**
Municipal	Cable networks and program distribution	421	$7.98	$1.89	$6.08	14	$1.15	$0.06
Municipal	Database- directory- and other publishers	416	$7.74	$3.73	$4.01	26	$3.99	$0.06
Municipal	Museums- historical sites- zoos- and parks	475	$7.53	$0.00	$7.53	201	$1.71	$0.04
Municipal	Water- sewage and other systems	32	$6.84	$2.06	$4.78	75	$5.22	$0.25
Municipal	Periodical publishers	414	$6.46	$3.17	$3.29	36	$1.91	$0.03
Municipal	Bowling centers	477	$6.07	$0.37	$5.69	154	$2.48	$0.49
Municipal	Spectator sports	472	$5.01	$2.85	$2.15	243	$3.36	$0.42
Municipal	Religious organizations	491	$4.52	$0.00	$4.52	38	$2.30	$0.00
Municipal	Performing arts companies	471	$3.48	$1.71	$1.78	125	$1.67	$0.13
Municipal	Sound recording industries	419	$2.71	$0.63	$2.07	12	$2.03	$0.01
Municipal	Scientific research and development services	446	$2.71	$2.08	$0.63	35	$0.85	$0.01
Municipal	Book publishers	415	$0.30	$0.03	$0.27	1	$0.10	$0.00
	Total Municipal	NA	$20,194.78	$5,394.42	$14,800.36	231,069	$12,032.80	$1,021.27

Based on year 2006 data from the Minnesota IMPLAN Group, Inc.

Appendix 2: Impacts by County for the Coastal Bend Regional Water Planning Area

Aransas County ($millions)						
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Municipal						
County-other						
Monetary value of domestic water shortages	$0.00	$0.00	$0.00	$0.00	$36.67	$34.66
Reduced income from reduced output for water intensive commercial businesses	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Reduced business taxes from reduced economic output	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Reduced jobs due to reduced economic output for water intensive commercial businesses	0	0	0	0	0	0
Reduced utility revenues	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Manufacturing						
Reduced income from reduced manufacturing output	$3.63	$4.34	$4.89	$5.40	$5.85	$6.86
Reduced business taxes from reduced manufacturing output	$0.07	$0.09	$0.10	$0.11	$0.12	$0.14
Reduced jobs from reduced manufacturing output	40	50	60	60	70	80

Bee County ($millions)						
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Irrigation						
Reduced income from reduced irrigation output	$1.70	$1.88	$2.07	$2.29	$2.55	$2.84
Reduced business taxes from reduced irrigation output	$0.08	$0.08	$0.09	$0.10	$0.11	$0.13
Reduced jobs from reduced irrigation output	40	45	50	55	60	70

Duval County ($millions)						
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Mining						
Reduced income from reduced mining output	$20.88	$30.24	$35.71	$40.67	$45.75	$50.51
Reduced business taxes from reduced mining output	$1.49	$2.16	$2.55	$2.91	$3.27	$3.61
Reduced jobs from reduced mining output	140	205	240	275	310	340

Jim Wells County ($millions)						
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Municipal						
County-other						
Monetary value of domestic water shortages	$0.20	$0.29	$0.32	$0.29	$0.26	$0.21
Reduced income from reduced output for water intensive commercial businesses	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Reduced business taxes from reduced economic output	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Reduced jobs due to reduced economic output for water intensive commercial businesses	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Reduced utility revenues	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

Live Oak County ($millions)						
	2010	2020	2030	2040	2050	2060
Irrigation						
Reduced income from reduced irrigation output	$0.04	$0.04	$0.07	$0.07	$0.06	$0.05
Reduced business taxes from reduced irrigation output	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Reduced jobs from reduced irrigation output	0	0	1	1	1	1
Manufacturing						
Reduced income from reduced manufacturing output	$27.88	$39.96	$92.48	$101.75	$108.70	$126.40
Reduced business taxes from reduced manufacturing output	$1.15	$1.65	$3.82	$4.20	$4.49	$5.22
Reduced jobs from reduced manufacturing output	180	260	605	665	710	830
Mining						
Reduced income from reduced mining output	$0.00	$0.99	$1.93	$2.56	$6.25	$7.29
Reduced business taxes from reduced mining output	$0.00	$0.05	$0.11	$0.14	$0.35	$0.40
Reduced jobs from reduced mining output	0	5	10	15	30	40

Nueces County ($millions)						
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Municipal						
River Acres						
Monetary value of domestic water shortages	$0.39	$2.46	$4.25	$6.03	$8.14	$9.20
Reduced income from reduced output for water intensive commercial businesses	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Reduced business taxes from reduced economic output	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Reduced jobs due to reduced economic output for water intensive commercial businesses	0	0	0	0	0	0
Reduced utility revenues	$0.04	$0.08	$0.11	$0.14	$0.16	$0.18
County-other						
Monetary value of domestic water shortages	$0.76	$0.00	$0.00	$0.00	$0.00	$0.00
Reduced income from reduced economic output for water intensive commercial businesses	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Reduced business taxes from reduced economic output	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Reduced jobs due to reduced economic output for water intensive commercial businesses	0	0	0	0	0	0
Reduced utility revenues	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Manufacturing						
Reduced income from reduced manufacturing output	$0.00	$327.38	$1,343.18	$1,977.09	$5,399.92	$6,988.45
Reduced business taxes from reduced manufacturing output	$0.00	$13.68	$56.11	$82.59	$225.58	$291.94
Reduced jobs from reduced manufacturing output	0	2,470	10,130	14,910	40,720	52,695
Mining						
Reduced income from reduced mining output	$0.00	$0.00	$31.82	$172.60	$176.84	$181.31
Reduced business taxes from reduced mining output	$0.00	$0.00	$1.48	$16.05	$16.44	$16.86
Reduced jobs from reduced mining output	0	0	5	60	65	65

San Patricio County ($millions)						
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Municipal						
Lake City						
Monetary value of domestic water shortages	$0.00	$0.00	$0.01	$0.03	$0.05	$0.11
Reduced income from reduced output for water intensive commercial businesses	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Reduced business taxes from reduced economic output	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Reduced jobs due to reduced economic output for water intensive commercial businesses	0	0	0	0	0	0
Reduced utility revenues	$0.000	$0.000	$0.003	$0.006	$0.009	$0.012
Irrigation						
Reduced income from reduced irrigation output	$1.77	$1.96	$2.17	$2.41	$2.67	$5.91
Reduced business taxes from reduced irrigation output	$0.05	$0.06	$0.06	$0.07	$0.08	$0.17
Reduced jobs from reduced irrigation output	24	27	30	33	36	81
Manufacturing						
Reduced income from reduced manufacturing output	$0.00	$0.00	$0.00	$24.95	$40.20	$154.79
Reduced business taxes from reduced manufacturing output	$0.00	$0.00	$0.00	$0.99	$1.59	$6.12
Reduced jobs from reduced manufacturing output	0	0	0	70	110	420

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Appendix G

Summary of Texas Parks and Wildlife Ecologically Significant River and Stream Segments of the Coastal Bend Water Planning Area (Region N), January 2010

Region N (Coastal Bend)

Aransas River Tidal - from the confluence with Copano Bay in Aransas/Refugio County about 6 miles to a point 3.3 miles upstream of Chiltipin Creek in Refugio/San Patricio County (TCEQ classified stream segment 2003).

- Biological function - Extensive estuarine wetland habitat (National Wetland Inventory, 2000, 1999).
- Threatened or endangered species/unique communities - reddish egret (SOC/St.T), piping plover (Fed.T/St.T), snowy plover (SOC), white-faced ibis (SOC/St.T), wood stork (SOC/St.T), brown pelican (Fed.DL/St.E) (TPWD, 2010, USFWS, 2010).

Nueces River Tidal - from the confluence with Nueces Bay in Nueces County about 12 miles upstream to Calallen Dam which is located 1870 yards upstream of US 77/IH 37 in Nueces/San Patricio County (TCEQ classified stream segment 2101).

- Biological function - Extensive freshwater and estuarine wetland habitat (Bauer et al., 1991).
- High water quality/exceptional aquatic life/high aesthetic value - exceptional aquatic life use (TCEQ, 2000).
- Threatened or endangered species/unique communities – Texas diamondback terrapin (SOC) (B. Ortego, 1999, pers. comm.)

Nueces River (below Lake Corpus Christi) – from the Calallan saltwater barrier upstream about 35 miles to Seale Dam at Lake Corpus Christi (TCEQ classified stream segment 2102).

- Biological function - Freshwater marsh on the floodplain at the lower portion of this segment (USFWS, 2000).
- Riparian conservation area - City of Corpus Christi Wildlife Sanctuary; Hazel Bazemore County Park.
- High water quality/exceptional aquatic life/high aesthetic value - High aesthetic and economic value for outdoor recreation, especially birdwatching. Hazel Bazemore Park is a world-class hawk migration site (Texas Parks & Wildlife and Texas Department of Transportation, 1999-2000).

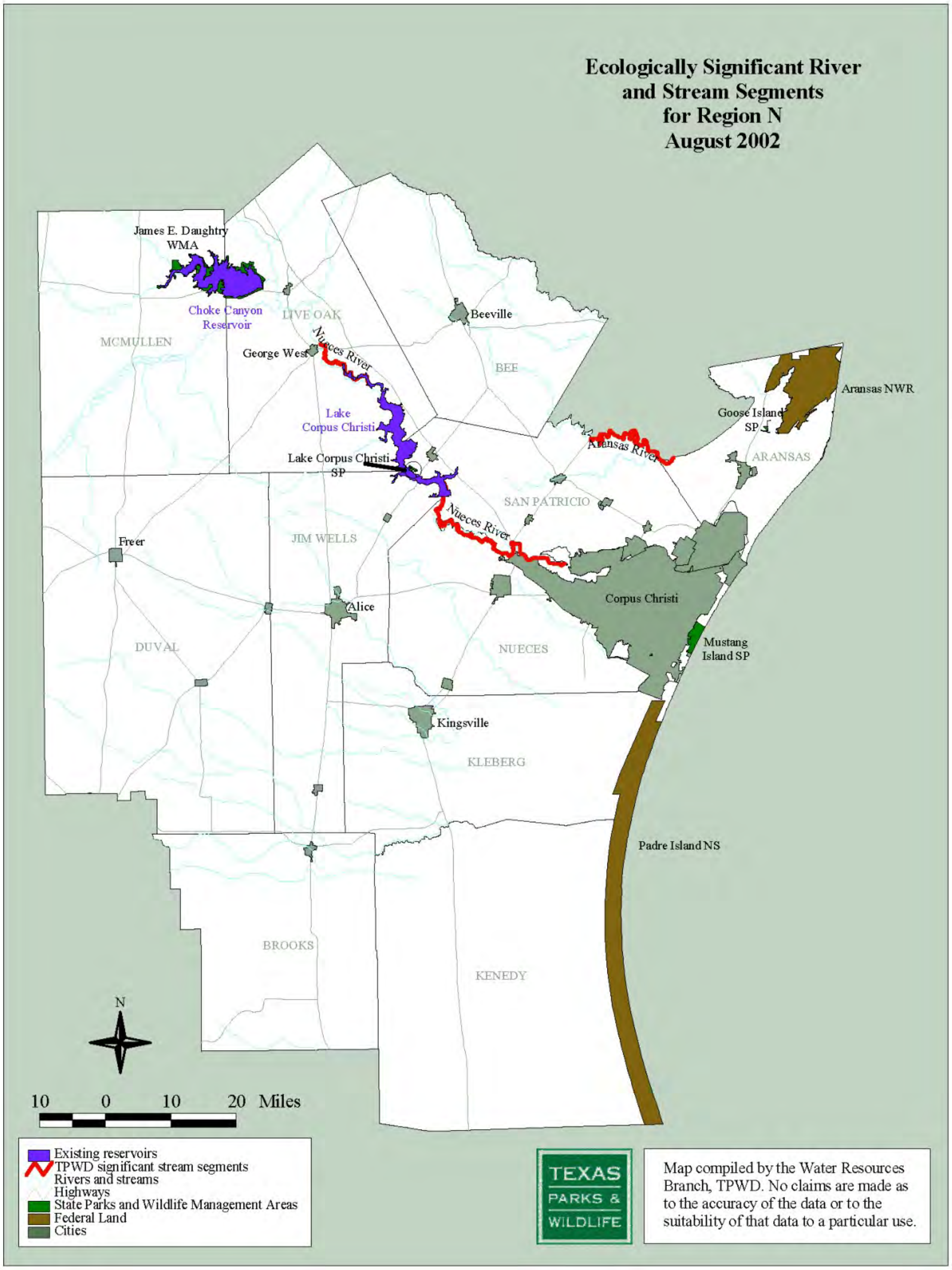
Nueces River (above Lake Corpus Christi) – from the headwaters of Lake Corpus Christi in Live Oak County upstream to US 59 in Live Oak County (within TCEQ classified stream segment 2103).

- Threatened or endangered species/unique communities - One of only four known remaining populations of the endemic golden orb (Howells, 1997 and Howells et al., 1997).

Abbreviation List

DL - De-listed
E - Endangered
Fed. - Federal
LE - Listed Endangered
SOC - Species of Concern
St. - State
T - Threatened
TCEQ - Texas Commission on Environmental Quality
TPWD - Texas Parks & Wildlife Department
USFWS - United States Fish and Wildlife Service

Map


Ecologically Significant River
and Stream Segments
for Region N
August 2002
James E. Daughtry
WMA
Choke Canyon
Reservoir
LIVE OAK
MCMULLEN
George West
Nueces River
Beeville
BEE
Lake
Corpus Christi
Lake Corpus Christi
SP
Aransas River
Goose Island
SP
Aransas NWR
ARANSAS
SAN PATRICIO
Nueces River
Freer
JIM WELLS
Alice
Corpus Christi
Mustang
Island SP
DUVAL
NUECES
Kingsville
KLEBERG
Padre Island NS
BROOKS
KENEDY
N
10 0 10 20 Miles
Existing reservoirs
TPWD significant stream segments
Rivers and streams
Highways
State Parks and Wildlife Management Areas
Federal Land
Cities
TEXAS
PARKS &
WILDLIFE
Map compiled by the Water Resources Branch, TPWD. No claims are made as to the accuracy of the data or to the suitability of that data to a particular use.

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Appendix H
RWPG Newsletters

COASTAL BEND
Water Report
Coastal Bend Regional Water Planning Group
Website: www.nueces-ra.org
No. 9 • October 2008

Planning Underway on Updated Version of Coastal Bend Regional Water Plan

The Coastal Bend Regional Water Planning Group (CBRWPG) has been at work for more than a year developing refinements to the comprehensive regional water plan first submitted in 2001 and updated in 2006.

The process will culminate in Fall 2010 with a round of public participation and adoption of a revised plan (2011 Plan) for the Coastal Bend, also known as Region N.

Primarily because new population data will be unavailable from the U.S. Census Bureau for this round of planning, the current planning cycle will not result in a complete plan revision. Instead, the downsized effort is focused on refining water management strategies previously identified and updating cost estimates for their possible implementation.

SCHEDULE

2007	**PHASE 1** - Begin planning process including work on five region-specific studies for Coastal Bend
2008	Draft, review and invite comment on five study reports; develop Phase 2 proposed scope of work
2009	**PHASE 2** - Update 2006 regional plan by refining and updating cost estimates for each water supply management strategy
2010	Spring - Publish Draft Plan for public comment Summer - Public meeting Fall - Comment period & adoption of 2011 Regional Plan
2011	Texas Water Development Board incorporates all regional plans into new comprehensive 2012 state water plan

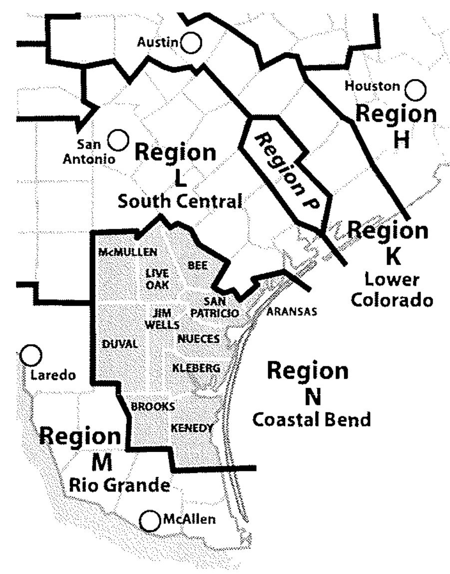
The regional planning process was established by Senate Bill 1 (SB 1) and enacted by the Legislature in 1997. It resulted in the creation of a "bottom up" water planning process with 16 regional water planning groups (RWPG) and the Texas Water Development Board (TWDB) serving as the overall statewide planning coordinator.

Each RWPG is responsible for preparing and adopting a regional water plan for their area. These 16 plans are then combined by the TWDB into a state water plan. The 2002 and 2007 State Water Plans were issued using results from the 2001 and 2006 Plans, respectively. Recognizing that water resources must be managed efficiently and effectively to meet future needs, the Legislature directed that regional and state water plans be updated every five years to respond to changing climate, environmental, socio-economic and demographic conditions.

The current planning cycle is the third round of this process and will result in development of the 2011 Plan. The planning horizon for the new plan is from 2010 to 2060. This period allows for long-term forecasts of the prospective water situation, sufficiently in advance of needs, to allow for appropriate water management strategies to be implemented.

Phase 1 of the Coastal Bend planning process is focused on five region-specific studies to assist in refinement and new analysis of water management strategies for Region N. The 2006 Coastal Bend plan includes 18 management strategies ranging from developing groundwater supplies to methods for increasing the yield from the Lake Corpus Christi-Choke Canyon Reservoir-Lake Texana system.

Phase 2 of the planning process, which begins near the end of 2008, will involve the detailed work of updating the 2006 Plan to reflect changed conditions and to incorporate results from region-specific Phase 1 studies. The resulting draft plan will be published in the spring of 2010. Public comments will be encouraged, evaluated and incorporated as necessary before the new regional plan is adopted in the Fall of 2010.



11-County Coastal Bend Region "N" Is One of 16 Regional Planning Areas In Texas

As part of Phase 1 the public is invited to review the five draft studies and provide comments either in writing or during a meeting of the CBRWPG at the Johnny Calderon County Building in Robstown on November 13 at 1:30 p.m. Draft Phase 1 reports are due to the Texas Water Development Board by the end of December. As they become available, the draft studies will be posted at the Nueces River Authority website: www.nueces-ra.org. If you do not have internet access and prefer to have a paper copy of draft reports, please contact the Nueces River Authority.

Region-Specific Water Studies & Updates Underway

Projections in the 2006 Coastal Bend Regional Water Plan indicate the region will have significant future water needs that cannot be met from supplies that are currently developed and being used.

While population growth in the 11-county Coastal Bend has been modest compared to much of the rest of Texas, the region's population is still projected to grow from an estimated 552,000 in 2007 to more than 880,000 in the next 50 years. In addition to growing municipal demands, demands for water used in manufacturing, at electric power plants, and in mining are projected to grow.

The long-range planning process mandated by the Legislature is intended to identify water supply options and to facilitate action that will provide adequate affordable water where and when it is needed in the future.

During Phase 1 of the current five-year planning cycle, the Coastal Bend Regional Water Planning Group has been working with consultants to perform five studies.

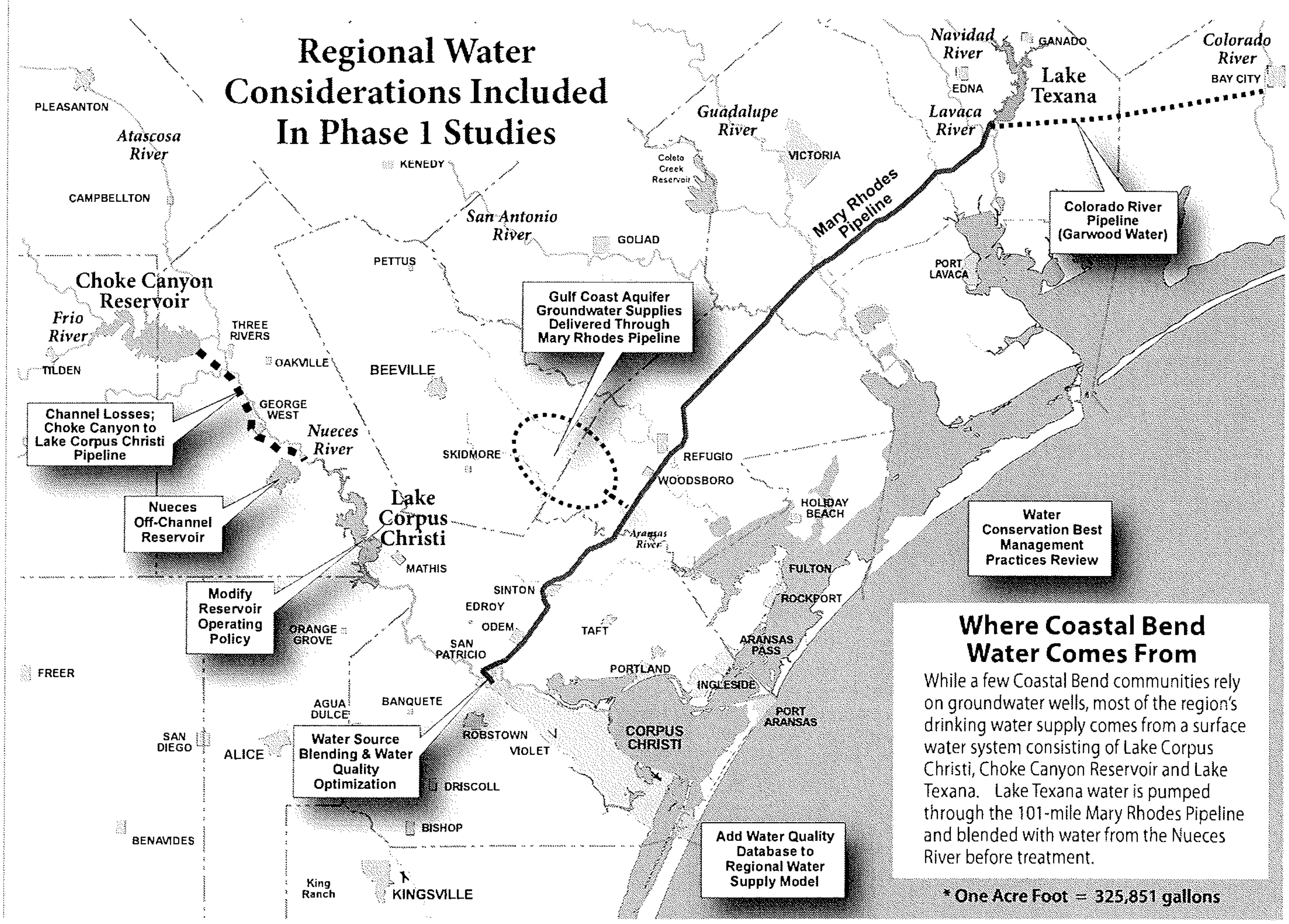
STUDY 1 – Additional Supplies Via Mary Rhodes Pipeline

Surface water supplies from Choke Canyon Reservoir, Lake Corpus Christi and Lake Texana meet more than 85% of the municipal and industrial water demand in the region. In the existing system, raw water from the Nueces River is blended with Lake Texana water delivered via the Mary Rhodes Pipeline. Based on median chloride levels, Nueces River water is 10 times higher in chlorides than Lake Texana water. The two are currently being blended on approximately a 50-50 basis before treatment.

The Mary Rhodes Pipeline was upsized at construction so that it could carry additional water in the future. Study 1 looks at how water quality, water treatment costs and reservoir system operations could be impacted by new water sources that could be delivered via the pipeline. The first source considered is groundwater that is potentially available in Bee County. A new pipeline would be needed to carry groundwater several miles from a well field to a connection with the Mary Rhodes Pipeline.

The second source considered is water from the Colorado River. The City of Corpus Christi holds water rights and an interbasin transfer permit to divert up to 35,000 acre feet* per year of Colorado River water (know as the Garwood Water). Access to this water may require building a 41-mile pipeline from Bay City to connect to the Mary Rhodes Pipeline. An alternative delivery method under consideration would involve pumping the Colorado River water into an existing irrigation canal and flowing it down Mustang Creek to Lake Texana for delivery through the Mary Rhodes Pipeline.

The study evaluates multiple blended water quality combinations and expected changes in treatment costs. Adding groundwater to the final blend would increase chloride levels but as long as the contribution of groundwater is maintained below 20% it is not expected to require additional treatment. Adding Colorado River water will decrease



Where Coastal Bend Water Comes From

While a few Coastal Bend communities rely on groundwater wells, most of the region's drinking water supply comes from a surface water system consisting of Lake Corpus Christi, Choke Canyon Reservoir and Lake Texana. Lake Texana water is pumped through the 101-mile Mary Rhodes Pipeline and blended with water from the Nueces River before treatment.

* One Acre Foot = 325,851 gallons

overall chloride levels. At the same time, the study found that blending groundwater with Lake Texana supplies would reduce treatment costs due to its lower TOC (total organic carbon) and lower turbidity.

The reservoir system optimization analysis found that as increased water supply deliveries are made through the Mary Rhodes Pipeline there will be additional freshwater inflows to the Nueces Bay estuary.

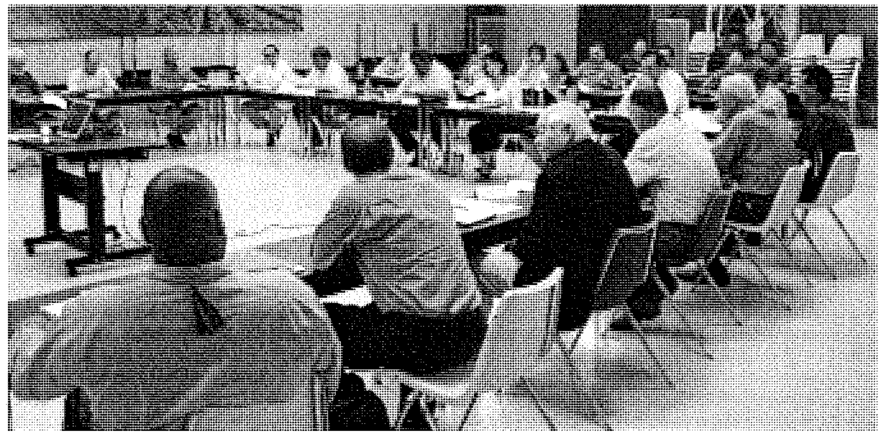
Study 2: Off-Channel Reservoir

One of the recommended water supply management strategies in the 2006 Water Plan is development of an off-channel storage reservoir south of George West in Live Oak County. Previous evaluations suggested that such a system could significantly increase the total water yield from the regional water supply system. Water would be pumped from Lake Corpus Christi into the new reservoir during high flow conditions when the lake is at or near its 94 foot top elevation. The project objective is to provide additional water supplies while still maintaining bay and estuary inflow targets.

Study 2 updates and refines work done in the last planning cycle to determine an optimal size for the off-channel reservoir and the pumping facilities that would move water from Lake Corpus Christi into the new storage unit. The study found that the greatest yield increase would be achieved by holding water in the off-channel reservoir until the level of Lake Corpus Christi hits a trigger elevation of 75 feet then releasing it to flow back into the lake. Additional analyses showed benefits of Lake Corpus Christi being filled more often by using a trigger elevation of 83 feet. Choke Canyon Reservoir is currently operated to provide water supply releases (above minimum flow requirements) to Lake Corpus Christi when the level of Lake Corpus Christi hits a trigger elevation of 74 feet.

Several possible off-channel reservoir sites were evaluated and the location identified earlier was confirmed to be the most beneficial. Based on minimizing project costs and increased system firm yield, a reservoir sized at 280,000 acre feet is recommended. The proposed reservoir would cover about 5,600 acres and have an average depth of 50 feet. The maximum reservoir surface water level would be at an elevation of 281 feet.

The study evaluates alternative reservoir operating options and finds that with a delivery pumping rate of 1,250 cubic feet per second to the off-channel reservoir the project could increase overall system firm yield by about 46,600 acre feet per year at raw water unit costs comparable to existing regional water supplies including water delivered from Lake Texana.



RWPG members discuss water source blending and water quality issues

Study 3: Choke Canyon to Lake Corpus Christi Pipeline

This is a two-part study that looks further at the channel losses of water between Choke Canyon Reservoir and Lake Corpus Christi. The 2006 Water Plan proposes construction of a pipeline to deliver water from Choke Canyon to Lake Corpus Christi, bypassing stream channels on the Frio and Nueces Rivers.

Field measurements were conducted during March, 2008, to more accurately estimate how much of the water being released from Choke Canyon was not making its way to Lake Corpus Christi. The results show that during these specific hydrologic conditions much of the water that appears to be lost between Choke Canyon and Three Rivers is actually being transported in a unique underground alluvium system and is rejoining the Nueces River a few miles downstream. The study also showed that impounded water in Lake Corpus Christi influences Nueces River streamflow further upstream than previously thought.

For the conditions during the field study the overall loss of Choke Canyon releases was estimated at 2% to 3%. The study concludes that these findings may significantly reduce potential benefits from a management strategy that includes building a pipeline to bypass the river channel. It also suggests that consideration should be given to long-term water balance in the Corpus Christi Water Supply Model to better reflect inflows and outflows from Lake Corpus Christi for a wide variety of hydrologic conditions.

Review draft study reports at:
www.nueces-ra.org
(Reports will be posted as they become available)

Study 4: Water Quality Modeling

The Corpus Christi Water Supply Model is a computerized multi-basin water supply model. It includes operations of Choke Canyon Reservoir, Lake Corpus Christi, and Lake Texana plus freshwater inflow to the Nueces Bay estuary and potential future water supplies. The model was updated in the 2006 Plan to include hydrologic conditions during the drought of the 1990s and can now provide monthly simulations for the hydrologic period 1934-2003 to determine firm (or safe) water supply yield of the system.

Study 4 involved developing and adding a water quality database to the existing model to simulate water quality at each reservoir and near water supply intakes for a range of hydrologic conditions. Daily water quality data was obtained from state and federal sources and equations were developed relating inflows to water quality in each of the reservoirs. This water quality modeling feature supports more efficient use of water supplies, and may help to prioritize water management strategies and/or system operations that may provide water quality impacts on regional water supplies.

Study 5: Water Conservation Best Management Practices

The CBRWPG set out to identify water conservation best management practices (BMPs) that may be region specific for the Coastal Bend area. Members selected 13 BMPs they felt best suited to promote to regional water users on a voluntary basis.

A survey sent to water suppliers and customers in the region found that numerous water conservation BMPs are already being successfully implemented on a voluntary basis. Most entities reported an annual reduction of 1 to 5% in water demand. The survey found that cost and lack of staff are major challenges to implementing new water conservation BMPs.

Coastal Bend Regional Water Planning Group Members

The 16 members of the Coastal Bend Regional Water Planning Group were appointed to represent a wide range of stakeholder interests and to act as a steering and decisionmaking organization.

South Texas Water Authority Executive Director Carola Serrato and Scott Bledsoe, III of Oakville co-chair the group. Bernard Paulson serves as secretary.

As required by law the members were appointed to represent specific interest categories. They are:

AGRICULTURE
Charles Ring, Sinton
Chuck Burns, Raymondville

COUNTY
Bill Stockton, Beeville
Lavoyger J. Durham, Falfurrias

ELECTRICAL GENERATING UTILITY
Gary Eddins, Corpus Christi

ENVIRONMENT
Teresa Carrillo, Realitos

INDUSTRY
Tom Ballou, Gregory
Robert Kunkel, Corpus Christi

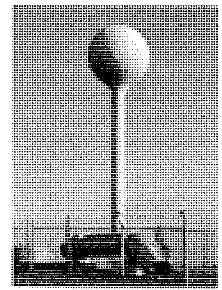
MUNICIPAL
Mark Scott, Corpus Christi
Billy Dick, Rockport

RIVER AUTHORITY
Thomas M. Reding, Jr., Portland

OTHER
Bernard Paulson, Corpus Christi

PUBLIC
Kimberly Stockseth, Corpus Christi

SMALL BUSINESS
Dr. Pancho Hubert, Corpus Christi
Pearson Knolle, Sandia



WATER DISTRICT
Scott Bledsoe, III, Oakville

WATER UTILITIES
Carola Serrato, Kingsville

Non-voting members are Matt Nelson of the Texas Water Development Board; George Aguilar, Texas Department of Agriculture; Dr. Jim Tolan, Texas Parks and Wildlife Dept.; and Tomas Dominguez, USDA-NRCS.

Public Comments Invited on Phase I Draft Study Reports

1:30 p.m. • Thursday • November 13, 2008 • Johnny Calderon County Building • 710 E. Main, Robstown

Send written comments to:

Nueces River Authority, Coastal Bend Division, 6300 Ocean Dr, Unit 5865, Corpus Christi, Tx 78412-5865

COASTAL BEND **Water Report**

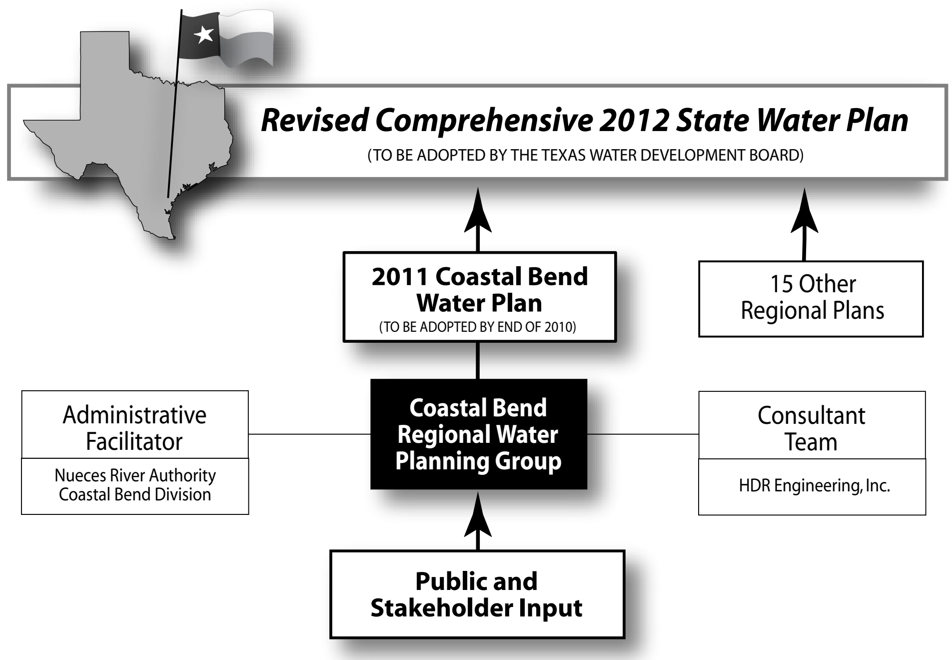
The Coastal Bend Water Report is published by the Coastal Bend Regional Water Planning Group which is reviewing and revising the current regional plan that will be included in the next comprehensive state water plan. A revised statewide plan will be issued by the Texas Water Development Board in 2012.

Prepared by: The Rodman Company

COASTAL BEND REGIONAL WATER PLANNING GROUP
c/o Nueces River Authority • Coastal Bend Division
6300 Ocean Drive, Unit 5865
Corpus Christi, Texas 78412-5865

COASTAL BEND
Water Report
Coastal Bend Regional Water Planning Group
Website: www.nueces-ra.org
No. 10 • February 2009

Planners Now at Work Drafting Elements of 2011 Coastal Bend Regional Water Plan



How the State Water Plan Is Developed Each Five-Year Cycle

Work is now underway on the second phase of the multi-year process of updating the comprehensive regional water plan covering the 11 counties in the Coastal Bend.

The Coastal Bend Regional Water Planning Group (RWPG) wrapped up Phase 1 of the process in December with publication of five studies dealing with possible water supply management strategies. Those draft study reports are available on line at the Nueces River Authority website:

www.nueces-ra.org

In Phase 2 the Coastal Bend RWPG and its consultants will be developing a draft revised regional plan. The draft plan will be published in the spring of 2010, an event that triggers a period of public review and comment, a public meeting and then plan adoption. The regional plan will be submitted to the Texas Water Development Board (TWDB), along with the plans from 15 other regions across the state, and ultimately will become part of the comprehensive 2012 State Water Plan.

The Coastal Bend RWPG will meet at least quarterly during 2009 to receive updates from the consulting team working on the technical analyses of the plan. Anyone interested in water supply planning is encouraged to attend these meetings which include a period for public comments and questions.

The current Plan update effort is part of the third five-year planning cycle of a process established by the Texas Legislature in 1997. Known as the Senate Bill 1 or SB 1 process, it established a system where local community members, including representatives of various stakeholder groups, guide the development of regional plans to meet local needs. The law requires that statewide water plans be brought up to date every five years.

The Coastal Bend plan was first adopted in 2001 and updated in 2006 to reflect the latest available information about projected population growth and potential future water demand.

State financial assistance may be provided only to water supply projects that meet needs in a manner that is consistent with the approved regional plan.

Administrative support for the RWPG is provided by the Nueces River Authority's office in Corpus Christi. A consultant team headed by HDR Engineering, Inc. of Austin assisted the RWPG in preparing the initial Coastal Bend regional plan, drafted the 2006 update and was selected to conduct additional studies and develop a newly revised 2011 Plan.

2009 Meeting Schedule
Coastal Bend Regional Water Planning Group

Meetings are held at 1:30 p.m. at the Johnny Calderon County Building 710 E. Main in Robstown

March 12
June 11
September 10
November 12

*These dates are subject to change. Agendas and notices of RWPG meeting dates and locations are posted on the Nueces River Authority website: www.nueces-ra.org

Phase I Study Reports Available For Review

During Phase 1 of the current planning cycle the Coastal Bend RWPG worked with consultants to perform five studies to better characterize issues that have been part of the planning process.

Drafts of the study reports were made available for public review and comment during the fall of 2008. They were the subject of a public meeting held on November 13th.

The five draft study reports were approved by the RWPG and were submitted to the Texas Water Development Board in December. They are available for review online at the Nueces River Authority's website.

Study 1 deals with the potential for supplying additional water to the area by way of the Mary Rhodes Pipeline. This study looks at the possible impacts of two water management strategies identified in the 2006 Regional Plan - groundwater from sources along the pipeline route and water from the Colorado River. The study evaluates blended water quality combinations and expected changes in treatment costs based on water quality.

Study 2 takes a closer look at a proposed new off-channel water storage reservoir in the Nueces River Basin at a location south of George West. Several sites were evaluated for water supply potential.

Study 3 looks at channel losses on the Frio River and Nueces River between Choke Canyon Reservoir and Lake Corpus Christi and the proposed strategy of building a pipeline to improve water delivery to Lake Corpus Christi.

Study 4 includes work on updating the complex computerized Corpus Christi Water Supply Model to include water quality data and to allow improved simulations.

Study 5 deals with water conservation best management practices in the region. Thirteen were selected by the Coastal Bend RWPG as best suited to promote on a voluntary basis in the region.

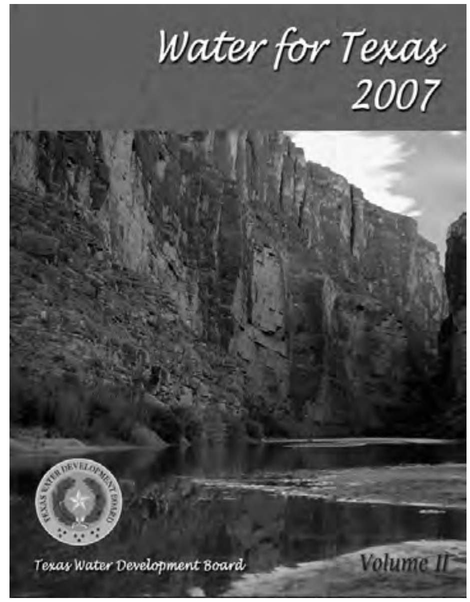
Review Phase 1 draft study reports at:
www.nueces-ra.org

Elements of the 2011 Regional Plan

State rules mandate that each of the 16 regional water plans include 10 basic elements. The existing 2006 Plan for the Coastal Bend has each of these sections and is available for review online at the Nueces River Authority website (under **Contracts and Programs**, click on **Regional Water Planning**, then **2006 Coastal Bend Regional Water Plan (01/2006**).

Elements in the updated initially prepared plan that will be published next year are:

1. Planning Area Description. This includes an overview of water providers, current water uses and socioeconomic conditions.
2. Population and Water Demand Projections. Because new Census Bureau data will not be available while the 2011 regional plan is being prepared, population and water demand projections from the 2007 State Water Plan will serve as estimates for the current round of planning. Alternate steam and electric water demands will be considered based on a recent study by the Bureau of Economic Geology and the TWDB.
3. Existing Water Supplies. Planning groups will reevaluate existing surface water and groundwater supplies in their region. This involves simulating firm yields under drought conditions for reservoir systems like the Choke Canyon-Lake Corpus Christi-Lake Texana systems that serve the Coastal Bend. If available, it will also include any updates to groundwater supplies based on Groundwater Management Area (GMA) desired future conditions.
4. Water Management Strategies. Planning groups will reevaluate water management strategies identified in 2006 regional plans for each water user group and wholesale water provider. This includes developing updated financial costs.
5. Impacts of Water Management Strategies on Key Water Quality Parameters. Each planning group must describe how implementing recommended and alternative water management strategies could affect water quality in Texas. This section must also discuss how strategies could affect agricultural resources.
6. Water Conservation and Drought Management Recommendations. Every region must consider "active" water conservation as one of its water management strategies. Drought management strategies are those that decrease short-term peak water requirements.
7. Description of How the Regional Plan is Consistent with the Long-Term Protection of the State's Water, Agricultural and Natural Resources. This section is specifically directed at making sure that recommendations honor all existing water rights and contracts.
8. Unique Stream Segments and Reservoir Sites. Planning groups may recommend all or parts of stream segments as having "unique ecological values" based on specific criteria. They could also identify recommended unique sites for future reservoirs in the region if any are available and are part of a specific water management strategy. None were identified for the Coastal Bend in the 2006 Plan.
9. Reporting of Financing Mechanisms. Each planning group is to assess how local governments, regional authorities and other political subdivisions would finance the implementation of water management strategies based on input from those local entities.
10. Adoption of Plan and Public Participation. In adopting their regional plan, each group must allow for public participation in the planning effort and the adoption process. This is documented as part of the final plan.



The 2007 Texas Water Plan, all 16 current 2006 regional plans and additional information about the third water planning cycle are available at the Texas Water Development Board website:

http://www.twdb.state.tx.us

Phase 2 Means More Fine Tuning for Water Plan

Work on Phase 2 of the Coastal Bend's 2011 Plan will include updates to all the minimum plan requirements and will revisit some recommended Coastal Bend water management strategies in substantial detail.

The 2006 Plan for the region identified 18 water management strategies, and recommended about a dozen key strategies that could be used to meet future water supply shortfalls.

The 2006 Plan options that could generate the greatest anticipated amount of water include building a pipeline to deliver Garwood Water from the Colorado River, developing groundwater resources in Bee and Refugio counties, developing an off-channel storage reservoir south of George West, building Stage II of Lake Texana to capture Lavaca River flows and, when economically feasible, brackish groundwater or seawater desalination.

The Scope of Work approved by the RWPG and the TWDB for Phase 2 focuses on these and other strategies that may have the potential to increase industrial water use efficiency even further. It will also update the estimated amount of water that could potentially be produced in the future from each of the identified strategies. This work will include taking into account the reduction in inflows to the Choke Canyon Reservoir/Lake Corpus Christi System that have been observed in recent decades.

Additional studies will look at the possibility of providing water from the Mary Rhodes Pipeline to more users and will evaluate strategies for managing Lake Corpus Christi based on water quality, both with the goal of making the regional water supply more reliable through a reduction in water consumption. Brackish groundwater desalination opportunities will also be studied in greater detail.

ACCESS TO PIPELINE WATER

Previous studies have indicated a significant increase in the concentration of dissolved minerals in the Calallen Pool, that part of the Nueces River behind the Calallen Saltwater Barrier Dam. This is the spot where most of the water used by municipal and industrial customers in Nueces, San Patricio, Kleberg and Aransas counties is pumped from the river.

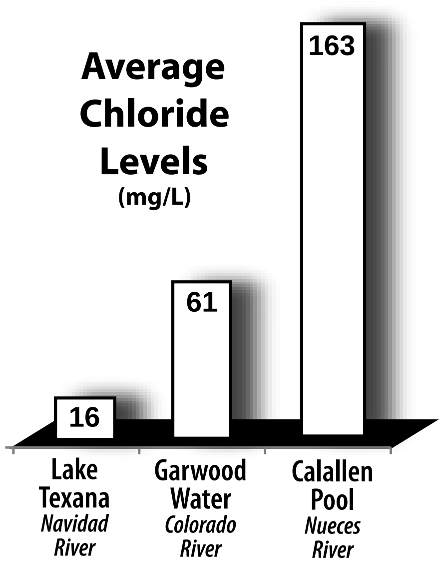
Chloride concentrations in this part of the river are 2.5 times higher than in the same water as it is released from Lake Corpus Christi, 35 river miles upstream. This increase has been attributed to natural groundwater seepage, enhanced mineralization of Lake Corpus Christi and periodic discharges of salty water likely from sand and gravel operations.

Five municipal and industrial pump stations withdraw water from the Nueces River pool behind the Calallen Saltwater Barrier Dam alongside Interstate 37.

Water coming from Lake Texana and potentially from the Colorado River near Bay City (Garwood water) have chloride levels that are 60% to 90% lower than the averages recorded at the Calallen Pool.

Currently the City of Corpus Christi and the San Patricio Municipal Water District are able to improve water quality by blending Nueces River water with supplies from Lake Texana delivered through the Mary Rhodes Pipeline.

In Phase 2 of 2011 Plan development, the project team will evaluate the potential for other water users with intakes in the Calallen Pool to be connected to the Mary Rhodes Pipeline. This would apply to Flint Hills Resources, Celanese and others with intakes, and potential future industrial users.



Work will include reviewing historical quality data including seasonal fluctuations and identifying the water quality constituents that are of particular interest to potential users.

Several scenarios will be evaluated including adding new water sources and using the full capacity of the Mary Rhodes Pipeline. Results will include estimated water quality improvements, water treatment efficiency, and project costs such as new pipeline connections to the Mary Rhodes Pipeline which runs about one-half mile west of the Calallen Pool.

WATER QUALITY MANAGEMENT

The project team will evaluate strategies for management of water supply and operation of Lake Corpus Christi to improve water quality.

This will include comparing river water quality at Calallen to levels recorded upstream from Lake Corpus Christi and conducting groundwater inflow analyses. Target levels for water quality will be established and all these components will be integrated into the existing computer model of the Corpus Christi area water supply system.

Model runs will seek to determine what level of water releases from Lake Corpus Christi would be required to hit quality targets at Calallen and what the resulting impacts would be on lake storage capacity.

Phase 2 (cont.)

This work will help in evaluating potential changes to the current operation of the Choke Canyon Reservoir/Lake Corpus Christi System with potential future water management strategies to improve water quality and increase water supply. It will also factor in possible changes in the operation of the Mary Rhodes Pipeline.

It is possible that improvements in river water quality at Calallen could result in greater overall system yield because water with lower total dissolved solids/chlorides can be treated more efficiently and can be recycled more times when used in industrial applications such as cooling systems.

SYSTEM YIELD

The Choke Canyon Reservoir/Lake Corpus Christi System is operated under an agreed order that provides for the freshwater inflow needs of the Nueces Estuary. An additional study will look at increases in biological productivity associated with return flows and water supplied to the Nueces delta through a new Rincon Bayou pump station and pipeline. It will look at the relationship of biological productivity multipliers and increases in reservoir system yield.

Palmetto Bend Dam creates the 11,000-acre Lake Texana in Jackson County. Lake water is delivered to Coastal Bend customers through the 101-mile long, 64-inch diameter Mary Rhodes Pipeline.

BRACKISH GROUNDWATER

Brackish groundwater desalination opportunities in the Coastal Bend will be the subject of additional studies. This will include analysis of two groundwater wellfield sites identified in the 2006 Plan or other locations proposed by the RWPG. Estimates for the amount of brackish groundwater available and water quality will be updated using the TWDB water quality database and Central Gulf Coast Groundwater Availability Model. Sites for a proposed brackish desalination water treatment plant will be evaluated and capital and annual costs of brackish groundwater desalination will be updated as necessary.

COASTAL BEND Water Report

The *Coastal Bend Water Report* is published by the Coastal Bend Regional Water Planning Group which is reviewing and revising the current regional plan that will be included in the next comprehensive state water plan. A revised statewide plan will be issued by the Texas Water Development Board in 2012.

Prepared by The Rodman Company

Coastal Bend Regional Water Planning Group
c/o Nueces River Authority • Coastal Bend Division
6300 Ocean Drive, Unit 5865
Corpus Christi, Texas 78412-5865

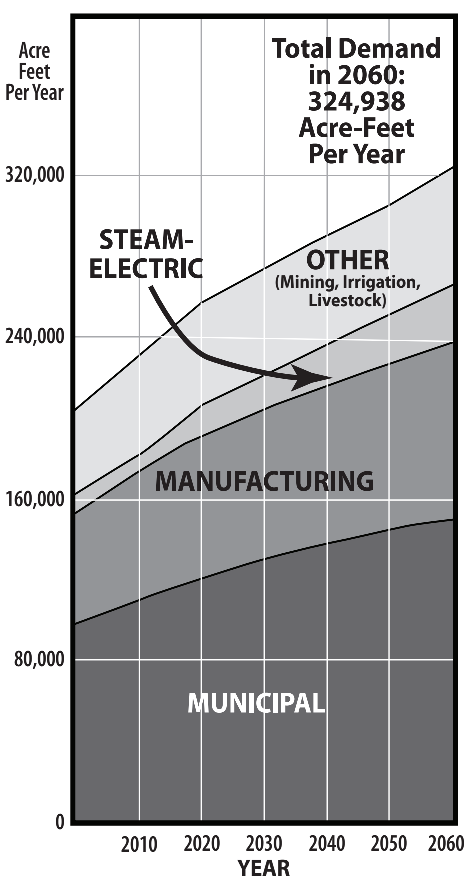
COASTAL BEND
Water Report
Coastal Bend Regional Water Planning Group
Website: www.nueces-ra.org
No. 11 • March 2010

Public hearing on 2011 Initially Prepared Regional Water Plan set for April 8th

The Coastal Bend Regional Water Planning Group (RWPG) will hold a public hearing to receive oral and written comments from the public on the 2011 Initially Prepared Regional Water Plan for the Coastal Bend region.

The hearing will be at 1:45 p.m. on April 8th at the Johnny Calderon County Building, 710 E. Main St., in Robstown.

Projected Water Demand For Coastal Bend Region



Demand projections were developed by the Texas Water Development Board

Written comments can be submitted to the RWPG until June 8th.

Mail comments to the Nueces River Authority, 1201 N. Shoreline, Corpus Christi, Tx 78401. Comments may also be sent by email to rfreund@nueces-ra.org.

All public comments received will be considered in preparing the final plan. The RWPG must adopt the final plan and submit it to the Texas Water Development Board (TWDB) by September 1st.

PLANNING PROCESS

Regional plans prepared by 16 regions across the state will ultimately become part of the comprehensive 2012 State Water Plan compiled by the TWDB.

In 1997 the Texas Legislature established an ongoing regional water planning program. The latest planning effort is the third five-year planning cycle in that program. Known as the Senate Bill 1 process, it provides a framework where local community members guide the development of regional plans to meet local needs now and in the future.

State financial assistance may be provided only to water supply projects that are consistent with the approved regional plan.

The Coastal Bend region is known as Region "N" and includes the following 11 counties: Aransas, Bee, Brooks, Duval, Jim Wells, Kenedy, Kleberg, Live Oak, McMullen, Nueces and San Patricio. The Coastal Bend plan was first adopted in 2001 and later updated in 2006. For the 2011 Coastal Bend Regional Water Plan, the TWDB did not issue new population or water demand projections due to lack of new Census data. The RWPG did request a water demand revision for irrigation in Bee and San Patricio Counties. Otherwise projections remain identical to the 2006 Plan.

The Regional Water Planning Group and its consultant team have spent much of the past two years reviewing the water needs of the region and refining water supply management strategies to address those needs in the decades ahead.

An Initially Prepared Plan has been prepared which outlines all identified water supply options and management strategies, the recommendations of the RWPG and other findings in a two volume report.

Coastal Bend RWPG Members

The 17 members of the Coastal Bend Water Planning Group were appointed to represent a wide range of stakeholder interests and act as a steering and decision-making body. They serve without pay and are appointed to represent specific interest categories as dictated in state law. Current members are:

Agriculture: Charles Ring, Chuck Burns
Counties: Lavoyger J. Durham, Bill Stockton
Electric Generating Utilities: Gary Eddins
Environmental: Teresa Carrillo
Industry: Tom Ballou, Robert Kunkel
Municipalities: Billy Dick, Mark Scott
Other: Bernard Paulson
Public: Kimberly Stockseth
River Authorities: Thomas Reding Jr.
Small Business: Dr. Pancho Hubert, Pearson Knolle
Water Districts: Scott Bledsoe III
Water Utilities: Carola Serrato

Elements of the 2011 Initially Prepared Plan

The Coastal Bend planning area has four regional wholesale water providers: City of Corpus Christi, San Patricio Municipal Water District, South Texas Water Authority, and Nueces County Water Control & Improvement District #3 at Robstown.

Major water demand areas consist of municipal water systems and a string of industrial users concentrated around the Corpus Christi and La Quinta Ship Channels. Data shows that industries in the Coastal Bend area are very efficient in their use of water compared to other areas.

The region depends mostly on regional surface water supplies from the Choke Canyon/Lake Corpus Christi and Lake Texana (CCR/LCC/Lake Texana) system. Water quality is generally good although there are some concerns in the Calallen Reservoir Pool where the bulk of the region's water supply intakes are located.

Some communities and rural areas are dependent on groundwater from the Carrizo-Wilcox Aquifer and Gulf Coast Aquifers which can yield moderate to large amounts of both fresh and slightly saline water on a sustainable basis.

Population in the region is concentrated in Corpus Christi, Kingsville, Alice, Beeville, Robstown, Portland, Ingleside, Aransas Pass and Rockport, all of which have access to the regional surface water supply system.

Population and Water Demand

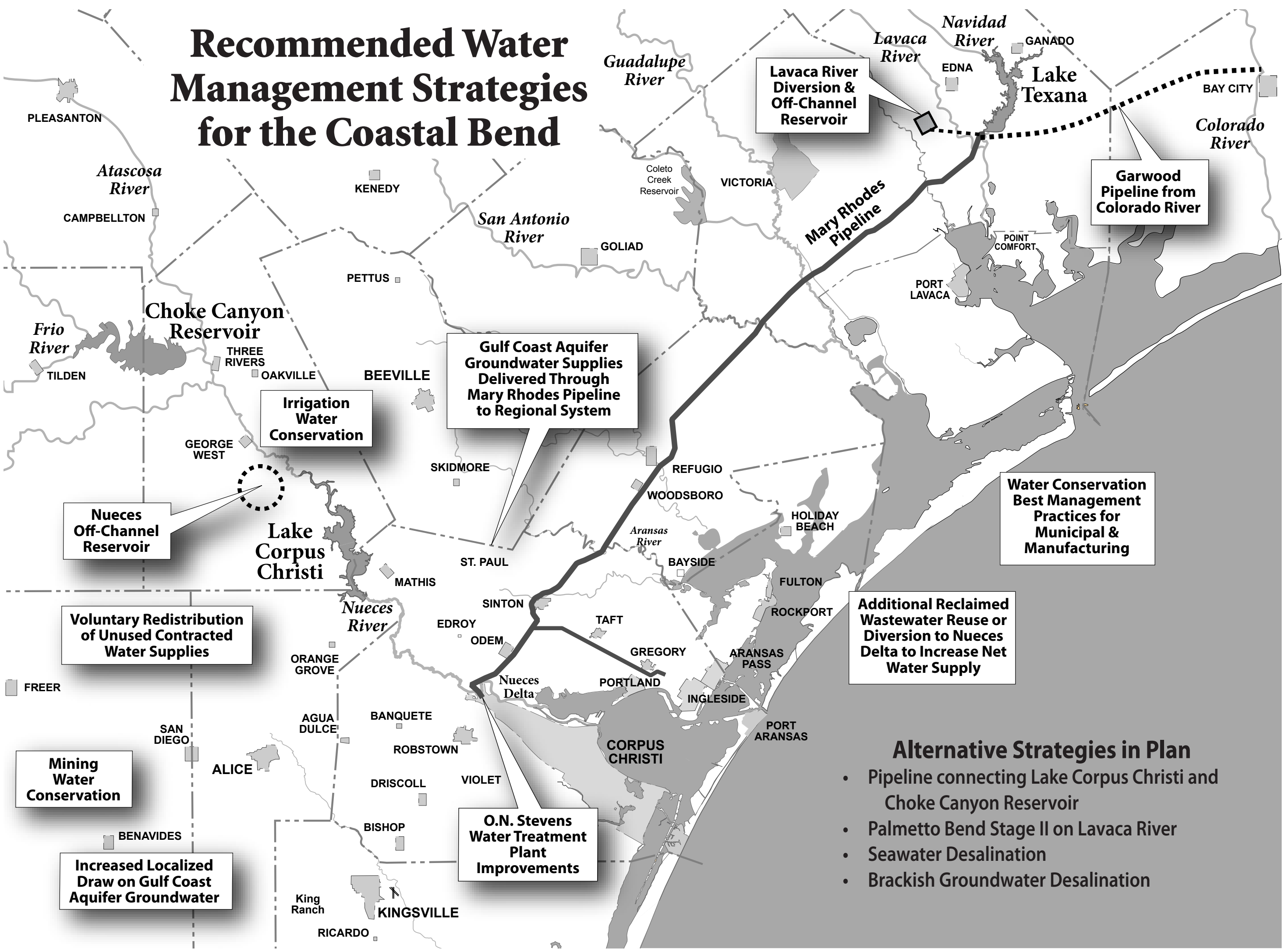
Water demand projections are divided by type of use including municipal for cities and special water districts, and county wide for manufacturing, steam-electric, mining, irrigation and livestock uses.

Total water demand is projected to increase from 205,936 acre feet per year (acft/yr) in Year 2000 to 324,938 acft/yr in 2060, a 57.8% increase. All categories are projected to increase including a 51% increase in municipal water demand over the 50-year planning horizon. Average per capita water use was 165 gallons in 2000 and is projected to decrease to 152 gallons per capita per day by 2060. That would result in a 12,000 acft/yr reduction in water demand, equal to about a quarter of the region's contracted water supplies from Lake Texana.

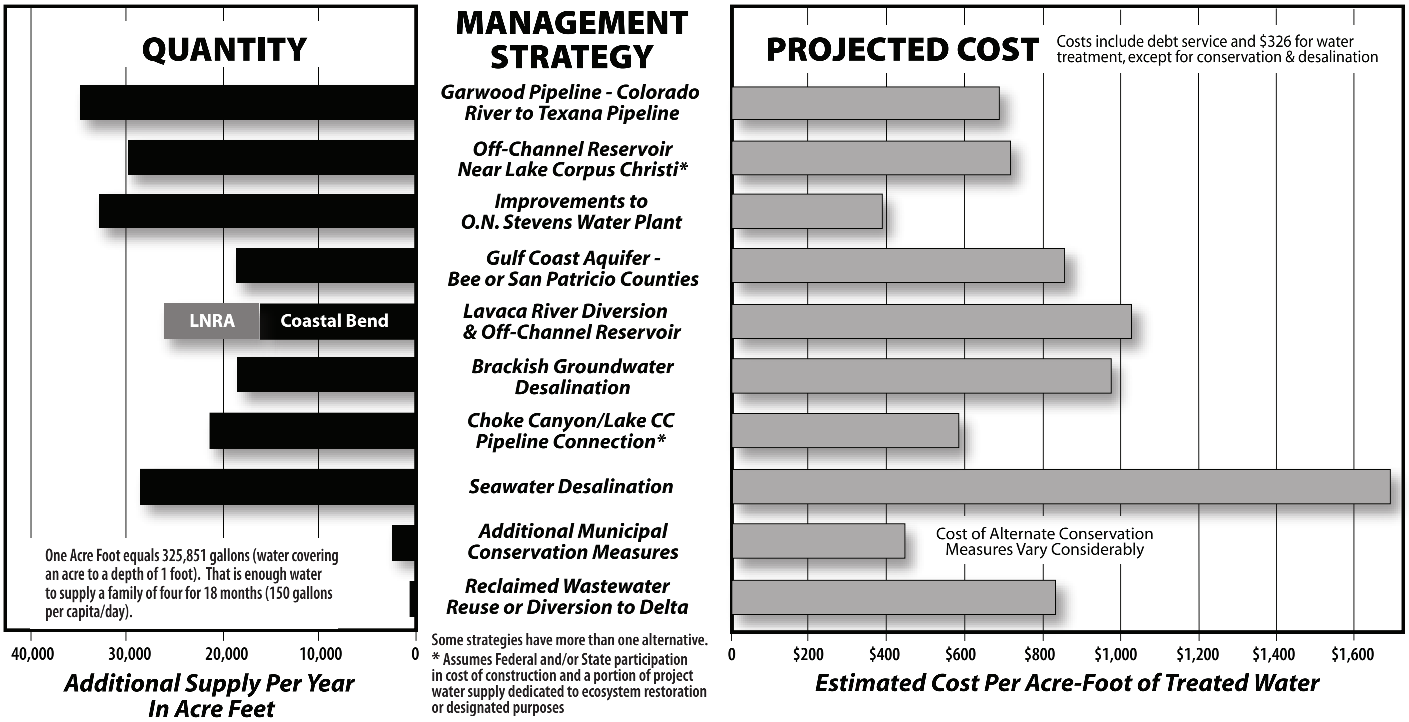
Water Supply

Today the safe yield from the CCR/LCC/Lake Texana system is calculated at 205,000 acft/yr of available raw water. Safe yield is based on keeping 75,000 acft in system storage during the critical month of the drought of record. The RWPG adopted use of safe yield supply for the 2011 Plan, which provides approximately 22,000 acft/yr less than "firm yield" in 2010.

Local Groundwater Management Areas 15 and 16 are currently in the process of identifying desired future conditions (DFCs) for their underlying aquifer systems and working with the TWDB to determine managed available groundwater associated



Updated Estimates of Additional Water Yield and Unit Cost in 2060



with the DFCs (i.e. groundwater supply availability). DFCs are to be submitted to the TWDB by September 1st. Approved groundwater models will then be used to simulate DFCs to determine aquifer availability, the results of which will be considered in future planning cycles. Based on drawdown criteria adopted by the Coastal Bend RWPG as used in the 2006 Plan. The groundwater aquifers in the region have a combined reliable yield of about 105,000 acft/yr and projected use over the 50 year planning period of about 64,000 acft/yr.

Water Quality

Studies show a significant increase in dissolved minerals concentrations below Wesley Seale Dam in the Nueces River. Potential sources include saltwater intrusion, groundwater seepage and upstream sources of contamination. This lower quality leads to an increase in industrial water demand due to accelerated buildup of minerals in industrial cooling facilities. Additionally, high levels of chlorides and bromides sometimes exceed drinking water standards. Groundwater supplies in the region are generally of good water quality but some areas have slightly brackish groundwater.

Water Supply Strategies

Numerous water management strategies were identified by the RWPG as potentially available to meet future water supply shortages.

Recommended strategies emphasize water conservation; maximize use of water resources; engage the efficiency of conjunctive use of surface and groundwater; and limit depletion of storage in aquifers. Some require additional study to confirm how much water they would yield during a severe drought. The Initially Prepared Plan includes details on recommended, alternative, and potentially feasible strategies. It also provides a comparison of updated unit costs and quantities of water provided for selected strategies evaluated.

The recommended strategies could produce new supplies in excess of the projected additional regional need of 75,700 acft/yr in Year 2060. Almost all of the recommended strategies were also in the 2001 and 2006 Coastal Bend plans. New strategies include potential Lavaca River diversion and off-channel reservoir project and improvements to the O.N. Stevens Water Treatment Plant. The recommended strategies include:

Colorado River Pipeline

In 1998 the Coastal Bend region purchased 35,000 acft/yr of senior water rights in the Colorado River from the Garwood Irrigation Company. Delivering this water will require construction of a pipeline from the Colorado River near Bay City to a connection with the Mary Rhodes Pipeline at Palmetto Bend Dam, a distance of about 40 miles. The City of Corpus Christi has an engineering team working on design, alignment and environmental review for the project but there is no schedule for right-of-way acquisition or construction.

The Mary Rhodes Pipeline was originally oversized to accommodate up to 112,000 acft/yr and is currently capable of pumping contracted supplies up to 53,800 acft/yr from Lake Texana. After the Garwood water is added there will be about 23,000 acft/yr reserve capacity remaining in the pipeline.

Lavaca River Diversion

Previous water plans included a possible future Palmetto Bend Stage II, a reservoir on the Lavaca River. As an alternative, the Lavaca-Navidad River Authority (LNRA) is investigating a Lavaca River Diversion project that involves building a

REVIEW THE REGIONAL PLAN

The entire 1,448-page 2011 Coastal Bend Initially Prepared Plan is available for downloading and review at the Nueces River Authority website:

www.nueces-ra.org

Copies are available for review at the County Clerk offices of each of the 11 counties and at the following libraries:

- Corpus Christi Central Library
- Alice Public Library
- Kleberg Public Library, Kingsville
- Sinton Public Library
- Aransas County Public Library, Rockport
- Bee County Library, Beeville
- Ed Rachal Library, Falfurrias
- San Diego Public Library
- Live Oak County Library, George West

large off-channel reservoir approximately 10 miles west of Lake Texana. It would allow LNRA to divert high flows from the river to the new reservoir where it could then be pumped as needed to end users. It would require substantial pump stations and pipelines. A 3,000-acre reservoir storing 75,000 acft would have an optimum yield of approximately 26,242 acft/yr. There is a need for 10,000 acft/yr by an existing LNRA industrial customer, leaving 16,242 acft for possible contract to others.

O.N. Stevens Plant Improvements

The O.N. Stevens Water Treatment Plant provides treated water to Corpus Christi and wholesale customers. Production at Stevens is limited to 159 MGD or less by a hydraulic bottleneck at the front end of the plant. Modifications would allow it to produce treated water supplies up to 200 MGD and would result in operational cost savings. Improvements would include changes to the intake pumps at the Nueces River and major modification of the plant's solids handling facilities. These changes could improve finished water quality. Under certain assumptions these improvements are estimated to provide access to additional treated water supplies of about 17,000 acft/yr from the surface water supply system plus reclaim 16,000 acft/yr from the solids handling process.

Nueces River Off-Channel Reservoir

Developing an off-channel reservoir south of George West near Lake Corpus Christi could increase Nueces Basin reservoir system yield. Water would be pumped from Lake Corpus Christi into the reservoir during high flow conditions then would flow back to the lake during dry seasons. The Texas Legislature has designated the Nueces off-channel reservoir as one of 19 unique reservoir sites in the state and it is one of the top ranked sites for protection and acquisition. It would have an average water depth of 50 feet and a surface area of 5,600 acres.

Gulf Coast Aquifer Well Fields

Studies have been conducted on the possibility of installing well fields in the area north of Sinton and west of the Mary Rhodes Pipeline. The pipeline could be used to deliver the groundwater which would blend with water already being transported from Lake Texana.

Other Strategies

Water conservation strategies are among the most cost effective water management strategies evaluated and are divided into four groups – municipal, irrigation, manufacturing and mining. The RWPG recommends that conservation strategies continue to be pursued in each of these categories.

A substantial amount of treated municipal wastewater is already being reused in the Coastal Bend for golf course irrigation and manufacturing purposes. Additional reuse is proposed as a way of replacing potable water use. Diversion of wastewater to the Nueces Delta also presents an opportunity to get credit for inflows and may allow recovery of additional reservoir system yield.

The Initially Prepared 2011 Plan also provides information on other potential water supply options that may become suitable in the future. These include a pipeline from Choke Canyon to Lake Corpus Christi to enhance system yield, brackish groundwater desalination and seawater desalination for potential use to address future regional water supply issues.

Notice of Public Hearing on Draft Region "N" Water Plan

1:45 p.m. • Thursday • April 8, 2010 • Johnny Calderon County Building • 710 E. Main, Robstown

COASTAL BEND

Water Report

The *Coastal Bend Water Report* is published by the Coastal Bend Regional Water Planning Group which is reviewing and revising the current regional plan that will be included in the next comprehensive state water plan. A revised statewide plan will be issued by the Texas Water Development Board in 2012.

Prepared by The Rodman Company

Coastal Bend Regional Water Planning Group

c/o Nueces River Authority • Coastal Bend Division

Phone: 361-653-2110

1201 N. Shoreline Drive

Corpus Christi, Texas 78401

Appendix I

Lower Nueces River Dissolved Minerals Study and Surface Water – Groundwater Interactions Study

Lower Nueces River Dissolved Minerals Study

Background

Previous studies by the U.S. Geological Survey (USGS) and others have indicated a significant increase in the concentration of dissolved minerals in the Lower Nueces River between Mathis and the Calallen Saltwater Barrier Dam. A graphical summary of the findings of these studies is shown in Figure 1.

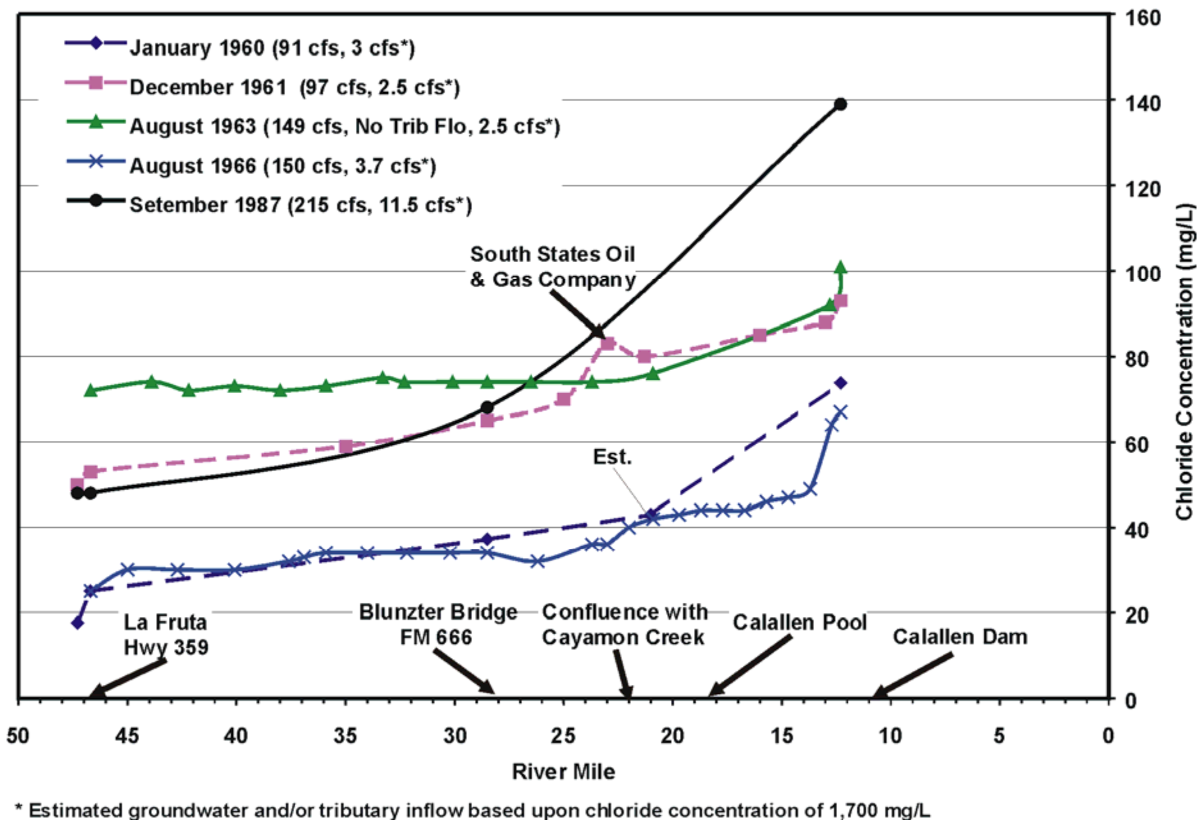


Figure 1. Summary of Historical Data — Chloride Content of the Lower Nueces River, Segment 2102

Figure 1 shows that chloride concentrations at the Calallen Pool on the average are 2.5 times the level of chlorides in water released from Lake Corpus Christi. Figure 1 also shows the change in chloride concentrations occurring between Lake Corpus Christi (Hwy 359 site) and the Calallen Dam for five previous studies. The results of these studies indicate that on the average about 60 percent of the increase in chlorides occurs upstream of the Calallen Pool and about 40 percent of the increase within the pool. Despite similar conclusions from the various previous studies, the source(s) of this increase in mineral concentrations has not previously been conclusively established. Potential sources of minerals to the Calallen Pool include saltwater intrusion, groundwater seepage, and upstream sources of contamination from abandoned wells in adjacent oil fields and gravel washing operations. During the course of this study, a Nueces River sampling program was implemented to confirm the increase in mineral concentrations and to determine the source of dissolved minerals within the Calallen Pool.

A summary of monitoring data collected by the City of Corpus Christi during the 1993 through 1999 timeframe is shown in Figure 2. This figure demonstrates the range of chloride concentrations within the Nueces River from the Fruta Bridge near Lake Corpus Christi to Hazel Bazemore Park. The maximum, mean and minimum values at nine sites are plotted against river mile. This stretch of river is over 33 river miles long. The data shows that the median increase in chlorides from Lake Corpus Christi to Hazel Bazemore Park is from 75 mg/L to about 140 mg/L -- a 90 percent increase. The highest variation in the chloride concentrations above Hazel Bazemore Park were observed to occur near river mile 22, which suggests that periodic discharges may influence readings at this site.

Project Description

The purpose of this study is to confirm the increase in mineral concentrations and to determine the source of dissolved minerals to the Nueces River between Lake Corpus Christi and the Calallen Dam. The sampling data was used to determine spatial and temporal trends in the distribution of dissolved minerals within the Calallen pool. To better understand the system, the river segment was evaluated using a geochemical approach to discern the unique chemical "fingerprint" for the inflows and outflows of the river segment to determine the source of the dissolved minerals. The inherent error in flow measurements may result in significant inflows to go undetected. This approach is useful because the analysis is independent of flow. This sampling plan was designed to collect the appropriate types and amount of information for conducting these analyses.

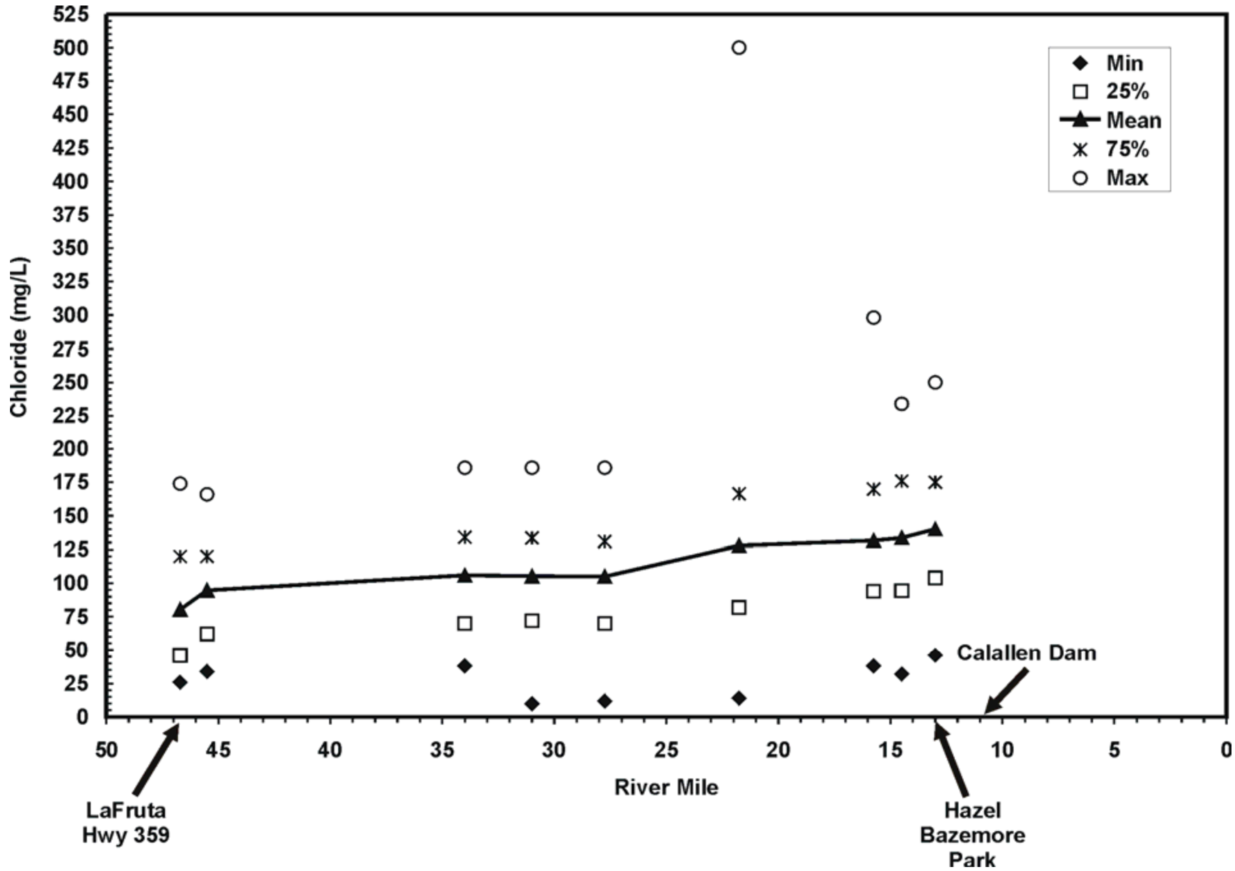


Figure 2. Nueces River Chloride Concentration from La Fruta Bridge to Hazel Bazemore Park (1993-1999)

Sampling trips were conducted once a month through the calendar year from August 1999 to June 2000. Various water quality parameters including pH, temperature, dissolved oxygen, specific conductance, and salinity were measured using a multimeter probe, in addition to measuring chloride concentrations with an ion specific probe. Water samples were also collected and sent to a laboratory for analysis of calcium, magnesium, sodium, potassium, sulfate, chloride, bromide, TDS, alkalinity (as calcium carbonate) and total hardness (as calcium carbonate). Surface water monitoring activities and sample collection were conducted at sites from an outboard motor boat that was navigated though the river channel. Groundwater samples were also taken at various locations along the channel by hand augering sample wells and analyzed for the same suite of constituents as the surface water samples.

Preliminary Field Investigation

On August 5, 1999, a preliminary series of samples were collected at various locations and depths along segment 2102 of the Nueces River in order to establish sampling sites for this study and to evaluate the extent of the saltwater intrusion. The following parameters were measured at each location using a Hydrolab Series 4-Data Sonde 4 portable multimeter probe:

- Specific Conductance (mS/cm)
- Total Dissolved Solids (mg/L)
- Dissolved Oxygen (mg/L)
- pH
- Temperature (^{o}C)
- Salinity (ppt)

Grab samples were also taken at four locations along the river segment (river miles 11, 12, 14.5 and 22.3) and analyzed for calcium, magnesium, sodium, potassium, sulfate, chloride, bromide, TDS, alkalinity (as calcium carbonate), and hardness (as calcium carbonate).

The results from this preliminary monitoring effort in the Calallen Pool of the Nueces River are summarized in Figures 3 and 4. The results indicate mineral concentrations increase with distance downstream toward the dam, especially just downstream of the Stevens Intake and at the San Patricio Intake. The results show stratification, with large mineral concentrations occurring in the bottom 1 to 2 feet. The dissolved oxygen levels (Figure 4) decrease sharply at the sites where the TDS increases significantly. This drop in DO may indicate that the source of the dissolved solids is from seepage of saline groundwater with very low dissolved oxygen levels into the channel lake, or that mixing and the resultant redistribution of dissolved oxygen is hindered by the more dense (heavier) saltwater settling in a depression on the bottom of the channel.

Table 1 reports the lab analysis results for the four grab samples taken. The significant results from this analysis are the concentration increases in chloride, sodium, total dissolved solids, and bromide between the confluence with Cayamon Creek to the Calallen Dam of 68 percent, 183 percent, 136 percent, and >200 percent, respectively. The lab and field results are consistent.

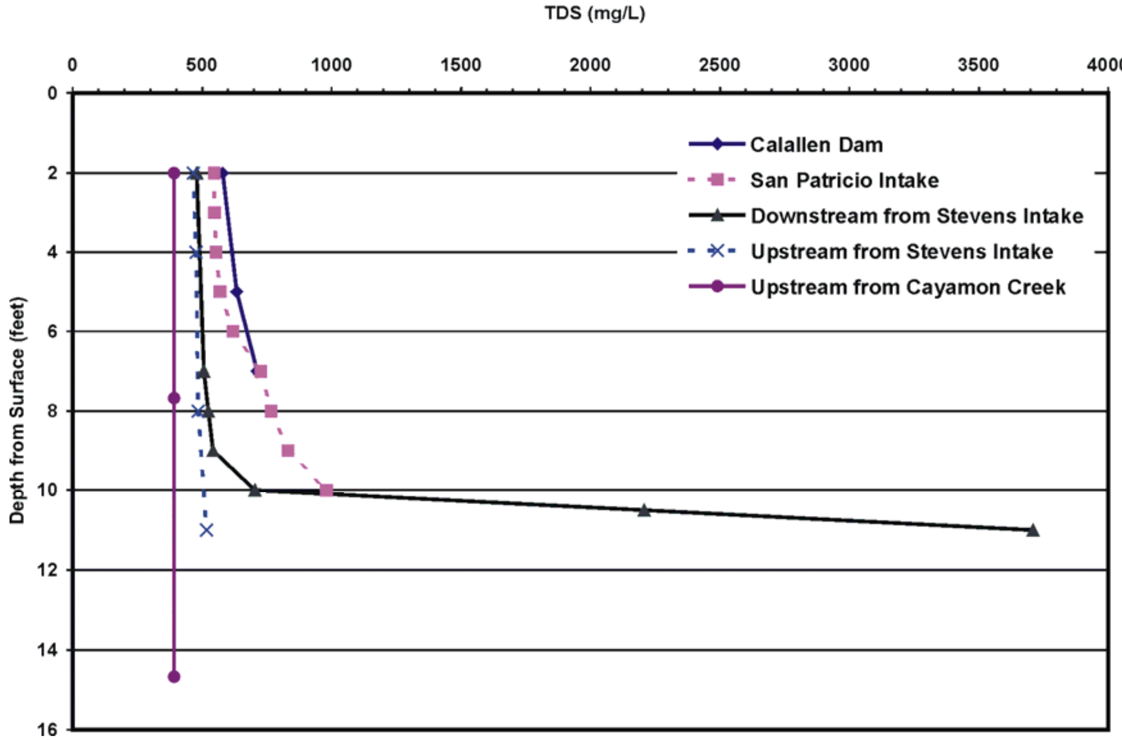


Figure 3. Total Dissolved Solids Profile at Selected Sites of the Nueces River (August 5, 1999)

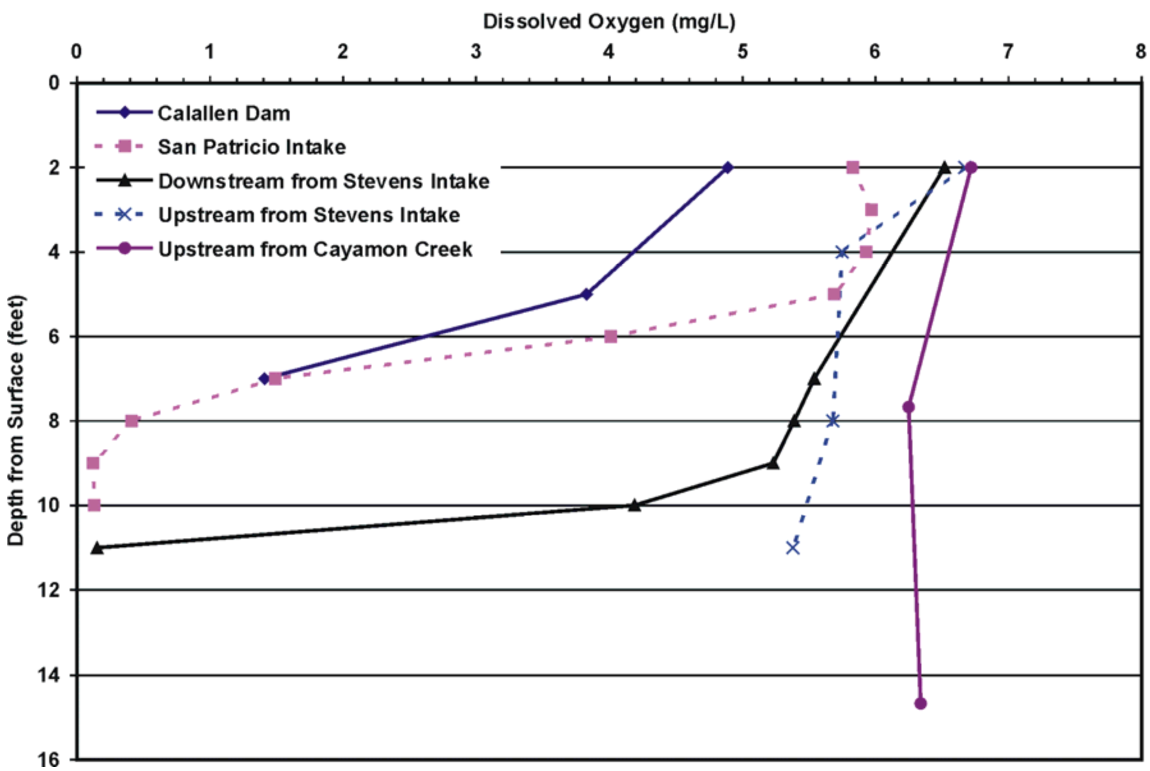


Figure 4. Dissolved Oxygen Profile at Selected Sites of the Nueces River (August 5, 1999)

Table 1.
Surface Grab Sample Analysis:
Concentration of Various Constituents

Constituent	Sample Mile			
	22.3	14.5	12	11
Calcium (mg/L)	66	68	75	75
Magnesium (mg/L)	11	12	13	13
Sodium (mg/L)	50	59	73	84
Potassium (mg/L)	8.8	8.9	9.1	9.6
Sulfate (mg/L)	43	46	52	64
Chloride (mg/L)	76	95	116	139
TDS (mg/L)	382	423	473	518
Alkalinity as $CaCO_3$ (mg/L)	173	177	177	178
Hardness as $CaCO_3$ (mg/L)	210	219	241	241
Bromide (mg/L)	<0.1	<0.1	0.2	0.3
pH (mg/L)	8.39	8.31	8.39	8.38

Surface Water Sampling

Based upon the historical studies and the findings of the preliminary field investigation in August 1999, the Calallen Channel Lake segment of the Nueces River is significantly impacted by sources of dissolved minerals. Therefore, the sampling effort was designed to concentrate on sites within the channel lake. The sample sites are described and identified by river mile in Table 2. The river mileage convention used for this study assumes a river mile of zero at the mouth of the Nueces River. River miles increase moving upstream. For example, the Calallen Dam is at river mile 11 and the USGS gauging station at the Bluntzer Bridge upstream is at river mile 27.8.

During the August 1999 through June 2000 timeframe, the Nueces River sampling sites described in Table 2 were monitored monthly for pH, temperature, specific conductance, total dissolved solids (TDS), dissolved oxygen, salinity and chloride concentrations. Water samples were collected and sent to Jordan Laboratories, Inc. in Corpus Christi, Texas for analysis of calcium, magnesium, sodium, potassium, sulfate, chloride, bromide, TDS, total hardness (as calcium carbonate) and alkalinity (as calcium carbonate). Figure 5 indicates the location of each surface water sampling site

Table 2.
Sample Sites for Nueces River Study

Sample Site	***Location Description***	***River Mile***	***Hydrolab Monitoring***	***Water Samples***
Surface Water				
1	Nueces River just Downstream from Calallen Dam	10.9	S	G
2	Nueces River at Calallen Dam	11	D_H	D_P
3	Nueces River at San Patricio MWD Intake	11.1	D_H	-
4	Nueces River 200 yd. upstream from San Patricio Intake	11.2	D_H	D_P
5	Nueces River 100 yd. Downstream from Stevens Intake	12.4	D_H	D_P
6	Nueces River 100yd. Upstream from Stevens Intake	12.6	D_H	D_P
7	Nueces River River View	14.5	S	G
Groundwater				
SP1	Adjacent to San Patricio Intake, 410 ft. from Bank	-	-	G
SP2	Adjacent to San Patricio Intake, 130 ft. from Bank	-	-	G
SP3	Adjacent to San Patricio Intake, 5 ft. from Bank	-	-	G
HB1	Hazel Bazemore Park, 1000 ft from Bank, Adjacent to Western Fence line	-	-	G
HB2	Hazel Bazemore Park Wetland area, Near Park Road	-	-	G

Key: S-single reading of parameters (temperature, specific conductance, pH, dissolved oxygen, salinity, chloride); D_H-parameter readings taken at top, middle and bottom depths within center of channel; G- single grab sample; D_P-water samples taken at middle and bottom depths within channel (Figure 5).

There were four different methods for collecting data at the sampling sites. Table 2 describes which method was used at each site. Water quality readings were taken with the Hydrolab multiprobe at a single location within the channel at two sites. A single grab sample was also taken at these sites. The Hydrolab monitoring was conducted at three depth fractions of 0.1, 0.5, and 0.9 within the center of the channel. The water samples were taken at 1 foot from the bottom of the channel and at the mid-depth within the channel.

To characterize potential mineral contributions to the main river channel from groundwater, one set of five groundwater samples were taken from hand augered wells along the riverbanks. The chemical composition of the samples was analyzed just like the surface water samples. Location descriptions of the groundwater sample sites are also included in Table 2. Figure 6 shows the site locations relative to the Nueces River channel.

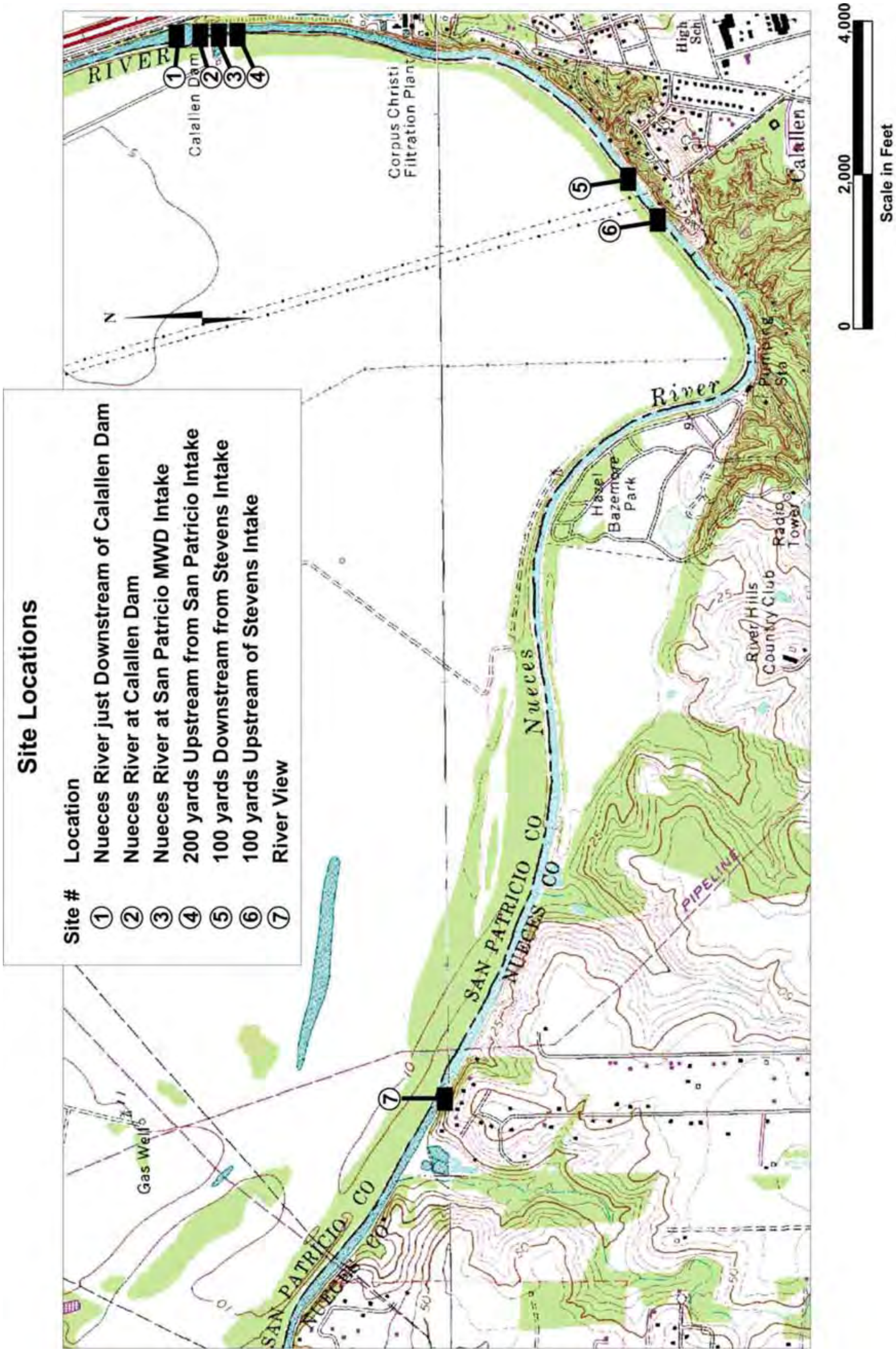


Figure 5. Nueces River Sampling Site Locations

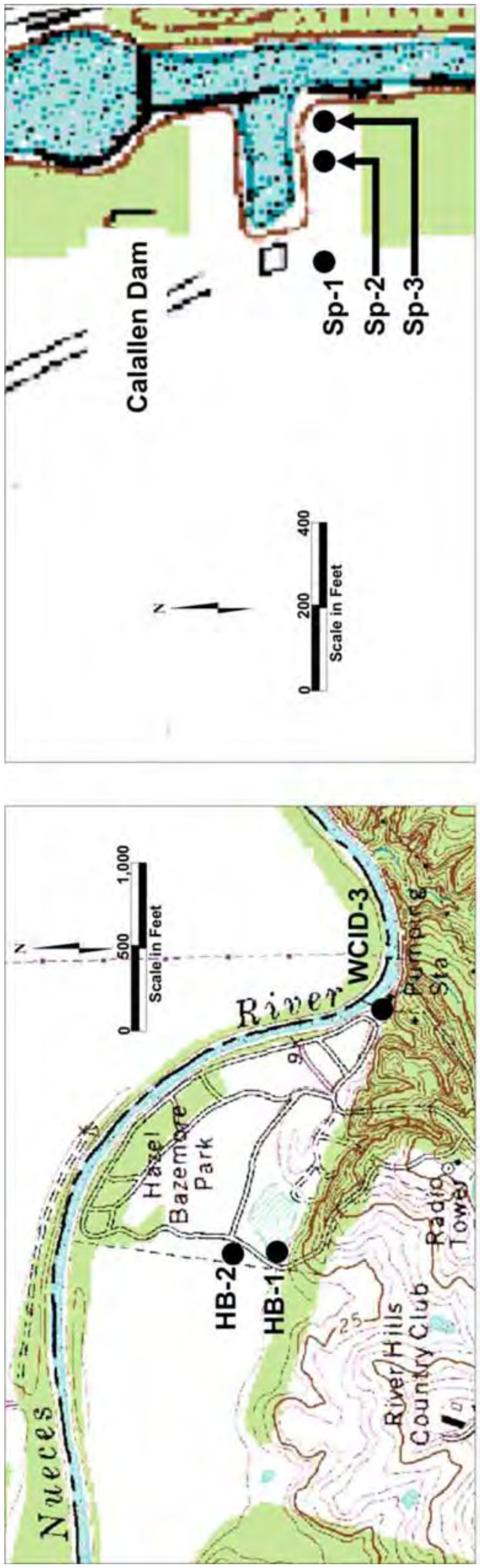


Figure 6. Groundwater Sampling Sites for the Nueces River Dissolved Mineral Study

Results

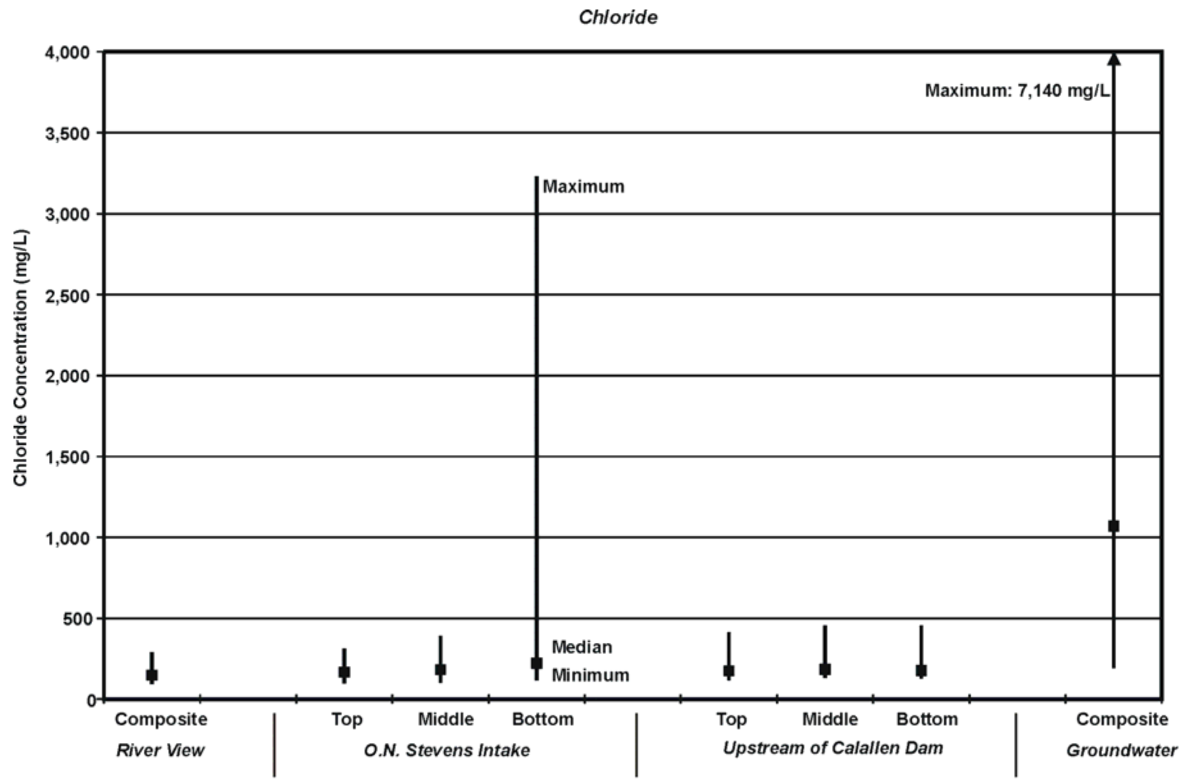
The purpose of the data analysis is to characterize the extent of the increase in dissolved solids occurring within the lower portion of the Calallen pool downstream of Hazel Bazemore Park, and to determine the source of this increase.

Composite observations of the stream monitoring and lab analysis obtained during this study are summarized in Figures 7, 8 and 9. Three sites along the river are represented to demonstrate the range in constituent concentration along the course of the river and at various depths within the channel at each site. Additionally, a composite of all groundwater samples is shown in the figures. The maximum, median and minimum surface water and composite groundwater concentration ranges are plotted for chloride, hardness, TDS, sulfate, bromide and dissolved oxygen at each site. Median values are plotted instead of mean values to prevent the maximum values from skewing the data. The entire set of data collected during this study is attached to the end of this report.

Figure 7 shows the range of chloride and bromide concentrations at the Riverview sampling site, just downstream of the O.N. Stevens Intake (site 5) and just upstream of the Calallen Dam. The distance between Riverview and the Calallen Dam is 3.5 river miles. The median chloride concentration range is from 95 mg/L to 117 mg/L along the river channel. The most significant concentration increase in chlorides (and dissolved minerals in general) occurs, however, with increasing depth within the channel. This is most apparent at Site 5, just downstream of the O.N. Stevens intake where the maximum chloride concentration ranges from 311.6 mg/L to 3,230 mg/L.

Bromide is a precursor to disinfection byproducts and is present in elevated concentrations in the Calallen Pool. Figure 7 presents the range of bromide within the pool. The median bromide concentration at the bottom of the river is 0.6 mg/L and was measured as high as 13 mg/L. These values are in contrast to the median bromide concentration at Riverview of 0.1 mg/L.

Figure 8 shows the concentration range of total hardness and total dissolved solids. The concentration of total hardness at Riverview was measured within a very narrow range compared to values downstream at the O.N. Stevens intake and at the Calallen Dam. The median total dissolved solids concentration at Calallen is 34% higher than at Riverview.



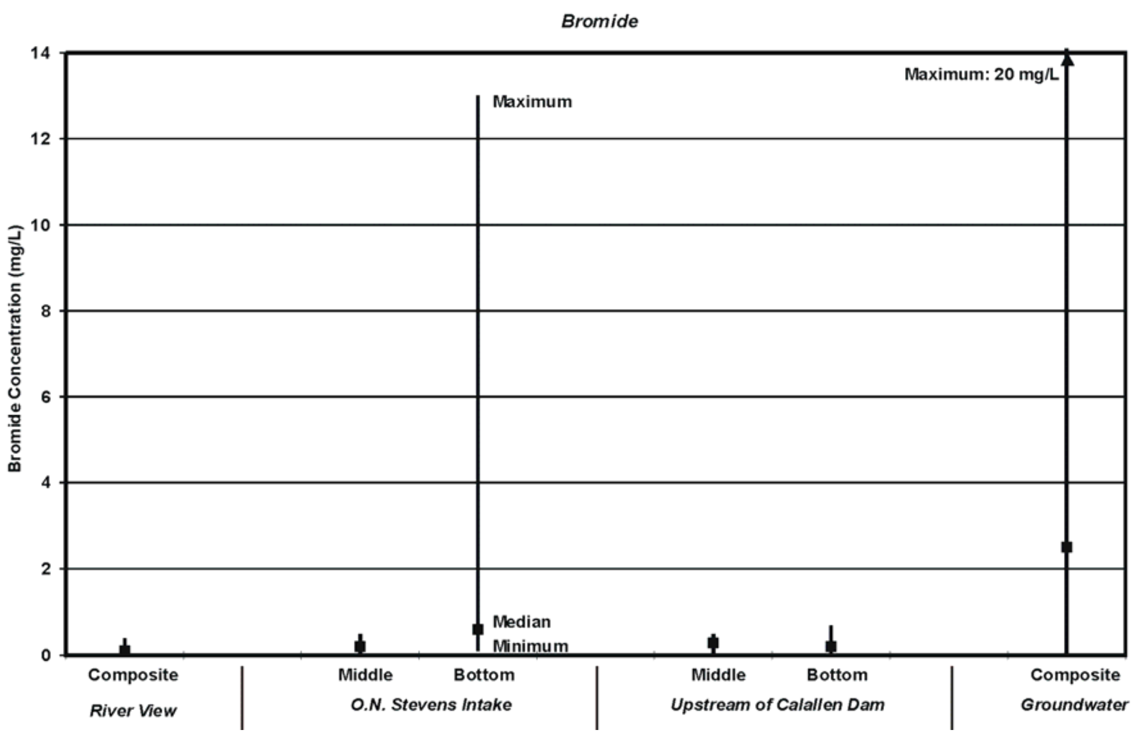
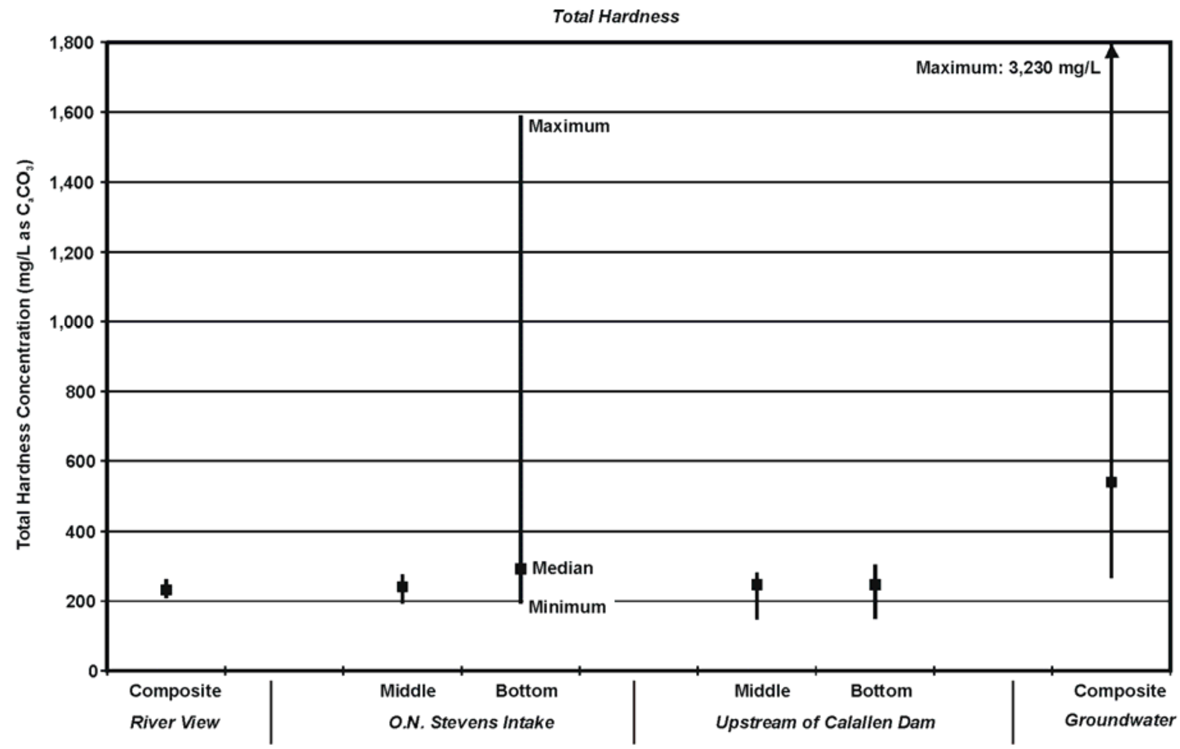


Figure 7. Nueces River Chloride and Bromide Concentrations at Selected Locations



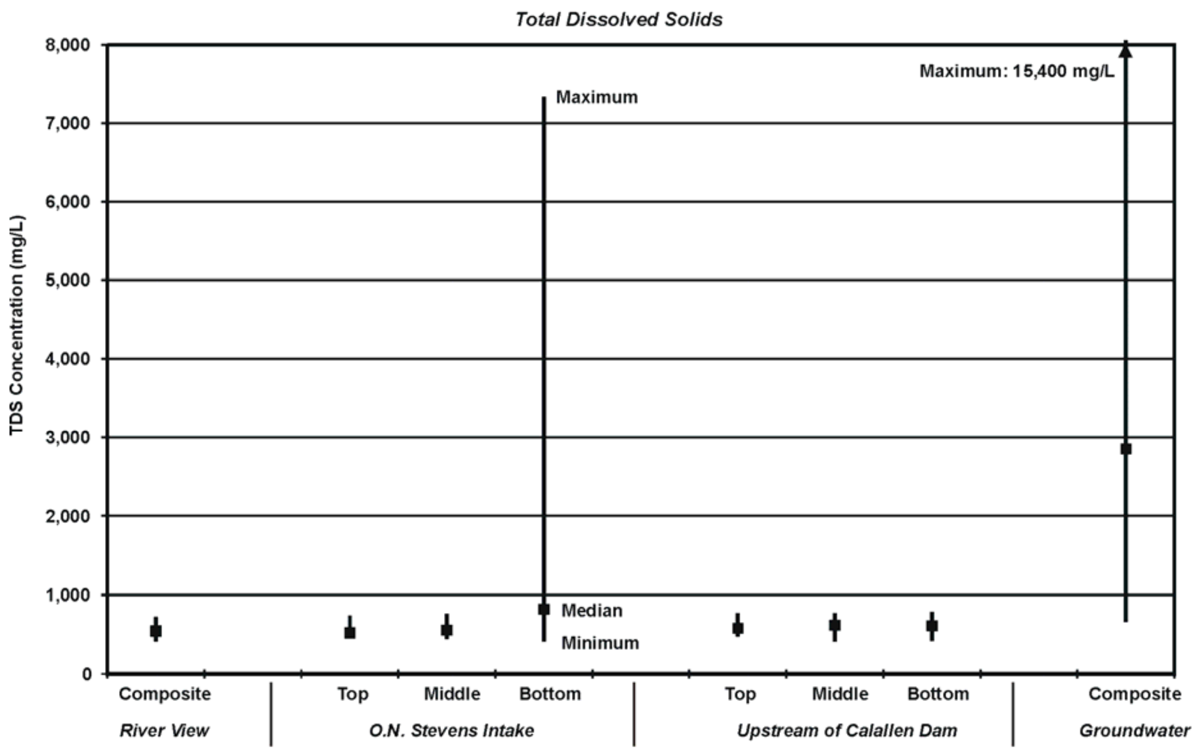
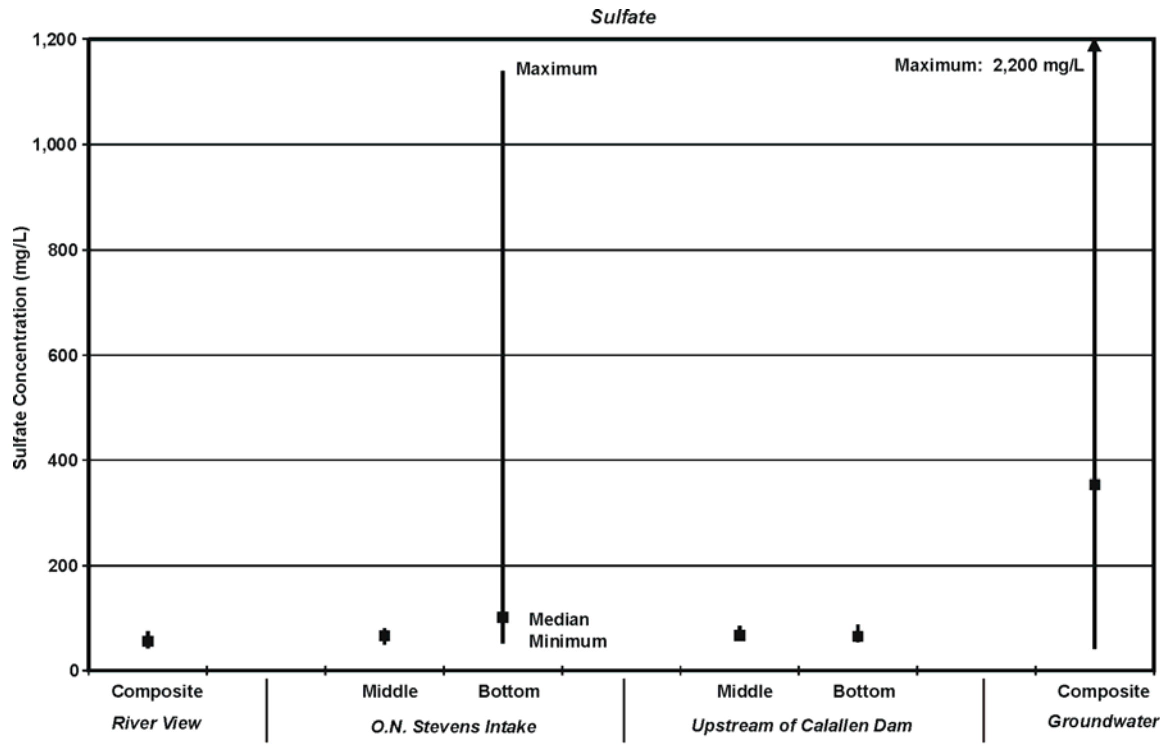


Figure 8. Nueces River Total Hardness and TDS Concentrations at Selected Locations



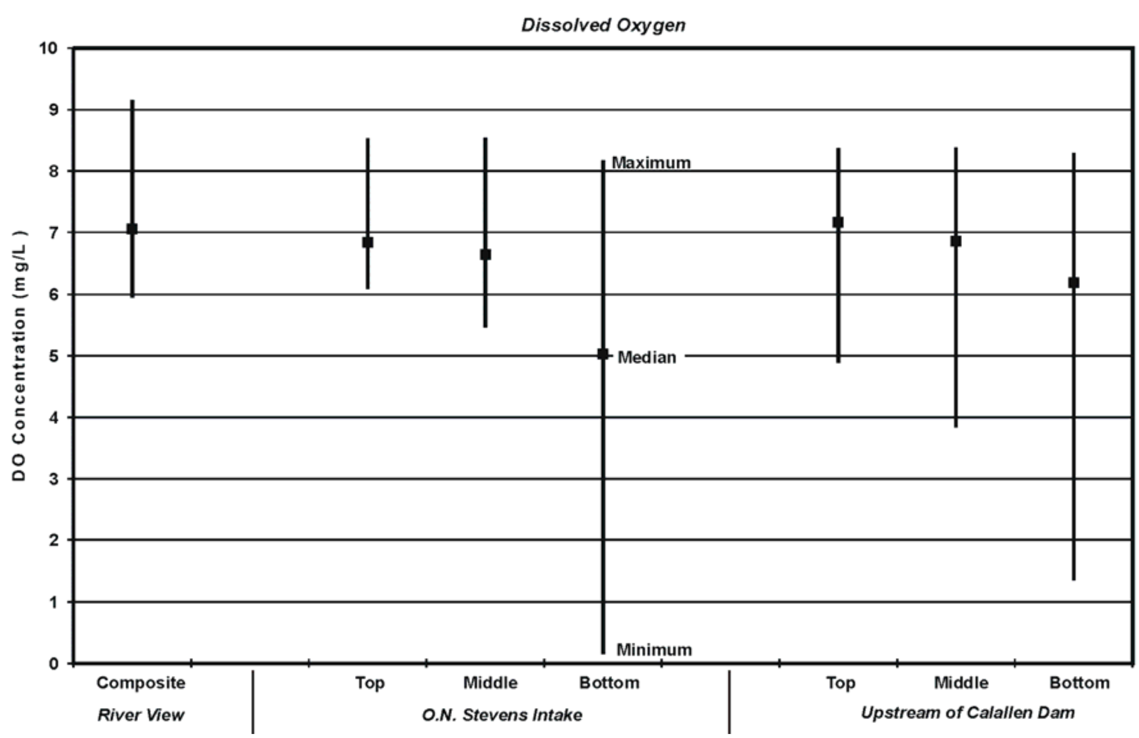


Figure 9. Nueces River Sulfate and Dissolved Oxygen Concentrations at Selected Locations

Figure 9 represents the concentration ranges of sulfate and dissolved oxygen. The variation in sulfate is very small for all samples except for the samples taken at the bottom of the Stevens intake site. At this site, the sulfate concentration ranges from 52 mg/L to 1140 mg/L. Dissolved oxygen concentration decrease with depth within the channel. The lowest values of dissolved oxygen were detected at the bottom of the channel at the Stevens intake.

Figure 10 is a representation of the total dissolved solids stratification measured within the channel on October 1999. The results show large mineral concentration increases occurring within the bottom 2 feet of the channel near the water intake locations. This stratification was found to be the most significant when no water was spilling over the dam and the least detectable during periods of high flow. The data supporting this observation is plotted in Figure 11. Chloride concentrations monitored at the Stevens intake and upstream of the Calallen Dam are plotted by sampling date. The flow over the dam is plotted on a second axis for the same sampling dates.

To determine the source of the dissolved minerals, the river segment was evaluated using a geochemical approach to discern different hydrochemical water types of the inflows and outflows of the river segment. A Schoeller diagram (Figure 12) plots the major ion concentrations for a composite set of surface water sample values, a groundwater sample taken at HB1 and a surface water sample taken from the bottom of the pool at the O.N. Stevens intake. The relative ion concentrations of calcium, magnesium, sodium, chloride, sulfate and bicarbonate (calculated from hardness and alkalinity values) are plotted on a logarithmic scale. The diagram shows that the surface water sample taken near the bottom at the Stevens intake is geochemically more similar to the groundwater sample taken at Hazel Bazemore Park, than to any of the other surface water samples (including samples taken at the same location, just three feet higher in the water column). This suggests that groundwater intrusion is taking place in the Calallen Pool. A more detailed analysis of groundwater inflows into the system will be needed to confirm these initial findings and to determine appropriate options to improve the water quality in the channel.

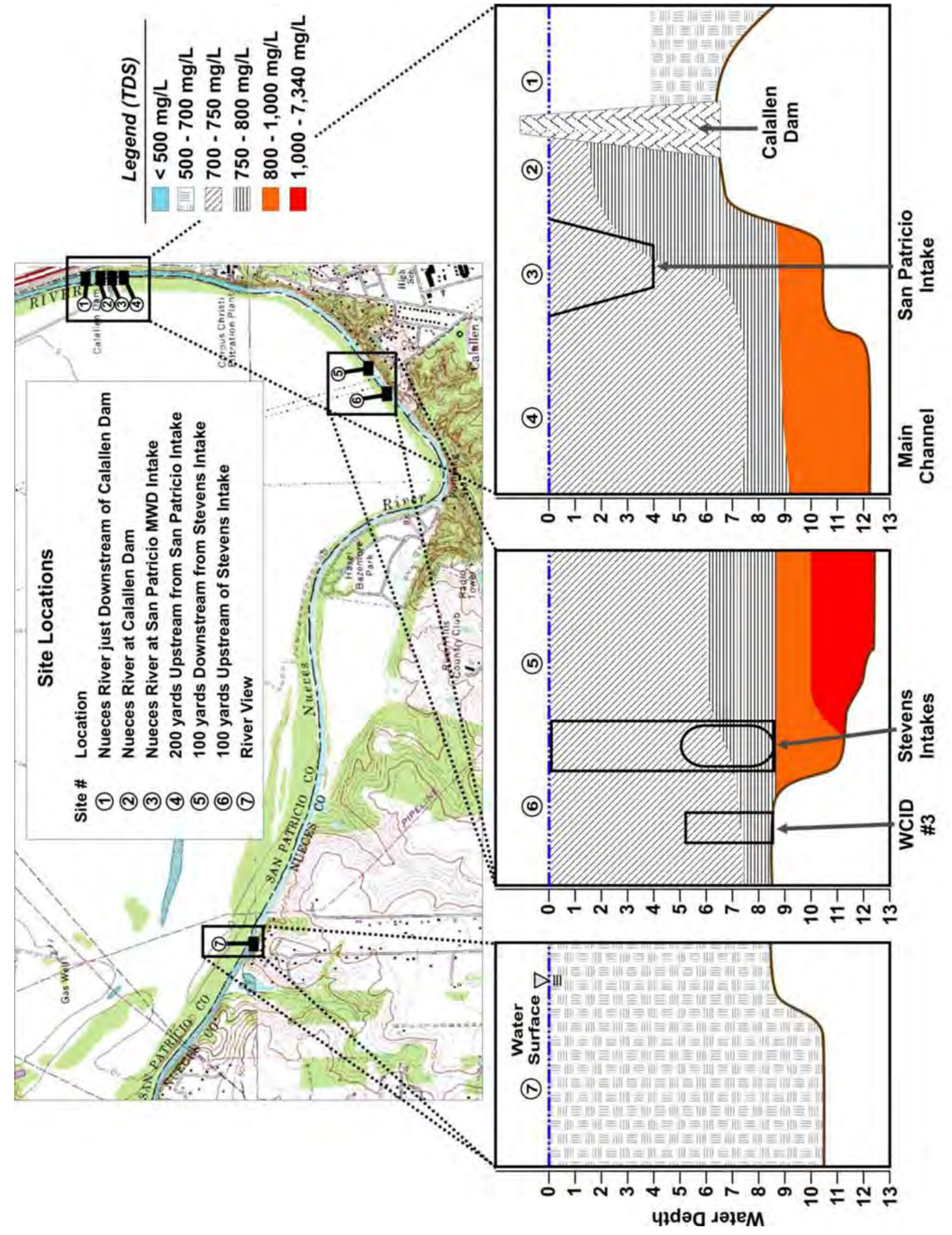


Figure 10. Stratification of TDS Concentration in the Nueces River Channel (October 1999)

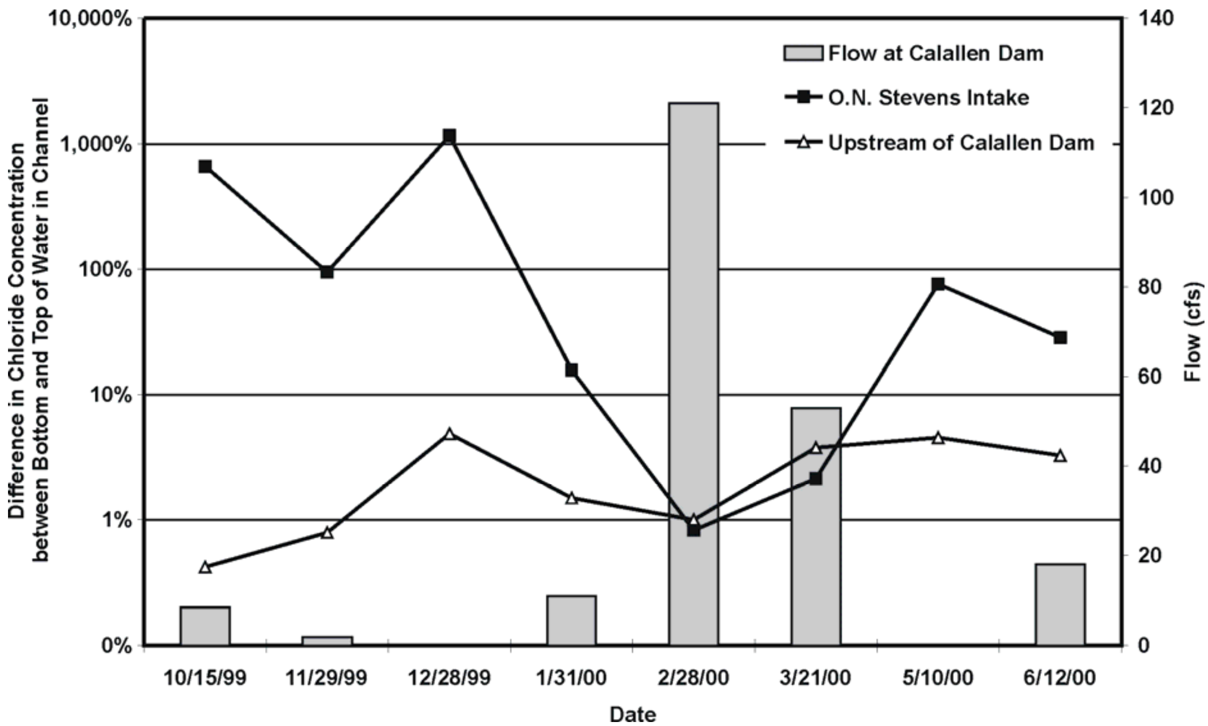


Figure 11. Variation of Chloride with Flow

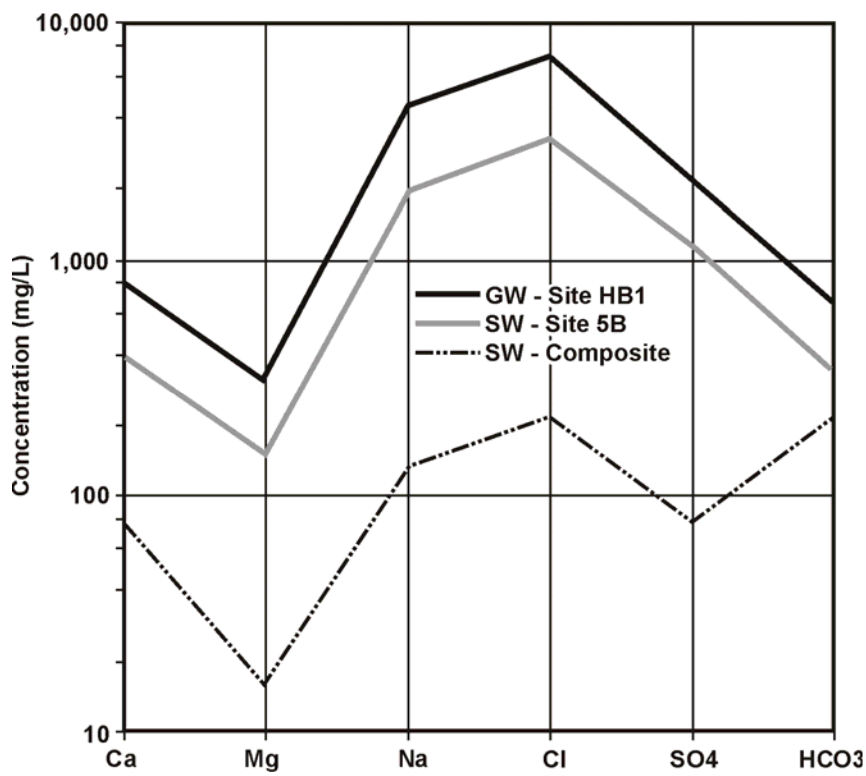


Figure 12. Schoeller Diagram- Nueces River Dissolved Minerals Study

Surface Water – Ground Water Interactions

A second phase of this investigation was initiated by HDR Engineering, Inc., the Nueces River Authority, and the Center for Water Supply Studies at Texas A&M University – Corpus Christi in an effort to identify the possible sources of elevated levels of dissolved solids in the Nueces River water in addition to the surface water sampling effort just described. This effort included monitor well installation, groundwater and surface water sampling, obtaining and interpreting aerial/satellite imagery of the area between Wesley Seale Dam and Calallen Pool, to identify possible point source contributions (specifically, abandoned oil and gas wells and sand/gravel washing operations), and groundwater intrusion. The results of this study are included in Appendix G2 of this report.

One of the primary objectives of this second phase was to investigate the potential interaction of groundwater in sediments along the Nueces River with surface water in the Calallen Pool. In order to measure groundwater levels and obtain samples of the groundwater, the study included the installation of several permanent monitoring wells. Seven borings, completed as monitor wells, were drilled at four locations adjacent to the Nueces River. The locations, well designations, and location considerations were as follows: (Note: the locations of these monitoring well sites are shown in Appendix G2.)

The first Hazel Bazemore Park site (HB-1, HB-2) is located where previous hand augered groundwater samples were collected. (Previous analyses indicated that the ionic ratios in those samples closely matched the ionic ratios found in samples of the more saline, stratified water of concern in the Calallen Pool.) The second site, in Hazel Bazemore Park (HB-3, HB-4), is located near the WCID # 3 intake and adjacent to a deeper pool of the Nueces River where stratification of water has been observed in previous investigations. The third site, on the San Patricio Municipal Water District (MWD) pump station property (SP-1, SP-2), is located near the Calallen Dam and a raw water intake where there has been noticeably elevated total dissolved solids and chlorides concentrations. The last site, at the City of Corpus Christi Cunningham Plant (CP-1), is adjacent to a deeper pool of the Nueces River close to both the Celanese—Bishop and the Koch Refinery raw water pump stations. (This site is on the opposite side of the Nueces River from the SP-1 and SP-2 sites and will be important for future use in making water level comparisons from each bank and the river surface to establish gaining and losing stream conditions as water releases and other system changes occur.)

On October 27, 2000 HDR Engineering, Inc., Nueces River Authority, and the Center for Water Supply Studies staff sampled the new groundwater wells. On October 30, 2000 the Nueces River Authority staff collected additional samples from the Nueces River. Surface water and groundwater samples were analyzed for dissolved constituents including cations (calcium, magnesium, sodium, and potassium) anions (carbonate, bicarbonate, sulfate, chloride), total dissolved solids (TDS), alkalinity (as calcium carbonate) and hardness (as calcium carbonate).

The results of the surface and groundwater sampling support the findings of the previous sampling effort. The groundwater sampled in the wells has chloride concentrations in excess of 1,000 ppm and more in the range of 2,000 to 3,000 ppm, except for CP-1 and SP-2. CP-1 is screened in a gravel/sand which appears to be in direct communication with the river. SP-2 is completed almost entirely in clay and goes dry during purging. Analytical results from SP-2 probably more closely represent pore water in the clays than formation water from a productive aquifer system. The chloride concentrations are shown in Figure 13.

The opportunity exists with permanent monitor wells in place around the Calallen Pool to conduct a comprehensive sampling program to evaluate the gaining and losing nature of the surface/groundwater system and then relate this information to surface water and groundwater sample results acquired within a time period during which the Calallen Pool experiences low and high flow conditions. Based upon the result of the sampling program best management practices and mitigation can then be suggested.

Water supply intakes in the Calallen Pool receive Lake Corpus Christi water via the 'bed and banks' of the Nueces River. The purpose of this section is to evaluate options to improve the quality of the water entering the water supply intakes. The following control strategies are considered:

- Blending of Lake Texana Water with Nueces River Water
- Outlet Works to Remove High TDS Water from the Calallen Pool
- Modification of Existing Intakes
- Pipeline from Lake Corpus Christi to the O.N. Stevens WTP
- Plugging Leaky and Abandoned Oil Wells

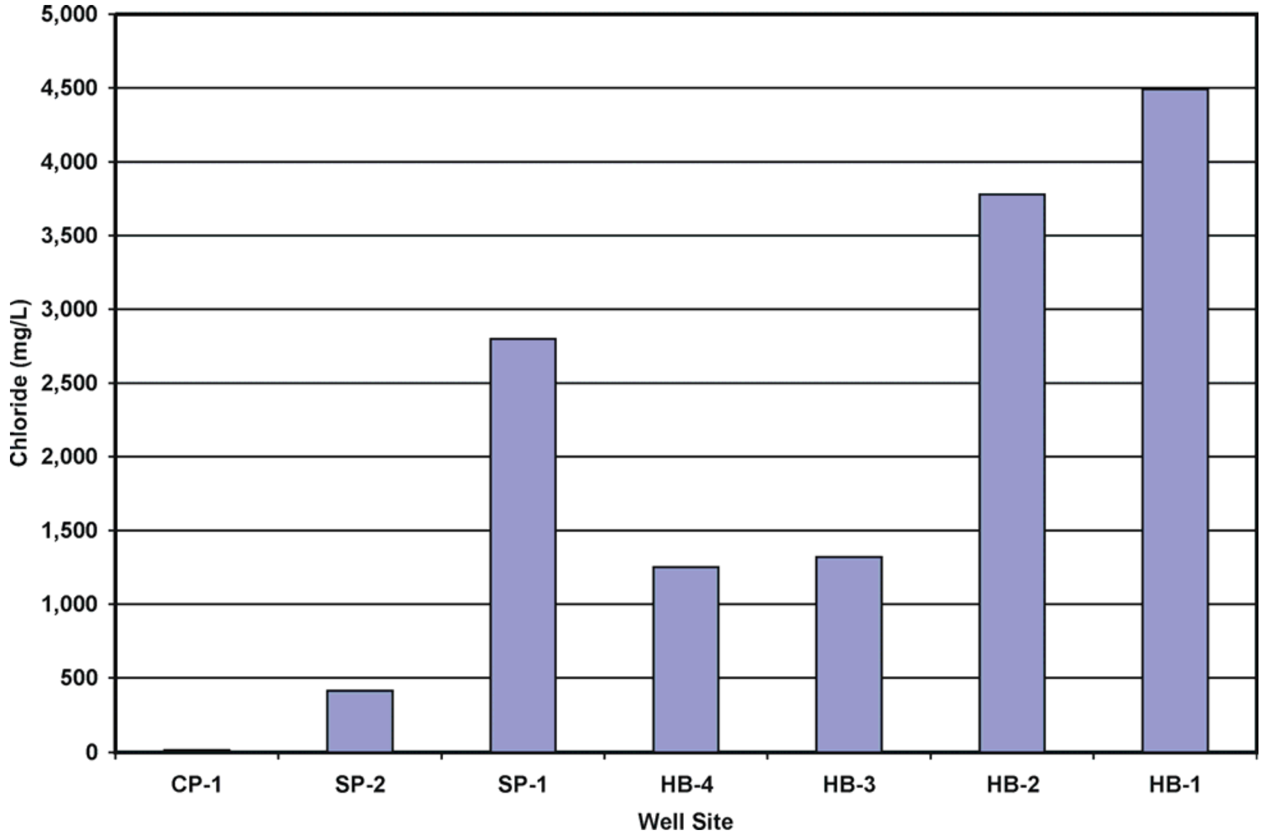


Figure 5A.3-13. Chloride Concentrations of Well Samples along the Lower Nueces River

The potential for manufacturing water use savings is based on the reduction in chloride concentration of the water supply achieved by each option. Figure 5A.3-9 shows the estimated industrial cooling water usage savings for various levels of water quality improvement. These estimates are based on correspondence with local industries and other sources.

Conclusions

High levels of dissolved minerals result in an increase in manufacturing water demands, due to accelerated build-up of mineral deposits in industrial cooling facilities. High bromide concentrations in source waters such as the Nueces River also lead to elevated disinfection by-product concentrations and higher drinking water treatment costs. Previous studies determined that there is a high dissolved solids problem in the Calallen channel, but did not conclusively determine the source. The results of the sampling program strongly suggests that groundwater intruding into the Calallen Pool is a major source of the high dissolved solids concentrations.

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Appendix
Water Quality Data

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Date	Flow (cfs) at Calallen Dam (USGS 08211500)	Sample Site	Analysis Type (Field/Lab)	Depth (ft)	Temp (oC)	pH	DO (mg/L)	Specific Conductance (mS/cm)	TDS (mg/l)	Salinity (mg/l)	Chloride (mg/L)	Alkalinity (mg/l as CaCO3)	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Potassium (mg/l)	Sulfate (mg/l)	Total Hardness (mg/l)	Bromide (mg/l)
8/5/99	20.00																		
8/5/99		2	Field	2.00	31.04	8.10	4.89	904.00	580.00	440	---	---	---	---	---	---	---	---	---
8/5/99		2	Field	5.00	30.04	7.93	3.83	987.00	634.00	490	---	---	---	---	---	---	---	---	---
8/5/99		2	Field	7.00	30.54	7.56	1.41	1086.00	712.00	550	---	---	---	---	---	---	---	---	---
8/5/99		2	Lab	Top	---	8.38	---	---	518.00	---	139.00	178	---	---	84.00	9.60	64.00	241.00	0.30
8/5/99		3	Field	2.00	31.06	8.22	5.83	853.00	546.00	420	---	---	---	---	---	---	---	---	---
8/5/99		3	Field	2.10	31.04	8.18	5.61	857.00	549.00	420	---	---	---	---	---	---	---	---	---
8/5/99		3	Field	3.00	31.04	8.19	5.97	857.00	548.00	420	---	---	---	---	---	---	---	---	---
8/5/99		3	Field	4.00	31.00	8.16	5.93	862.00	554.00	420	---	---	---	---	---	---	---	---	---
8/5/99		3	Field	5.00	30.93	8.11	5.69	886.00	569.00	440	---	---	---	---	---	---	---	---	---
8/5/99		3	Field	6.00	30.86	7.95	4.01	983.00	619.00	480	---	---	---	---	---	---	---	---	---
8/5/99		3	Field	7.00	30.52	7.65	1.49	1137.00	727.00	550	---	---	---	---	---	---	---	---	---
8/5/99		3	Field	8.00	30.32	7.50	0.41	1216.00	767.00	600	---	---	---	---	---	---	---	---	---
8/5/99		3	Field	9.00	29.82	7.34	0.12	1297.00	832.00	620	---	---	---	---	---	---	---	---	---
8/5/99		3	Field	10.00	29.28	7.20	0.13	1401.00	980.00	700	---	---	---	---	---	---	---	---	---
8/5/99		4	Field	2.00	31.04	8.18	5.87	870.00	557.00	430	---	---	---	---	---	---	---	---	---
8/5/99		4	Field	10.00	28.53	7.13	0.01	1839.00	1180.00	990	---	---	---	---	---	---	---	---	---
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8/5/99		5	Field	8.00	31.40	8.31	5.39	818.00	524.00	400	---	---	---	---	---	---	---	---	---
8/5/99		5	Field	9.00	31.34	8.28	5.23	848.00	542.00	410	---	---	---	---	---	---	---	---	---
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8/5/99		5	Field	11.00	29.54	6.99	0.15	5749.00	3710.00	3130	---	---	---	---	---	---	---	---	---
8/5/99		5	Lab	Top	---	8.39	---	---	473.00	---	116.00	177	---	---	73.00	9.10	52.00	241.00	0.20
8/5/99		6	Field	2.00	33.02	8.33	6.67	727.00	466.00	360	---	---	---	---	---	---	---	---	---
8/5/99		6	Field	4.00	31.51	8.27	5.75	744.00	477.00	360	---	---	---	---	---	---	---	---	---
8/5/99		6	Field	8.00	31.57	8.22	5.68	752.00	485.00	380	---	---	---	---	---	---	---	---	---
8/5/99		6	Field	11.00	31.28	8.29	5.38	810.00	517.00	400	---	---	---	---	---	---	---	---	---
8/5/99		7	Field	2.00	32.23	8.28	6.30	682.00	438.00	330	---	---	---	---	---	---	---	---	---
8/5/99		7	Field	12.00	31.41	8.23	5.68	687.00	440.00	330	---	---	---	---	---	---	---	---	---
8/5/99		7	Lab	Top	---	8.31		---	423.00	---	95.00	177	---	---	59.00	8.90	46.00	219.00	<0.1

Note: Grab samples taken near surface of water

Date	Flow (cfs) at Calallen Dam (USGS 08211500)	Sample Site	Analysis Type (Field/Lab)	Depth (ft)	Temp (oC)	pH	DO (mg/L)	Specific Conductance (mS/cm)	TDS (mg/l)	Salinity (mg/l)	Chloride (mg/L)	Alkalinity (mg/l as CaCO3)	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Potassium (mg/l)	Sulfate (mg/l)	Total Hardness (mg/l)	Bromide (mg/l)
10/15/99	8.40																		
10/15/99		1	Lab	Top	---	8.01	---	---	656.00	---	247.00	161	73.00	16.00	144.00	10.00	74.00	248.00	0.40
10/15/99		2	Field	0.98	27.47	8.06	7.61	1204.00	771.30	600	413.90	---	---	---	---	---	---	---	---
10/15/99		2	Field	2.93	27.20	8.00	7.35	1206.00	770.50	600	397.00	---	---	---	---	---	---	---	---
10/15/99		2	Field	4.88	26.81	8.00	6.74	1205.00	771.10	600	456.40	---	---	---	---	---	---	---	---
10/15/99		2	Field	6.83	26.14	7.57	3.44	1186.00	754.90	590	469.10	---	---	---	---	---	---	---	---
10/15/99		2	Field	8.78	25.45	7.32	1.34	1121.00	710.30	560	454.50	---	---	---	---	---	---	---	---
10/15/99		2	Lab	Bottom	---	7.38	---	---	648.00	---	216.00	162	75.00	15.00	131.00	10.00	76.00	249.00	0.30
10/15/99		2	Lab	Middle	---	7.98	---	---	720.00	---	235.00	185	82.00	17.00	143.00	9.80	85.00	275.00	0.50
10/15/99		3	Field	1.03	27.83	8.05	8.19	1208.00	772.60	600	363.90	---	---	---	---	---	---	---	---
10/15/99		3	Field	3.08	27.47	7.97	8.50	1207.00	774.50	600	399.40	---	---	---	---	---	---	---	---
10/15/99		3	Field	5.14	26.81	7.96	6.28	1224.00	781.70	610	477.00	---	---	---	---	---	---	---	---
10/15/99		3	Field	7.19	26.06	7.53	2.69	1232.00	787.00	610	493.70	---	---	---	---	---	---	---	---
10/15/99		3	Field	9.24	24.90	7.29	0.32	1102.00	711.90	540	462.90	---	---	---	---	---	---	---	---
10/15/99		4	Field	1.30	28.03	8.13	8.27	1194.00	764.30	590	398.60	---	---	---	---	---	---	---	---
10/15/99		4	Field	3.90	26.92	8.04	6.82	1208.00	780.10	600	460.20	---	---	---	---	---	---	---	---
10/15/99		4	Field	6.60	26.52	7.75	4.32	1277.00	819.20	640	510.70	---	---	---	---	---	---	---	---
10/15/99		4	Field	9.20	24.97	7.35	0.50	1150.00	748.00	570	493.40	---	---	---	---	---	---	---	---
10/15/99		4	Field	11.80	24.69	7.20	0.14	1274.00	816.90	630	537.50	---	---	---	---	---	---	---	---
10/15/99		4	Lab	Bottom	---	7.26	---	---	755.00	---	263.00	159	83.00	18.00	159.00	9.70	94.00	281.00	0.30
10/15/99		4	Lab	Middle	---	7.71	---	---	738.00	---	260.00	180	83.00	18.00	159.00	9.70	92.00	281.00	0.50
10/15/99		5	Lab	Bottom	---	6.91	---	---	7340.00	---	3230.00	274	390.00	150.00	1980.00	21.00	1140.00	1590.00	10.00
10/15/99		5	Lab	Middle	---	7.98	---	---	658.00	---	207.00	183	76.00	16.00	125.00	9.40	76.00	256.00	0.40
10/15/99		6	Lab	Bottom	---	7.98	---	---	673.00	---	212.00	182	79.00	16.00	129.00	9.20	79.00	263.00	0.40
10/15/99		6	Lab	Middle	---	8.00	---	---	579.00	---	175.00	181	74.00	15.00	108.00	9.20	65.00	247.00	0.30
10/15/99		7	Field	2.50	26.71	7.93	6.31	874.40	559.80	430	258.10	---	---	---	---	---	---	---	---
10/15/99		7	Field	2.50	26.71	7.97	6.34	870.30	556.10	430	289.20	---	---	---	---	---	---	---	---
10/15/99		7	Field	6.10	26.67	8.02	6.21	876.60	560.60	430	304.90	---	---	---	---	---	---	---	---
10/15/99		7	Field	10.80	26.65	8.02	6.15	877.10	561.40	430	311.10	---	---	---	---	---	---	---	---
10/15/99		7	Lab	Top	---	8.06	---	---	533.00	---	146.00	178	71.00	13.00	91.00	9.40	56.00	231.00	0.20

Date	Flow (cfs) at Calallen Dam (USGS 08211500)	Sample Site	Analysis Type (Field/Lab)	Depth (ft)	Temp (oC)	pH	DO (mg/L)	Specific Conductance (mS/cm)	TDS (mg/l)	Salinity (mg/l)	Chloride (mg/L)	Alkalinity (mg/l as CaCO3)	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Potassium (mg/l)	Sulfate (mg/l)	Total Hardness (mg/l)	Bromide (mg/l)
11/29/99	1.90																		
11/29/99		1	Lab	Top	---	8.05	---	---	648.00	---	196.00	179	78.00	16.00	123.00	9.30	70.00	261.00	0.30
11/29/99		1	Field	Top	19.90	7.76	8.34	1000.30	659.90	510	253.40	---	---	---	---	---	---	---	---
11/29/99		2	Field	0.83	18.28	7.94	7.28	970.70	624.30	480	255.00	---	---	---	---	---	---	---	---
11/29/99		2	Field	2.50	17.07	7.92	7.07	971.80	622.00	480	263.10	---	---	---	---	---	---	---	---
11/29/99		2	Field	4.17	17.80	7.93	6.98	971.80	621.60	480	264.70	---	---	---	---	---	---	---	---
11/29/99		2	Field	5.84	17.72	7.91	6.80	972.60	623.60	480	266.70	---	---	---	---	---	---	---	---
11/29/99		2	Field	7.51	17.62	7.88	6.82	976.40	624.90	480	266.80	---	---	---	---	---	---	---	---
11/29/99		2	Lab	Bottom	---	7.99	---	---	623.00	---	177.00	179	78.00	15.00	109.00	9.00	67.00	257.00	0.20
11/29/99		2	Lab	Middle	---	8.00	---	---	620.00	---	176.00	179	75.00	15.00	109.00	9.50	67.00	249.00	0.30
11/29/99		3	Field	1.24	18.62	7.95	7.38	972.10	622.00	480	263.40	---	---	---	---	---	---	---	---
11/29/99		3	Field	3.20	17.99	7.94	7.07	972.50	622.10	480	268.10	---	---	---	---	---	---	---	---
11/29/99		3	Field	5.30	17.75	7.93	6.79	970.40	619.70	480	277.80	---	---	---	---	---	---	---	---
11/29/99		3	Field	7.40	17.72	7.87	6.49	7005.00	643.60	500	281.10	---	---	---	---	---	---	---	---
11/29/99		3	Field	9.60	17.72	7.87	6.57	1004.00	642.50	500	282.10	---	---	---	---	---	---	---	---
11/29/99		4	Field	1.20	19.49	8.10	84.00	970.30	620.40	480	272.30	---	---	---	---	---	---	---	---
11/29/99		4	Field	3.50	18.07	8.02	7.51	964.00	617.60	480	282.00	---	---	---	---	---	---	---	---
11/29/99		4	Field	5.80	17.83	7.97	7.14	982.20	628.80	490	292.20	---	---	---	---	---	---	---	---
11/29/99		4	Field	8.10	17.77	7.88	6.61	1069.00	682.30	530	309.60	---	---	---	---	---	---	---	---
11/29/99		4	Field	10.40	17.77	7.86	6.66	1093.00	699.00	540	312.40	---	---	---	---	---	---	---	---
11/29/99		4	Lab	Bottom	---	7.93	---	---	695.00	---	207.00	179	78.00	17.00	125.00	9.20	77.00	265.00	0.40
11/29/99		4	Lab	Middle	---	8.03	---	---	638.00	---	179.00	178	75.00	15.00	108.00	9.20	66.00	249.00	0.20
11/29/99		5	Field	1.20	19.21	8.05	7.78	945.30	604.90	470	311.60	---	---	---	---	---	---	---	---
11/29/99		5	Field	3.50	18.56	8.04	7.60	949.20	606.90	470	328.50	---	---	---	---	---	---	---	---
11/29/99		5	Field	5.80	17.74	7.99	7.29	1001.00	640.80	500	390.40	---	---	---	---	---	---	---	---
11/29/99		5	Field	8.20	17.65	7.97	7.24	1038.00	664.70	520	425.50	---	---	---	---	---	---	---	---
11/29/99		5	Field	10.50	17.73	7.59	5.61	1887.00	1008.00	800	643.00	---	---	---	---	---	---	---	---
11/29/99		5	Lab	Bottom	---	7.68	---	---	1360.00	---	483.00	195	110.00	32.00	305.00	13.00	201.00	406.00	1.20
11/29/99		5	Lab	Middle	---	8.05	---	---	630.00	---	182.00	178	85.00	15.00	128.00	9.30	68.00	274.00	0.30
11/29/99		6	Field	0.90	18.62	8.05	7.90	915.00	585.90	450	274.50	---	---	---	---	---	---	---	---
11/29/99		6	Field	2.80	18.41	8.03	7.61	939.70	601.20	470	297.00	---	---	---	---	---	---	---	---
11/29/99		6	Field	4.70	17.57	8.01	7.38	929.90	594.50	460	318.30	---	---	---	---	---	---	---	---
11/29/99		6	Field	6.60	17.51	7.96	7.32	999.90	639.10	510	335.10	---	---	---	---	---	---	---	---
11/29/99		6	Field	8.40	17.54	7.94	7.30	1043.00	664.90	510	383.20	---	---	---	---	---	---	---	---
11/29/99		6	Lab	Bottom	---	8.05	---	---	66.00	---	193.00	178	83.00	15.00	135.00	9.30	71.00	269.00	0.40
11/29/99		6	Lab	Middle	---	8.12	---	---	588.00	---	167.00	177	86.00	15.00	103.00	9.10	61.00	277.00	0.10
11/29/99		7	Lab	Top	---	8.04	---	---	565.00	---	149.00	177	70.00	14.00	90.00	9.10	56.00	232.00	0.10
11/29/99		7	Field	Top	17.16	8.02	8.47	866.20	554.20	430	215.60	---	---	---	---	---	---	---	---

Date	Flow (cfs) at Calallen Dam (USGS 08211500)	Sample Site	Analysis Type (Field/Lab)	Depth (ft)	Temp (oC)	pH	DO (mg/L)	Specific Conductance (mS/cm)	TDS (mg/l)	Salinity (mg/l)	Chloride (mg/L)	Alkalinity (mg/l as CaCO3)	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Potassium (mg/l)	Sulfate (mg/l)	Total Hardness (mg/l)	Bromide (mg/l)
12/28/99	0.00																		
12/28/99		1	Lab	Top	---	8.37	---	---	743.00	---	223.00	188	81.00	18.00	132.00	9.60	77.00	276.00	0.50
12/28/99		1	Field	Top	12.80	8.24	13.87	1228.00	781.90	620	---	---	---	---	---	---	---	---	---
12/28/99		2	Field	1.50	14.10	7.80	7.67	1161.00	743.00	580	---	---	---	---	---	---	---	---	---
12/28/99		2	Field	3.50	13.90	7.76	7.28	1199.00	766.10	600	---	---	---	---	---	---	---	---	---
12/28/99		2	Field	5.94	13.97	7.72	6.96	1222.00	784.20	620	---	---	---	---	---	---	---	---	---
12/28/99		2	Lab	Bottom	---	7.97	---	---	788.00	---	246.00	187	92.00	18.00	146.00	11.00	88.00	304.00	0.70
12/28/99		2	Lab	Middle	---	8.04	---	---	768.00	---	234.00	186	83.00	18.00	140.00	9.80	86.00	281.00	0.50
12/28/99		3	Field	1.50	14.09	7.05	8.11	1129.00	724.40	570	---	---	---	---	---	---	---	---	---
12/28/99		3	Field	5.40	14.01	7.04	7.88	1134.00	726.00	570	---	---	---	---	---	---	---	---	---
12/28/99		3	Field	9.80	13.98	7.75	7.01	1237.00	795.30	620	---	---	---	---	---	---	---	---	---
12/28/99		4	Field	1.50	14.30	7.88	8.40	1094.00	700.10	550	---	---	---	---	---	---	---	---	---
12/28/99		4	Field	6.10	13.95	7.87	8.23	1107.00	709.40	550	---	---	---	---	---	---	---	---	---
12/28/99		4	Field	11.20	14.12	7.71	7.38	1366.00	873.30	690	---	---	---	---	---	---	---	---	---
12/28/99		4	Lab	Bottom	---	8.02	---	---	868.00	---	286.00	187	88.00	20.00	163.00	9.60	100.00	302.00	0.70
12/28/99		4	Lab	Middle	---	8.07	---	---	715.00	---	213.00	184	80.00	17.00	126.00	9.10	76.00	270.00	0.40
12/28/99		5	Field	1.50	14.77	7.90	8.53	1157.00	739.20	580	---	---	---	---	---	---	---	---	---
12/28/99		5	Field	6.05	14.24	7.89	8.54	1170.00	749.50	590	---	---	---	---	---	---	---	---	---
12/28/99		5	Field	10.00	15.01	7.29	4.48	3023.00	2147.00	1800	---	---	---	---	---	---	---	---	---
12/28/99		5	Field	10.90	17.12	6.82	1.05	9763.00	6276.00	5690	---	---	---	---	---	---	---	---	---
12/28/99		5	Field	11.20	18.28	6.73	0.59	11125.00	7123.00	6400	---	---	---	---	---	---	---	---	---
12/28/99		5	Lab	Bottom	---	7.36	---	---	7210.00	---	3100.00	282	388.00	151.00	1880.00	20.00	1130.00	1590.00	13.00
12/28/99		5	Lab	Middle	---	8.04	---	---	765.00	---	229.00	190	83.00	17.00	131.00	9.00	81.00	277.00	0.50
12/28/99		6	Field	1.50	14.73	7.92	8.58	1122.00	714.70	560	---	---	---	---	---	---	---	---	---
12/28/99		6	Field	4.20	14.60	7.92	8.52	1150.00	734.30	580	---	---	---	---	---	---	---	---	---
12/28/99		6	Field	7.50	14.34	7.90	8.53	1162.00	744.00	570	---	---	---	---	---	---	---	---	---
12/28/99		6	Lab	Bottom	---	7.89	---	---	765.00	---	233.00	189	82.00	18.00	133.00	9.30	80.00	279.00	0.50
12/28/99		6	Lab	Middle	---	8.05	---	---	748.00	---	222.00	190	81.00	17.00	128.00	9.30	79.00	272.00	0.50
12/28/99		7	Field	1.90	14.61	7.93	8.82	1082.00	693.00	540	---	---	---	---	---	---	---	---	---
12/28/99		7	Lab	Top	---	8.03	---	---	720.00	---	204.00	189	77.00	17.00	121.00	9.30	75.00	262.00	0.40

Date	Flow (cfs) at Calallen Dam (USGS 08211500)	Sample Site	Analysis Type (Field/Lab)	Depth (ft)	Temp (oC)	pH	DO (mg/L)	Specific Conductance (mS/cm)	TDS (mg/l)	Salinity (mg/l)	Chloride (mg/L)	Alkalinity (mg/l as CaCO3)	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Potassium (mg/l)	Sulfate (mg/l)	Total Hardness (mg/l)	Bromide (mg/l)
1/31/00	11.00																		
1/31/00		1	Lab	Top	---	8.26	---	---	558.00	---	135.00	178	69.00	13.00	83.00	8.70	55.00	226.00	0.10
1/31/00		1	Field	Top	13.85	8.16	10.10	818.50	524.00	410	---	---	---	---	---	---	---	---	---
1/31/00		2	Field	1.00	13.44	8.04	8.37	813.40	520.60	400	---	---	---	---	---	---	---	---	---
1/31/00		2	Field	3.75	13.41	8.04	8.38	813.70	520.70	400	---	---	---	---	---	---	---	---	---
1/31/00		2	Field	7.50	13.41	8.03	8.29	813.80	520.90	400	---	---	---	---	---	---	---	---	---
1/31/00		2	Lab	Bottom	---	8.17	---	---	547.00	---	134.00	179	68.00	13.00	82.00	8.60	56.00	223.00	0.20
1/31/00		2	Lab	Middle	---	8.18	---	---	535.00	---	132.00	179	69.00	13.00	82.00	8.70	56.00	226.00	0.20
1/31/00		3	Field	1.00	13.57	8.05	8.42	813.10	520.10	400	---	---	---	---	---	---	---	---	---
1/31/00		3	Field	4.90	13.45	8.03	8.15	813.20	520.40	400	---	---	---	---	---	---	---	---	---
1/31/00		3	Field	8.75	13.40	8.00	8.62	814.70	521.30	400	---	---	---	---	---	---	---	---	---
1/31/00		4	Field	1.30	13.59	8.06	8.22	813.60	521.40	400	---	---	---	---	---	---	---	---	---
1/31/00		4	Field	1.70	13.36	8.06	7.95	818.50	524.10	410	---	---	---	---	---	---	---	---	---
1/31/00		4	Field	6.50	13.35	8.04	7.96	817.20	522.90	400	---	---	---	---	---	---	---	---	---
1/31/00		4	Lab	Bottom	---	8.17	---	---	543.00	---	134.00	179	69.00	13.00	83.00	8.70	56.00	226.00	0.10
1/31/00		4	Lab	Middle	---	8.17	---	---	543.00	---	134.00	179	69.00	13.00	82.00	8.90	56.00	226.00	0.10
1/31/00		5	Field	1.00	13.49	8.05	8.45	824.90	528.10	410	---	---	---	---	---	---	---	---	---
1/31/00		5	Field	5.00	13.40	8.04	8.29	834.40	537.10	420	---	---	---	---	---	---	---	---	---
1/31/00		5	Field	9.00	13.34	7.97	8.17	920.10	588.90	460	---	---	---	---	---	---	---	---	---
1/31/00		5	Lab	Bottom	---	8.14	---	---	610.00	---	160.00	179	71.00	14.00	100.00	9.20	66.00	235.00	0.30
1/31/00		5	Lab	Middle	---	8.18	---	---	568.00	---	139.00	179	70.00	13.00	85.00	8.60	57.00	228.00	0.20
1/31/00		6	Field	1.00	13.30	8.03	8.74	795.50	509.60	390	---	---	---	---	---	---	---	---	---
1/31/00		6	Field	5.00	13.25	8.01	11.38	951.10	604.10	470	---	---	---	---	---	---	---	---	---
1/31/00		6	Lab	Bottom	---	8.12	---	---	590.00	---	153.00	179	73.00	14.00	89.00	8.90	62.00	240.00	0.20
1/31/00		6	Lab	Middle	---	8.21	---	---	520.00	---	131.00	179	69.00	13.00	75.00	8.90	53.00	226.00	0.11
1/31/00		7	Lab	Top	---	8.15	---	---	493.00	---	116.00	178	68.00	12.00	70.00	8.50	45.00	219.00	<0.1
1/31/00		7	Field	Top	12.68	8.03	9.16	740.80	474.30	370	---	---	---	---	---	---	---	---	---

Date	Flow (cfs) at Calallen Dam (USGS 08211500)	Sample Site	Analysis Type (Field/Lab)	Depth (ft)	Temp (oC)	pH	DO (mg/L)	Specific Conductance (mS/cm)	TDS (mg/l)	Salinity (mg/l)	Chloride (mg/L)	Alkalinity (mg/l as CaCO3)	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Potassium (mg/l)	Sulfate (mg/l)	Total Hardness (mg/l)	Bromide (mg/l)
2/28/00	121.00																		
2/28/00		1	Lab	Top	---	8.09	---	---	488.00	---	132.00	181	70.00	12.00	83.00	9.20	54.00	554.00	0.20
2/28/00		1	Field	Top	20.43	8.13	8.49	818.80	524.00	400	172.70	---	---	---	---	---	---	---	---
2/28/00		2	Field	1.14	20.58	8.12	7.05		516.70	400	170.60	---	---	---	---	---	---	---	---
2/28/00		2	Field	3.25	20.35	8.09	7.02	806.80	516.40	400	168.60	---	---	---	---	---	---	---	---
2/28/00		2	Field	5.54	20.34	8.08	7.08	807.70	516.50	400	170.30	---	---	---	---	---	---	---	---
2/28/00		2	Lab	Bottom	---	8.15	---	---	478.00	---	128.00	180	70.00	12.00	80.00	8.60	54.00	224.00	0.10
2/28/00		3	Field	1.10	20.67	8.11	7.07	807.00	517.10	400	163.70	---	---	---	---	---	---	---	---
2/28/00		3	Field	4.94	20.36	8.10	6.94	807.70	516.90	400	161.70	---	---	---	---	---	---	---	---
2/28/00		3	Field	8.97	20.31	8.08	6.90	807.30	516.80	400	155.80	---	---	---	---	---	---	---	---
2/28/00		3	Lab	Bottom	---	8.19	---	---	498.00	---	126.00	181	69.00	12.00	78.00	8.60	54.00	222.00	0.20
2/28/00		3	Lab	Middle	---	8.18	---	---	460.00	---	126.00	182	69.00	12.00	79.00	8.70	54.00	222.00	0.20
2/28/00		4	Field	1.10	20.66	8.13	7.04	803.00	513.90	390	163.70	---	---	---	---	---	---	---	---
2/28/00		4	Field	5.50	20.34	8.10	6.91	804.20	514.70	400	158.60	---	---	---	---	---	---	---	---
2/28/00		4	Field	10.31	20.26	8.08	6.86	809.60	519.30	400	158.70	---	---	---	---	---	---	---	---
2/28/00		4	Lab	Bottom	---	8.12	---	---	485.00	---	128.00	181	71.00	12.00	79.00	9.30	57.00	227.00	0.10
2/28/00		4	Lab	Middle	---	8.20	---	---	455.00	---	128.00	181	68.00	12.00	77.00	8.80	57.00	219.00	0.10
2/28/00		5	Field	1.09	21.27	8.15	7.15	743.60	476.30	360	140.90	---	---	---	---	---	---	---	---
2/28/00		5	Field	6.00	20.53	8.12	7.05	741.60	476.10	360	142.60	---	---	---	---	---	---	---	---
2/28/00		5	Field	11.05	20.34	8.09	6.96	761.50	487.20	370	141.20	---	---	---	---	---	---	---	---
2/28/00		5	Lab	Bottom	---	8.20	---	---	415.00	---	116.00	181	70.00	12.00	72.00	8.80	52.00	224.00	0.10
2/28/00		5	Lab	Middle	---	8.19	---	---	443.00	---	113.00	181	70.00	12.00	69.00	8.90	49.00	224.00	<0.1
2/28/00		6	Field	1.17	20.99	8.14	7.19	724.70	463.60	350	135.30	---	---	---	---	---	---	---	---
2/28/00		6	Field	2.83	20.33	8.12	7.08	728.80	463.40	360	134.50	---	---	---	---	---	---	---	---
2/28/00		6	Field	4.86	20.30	4.85	6.99	749.70	479.90	360	138.80	---	---	---	---	---	---	---	---
2/28/00		6	Lab	Middle	---	8.21	---	---	434.00	---	106.00	180	66.00	12.00	66.00	8.40	47.00	214.00	<0.1
2/28/00		7	Lab	Top	---	8.17	---	---	413.00	---	95.00	180	65.00	11.00	60.00	9.40	43.00	208.00	0.10
2/28/00		7	Field	Top	19.89	8.10	7.06	680.20	434.50	330	115.60	---	---	---	---	---	---	---	---

Date	Flow (cfs) at Calallen Dam (USGS 08211500)	Sample Site	Analysis Type (Field/Lab)	Depth (ft)	Temp (oC)	pH	DO (mg/L)	Specific Conductance (mS/cm)	TDS (mg/l)	Salinity (mg/l)	Chloride (mg/L)	Alkalinity (mg/l as CaCO3)	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Potassium (mg/l)	Sulfate (mg/l)	Total Hardness (mg/l)	Bromide (mg/l)
3/21/00	53.00																		
3/21/00		1	Lab	Top	---	7.70	---	---	420.00	---	141.00	106	45.00	8.50	90.00	7.90	58.00	147.00	<0.1
3/21/00		1	Field	Top	20.94	7.57	8.59	735.20	470.70	360	166.50	---	---	---	---	---	---	---	---
3/21/00		2	Field	1.00	20.96	7.50	5.90	742.20	474.70	360	178.90	---	---	---	---	---	---	---	---
3/21/00		2	Field	2.80	19.75	7.45	5.49	782.50	481.60	370	181.70	---	---	---	---	---	---	---	---
3/21/00		2	Field	5.00	19.74	7.42	5.56	758.20	486.60	370	188.80	---	---	---	---	---	---	---	---
3/21/00		2	Lab	Bottom	---	7.60	---	---	422.00	---	148.00	105	46.00	8.60	93.00	8.10	57.00	150.00	<0.1
3/21/00		2	Lab	Middle	---	7.70	---	---	415.00	---	147.00	106	45.00	8.50	93.00	7.70	56.00	147.00	<0.1
3/21/00		3	Field	1.00	21.35	7.52	6.05	743.60	476.50	360	173.70	---	---	---	---	---	---	---	---
3/21/00		3	Field	5.00	19.65	7.42	5.27	766.60	490.70	380	177.20	---	---	---	---	---	---	---	---
3/21/00		3	Field	9.00	19.56	8.58	5.10	767.50	491.20	380	177.20	---	---	---	---	---	---	---	---
3/21/00		4	Field	1.00	21.04	7.52	5.88	749.50	480.00	370	170.30	---	---	---	---	---	---	---	---
3/21/00		4	Field	3.30	20.21	7.47	5.62	745.10	478.70	370	172.20	---	---	---	---	---	---	---	---
3/21/00		4	Field	6.00	19.85	7.45	5.49	757.60	484.70	370	172.00	---	---	---	---	---	---	---	---
3/21/00		4	Lab	Bottom	---	7.60	---	---	430.00	---	150.00	106	46.00	8.80	96.00	8.50	55.00	151.00	<0.1
3/21/00		4	Lab	Middle	---	7.70	---	---	430.00	---	145.00	105	45.00	8.50	92.00	8.00	57.00	147.00	<0.1
3/21/00		5	Field	1.00	21.28	7.62	6.46	805.50	514.60	400	191.60	---	---	---	---	---	---	---	---
3/21/00		5	Field	4.75	20.22	7.57	6.24	852.30	551.00	430	218.40	---	---	---	---	---	---	---	---
3/21/00		5	Field	8.10	20.15	7.53	6.09	895.60	572.70	440	214.40	---	---	---	---	---	---	---	---
3/21/00		5	Lab	Bottom	---	7.70	---	---	578.00	---	176.00	125	59.00	11.00	108.00	8.10	66.00	193.00	0.10
3/21/00		5	Lab	Middle	---	7.70	---	---	553.00	---	169.00	124	59.00	11.00	105.00	8.60	65.00	193.00	0.10
3/21/00		6	Field	1.00	21.14	7.65	6.49	822.50	524.50	400	184.80	---	---	---	---	---	---	---	---
3/21/00		6	Field	4.50	20.60	7.64	6.30	826.30	522.80	410	189.80	---	---	---	---	---	---	---	---
3/21/00		6	Lab	Bottom	---	7.80	---	---	578.00	---	177.00	132	63.00	11.00	109.00	8.80	62.00	203.00	0.10
3/21/00		6	Lab	Middle	---	7.80	---	---	525.00	---	158.00	128	58.00	9.80	94.00	8.70	58.00	185.00	<0.1
3/21/00		7	Lab	Top	---	8.00	---	---	591.00	---	161.00	175	74.00	12.00	96.00	96.00	55.00	234.00	0.10
3/21/00		7	Field	Top	20.17	7.78	7.09	906.80	581.30	450	217.40	---	---	---	---	---	---	---	---
3/21/00		HB-2	Lab	GW: 7.00	---	6.90	---	---	12400.00	---	5460.00	367	920.00	185.00	3250.00	11.00	2010.00	3080.00	20.00
3/21/00		SP-1	Lab	GW: 6.70	---	7.40	---	---	7160.00	---	3570.00	634	125.00	82.00	2400.00	16.00	406.00	650.00	18.00
3/21/00		SP-2	Lab	GW: 4.00	---	6.90	---	---	1590.00	---	422.00	632	160.00	34.00	358.00	8.50	150.00	539.00	2.50
3/21/00		SP-3	Lab	GW: 4.00	---	6.80	---	---	883.00	---	214.00	424	135.00	14.00	153.00	3.00	41.00	395.00	0.70
3/21/00		WCID-3	Lab	GW: 2.25	---	7.10	---	---	2850.00	---	1070.00	550	1160.00	31.00	820.00	8.70	354.00	527.00	4.00
4/23/00	79.00																		
4/23/00		HB-1	Lab	GW: 2.50	---	6.87	---	---	15400.00	---	7140.00	538	800.00	300.00	4350.00	23.00	2200.00	3230.00	<0.1

Note: The depth of the groundwater samples (GW) refers to depth from ground surface.

Date	Flow (cfs) at Calallen Dam (USGS 08211500)	Sample Site	Analysis Type (Field/Lab)	Depth (ft)	Temp (oC)	pH	DO (mg/L)	Specific Conductance (mS/cm)	TDS (mg/l)	Salinity (mg/l)	Chloride (mg/L)	Alkalinity (mg/l as CaCO3)	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Potassium (mg/l)	Sulfate (mg/l)	Total Hardness (mg/l)	Bromide (mg/l)
5/10/00	0.00																		
5/10/00		1	Lab	Top	---	8.55	---	---	1470.00	---	622.00	195	96.00	43.00	338.00	21.00	128.00	417.00	1.50
5/10/00		2	Lab	Bottom	---	8.22	---	---	633.00	---	176.00	194	84.00	15.00	105.00	10.00	73.00	272.00	0.40
5/10/00		2	Lab	Middle	---	8.49	---	---	653.00	---	184.00	196	80.00	16.00	106.00	12.00	74.00	266.00	0.40
5/10/00		4	Lab	Bottom	---	8.17	---	---	620.00	---	165.00	195	78.00	15.00	99.00	10.00	69.00	257.00	0.30
5/10/00		4	Lab	Middle	---	8.46	---	---	650.00	---	184.00	194	83.00	15.00	106.00	11.00	73.00	269.00	0.30
5/10/00		5	Field	1.30	28.39	7.23	6.09	3739.00	2395.00	1970	216.30	---	---	---	---	---	---	---	---
5/10/00		5	Field	3.10	28.15	7.19	5.83	3747.00	2397.00	1970	223.50	---	---	---	---	---	---	---	---
5/10/00		5	Field	4.70	28.07	7.14	5.47	3709.00	2374.00	1950	244.60	---	---	---	---	---	---	---	---
5/10/00		5	Field	5.80	27.84	7.11	5.43	3714.00	2377.00	1950	350.90	---	---	---	---	---	---	---	---
5/10/00		5	Field	7.60	27.21	6.86	1.27	3721.00	2385.00	1950	378.80	---	---	---	---	---	---	---	---
5/10/00		5	Lab	Bottom	---	8.13	---	---	898.00	---	280.00	198	90.00	20.00	168.00	11.00	107.00	307.00	0.70
5/10/00		5	Lab	Middle	---	8.48	---	---	660.00	---	188.00	195	80.00	17.00	115.00	10.00	73.00	270.00	0.50
5/10/00		6	Field	1.50	28.32	8.17	6.22	1011.00	646.80	500	201.90	---	---	---	---	---	---	---	---
5/10/00		6	Field	2.50	28.11	8.14	6.02	1019.00	652.70	500	205.60	---	---	---	---	---	---	---	---
5/10/00		6	Field	3.50	28.07	8.13	5.95	1032.00	657.90	500	230.00	---	---	---	---	---	---	---	---
5/10/00		6	Field	4.50	28.04	8.10	5.86	1230.00	788.00	620	272.90	---	---	---	---	---	---	---	---
5/10/00		6	Lab	Bottom	---	8.25	---	---	798.00	---	240.00	194	88.00	18.00	141.00	11.00	95.00	294.00	0.50
5/10/00		6	Lab	Middle	---	8.47	---	---	658.00	---	186.00	195	80.00	16.00	108.00	11.00	72.00	266.00	0.30
5/10/00		7	Lab	Top	---	8.48	---	---	612.00	---	170.00	194	78.00	15.00	100.00	11.00	67.00	257.00	0.30
5/10/00		7	Field	Top	27.81	8.17	5.95	974.30	623.60	480	193.00	---	---	---	---	---	---	---	---

Date	Flow (cfs) at Calallen Dam (USGS 08211500)	Sample Site	Analysis Type (Field/Lab)	Depth (ft)	Temp (oC)	pH	DO (mg/L)	Specific Conductance (mS/cm)	TDS (mg/l)	Salinity (mg/l)	Chloride (mg/L)	Alkalinity (mg/l as CaCO3)	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Potassium (mg/l)	Sulfate (mg/l)	Total Hardness (mg/l)	Bromide (mg/l)
6/12/00	18.00																		
6/12/00		1	Lab	Top	---	8.38	---	---	530.00	---	144.00	195	75.00	14.00	86.00	10.00	62.00	245.00	0.20
6/12/00		1	Field	Top	28.90	8.19	6.67	902.10	577.30	400	103.40	---	---	---	---	---	---	---	---
6/12/00		2	Field	1.37	29.04	8.18	6.02	909.70	582.10	450	117.00	---	---	---	---	---	---	---	---
6/12/00		2	Field	4.14	28.96	8.18	6.07	910.60	582.70	450	237.80	---	---	---	---	---	---	---	---
6/12/00		2	Field	6.73	28.75	8.09	5.32	932.50	596.40	400	230.30	---	---	---	---	---	---	---	---
6/12/00		2	Lab	Bottom	---	8.29	---	---	550.00	---	144.00	196	75.00	14.00	86.00	10.00	63.00	245.00	0.20
6/12/00		2	Lab	Middle	---	8.38	---	---	538.00	---	144.00	194	75.00	14.00	85.00	10.00	63.00	245.00	0.30
6/12/00		3	Field	1.57	29.05	8.21	6.23	904.80	578.70	440	112.10	---	---	---	---	---	---	---	---
6/12/00		3	Field	5.20	28.83	8.11	5.30	926.60	592.40	450	115.30	---	---	---	---	---	---	---	---
6/12/00		3	Field	8.93	28.70	8.07	4.94	937.00	597.20	460	114.80	---	---	---	---	---	---	---	---
6/12/00		3	Lab	Bottom	---	8.29	---	---	560.00	---	151.00	194	75.00	14.00	90.00	10.00	65.00	245.00	0.30
6/12/00		3	Lab	Middle	---	8.40	---	---	555.00	---	148.00	193	75.00	14.00	89.00	10.00	64.00	245.00	0.30
6/12/00		4	Field	1.34	29.10	8.20	6.14	906.30	570.00	440	111.90	---	---	---	---	---	---	---	---
6/12/00		4	Field	7.92	28.72	8.08	4.90	938.70	603.20	460	111.60	---	---	---	---	---	---	---	---
6/12/00		4	Field	12.20	28.20	8.06	3.23	903.80	580.90	440	105.70	---	---	---	---	---	---	---	---
6/12/00		4	Lab	Bottom	---	8.36	---	---	543.00	---	140.00	197	76.00	14.00	85.00	10.00	63.00	247.00	0.30
6/12/00		4	Lab	Middle	---	8.28	---	---	578.00	---	152.00	193	75.00	15.00	91.00	10.00	64.00	249.00	0.20
6/12/00		5	Field	1.14	29.54	8.26	6.49	851.60	545.20	420	96.66	---	---	---	---	---	---	---	---
6/12/00		5	Field	5.43	28.99	8.19	5.78	866.80	555.80	430	100.60	---	---	---	---	---	---	---	---
6/12/00		5	Field	10.19	28.73	7.86	4.45	1188.00	821.20	600	166.10	---	---	---	---	---	---	---	---
6/12/00		5	Lab	Bottom	---	8.33	---	---	748.00	---	222.00	196	83.00	17.00	136.00	11.00	96.00	277.00	0.50
6/12/00		5	Lab	Middle	---	8.39	---	---	518.00	---	132.00	193	73.00	14.00	82.00	10.00	60.00	240.00	0.20
6/12/00		6	Field	1.41	29.48	8.25	6.52	836.70	535.50	410	90.51	---	---	---	---	---	---	---	---
6/12/00		6	Field	2.51	29.31	8.21	6.03	835.70	535.70	410	91.38	---	---	---	---	---	---	---	---
6/12/00		6	Field	3.76	29.15	8.18	5.93	870.90	557.60	430	96.41	---	---	---	---	---	---	---	---
6/12/00		6	Lab	Bottom	---	8.40	---	---	540.00	---	135.00	192	73.00	14.00	81.00	10.00	63.00	240.00	0.10
6/12/00		6	Lab	Middle	---	8.45	---	---	513.00	---	128.00	193	73.00	13.00	77.00	10.00	60.00	236.00	0.30
6/12/00		7	Lab	Top	---	8.41	---	---	508.00	---	123.00	192	73.00	13.00	71.00	9.80	56.00	236.00	0.10
6/12/00		7	Field	Top	28.96	8.25	6.49	814.70	521.20	400	110.40	---	---	---	---	---	---	---	---

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Surface Water – Ground Water Interactions Study

As part of the Senate Bill 1 Regional Water Planning Program for the Coastal Bend area, HDR Engineering, Inc., the Nueces River Authority, and the Center for Water Supply Studies at Texas A&M University – Corpus Christi initiated an effort to identify the possible sources of elevated levels of dissolved solids in the Nueces River water. This initial phase of investigation included monitor well installation, groundwater and surface water sampling, obtaining and interpreting aerial/satellite imagery of the area between Wesley Seale Dam and Calallen Pool, possible point source contributions (specifically, abandoned oil and gas well and sand/gravel washing operations), and groundwater intrusion.

The Calallen Pool

In his book “Corpus Christi Water Supply Documented History 1852 – 1997,” former Corpus Christi Water Superintendent, Atlee Cunningham, P.E., described the development of the Calallen Pool:

> *Prior to construction of the Calallen Dam, the lower reach of the Nueces River consisted of a salt water estuary with a bottom elevation below sea level for a distance of 23.17 miles upstream from the mouth of the River where it empties into the Nueces Bay. This section, which includes the area known now as the Calallen Pool, was subject to salt water intrusion during periods of high tides, wind tides and drought conditions when the river flow was not sufficient to keep the river fresh. The combination of tidal surges from the Nueces Bay into the lower reach of the river and groundwater seepage from the salt flats increased salinity to levels which made the water unfit for public use.*
>
> *To mitigate the saltwater intrusion problem the Calallen Dam was constructed. The dates that the dam construction was started and finished are not known; however, the first work is estimated to have started around 1898. The dam construction was described as being wood crib type construction extending across the river channel with sand and loose rock fill. The cribbing was made of cut cypress and assembled into nine foot square cribs. The walls of the crib were made of seven by seven inch cypress timber installed vertically with seven by seven inch whalers. These dimensions were confirmed on June 22, 1971 by city water crews excavating one of the cribs for inspecting and measuring. The cribs were constructed to sit on the river bottom according to the depth of water at that crib location with the maximum depth being 16.5 feet. The first crest of the dam was 1.5 feet above high tide and created a 928 acre foot reservoir within the natural river channel for a distance of about ten miles upstream to near Bluntzer, Texas. This is known as the Calallen Pool. In 1952, the City of Corpus Christi completed constructing a concrete spillway across the dam with a crest 4.5 feet*

above high tide. This height increase of the dam increased the total storage to 1,273.4 acre feet.
In 1964, the City of Corpus Christi Water Division measured the amount of leakage through the dam and reported leakage averages 34.2 gpm at reservoir level of 4.5 feet on the staff gage with a down stream water surface elevation of 0.6 feet msl. This leakage will remain relatively constant since it is due to leakage through the interlocking steel sheet piling and will decrease as the reservoir is drawn down.

Today, the majority of the diversions for municipal and industrial (M&I) water supply in the Coastal Bend area are drawn from the Calallen Pool. Five pump stations are located on its banks: City of Corpus Christi Stevens Water Treatment Plant Intake and Pump Station; San Patricio Municipal Water District Raw Water Intake; WCID No. 3 (Robstown) Pump Station; Celanese – Bishop Facility Raw Water Pump Station; and Koch Refinery Raw Water Pump Station. Water quality in the Calallen Pool has a direct bearing on the final quality of potable and industrial water supplies throughout the region. The problem of elevated dissolved solids in the water withdrawn from the Calallen Pool is therefore a major concern from both a human health and a water use/water conservation perspective. The current investigation is designed to provide additional information that can be used to address this problem.

Potential sources of elevated levels of dissolved solids in the Nueces River water in the Calallen Pool include:

- Saltwater intrusion
- Groundwater seepage
- Oilfield impacts
- Sand and gravel washing operations

Saltwater Intrusion

Studies have suggested that saltwater intrusion from the Calallen Dam is a source of dissolved solids in the Calallen Pool. However, there is no direct evidence that can identify whether this process is occurring or, if it is occurring, to what extent it is contributing to the elevated total dissolved solids (TDS) levels above the Calallen Dam. It has been suggested that the density gradient between the fresh water upstream of the dam and saltwater downstream of the dam is the source of the saltwater intrusion. However, the range in elevation difference is never small enough between the upstream and downstream sides of the dam for the density gradient to overcome the hydraulic gradient.

Groundwater seepage

In his book, Atlee Cunningham also described the physical and geological setting that results in groundwater seepage into the Calallen Pool:

> *The Calallen Pool resides in a flood plain area identified as a salt water bay. The salt deposits from the evaporated prehistoric shallow bays are partially dissolved by rainfall seeping downward through the soil then carried into the natural river channel with the groundwater seepage inflow. This causes the inflow to be highly saline. The United States Geological Service has found the ground water in the flood plain to have a saline content of as much as 23,000 parts per million. Typically, however, the salt seepage inflow along the river banks through the salt flat or flood plain area is in the range of 3,000 parts per million. During periods of low flow in the river this salt intrusion adds to the brackish condition of the water.*
>
> *Any attempt to pump the water below minus 4.5 foot elevation will cause an inflow of highly saline water from the bed and banks of the river. During periods of no flood flows the salt water accumulated in the low sections of the river bottom. We found the chloride content of the water, at a depth of twelve feet, to be in the thousands of parts per million and far too saline to use for domestic or industrial purposes.*
>
> *The profile showing the 1913 soundings of the river bed in the Calallen Reservoir show an uneven bottom from the dam to Bluntzer. It also shows the presence of saline water and dead storage that severely limits the amount and quality of usable storage. During the years from 1898 to 1933, the city operated the reservoir with the water surface from the dam crest down to –1.5 feet elevation. This could be done due to the small suction pipe and low flow velocities whereby a vortex would not be created. However, when water levels in the reservoir were lowered to below sea level, salty groundwater flowed from the adjacent saline sand and raised the chloride content of the reservoir water in excess of the limits set by the United States Public Health Service. The State Health Department made two investigations of the source of saline water intrusion into the Calallen Reservoir: Lower Nueces River Chloride Investigation in January 1960 and Lower Nueces River Water Quality Survey in 1961. The Texas Water Rights Commission made further studies on both saline water intrusion and water quantity gain or loss in transit. The surveys were made by taking river flow measurements at the state highway bridge at Bluntzer and at the stream flow gaging station below Lake Corpus Christi. The Bluntzer location was at the head of the Calallen Reservoir and the results do not include losses or gains in the 10.5 miles of the reservoir. A portion of the findings is as follows:*

August	*20 ppm chloride gain with 15 cfs loss (149 cfs to 134 cfs)*
February	*37 ppm chloride gain with 8 cfs loss (150 cfs to 142 cfs)*
August	*47 ppm chloride gain with 3 cfs gain (145 cfs to 148 cfs)*

The Water Division had determined that the losses in the upper reach of the river were affected by irrigation from wells on the Knolle Dairy Farm near Sandia, Texas. The river channel passes through gravel deposits near the dairy farm and the wells are located nearby with a depth of approximately 80 feet. Prior to the drilling of the wells, the owner had been irrigating from the river until being stopped the City of Corpus Christi and the Water Rights Commission for taking water from the river without a permit. One study indicated a loss of approximately 10% but did not identify the cause. The study included mineral analysis of ground water from test wells that were placed in the flood plain (known as the salt flats) near the reservoir and tree line and found shallow ground water a few feet below the surface that had up to 22,000 parts per million of chlorides. The study also showed that the test wells in the tree line were affected by the time of day and weather.

Saline groundwater was found at the O.N. Stevens water plant construction site of an intake flume on the river in 1954 where it was necessary to excavate the East bank to a depth of twelve feet below sea level. A coffer dam was placed in the river to hold the water back, and well points were used to dewater for excavation. The groundwater was pumped continuously for several months with a salt content of approximately 3,000 parts per million while the structure was completed. The same groundwater condition was found in 1982 when the O.N. Stevens plant was expanded and a new river pump station was constructed upstream from the 1954 plant's river station. The inflow of groundwater along the 35 miles of river caused the chlorides in the water from the lake to increase an average of 50 parts per million and also reduced losses somewhat. A flow of 75 mgd would gain 50 ppm; however, a higher rate would reduce a gain by dilution. Also, a higher flow of groundwater, due to rainfall on the flood plain, would increase the saline water flow into the Calallen reservoir. A flow of 75 mgd in the river would require 31,294 pounds of salt to produce a 50 ppm gain by assuming that the groundwater had 3,000 ppm of chloride salt. This would require an inflow of 1.25 mgd of saline water to raise the chloride content of the 75 mgd flow from the lake by 50 ppm.

During the 1960's, the City of Corpus Christi Water Department made an extensive field investigation of the water gain and loss in the 25 mile reach of the Nueces River from the Wesley Seale Dam to the Calallen Dam. It was found that an average loss of 7.74 cubic feet per second or 5 mgd occurred throughout the months of March to September during the growing season. The loss started as the leaves appeared on the trees in the Spring at twice the average rate, then decreased to no loss six months later. No loss was noted on overcast days and the remaining months. Variation in the river flow made no noticeable difference in the loss rate. The annual loss averaged 2,801 ac-ft or 913 million gallons. Assuming that all saline water inflow averaged 3,000 ppm of chlorides, the annual inflow would be 457 million gallons. During the years that the City of Corpus Christi was surviving on the storage in the Calallen Reservoir and during periods of no flow in the river, the saline seepage benefited the city; however, the chlorides became excessive at times and created problems in irrigation. The use *of the reservoir was made possible due to the short critical period of two months when local rainfall or a rise in the river would freshen the reservoir water. Irrigators in the Nueces County WC&ID (Robstown) often complained of the salty water and were grateful for fresh water after a freshening of the river.*

Several attempts to farm the flood plain in the first three decades of this century were without success. A few inches to a foot of fresh water generally can be found in the flood plain resting on the saline water layer which is about three feet from the surface. The soil is predominately coarse, usually referred to as "buckshot", that is very pervious and will hold moisture for only a short time. Salt tolerant bunch grass grows well in the flood plain and is used for cattle grazing. Hackberry, willow and river elm grow along the river in a band some 50 feet wide where their roots can have access to the fresh river water. Vegetation returns to the salt grass immediately beyond the tree line.

Intrusion of higher salinity groundwater into the surface water residing in the Calallen Pool is a fairly well documented occurrence. However, the information published to date does not provide enough definition on the various sources, flux rates and chemical characteristics to determine if these contributions can be reduced through changes in operating policies, intake structures, or other measures. This investigation, including the installation of permanent groundwater monitoring wells, is designed to provide new information that will better identify the nature of the groundwater intrusion and develop appropriate measures to address the problem.

Oilfield impacts

Oil and gas production facilities dot the flood plain along both sides of the Nueces River between Wesley Seale Dam and the Calallen Pool. While current regulations prohibit the discharge of "produced water" (brines) into freshwater streams, the practice seems to have been fairly widespread at one time and was thought to have been at least one source of the TDS loadings in this reach of the Nueces River. Atlee Cunningham wrote that:

Daily chemical analysis of the river water at the plants, when compared with the water analysis leaving the lake, showed an approximate gain of 50 parts per million of chlorides while in transit from the lake. At first, it was thought that the salt was from six oil fields located along the river, and a thorough investigation was made to find the pollution source. Some illegal discharge was found and stopped; however, the tonnage of salt necessary to produce 50 ppm chloride gain at the water plants was far greater than could be produced by the oil fields.

While current oil and gas operations are required to dispose of produced water via injection wells or other methods besides discharge to surface waters, it is possible that historical contamination of soils and shallow aquifers in the vicinity of these operations could still contribute TDS loadings periodically during runoff events or continually from groundwater discharge to creeks and other tributary streams. Additionally, improperly plugged oil and gas wells may allow brine waters to come to surface and recharge the water table aquifer. Determination of the quantity and quality of these discharges is extremely difficult, but this investigation attempts to locate potential sites where impacts from oil and gas operations may be occurring by using remote sensing imagery to evaluate site conditions around abandoned oil and gas wells to determine if impact to vegetation has occurred at these sites (Appendix 1).

Sand and gravel washing operations

The alluvium in the flood plain of the Nueces River below Wesley Seale Dam is a rich source of construction grade sand and gravel materials. A number of commercial sand and gravel mining operations have operated in the area around Bluntzer and San Patricio, as well as downstream in the County Road No. 73 area. These operations excavate large pits to expose deposits of sand and gravel, then remove these materials, some of which then undergoes rinsing to remove clays and other fine sediments. Because of the shallow groundwater levels in these flood plain areas, these pits invariably fill with groundwater, often of a fairly brackish nature, which is then used to rinse the excavated materials. The rinsing operations sometimes generate discharges into creeks and other tributary streams, ultimately impacting the Nueces River. Atlee Cunningham described these activities:

> *Several gravel pits were located on either side of the river from Riverside area to above Bluntzer. Each pit had high salt content in the groundwater, which was used in the gravel washing operation. Occasionally, the water would accumulate and interfere with the mining of the gravel, at which time the excess water would be pumped to a drainage ditch. The salt water would either flow into the river or accumulate and be washed into the river at the next rain. We were able to pursued the pit owners to store the excess water in worked out pit; however, since the gravel strata crossed the river in a number of locations, we felt that most of the salt increase in the river above Bluntzer was from the gravel pits.*

Today, several active sand and gravel washing operations exist along the reach of the Nueces River between Wesley Seale Dam and the Calallen Dam. Remnant pits from suspended operations also exist throughout the same area. Two of the larger existing sand and gravel mining operations are the Wright Materials, Inc. facilities and the Bay, Inc. facility. However, a review of active water quality permits in the Texas Natural Resource Conservation Commission (TNRCC) Water Quality Permit Application database for facilities in Nueces, San Patricio, and Jim Wells counties revealed Wright Materials, Inc. as the only permittee with a designation of a sand and gravel washing operation (SIC 1442) (Appendix 2). According to local sources, another sand and gravel mining operation is being developed on the North bank of the Calallen Pool, just upstream from Hazel Bazemore Park, but no record of this pending operation exists in TNRCC files.

Applicable regulations for sand and gravel washing operations are: the Federal Clean Water Act – Section 402; Texas Water Code § 26.027; and 30 Texas Administrative Code Chapter 305, Subchapters C through F, Chapter 307 and 319, as well as TNRCC policies and EPA guidelines. Wright Materials, Inc. operates the Nason Plant No. 1 as an industrial wastewater permittee under the Texas Pollutant Discharge Elimination System (TPDES) Permit No. 02027 (TX0070629) issued November 29, 1999 and expiring May 1, 2003. As Wright Materials, Inc. mines for sand and gravel, groundwater infiltrates existing ponds which were previously mined areas. Stormwater runoff and washwater discharges also enter these ponds. The permitee stated in the permit application that no discharge occurs from these ponds except in unusually large floods. In such a situation, pumping is required until the water level in the ponds is lowered. Exhibit 5 of the permit application illustrates the poteniometric surface of the water table is encountered 15 feet below ground surface, a fine sand strata between 15 and 20 feet below ground surface and a sand/gravel strata interval between 20 and 40 feet below ground surface. According to the "Statement of Technical Summary" in their most recent permit application, the Nason Plant No. 1 had no occurrence of such discharge during the previous self-reporting interval -- from December 1996 through May 1999.

The Nason Plant No. 1 is located on Farm-to-Market Road 3088, approximately 1.5 miles northwest of intersection of Farm-to-Market Road 624 and Farm-to-Market Road 666, and approximately ten miles northwest of the City of Robstown, Nueces County, Texas. During large rain events, their permit states that stormwater is discharged into Cayamon Creek; thence into Segment No. 2102 of the Nueces River Basin (the "Nueces River Below Lake Corpus Christi"). Stream Segment No. 2102 is effluent limited. The designated uses for Segment No 2102 are high aquatic life use, contact recreation, and public water supply. Under the TPDES permit for the Nason Plant No. 1, Outfall 001, which discharges from the holding pond to Cayamon Creek, has discharge limitations (single grab sample) for total suspended solids (TSS) of 45 mg/l and chlorides of 300 mg/l (Appendix 3). Sample results reported in the most recent permit renewal application, dated January 8, 1998, revealed that a grab sample obtained at Outfall 001 had a TSS concentration of 24 mg/l and chlorides of **490 mg/l,** with total dissolved solids of 1,448 mg/l. This was the only documented grab sample reported for Outfall 001 found during TNRCC Region 14 record review (Appendix 3).

The City of Corpus Christi Water Division monitors, twice monthly, a number of water quality parameters, including chlorides, at stations along the Nueces River between the Wesley Seale Dam and Calallen Dam. One of these stations is located where Cayamon Creek discharges into the Nueces River. Samples taken from Cayamon Creek at this location consistently reveal chloride levels an order of magnitude greater than samples taken directly from the Nueces River above and below this station. Whether the high chlorides in Cayamon Creek are the result of natural sources such as brackish groundwater discharges, or the result of anthropogenic activities such as sand and gravel mining operations or oil and gas extraction, this water is discharged into the Nueces River and can have a significant impact on TDS levels.

The relationship between the discharges from Cayamon Creek and elevated TDS levels in raw water being diverted to the City of Corpus Christi O.N. Stevens Water Treatment Plant were identified during Atlee Cunningham's tenure as Water Superintendent for the City of Corpus Christi. He noticed that elevated TDS levels occurred at the water treatment plant during discharges from Cayamon Creek and routinely reported these episodes to the local office of the Texas Water Quality Commission (now TNRCC), asking that they investigate and cite the sand and gravel operators for any permit violations that may be occurring **(Personal Communication, Jim Bowman, Air Program Manager (and former Water Quality Program Manager), TNRCC Region 14)**.

Current monitoring data and historical information support the fact that sand and gravel mining operations have the potential to contribute brackish groundwater and surface water discharges to the Nueces River. The most recognizable problem is episodic point source discharges, primarily during higher rainfall periods. Less definable is the contribution of higher TDS groundwater discharging into the Nueces River on a regular basis. This signal may be too difficult to detect in the background of natural discharges of brackish groundwater.

Surface Water – Ground Water Interactions

Monitoring Well Installation

One of the primary objectives of this study was to investigate the potential interaction of groundwater in sediments along the Nueces River with surface water in the Calallen Pool. In order to measure groundwater levels and obtain samples of the groundwater, the study included the installation of several permanent monitoring wells. Seven borings, completed as monitor wells, were drilled at four locations adjacent to the Nueces River. Access agreements were acquired and formalized by letter where appropriate (Appendix 5). The four locations were selected based on drilling rig accessibility requirements, underground utility and pipeline locations, and areas of most significant hydrogeologic interest. The locations, well designations, and location considerations were as follows:

The first Hazel Bazemore Park site (**HB-1, HB-2**) is located where previous hand augered groundwater samples were collected. Previous analyses indicated that the ionic ratios in those samples closely matched the ionic ratios found in samples of the more saline, stratified water of concern in the Calallen Pool. The second site, in Hazel Bazemore Park (**HB-3, HB-4**), is located near the WCID # 3 intake and adjacent to a deeper pool of the Nueces River where stratification of water has been observed in previous investigations. The third site, on the San Patricio Municipal Water District (MWD) pump station property (**SP-1, SP-2**), is located near the Calallen Dam and a raw water intake where there has been noticeably elevated total dissolved solids and chlorides concentrations. The last site, at the City of Corpus Christi Cunningham Plant (**CP-1**), is adjacent to a deeper pool of the Nueces River close to both the Celanese – Bishop and the Koch Refinery raw water pump stations. This site is on the opposite side of the Nueces River from the **SP-1** and **SP-2** sites and will be important for future use in making water level comparisons from each bank and the river surface to establish gaining and losing stream conditions as water releases and other system changes occur. The locations of these monitoring well sites are shown in Appendix 6.

A well arrangement of 2 wells per location was established in order to screen and characterize groundwater at various depths. An exception to this arrangement was made at the Cunnigham Plant location where steep banks and unmapped underground hazards prevented safe installation of more than the one well.

The monitor wells were installed by Charles Thomas Weakley of Front Range Environmental, a licensed water well driller with the Texas Department of Licensing and Regulation (License Number WWDPMP00002094). The borings were drilled using a hollow stem auger and completed as wells constructed of 2 inch PVC and 2 feet of .010 inch slotted screen. The wells have a minimum two foot stick-up surrounded by a metal riser mounted in a 3 foot by 3 foot sloped concrete surface pad. Additionally, each well is equipped with a watertight sanitary well seal and is secured with a locked protective casing.

Sediment samples were collected during drilling using a split spoon corer or taking a grab sample between auger flights, depending on the lithology. Where possible, cores from the split spoon have been retained and are being stored at the Center for Water Supply Studies laboratory. Additionally, grab samples have also been retained and stored should further analysis of the samples be desired in future studies.

The borings were completed to a depth determined by the onsite geologist. The shallow well of each paired well was set at a depth just below the depth where water was first encountered in the boring. The shallow well completion represents the first water bearing sand. The deeper well of the well pair was set at a depth of about 10 feet below the first water bearing sand in the most appropriate water-bearing unit. The air-lift method was used to develop the wells (Appendix 7).

Naismith Engineering surveyed the wells to measure top-of-casing elevations to a referenced bench mark so that extremely accurate measurements may be obtained to evaluate shallow groundwater levels relative to various Nueces River stage heights. Previous survey efforts near the Calallen Dam as reported by Atlee Cunningham consisted of the following:

> *The river staff gage was established on May 8, 1915 and a bench mark was installed on the top of the concrete intake suction box in 1916 by the USGS at elevation 2.19 feet mean sea level. The USGS records show that the river gage was set with the 0.0 on the gage at 0.84 feet msl, USGS datum or at high tide. When the 1898 reservoir was full the gage registered 1.5 feet of storage above high tide which would be a surface elevation of 2.34 feet msl USGS datum. The USGS installed a benchmark No. 4 at elevation 19.2 feet USGS on the top of the circular clear well west of the 1915 pump house on September 4, 1939.*
>
> *Survey discrepancies exist for the actual height of the Calallen Dam crest. The elevation had been estimated to be 5.62 feet msl, USGS datum but not verified by survey. According to Mr. Cunningham, the elevation should be 5.34, USGS*

datum if the river gage was set with 0.0 on the gage at the 0.84 USGS datum when the dam was increased in height.

Groundwater and Surface Water Sampling

On October 27, 2000 HDR Engineering, Inc., Nueces River Authority, and the Center for Water Supply Studies staff sampled the recently installed groundwater wells and the Nueces River at two locations. R-1 was a surface water sample collected from the banks of the Nueces River most adjacent to the HB-3/HB-4 well cluster. R-2 was a surface water sample collected from the banks of the Nueces River most adjacent to the SP-1/SP-2 well cluster. The daily average flow of the river was 119 cubic feet per second (cfs). Well volumes were calculated for each well and a minimum of three well volumes was purged from each well using a bailer.

On October 30, 2000 the Nueces River Authority staff collected additional samples from the Nueces River. Two samples were collected at the deep pool near the O.N. Stevens pump station. OS1-B was collected near bottom and OS1-M was collected near the middle vertical depth of the Nueces River. Two samples were collected at the deep pool near the Robstown intake. WCID1-B was collected near bottom and WCID1-M was collected near the middle vertical depth of the Nueces River. Water releases from the reservoir system were occurring and the flow was 336 cfs. The river system was “well-flushed” due to previous releases and the release amount between October 27 and October 30, 2000, which exceeded 1927 acre-feet, the total capacity of the Calallen Pool.

Surface water and groundwater samples were analyzed for dissolved constituents including cations (calcium, magnesium, sodium, and potassium) anions (carbonate, bicarbonate, sulfate, chloride), total dissolved solids (TDS), alkalinity (as calcium carbonate) and hardness (as calcium carbonate) (Appendix 8)

The results of the sampling program (Appendix 9) support previous investigations conducted by USGS and others. The groundwater sampled in the wells have chloride concentrations in excess of 1,000 ppm and more in the range of 2,000 to 3,000 ppm, except for CP-1 and SP-2. CP-1 is screened in a gravel/sand which appears to be in direct communication with the river. SP-2 is completed almost entirely in clay and goes dry during purging. Analytical results from SP-2 probably more closely represent pore water in the clays than formation water from a productive aquifer system. The graph represents the separate nature of the groundwater versus surface water which would be present in a fresh surface water system that partially penetrates a flood plain area identified as a saltwater bay. Earlier studies conducted by HDR and others indicate stratification of the channel was found to be the most significant when no water was spilling over Calallen dam and the least detectable during periods of high flow. This “flushing” of the stratification in the channel is supported because the Nueces River samples collected are very consistent with each other in their geochemical nature or “fingerprint” and releases were occurring during the sampling event.

Conclusion

Groundwater seepage, **oilfield impacts**, and **sand and gravel operations** all appear to be contributors to the degraded water quality along the reach of the Nueces River between Wesley Seale Dam and Calallen Dam. Saltwater intrusion is an unlikely contributor. To prioritize the relative contributions of these various sources to the elevated levels of dissolved solids in the water in the Calallen Pool, it is necessary to develop some criteria relating the volume and concentration of loading of dissolved solids - primarily chlorides – with its impact on waters in the proximity of intake structures of the raw water users.

Saltwater intrusion has been indicated as a possible source of high dissolved solids in the lower Calallen Pool. However, there is not direct evidence that this is occurring. The Nueces River Authority conducts routine sampling in the Calallen Pool and has demonstrated that the San Patricio Municipal Water District intake structure which is closest to the Calallen Dam is most significantly impacted by increased dissolved solids. The City of Corpus Christi has launched a comprehensive study to evaluate the integrity of the Calallen Dam. This study coupled with previous SB1 studies conducted by HDR and another phase of investigations originating from the findings of this report should provide the stakeholders some best management practices.

Based on previous accounts documented by Atlee Cunningham, USGS and others, **groundwater seepage** is a significant contributor to increase in dissolved solids in the Calallen Pool during low flow conditions. This occurrence is supported by the sampling program undertaken by HDR in previous studies and continued in this investigation. The opportunity exists with permanent monitor wells in place around the Calallen Pool to conduct a comprehensive sampling program. This sampling program would evaluate the gaining and losing nature of the surface/groundwater system and then relate this information to surface water and groundwater sample results acquired during this same period of time. The time period would include events where the Calallen Pool experiences low and high flow conditions. Best management practices and mitigation can then be suggested.

Oilfield impacts from brine water discharges, improperly plugged and abandoned wells, and historical contamination can be mitigated now that the locations of the oilfield activities have been identified. Compliance monitoring for brine water discharges and continued remote sensing evaluation of the oilfield areas coupled with ground truthing could be a method used to establish any impacted areas. If improperly plugged and abandoned wells are identified, mechanisms exist to pursue proper plugging and abandonment of these wells, which includes accessing a fund administered by the Railroad Commission to address plugging of abandoned wells. None of the sample results in this investigation revealed the geochemical “fingerprint” which directly relates to brine water associated with oil and gas wells. The specific characteristic of undiluted brine water is the absence of the sulfate. However, to adequately determine the contribution of the oilfield impacts, samples would need to be taken closer to the source where dilution from groundwater or surface water would be minimal.

Sand and gravel washing operations contribution to increase dissolved solids in the Calallen Pool could be significant. Based on accounts documented by Jim Bowman and Atlee Cunningham, upsets in the surface water treatment plant can be directly related back to episodic point discharges from the sand and gravel washing operations. Also the less definable contribution of higher TDS groundwater discharging into the Nueces River on a regular basis may have a significant impact to the cumulative increase in dissolved solids – primarily chlorides. A sampling program which involves sampling upstream of the sand and gravel pits as well as the pits ponds and discharge points would better define this impact. Further groundwater quality assessments in the areas where the pits are located, may determine that the daily maximum limit of 300 mg/l chlorides taken as a grab at the point of discharge or designated outfall may not be obtainable. Further compliance monitoring and evaluation of the potential of non-permitted discharges is recommended especially in view of the fact that these operations are increasing along this reach of the river with the latest account of activity occurring off the North bank of the Calallen Pool. The extensive marking on the aerial photograph of remnant pits and ponds from gravel and sand washing operations suggests that these inactive sites should also be evaluated as to their impact to the water quality along the Nueces River.

Appendices

1 Aerial imagery with stress vegetation results
2 TNRCC water quality permit application database query
3 Wright Materials, Inc., Permit No. 02027
4 Sample results from outfall 001
5 Signed access agreement letter for groundwater monitor well installation in Hazel Bazemore Park
6 Aerial image with well location information
7 Monitor well logs
8 Sample results
9 Sample graphs

Appendix 1
Aerial Imagery with Stressed Vegetation Results

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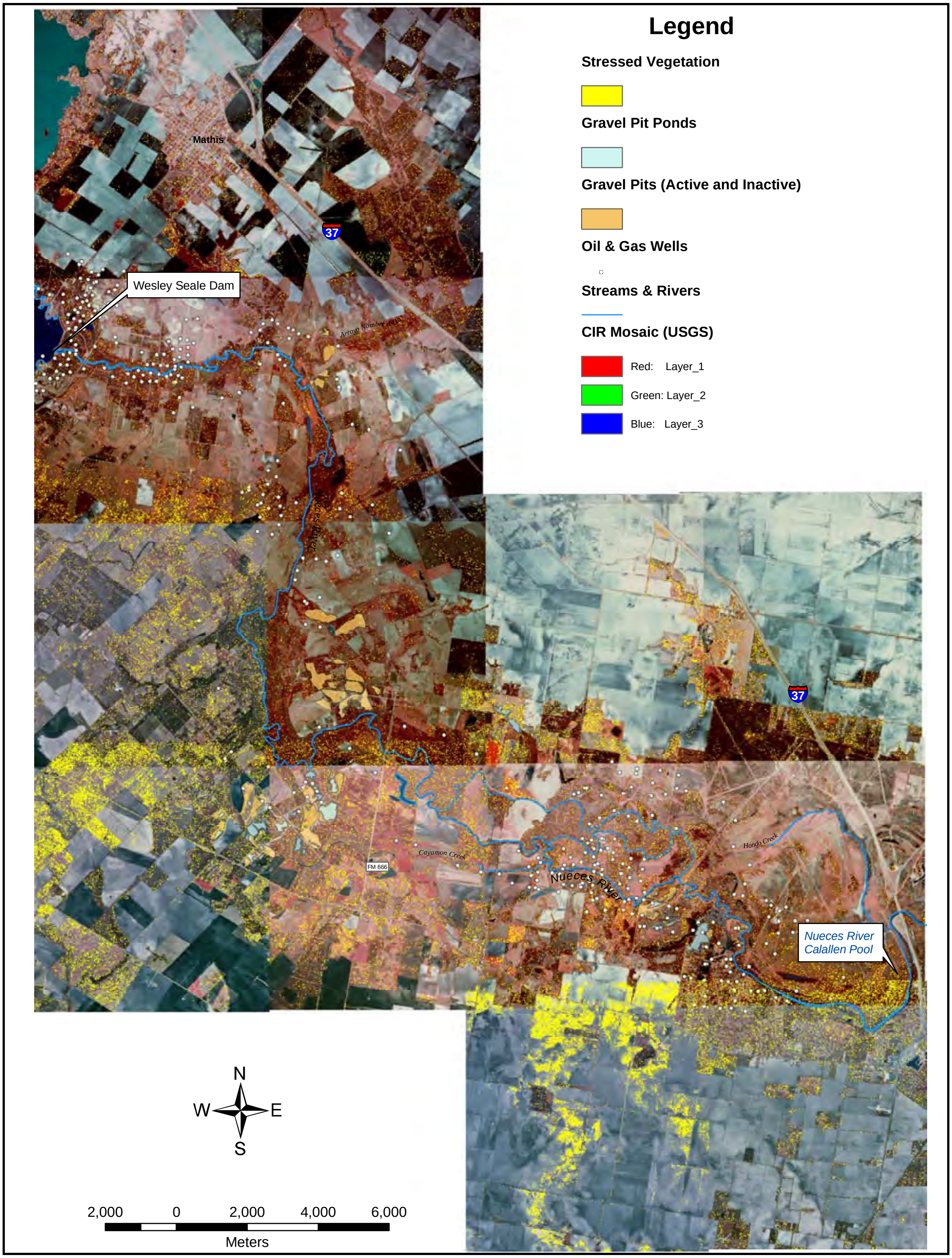

Appendix 1. Aerial Imagery with Stressed Vegetation Results

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Appendix 2
TNRCC Water Quality Permit Application
Database Query Results

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TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

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12-OCT-2000 * * * TEXAS NATURAL RESOURCE CONSERVATION COMMISSION * * * Page: 1

STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M Un sity

TWC PERMIT EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
WQ0010536-002 TPDES0034002	ALICE, CITY OF 500 E MAIN ALICE, TX 78332	SOUTHSIDE PLANT	Active Jim Wells	14 22 2492 Public Domestic Major	Municipal Gover 00/07/11	49520 05/07/01
	ALICE CITY OF	Self Reporting Contact				
	1 OTFL 001 SOUTHSIDE PLANT	*TPDES*	Active	Discharge	3 89/04/10	/ /
WQ0010536-004 TX0091219-000	ALICE, CITY OF PO BOX 3229 ALICE, TX 78333	East Plant	Active Jim Wells	14 22 2492 Public Domestic Major	Municipal Gover 95/02/28	49520 00/02/28
	ALICE, CITY OF	Self Reporting Contact				
	4 OTFL 001 East Plant 104 Soil Mon 104 Ann 0-6 inches 204 Soil Mon 204 Ann 6-18 inches 304 Soil Mon 304 Ann 18-30 inches		Active Active Active Active	Discharge Sample Sample Sample	3 92/10/01 1 95/02/28 1 95/02/28 1 95/02/28	/ / / / / / / /
WQ0003330-000 TPDES0121690	HOWELL CATTLE CO., INC. DRAWER 809 PREMONT, TX 78375-0000	CATTLE FEEDLOT 10000	Active Jim Wells	14 22 2492 Agricultural-B Minor	Corporation 00/01/14	02110 01/04/26
	JESSE W HOWELL	Self Reporting Contact				
	1 CATTLE FEEDLOT 10000 HEAD *TPDES* 101 SOIL MON 101 ANN 0-6 *TPDES* 201 SOIL MON 201 ANN 6-18 301 SOIL MON 301 ANN 18-30 401 SOIL MON 401 ANN 6-24 *TPDES*		Active Active Stopped Stopped Active	Retention Sample Sample Sample Sample	1 96/04/26 1 91/09/18 1 91/09/18 1 91/09/18 1 00/01/14	/ / / / / / / / / /
WQ0003009-000 TPDES0131105	KNOLLE CATTLE COMPANY RT 1 BOX 37 SANDIA, TX 78383-0000	DAIRY FARM 950	Active Jim Wells	14 21 2102 Agricultural-B Minor	Corporation 00/08/04	02410 05/08/04
	KNOLLE CATTLE COMPANY	Self Reporting Contact	512-547-6501			
	1 OFLT 001 TPDES 101 SOIL MON 101 ANN 0-6 TPDES 201 SOIL MON 201 ANN 6-24 TPDES		Active Active Active	Retention Sample Sample	1 88/11/29 1 88/11/29 1 00/08/04	/ / / / / /
WQ0010592-001 TPDES0020397	ORANGE GROVE, CITY OF P.O. BOX 1350 ORANGE GROVE, TX 78372	CITY OF ORANGE GROVE	Active Jim Wells	14 22 2204 Public Domestic Minor	Municipal Gover 99/10/07	49520 00/06/01
		Self Reporting Contact				

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STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M University

TWC PERMIT EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
	1 OTFL 001		Active	Discharge	6 96/01/01	/ /
WQ0010253-001	PREMONT, CITY OF P O DRAWER 340 PREMONT, TX 78375-0000	City of Premont	Active Jim Wells	14 22 2492 Public Domestic Minor	Municipal Gover 88/01/05	49520 98/01/05
	PREMONT, CITY OF	Self Reporting Contact				
	1 OTFL 001 101 SOIL MONITORING INPT 101		Active Active	Retention Sample	3 88/01/05 1 88/01/05	/ / / /
WQ0003435-000	SANDIA AGRICULTURAL ENTP INC PO BOX 119 SANDIA, TX 78383-0000	DAIRY FARM 450	Active Jim Wells	14 21 2102 Agricultural-B Minor	Corporation 97/02/14	02410 02/05/08
	SANDIA AGRICULTURAL ENTP INC	Self Reporting Contact				
	1 DAIRY FARM 450 HEAD 101 SOIL MON 101 ANN 0-6 IN 201 SOIL MON 201 ANN 6-18 IN 301 SOIL MON 301 ANN 18-30 IN		Active Active Active Active	Retention Sample Sample Sample	1 97/02/14 1 92/05/08 1 92/05/08 1 92/05/08	02/05/08 / / / / / /
WQ0010140-001 TX0033367-000	AGUA DULCE, CITY OF P.O. Box 297 Agua Dulce, TX 78330-0000	City of Agua Dulce	Active Nueces	14 22 2204 Public Domestic Minor	Municipal Gover 94/11/04	49520 99/11/04
	AGUA DULCE CITY OF	Billing Contact Self Reporting Contact	(512)-998-2532	Ext:		
	1 OTFL 001 City of Agua Dulce		Active	Discharge	3 89/07/10	/ /
WQ0002291-000 TPDES0081647	APPLIED INDUSTRIAL MATERIALS P.O. Box 1727 Texas City, TX 77592	AIMCOR TERMINAL	Active Nueces	14 22 2484 Industrial Minor	Corporation 00/08/24	44910 05/06/01
	F D OSBORNE	Self Reporting Contact	409-945-7210			
	1 OTFL 001 -"TPDES"		Active	Discharge	1 82/06/07	/ /
WQ0011754-001 TPDES0069884	BISHOP CONSOLIDATED ISD 719 E SIXTH ST. BISHOP, TX 78343	PETRONILA ELEMENTARY	Active Nueces	14 22 2204 Public Domestic Minor	Independent Sch 00/06/01	49520 02/12/01
	BISHOP CONSOLIDATED ISD	Self Reporting Contact				
	1 OTFL 001	*TPDES*	Active	Discharge	3 96/04/01	/ /

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STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M University

TWC PERMIT EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
WQ0010427-001 TX0023019-000	BISHOP, CITY OF PO BOX 356 BISHOP, TX 78343-0000	CITY OF BISHOP	Active Nueces	14 22 2492 Public Domestic Minor	Municipal Gover 96/04/12	49520 00/07/01
	BISHOP CITY OF	Self Reporting Contact				
	1 OTFL 001		Active	Discharge	6 96/04/01	/ /
WQ0003450-000 TPDES0118796	CELANESE LTD. P O BOX 9077 CORPUS CHRISTI, TX 78469-9077	HOECHST CELANESE CORP	Active Nueces	14 22 2485 Industrial Minor	Partnership 99/09/08	28690 00/06/01
	CELANESE LTD.	Self Reporting Contact	512-242-4075			
	1 OTFL 001 *TPDES*		Active	Discharge	1 92/10/16	/ /
WQ0000311-000	CENTEX CEMENT CORP 1000 JACK C. HAYS TRAIL BUDA, TX 78610	CORPUS CHRISTI CEMENT PLANT	Active Nueces	14 20 2482 Industrial Minor	Corporation 88/12/13	32410 98/12/13
	POB 9294 CORPUS CHRISTI 78469 CENTEX CEMENT CORPORATION	Billing Contact Self Reporting Contact	()-- Ext:			
	1 OTFL 001 containment/ evaporation ponds 101 OUTFALL 101 PRECIPITATOR		Active Stopped	Retention Discharge	1 88/12/13 1 88/12/13	98/12/13 98/12/13
WQ0001244-000 TX0003581-000	CENTRAL POWER & LIGHT COMPANY PO BOX 2121 CORPUS CHRISTI, TX 78403-0000	NUECES BAY SES	Active Nueces	14 20 2482 Industrial Major	Corporation 96/01/22	49110 01/01/22
	CENTRAL POWER & LIGHT COMPANY	Self Reporting Contact	512-886-4724			
	1 OTFL 001 NUECES BAY SES 101 INPT 101 NUECES BAY SES		Active Active	Discharge Sample	5 87/06/09 3 87/06/09	/ / / /
WQ0001255-000 TPDES0003565	CENTRAL POWER & LIGHT COMPANY PO BOX 2121 CORPUS CHRISTI, TX 78403-0000	Lon C. Hill Power Station	Active Nueces	14 21 2101 Industrial Major	Corporation 00/01/03	49110 03/05/01
	CENTRAL POWER & LIGHT COMPANY	Self Reporting Contact	512-241-1521			
	1 OTFL 001 2 OTFL 002	*TPDES *TPDES*	Active Active	Discharge Discharge	4 88/05/03 4 88/05/03	/ / / /

Abbreviations and Codes: RGN = Region SEG = Segment SIC = Standard Industrial Classification Code

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12-OCT-20.            * * * TEXAS  NATURAL  RESOURCE  CONSERVA. JN  COMMISSION * * *              Page:    4
                                        STATE PERMIT SUBSYSTEM
                                       CLIENT FACILITY SUMMARY
                                       For Texas A & M University

 TWC PERMIT    PERMITTEE NAME                    FACILITY NAME            PERMIT STATUS  RGN BASIN SEG   BUSINESS TYPE   SIC CD
 EPA PERMIT    MAILING ADDRESS                                            COUNTY         PMT CATEGORY    PMT BEGIN DTE   PMT END
               CONTACT NAME                      CONTACT TYPE             PHONE
               EXT  EXTENSION NAME                                        EXT STATUS      DSCG/RETAIN    SET BEGIN DTE   EXT END
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
WQ0001490-000  CENTRAL POWER & LIGHT COMPANY  BARNEY M DAVIS SES          Active          14  22   2485  Corporation      49110
TPDES0008826   PO BOX 2121                                                Nueces         Industrial           00/07/13  03/06/01
               CORPUS CHRISTI, TX  78403-0000                                            Major

               CENTRAL POWER  & LIGHT COMPANY    Self Reporting Contact   214-777-2014

                 1  OTFL 001 BARNEY M DAVIS SES   *TPDES*                 Active         Discharge        5  87/06/09    / /
               101  INPT 101 BARNEY M DAVIS SES     *TPDES*               Active         Sample           2  87/06/09    / /
               201  INPT 201 BARNEY M DAVIS SES   *TPDES*                 Active         Sample           3  87/06/09    / /
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
WQ0000467-000  CITGO REFINING AND CHEMICALS   CORPUS CHRISTI REFINERY     Active          14  22   2484  Partnership      29110
TPDES0006211   P O BOX 9176                                               Nueces         Industrial           99/07/30  02/06/01
               CORPUS CHRISTI, TX  78469-0321                                            Major

               CITGO REFINING & CHEMICALS CO LP  Self Reporting Contact   512-844-4000

                 1  OTFL 001 PROCESS WASTEWATER *TPDES*                   Active         Discharge        9  92/10/22    / /
                 2  OTFL 002 PROCESS WASTEWATER *TPDES*                   Active         Discharge        4  92/10/22    / /
                 3  OTFL 003 STORMWATER *TPDES*                           Active         Discharge        4  92/10/22    / /
                 4  OTFL 004 NON PROCESS  AREA SW *TPDES*                 Active         Discharge        1  99/07/30    / /
                 5  OTFL 005 NON PROCESS AREA SW *TPDES*                  Active         Discharge        1  99/07/30    / /
                 6  OTFL 006 NON PROCESS AREA SW *TPDES*                  Active         Discharge        1  99/07/30    / /
                 7  OTFL 007 NON PROCESS AREA SW *TPDES*                  Active         Discharge        1  99/07/30    / /
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
WQ0002614-000  CITGO REFINING AND CHEMICALS   DEEP SEA TERMINAL           Active          14  22   2484  Partnership      42260
TPDES0092461   P O BOX 9176                                               Nueces         Industrial           99/10/05  02/01/01
               CORPUS CHRISTI, TX  78469-0321                                            Minor

               CITGO REFINING & CHEMICALS CO. L.P Self Reporting Contact  512-844-4000

                 1  OTFL 001 DEEP SEA TERMINAL                            Active         Discharge        2  89/05/01    / /
                 2  OTFL 002 DEEP SEA TERMINAL                            Active         Discharge        2  89/05/01    / /
                 3  OTFL 003                                              Active         Discharge        1  99/10/05    / /
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
WQ0003562-000  CITGO REFINING AND CHEMICALS   CITGO REFINING AND CHEMICALS Active         14  22   2484  Partnership      51710
TPDES0110124   P O BOX 9176                                               Nueces         Industrial           99/11/30  02/06/01
               CORPUS CHRISTI, TX  78469                                                 Minor

               CITGO REFINING & CHEMICALS CO L P  Self Reporting Contact  512-844-4000

                 1  OTFL 001 PORT AVENUE TERMINAL          *TPDES*        Active         Discharge        1  93/03/12    / /
                 2  OTFL 002 PORT AVENUE TERMINAL        *TPDES*          Active         Discharge        1  93/03/12    / /
                 3  OTFL 003 PORT AVENUE TERMINAL    *TPDES*              Active         Discharge        1  93/03/12    / /

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Abbreviations and Codes:  RGN = Region   SEG = Segment   SIC = Standard Industrial Classification Code
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STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M University

TWC PERMIT EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
WQ0011689-001 TPDES0064408	COASTAL BEND YOUTH CITY 2547 U. S. HWY 77 DRISCOLL, TX 78351	CITY OF COASTAL BEND YOUTH CI	Active Nueces	14 22 2204 Private Domestic Minor	Corporation 99/11/18	49520 00/06/01
	COASTAL BEND YOUTH CITY	Self Reporting Contact				
	1 OTFL 001		Active	Discharge	3 96/04/01	/ /
WQ0000465-000 TX0006904-000	COASTAL REFINING & MARKETING, PO BOX 109 CORPUS CHRISTI, TX 78403	COASTAL/CORPUS CHRISTI	Active Nueces	14 22 2484 Industrial Major	Corporation 93/03/23	29110 98/03/23
	TERRY A. SOULE'	Self Reporting Contact	512-887-4100			
	1 OTFL 001 CORPUS CHRISTI REFINERY 2 OTFL 002 CORPUS CHRISTI REFINERY 3 OTFL 003 CORPUS CHRISTI REFINERY 4 OTFL 004 CORPUS CHRISTI REFINERY		Active Active Active Active	Discharge Discharge Discharge Discharge	5 89/10/17 2 79/05/29 1 79/05/29 1 89/10/17	/ / / / / / / /
WQ0002540-000 TPDES0089516	COASTAL REFINING & MARKETING, P O BOX 109 CORPUS CHRISTI, TX 78403	COASTAL REFINING AND MARKETIN	Active Nueces	14 22 2484 Industrial Minor	Corporation 00/07/18	51710 05/06/01
	TERRY A. SOULE'	Self Reporting Contact	361-887-4202			
	1 COASTAL REFINING & MARKETING - OTFL 001 "TPDES"		Active	Discharge	2 93/02/19	/ /
WQ0004158-000 TPDES0119725	CORPUS CHRISTI COGENERATION L 650 DUNDEE RD. SUITE 350 NORTHBROOK, IL 60062	CORPUS CHRISTI ENERGY CENTER	Active Nueces	14 22 2484 Industrial Minor	Partnership 00/06/01	49110 05/06/01
	CORPUS CHRISTI COGENERATION LP	Self Reporting Contact				
	1 OTFL 001 *TPDES*		Inactive	Discharge	1 00/06/01	/ /
WQ0011134-001 TX0076767-000	CORPUS CHRISTI PEOPLES BAPTIS ROUTE 3, BOX 440-A CORPUS CHRISTI, TX 78415	ROLOFF FACILITY	Active Nueces	14 22 2485 Public Domestic Minor	Unknown 97/11/14	49520 00/06/01
	CORPUS CHRISITI PEOPLES BAPTIST CH	Self Reporting Contact				
	1 OTFL 001 ROLOFF FACILITY		Active	Discharge	3 95/10/01	/ /

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12-OCT-20ᴗ              * * * TEXAS  NATURAL  RESOURCE  CONSERVA..ᴗN  COMMISSION * * *                Page:    6
                                     STATE PERMIT SUBSYSTEM
                                    CLIENT FACILITY SUMMARY
                                    For Texas A & M University

 TWC PERMIT   PERMITTEE NAME                   FACILITY NAME             PERMIT STATUS  RGN BASIN SEG   BUSINESS TYPE    SIC CD
 EPA PERMIT   MAILING ADDRESS                                            COUNTY          PMT CATEGORY   PMT BEGIN DTE   PMT END
              CONTACT NAME                     CONTACT TYPE              PHONE
              EXT  EXTENSION NAME                                        EXT STATUS      DSCG/RETAIN    SET BEGIN DTE   EXT END
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
WQ0004200-000 CORPUS CHRISTI, CITY OF       ***DO NOT MAIL OUT SR FORMS F Active     14  22   2485  Municipal Gover  91210
TXS000601     P O BOX 9277                                               Nueces      Industrial            95/04/21  00/05/31
              CORPUS CHRISTI, TX  78469                                              Minor

              CITY OF CORPUS CHRISTI           Self Reporting Contact

                1  OTFL 001   MW4 SW  *DO NOT MAIL*                      Active      Discharge        1  95/01/01   /  /
                2  OTFL 002  MS4  SW  *DO NOT MAIL*                      Active      Discharge        1  95/05/01   /  /
                3  OTFL 003  MS4 SW  *DO NOT MAIL*                       Active      Discharge        1  95/05/01   /  /
                4  OTFL 004  MSW4  SW  *DO NOT MAIL*                     Active      Discharge        1  95/05/01   /  /
                5  OTFL 005  MS4  SW  *DO NOT MAIL*                      Active      Discharge        1  95/05/01   /  /
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
WQ0010401-003 CORPUS CHRISTI, CITY OF       GREENWOOD PLANT              Active      14  22   2485  Municipal Gover  49520
TPDES0047074  P.O. BOX 9277                                              Nueces      Public Domestic       99/12/22  02/02/01
              CORPUS CHRISTI, TX  78469-9277                                         Major

              FOSTER CROWELL, ASST WW SUPERI   Billing Contact           (512)-857-1800  Ext:
              CORPUS CHRISTI CITY OF           Self Reporting Contact

                1  OTFL 001 GREENWOOD PLT    *TPDES*                     Active      Discharge        4  97/03/31   /  /
              103  SOIL MON 103 ANN 0-6                                  Stopped     Sample           4  97/03/31   /  /
              189  COMBINED MON FOR 001,800 & 900 GREENWOOD PLT          Active      Sample           1  99/12/22   /  /
              203  SOIL MON 203 ANN 6-18                                 Stopped     Sample           1  99/12/22   /  /
              303  SOIL MON 303 ANN 18-30                                Stopped     Sample           1  99/12/22   /  /
              800  RECLAIMED WATER  800 TYPE I GREENWOOD PLT             Active      Sample           1  99/12/22   /  /
              900  RECLAIMED WATER 900 TYPE II GREENWOOD PLT             Active      Sample           1  99/12/22   /  /
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
WQ0010401-004 CORPUS CHRISTI, CITY OF       OSO FACILITY                 Active      14  22   2485  Municipal Gover  49520
TPDES0047058  P.O. BOX 9277                                              Nueces      Public Domestic       99/12/22  01/09/01
              CORPUS CHRISTI, TX  78469-9277                                         Major

              CORPUS CHRISTI CITY OF           Self Reporting Contact

                1  OTFL 001  OSO PLANT 10401-004    *TPDES*              Active      Discharge        4  88/03/01   /  /
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
WQ0010401-005 CORPUS CHRISTI, CITY OF       BROADWAY PLANT               Active      14  22   2484  Municipal Gover  49520
TX0047066-000 P.O. BOX 9277                                              Nueces      Public Domestic       97/08/01  00/06/01
              CORPUS CHRISTI, TX  78469-9277                                         Major

              CORPUS CHRISTI CITY OF           Self Reporting Contact

                1  OTFL 001 BROADWAY PLANT (10401-005)                   Active      Discharge        4  92/11/01   /  /


- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Abbreviations and Codes:  RGN = Region   SEG = Segment   SIC = Standard Industrial Classification Code
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STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M University

TWC PERMIT EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
WQ0010401-006 TX0047082-000	CORPUS CHRISTI, CITY OF P O BOX 9277 CORPUS CHRISTI, TX 78469	ALLISON PLANT	Active Nueces	14 21 2101 Public Domestic Major	Municipal Gover 97/11/14	49520 02/11/14
	CORPUS CHRISTI CITY OF	Self Reporting Contact				
	1 OTFL 001		Active	Discharge	3 96/11/01	/ /
	2 OTFL 002 EFFL DIVERSION DEMO PROJECT		Active	Discharge	1 96/03/08	/ /
	102 INPT 102 COMBINED FLOW		Active	Sample	1 96/03/08	/ /
WQ0010401-008 TX0047104-000	CORPUS CHRISTI, CITY OF P O BOX 9277 CORPUS CHRISTI, TX 78469-9277	LAGUNA MADRE	Active Nueces	14 22 2491 Public Domestic Major	Municipal Gover 98/09/14	49520 00/10/01
	CORPUS CHRISTI CITY OF	Self Reporting Contact				
	1 OTFL 001 LAGUNA MADRE		Active	Discharge	6 87/12/01	/ /
WQ0010401-009 TPDES0047121	CORPUS CHRISTI, CITY OF P.O. BOX 9277 CORPUS CHRISTI, TX 78469-9277	WHITECAP PLANT	Active Nueces	14 22 2491 Public Domestic Minor	Municipal Gover 99/12/27	49520 02/07/01
	CORPUS CHRISTI CITY OF	Self Reporting Contact				
	1 OTFL 001 "TPDES"		Active	Discharge	4 92/03/20	/ /
WQ0002857-000 TPDES0007129	DIAMOND SHAMROCK REFINING AND PO BOX 696000 SAN ANTONIO, TX 78269-6000	Diamond Shamrock Refining	Active Nueces	14 22 2484 Industrial Minor	Corporation 99/09/28	47890 02/06/01
	Diamond Shamrock Refining &	Self Reporting Contact				
	1 OTFL 001 *TPDES*		Active	Discharge	2 92/12/11	/ /
	2 Otfl 002 *TPDES*		Active	Discharge	1 92/12/11	/ /
	3 Otfl 003 *TPDES*		Active	Discharge	1 92/12/11	/ /
WQ0011541-001 TX0094145-000	DRISCOLL, CITY OF PO BOX 178 DRISCOLL, TX 78351-0000	Driscoll Plant	Active Nueces	14 22 2204 Public Domestic Minor	Municipal Gover 95/03/24	49520 00/03/24
	DRISCOLL CITY OF	Self Reporting Contact				
	1 OTFL 001 Driscoll Plant		Active	Discharge	3 90/04/25	/ /

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STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M University

TWC PERMIT EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
WQ0000349-000 TX0004685-000	ELEMENTS CHROMIUM L.P. P O BOX 9912 CORPUS CHRISTI, TX 78469	CORPUS CHRISTI FACILITY	Active Nueces	14 22 2484 Industrial Major	Partnership 96/07/19	28190 99/10/31
	ELEMENTIS CHROMIUM L.P.	Self Reporting Contact				
	1 OTFL 001 MIXED WASTEWATER		Active	Discharge	4 89/09/26	/ /
	101 INPT 101 process, chrome reduction, storm etc		Active	Sample	4 89/09/26	/ /
	201 INPT 201 chromic oxide, utility & storm (NEW)		Active	Sample	1 89/09/26	/ /
WQ0000314-000 TX0003191-000	ENCYCLE/TEXAS, INC. 5500 UP RIVER RD. CORPUS CHRISTI, TX 78407	CORPUS CHRISTI PLANT	Active Nueces	14 22 2484 Industrial Major	Corporation 97/08/22	49530 00/06/01
	J. W. O'NEIL	Self Reporting Contact	512-289-0300			
	1 OTFL 001 TPWW,TDS & SW		Active	Discharge	8 89/05/01	/ /
	2 OTFL 002 SW		Active	Discharge	2 89/03/06	/ /
WQ0002075-000 TX0076996-000	EQUISTAR CHEMICALS, L.P. P O BOX 10940 CORPUS CHRISTI, TX 78640	OXY PETROCHEMICALS/CORPUS	Active Nueces	14 22 2484 Industrial Major	Partnership 97/08/22	28690 00/06/01
	EQUISTAR CHEMICALS, L.P.	Self Reporting Contact				
	1 OTFL 001		Active	Discharge	6 92/09/01	/ /
	2 OTFL 002		Active	Discharge	1 80/06/05	/ /
	3 OTFL 003		Active	Discharge	1 92/02/03	/ /
	101 INPT 101		Stopped	Sample	1 92/02/03	/ /
	201 INPT 201		Stopped	Sample	1 92/02/03	/ /
WQ0002506-000	FARCO MINING, INC 7305 SAN DARIO 329 LAREDO, TX 78045	Farco Mining	Active Nueces	14 22 2484 Industrial Minor	Corporation 89/09/12	44630 99/09/12
		Billing Contact	(501)-646-4366	Ext:		
	FARCO MINING, INC.	Self Reporting Contact				
	1 OTFL 001		Active	Retention	1 89/09/12	/ /
WQ0011712-001	J. RAY MCDERMOTT, INC. P.O. Box 188 Morgan City, LA 70381	McDermott	Active Nueces	14 20 2481 Private Domestic Minor	Corporation 89/07/31	49520 99/07/31
	J. Ray McDermott, Inc.	Self Reporting Contact				
	1 OTFL 001		Active	Retention	2 89/07/31	/ /

Abbreviations and Codes: RGN = Region SEG = Segment SIC = Standard Industrial Classification Code

12-OCT-2000 * * * TEXAS NATURAL RESOURCE CONSERVATION COMMISSION * * * Page: 9
STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M University

TWC PERMIT EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
WQ0003137-000 TPDES0105481	JAVELINA COMPANY P.O. Box 23055 Environmental Supervisor Corpus Christi, TX 78403	JAVELINA COMPANY	Active Nueces	14 22 2484 Industrial Major	Corporation 99/12/31	49250 02/12/31
	JAVELINA COMPANY	Self Reporting Contact				
	1 OTFL 001 PROCESS	*TPDES*	Active	Discharge	1 90/08/31	/ /
	101 INPT 101 PROCESS/SW	*TPDES*	Active	Sample	1 90/08/31	/ /
	201 INPT 201 UTILITY	*TPDES*	Active	Sample	1 90/08/31	/ /
WQ0002774-000 TX0100048-000	KOCH CARBON INC PO BOX 2219 WICHITA, KS 67201-0000	CORPUS CHRISTI COKE S	Active Nueces	14 22 2484 Industrial Minor	Corporation 91/06/17	44630 01/06/17
	CK ADDR: POB 2256 ZIP --2256 KOCH CARBON INC	Billing Contact Self Reporting Contact	(316)-832-5641	Ext:		
	1 OTFL 001 CORPUS CHRISTI COKE S		Active	Retention	1 91/06/17	01/06/17
WQ0002578-000 TX0090328-000	KOCH PIPELINE COMPANY, L.P 8606 IH 37 Corpus Christi, TX 78409	Corpus Christi Term/Koch	Active Nueces	14 22 2484 Industrial Minor	Partnership 94/09/02	44910 99/09/02
	KOCH PIPELINE COMPANY LP	Self Reporting Contact	512-776-7535			
	1 OTFL 001 CORPUS CHRISTI TERM.		Active	Discharge	2 88/02/09	/ /
WQ0000457-000 TX0006599-000	KOCH REFINING COMPANY, L.P. P O BOX 2608 CORPUS CHRISTI, TX 78403	CORPUS CHRISTI REFINERY	Active Nueces	14 22 2484 Industrial Major	Partnership 96/08/02	29110 00/01/19
	KOCH REFINING COMPANY LP	Self Reporting Contact				
	1 OTFL 001		Active	Discharge	4 95/01/19	/ /
	2 OTFL 002 (Termiani 1 area)		Stopped	Discharge	4 95/01/19	/ /
	3 OTFL 003 (Terminal 2 area)		Active	Discharge	6 95/01/19	/ /
	4 OTFL 004 (Terminal 3 area)		Active	Discharge	4 95/01/19	/ /
	5 OTFL 005		Stopped	Discharge	4 95/01/19	/ /
	6 OTFL 006		Active	Discharge	1 95/01/19	/ /
	7 OTFL 007		Active	Discharge	1 95/01/19	/ /
	8 OTFL 008		Active	Discharge	1 95/01/19	/ /
WQ0000531-000 TPDES0006289	KOCH REFINING COMPANY, L.P. P.O. Box 2608 Corpus Christi, TX 78403	KOCH PETROLEUM	Active Nueces	14 22 2484 Industrial Major	Partnership 99/12/31	29110 02/12/31
	KOCH REFINING COMPANY L P	Self Reporting Contact				

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STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M Ur 'sity

TWC PERMIT EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
WQ0012731-001 TX0093157-000	TESORO MARINE SERVICES, INC. 9426 TELEPHONE RD. ATTN: JEFF BAKER JR., P.E. HOUSTON, TX 77075	Harbor Island Plant	Active Nueces	14 12 2501 Private Domestic Minor	Corporation 95/01/30	49520 00/01/30
	TESORO MARINE SERVICES INC	Self Reporting Contact				
	1 OTFL 001 Harbor Island Plant		Active	Discharge	2 89/02/27	/ /
WQ0003646-000 TX0112194	TEXAS A&M UNIVERSITY SYSTEM 6300 OCEAN DR. TEXAS A&M UNIVERSITY SYSTEM CORPUS CHRISTI, TX 78412	LA COSS FACILITY CORPUS CHRIS	Active Nueces	14 22 2485 Industrial Minor	Unknown 96/05/03	87330 00/06/16
	CHRIS FULLER	Self Reporting Contact	512-9372677			
	1 OTFL 001		Active	Discharge	1 95/06/16	/ /
WQ0011345-001 TPDES0066036	TEXAS A&M UNIVERSITY SYSTEM ROUTE 2, BOX 589 CORPUS CHRISTI, TX 78406	RESEARCH & EXTENSION	Active Nueces	14 22 2485 Public Domestic Minor	State Governmen 99/10/15	49520 00/06/01
	TEXAS A&M UNIVERSITY SYSTEM	Self Reporting Contact				
	1 OTFL 001 RESEARCH & EXTENSION		Active	Discharge	3 96/01/01	/ /
WQ0002888-000 TPDES0104400	TEXAS ECOLOGISTS, INC. P. O. Box 307 Robstown, TX 78380-0000	TEXAS ECOLOGISTS INC	Active Nueces	14 22 2492 Industrial Minor	Corporation 99/11/30	49530 02/07/01
	Philip D. Minns	Self Reporting Contact	713-624-1900			
	1 OTFL 001 2 OTFL 002 3 OTFL 003	*TPDES* *TPDES* *TPDES*	Active Active Suspended	Discharge Discharge Discharge	1 88/12/05 1 88/12/05 1 88/12/05	/ / / / / /
WQ0000579-000 TX0006025-000	TICONA POLYMERS, INC. P O BOX 428 BISHOP, TX 78343	BISHOP PLANT	Active Nueces	14 22 2492 Industrial Major	Corporation 98/08/21	28690 00/10/01
	TICONA POLYMERS, INC.	Self Reporting Contact				
	1 OTFL 001 PROCESS/UTIL/DOM/SW 2 OTFL 002 STORMWATER 101 INPT 101 PROCESS/DOMESTIC		Active Active Active	Discharge Discharge Sample	4 92/09/08 1 85/05/29 3 92/09/08	/ / / / / /

Abbreviations and Codes: RGN = Region SEG = Segment SIC = Standard Industrial Classification Code

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STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M University

TWC PERMIT EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
	1 OTFL 001 PAGES 2 & 2A PHASE	*TPDES*	Active	Discharge	1 74/10/22	/ /
	2 OTFL 002 *TPDES*		Active	Discharge	2 83/04/04	/ /
	3 OTFL 003 *TPDES*		Active	Discharge	2 83/04/04	/ /
	4 OTFL 004 *TPDES*		Active	Discharge	2 83/04/04	/ /
	5 OTFL 005 WEST PLANT *TPDES*		Active	Discharge	1 84/02/28	/ /
	6 OTFL 006 NORTH *TPDES*		Active	Discharge	1 86/12/09	/ /
	7 OTFL 007 *TPDES*		Active	Discharge	1 94/09/13	/ /
	8 OTFL 008 *TPDES*		Active	Discharge	1 94/09/13	/ /
	9 OTFL 009 *TPDES*		Active	Discharge	1 94/09/13	/ /
	10 OTFL 010 *TPDES*		Active	Discharge	1 99/12/31	/ /
WQ0010846-001 TPDES0024287	NUECES CO WCID NO. 4 315 S 9TH ST. PORT ARANSAS, TX 78373	MUSTANG ISLAND NORTH	Active Nueces	14 22 2481 Public Domestic Major	Local Water Dis 00/05/18	49520 05/04/01
	NUECES CO WCID 004	Self Reporting Contact				
	1 OTFL 001 MUSTANG ISLAND NORTH	*TPDES*	Active	Discharge	6 97/02/01	/ /
WQ0010846-002 TPDES0091031	NUECES CO WCID NO. 4 315 S 9TH ST. PORT ARANSAS, TX 78373	DIST MUSTANG ISLAND SOUTH PLA	Active Nueces	14 20 2481 Public Domestic Major	Local Water Dis 94/06/16	49520 99/06/16
	NONA SHERRILL NUECES CO WCID 004	Billing Contact Self Reporting Contact	(512)-749-5201	Ext:		
	2 OTFL 002 Dist. Mustang Island South Plant		Inactive	Discharge	1 / /	/ /
WQ0011583-001 TX0054291-000	NUECES CO WCID NO. 5 PO BOX 157 Banquete, TX 78339-0157	Banquete Plant	Active Nueces	14 22 2204 Public Domestic Minor	Local Water Dis 95/10/20	49520 00/06/01
	NUECES CO WCID 005	Self Reporting Contact				
	1 OTFL 001		Active	Discharge	3 95/10/01	/ /
WQ0010261-001 TX0020389-000	ROBSTOWN, CITY OF PO BOX 71 ROBSTOWN, TX 78380-0000	CITY OF ROBSTOWN	Active Nueces	14 22 2485 Public Domestic Major	Municipal Gover 96/03/29	49520 00/06/01
	ROBSTOWN CITY OF	Self Reporting Contact				
	1 OTFL 001		Active	Discharge	6 95/10/01	/ /

Abbreviations and Codes: RGN = Region SEG = Segment SIC = Standard Industrial Classification Code

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12-OCT-20..            * * * TEXAS  NATURAL  RESOURCE  CONSERVATION  COMMISSION * * *                    Page:   12
                                          STATE PERMIT SUBSYSTEM
                                          CLIENT FACILITY SUMMARY
                                          For Texas A & M University

TWC PERMIT   PERMITTEE NAME                       FACILITY NAME             PERMIT STATUS  RGN BASIN SEG  BUSINESS TYPE    SIC CD
EPA PERMIT   MAILING ADDRESS                                                COUNTY         PMT CATEGORY   PMT BEGIN DTE   PMT END
             CONTACT NAME                         CONTACT TYPE              PHONE
             EXT  EXTENSION NAME                                            EXT STATUS     DSCG/RETAIN    SET BEGIN DTE   EXT END
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
WQ0002720-000  TRIFINERY PETROLEUM SERVICES   CORPUS CHRISTI PLT            Active          14  22   2484  Corporation     29110
TPDES0096474   P O BOX 9606                                                 Nueces         Industrial           99/12/20  04/10/01
               CORPUS CHRISTI, TX  76469-9606                                              Minor

               TRIFINERY PETROLEUM SERVICES, A TE Self Reporting Contact    361-289-6762 EXT. 22

                 1  OTFL 001 PROCESS                                        Active         Discharge       2  87/06/30    /  /
                 2  OTFL 002 STORMWATER                                     Active         Discharge       1  84/12/04    /  /
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
WQ0002317-000  US DEPT OF THE NAVY            CORPUS CHRISTI NAVAL AIR STAT Active          14  22   2481  Federal Governm 34710
TPDES0007889   8851 OCEAN DR.                                               Nueces         Industrial           99/12/31  02/04/01
               STE. 205 BLDG 19; ATTN: PUBLIC WORKS
               CORPUS CHRISTI, TX  78419                                                   Major

               C R POTTS                         Self Reporting Contact     512-939-2170

                 1  OTFL 001 CORPUS   DOMESTIC         *TPDES*              Active         Discharge       7  94/05/31    /  /
               101  OTFL 101 CORPUS  PROCESS           *TPDES*              Active         Discharge       4  94/05/31    /  /
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
WQ0001909-000  VALERO REFINING COMPANY-TEXAS  CORPUS CHRISTI PLANT          Active          14  22   2484  Corporation     29110
TPDES0063355   P O BOX 9370                                                 Nueces         Industrial           99/12/31  04/12/01
               CORPUS CHRISTI, TX  78469-9370                                              Major

               VALERO REFINING COMPANY-TEXAS     Self Reporting Contact     361-289-3305

                 1  OTFL 001 CORPUS PLANT (SW)      *TPDES*                 Active         Discharge       4  94/05/23    /  /
                 2  OTFL 002 CORPUS PLANT   SW      *TPDES*                 Active         Discharge       4  94/05/23    /  /
                 3  OTFL 003 CORPUS PLANT  PROCESS WATER  *TPDES*           Active         Discharge       7  94/05/23    /  /
                 4  OTFL 004 CORPUS PLANT  SW     *TPDES*                   Active         Discharge       3  94/05/23    /  /
                 5  OTFL 005 CORPUS PLANT (DOMESTIC)  *TPDES*               Active         Discharge       5  96/10/01    /  /
                 6  OTFL 006 CORPUS FACILITY  SW    *TPDES*                 Active         Discharge       3  94/05/23    /  /
                 7  OTFL 007 CORPUS FACILITY   UTILITY     *TPDES*          Active         Discharge       4  94/05/23    /  /
                 8  OTFL 008 CORPUS PLANT  SW    *TPDES*                    Active         Discharge       2  94/05/23    /  /
                 9  OTFL 009  CORPUS PLANT   SW               *TPDES*       Active         Discharge       1  99/12/31    /  /
                10  OTFL 010  CORPUS PLANT   SW      *TPDES*                Active         Discharge       1  99/12/31    /  /
                11  OTFL 011  CORPUS PLANT  SW       *TPDES*                Active         Discharge       1  99/12/31    /  /
                12  OTFL 012   CORPUS PLANT  SW     *TPDES*                 Active         Discharge       1  99/12/31    /  /
                13  OTFL 013  CORPUS PLANT   SW     *TPDES*                 Active         Discharge       1  99/12/31    /  /
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
WQ0002070-000  WILLIAMS TERMINALS HOLDINGS,   CORPUS CHRISTI PLANT          Active          14  22   2484  Partnership     42260
TPDES0072737   P O BOX 1396                                                 Nueces         Industrial           99/06/18  02/06/18
               HOUSTON, TX  77251-1396                                                     Minor

               WILLIAMS TERMINALS HOLDINGS LLC   Self Reporting Contact

                 1  OTFL 001 Corpus Christi Terminal                        Active         Discharge       3  88/02/02    /  /
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Abbreviations and Codes:  RGN = Region   SEG = Segment   SIC = Standard Industrial Classification Code
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STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M University

TWC PERMIT / EPA PERMIT	PERMITTEE NAME / MAILING ADDRESS / CONTACT NAME / EXT EXTENSION NAME	FACILITY NAME / CONTACT TYPE	PERMIT STATUS / COUNTY / PHONE / EXT STATUS	RGN BASIN SEG / PMT CATEGORY / DSCG/RETAIN	BUSINESS TYPE / PMT BEGIN DTE / SET BEGIN DTE	SIC CD / PMT END / EXT END
WQ0002027-000 TPDES0070629	WRIGHT MATERIALS, INC. RT 1 BOX 143 ROBSTOWN, TX 78380	WRIGHT MATERIALS	Active Nueces	14 21 2102 Industrial Minor	Corporation 99/11/29	14420 03/05/01
	WRIGHT MATERIALS INC	Self Reporting Contact	512-387-1511			
	1 OTFL 001	*TPDES*	Active	Discharge	3 92/12/11	/ /
WQ0003012-000 TPDES0102890	AKER GULF MARINE P.O. Box C Ingleside, TX 78362	AKER GULF MARINE	Active San Patricio	14 20 2483 Industrial Minor	Partnership 99/11/08	34410 03/06/01
	AKER GULF MARINE	Self Reporting Contact	361-779-3367			
	1 OTFL 001		Active	Discharge	3 96/10/01	/ /
WQ0012064-001 TPDES0078743	AKER GULF MARINE P.O. Box C Ingleside, TX 78362	AKER GULF MARINE	Active San Patricio	14 20 2483 Private Domestic Minor	Partnership 00/01/04	49520 02/06/01
	AKER GULF MARINE	Self Reporting Contact				
	1 OTFL 001 *TPDES*		Active	Discharge	6 96/07/01	/ /
WQ0010521-002 TPDES0025682	ARANSAS PASS, CITY OF P O BOX 2000 ARANSAS PASS, TX 78336	CITY OF ARANSAS PASS	Active San Patricio	14 20 2483 Public Domestic Major	Municipal Gover 00/02/15	49520 02/02/01
	ARANSAS PASS CITY OF	Self Reporting Contact				
	1 OTFL 001 *TPDES* 2 OTFL 002 NO DISCHARGE	*TPDES*	Active Active	Discharge Retention	3 88/02/16 1 00/02/15	/ / / /
WQ0003780-000 TX0118907	COASTAL CHEMICAL CO L.L.C. P O BOX 277 PORTLAND, TX 78374	Portland Plant	Active San Patricio	14 20 2482 Industrial Minor	Partnership 95/10/27	51690 00/10/27
	COASTAL CHEMICAL CO LLC Wayne McClelland	Self Reporting Contact Unknown	713 477 6675			
	1 OTFL 001		Active	Discharge	1 95/10/27	/ /
WQ0001651-000 TX0008907-000	E.I. DU PONT DE NEMOURS & CO. P.O. Box JJ Ingleside, TX 78362	Ingleside plant	Active San Patricio	14 20 2481 Industrial Major	Corporation 95/10/20	28120 00/04/01
	D J GOODCHILD	Self Reporting Contact	512-643-7511			

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STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M University

TWC PERMIT EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
	1 OTFL 001 CHEMICAL MFG PLANT 2 OTFL 002 CHEMICAL MFG PLANT		Active Active	Discharge Discharge	11 97/06/30 2 88/01/26	/ / / /
WQ0010092-001 TX0083062-000	GREGORY, CITY OF PO BOX 297 GREGORY, TX 78359-0000	CITY OF GREGORY	Active San Patricio	14 20 2481 Public Domestic Minor	Municipal Gover 97/01/31	49520 00/04/01
	GREGORY CITY OF	Self Reporting Contact				
	1 OTFL 001		Active	Discharge	5 96/07/01	/ /
WQ0001497-000 TX0037117-000	Hondo Creek Cattle Co. PO BOX 70 EDROY, TX 78352-0000	CATTLE FEEDLOT 10500	Active San Patricio	14 21 2102 Agricultural-B Minor	Corporation 80/02/25	02110 99/12/31
	LYKES BROS., INC. FEED YARD	Self Reporting Contact				
	1 CATTLE FEEDLOT 10500		Active	Retention	5 80/02/25	99/12/31
WQ0010422-001 TPDES0020401	INGLESIDE, CITY OF PO Drawer 400 INGLESIDE, TX 78362-0000	City of Ingleside	Active San Patricio	14 20 2481 Public Domestic Major	Municipal Gover 99/12/27	49520 02/12/27
	INGLESIDE, CITY OF	Self Reporting Contact				
	1 OTFL 001 *TPDES*		Active	Discharge	6 97/06/30	/ /
WQ0001207-000 TX0002771-000	KOCH PIPELINE COMPANY, L.P. 8606 IH 37 Corpus Christi, TX 78409	INGLESIDE TERMINAL	Active San Patricio	14 20 2481 Industrial Minor	Partnership 95/11/03	44910 00/04/01
	KOCH PIPELINE COMPANY LP	Self Reporting Contact	361-776-7535			
	1 OTFL 001 northeast corner 2 OTFL 002 Eastern Location 3 OTFL 003 Central location 4 OTFL 004 western location		Active Active Active Active	Discharge Discharge Discharge Discharge	5 95/11/03 3 95/11/03 3 95/11/03 3 95/11/03	/ / / / / / / /
WQ0010015-001 TPDES0020419	MATHIS, CITY OF 411 E SAN PATRICIO AVE MATHIS, TX 78368-0000	CITY OF MATHIS	Active San Patricio	14 21 2103 Public Domestic Minor	Municipal Gover 99/10/11	49520 00/12/01
	MATHIS, CITY OF	Self Reporting Contact				
	1 OTFL 001 *TPDES* 101 Soil Mon 101 ANN O-6 *TPDES*		Active Active	Discharge Sample	8 95/10/01 2 92/11/20	/ / / /

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STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M University

TWC PERMIT EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
	201 Soil Mon 201 ANN 6-18 301 Soil Mon 301 ANN 18-30	*TPDES* *TPDES*	Active Active	Sample Sample	1 92/11/20 1 92/11/20	/ / / /
WQ0003083-000 TX0104876-000	OCCIDENTAL CHEMICAL CORPORATI .	CORPUS CHRISTI PLANT	Active San Patricio	14 22 2481 Industrial Major	Corporation 97/06/02	28690 00/06/01
	ENCARNACION SERNA, JR.	Self Reporting Contact	361-776-6174			
	1 OTFL 001 CORPUS CHRISTI PLANT		Active	Discharge	1 89/03/06	/ /
WQ0010237-001 TX0025135-000	ODEM CITY OF P O BOX 754 ODEM, TX 78370-0754	City of Odem	Active San Patricio	14 20 2003 Public Domestic Minor	Municipal Gover 96/02/09	49520 00/03/01
	ODEM CITY OF	Self Reporting Contact				
	1 OTFL 001		Active	Discharge	7 97/03/01	/ /
WQ0010478-001 TPDES0055433	PORTLAND, CITY OF PO DRAWER 1285 PORTLAND, TX 78374-0000	PLANT #1, CITY OF PORTLAND	Active San Patricio	14 20 2482 Public Domestic Major	Municipal Gover 00/01/24	49520 02/04/01
	PORTLAND, CITY OF	Self Reporting Contact				
	1 OTFL 001 PLANT #1	*TPDES*	Active	Discharge	7 97/01/01	/ /
WQ0003966-000 SS0003966-000	REYNOLDS METALS COMPANY P O BOX 9911 CORPUS CHRISTI, TX 78469-9911	REYNOLDS METAL CO INC	Active San Patricio	14 22 2481 Industrial Minor	Corporation 98/07/07	49520 00/07/01
	REYNOLDS METAL CO INC	Self Reporting Contact				
	1 OTFL 001		Active	Retention	7 98/07/07	00/07/01
WQ0013644-001 TPDES0110337	SAN PATRICIO CO MUD NO. 1 P. O. BOX 39 EDROY, TX 78352	SAN PATRICIO CO MUD 001	Active San Patricio	14 21 2101 Public Domestic Minor	County Governme 99/06/25	49520 02/05/01
	SAN PATRICIO CO MUD 001	Self Reporting Contact				
	1 OTFL 001		Active	Discharge	2 96/01/01	/ /

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STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M University

TWC PERMIT EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
WQ0010055-001 TPDES0024562	SINTON, CITY OF PO BOX 1395 SINTON, TX 78387-0000	CITY OF SINTON	Active San Patricio	14 20 2003 Public Domestic Minor	Municipal Gover 99/07/02	49520 02/08/01
	SINTON, CITY OF	Self Reporting Contact				
	1 OTFL 001		Active	Discharge	7 96/09/01	/ /
WQ0013641-001 TPDES0110361	SINTON, CITY OF P. O. BOX 1395 SINTON, TX 78387	Rob & Bessie Welder Park	Active San Patricio	14 20 2003 Public Domestic Minor	 99/08/24	49520 01/07/01
	Sinton, City of	Self Reporting Contact				
	1 OTFL 001 ROB & BESSIE WELDER PARK		Active	Discharge	1 95/06/01	/ /
WQ0014119-001 TPDES0119563	ST. PAUL WATER SUPPLY CORPORA ROUTE 1, BOX 207B SINTON, TX 78387	ST. PAUL WSC	Active San Patricio	14 20 2003 Private Domestic Minor	Water Supply Co 00/07/13	49520 05/03/01
	ST PAUL WSC	Self Reporting Contact				
	1 OTFL 001	*TPDES*	Inactive	Discharge	1 00/07/13	/ /
WQ0011096-001 TX0066664-000	SUBLIGHT ENTERPRISES, INC. 601 HIGHWAY 181 PORTLAND, TX 78374	PORTLAND INN	Active San Patricio	14 20 2482 Private Domestic Minor	Corporation 97/11/21	49520 00/04/01
	SUBLIGHT ENTERPRISES INC	Self Reporting Contact				
	1 OTFL 001 PORTLAND INN		Active	Discharge	4 95/10/01	/ /
WQ0010705-001 TX0027472-000	TAFT, CITY OF P O BOX 416 TAFT, TX 78390-0416	CITY OF TAFT	Active San Patricio	14 20 2472 Public Domestic Minor	Municipal Gover 96/03/29	49520 00/03/01
	TAFT CITY OF	Self Reporting Contact				
	1 OTFL 001		Active	Discharge	5 96/01/01	/ /
WQ0011660-001	TEXAS DEPT OF TRANSPORTATION P.O. Box 9907 District 16 Corpus Christi, TX 78469	SAN PATRICIO COUNTY REST AREA	Active San Patricio	14 21 2102 Public Domestic Minor	State Governmen 99/12/16	49520 05/05/01
	STATE DEPT OF HIGHWAYS AND	Self Reporting Contact				

Abbreviations and Codes: RGN = Region SEG = Segment SIC = Standard Industrial Classification Code

12-OCT-2000 * * * TEXAS NATURAL RESOURCE CONSERVATION COMMISSION * * * Page: 17

STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M University

TWC PERMIT EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
	1 OTFL 001 SAN PATRICIO RESTAREA		Active	Retention	2 89/06/26	/ /
	101 SOIL MON 101 ANN 0-6		Active	Sample	1 99/12/16	/ /
	201 SOIL MON 201 ANN 6-18		Active	Sample	1 99/12/16	/ /
	301 SOIL MON 301 ANN 18-30		Active	Sample	1 99/12/16	/ /
WQ0011660-002	TEXAS DEPT OF TRANSPORTATION P O BOX 9907 CORPUS CHRISTI, TX 78469	SAN PATRICIO COUNTY REST AREA	Active San Patricio	14 21 2102 Public Domestic Minor	State Governmen 99/10/06	49520 05/05/01
	TEXAS DEPT OF TRANSPORTATION	Self Reporting Contact				
	1 OTFL 001 SAN PATRICIO CO SOUTH		Active	Retention	2 89/06/26	/ /
	201 SOIL MON 201 (ANNUAL) SANPAT/SS		Stopped	Sample	2 89/06/26	/ /
	301 SOIL MON 301 ANN 0-6		Active	Sample	1 99/10/06	/ /
	401 SOIL MON 401 ANN 6-18		Active	Sample	1 99/10/06	/ /
	501 SOIL MON 501 ANN 18-30		Active	Sample	1 99/10/06	/ /
WQ0013412-001 TPDES0102920	TEXAS DEPT OF TRANSPORTATION P.O. Box 9907 Corpus Christi, TX 78469	SINTON MAINT./CONST	Active San Patricio	14 20 2003 Public Domestic Minor	State Governmen 99/07/09	49520 02/08/01
		Self Reporting Contact				
	1 OTFL 001 SINTON MAINT./CONST		Active	Discharge	3 96/01/01	/ /
WQ0011165-001	TEXAS PARKS & WILDLIFE DEPT 4200 SMITH SCHOOL RD. TNRCC COOR (CODE 32); INFRASTRUCTURE DIV AUSTIN, TX 78744-9822	LAKE CORPUS CHRISTI PARK	Active San Patricio	14 21 2103 Public Domestic Minor	State Governmen 89/08/07	49520 99/08/07
	TEXAS PARKS & WILDLIFE DEPT	Self Reporting Contact				
	1 OTFL 001 LK CORPUS CHRISTI PK.		Active	Retention	2 89/08/07	10/12/31

END OF REPORT

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Appendix 3
Wright Materials, Inc., TPDES Permit No. 02027

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RG

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

Protecting Texas by Reducing and Preventing Pollution

December 7, 1999

Mr. Milus Wright, Manager
Wright Materials, Inc.
Route 1, Box 143
Robstown, Texas 78380

Re: Wright Materials, Inc., Permit No. 02027

Dear Mr. Wright:

Enclosed is a copy of the above referenced permit for a wastewater treatment facility issued on behalf of the Executive Director pursuant to Chapter 26 of the Texas Water Code.

Self-reporting or Discharge Monitoring Forms and instructions will be forwarded to you from the Water Quality Management Information Systems Team so that you may comply with monitoring requirements. For existing facilities, revised forms will be forwarded if monitoring requirements have changed.

Enclosed is a "Notification of Completion of Wastewater Treatment Facilities" form. Use this form when the facility begins to operate or goes into a new phase. The form notifies the agency when the proposed facility is completed or when it is placed in operation. This notification complies with the special provision incorporated into the permit.

Should you have any questions, please contact Ms. Nicole Janak of the Texas Natural Resource Conservation Commission's Wastewater Permitting Section at (512) 239-4433, or if by correspondence, include MC 148 in the letterhead address below.

Sincerely,

Ronald R. Pedde, P.E., Director
Water Permits & Resource Management Division

RRP/nj

Enclosures

cc: [redacted]
Ms. Nicole Janak, Permit Writer, Industrial Permits Team, MC 148
Mr. C.W. Settles, P.E., Associated Engineers and Surveyors, P.O. Box 4256, Victoria, Texas 77903

P.O. Box 13087 • Austin, Texas 78711-3087 • 512/239-1000 • Internet address: www.tnrcc.state.tx.us
printed on recycled paper using soy-based ink

TPDES PERMIT NO. 02027
[For TNRCC office use only - EPA I.D. No. TX0070629]

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION
P. O. Box 13087
Austin, Texas 78711-3087

This is a renewal of TNRCC Permit No. 02027, issued on December 11, 1992.

PERMIT TO DISPOSE OF WASTES
under provisions of
Section 402 of the Clean Water Act
and Chapter 26 of the Texas Water Code

Wright Materials Inc.

whose mailing address is

Route 1, Box 143
Robstown, Texas 78380

is authorized to treat and dispose of wastes from the Nason Plant No. 1, a sand and gravel washing operation (SIC 1442)

located on Farm-to-Market Road 3088, approximately 1.5 miles northwest of the intersection of Farm-to-Market Road 624 and Farm-to-Market Road 666, and approximately ten miles northwest of the City of Robstown, Nueces County, Texas

to Cayamon Creek; thence to the Nueces River Below Lake Corpus Christi in Segment No. 2102 of the Nueces River Basin

only according to effluent limitations, monitoring requirements and other conditions set forth in this permit, as well as the rules of the Texas Natural Resource Conservation Commission (TNRCC), the laws of the State of Texas, and other orders of the TNRCC. The issuance of this permit does not grant to the permittee the right to use private or public property for conveyance of wastewater along the discharge route described in this permit. This includes, but is not limited to, property belonging to any individual, partnership, corporation or other entity. Neither does this permit authorize any invasion of personal rights nor any violation of federal, state, or local laws or regulations. It is the responsibility of the permittee to acquire property rights as may be necessary to use the discharge route.

This permit shall expire at midnight on May 1, 2003.

ISSUED DATE: NOV 29 1999

For the Commission

EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Outfall Number 001

1. During the period beginning upon date of issuance and lasting through the expiration date, the permittee is authorized to discharge washwater and stormwater subject to the following effluent limitations:

   Volume: Intermittent and Flow Variable.

Effluent Characteristic	Discharge Limitations			Minimum Self-Monitoring Requirements	
	Daily Avg mg/l	Daily Max mg/l	Single Grab mg/l	Report Daily Avg. & Daily Max. Measurement Frequency	Sample Type
Flow (MGD)	(Report)	(Report)	N/A	1/day (*1)	Instantaneous
Total Suspended Solids	25	45	45	3/day (*1)	Grab
Chlorides	N/A	300	300	1/year (*1)	Grab

   (*1) When discharging.

2. The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored 1/day (*1), by grab sample.

3. There shall be no discharge of floating solids or visible foam in other than trace amounts and no discharge of visible oil.

4. Effluent monitoring samples shall be taken at the following location: At Outfall 001, which discharges from the holding pond to Cayamon Creek.

Wright Materials Inc. TPDES Permit No. 02027

DEFINITIONS AND STANDARD PERMIT CONDITIONS

As required by Title 30 Texas Administrative Code (TAC) Chapter 305, certain regulations appear as standard conditions in waste discharge permits. 30 TAC §§ 305.121 - 305.129, Subchapter F, "Permit Characteristics and Conditions" as promulgated under the Texas Water Code §§ 5.103 and 5.105, and the Texas Health and Safety Code §§ 361.017 and 361.024(a), establish the characteristics and standards for waste discharge permits, including sewage sludge, and those sections of 40 Code of Federal Regulations (CFR) 122 adopted by reference by the Commission. The following text includes these conditions and incorporates them into this permit. All definitions in Section 26.001 of the Texas Water Code and 30 TAC Chapter 305 shall apply to this permit and are incorporated by reference. Some Specific definitions of words or phrases used in this permit are as follows:

1. Flow Measurements

   a. Annual average flow - the arithmetic average of all daily flow determinations taken within the preceding 12 consecutive calendar months. The annual average flow determination shall consist of daily flow volume determinations made by a totalizing meter, charted on a chart recorder and limited to major domestic wastewater discharge facilities with a 1 million gallons per day or greater permitted flow.

   b. Daily average flow - the arithmetic average of all determinations of the daily discharge within a period of one calendar month. The daily average flow determination shall consist of determinations made on at least four separate days. If instantaneous measurements are used to determine the daily discharge, the determination shall be the arithmetic average of all instantaneous measurements taken during that month. Daily average flow determination for intermittent discharges shall consist of a minimum of three flow determinations on days of discharge.

   c. Daily maximum flow - the highest total flow for any 24-hour period in a calendar month.

   d. Instantaneous flow - the measured flow during the minimum time required to interpret the flow measuring device.

   e. 2-hour peak flow (domestic wastewater treatment plants) - the maximum flow sustained for a two-hour period during the period of daily discharge. Multiple measurements of instantaneous maximum flow within a two-hour period may be compared to the permitted 2-hour peak flow.

   f. Maximum 2-hour peak flow (domestic wastewater treatment plants) - the highest 2-hour peak flow for any 24-hour period in a calender month.

2. Concentration Measurements

   a. Daily average concentration - the arithmetic average of all effluent samples, composite or grab as required by this permit, within a period of one calendar month, consisting of at least four separate representative measurements. When four samples are not available in a calendar month, the arithmetic average of the four most recent measurements or the arithmetic average (weighted by flow) of all values taken during the month shall be used as the daily average concentration.

   b. 7-day average concentration - the arithmetic average of all effluent samples, composite or grab as required by this permit, within a period of one calendar week, Sunday through Saturday.

   c. Daily maximum concentration - the maximum concentration measured on a single day, by composite sample unless otherwise specified elsewhere in this permit, within a period of one calender month.

   d. Daily discharge - the discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants with limitations expressed in terms of mass, the "daily discharge" is calculated as the total mass of the pollutant discharged over the sampling day. For pollutants with limitations expressed in other units of measurement, the "daily discharge" is calculated as the average measurement of the pollutant over the sampling day.

      The "daily discharge" determination of concentration made using a composite sample shall be the concentration of the composite sample. When grab samples are used, the "daily discharge" determination of concentration shall be the arithmetic average (weighted by flow value) of all samples collected during that day.

Wright Materials Inc. TPDES Permit No. 02027

e. Fecal coliform bacteria concentration - the number of colonies of fecal coliform bacteria per 100 milliliters effluent. The fecal coliform bacteria daily average is a geometric mean of the values for the effluent samples collected in a calendar month. The geometric mean shall be determined by calculating the nth root of the product of all measurements made in a particular period of time. For example in a month's time, where n equals the number of measurements made; or, computed as the antilogarithm of the sum of the logarithm of each measurement made. For any measurement of fecal coliform bacteria equaling zero, a substituted value of one shall be made for input into either computation method.

3. Sample Type

a. Composite sample - for domestic wastewater a sample made up of a minimum of three effluent portions collected in a continuous 24-hour period or during the period of daily discharge if less than 24 hours, and combined in volumes proportional to flow, and collected no closer than two hours apart. For industrial wastewater a composite sample is a sample made up of a minimum of three effluent portions collected in a continuous 24-hour period or during the period of daily discharge if less than 24 hours, and combined in volumes proportional to flow, and collected no closer than one hour apart.

b. Grab sample - an individual sample collected in less than 15 minutes.

4. Treatment Facility (facility) - wastewater facilities used in the conveyance, storage, treatment, recycling, reclamation and/or disposal of domestic sewage, industrial wastes, agricultural wastes, recreational wastes, or other wastes including sludge handling or disposal facilities under the jurisdiction of the Commission.

5. The term "sewage sludge" is defined as solid, semi-solid, or liquid residue generated during the treatment of domestic sewage in 30 TAC Chapter 312. This includes the solids which have not been classified as hazardous waste separated from wastewater by unit processes .

6. Bypass - the intentional diversion of a waste stream from any portion of a treatment facility.

MONITORING AND REPORTING REQUIREMENTS

1. Self-Reporting

Monitoring results shall be provided at the intervals specified in the permit. Unless otherwise specified in this permit or otherwise ordered by the Commission, the permittee shall conduct effluent sampling and reporting in accordance with 30 TAC §§ 319.4 - 319.12. Unless otherwise specified, a monthly effluent report shall be submitted each month, to the location(s) specified on the reporting form or the instruction sheet, by the 20th day of the following month for each discharge which is described by this permit whether or not a discharge is made for that month. Monitoring results must be reported on the approved TPDES self-report form, Discharge Monitoring Report (DMR) Form EPA No. 3320-1, signed and certified as required by Monitoring and Reporting Requirements No. 10.

As provided by state law, the permittee is subject to administrative, civil and criminal penalties, as applicable, for negligently or knowingly violating the Clean Water Act, the Texas Water Code, Chapters 26, 27, and 28, and Texas Health and Safety Code, Chapter 361, including but not limited to knowingly making any false statement, representation, or certification on any report, record, or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or noncompliance, or falsifying, tampering with or knowingly rendering inaccurate any monitoring device or method required by this permit or violating any other requirement imposed by state or federal regulations.

2. Test Procedures

Unless otherwise specified in this permit, test procedures for the analysis of pollutants shall comply with procedures specified in 30 TAC §§319.11 - 319.12. Measurements, tests and calculations shall be accurately accomplished in a representative manner.

3. Records of Results

a. Monitoring samples and measurements shall be taken at times and in a manner so as to be representative of the monitored activity.

Page 4

b. Except for records of monitoring information required by this permit related to the permittee's sewage sludge use and disposal activities, which shall be retained for a period of at least five years (or longer as required by 40 CFR Part 503), monitoring and reporting records, including strip charts and records of calibration and maintenance, copies of all records required by this permit, records of all data used to complete the application for this permit, and the certification required by 40 CFR § 264.73(b)(9) shall be retained at the facility site and/or shall be readily available for review by a TNRCC representative for a period of three years from the date of the record or sample, measurement, report, application or certification. This period shall be extended at the request of the Executive Director.

c. Records of monitoring activities shall include the following:

i. date, time and place of sample or measurement;
ii. identity of individual who collected the sample or made the measurement.
iii. date and time of analysis;
iv. identity of the individual and laboratory who performed the analysis;
v. the technique or method of analysis; and
vi. the results of the analysis or measurement and quality assurance/quality control records.

The period during which records are required to be kept shall be automatically extended to the date of the final disposition of any administrative or judicial enforcement action that maybe instituted against the permittee.

4. Additional Monitoring by Permittee

If the permittee monitors any pollutant at the location(s) designated herein more frequently than required by this permit using approved analytical methods as specified above, all results of such monitoring shall be included in the calculation and reporting of the values submitted on the approved TPDES self-report form. Increased frequency of sampling shall be indicated on the self-report form.

5. Calibration of Instruments

All automatic flow measuring and/or recording devices and/or totalizing meters for measuring flows shall be accurately calibrated by a trained person at plant start-up and as often thereafter as necessary to ensure accuracy, but not less often than annually unless authorized by the Executive Director for a longer period. Such person shall verify in writing that the device is operating properly and giving accurate results. Copies of the verification shall be retained at the facility site and/or shall be readily available for review by a TNRCC representative for a period of three years.

6. Compliance Schedule Reports

Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of the permit shall be submitted no later than 14 days following each schedule date to the Regional Office and the Manager of the Water and Multimedia Section (MC 149) of the Enforcement Division.

7. Noncompliance Notification

a. In accordance with 30 TAC § 305.125(9) any noncompliance which may endanger human health or safety, or the environment shall be reported by the permittee to the TNRCC. Report of such information shall be provided orally or by facsimile transmission (FAX) to the Regional Office within 24 hours of becoming aware of the noncompliance. A written submission of such information shall also be provided by the permittee to the Regional Office and the Manager of the Water and Multimedia Section (MC 149) of the Enforcement Division within five working days of becoming aware of the noncompliance. The written submission shall contain a description of the noncompliance and its cause; the potential danger to human health or safety, or the environment; the period of noncompliance, including exact dates and times; if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance, and to mitigate its adverse effects.

b. The following violations shall be reported under Monitoring and Reporting Requirement 7.a.:

i. Unauthorized discharges as defined in Permit Condition 2(g).
ii. Any unanticipated bypass which exceeds any effluent limitation in the permit.
iii. Violation of a permitted maximum daily discharge limitation for pollutants listed specifically in the Other Requirements section of an Industrial TPDES permit.

c. In addition to the above, any effluent violation which deviates from the permitted effluent limitation by more than 40% shall be reported by the permittee in writing to the Regional Office and the Manager of the Water and Multimedia Section (MC 149) of the Enforcement Division within 5 working days of becoming aware of the noncompliance.

d. Any noncompliance other than that specified in this section, or any required information not submitted or submitted incorrectly, shall be reported to the Water Quality Management Information Systems Team (MC 224) of the Enforcement Division as promptly as possible. This requirement means to report these types of noncompliance on the approved TPDES self-report form.

8. In accordance with the procedures described in 30 TAC §§ 305.21, 305.22 and 305.23 (relating to Emergency Orders, Temporary Orders and Executive Director Authorizations) if the permittee knows in advance of the need for a bypass, it shall submit prior notice by applying for such authorization.

9. Changes in Discharges of Toxic Substances

All existing manufacturing, commercial, mining, and silvicultural permittees shall notify the Regional Office, orally or by facsimile transmission within 24 hours, and both the Regional Office and the Manager of the Water and Multimedia Section (MC 149) of the Enforcement Division in writing within five (5) working days, after becoming aware of or having reason to believe:

a. That any activity has occurred or will occur which would result in the discharge, on a routine or frequent basis, of any toxic pollutant listed at 40 CFR Part 122, Appendix D, Tables II and III (excluding Total Phenols) which is not limited in the permit, if that discharge will exceed the highest of the following "notification levels":

i. One hundred micrograms per liter (100 μg/L);
ii. Two hundred micrograms per liter (200 μg/L) for acrolein and acrylonitrile; five hundred micrograms per liter (500 μg/L) for 2,4-dinitrophenol and for 2-methyl-4,6-dinitrophenol; and one milligram per liter (1 mg/L) for antimony;
iii. Five (5) times the maximum concentration value reported for that pollutant in the permit application; or
iv. The level established by the TNRCC.

b. That any activity has occurred or will occur which would result in any discharge, on a nonroutine or infrequent basis, of a toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the following "notification levels":

i. Five hundred micrograms per liter (500 μg/L);
ii. One milligram per liter (1 mg/L) for antimony;
iii. Ten (10) times the maximum concentration value reported for that pollutant in the permit application; or
iv. The level established by the TNRCC.

10. Signatories to Reports

All reports and other information requested by the Executive Director shall be signed by the person and in the manner required by 30 TAC § 305.128 (relating to Signatories to Reports).

11. All POTWs must provide adequate notice to the Executive Director of the following:

a. Any new introduction of pollutants into the POTW from an indirect discharger which would be subject to section 301 or 306 of the CWA if it were directly discharging those pollutants;

b. Any substantial change in the volume or character of pollutants being introduced into that POTW by a source introducing pollutants into the POTW at the time of issuance of the permit; and

c. For the purpose of this paragraph, adequate notice shall include information on:

i. The quality and quantity of effluent introduced into the POTW; and
ii. Any anticipated impact of the change on the quantity or quality of effluent to be discharged from the POTW.

Wright Materials Inc. TPDES Permit No. 02027

PERMIT CONDITIONS

1. General

   a. When the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in an application or in any report to the Executive Director, it shall promptly submit such facts or information.

   b. This permit is granted on the basis of the information supplied and representations made by the permittee during action on an application in accordance with 30 TAC Chapter 50 and the application process in accordance with 30 TAC Chapter 281, and relying upon the accuracy and completeness of that information and those representations in accordance with 30 TAC Chapter 305. After notice in accordance with 30 TAC Chapter 39 and opportunity for a hearing in accordance with 30 TAC §§ 55.21 - 55.31, Subchapter B, "Hearing Requests, Public Comment", this permit may be modified, suspended, or revoked, in whole or in part in accordance with 30 TAC Chapter 305 Subchapter D, during its term for cause including but not limited to, the following:

      i. Violation of any terms or conditions of this permit;
      ii. Obtaining this permit by misrepresentation or failure to disclose fully all relevant facts; or
      iii. A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge.

   c. The permittee shall furnish to the Executive Director, upon request and within a reasonable time, any information to determine whether cause exists for amending, revoking, suspending or terminating the permit. The permittee shall also furnish to the Executive Director, upon request, copies of records required to be kept by the permit.

2. Compliance

   a. Acceptance of the permit by the person to whom it is issued constitutes acknowledgment and agreement that such person will comply with all the terms and conditions embodied in the permit, and the rules and other orders of the Commission.

   b. The permittee has a duty to comply with all conditions of the permit. Failure to comply with any permit condition constitutes a violation of the permit and the Texas Water Code or the Texas Health and Safety Code, and is grounds for enforcement action, for permit amendment, revocation or suspension, or for denial of a permit renewal application or of an application for a permit for another facility.

   c. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of the permit.

   d. The permittee shall take all reasonable steps to minimize or prevent any discharge or sludge use or disposal or other permit violation which has a reasonable likelihood of adversely affecting human health or the environment.

   e. Authorization from the Commission is required before beginning any change in the permitted facility or activity that may result in noncompliance with any permit requirements.

   f. A permit may be amended, suspended and reissued, or revoked for cause in accordance with 30 TAC §§ 305.62 and 305.66 and the Texas Water Code Section 7.302. The filing of a request by the permittee for a permit amendment, suspension and reissuance, or termination, or a notification of planned changes or anticipated noncompliance, does not stay any permit condition.

   g. There shall be no unauthorized discharge of wastewater or any other waste. For the purpose of this permit, an unauthorized discharge is considered to be any discharge of wastewater into or adjacent to waters in the state at any location not permitted as an outfall or otherwise defined in the Other Requirements section of this permit.

   h. In accordance with 30 TAC § 305.535(a), the permittee may allow any bypass to occur from a TPDES permitted facility which does not cause permitted effluent limitations to be exceeded, but only if the diversion is also for essential maintenance to assure efficient operation.

Page 7

i. The permittee is subject to administrative, civil, and criminal penalties, as applicable, under Texas Water Code §§ 26.136, 26.212, and 26.213 for violations including but not limited to negligently or knowingly violating the federal Clean Water Act, §§ 301, 302, 306, 307, 308, 318, or 405, or any condition or limitation implementing any sections in a permit issued under the CWA § 402, or any requirement imposed in a pretreatment program approved under the CWA §§ 402 (a)(3) or 402 (b)(8).

3. Inspections and Entry

a. Inspection and entry shall be allowed as prescribed in the Texas Water Code Chapters 26, 27, and 28, and Texas Health and Safety Code Chapter 361.

b. The members of the Commission and employees and agents of the Commission are entitled to enter any public or private property at any reasonable time for the purpose of inspecting and investigating conditions relating to the quality of water in the state or the compliance with any rule, regulation, permit or other order of the Commission. Members, employees, or agents of the Commission and Commission contractors are entitled to enter public or private property at any reasonable time to investigate or monitor or, if the responsible party is not responsive or there is an immediate danger to public health or the environment, to remove or remediate a condition related to the quality of water in the state. Members, employees, Commission contractors, or agents acting under this authority who enter private property shall observe the establishment's rules and regulations concerning safety, internal security, and fire protection, and if the property has management in residence, shall notify management or the person then in charge of his presence and shall exhibit proper credentials. If any member, employee, Commission contractor, or agent is refused the right to enter in or on public or private property under this authority, the Executive Director may invoke the remedies authorized in Texas Water Code Section 7.002.

4. Permit Amendment and/or Renewal

a. The permittee shall give notice to the Executive Director as soon as possible of any planned physical alterations or additions to the permitted facility if such alterations or additions would require a permit amendment or result in a violation of permit requirements. Notice shall also be required under this paragraph when:

i. The alteration or addition to a permitted facility may meet one of the criteria for determining whether a facility is a new source in accordance with 30 TAC § 305.534 (relating to New Sources and New Dischargers); or

ii. The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants which are subject neither to effluent limitations in the permit, nor to notification requirements in Monitoring and Reporting Requirements No. 8 and as adopted by 30 TAC § 305.531(a) (relating to Establishing and Calculating Additional Conditions and Limitations for TPDES Permits);

iii The alteration or addition results in a significant change in the permittee's sludge use or disposal practices, and such alteration, addition, or change may justify the application of permit conditions that are different from or absent in the existing permit, including notification of additional use or disposal sites not reported during the permit application process or not reported pursuant to an approved land application plan.

b. Prior to any facility modifications, additions and/or expansions of a permitted facility that will increase the plant capacity beyond the permitted flow, the permittee must apply for and obtain proper authorization from the Commission before commencing construction.

c. The permittee must apply for an amendment or renewal at least 180 days prior to expiration of the existing permit in order to continue a permitted activity after the expiration date of the permit. Authorization to continue such activity will terminate upon the effective denial of said application.

d. Prior to accepting or generating wastes which are not described in the permit application or which would result in a significant change in the quantity or quality of the existing discharge, the permittee must report the proposed changes to the Commission. The permittee must apply for a permit amendment reflecting any necessary changes in permit conditions, including effluent limitations for pollutants not identified and limited by this permit.

e. In accordance with the Texas Water Code § 26.029(b), after a public hearing, notice of which shall be given to the permittee, the Commission may require the permittee, from time to time, for good cause, in accordance with applicable laws, to conform to new or additional conditions.

f. If any toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is promulgated under Section 307(a) of the Clean Water Act for a toxic pollutant which is present in the discharge and that standard or prohibition is more stringent than any limitation on the pollutant in this permit, this permit shall be modified or revoked and reissued to conform to the toxic effluent standard or prohibition. The permittee shall comply with effluent standards or prohibitions established under Section 307(a) of the Clean Water Act for toxic pollutants within the time provided in the regulations that established those standards or prohibitions, even if the permit has not yet been modified to incorporate the requirement.

5. Permit Transfer

a. Prior to any transfer of this permit, Commission approval must be obtained. The Commission shall be notified in writing of any change in control or ownership of facilities authorized by this permit. Such notification should be sent to the Wastewater Permits Section Application Team (MC 148) of the Water Quality Division.

b. A permit may be transferred only according to the provisions of 30 TAC § 305.64 (relating to Transfer of Permits) and 30 TAC § 50.33 (relating to Executive Director Action on Application for Transfer).

6. Relationship to Hazardous Waste Activities

This permit does not authorize any activity of hazardous waste storage, processing, or disposal which requires a permit or other authorization pursuant to the Texas Health and Safety Code.

7. Relationship to Water Rights

Disposal of treated effluent by any means other than discharge directly to the waters in the state must be specifically authorized in this permit and may require a permit pursuant to Chapter 11 of the Texas Water Code.

8. Property Rights

A permit does not convey any property rights of any sort, or any exclusive privilege.

9. Permit Enforceability

The conditions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstances, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

OPERATIONAL REQUIREMENTS

1. The permittee shall at all times ensure that the facility and all of its systems of collection, treatment, and disposal are properly operated and maintained. This includes the regular, periodic examination of wastewater solids within the treatment plant by the operator in order to maintain an appropriate quantity and quality of solids inventory as described in the various operator training manuals and according to accepted industry standards for process control such as the Commission's "Recommendations for Minimum Process Control Tests for Domestic Wastewater Treatment Facilities." Process control records shall be retained at the facility site and/or shall be readily available for review by a TNRCC representative for a period of three years.

2. Upon request by the Executive Director, the permittee shall take appropriate samples and provide proper analysis in order to demonstrate compliance with Commission rules. Unless otherwise specified in this permit or otherwise ordered by the Commission, the permittee shall comply with all provisions of 30 TAC §§ 312.1 - 312.13 concerning sewage sludge use and disposal and 30 TAC §§ 319.21 - 319.29 concerning the discharge of certain hazardous metals.

3. Domestic wastewater treatment facilities shall comply with the following provisions:

a. The permittee shall notify the Executive Director in care of the Wastewater Permits Section (MC 148) of the Water Quality Division, in writing of any closure activity or facility expansion at least 90 days prior to conducting such activity.

b. Closure activities include those associated with any pit, tank, pond, lagoon, or surface impoundment regulated by this permit.

c. As part of the notification, the permittee shall submit to the Municipal Permits Team (MC 148) of the Wastewater Permits Section of the Water Quality Division, a closure plan which has been developed in accordance with the "Closure Guidance Documents Nos. 4 and 5" available through the Publications Inventory and Distribution Section (MC 195) of the Agency Communications Division.

4. The permittee is responsible for installing prior to plant start-up, and subsequently maintaining, adequate safeguards to prevent the discharge of untreated or inadequately treated wastes during electrical power failures by means of alternate power sources, standby generators, and/or retention of inadequately treated wastewater.

5. Unless otherwise specified, the permittee shall provide a readily accessible sampling point and, where applicable, an effluent flow measuring device or other acceptable means by which effluent flow may be determined.

6. The permittee shall remit an annual waste treatment fee to the Commission as required by 30 TAC Chapter 305 Subchapter M and an annual water quality assessment fee to the Commission as required by 30 TAC Chapter 320. Failure to pay either fee may result in revocation of this permit.

7. Documentation

For all written notifications to the Commission required of the permittee by this permit, the permittee shall keep and make available a copy of each such notification under the same conditions as self-monitoring data are required to be kept and made available. Except for applications, effluent data, permits, and other data specified in 30 TAC § 305.46, any information submitted pursuant to this permit may be claimed as confidential by the submitter. Any such claim must be asserted in the manner prescribed in the application form or by stamping the words "confidential business information" on each page containing such information. If no claim is made at the time of submission, information may be made available to the public without further notice.

8. Facilities which generate domestic wastewater shall comply with the following provisions; domestic wastewater treatment facilities at permitted industrial sites are excluded.

a. Whenever flow measurements for any domestic sewage treatment facility reach 75 percent of the permitted daily average or annual average flow for three consecutive months, the permittee must initiate engineering and financial planning for expansion and/or upgrading of the domestic wastewater treatment and/or collection facilities. Whenever, the flow reaches 90 percent of the permitted daily average or annual average flow for three consecutive months, the permittee shall obtain necessary authorization from the Commission to commence construction of the necessary additional treatment and/or collection facilities. In the case of a domestic wastewater treatment facility which reaches 75 percent of the permitted daily average or annual average flow for three consecutive months, and the planned population to be served or the quantity of waste produced is not expected to exceed the design limitations of the treatment facility, the permittee shall submit an engineering report supporting this claim to the Executive Director of the Commission.

If in the judgement of the Executive Director the population to be served will not cause permit noncompliance, then the requirement of this section may be waived. To be effective, any waiver must be in writing and signed by the Director of the Water Quality Division (MC 148) of the Commission, and such waiver of these requirements will be reviewed upon expiration of the existing permit; however, any such waiver shall not be interpreted as condoning or excusing any violation of any permit parameter.

b. The plans and specifications for domestic sewage collection and treatment works associated with any domestic permit must be approved by the Commission, and failure to secure approval before commencing construction of such works or making a discharge is a violation of this permit and each day is an additional violation until approval has been secured.

c. Permits for domestic wastewater treatment plants are granted subject to the policy of the Commission to encourage the development of area-wide waste collection, treatment and disposal systems. The Commission reserves the right to amend any domestic wastewater permit in accordance with applicable procedural requirements to require the system covered by this permit to be integrated into an area-wide system, should such be developed; to require the delivery of the wastes authorized to be collected in, treated by or discharged from said system, to such area-wide system; or to amend this permit in any other particular to effectuate the Commission's policy. Such amendments may be made when the changes required are advisable for water quality control purposes and are feasible on the basis of waste treatment technology, engineering, financial, and related considerations existing at the time the changes are required, exclusive of the loss of investment in or revenues from any then existing or proposed waste collection, treatment or disposal system.

9. Domestic wastewater treatment plants shall be operated and maintained by sewage plant operators holding a valid certificate of competency at the required level as defined in 30 TAC Chapter 325.

10. For publicly owned treatment works, the 30-day average (or Monthly average) percent removal for BOD and TSS shall not be less than 85 percent, unless otherwise authorized by this permit.

11. Facilities which generate industrial solid waste as defined in 30 TAC § 335.1 shall comply with these provisions:

    a. Any solid waste generated by the permittee during the management and treatment of wastewater, as defined in 30 TAC § 335.1 (including but not limited to such wastes as garbage, refuse, sludge from a waste treatment, water supply treatment plant or air pollution control facility, discarded materials, discarded materials to be recycled, whether the waste is solid, liquid, or semisolid) must be managed in accordance with all applicable provisions of 30 TAC Chapter 335, relating to Industrial Solid Waste Management.

    b. Industrial wastewater that is being collected, accumulated, stored, or processed before discharge through any final discharge outfall, specified by this permit, is considered to be industrial solid waste until the wastewater passes through the actual point source discharge and must be managed in accordance with all applicable provisions of 30 TAC Chapter 335.

    c. The permittee shall provide written notification, pursuant to the requirements of 30 TAC § 335.6(g), to the Corrective Action Section (MC 127) of the Industrial and Hazardous Waste Division informing the Commission of any closure activity involving an Industrial Solid Waste Management Unit, at least 90 days prior to conducting such an activity.

    d. Construction of any industrial solid waste management unit requires the prior written notification of the proposed activity to the Waste Evaluation Section (MC 129) of the Industrial and Hazardous Waste Division. No person shall dispose of industrial solid waste, including sludge or other solids from wastewater treatment processes, prior to fulfilling the deed recordation requirements of 30 TAC § 335.5.

    e. The term "industrial solid waste management unit" means a landfill, surface impoundment, waste-pile, industrial furnace, incinerator, cement kiln, injection well, container, drum, salt dome waste containment cavern, or any other structure vessel, appurtenance, or other improvement on land used to manage industrial solid waste.

    f. The permittee shall keep management records for all sludge (or other waste) removed from any wastewater treatment process. These records shall fulfill all applicable requirements of 30 TAC Chapter 335 and must include the following, as it pertains to wastewater treatment and discharge:

        i. Volume of waste and date(s) generated from treatment process;
        ii. Volume of waste disposed of on-site or shipped off-site;
        iii. Date(s) of disposal;
        iv. Identity of hauler or transporter;
        v. Location of disposal site; and
        vi. Method of final disposal.

        The above records shall be maintained on a monthly basis. The records shall be retained at the facility site and/or shall be readily available for review by authorized representatives of the TNRCC for at least five years.

12. For industrial facilities to which the requirements of 30 TAC Chapter 335 do not apply, sludge and solid wastes, including tank cleaning and contaminated solids for disposal, shall be disposed of in accordance with Chapter 361 of the Health and Safety Code of Texas.

TNRCC Revision 6/99

Wright Materials Inc. TPDES Permit No. 02027

OTHER REQUIREMENTS

1. Violations of daily maximum limitations for the following pollutants shall be reported orally to TNRCC Region 14, within 24 hours from the time the permittee becomes aware of the violation followed by a written report within five days: None.

2. There is no mixing zone established for this discharge to an intermittent stream. Acute toxic criteria apply at the point of discharge.

3. There shall be no discharge of domestic sewage. All sewage shall be routed to a septic tank/drainfield system.

4. The applicant will take all necessary precautions, such as diking the storage ponds and working pits to prevent the accumulation of surface runoff during periods of average rainfall. During periods of heavy rainfall when overflow into the storage and working pits occurs, the applicant may dewater the pits in order to resume operations. All such discharges will be made in accordance with the requirements on page 2.

5. All new points of discharge to the Nueces River and/or Cayamon Creek will be established with prior notification to the Texas Natural Resource Conservation Commission Region 14 Office. These discharge points will be temporary and must be re-established for each dewatering after major storm events.

6. No discharge shall be made from this operation unless the Texas Natural Resource Conservation Commission Region 14 Office has been notified 24 hours prior to discharge.

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Appendix 4
Sample Results from Outfall 001
Wright Materials, Inc. Nason Plant No. 1

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... consist solely of stormwater. Outfalls that contain any wastewater other than stormwater, for example, process wastewater, utility wastewater, domestic wastewater or groundwater, must complete TABLE 2. Facilities that utilize land application or evaporation for wastewater treatment/disposal must also provide these analytical results. Average and maximum concentrations must be calculated from at least 4 separate analytical results obtained from 4 grab or composite samples collected at a frequency of 1/week for a period of 4 weeks from the wastewater stream. If this application is for a new facility, submit results from similar facilities, treatability studies, design information, or literature sources. If this application is for an operating facility, report the results for the influent and effluent.

TABLE 2

OUTFALL 001 Sample Type: GRAB X COMPOSITE____

POLLUTANT	INFLUENT CONCENTRATION (mg/l) AVG.	INFLUENT CONCENTRATION (mg/l) MAX.	NUMBER OF SAMPLES	EFFLUENT CONCENTRATION (mg/l) AVG.	EFFLUENT CONCENTRATION (mg/l) MAX.	NUMBER OF SAMPLES
BOD (5-day)					< 2.0	1
CBOD (5-day)					< 2.0	1
Chemical Oxygen Demand					< 5.0	1
Total Organic Carbon					2.5	1
Ammonia Nitrogen					< 0.1	1
Total Suspended Solids					24.0	1
Nitrate Nitrogen					0.05	1
Total Organic Nitrogen	*Discharges have not been				1.4	1
Total Phosphorus	required during the				< 0.01	1
Oil and Grease	current permit period				< 1.0	1
Total Residual Chlorine					< 0.10	1
Total Dissolved Solids	*Tests are from Cayamon				1,448.0	1
Sulfate	Creek (see attached				220.0	1
Chloride	sheet)				490.0	1
Fluoride					1.12	1
Fecal Coliform	-50 CFU/100 ML-					1
Summer Temperature (°F)					Not Available	1
Winter Temperature (°F)					62	1
pH (Standard Units; min/max)					8.23	1

*Discharges are required by floods. Exact testing is not possible.

POLLUTANT	EFFLUENT CONCENTRATION (µg/l) AVG.	EFFLUENT CONCENTRATION (µg/l) MAX.	NUMBER OF SAMPLES	MAL µg/l
Total Aluminum *		0.91	1	30
Total Arsenic *		0.016	1	10
Total Barium *		0.11	1	10
Total Cadmium *		≤ 0.001	1	1
Total Chromium *		≤ 0.005	1	10
Trivalent Chromium		≤ 0.005	1	--
Hexavalent Chromium *		≤ 0.01	1	10
Total Copper *		0.01	1	10
Cyanide, (Amenable to Chlorination or Weak-Acid Dissociable) *		≤ 0.02	1	20
Total Lead *		≤ 0.002	1	5
Total Mercury *		≤ 0.0002	1	0.2
Total Nickel *		0.01	1	10
Total Selenium *		≤ 0.002	1	10
Total Silver *		≤ 0.001	1	2
Total Zinc *		≤ 0.005	1	5

*** Test Methods utilized should be sensitive enough to detect these constituents at the Minimum Analytical Level (MAL) specified above in micrograms/liter (µg/l).**

REVISED 11/95 INDUSTRIAL WASTEWATER PERMIT APPLICATION TECHNICAL REPORT PAGE 11

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Appendix 5
Signed Access Agreement Letter for Groundwater Monitor Well Installation in Hazel Bazemore Park

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NUECES RIVER AUTHORITY

GENERAL OFFICE
First State Bank Bldg., Suite 206
200 E. Nopal ● P O Box 349
Uvalde, Texas 78802-0349
Tel 830-278-6810 ● Fax 830-278-2025

COASTAL BEND DIVISION
Natural Resources Center, Suite 3100
6300 Ocean Drive
Corpus Christi, Texas 78412
Tel. 361-825-3193 ● Fax 361-825-3195

October 9, 2000

Honorable Richard Borchard
County Judge
Nueces County
901 Leopard St.
Corpus Christi, Texas 78401

Re: Groundwater Monitoring Well Installations in Hazel Bazemore Park

Dear Judge Borchard:

As part of the Senate Bill 1 Regional Water Planning Program for the Coastal Bend area, the Nueces River Authority and the Center for Water Supply Studies at Texas A&M University - Corpus Christi are conducting water quality investigations in the Nueces River above the Calallen Dam. These studies are designed to address the problem of elevated levels of dissolved solids in the Nueces River water. The higher salt content in the water being diverted from the Nueces River at Calallen interferes with industrial water use. If we can find ways to prevent these increases, industries can use these water supplies more efficiently, thus reducing industrial water demands.

The levels of chloride and other dissolved minerals increase significantly in the river reach below Wesley Seale Dam, particularly in the vicinity of the Calallen Pool. We believe that groundwater intrusion may be the primary cause of these salt loadings. In order to identify the sources, we are installing groundwater monitoring wells at several locations adjacent to the Calallen Pool. The Hazel Bazemore Nueces County Park is one of the best situated sites we have identified for our monitoring studies.

With your permission, we would like to install two permanent groundwater monitoring wells and sample these wells on a routine basis. Both wells would be 4" diameter, cased wells; one would be drilled to approximately 15 feet in depth and the other to approximately 30 feet in depth. Both wells would be installed by a licensed water well driller according to the requirements in the Texas Water Code. The wells would be capped with a locking device to prevent unauthorized access. We will be happy to work with the Nueces County Parks Department personnel in selecting an appropriate site for the wells within Hazel Bazemore Park.

Our timeframe for installing these wells is fairly tight in order to meet a monitoring schedule that begins in the last week of this month. If possible, we would like to have the wells installed by the end of this week. I apologize for the lateness of this request, but would ask for your approval as quickly as possible. I have included a signature line at the end of this letter as a method of approval.

Honorable Richard Borchard
County Judge, Nueces County
October 9, 2000
Page two

Thank you for your kind consideration and cooperation.

Sincerely,

James Dodson

James A. Dodson
Deputy Executive Director

c: Mr. Frank Rios, Director, Nueces County Parks and Recreation
Dr. C. Alan Berkebile, Director, Center for Water Supply Studies, TAMU-CC

Approved by:

R Borchard 10/9/00

Judge Richard Borchard **Date**
Nueces County, Texas

Appendix 6
Aerial Image with Well Location Information

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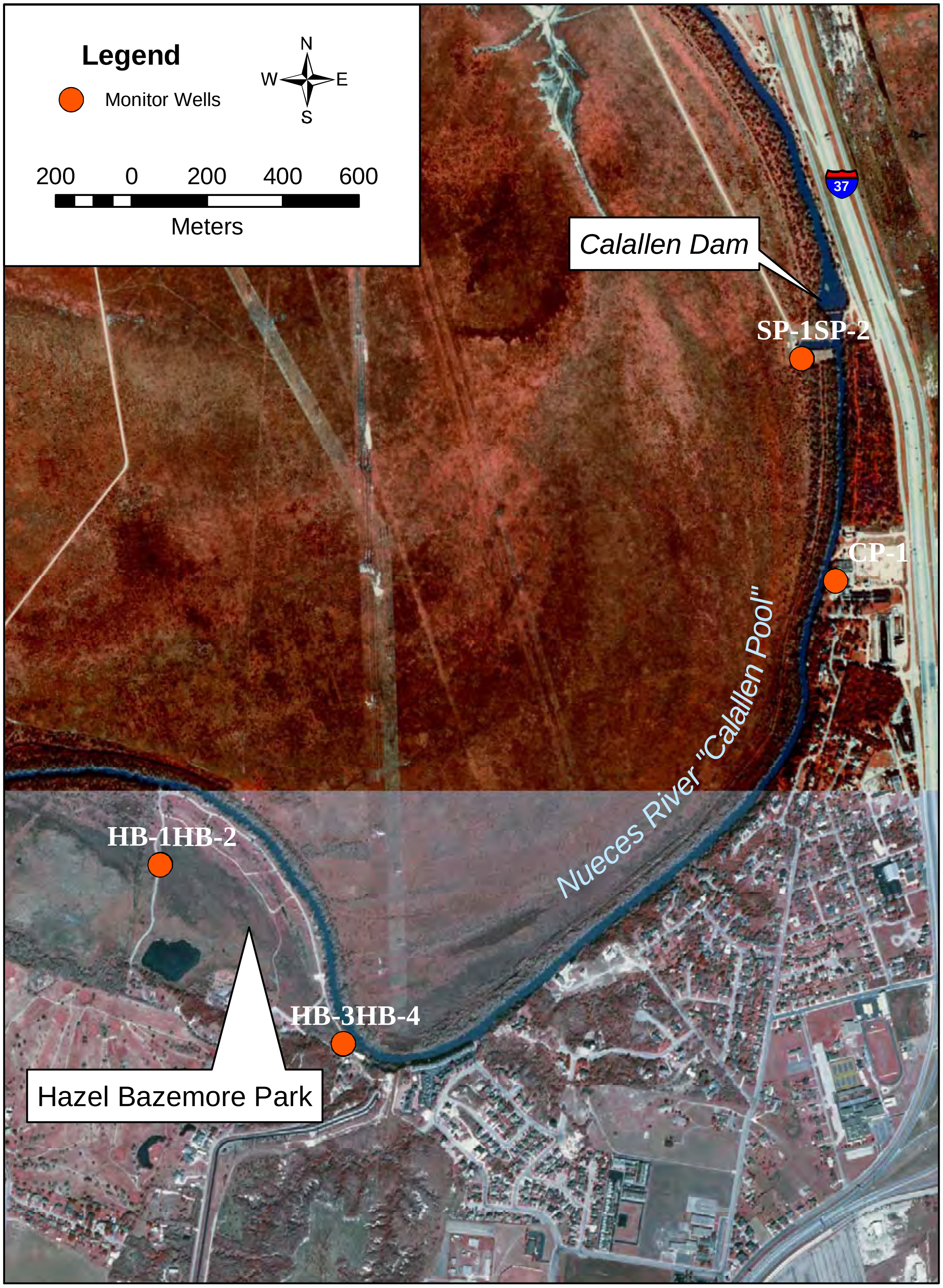

Appendix 6. Aerial Image with Well Location Information

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Appendix 7
Monitor Well Logs

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CENTER FOR WATER SUPPLY STUDIES	**6300 Ocean Drive CORPUS CHRISTI, TX 78412 (361) 825-3344**	**BORING NUMBER**	HB-1
		PROJECT NAME	Nueces River Project
		LOCATION	Hazel Bazemore Park
COORDINATES	E 633515 N 3083345	**PROJECT NUMBER**	
SURFACE ELEVATION	**DATUM** GL	**LOGGED BY**	K. Dodson

DEPTH FEET	LAB SAMPLE	SAMPLE TYPE	BLOW COUNTS	Recovery %	OVA (ppm)	STRATA	DESCRIPTION	WELL CONSTRUCTION DETAIL	ELEVATION FEET
		SS					Clay	Cement	
3		SS					Clay	Bentonite	
								PVC Riser	
		SS							
6							Clay - lt. Gray		
		SS					Sand w/clay stringers	PVC Screen	
9									

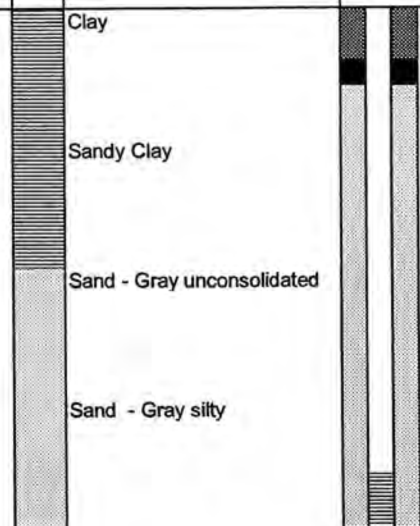
DRILLING CONTRACTOR	Front Range Environmental
DRILLING METHOD	Hollow stem auger
DRILLING EQUIPMENT	
DRILLING STARTED	10/13/2000 **ENDED** 10/13/2000

REMARKS: Water 5' below surface. TD 8' UTM 14 - NAD27

CENTER FOR WATER SUPPLY STUDIES
6300 Ocean Drive
CORPUS CHRISTI, TX 78412
(361) 825-3344

COORDINATES	E 633515 N 3083345
SURFACE ELEVATION	DATUM GL
BORING NUMBER	HB-2
PROJECT NAME	Nueces River Project
LOCATION	Hazel Bazemore Park (West End)
PROJECT NUMBER	
LOGGED BY	R. Hay

SAMPLE INFORMATION						STRATA	DESCRIPTION	WELL CONSTRUCTION DETAIL	ELEVATION FEET
DEPTH FEET	LAB SAMPLE	SAMPLE TYPE	BLOW COUNTS	Recovery %	OVA (ppm)				
		GS					Clay	Cement	
3								Bentonite PVC Riser	
6		GS					Sandy Clay		
9									
		GS					Sand - Gray unconsolidated		
12									
15									
		GS					Sand - Gray silty		
18								PVC Screen	
21									



DRILLING CONTRACTOR	Front Range Environmental
DRILLING METHOD	Hollow stem auger
DRILLING EQUIPMENT	
DRILLING STARTED	10/13/2000 ENDED 10/13/2000

REMARKS: TD 20' UTM 14 - NAD27

CENTER FOR WATER SUPPLY STUDIES
6300 Ocean Drive
CORPUS CHRISTI, TX 78412
(361) 825-3344

BORING NUMBER	HB-3
PROJECT NAME	Nueces River Project
LOCATION	Hazel Bazemore Park (east end)
PROJECT NUMBER	
LOGGED BY	R. Hay

COORDINATES
SURFACE ELEVATION DATUM GL

DEPTH FEET	LAB SAMPLE	SAMPLE TYPE	BLOW COUNTS	Recovery %	OVA (ppm)	DESCRIPTION	WELL CONSTRUCTION DETAIL	ELEVATION FEET
		SS				Black-Brown Clay	Cement	
						Brown Sand		
3		SS				lt. Brown clay w/ some sand	Bentonite	
							PVC Riser	
		SS				lt. Brown clay (sandy)		
6						Black Clay		
		SS				Black Clay		
						Black Clay		
9		SS				Clay Sand w/pebble & caliche		
						lt. Brown Sand (clayey)	PVC Screen	
		SS				poorly sorted w/ pebbles		
12								

DRILLING CONTRACTOR Front Range Environmental
DRILLING METHOD Hollow stem auger
DRILLING EQUIPMENT
DRILLING STARTED 10/18/2000 ENDED 10/18/2000

REMARKS: Water 3.66' below surface. TD 12'

CENTER FOR WATER SUPPLY STUDIES	6300 Ocean Drive CORPUS CHRISTI, TX 78412 (361) 825-3344	BORING NUMBER	HB-4
COORDINATES		PROJECT NAME	Nueces River Project
SURFACE ELEVATION	DATUM GL	LOCATION	Hazel Bazemore Park
		PROJECT NUMBER	
		LOGGED BY	R. Hay

DEPTH FEET	LAB SAMPLE	SAMPLE TYPE	BLOW COUNTS	Recovery %	OVA (ppm)	STRATA	DESCRIPTION	WELL CONSTRUCTION DETAIL	ELEVATION FEET
		SS					Not Logged	Cement	
3		SS						Bentonite PVC Riser	
6		SS					Gray Clay		
9		SS					lt. Brown-gray sand w/clay stringers		
12		SS							
15		SS					Partial returns w/clay stringers		
18		SS						PVC Screen	
21		SS							

DRILLING CONTRACTOR	Front Range Environmental	REMARKS:
DRILLING METHOD	Hollow stem auger	
DRILLING EQUIPMENT		
DRILLING STARTED	10/18/2000 ENDED 10/18/2000	

CENTER FOR WATER SUPPLY STUDIES	**6300 Ocean Drive CORPUS CHRISTI, TX 78412 (361) 825-3344**	**BORING NUMBER**	SP-1
		PROJECT NAME	Nueces River Project
		LOCATION	SPMWD
COORDINATES	E 635207 N 3084684	**PROJECT NUMBER**	
SURFACE ELEVATION	**DATUM** GL	**LOGGED BY**	R. Hay

DEPTH FEET	LAB SAMPLE	SAMPLE TYPE	BLOW COUNTS	Recovery %	OVA (ppm)	STRATA	DESCRIPTION	WELL CONSTRUCTION DETAIL	ELEVATION FEET
		GS					Black Clay	Cement	
3		GS						Bentonite	
							Sand	PVC Riser	
		GS					Tan/gray Clay w/sand stringers		
6		GS					Tan/gray Clay w/sand stringers		
9		GS					Sandy Clay		
		GS					Gray Sand		
12							Gray Clay		
		GS					Gray Sand w/brown-tan clay		
15		GS					Brown Clay	PVC Screen	
							Gray Sandy Clay		
		GS					Brown Clay		
18							Gray Sandy Clay		

DRILLING CONTRACTOR Front Range Environmental	REMARKS: Water 10.5' below surface. TD 18'
DRILLING METHOD Hollow stem auger	
DRILLING EQUIPMENT	
DRILLING STARTED 10/16/2000 **ENDED** 10/16/2000	

CENTER FOR WATER SUPPLY STUDIES	6300 Ocean Drive CORPUS CHRISTI, TX 78412 (361) 825-3344	**BORING NUMBER**	SP-2
		PROJECT NAME	Nueces River Project
		LOCATION	SPMWD
COORDINATES	E 635207 N 3084684	**PROJECT NUMBER**	
SURFACE ELEVATION	**DATUM** GL	**LOGGED BY**	R. Hay

DEPTH FEET	LAB SAMPLE	SAMPLE TYPE	BLOW COUNTS	Recovery %	OVA (ppm)	STRATA	DESCRIPTION	WELL CONSTRUCTION DETAIL	ELEVATION FEET
		GS					Black Clay	Cement	
3								Bentonite	
		GS					Brown Clay	PVC Riser	
6		GS					Brown Clay		
9		GS					Brown-gray Sandy Clay		
		GS					Gray Sandy Clay		
12									
		GS					No Returns		
15									
		GS					Gray Sandy Clay		
18									
21		GS					Gray Sandy Clay occasionally no returns		
24								PVC Screen	
27									

DRILLING CONTRACTOR	Front Range Environmental	REMARKS: Water 6.5' below surface. TD 8'
DRILLING METHOD	Hollow stem auger	
DRILLING EQUIPMENT		
DRILLING STARTED	10/16/2000 **ENDED** 10/16/2000	

CENTER FOR WATER SUPPLY STUDIES	6300 Ocean Drive CORPUS CHRISTI, TX 78412 (361) 825-3344	BORING NUMBER	CP-1
COORDINATES	E 635298 N 3084123	PROJECT NAME	Nueces River Project
SURFACE ELEVATION	DATUM GL	LOCATION	Cunningham Plant
		PROJECT NUMBER	
		LOGGED BY	R. Hay

DEPTH FEET	LAB SAMPLE	SAMPLE TYPE	BLOW COUNTS	Recovery %	OVA (ppm)	STRATA	DESCRIPTION	WELL CONSTRUCTION DETAIL	ELEVATION FEET
		SS					Dark Brown Clay	Cement	
							Hard Caliche		
3		SS					Caliche	Bentonite	
								PVC Riser	
		SS					Caliche		
6									
		SS					Caliche		
							lt. Brown Sand w/ gravel		
9		SS					lt. Brown Sand w/ gravel		
		SS					lt. Brown Sand w/ gravel		
12									
		SS					Gravel and Sand		
							Clay at bottom		
15		SS					Gavel and Sand	PVC Screen	
							moderate production		
18									
27									

DRILLING CONTRACTOR	Front Range Environmental	REMARKS: Water 11' below surface. TD 16'
DRILLING METHOD	Hollow stem auger	
DRILLING EQUIPMENT		
DRILLING STARTED	10/17/2000 ENDED 10/17/2000	

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Appendix 8
Sample Results

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CUSTOM__R RECORD and ANALYS__

Send Results to: __ielle Grunkemeyer
Nueces River Authority

Address: NRC Bldg., Suite 3100
6300 Ocean Drive
Corpus Christi, TX 78412

Phone:	Fax:	Project Name:	Project No.:
361-825-3193	361-825-3195	Nueces River Dissolved Minerals Study	SB-1

Sampling by: Gabrielle Grunkemeyer, Karen Dodson, and Angela Rodriguez

NUECES RIVER AUTHOR..Y

Lab Analysis Request

Sampling Location Identification:	Lab Only	No. Containers	Matrix: Liquid	Matrix: Soil	Preserved with Ice (4° C)	Sampling Date	Sampling Time	Calcium 600 215.1	Magnesium 600 242.1	Sodium 600 273.1	Potassium 600 258.1	Sulfate method 600 375.3	Chloride method SM 4500-Cl B	TDS method 600 310.1	Alkalinity method 310.1	Bromide SM 4500-Br- B	Hardness method 130
HB-1			X		✓	10/27/2000	9:55										
HB-2			X		✓	10/27/2000	9:50										
HB-3			X		✓	10/27/2000	10:45										
HB-4			X		✓	10/27/2000	10:45										
R-1			X		✓	10/27/2000	10:30										
R-2			X		✓	10/27/2000	11:36										
SP-1			X		✓	10/27/2000	11:59										
SP-2			X		✓	10/27/2000	11:54										
CP-1			X		✓	10/27/2000	12:40										
			X														
Replicate:			X														

Relinquished by:	Date	Time	Received By:	Date	Time	Remarks: X = laboratory measurement Field measurements = DO, Conductance, Temperature, pH.
[signature]	10/27/2000	1:35 p.m.	[signature]	10-27-00	1:35	

D-1

CUSTOMER RECORD and ANALYSI

Send Results to: Gabrielle Grunkemeyer
Address: Nueces River Authority
NRC Bldg., Suite 3100
6300 Ocean Drive
Corpus Christi, TX 78412

NUECES RIVER AUTHORITY

Lab Analysis Request

Phone:	Fax:	Project Name:	Project No.:
361-825-3193	361-825-3195	Nueces River Dissolved Minerals Study	SB-1

Sampling by: Gabrielle Grunkemeyer, Karen Dodson, and Angela Rodriguez
Sani Sugarek

Sampling Location Identification:	Lab Only	No. Containers	Matrix: Liquid	Matrix: Soil	Preserved with Ice (4° C)		Sampling: Date	Sampling: Time	Calcium 600 215.1	Magnesium 600 242.1	Sodium 600 273.1	Potassium 600 258.1	Sulfate method 600 375.3	Chloride method SM 4500-Cl⁻ B	TDS method 600 310.1	Alkalinity method 310.1	Bromide SM 4500-Br⁻ B	Hardness method 130					
WC1D1-B			X		✓		10-30-00	1050	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
WC1D-1-M			X		✓		10-30-00	1115															
DS1-B			X		✓		10-30-00	1144															
DS1-M			X		✓		10-30-00	1153															
DS1-M (dup.)			X		✓		10-30-00	1156															
			X																				
			X																				
			X																				
			X																				
			X																				
			X																				

Replicate:

Relinquished by:	Date	Time	Received By:	Date	Time	Remarks: X = laboratory measurement
	10-30-00	12:45	C. Meske	10-30-00	1245	Field measurements = DO, Conductance, Temperature, pH.

D-1

TEL. 361-884-0371 PO BOX 2552 78403

JORDAN LABORATORIES, INCORPORATED
ANALYTICAL & ENVIRONMENTAL CHEMISTS
CORPUS CHRISTI, TEXAS
November 29, 2000

NUECES RIVER AUTHORITY
6300 Ocean Drive, NRC 3100
Corpus Christi, TX 78412

Report of Analysis

Identification: HB-1
9:55 AM 10-27-00

Method Number		mg/L	meq/L	Analyst	Analysis Date
	Cations:				
EPA 600 215.1	Calcium	820	40.92	Merks	10-31-00
EPA 600 242.1	Magnesium	240	19.74	Merks	10-31-00
EPA 600 273.1	Sodium	2450	106.57	Merks	10-31-00
EPA 600 258.1	Potassium	41	1.05	Merks	10-31-00
	Total Cations		168.28		
	Anions:				
EPA 600 310.1	Carbonate	0	0.00	Merks	10-27-00
EPA 600 310.1	Bicarbonate	394	6.46	Merks	10-27-00
EPA 600 375.3	Sulfate	1290	26.86	Merks	11-02-00
SM 4500-Cl~ B.	Chloride	4490	126.66	Merks	10-30-00
	Total Anions		159.98		
	Ion Ratio (Cation/Anion) --- 1.052				

		mg/L	Analyst	Analysis Date
EPA 600 150.1	pH --------------- 7.00		Merks	10-27-00
EPA 600 310.1	Total Alkalinity as Calcium Carbonate ----------------	323	Merks	10-27-00
SM 2340 B.	Total Hardness as Calcium Carbonate ----------------	3040	Merks	10-31-00
EPA 600 160.1	Total Dissolved Solids (180 Deg.C) --------------	10300	Merks	10-31-00
SM 4500-Br~	Bromide --------------------	14	Moore	10-31-00

Lab. No. M38-4867

Signed: Carl Crownover

Carl F. Crownover, Pres.

form: S2-26

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JORDAN LABORATORIES, INCORPORATED
ANALYTICAL & ENVIRONMENTAL CHEMISTS
CORPUS CHRISTI, TEXAS
November 29, 2000

NUECES RIVER AUTHORITY
6300 Ocean Drive, NRC 3100
Corpus Christi, TX 78412

Report of Analysis

Identification: HB-2
9:50 AM 10-27-00

Method Number		mg/L	meq/L	Analyst	Analysis Date
	Cations:				
EPA 600 215.1	Calcium	600	29.94	Merks	10-31-00
EPA 600 242.1	Magnesium	200	16.45	Merks	10-31-00
EPA 600 273.1	Sodium	2180	94.82	Merks	10-31-00
EPA 600 258.1	Potassium	17	0.43	Merks	10-31-00
	Total Cations		141.64		
	Anions:				
EPA 600 310.1	Carbonate	0	0.00	Merks	10-27-0ι
EPA 600 310.1	Bicarbonate	376	6.16	Merks	10-27-00
EPA 600 375.3	Sulfate	1030	21.44	Merks	11-02-00
SM 4500-Cl~ B.	Chloride	3780	106.63	Merks	10-30-00
	Total Anions		134.23		

Ion Ratio (Cation/Anion) --- 1.055

Method Number		mg/L	Analyst	Analysis Date
EPA 600 150.1	pH --------------- 6.89		Merks	10-27-00
EPA 600 310.1	Total Alkalinity as Calcium Carbonate ----------------	308	Merks	10-27-00
SM 2340 B.	Total Hardness as Calcium Carbonate ----------------	2320	Merks	10-31-00
EPA 600 160.1	Total Dissolved Solids (180 Deg.C) --------------	8430	Merks	10-31-00
SM 4500-Br~	Bromide --------------------	13	Moore	10-31-00

Lab. No. M38-4868

Signed: CaFCrow
Carl F. Crownover, Pres.

form: S2-26

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ANALYTICAL & ENVIRONMENTAL CHEMISTS
CORPUS CHRISTI, TEXAS
November 29, 2000

NUECES RIVER AUTHORITY
6300 Ocean Drive, NRC 3100
Corpus Christi, TX 78412

Report of Analysis

Identification: HB-3
10:45 AM 10-27-00

Method Number		mg/L	meq/L	Analyst	Analysis Date
	Cations:				
EPA 600 215.1	Calcium	240	11.98	Merks	10-31-00
EPA 600 242.1	Magnesium	74	6.09	Merks	10-31-00
EPA 600 273.1	Sodium	810	35.23	Merks	10-31-00
EPA 600 258.1	Potassium	24	0.61	Merks	10-31-00
	Total Cations		53.91		
	Anions:				
EPA 600 310.1	Carbonate	0	0.00	Merks	10-27-00
EPA 600 310.1	Bicarbonate	450	7.37	Merks	10-27-00
EPA 600 375.3	Sulfate	462	9.62	Merks	11-02-00
SM 4500-Cl⁻ B.	Chloride	1320	37.24	Merks	10-30-00
	Total Anions		54.23		

Ion Ratio (Cation/Anion) --- 0.994

Method Number		mg/L	Analyst	Analysis Date
EPA 600 150.1	pH --------------- 7.05		Merks	10-27-00
EPA 600 310.1	Total Alkalinity as Calcium Carbonate ----------------	369	Merks	10-27-00
SM 2340 B.	Total Hardness as Calcium Carbonate ----------------	904	Merks	10-31-00
EPA 600 160.1	Total Dissolved Solids (180 Deg.C) --------------	3290	Merks	10-31-00
SM 4500-Br⁻	Bromide --------------------	2.5	Moore	10-31-00

Lab. No. M38-4869

Signed: Carl F. Crownover

Carl F. Crownover, Pres.

form: S2-26

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JORDAN LABORATORIES, INCORPORATED
ANALYTICAL & ENVIRONMENTAL CHEMISTS
CORPUS CHRISTI, TEXAS
November 29, 2000

NUECES RIVER AUTHORITY
6300 Ocean Drive, NRC 3100
Corpus Christi, TX 78412

Report of Analysis

Identification: HB-4
10:45 AM 10-27-00

Method Number		mg/L	meq/L	Analyst	Analysis Date
	Cations:				
EPA 600 215.1	Calcium	217	10.83	Merks	10-31-00
EPA 600 242.1	Magnesium	67	5.51	Merks	10-31-00
EPA 600 273.1	Sodium	860	37.41	Merks	10-31-00
EPA 600 258.1	Potassium	17	0.43	Merks	10-31-00
	Total Cations		54.18		
	Anions:				
EPA 600 310.1	Carbonate	0	0.00	Merks	10-27-0(
EPA 600 310.1	Bicarbonate	454	7.44	Merks	10-27-00
EPA 600 375.3	Sulfate	459	9.56	Merks	11-02-00
SM 4500-Cl⁻ B.	Chloride	1250	35.26	Merks	10-30-00
	Total Anions		52.26		

Ion Ratio (Cation/Anion) --- 1.037

		mg/L	Analyst	Analysis Date
EPA 600 150.1	pH ---------------- 7.04		Merks	10-27-00
EPA 600 310.1	Total Alkalinity as Calcium Carbonate ----------------	372	Merks	10-27-00
SM 2340 B.	Total Hardness as Calcium Carbonate ----------------	818	Merks	10-31-00
EPA 600 160.1	Total Dissolved Solids (180 Deg.C) --------------	3150	Merks	10-31-00
SM 4500-Br⁻	Bromide --------------------	3.5	Moore	10-31-00

Lab. No. M38-4870

Signed: [signature]
Carl F. Crownover, Pres.

form: S2-26

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JORDAN LABORATORIES, INCORPORATED
ANALYTICAL & ENVIRONMENTAL CHEMISTS
CORPUS CHRISTI, TEXAS
November 29, 2000

NUECES RIVER AUTHORITY
6300 Ocean Drive, NRC 3100
Corpus Christi, TX 78412

Report of Analysis

Identification: R-1
10:30 AM 10-27-00

Method Number		mg/L	meq/L	Analyst	Analysis Date
	Cations:				
EPA 600 215.1	Calcium	94	4.69	Merks	10-31-00
EPA 600 242.1	Magnesium	13	1.07	Merks	10-31-00
EPA 600 273.1	Sodium	84	3.65	Merks	10-31-00
EPA 600 258.1	Potassium	12	0.31	Merks	10-31-00
	Total Cations		9.72		
	Anions:				
EPA 600 310.1	Carbonate	1	0.03	Merks	10-27-00
EPA 600 310.1	Bicarbonate	243	3.98	Merks	10-27-00
EPA 600 375.3	Sulfate	60	1.25	Merks	11-02-00
SM 4500-Cl⁻ B.	Chloride	132	3.72	Merks	10-30-00
	Total Anions		8.98		
	Ion Ratio (Cation/Anion) --- 1.082				

		mg/L		
EPA 600 150.1	pH --------------- 8.39		Merks	10-27-00
EPA 600 310.1	Total Alkalinity as Calcium Carbonate ----------------	201	Merks	10-27-00
SM 2340 B.	Total Hardness as Calcium Carbonate ----------------	288	Merks	10-31-00
EPA 600 160.1	Total Dissolved Solids (180 Deg.C) --------------	530	Merks	10-31-00
SM 4500-Br⁻	Bromide -------------------	0.3	Moore	10-31-00

Lab. No. M38-4871

Signed: [signature]
Carl F. Crownover, Pres.

form: S2-26

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ANALYTICAL & ENVIRONMENTAL CHEMISTS
CORPUS CHRISTI, TEXAS
November 29, 2000

NUECES RIVER AUTHORITY
6300 Ocean Drive, NRC 3100
Corpus Christi, TX 78412

Report of Analysis

Identification: R-2
11:30 AM 10-27-00

Method Number		mg/L	meq/L	Analyst	Analysis Date
	Cations:				
EPA 600 215.1	Calcium	99	4.94	Merks	10-31-00
EPA 600 242.1	Magnesium	15	1.23	Merks	10-31-00
EPA 600 273.1	Sodium	109	4.74	Merks	10-31-00
EPA 600 258.1	Potassium	12	0.31	Merks	10-31-00
	Total Cations		11.22		
	Anions:				
EPA 600 310.1	Carbonate	1	0.03	Merks	10-27-0[illegible]
EPA 600 310.1	Bicarbonate	245	4.02	Merks	10-27-00
EPA 600 375.3	Sulfate	75	1.56	Merks	11-02-00
SM 4500-Cl⁻ B.	Chloride	174	4.91	Merks	10-30-00
	Total Anions		10.52		
	Ion Ratio (Cation/Anion) --- 1.067				

Method Number		mg/L	Analyst	Analysis Date
EPA 600 150.1	pH --------------- 8.37		Merks	10-27-00
EPA 600 310.1	Total Alkalinity as Calcium Carbonate ----------------	203	Merks	10-27-00
SM 2340 B.	Total Hardness as Calcium Carbonate ----------------	309	Merks	10-31-00
EPA 600 160.1	Total Dissolved Solids (180 Deg.C) --------------	640	Merks	10-31-00
SM 4500-Br⁻	Bromide --------------------	0.4	Moore	10-31-00

Lab. No. M38-4872

Signed: Carl F. Crownover

Carl F. Crownover, Pres.

form: S2-26

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ANALYTICAL & ENVIRONMENTAL CHEMISTS
CORPUS CHRISTI, TEXAS
November 29, 2000

NUECES RIVER AUTHORITY
6300 Ocean Drive, NRC 3100
Corpus Christi, TX 78412

Report of Analysis

Identification: SP-1
11:59 AM 10-27-00

Method Number		mg/L	meq/L	Analyst	Analysis Date
	Cations:				
EPA 600 215.1	Calcium	115	5.74	Merks	10-31-00
EPA 600 242.1	Magnesium	79	6.50	Merks	10-31-00
EPA 600 273.1	Sodium	2030	88.30	Merks	10-31-00
EPA 600 258.1	Potassium	28	0.72	Merks	10-31-00
	Total Cations		101.26		
	Anions:				
EPA 600 310.1	Carbonate	0	0.00	Merks	10-27-00
EPA 600 310.1	Bicarbonate	1004	16.45	Merks	10-27-00
EPA 600 375.3	Sulfate	301	6.27	Merks	11-02-00
SM 4500-Cl⁻ B.	Chloride	2800	78.98	Merks	10-30-00
	Total Anions		101.70		

Ion Ratio (Cation/Anion) --- 0.996

Method Number		mg/L	Analyst	Analysis Date
EPA 600 150.1	pH --------------- 7.57		Merks	10-27-00
EPA 600 310.1	Total Alkalinity as Calcium Carbonate ----------------	823	Merks	10-27-00
SM 2340 B.	Total Hardness as Calcium Carbonate ----------------	612	Merks	10-31-00
EPA 600 160.1	Total Dissolved Solids (180 Deg.C) --------------	6050	Merks	10-31-00
SM 4500-Br⁻	Bromide --------------------	8.0	Moore	10-31-00

Lab. No. M38-4873

Signed: Carl F. Crownover
Carl F. Crownover, Pres.

form: S2-26

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PO BOX 2552 78403

JORDAN LABORATORIES, INCORPORATED
ANALYTICAL & ENVIRONMENTAL CHEMISTS
CORPUS CHRISTI, TEXAS
November 29, 2000

NUECES RIVER AUTHORITY
6300 Ocean Drive, NRC 3100
Corpus Christi, TX 78412

Report of Analysis

Identification: SP-2
11:54 AM 10-27-00

Method Number		mg/L	meq/L	Analyst	Analysis Date
	Cations:				
EPA 600 215.1	Calcium	13	0.65	Merks	10-31-00
EPA 600 242.1	Magnesium	6.1	0.50	Merks	10-31-00
EPA 600 273.1	Sodium	473	20.57	Merks	10-31-00
EPA 600 258.1	Potassium	9.5	0.24	Merks	10-31-00
	Total Cations		21.96		
	Anions:				
EPA 600 310.1	Carbonate	0	0.00	Merks	10-27-00
EPA 600 310.1	Bicarbonate	656	10.75	Merks	10-27-00
EPA 600 375.3	Sulfate	44	0.92	Merks	11-02-00
SM 4500-Cl⁻ B.	Chloride	415	11.71	Merks	10-30-00
	Total Anions		23.38		
	Ion Ratio (Cation/Anion) --- 0.939				

Method Number		mg/L	Analyst	Analysis Date
EPA 600 150.1	pH ---------------- 8.17		Merks	10-27-00
EPA 600 310.1	Total Alkalinity as Calcium Carbonate ----------------	538	Merks	10-27-00
SM 2340 B.	Total Hardness as Calcium Carbonate ----------------	58	Merks	10-31-00
EPA 600 160.1	Total Dissolved Solids (180 Deg.C) --------------	1360	Merks	10-31-00
SM 4500-Br⁻	Bromide ------------------	1.0	Moore	10-31-00

Lab. No. M38-4874

Signed: CFCrownover
Carl F. Crownover, Pres.

form: S2-26

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ANALYTICAL & ENVIRONMENTAL CHEMISTS
CORPUS CHRISTI, TEXAS
November 29, 2000

NUECES RIVER AUTHORITY
6300 Ocean Drive, NRC 3100
Corpus Christi, TX 78412

Report of Analysis

Identification: CP-1
12:40 PM 10-27-00

Method Number		mg/L	meq/L	Analyst	Analysis Date
	Cations:				
EPA 600 215.1	Calcium	78	3.89	Merks	10-31-00
EPA 600 242.1	Magnesium	10	0.82	Merks	10-31-00
EPA 600 273.1	Sodium	84	3.65	Merks	10-31-00
EPA 600 258.1	Potassium	8.7	0.22	Merks	10-31-00
	Total Cations		8.58		
	Anions:				
EPA 600 310.1	Carbonate	0	0.00	Merks	10-27-00
EPA 600 310.1	Bicarbonate	215	3.52	Merks	10-27-00
EPA 600 375.3	Sulfate	64	1.33	Merks	11-02-00
SM 4500-Cl~ B.	Chloride	116	3.27	Merks	10-30-00
	Total Anions		8.12		
	Ion Ratio (Cation/Anion) --- 1.057				

		mg/L		
EPA 600 150.1	pH -------------- 7.65		Merks	10-27-00
EPA 600 310.1	Total Alkalinity as Calcium Carbonate ----------------	176	Merks	10-27-00
SM 2340 B.	Total Hardness as Calcium Carbonate ----------------	236	Merks	10-31-00
EPA 600 160.1	Total Dissolved Solids (180 Deg.C) --------------	483	Merks	10-31-00
SM 4500-Br~	Bromide -------------------	0.3	Moore	10-31-00

Lab. No. M38-4875

Signed: Carl F. Crownover

Carl F. Crownover, Pres.

form: S2-26

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JORDAN LABORATORIES, INCORPORATED
ANALYTICAL & ENVIRONMENTAL CHEMISTS
CORPUS CHRISTI, TEXAS
November 29, 2000

NUECES RIVER AUTHORITY
6300 Ocean Drive, NRC 3100
Corpus Christi, TX 78412

Report of Analysis

Identification: WCID1-B
10:50 AM 10-30-00

Method Number		mg/L	meq/L	Analyst	Analysis Date
	Cations:				
EPA 600 215.1	Calcium	90	4.49	Merks	11-14-00
EPA 600 242.1	Magnesium	11	0.90	Merks	11-14-00
EPA 600 273.1	Sodium	64	2.78	Merks	11-14-00
EPA 600 258.1	Potassium	11	0.28	Merks	11-14-00
	Total Cations		8.45		
	Anions:				
EPA 600 310.1	Carbonate	6	0.20	Merks	10-30-0
EPA 600 310.1	Bicarbonate	229	3.75	Merks	10-30-00
EPA 600 375.3	Sulfate	55	1.15	Merks	11-02-00
SM 4500-Cl~ B.	Chloride	95	2.68	Merks	11-13-00
	Total Anions		7.78		
	Ion Ratio (Cation/Anion) --- 1.086				

		mg/L	Analyst	Analysis Date
EPA 600 150.1	pH --------------- 8.49		Merks	10-30-00
EPA 600 310.1	Total Alkalinity as Calcium Carbonate ----------------	198	Merks	10-30-00
SM 2340 B.	Total Hardness as Calcium Carbonate ----------------	270	Merks	11-14-00
EPA 600 160.1	Total Dissolved Solids (180 Deg.C) --------------	458	Merks	10-31-00
SM 4500-Br~	Bromide -------------------	0.2	Moore	11-16-00

Lab. No. M38-4931

Signed: [signature]
Carl F. Crownover, Pres.

form: S2-26

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JORDAN LABORATORIES, INCORPORATED
ANALYTICAL & ENVIRONMENTAL CHEMISTS
CORPUS CHRISTI, TEXAS
November 29, 2000

NUECES RIVER AUTHORITY
6300 Ocean Drive, NRC 3100
Corpus Christi, TX 78412

Report of Analysis

Identification: WCID1-M
11:15 AM 10-30-00

Method Number		mg/L	meq/L	Analyst	Analysis Date
	Cations:				
EPA 600 215.1	Calcium	90	4.49	Merks	11-14-00
EPA 600 242.1	Magnesium	11	0.90	Merks	11-14-00
EPA 600 273.1	Sodium	64	2.78	Merks	11-14-00
EPA 600 258.1	Potassium	9.8	0.25	Merks	11-14-00
	Total Cations		8.42		
	Anions:				
EPA 600 310.1	Carbonate	6	0.20	Merks	10-30-00
EPA 600 310.1	Bicarbonate	229	3.75	Merks	10-30-00
EPA 600 375.3	Sulfate	55	1.15	Merks	11-02-00
SM 4500-Cl⁻ B.	Chloride	94	2.65	Merks	11-13-00
	Total Anions		7.75		
	Ion Ratio (Cation/Anion) --- 1.086				

		mg/L	Analyst	Analysis Date
EPA 600 150.1	pH --------------- 8.52		Merks	10-30-00
EPA 600 310.1	Total Alkalinity as Calcium Carbonate ----------------	198	Merks	10-30-00
SM 2340 B.	Total Hardness as Calcium Carbonate ----------------	270	Merks	11-14-00
EPA 600 160.1	Total Dissolved Solids (180 Deg.C) --------------	468	Merks	10-31-00
SM 4500-Br⁻	Bromide -------------------	0.1	Moore	11-16-00

Lab. No. M38-4932

Signed: Carl Crownover
Carl F. Crownover, Pres.

form: S2-26

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JORDAN LABORATORIES, INCORPORATED
ANALYTICAL & ENVIRONMENTAL CHEMISTS
CORPUS CHRISTI, TEXAS
November 29, 2000

NUECES RIVER AUTHORITY
6300 Ocean Drive, NRC 3100
Corpus Christi, TX 78412

Report of Analysis

Identification: OS1-B
11:46 AM 10-30-00

Method Number		mg/L	meq/L	Analyst	Analysis Date
	Cations:				
EPA 600 215.1	Calcium	90	4.49	Merks	11-14-00
EPA 600 242.1	Magnesium	11	0.90	Merks	11-14-00
EPA 600 273.1	Sodium	67	2.91	Merks	11-14-00
EPA 600 258.1	Potassium	10	0.26	Merks	11-14-00
	Total Cations		8.56		
	Anions:				
EPA 600 310.1	Carbonate	7	0.23	Merks	10-30-00
EPA 600 310.1	Bicarbonate	228	3.74	Merks	10-30-00
EPA 600 375.3	Sulfate	52	1.08	Merks	11-02-00
SM 4500-Cl~ B.	Chloride	97	2.74	Merks	11-13-00
	Total Anions		7.79		
	Ion Ratio (Cation/Anion) --- 1.099				

		mg/L	Analyst	Analysis Date
EPA 600 150.1	pH --------------- 8.51		Merks	10-30-00
EPA 600 310.1	Total Alkalinity as Calcium Carbonate ----------------	199	Merks	10-30-00
SM 2340 B.	Total Hardness as Calcium Carbonate ----------------	270	Merks	11-14-00
EPA 600 160.1	Total Dissolved Solids (180 Deg.C) --------------	483	Merks	10-31-00
SM 4500-Br~	Bromide -------------------	0.3	Moore	11-16-00

Lab. No. M38-4933

Signed: ____________________
Carl F. Crownover, Pres.

form: S2-26

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JORDAN LABORATORIES, INCORPORATED
ANALYTICAL & ENVIRONMENTAL CHEMISTS
CORPUS CHRISTI, TEXAS
November 29, 2000

NUECES RIVER AUTHORITY
6300 Ocean Drive, NRC 3100
Corpus Christi, TX 78412

Report of Analysis

Identification: OS1-M
11:53 AM 10-30-00

Method Number		mg/L	meq/L	Analyst	Analysis Date
	Cations:				
EPA 600 215.1	Calcium	90	4.49	Merks	11-14-00
EPA 600 242.1	Magnesium	12	0.99	Merks	11-14-00
EPA 600 273.1	Sodium	63	2.74	Merks	11-14-00
EPA 600 258.1	Potassium	13	0.33	Merks	11-14-00
	Total Cations		8.55		
	Anions:				
EPA 600 310.1	Carbonate	7	0.23	Merks	10-30-00
EPA 600 310.1	Bicarbonate	227	3.72	Merks	10-30-00
EPA 600 375.3	Sulfate	57	1.19	Merks	11-02-00
SM 4500-Cl⁻ B.	Chloride	99	2.79	Merks	11-13-00
	Total Anions		7.93		
	Ion Ratio (Cation/Anion) --- 1.078				

		mg/L	Analyst	Analysis Date
EPA 600 150.1	pH --------------- 8.50		Merks	10-30-00
EPA 600 310.1	Total Alkalinity as Calcium Carbonate ----------------	198	Merks	10-30-00
SM 2340 B.	Total Hardness as Calcium Carbonate ----------------	274	Merks	11-14-00
EPA 600 160.1	Total Dissolved Solids (180 Deg.C) --------------	503	Merks	10-31-00
SM 4500-Br⁻	Bromide -------------------	0.2	Moore	11-16-00

Lab. No. M38-4934

Signed: Carl F. Crownover, Pres.

form: S2-26

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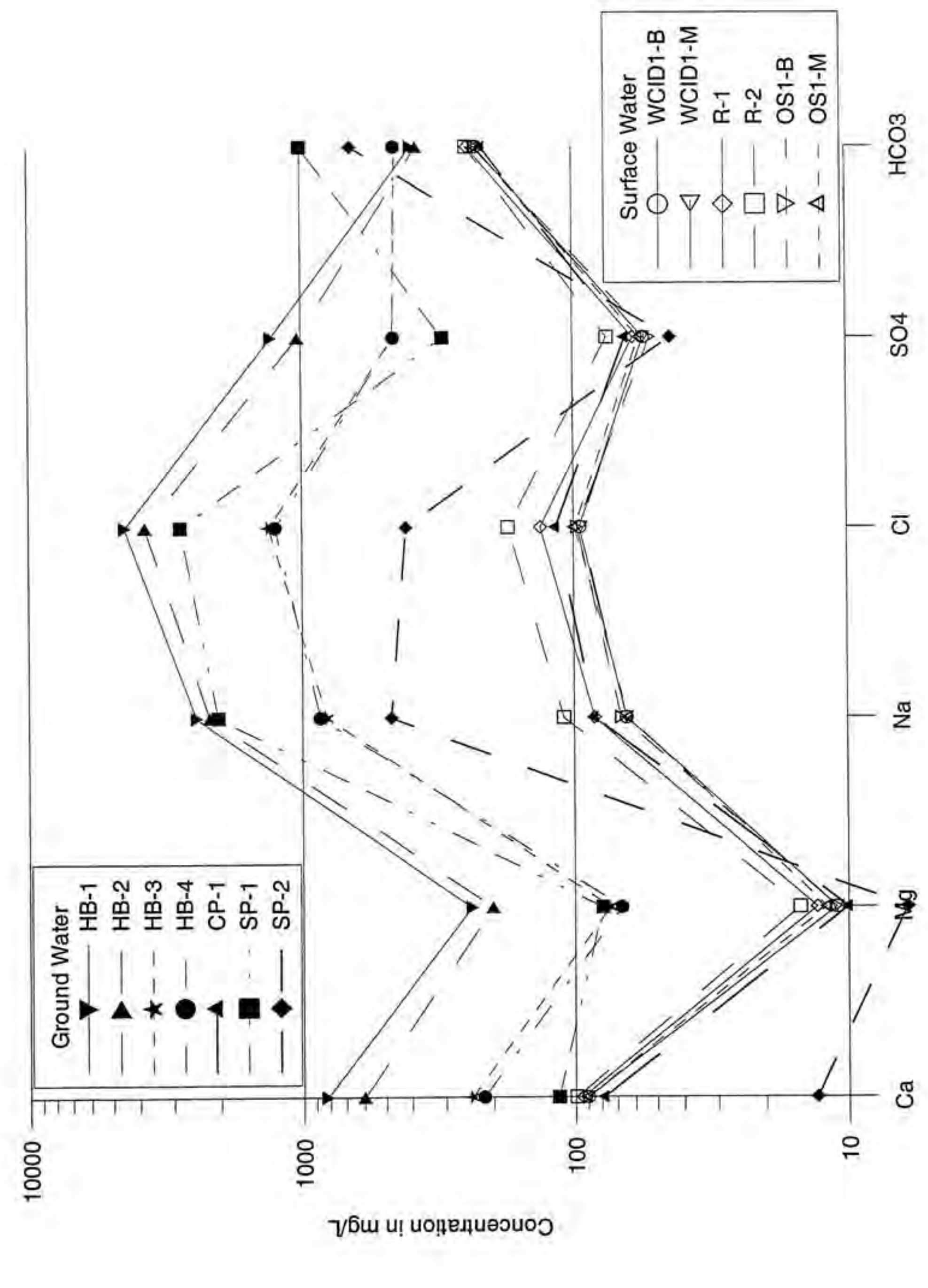
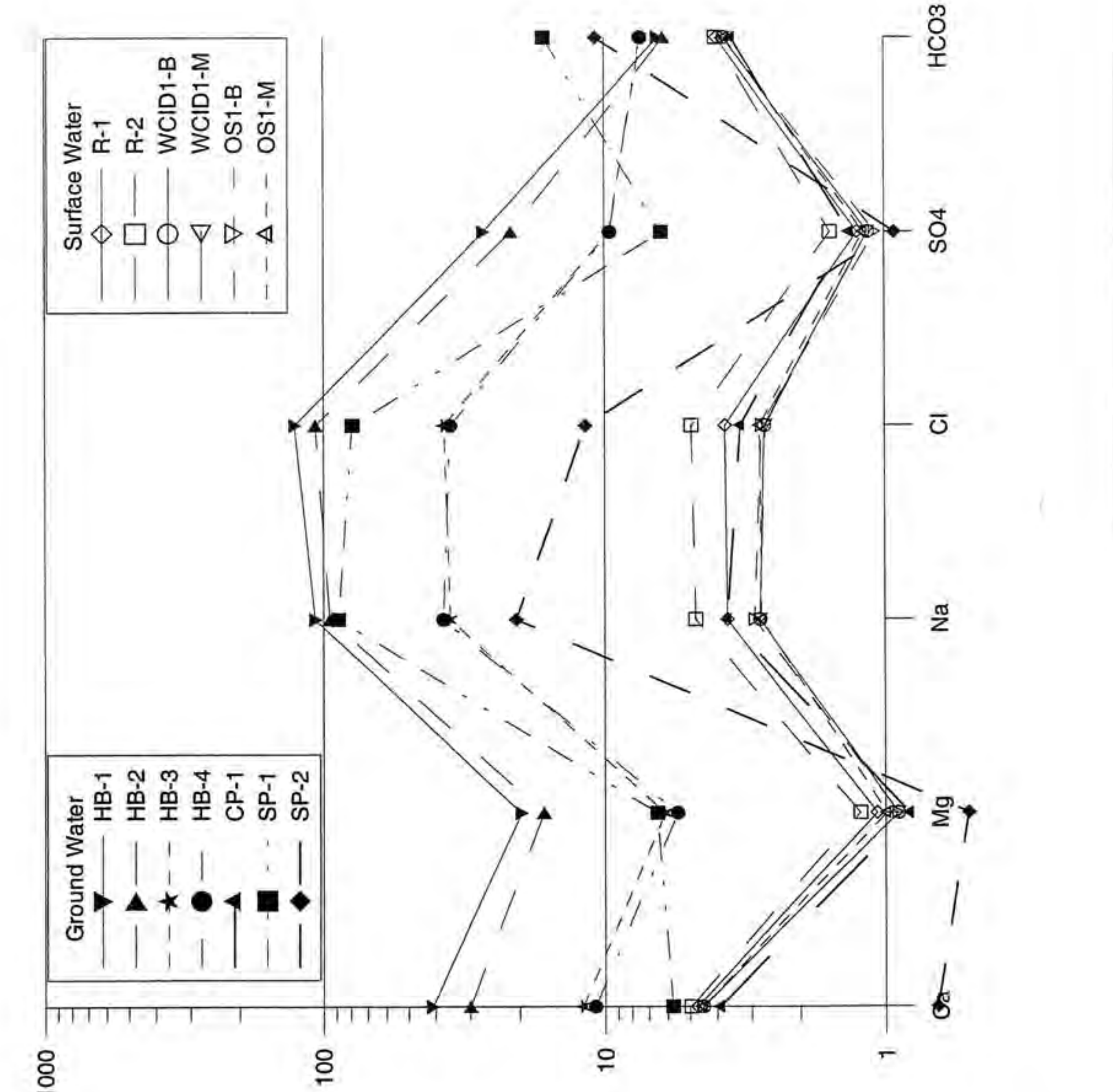
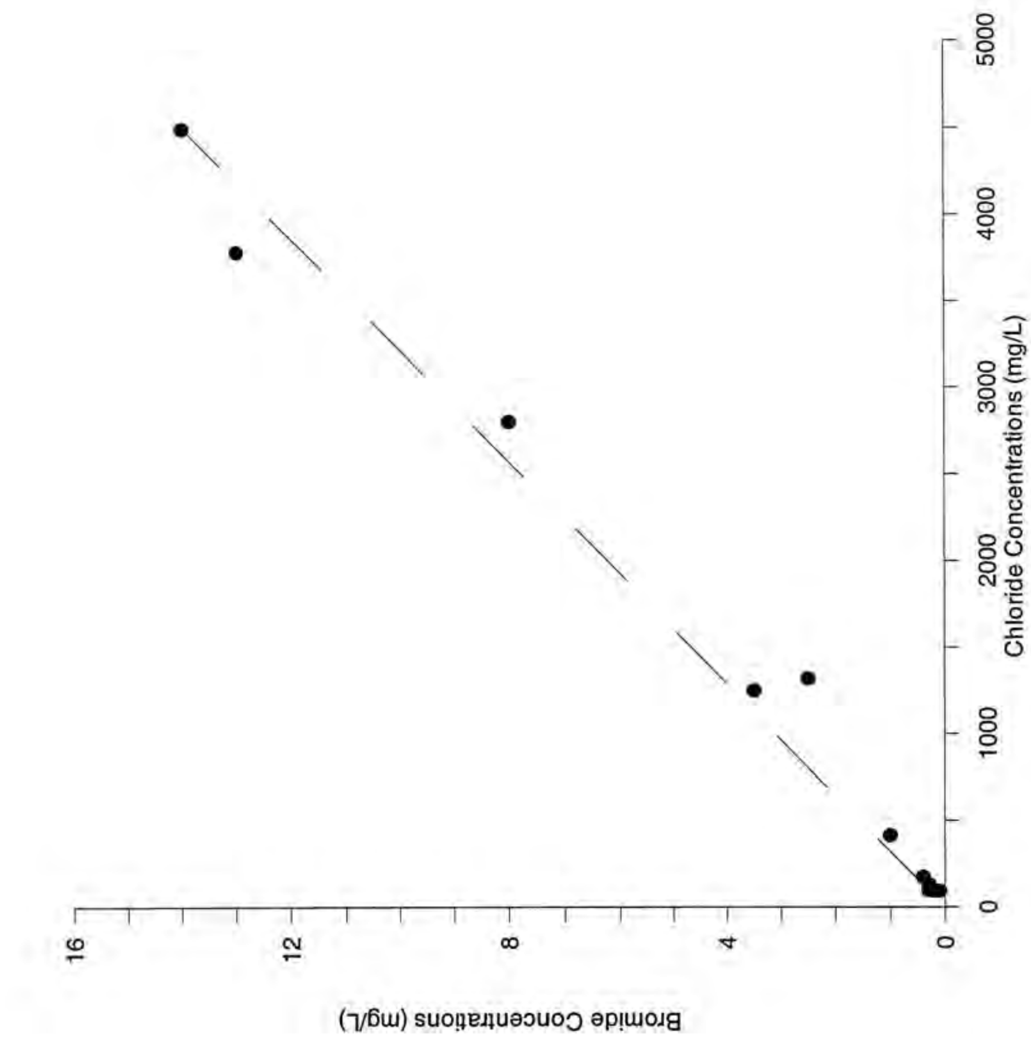
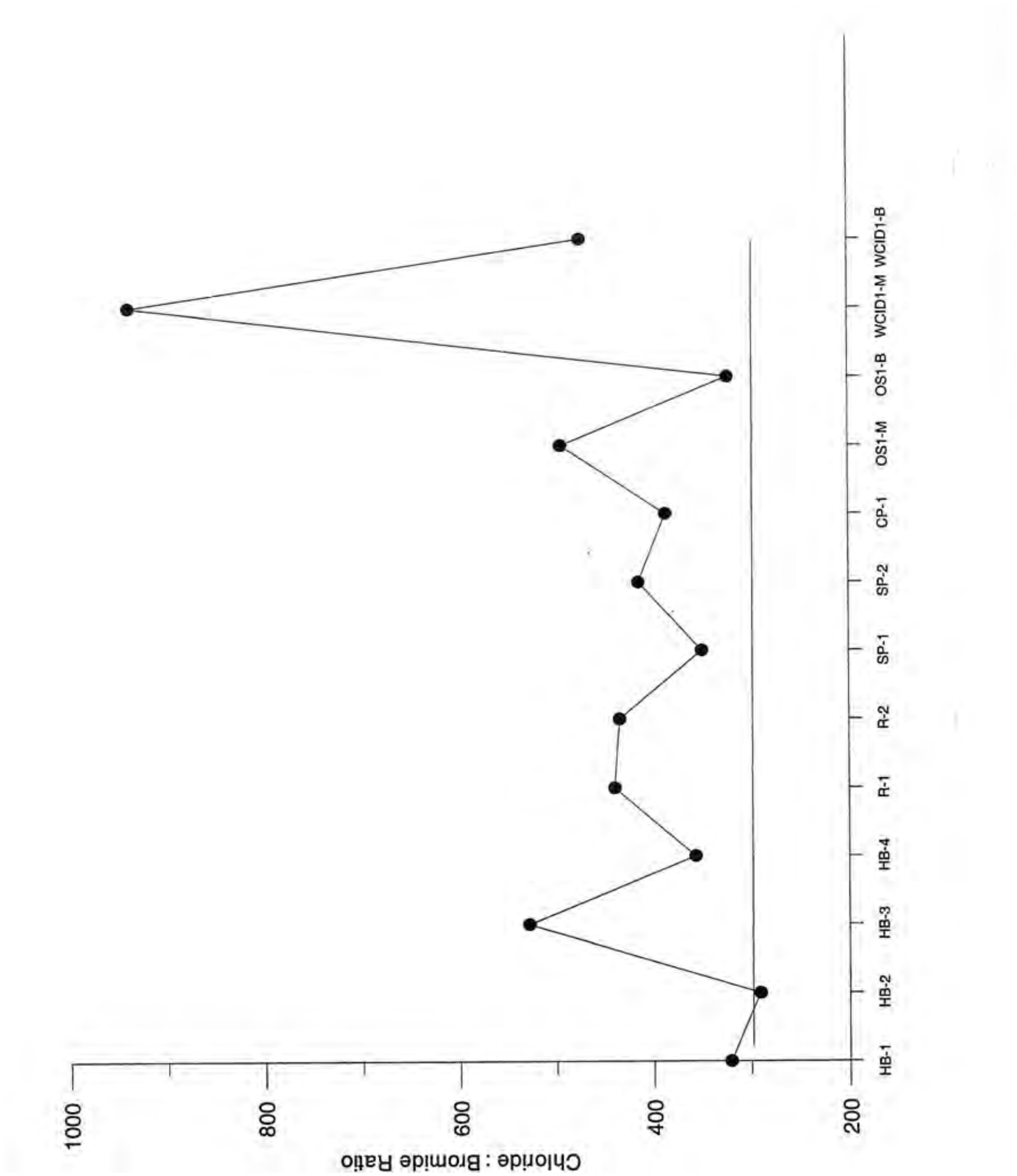
Appendix 9
Sample Results — Graphs


Concentration in mg/L
10000
1000
100
10
Ca
Mg
Na
Cl
SO4
HCO3
Ground Water
HB-1
HB-2
HB-3
HB-4
CP-1
SP-1
SP-2
Surface Water
WCID1-B
WCID1-M
R-1
R-2
OS1-B
OS1-M


Ground Water
HB-1
HB-2
HB-3
HB-4
CP-1
SP-1
SP-2
Surface Water
R-1
R-2
WCID1-B
WCID1-M
OS1-B
OS1-M
Concentration in Meq/L
1000
100
10
1
Ca
Mg
Na
Cl
SO4
HCO3


Bromide Concentrations (mg/L)
16
12
8
4
0
Chloride Concentrations (mg/L)
0
1000
2000
3000
4000
5000


Chloride : Bromide Ratio
1000
800
600
400
200
HB-1
HB-2
HB-3
HB-4
R-1
R-2
SP-1
SP-2
CP-1
OS1-M
OS1-B
WCID1-M
WCID1-B

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Appendix J
Literature Review of Recent Ecological Studies of the Nueces Bay and Estuary Prepared in Conjunction with Analysis included in Section 4C.5

J.1 Evaluation of the Literature

HDR personnel compiled and reviewed the following available literature sources in an attempt to find ecological studies providing beneficial information relevant to the strategy of river-water and treated wastewater diversion projects (e.g., Rincon Bayou channel diversion, Allison wastewater treatment plant discharge, etc.) as examples of water management solutions with potential to enhance productivity of upper Nueces Bay by increasing the freshwater inundation regimes of the Nueces Estuary. The Nueces Estuary has been the subject of intense scientific study in recent decades, stimulated largely by concerns about extended periods of excessively hypersaline conditions, physical habitat complexity, biological productivity, and desire to protect species richness and diversity. The Nueces Bay and Estuary are being studied and evaluated for restoration efforts. The Nueces Delta Studies Integrated Monitoring Plan (IMP) was developed to implement a data collection, analysis, management, and reporting system to inform and guide management actions of the Nueces Delta ecosystem.

J.1.1 The Nueces River and Estuary System – Study Area of Concern

The Nueces River Basin originates in Edwards County and flows southeast for approximately 315 miles to Nueces Bay near Corpus Christi. Streamflow in the Nueces River and its tributaries, along with municipal and industrial water rights in the Nueces River Basin, comprise a significant supply of water in the Texas Coastal Bend Region, as this basin drains about 17,000 square miles. Because the Nueces River Basin is subject to periods of significant drought and low flows, water storage is very important. The two major reservoirs in the Nueces River Basin are Choke Canyon Reservoir (CCR) and Lake Corpus Christi (LCC) collectively known as the CCR/LCC System.

The Nueces Estuary system is composed of several distinct segments: north Corpus Christi Bay, Oso Bay, Nueces Bay, Redfish Bay, the Harbor Island complex, and the bay side of Mustang Island. The Nueces River is responsible for the estuarine character of the Nueces Estuary as it is the primary discrete source of freshwater. The majority of the Nueces River discharges directly into Nueces Bay. Historical inflows of freshwater have entered the delta system more diffusely, from several washout areas along the northern banks of the Nueces River, or as direct precipitation. Excavation of the Nueces Overflow Channel (NOC) and Rincon Overflow Channel (ROC) as part of the Bureau of Reclamation's Rincon Bayou Demonstration

Project conducted from 1994 to 1999 has introduced an increase in the amount of Nueces River water entering the estuary through the upper reach of Rincon Bayou.

J.1.2 Water Availability

One of the main issues confronting the South Texas region is the scarcity of water. Population growth has greatly increased municipal and industrial use. When unregulated, river inflows had extreme variability ranging from drought stage to flooding which resulted in a direct contribution of freshwater into Corpus Christi Bay. Since construction of the two reservoirs in the Basin, the direct influence of the river (i.e., downstream flow) has been limited but nonetheless has some influence in establishing salinity variation across the delta and bay area. Lake Corpus Christ is a 19, 447- acre reservoir located on the Nueces River approximately 20 miles northwest of Corpus Christi. The lake was built in 1958 by the defunct Lower Nueces River Authority as a water supply for the City and other coastal bend communities. Choke Canyon Reservoir, a 25,989-acre lake, is located on the Frio River approximately 80 miles south of San Antonio. The reservoir was built in 1982 by the Bureau of Reclamation, but it is operated by the City of Corpus Christi. This lake is used for water supply and recreation. Cunningham ((1999) provides an historical account of the Corpus Christi water supply system for the period 1852 to 1997.

Due to the rising demand for raw water, the City of Corpus Christi has a contract with the Lavaca-Navidad River Authority (LNRA) to purchase 41,840 acre-feet per year of raw water from Lake Texana. Construction of the 101-mile long Mary Rhodes Memorial Pipeline was funded by the City and became operational in September 1998. The 64-inch diameter pipeline currently supplies water to about 50% of the homes in Corpus Christi.

Lake Corpus Christi has rarely attained full storage capacity since 1993. Maximum storage was achieved briefly in 1993 and 1994, most of the period between January 2002 and mid-2005 and again for most of 2007. Since January 2008, the CCR/LCC System has received little inflows resulting in the continual lowering of the reservoir levels. In early July, Lake Corpus Christi and Choke Canyon Reservoir received minimal inflows during July 2009 and had a combined capacity of 61.6 percent with Lake Corpus Christi at 36.0 percent of storage capacity and Choke Canyon Reservoir at 71.1 percent of storage capacity (TxDPS, 2009a). Persistent rainfall during September provided some inflows into the reservoir system but there was still a slight decrease in combined capacity of 58.7%. Lake Corpus Christi fell to 28.6 percent of capacity and Choke Canyon Reservoir dropped to 69.8% of capacity (TxDPS, 2009b). A smaller decrease in combined storage capacity (58.3%) was recorded for November as Lake Corpus Christi rose in storage capacity to 31.7% while Choke Canyon Reservoir dropped to 68.1% of capacity (TxDPS, 2009c). During these drought periods, much of Corpus Christi's monthly water supply needs were provided by diverted, contracted supplies from Lake Texana.

J.1.3 Water Quality

The quality of water in the Nueces Estuary, comprised of the Nueces River delta and Nueces Bay, a secondary bay of the Corpus Christi Bay system, is greatly influenced by freshwater inflows, (monitored and non-monitored) and point and non-point waste sources. Point sources include effluent discharges from domestic wastewater treatment facilities and industrial facility discharges. The major nonpoint sources to the Bay system arise from agricultural runoff and irrigation return flows.

J.2 General Characterization of the Estuarine Community

The hydrodynamic regimes in the Nueces Estuary are a function of several complex and highly interactive processes. In general, the circulation of the bay and estuary is dependent upon many principal influences such as astronomically induced tides, freshwater inflow, bathymetry, long-term weather patterns, wind speed (direction and duration), and by density differences in mixing zones between freshwater from land and saltwater from the ocean. Historically, monthly inflows of freshwater into the estuaries are regulated by the amount of precipitation received by a particular river watershed in the spring and fall months. To address concerns about the health of the Nueces Estuary, a Technical Advisory Committee (Nueces Estuary Advisory Council, NEAC) chaired by the Texas Natural Resource Conservation Commission (TNRCC) presently the Texas Commission on Environmental Quality (TCEQ), was formed in 1990 to establish operational guidelines for the CCR/LCC System and desired monthly freshwater inflows to the Nueces Estuary (in accordance with Special Condition 5.B. of the Certificate of Adjudication No. 21-3214).

The City of Corpus Christi operates the CCR/LCC System in compliance with the TNRCC (now TCEQ) Agreed Order, a legal imperative. The Agreed Order, last amended and issued April 17, 2001, established an operating procedure that specifies monthly inflow targets for the Nueces Bay that must be met by allowing reservoir inflows to pass through the reservoirs to the Nueces Bay based on total system storage of the reservoirs. The annual amount has monthly targets that were developed by the Texas Water Development Board (TWDB) and the Texas Parks and Wildlife Department (TPWD) to maximize the biological benefit to the species that inhabit the estuary.

The northern coastal region usually receives a greater annual rainfall amount than the semi-arid coastal region of South Texas. Currently, several locations around the state are reporting below average rainfall totals including the Corpus Christi area resulting in an extension of severe drought conditions that first appeared in the state in November 2007. According to the Palmer Drought Severity Index, the South-Central region was in an "Extreme Drought" as of July 18, 2009 (TWDB, 2009). Severity intensified to "Exceptional Drought" as the long-term drought was entrenched in South Texas although above normal precipitation during September 2009 fell in the core drought areas. Drought conditions improved over most of South Texas including the coastal counties as a warm El Nino phase of the El Nino-Southern Oscillation in the Pacific Ocean brought widespread rainfall to the area in November and December 2009. The Drought Information Statement issued by the National Weather Service (NOAA, 2010) for January,7 2010 indicates improvement in some locations more than others as the intensity of drought in the Coastal Bend area on January 12, 2010 varied from "Abnormally Dry" to "Severe Drought" (National Drought Mitigation Center, 2010). El Nino conditions are expected to persist through the spring of 2010.

The estuarine system is subject to changes in physical and chemical characteristics, and factors such as temperature and salinity can influence the assemblage, distribution and abundance of aquatic biota at any given time or place. A characteristic of estuaries is a gradient in salinity, with lower salinities in the river and higher salinities toward the ocean mouth. The salinity gradient plays a major role in determining the distribution of communities of plants, animals, and microorganisms within the estuary. Estuarine species and communities are well adapted to the variations in salinity related to tidal cycles and seasonal rainfall patterns.

Nutrients critical to plant productivity including nitrogen, phosphorus, and silica are transported to the estuary by freshwater inflows and return flows. Although the delivery of nutrients is vital to estuarine production, there is an upper limit to the level of nutrients necessary to sustain balanced production. Extensive growths of algae, seagrasses and marsh plants typically occur in the shallow depths of the estuary. This vegetation stabilizes the bottom and provides the larvae and juvenile stages of many invertebrate and vertebrate species protection from predation as well as an abundant supply of food to support their rapid growth rates.

Freshwater inflow from streams and rivers carries sediments into the estuary. These sediments build and stabilize intertidal wetlands, banks and shoals, and may contribute to beach nourishment.

J.3 Aquatic Biota

The salt marsh (including brackish water marshes) component of the coastal bay-estuarine system is of prime importance as a nursery area for commercial shrimp, fish and oysters. These habitats typically support large populations of relatively few resident species. Brackish marshes usually form the transition between shoreline salt marshes and inland fresh marshes, with salinities generally decreasing in a landward direction.

The biological impacts of freshwater inflow alterations/reductions relate primarily to the changes in bay salinities and to changes in organic and inorganic nutrient inputs. Freshwater inflow reduction affects the pelagic shellfish environment by modifying water quality (primarily salinity and nutrients) and possibly habitats of certain life stages. Reduction of marsh grass productivity may be brought about by freshwater-flow reduction because increasing salinity above optimum would reduce growth and fertility of marsh plants. Marsh plants primarily obtain their nutrients from the sediments (usually of delta origin) in which they grow or through nitrogen fixation.

Although most benthic organisms have little or no direct economic significance themselves, their value in the food chain is considerable. Benthic invertebrates are an important food source for fish and larger invertebrates. In addition, invertebrates are valuable indicators of water/sediment pollution and construction-related sediment disturbance. In general, populations of invertebrates increase from fall to spring in coastal Texas waters. Common benthic organisms in the Nueces Estuary include polychaete worms, bi-valve mollusks, crustaceans, and crabs that burrow in the sediments, and in areas of low salinity, insect larvae.

Many nekton (active swimmers) species are estuarine dependent, with adults spawning in the Gulf and larval and juvenile forms being carried into the bay where they mature and from which they later return to the Gulf to spawn.

J.3.1 Freshwater Inflows

Instream flows have been a subject of research in Texas for several decades. In 2001, the Texas Legislature enacted Senate Bill 2 that mandated the TWDB, the TPWD, and the TCEQ to jointly establish and maintain a data collection and analytical study program focused on determining the effects of and needs for freshwater inflows to support a sound environment in the state's 10 bay and estuary systems (TWDB, 2008). The Texas Instream Flow Program is the first statewide program designed to address how much water is needed to maintain a healthy ecosystem while meeting human consumptive needs. The study is a long-range examination of river and freshwater inflows into estuaries and bays.

J.4 Monitoring in the Nueces Estuary

Historical information collected during the demonstration projects for the Allison Wastewater Plant (Dunton and Hill, 2006a; 2006b) and Rincon Bayou (U.S. Bureau of Reclamation, 2000a; 2000b) support the fact that freshwater diversion into the Delta has shown beneficial contributions in the enhancement of ecological conditions through freshwater diversion in the Nueces Estuary and in particular, the Nueces Delta. Continued monitoring is being conducted pursuant to the 2001 Amendment of the Reservoir System Agreed Order. The City of Corpus Christi is required to provide freshwater inflows into Nueces Bay as specified in the TCEQ Agreed Order amended in April 2001.

(http://www.cctexas.com/files/g17/2001%20Agreed%20Order.pdf).

Current monitoring activities are located in six major areas of the Nueces Estuary (Alan Plummer Associates, Inc., 2007) associated with the Allison Wastewater Treatment Plant Effluent Diversion Demonstration Project (EDPP), the Rincon Bayou Nueces Delta Study (RBND), the TCEQ Clean Rivers Program (CRP), independent academic research, TPWD ichthyoplankton studies and a 12-month continuous monitoring conductivity/salinity program recently initiated by the Coastal Bend Bays and Estuaries Program (CBBEP) and authorized by the TCEQ in the spring of 2009 (CBBEP, 2009).

Research on freshwater diversions provided the impetus to formulate a long-term monitoring plan to facilitate an adaptive management program for freshwater inflows into the Nueces Estuary. The CBBEP, formally established in October 1992 as the Corpus Christi Bay National Estuary Program (CCBNEP), emphasizes an estuarine ecosystem management approach of a 514 square mile area of water in a 12 county region, collectively known as the

Texas Coastal Bend, to implement the Coastal Bend Bays Plan. This planning document is a comprehensive management plan involving consensus building that offers partnership opportunities among citizens, industry, business, development, academia, and government. Since September 1, 1994, annual work plans have been developed for each fiscal year providing a detailed list of CBBEP projects by project number, project titles, performing organization(s), total project budget and specific plan action items. Two projects involving freshwater flow studies have been scheduled for the Nueces Estuary (CBBEP, 2007; 2008). As part of the project activity described in the CBBEP Fiscal Year 2008 work plan, Montagna et al. (2009a) integrates long-term hydrological datasets collected in the Estuary with the biological responses by resident macrofauna and emergent vascular vegetation based on statistical, geostatistical, and synthetic interdisciplinary analyses.

As previously mentioned, a freshwater inflow/salinity monitoring study on Rincon Bayou has been developed and initiated by the CBBEP during FY2010. Although salinity measurements at four locations were tentatively scheduled to begin upon TCEQ approval in the spring, the first substantial inflows recorded into the Reservoir System since completion of pipeline construction in the summer of 2008, did not occur until late August/early September 2009. The first eligible “pass through” pumping event mandated by the Agreed Order began on 28 September, 2009. Of the three pumps built, delivery of freshwater to Rincon Bayou via the diversion pipeline was accomplished by the operation of only one or two pumps. Changes in salinity were observed in the bayou within a few hours of initial pumping. A total of 3,000 acft of water was pumped over a 24-day period ending on 21 October 2009 (Tunnell, 2009).

Salinity levels in the Nueces Estuary have been monitored by the City of Corpus Christi and the Division of Nearshore Research (DNR) since November 1991 to study the effects of artificially introduced freshwater to approximate historical natural freshwater flows prior to construction of Choke Canyon Reservoir from the Nueces River watershed into Nueces Bay. Currently, the relationship of freshwater inflow and salinity is being monitored downstream of the Rincon Bayou Pipeline in the Nueces Delta (CBBEP, 2009).

Because the internet is a very important tool for providing information, increasing stakeholder and public awareness, and improving involvement in the HMP process, several groups and organizations, in addition to the City of Corpus Christi, and the DNR have developed, maintained, updated, and posted scientific and technical reports containing data relevant to the Nueces Estuary. With a continued increased in accessibility of data and information over time, the general public, stakeholders, and other interested parties will be able to locate and acquire existing databases from federal, other state or local agencies, private groups, and universities that may contain habitat data for their specific project for scientific uses of the data.

J.5 Long-Term Objectives

Effects of reduced freshwater inflow on the Nueces Delta ecosystem can not be generalized. Complicated interconnections exist between the quality, quantity and timing of freshwater inflows and the health of the Nueces Estuary.

Managing sustainable aquatic ecosystems requires restoration of ecological processes; such as the natural flow regime, as well as restoration of specific habitat structure and biological attributes. A general understanding of the ecological effects of altered flow regimes currently exists, but more data on specific ecological responses to flow alteration will help quantify freshwater inflow impacts and further restoration efforts.

The ability to react to changing circumstances is the basis for adaptive management. The adaptive management premise is to addresses issues as they arise; developing solutions based on contemporary circumstances and available resources. It appears from the literature that solutions to management needs are developed in a judicious manner as they arise through the Nueces Estuary Advisory Council (NEAC).

A strategy for achieving effective ecosystem-based management (EBM) includes the development of a Habitat Management Plan (HMP) for implementation in an adaptive management framework. A partnership of citizens, elected officials, resource managers, and commercial and recreational users working as stakeholders met in a series of individual meetings over a 6-month period to identify ways to incorporate resource protection strategies into economic development decisions (Brenner et al., 2009). Participation provided multiple opportunities and venues for collaboration for implementation of a transparent process for development of a HMP. The objectives and priorities identified in this plan will help facilitate the protection, creation, restoration, and enhancement efforts of existing coastal habitat associated with key economic developments in the Corpus Christi/Nueces Bay area. A focused stakeholder workshop was designed to help enable the HMP policy framework and context. The four workshop goals were to identify: priority habitats and ecosystem services; the management plan's geographical coverage; the range and scope of activities in the overall plan; and the mechanisms and resources needed to support the plan (Palmer et al., 2009a). The intent of defining the boundary for the proposed Corpus Christi Bay area HMP included a geospatial framework using GIS layers used to assemble a map representing the planning area and its larger area of influence in the Coastal Bend (Palmer et al., 2009b). Montangna (2009) provides a progress summary of all activities and accomplishments taken in the development of the preliminary HMP.

Montagna et al., (2009b) are encouraged about the accomplishments made thus far in the Nueces Estuary with a blend and balance of science and a stakeholder decision process. Understanding the goals of the Texas statutes for environmental flows and the various legislative implementation mechanisms can enhance science-based programs by improving communication among interested parties. Describing legislature terminology with consistent and precise use of U.S. Environmental Agency (EPA)-defined terms facilitates discussion of and improvements to implementation issues.

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Abstract: The first of two volumes, this report summarizes the results of a comprehensive research demonstration project initiated by the City of Corpus Christi to study the effects of treated wastewater to the Nueces Delta. Information collected between the summer of 1996 and the summer of 2003 included physicochemical parameters, inorganic nutrients, water quality, and assessment of responses by various species in the water column, sediments and tidal flats surrounding South Lake to the diversion of treated wastewater. It was concluded that no measurable negative effects on the local ecosystem although early positive changes to the environment was subsequently confounded by unusually large precipitation and inflow events beginning in late summer 2001. The physiochemical parameters measured suggest that the small volume (7,570 $m^{-3}d^{-1}$) of effluent inflows helped moderate the strongly hypersaline soils in the immediate area of the diversion at South Lake. Dissolved oxygen (DO) concentrations remained adequate to sustain aquatic life and were similar at all locations investigated. Vegetation responded positively to increased nutrient availability and reduced salinities associated with freshwater inputs in a limited area receiving municipal discharges. There was a rapid shift in species composition from a highly salt-tolerant succulent to less salt tolerant shrub along with the introduction of a variety of plant species in areas previously devoid of vegetation. A three-fold increase in localized shorebird activity was observed at the South Lake diversion site between the baseline year and 1998/1999. Consumption of nutrients by plant and phytoplankton led to the reduction of average concentrations of total inorganic nitrogen and phosphorous over a 300 m distance downstream from the discharge point. Ammonium and nitrate levels also decreased in the Nueces River following the diversion of effluent into the marsh environment. Although primary production values were similar among all locations in the marsh, rates of primary production was clearly the highest at the two locations closest to the treated water release. No significant differences between station locations or areas were seen in overall benthic species diversity, density or total biomass. No negative effects on the zooplankton, epifaunal crustaceans (shrimp and crabs) and fish communities were linked to EDDP introduction into South Lake.
Area of Coverage: The lower Nueces Delta including the Nueces River, South Lake, Rincon Bayou and the Delta Access Channel.

Key Words: treated freshwater inputs, water quality, sediment characteristics, primary production, secondary production.

Positive Benefits of Project: There was an increase in vegetation and the creation of approximately 7 hectares of newly created salt marsh was observed. The combined increase in emergent vegetation growth and diversity resulted in the extensive localized recruitment of birds, primarily shorebirds to the area. No significant changes in response to the introduction were documented in either the epifaunal or nekton communities. The high accumulation of inorganic nutrients added to the ecosystem into the Nueces Delta at South Lake by the diversion of treated effluent was rapidly assimilated at the release point by the vegetative community. Inorganic nitrogen concentrations disappeared rapidly downstream of South Lake. Recorded levels of dissolved oxygen were similar at the reference, river, and bay stations at levels sufficient for aquatic life use requirements. The diversion of EDDP water into the marsh resulted in an approximately 50 percent removal of wastewater discharge into the Nueces River. The drop in inorganic nitrogen concentrations entering the river has effectively reduced the potential for nutrient-driven algal blooms. Although four hypoxic (low oxygen) events attributed to algal or bacterial blooms have occurred as recent as August 1998, no hypoxic events have been recorded in the Nueces River by the TPWD since the diversion of wastewater began in October 1998.

Dunton, K.H. and E.M. Hill. 2006b. *Allison Wastewater Treatment Plant Effluent Diversion Demonstration Project (EDDP), Volume II: Monitoring Results 1997-2003*. The University of Austin, Marine Science Institute, Port Aransas, Texas and Texas A&M University-Corpus Christi, Center for Coastal Studies, Corpus Christi, Texas.

Abstract: This eight-chapter report presents the detailed EDDP monitoring results taken in the lower Nueces Delta. This document examines the development of fauna and flora near the freshwater release site and biological production during 1997 through 2003. Pre- and post-diversion collections by the Texas A&M University- Corpus Christi Center for Coastal Studies (TAMUCC-CCS) and UTMSI personnel were taken in the river, bayou, bay and at two reference locations. Physicochemical parameters were measured monthly at seven stations in the Delta Access Channel and the mid-delta area to provide baseline information prior to initial effluent inputs and at 11 locations including the river and bay once EDDP effluent commenced. In addition to physicochemical measurements, water quality and primary production samples were collected for laboratory analysis of total suspended solids, water column chlorophyll-a, five inorganic nutrients, benthic primary productivity and benthic chlorophyll a determinations. Vegetation characteristics and sediment chemistry were monitoring during quarterly sampling efforts. Abundance, species composition, and biomass of the zooplankton and benthic infauna communities were analyzed to assess the pre- and post-diversion population assemblages. Nekton and epifaunal invertebrates were sampled to determine Catch Per Unit Effort (CPUE), biomass, and specie composition. Avian surveys were conducted month for approximately 30 minutes. These bird observations were focused on the total number of species and type of behavior activity such as foraging, nesting, flyover, or nesting. The discussion and results of each research parameter are reported in a separate chapter and arranged in a similar format. The authors provide a brief introduction, then their methodology, results, discussion, conclusions if any, and literature citations. Each section contains a detailed discussion of pre- and post-diversion results and includes distinctive graphical and figure presentation to summarize this information. The high level of detail may be confusing to the general public.
Area of Coverage: The lower Nueces Delta including the Nueces River, South Lake, Rincon Bayou and the Delta Access Channel.

Key Words: treated freshwater inputs, water quality, sediment characteristics, primary production, secondary production.

Conclusions: Each chapter provides a separate detailed conclusion of the results taken through 2003 and are briefly summarized under positive benefits of project associated with Volume I.

- Suppressed salinities and limited salt accumulation in the soils resulting from daily freshwater diversion were limited to the station closest to the diversion point (272).
- There was little evidence of a direct relationship between DO and primary production.
- The Delta Access Channel station (254), near the diversion, had the highest percentage of microphytobenthos production to total production. The localized input of nutrients at this station was evident but showed a rapid decrease downstream. The chlorophyll and productivity data both show a localized biomass and production increase but values decreased downstream and indistinguishable form the reference stations. No flow data available.

- Increases in nutrients associated with the wastewater diversion appear to have locally enhanced primary productivity of both phytoplankton and emergent vegetation. A significant increase in the mean ammonium values following the diversion was observed at the two stations closest to the release. Nitrite/Nitrate values increased afterwards at three locations in the diversion channel; with the greatest concentrations measured closest to the diversion and decreasing downstream within 325 m of the outfall.
- Most notable emergent vegetation biomass change was seen in the increase of *Borrichia frutescens* and *Distichlis spicata*. *Borrichia* was the greatest in the location nearest the diversion. *Distichalis* was found near the diversion and a location in the DAC just downstream of the diversion. *Salicornia virginica* declined at several stations over the study period. No impacts to *Batis maritima* could be detected following effluent diversion.
- Although no detrimental impacts were observed on the Nueces Marsh, the study recommended 10-20 year assessments should be implemented to prevent potential salt marsh degradation as a result of future increases in wastewater diversions.
- Zooplankton is an important trophic link between phytoplankton and commercially important finfish and shellfish species. There was less clear evidence for a positive change in zooplankton populations as a result of the wastewater diversion. The calanoid copepod (Acarcia tonsa) was the most abundant species of zooplankton in the Nueces Estuary comprising an average of 60 to 85% of the composition at each station. This species nearly always dominate in terms of numbers and biomass in all Texas estuaries.
- Six species dominated the benthic invertebrate collections during the study: Four species of polychaetes (*Mediomastus* sp., *Streblospio benedicti*, *Laeonereis culveri*, and *Capitella capitata*) and two species of crustaceans (*Corophium louisianum* and *Ampelisca abdita*).
- *Mediomastus* sp. was the dominant species collected during the study. Streblospio benedicti was the third most abundant species collected and increases in abundance was correlated with major inflow events. *Corophium louisianum*, an amphipod preferring hard substrates, was the second most dominant species collected overall and also increased in abundance following salinity declines after scouring events. Populations of *Laeonereis culveri*, *Capitella capitata,* and *Ampelisca abdita* begin to decline in response to flood conditions.
- Freshwater inputs into South Lake created a habitat conducive for a broad range of species. New species were collected through time in response to the increased inputs. Ostracods and Chironomidae insect larvae, indicators of nutrient enrichment, increased in density and their continued presence throughout the remainder of the study may be attributable to the EDDP inputs. The presence of the species is more indicative of an increase in nutrients and freshwater within a localized area rather than suggesting any negative effects.
- The authors concluded that the small volume of diverted water offered no evidence to show any potential benefit or harm on the benthic community.
- The four dominant fish families collected during the study include gobies (Gobiidae), drum (Sciaenidae), menhaden (Clupeidae) and anchovy (Engraulidae). The four dominant commercially and ecologically important shellfish were the brown shrimp (*Farfantepenaeus aztecus*), white shrimp (*Litopenaeus setiferus*), blue crab (*Callinectes sapidus*) and grass shrimp (*Palaemonetes pugio*).
- The presence/absence of the finfish and shellfish species collected in the Nueces Delta was due to seasonal fluctuations and freshwater inflows versus the consequence of the EDDP diversion. Species richness, diversity, CPUE, and biomass among sample years were influenced by flooding events. Optimum estuarine salinity ranges from 10.9 to 28.9 ppt during Year 2 allowed for a broad range of salt tolerant species to enter the delta. Hypersaline conditions (25.0 to 40.0 ppt) experienced during Year 3 narrowed the entry of salt tolerant species into the delta. Periodic pulses of freshwater inflows during Years 5 and 6inundated the delta reducing salinities to 0.0 ppt resulting in the appearance of freshwater species not previously recorded during the study.

- Yearly differences in the shellfish species CPUE and biomass was influenced by salinity and volume of freshwater received by the delta. Shrimp and crab species CPUE and biomas were significantly higher in Rincon Bayou and the lower delta locations near Nueces Bay. Brown shrimp were abundant during low freshwater inflow and higher salinity years. Distribution of white shrimp was homogeneous throughout the delta after major inflow events.
- No ecological harm to the nekton and epifaunal community as a result of EDDP diversion was observed.
- Avian distribution within the Nueces Delta was not dependent on the EDDP, however the effluent diversion into South Lake was significant enough to make localized environmental changes.
- All studies recommended further research if the volume of effluent is increased into South Lake.

U.S. Department of the Interior, Bureau of Reclamation. 2000a. *Concluding Report: Rincon Bayou Demonstration Project, Volume I: Executive Summary.* In cooperation with the University of Texas Marine Science Institute. U.S. Dept. of the Interior, Bureau of Reclamation, Oklahoma-Texas Area Office, Austin, Texas.

Abstract: A five-year long, comprehensive study was undertaken for the purposes of understanding the importance of increased freshwater inflow events in maintaining quality of habitat and ecological function of the Nueces Delta. This study was based upon recommendations from the 1991 and 1992 Nueces Estuary Regional Wastewater Planning Studies. This report summarizes the results of the several tasks, undertaken by the Bureau of Reclamation to initiate the study and assessment of changes in delta productivity from diverted river water input through two excavated diversion channels, the Nueces Overflow Channel (NOC) and Rincon Overflow Channel (ROC). The format structure of the executive summary is grouped into three parts for discussion purposes. Part 1 contains the study results including changes in hydrography, effects on salinity, and biological responses. Part 2 discusses the integration of overall project effects directly attributable to the re-introduction and Part 3 provides a description of potential future opportunities for a permanent diversion project, considerations for further ecological monitoring of delta productivity, development of a numerical model to integrate the various data components to forecast marsh functions under various conditions, integration of a permanent diversion project with reservoir operations and the application of adaptive management to assess restoration success.

Area of Coverage: Nueces Overflow Channel, Rincon Overflow Channel, upper Rincon Bayou.

Key Words: Minimum flooding threshold, positive-flow events, biological responses, future opportunities.

Positive Benefits of Project: The re-routing of freshwater through the NOC and ROC increased the opportunity for larger and more frequent diversion of freshwater as the minimum flooding threshold of the upper Nueces Delta was lowered by 5.4 feet. Daily exchange of water between the river and upper delta was restored, diminishing the extreme concentration of salt. A sevenfold increase in a constant supply of freshwater contributed to positive-flow events that *allowed preservation of seasonally-critical salinity and nutrient regimes and a viable nursery area for emigrating estuarine organisms.* Inundation of the tidal flats lowered open water and soil salinity concentrations and organic material was transported to the lower bay. Primary production increased as the inflow of river water decreased salinities (< 60 ppt) and imported vital nutrients (nitrogen, phosphorus and silicon) into the area. Increased frequency in bloom-forming blue-green algae was also observed. There was an increase in plant production in both the water column and marsh leading to an increase in secondary production and ultimately an increase in habitat quality and complexity. The benthic communities experienced increases in numbers and biomass in salinity concentrations ranging from 10 to 45 ppt providing a greater diversity and abundant food source for shrimp and fish.

U.S. Department of the Interior, Bureau of Reclamation. 2000b. *Concluding Report: Rincon Bayou Demonstration Project, Volume II: Findings.* In cooperation with the University of Texas Marine Science Institute. U.S. Department. of the Interior, Bureau of Reclamation, Oklahoma-Texas Area Office, Austin, Texas.

Abstract: This nine-chapter report presents the detailed demonstration project monitoring results taken in the lower Nueces Delta as summarized in Volume I: Executive Summary. This document was prepared for the purposes of providing baseline environmental data for future research, monitoring and restoration. In 1993, the U.S. Bureau of Reclamation began a 5-yr diversion project that was designed to complement the Nueces Estuary Regional Wastewater Planning Study with emphasis on options to increase freshwater flow and accompanying nutrients and sediment to increase into the Nueces-Corpus Christi estuary. Two excavated overflow channels enabled more frequent diversions of freshwater from the Nueces River significantly lowering the minimum flooding threshold for the upper delta. The amount of freshwater increased sevenfold over a 50-month period as the average salinity concentrations returned to a more natural pattern with a corresponding improvement in nutrient cycling, plant production and benthic colonization. The overflow channels were filled upon completion of the project in December 1999. Similar to the Allison Wastewater Treatment Plant Effluent Diversion Demonstration Project Study, the Volume II discussion and results of each research parameter investigated are reported in a separate chapter and arranged in a similar format. The authors provide a brief introduction, then their methodology, results, discussion, conclusions if any, and literature citations. Each section contains a detailed discussion of pre- and post-diversion results and includes distinctive graphical and figure presentation to summarize this information. The high level of detail may be confusing to the general public.

Area of Coverage: Nueces Overflow Channel, Rincon Overflow Channel, upper Rincon Bayou.

Key Words: Minimum flooding threshold, positive-flow events, biological responses, future opportunities.

Conclusions: Each chapter provides a separate detailed conclusion of the results taken through 1999 and are briefly summarized under positive benefits of project associated with Volume I.

- Hydrology is altered by changes in freshwater flow, volume, and timing. Large freshwater diversion events were absent during the study period however, modest flow events occurred during Fall 1996, Summer and Fall 1997, Fall 1998, and Fall 1999 supplying the tidal flats of the upper marsh with diverted fresh water. During the months following these high inflow periods, the upper Rincon Bayou exhibited lower salinity values than the central portion of Rincon Bayou. There were 3 small exchange events during Fall 1996. A sustained positive overflow through the ROC peaked at 36.9 cfs and flow in the river rose to around 165 cfs. It was concluded that at low flow volumes in the river, diversions through the overflow channel was driven by water level variations in the Bay and upper delta. A total net diversion into Rincon Bayou amounted to 234 acre-ft and was relatively fresh water. Two storm events during Summer 1997 occurred very close together bringing the first significant episode of freshwater flow to the area. Although a large quantity of rainfall was associated with these storms, direct precipitation in the upper delta only amounted to 1.98 inches. The diversion rate was primarily a function of the elevated stage of the river. Water was channeled through the ROC into the extensive tidal flat area of the upper delta. Intense local precipitation fell in the lower Nueces Watershed contributing to heavy local runoff and artificially elevated water levels in the upper delta and the Bay. The rate of diversion into the delta sharply dropped after the river crested. Approximately 60% of the volume initially diverted into Rincon Bayou returned back to the river. A series of seven events occurred during Fall 1999 and presented a complex and challenging interpretation. Over a 96-day period, two tropical storms made landfall in the region, a fall-maxima high water event occurred in the Gulf, over 22 inches of local rainfall was recorded in the study area,, over 178,194 acre-ft flowed from the river into the bay, and over 4,128 acre-ft was diverted into the delta. Hurricane Bret made landfall between Brownsville and Corpus Christi during Fall 1999 bringing a substantial storm surge combined with 5.68 inches of rainfall. The Rincon gauge recorded the highest elvation (5.79 ft msl) recorded during the study period without a corresponding flow event in the river. The amount of diverted flow through the overflow channel was the second largest recorded for any event with a net flow of 853 acre-ft over a 17 day period.

- It was surmised that the rapid uptake of nitrate due to freshwater inflow occurred in the upper Nueces Delta shortly after each hydrographic event listed above.
- The diversion of 7,142 acre-ft into Rincon Bayou lowered the salinity concentrations reducing the amount of stress on individual organisms thus hypothesized that primary production increased and especially prominent in salinities < 60 ppt.
- Inputs of riverine nutrients especially dissolved inorganic nitrogen, in the form of ammonium, was high enough to be utilized by both water column and benthic phytoplankton accelerating growth rates and accumulation of biomass.
- Phytoplankton was dominated by small diatom species. Other phytoplankton species were noted immediately after freshwater inflow events such as blooms of blue-green algae normally indicative of freshwater or low salinity environments.
- Freshwater inflow plays an important role in maintaining the observed character of estuarine productivity through the combined effects of frequency, duration, timing, and magnitude of inflow, particularly during droughts or low-flow periods. Two major size classes of the sediment infauna community, macroinfauna and meiofauna, were collected quarterly to identify annual trends beginning one year before the NOC was excavated. Both trophic levels of benthos responded favorably to inflow with corresponding increases in biomass and abundance. Salinity levels between 20 and 45 ppt triggered increases in macrofaunal density and biomass. Meiofaunal biomass and abundance increased in salinities between 10 and 40 ppt, with the greatest numbers being seen in the salinity range of 18 to 22 ppt. Macrofauna and meiofauna responded to inflow events with increased abundances, biomass, and diversity during the spring but decreased during summer hypersaline conditions. An increase in biodiversity was observed 3-6 months after inflow events demonstrating more species were able to utilize the marsh habitat.
- The project demonstrated marsh plants are sensitive to changing salinity regimes. Brief periods of freshwater inundation occurring at certain times of the year might lessen stress conditions imposed by hypersalinity. The absence of flooding events at several study area locations would have likely increased the soil salinity concentrations to toxic levels resulting in plant mortality. During sampling with no hydrographic events, soil salinity levels ranged from 80-90 ppt with salt levels of 40-60 ppt in the water column. Major hydrographic events lowered open water and soil salinity concentrations by over 40 ppt at some stations. Certain species have proved useful as indicators of the timing and quantity of freshwater inundation. The annual pickleweed (Salicornia bigelovii) is an annual species that occur only if soil salinity concentrations are reduced at the appropriate time of the year allowing for successful seed germination and establishment. Freshwater inputs via precipitation or project diversions as a result of hydrographic events during the late fall/early winter reduced salinity concentrations in the upper delta encouraging the establishment of Salicornia bigelovii in bare areas at all three vegetation sampling stations. The authors concluded that the chances of long-term successful establishment of plant cover might be improved by the increased prospect of freshwater inflow.
- By re-introducing freshwater inflow into the upper delta via the ROC, average salinity values were lowered at the in the upper and central segments of Rincon Bayou. Nutrient cycling and

primary production responded as more oxidized forms of nitrogen were available for uptake by organisms such as diatoms and marsh plant production that provided a link with higher trophic levels. This increase in food and habitat quality presented an opportunity in the increase in secondary production.

Ward, G.H., M.J. Irlbeck, and P.A. Montagna. 2002. *Experimental river diversion for marsh enhancement*. Estuaries 25(6B): 1416-1425.

Abstract: The authors provide a brief historical account of the effects of reduced freshwater inflow to Corpus Christi Bay, Nueces Bay and the delta of the Nueces River in association with reservoir development and operation since 1958. Infrequent freshwater exchange with the Nueces River began to substantially modify the hydrography and vegetation of the Nueces Delta. The lack of consistent freshwater inflow together with the natural intrusion of salinity from tidal waters into extensive areas of the estuary contributes to hypersaline conditions creating a harsh environment for species that inhabit the estuary for all or parts of their life cycle.

This paper examines and synthesizes the literature pertaining to the current state of knowledge on the hydrographic, physical, and biological effects of freshwater inflow, the estuarine community, reservoir development and operation, channel and floodplain modifications and past efforts for rehabilitation and restoration of the estuary affected by human modification. It also examines the literature found in the two-volume U.S. Bureau of Reclamation's Rincon Bayou Demonstration Project with a summary on the project's principal features, the collection and analysis of data in the marsh and estuary, and selected major conclusions.

Area of Coverage: The Nueces River Delta from the Nueces Overflow Channel east of U.S. Hwy. 37 downstream to the western extreme of Nueces Bay.

Key Words: Nueces River, Nueces Delta, experimental river diversion, marsh enhancement, Nueces Overflow Channel, Rincon Overflow Channel, U.S. Bureau of Reclamation.

Alan Plummer Associates, Inc. 2007. *Nueces Delta Studies Integrated Monitoring Plan, Fiscal Year 2007*. City of Corpus Christi Water Supply Project. Document 537-1302.

Abstract: All of the scientific programs associated with the 2001 TCEQ Agreed Order requiring freshwater inflows to the Nueces Estuary are described more completely in this publication. This document serves as a quick, look-up reference guide for determining where gathered scientific information is located amongst the various demonstration projects and monitoring studies implemented to enhance ecological conditions in the Nueces Estuary.

The Nueces Delta Studies Integrated Monitoring Plan (IMP) presents an overview of past, current and planned monitoring and initiatives of relevance to the ecological enhancement of the Nueces Estuary. The document provides an inventory and a consolidated description of the goals and activities of the several scientific programs initiated by the City of Corpus Christi, in conjunction with local, state and federal agencies.

The primary objective of the IMP is to assist in the coordination of all studies related to the Nueces Estuary. The IMP will be evaluate the results of the ongoing studies associated with the Nueces River Overflow Channel, Rincon Bayou Overflow Channel, the Calallen freshwater diversion pipeline, and the

Allison EDDP to provide a matrix for progress and goals and will make recommendations on adaptive management for refinement and analysis of the monitoring methods.

The FY2007 IMP provides an integrated summary of the monitoring (Table 1) being conducted pursuant to the Reservoir System Agreed Order, the EDDP, the RBND study, the TCEQ Clean Rivers Program (CRP), independent research, the Zinc TMDL Study. Sampling is conducted in compliance with approved quality assurance/quality control protocol.

A total of 41 stations are being monitored in six major areas of the Nueces Estuary. Many of these locations have been monitored for years. A description of the various studies conducted by all participants for FY2007 including data collection and evaluation techniques, is discussed in detail. Each participant is responsible for management and evaluation of their data. The University of Texas Marine Science Institute (UTMSI) is responsible for the collection and interpretation of the phytoplankton and salt marsh vegetation data. The Texas A&M University – Corpus Christi, Center for Coastal Studies (TAMUCC-CCS) is responsible for the collection and interpretation of the benthic invertebrate data. Monthly water column samples are collected by UTMSI and TAMUCC-CCS collects monthly water quality samples at multiple monitoring sites for the RBND and EDDP studies. Whole effluent toxicity and trace metal analyses of the Allison WWTP effluent are conducted twice a year by the City and ammonia analyses of the effluent is conducted five times per week. TAMUCC-CCS collects water samples for ammonia from the EDDP dispersal ponds three times per week. TAMUCC-CCS continues to monitor the 14 stations examined during the Zinc TMDL Study. Quarterly field measurements are taken and water and sediment samples are collected for zinc analyses. Physical evaluations of the Nueces Estuary hydrography include continuous monitoring of water elevation and flow. A workshop will be scheduled at the end of 2007 to discuss data collected by each entity conducting research with recommendations for future studies.

Area of Coverage: Nueces Estuary.

Key Words: Agreed Order (1992, 1995, 2001), Nueces Delta Mitigation Project, Rincon Bayou Demonstration Project, Allison Wastewater Treatment Plant Effluent Diversion Demonstration Project, Rincon Bayou, Nueces Delta Study, TMDL, Texas Coastal Ocean Observation Network.

Coastal Bend Bays & Estuaries Program, Inc. 2006. FY 2007 Comprehensive Annual Work Plan, *Comprehensive Habitat Mangement Plan for Coastal Bend Bays and Estuaries.* Coastal Bend Bays & Estuaries Program Contract No. 0708 with the Harte Research Institute for Gulf of Mexico Studies, Texas A&M University - Corpus Christi, Corpus Christi, Texas. Coastal Bend Bays & Estuaries Program, Inc., Corpus Christi, Texas.

Abstract: As part of the Fiscal Year 2006 work plan, this project summary identifies the work to be accomplished within the scope of the long-range Coastal Bend Bays Plan. This main objective of this study is to develop a long-term comprehensive habitat management plan used to direct future habitat preservation, creation and/or restoration activities in the Coastal Bend area, and facilitate economic development created by future dredging and dredge material placement activities to maintain navigable waterways and berthing facilities. By minimizing societal and environmental disruptions, this plan would provide guidance for both resource agencies and industrial entities in meeting the challenge of future planning for maintenance, growth and development. To date, three major deliverables associated with Project 0708 have been submitted to the CBBEP in May, June and August 2009 as summarized by Montanga (2009) at http://www.cbbep.org/projects/ecomanagement/Revisedsummaryreport12309.pdf.

Area of Coverage: Texas Coastal Bend area.

Key Words: dredging, regional beneficial uses plan, habitat opportunities, dredging material.

Coastal Bend Bays & Estuaries Program, Inc. 2007. FY 2008 Comprehensive Annual Work Plan, *Response of the Nueces Estuarine Marsh System to Freshwater Inflow – An Integrative Data Synthesis (Part 1).* Coastal Bend Bays & Estuaries Program Contract No. 0821 with the Harte Research Institute for Gulf of Mexico Studies, Texas A&M University - Corpus Christi, Corpus Christi, Texas. Coastal Bend Bays & Estuaries Program, Inc., Corpus Christi, Texas.

Abstract: As part of the Fiscal Year 2008 work plan, this project summary identifies the work to be accomplished within the scope of the long-range Coastal Bend Bays Plan. This study will involve the continuation of monitoring for changes in water column chemical and hydrological characteristics, phytoplankton biomass, emergent vegetation composition and distribution, soil characteristics, benthic, epifaunal, and nektonic macrofauna at several study locations examined almost uninterrupted for nearly 17 years. The project objectives listed in the work plan were 1) the development and organization of a geo-database to enable accessibility of data and information over the internet to facilitate discovery and acquisition of existing databases for analyses; and 2) produce a synthesis report presenting analysis relevant using the new database. The results of this study is found in CBBEP Publication 62 entitled *Response of the Nueces Estuarine Marsh System to Freshwater Inflow: An Integrative Data Synthesis of Baseline Conditions for Faunal Communities* issued in July 2009.

Area of Coverage: Nueces Estuary.

Key Words: freshwater diversions, geo-database, synthesis report, macroinfauna.

Coastal Bend Bays & Estuaries Program, Inc. 2008. FY 2009 Comprehensive Annual Work Plan, *Fresh Water Inflow/Salinity Monitoring of Rincon Bayou Pipeline Discharge in the Nueces Delta.* Coastal Bend Bays & Estuaries Program Contract No. 0921 with the Harte Research Institute for Gulf of Mexico Studies, Texas A&M University - Corpus Christi, Corpus Christi, Texas. Coastal Bend Bays & Estuaries Program, Inc., Corpus Christi, Texas.

Abstract: As part of the Fiscal Year 2009 work plan, this project summary identifies the work to be accomplished within the scope of the long-range Coastal Bend Bays Plan. The primary focus is to monitor freshwater inflows via a diversion pipeline into the upper Rincon Bayou to calculate spatial and temporal environmental affects from salinity levels measured at various stations downstream of the diversion pipeline. Additionally, these measurements will compliment other monitoring efforts in Rincon Bayou to aid in the determination of the amount of freshwater necessary to manage healthier estuarine conditions within the Nueces River Delta. As this project is primarily an exercise in data collection and analysis, the results may provide input to the City of Corpus Christi and the Nueces Estuary Advisory Council's concern for potential modifications to the present Agreed Order provisions governing freshwater pass-through requirements to meet the environmental demands in the Delta.

This study was initiated with a Quality Assurance Project Plan (QAPP) submitted to and approved by the TCEQ on 23 March 2009.

Area of Coverage: Nueces Delta.

Key Words: Rincon Bayou, Agreed Order, freshwater inflows, salinity measurements, environmental effects.

Brenner, J., P. Montagna, and J.B. Pollack. 2009. *Habitat Management Plan for Corpus Christi/Nueces Bay, Initial Meetings Summary*. Harte Research Institute for Gulf of Mexico Studies, Texas A&M

University - Corpus Christi, Corpus Christi, Texas. Prepared for the Coastal Bend Bays and Estuary Program, Project No. 0708. 17 pp.
<< http://www.cbbep.org/projects/ecomanagement/0708individmtgrprt.pdf >>

Abstract: As part of the project activity (Project No. 0708) described in the Fiscal Year 2007 Comprehensive Annual Work Plan, this Phase 1 report was submitted tot the CBBEP in May 2009 involves a partnership of citizens, elected officials, resource managers, and commercial and recreational users working as stakeholders to develop a habitat management plan (Plan). The objectives and priorities identified in this plan will help facilitate the protection, creation, restoration, and enhancement efforts of existing coastal habitat associated with key economic developments in the Corpus Christi/Nueces Bay area. Funding consideration will focus on all applications of fiscal opportunities and resources while providing helpful guidance for habitat conservation. Individual meetings were held with over 50 stakeholders for the purpose of a project summary and explanation to solicit each participants stated goals and objectives. This Plan would demonstrate the importance of environmental stewardship around the Coastal Bend area by working with commerce and industrial partners for sustainable development. This document contains the purpose of the project, purpose of initial meetings, description of methods, a summary of initial meetings, a summary of stakeholder comments from the initial meetings and existing plans. This project is to be divided into two phases. The Phase 1 deliverables would include a preliminary report and boundary map for completion by August 2009. This document is one of three deliverables submitted to the CBBEP as part of this contract. The Phase 2 deliverables would include the final report and project map with a deadline of December 2010.

Area of Coverage: Corpus Christi/Nueces Bay area.

Key Words: Multi-stakeholder participation, ecosystem based management plan, long term goals

Palmer, T., J. Brenner, T. Nance, and P.A. Montagna. 2009a. *Workshop Summary: Habitat Management Plan for the Corpus Christi Bay Area.* Harte Research Institute for Gulf of Mexico Studies, Texas A&M University - Corpus Christi, Corpus Christi, Texas. Prepared for the Coastal Bend Bays and Estuaries Program, Project 0708. 118 pp.
<< http://www.cbbep.org/projects/ecomanagement/0708workshopsummrprt.pdf>>

Abstract: As part of the project activity (Project No. 0708) described in the Fiscal Year 2007 Comprehensive Annual Work Plan, this Phase 1 report was submitted tot the CBBEP in June 2009. This document provides a summary of the presentations and discussion that transpired during the workshop. The four workshop goals were to identify: priority habitats and ecosystem services; the management plan's geographical coverage; the range and scope of activities in the overall plan; and the mechanisms and resources needed to support the plan. A breakout session involving seven groups discussed four questions created to correspond with each of the four workshop objectives. The results drawn from these discussions shows a breakdown of specific habitats reported by the different groups, what benefits these habitats provide to the public, a list of beneficiaries of services provided by the habitats identified, a list of general and specific locations for inclusion with each participant's reason(s) for inclusion, what activities promote sustainable production of goods and services with a priority of importance for each, the several types of government funding opportunities available and other existing funding sources for financial support, should be included, the identification of private and public barriers that may discourage plan implementation, and recognition of potential partners from governmental, educational, non-profit, and private organization in enabling the habitat management plan policy framework and context. This document is one of three deliverables submitted to the CBBEP as part of the Phase 1 portion of this contract.

Area of Coverage: Corpus Christi/Nueces Bay area.

Key Words: ecosystem based management plan, breakout group discussion, priority and specific habitats, activity types, funding opportunities, potential partnerships

Palmer, T., J. Brenner, T. Nance, and P.A. Montagna. 2009b. *Boundary Map Report - Habitat Management Plan of Corpus Christi Bay*. Harte Research Institute for Gulf of Mexico Studies, Texas A&M University - Corpus Christi, Corpus Christi, Texas. Prepared for the Coastal Bend Bays and Estuaries Program, Project 0708. 33 pp.
<< http://www.cbbep.org/projects/ecomanagement/Habitat_boundary_map_report.pdf >>

Abstract: As part of the project activity (Project No. 0708) described in the Fiscal Year 2007 Comprehensive Annual Work Plan, this Phase 1 report was submitted tot the CBBEP in August 2009. The intent of defining the boundary for the proposed Corpus Christi Bay area habitat management plan included a geospatial framework using GIS layers used to assemble a map representing the planning area and its larger area of influence in the Coastal Bend. The datasets for hydrologic units (HU) and ecoregions had the most influence in establishing a base-line natural characteristics and drainage boundary framework, accounting for all land and surface water areas creating a consistent, seamless, and hierarchical watershed boundary dataset based on the topographic and hydrologic features across the Corpus Christi Bay area. The spatial data layers created from the geospatial database along with information relevant discussed during the June 2009 workshop were grouped by specific thematic categories to help guide the formation of the proposed boundary. A map with a boundary based on conceptual and geographic criteria was created. A series of maps with applicable thematic information were presented for illustration and discussion. The characteristics of a GIS created polygon representing the Habitat Management Plan (HMP) boundary were created and presented in tabular format. A narrative description was provided for each segment of the HMP boundary. An area of influence extending from the core boundary area generates a large buffer zone around the HMP. Identification of this larger area is also subjected to the same overly and proximity analysis parameters determined for the HMP planning area. This will provide the CBBEP the opportunity to guide the future of the HMP area through judicious and sustainable management of development in the buffer zone. This document is one of three deliverables submitted to the CBBEP as part of the Phase 1 portion of this contract.

Area of Coverage: Corpus Christi/Nueces Bay area.

Key Words: GIS, thematic maps, stakeholder workshop input, ecoregions, hydrological unit.

Montagna, P.A., T. Palmer, M. Gil, K. Dunton, E. Hill, and B. Nicolau. 2009a. *Response of the Nueces Estuarine Marsh System to Freshwater Inflow: An Integrative Data Synthesis of Baseline Conditions for Faunal Communities, Publication 62, July 2009.* Coastal Bend Bays & Estuaries Program Contract No. 0821 with the Harte Research Institute for Gulf of Mexico Studies, Texas A&M University - Corpus Christi, Corpus Christi, Texas. Coastal Bend Bays & Estuaries Program, Inc., Corpus Christi, Texas.

Abstract: As part of the project activity (Project No. 0821) described in the Fiscal Year 2008 work plan, this synthesis report integrates the hydrological data with the biological responses by resident macrofauna and emergent vegetation based on statistical, geostatistical, and synthetic interdisciplinary analyses. The final document can be found on the CBBEP website at http://www.cbbep.org/publications/virtuallibrary/0821.pdf. Work associated with this study was accomplished using long-term monitoring datasets and consisted of two major parts. The first part was conducted using hydrological data measured by multiple continuous monitors over a 14-year period (1994 - 2008) to determine objective and consistent separation of wet and dry periods. The second part

combined the wet and dry period information with water quality, benthic macrofauna, and marsh vegetation for comparison of biological responses to inflow events. Benthic macrofauna, vegetation, and water quality samples were collected by three research groups from 10 sites divided into three zones: upper Rincon Bayou, lower Rincon Bayou, and Nueces Bay. Using statistical approaches such as the Principal Component Analysis (PCA), the water quality data was analyzed. The multivariate method (BIO-ENV) was used to investigate the relationships between each of the biotic communities (macrofauna and vegetation) with water quality variables. Using the statistical test, RELATE, comparisons among the biotic and water quality multivariate datasets were investigated.

Area of Coverage: upper and lower Rincon Bayou, Nueces Bay.

Key Words: statistical analyses, spatial-temporal changes, macrobenthic, emergent vegetation
Conclusions:

- Analysis of the hydrological variables indicates that wet and dry periods occurred at a frequency of every two years.
- Water quality at all stations varied with changes in the wet and dry periods.
- Flows in the Nueces River, sufficient enough to surge into Rincon Bayou via the Nueces River Overflow Channel, occurs only 15% of the time.
- Regardless of the varying amounts of freshwater inflow into the upper portion of Rincon Bayou, water quality in the lower half of Rincon Bayou was always more similar to Nueces Bay.
- A correlation was established between macrofauna community structure changes with spatial-temporal changes in water quality.
- The vegetation community structure was not correlated to spatial-temporal changes in water quality although correlated with the macrofauna community structure.
- The biotic communities found in the upper Rincon Bayou were considerably different from the lower Rincon Bayou communities regardless of wet or dry conditions.
- The overall results suggest that the effects of freshwater inflow are restricted even during periods of extended flooding.

Coastal Bend Bays & Estuaries Program, Inc. 2009. *Freshwater Inflow/Salinity Monitoring of Rincon Bayou Pipeline in the Nueces Delta Using Salinity Monitoring, Quality Assurance Project Plan.* Coastal Bend Bays & Estuaries Program Contract No. 0921 with the Texas Commission on Environmental Quality. Coastal Bend Bays & Estuaries Program, Inc., Corpus Christi, Texas.

Abstract: As part of the project activity (Project No. 0921) described in the Fiscal Year 2009 Comprehensive Annual Work Plan, this Quality Assurance Project Plan (QAPP) for freshwater inflow/salinity monitoring in the Nueces Delta was recently approved by the TCEQ on 23 March 2009. QAPP's are a key component of a systematic planning process. A well-planned QAPP helps ensure that environmental data are accurate enough to be used in decision making. Based on a recommendation by the Nueces Estuary Advisory Committee (NEAC), an agreement was made between the City of Corpus Christi and the TCEQ to implement a strategy of maximizing freshwater inflows by introducing supplemental inflows into the upper Nueces Delta rather than into the Nueces River. The City of Corpus Christi has reopened the Nueces Overflow Channel and constructed the Rincon Bayou Diversion Pipeline to pump raw water from the river from Calallen Pool upstream of the salt water barrier and release into the upper end of Rincon Bayou. Beginning in the spring of 2009, continuously monitored water quality parameters (salinity, conductivity, and water temperature) will be captured in real time (approximately every 15 minutes) at four stations in upper Rincon Bayou. An accurate understanding of the interrelationship between freshwater inflow and dispersion patterns will be helpful for future freshwater management strategies. A web service that allows integrating data for analysis and visualization is found on the Division of Nearshore Research's website. The following is a list of accessible internet sites storing the project-specific QAPP and project support documentation, maps of sampling sites, daily salinity measurements, and links to other related websites associated with the study area:

Freshwater Inflow/Salinity Monitoring of Rincon Bayou Pipeline in the Nueces Delta Using Salinity Monitoring.
http://lighthouse.tamucc.edu/RinconSalinity/RinconSalinity

Quality Assurance Project Plan
http://lighthouse.tamucc.edu/dnrpub/uploads/RinconSalinity/0921%20Rincon%20Final%20QAPP%203-20-09.pdf
Appendix A – Scope of Work
http://lighthouse.tamucc.edu/dnrpub/uploads/RinconSalinity/0921%20FINAL%20Rincon%20Salinity%20SOW%2011-10-08.pdf

Appendix B – DNR Data Management
http://lighthouse.tamucc.edu/Main/DataManagement

Appendix C – TCEQ Hydrolab SOP
http://lighthouse.tamucc.edu/dnrpub/uploads/RinconSalinity/Hydrolab%20SOP

Appendix D – TCEQ YSI SOP
http://lighthouse.tamucc.edu/dnrpub/uploads/RinconSalinity/YSI_CALIBRATION_LOG.pdf

Appendix E – TCEQ Quality Assurance Quality Control
http://lighthouse.tamucc.edu/dnrpub/uploads/RinconSalinity/YSI_CALIBRATION_LOG.pdf

Appendix F – TCEQ Multisonde Calibration and Maintenance Methods
http://lighthouse.tamucc.edu/dnrpub/uploads/RinconSalinity/rg_415_chapter8.pdf

Daily Salinity Graph – NUDE01
http://lighthouse.tamucc.edu/qc/041

Daily Salinity Graph – NUDE02
http://lighthouse.tamucc.edu/qc/042

Daily Salinity Graph – NUDE03
http://lighthouse.tamucc.edu/qc/043

Daily Salinity Graph – USGS Gauge 0821150305 Rincon Bayou Channel near Odem, TX.
http://waterdata.usgs.gov/tx/nwis/uv?cb_00010=on&cb_00095=on&cb_90860=on&format=gif_default&period=7&site_no=0821150305
http://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=08211503

Rincon Pump Stations – Nueces River Authority
http://www.nueces-ra.org/CP/CITY/rincon/

Daily Meteorological Graph – NUDEWX
http://lighthouse.tamucc.edu/qc/069

Area of Coverage: The upper end of Rincon Bayou between the existing USGS near the weather station NUDEWX to the central portion of Rincon Bayou.

Key Words: salinity monitoring stations, USGS, automated sampling, internet accessible.

HDR Engineering, Inc. and Naismith Engineering, Inc. 1993. *Nueces Estuary Regional Wastewater Planning Study-Phase II.* Prepared for the City of Corpus Christi, Port of Corpus Christi Authority, Corpus Christi Board of Trade, South Texas Water Authority and the Texas Water Development Board.

Abstract: In 1991, the City of Corpus Christi and local sponsors initiated a two-phased study to consider the feasibility of diverting river water and treated effluent into the Nueces Delta with the main objective of reducing freshwater inflow requirements from the two upstream impoundments, Choke Canyon Reservoir and Lake Corpus Christi. The Phase 1 report recommended one or two demonstration projects for evaluation and suggested an increase in research studies necessary to understand the biological processes operating in the aquatic environments of the Nueces Delta and Bay. Phase 2 focused on detailed preparation for the demonstration projects through the biological monitoring of effects of diversion of freshwater inflow and wastewater return flows in Rincon Bayou and the Nueces Delta. This document also presented detailed baseline information collected since 1991 in an attempt to observe biological responses of phytoplankton and emergent marsh vegetation to freshwater releases into Rincon Bayou. The results demonstrated that rerouting of freshwater from the river or the Allison WWTP through this marsh system of the delta is more beneficial to the receiving bay and estuary. These two studies provided the foundation for the eventual development of the Rincon Bayou and Allison Wastewater Treatment Plant Effluent demonstration projects intended to restore and enhance coastal wetlands.

Area of Coverage: Nueces Bay, Rincon Bayou, Nueces Delta, Nueces River.

Key Words: primary productivity, demonstration projects, freshwater diversion, deltaic inundation.

Hill, R. and B.A. Nicolau. 2008. Rincon Bayou Diversion Project. FY 2007 Annual Report, October 2006-September 2007. Texas A&M University-Corpus Christi, Center for Coastal Studies, Corpus Christi, Texas.

Abstract: The report focuses on the Year 6 monitoring data collected by Texas A&M University-Corpus Christi Center for Coastal Studies with a review of years one through five collections. The introduction presents background material on the evolution of the Nueces Estuary hydrology since impoundment of the Nueces River by Choke Canyon Reservoir and Lake Corpus Christi and the steps taken by the City of Corpus Christi in search for alternative freshwater sources for delivery into the Delta. A list of three project objectives were provided to the City and a monitoring program was established in Rincon Bayou and the Nueces River with four tasks to achieve these stated goals. The three project objectives of the Rincon Bayou Diversion Project are 1) determine if “no harm” occurs as a result of freshwater diversion from the Nueces River into Rincon Bayou, 2) assess any benefits of the diversion on Rincon Bayou and, 3) assist the City in developing an optimal operational management procedure for freshwater pass-throughs based on sound science. The four tasks identified for attainment of the project objectives are 1) comparison of water quality results to determine physiochemical changes, 2) quantify benthic density, biomass, diversity, and species distribution for comparison to relevant changes in water quality and sediment grain size, 3) quantify nekton catch per unit effort (CPUE), biomass, diversity, and species distribution for comparison to water quality changes and, 4) quantify avian species abundance, habitat usage, diversity, and species distribution for comparison with changes in benthic and nekton communities and water quality.

A brief description of the study area and climate is included as well as sampling design and statistical analysis. Monthly sampling occurred at eight locations representing three areas: lower tidal reach of Rincon Bayou, lower tidal reach of the Nueces River and Nueces Bay located outside the mouth of Rincon Bayou and Nueces River. The timing of precipitation and resulting inflows were discussed by collection year. The largest amount of rainfall was recorded during the Year 6 sampling period resulting

in substantial increases in freshwater inflows to the Nueces River. The volume of freshwater was great enough to reach the Rincon Diversion Channel as salinity decreased to 9.70 near central Rincon Bayou in January 2007 before increasing to 29.46 the following month. Flooding rains in July 2007 was of significant volume and duration that salinities throughout the delta remained below 10.00 until September 2007. The benthic community increased in abundance and biomass showing a recovery from Year 5 but remained lower than the abundance numbers observed during Year 3 and Year 4. Total monthly freshwater inflow recorded at the USGS Calallen Gauge No. 0821150 was high during each of these three sampling events and there appears to be some correlation between these inflow amounts to the total benthic species richness with total benthic tax abundance and biomass listed for Collection Years 1, 3, 4 and 6. Benthic species were categorized by feeding guilds and as more data becomes available, yearly comparisons will help identify changes within the Nueces Delta. Monthly bird observations were recorded within the Nueces Delta to determine differences in abundance, behavior, habitat use, and species composition. An appendix included the results of an independent effort to monitor the biological effects of the EDDP at two stations located in the Delta Access Channel (DAC).

Area of Coverage: Nueces Delta

Key Words: freshwater inflows, Nueces Delta, salinity, multidimensional scaling, trophic structure.

Montagna, P.A., E.M. Hill, and B. Moulton. 2009. *Role of science-based and adaptive management in allocating environmental flows to the Nueces Estuary, Texas, USA.* Ecosystems and Sustainable Development. In press.

Abstract: This concise manuscript is primarily targeted toward interested public/concerned citizens because it discusses a specific region and the issue of freshwater inflow; the report also is effective in providing uncomplicated information to the general public policymakers, resource managers, and scientists. The report is a compilation of several different studies undertaken to address the need for freshwater input into an estuary that became hypersaline after reservoir construction halted a dependable source of inflow to the area and worsened by drought. A brief background description of the Nueces River, Delta and Estuary was provided along with a discussion of the major alterations to the river. The Texas Water Commission (TWC) issued orders to the City of Corpus Christi to provide for freshwater inflows that subsequently led to a series of restoration activities, monitoring and experimental studies. These management actions are listed by a description of project activity with the adaptive management actions that followed including the creation of the Nueces Estuary Technical Advisory Committee (NETAC) in June 1990. NETAC, composed of stakeholders, was authorized by the State with the task of protecting environmental flows in the Nueces Estuary. Since the passage of the Clean Water Act in 1972, the United States has not yet enacted any federal laws regulating water quantity to protect the environment. The issues surrounding environmental flows raises fascinating economic, institutional, and political issues that will not soon disappear unless the traditional legislation ambiguity on how ecological indicators are clearly defined and therefore can be used to resolve issues of conflict. The authors are encouraged about the accomplishments made in the Nueces Estuary with a blend and balance of science and a stakeholder decision process. Concludes that a combination of science-based decision-making and adaptive management has led to an increased awareness to understand that and more stable and consistent supply of freshwater is needed for environmental restoration and protection.

Area of Coverage: Nueces Estuary.

Key Words: freshwater inflow, wetlands, marsh, shellfish, dams, water resources, interpretation of legislative language.

Palmer, T.A, P.A. Montagna, and R.D. Kalke. 2002. *Downstream effects of restored freshwater inflow to Rincon Bayou, Nueces Delta, USA*. Estuaries 25(6B): 1448-1456.

Abstract: The authors provide a detailed portrait of the Nueces River watershed since average annual inflow to the delta has been reduced by 99 percent when the river was first dammed in 1958. This report provides information on the benthic infauna and hydrologic variables of the Nueces Estuary and Nueces Bay studied between October 1998 and October 1999. Five quarterly collections were taken over the 12-month period at eight stations starting in the upper Rincon Bayou downstream of the Nueces Overflow Channel (NOC) and extending into the lower reach of Nueces Bay. The vertical distribution of macroinfauna was investigated by collecting triplicate 10 cm deep cores, sectioned at depth intervals of 0-3 and 3-10 cm, and sieved on a 0.5 mm mesh-size screen. Species diversity, abundance, biomass and community structure were all calculated by statistical analysis including Hill's number one (N1) diversity index, two-way ANOVA, and Principal Components Analysis (PCA) to assess ecological change. A total of 12 precipitation and freshwater inflow events occurred between the months preceding and ending sampling. The rainfall effects from two tropical storms in the region during October 1998 had a major influence on salt content of the water as low salinities persisted throughout the entire Nueces Delta that allowed the entire Rincon Bayou to temporarily exhibit a normal estuarine salinity pattern. However, high salinities returned quickly while high tides pushed marine water upstream in the spring and summer months of 1999. A total of 120 species were identified in the survey. The macrobenthic community was found to be different in three zones along the 27-km sampling areabut was dominated by a few polychaete (annelid worms) species including *Streblospio benedicti*, *Mediomastus ambiseta* and *Laeonereis culveri*. The four locations closest to the NOC were highly variable in water inundation and salinity resulting in lower diversity caused by a broad salinity range. Flow velocities may have been too high during the October 1998 flooding events or the loss of low salinity intolerant species. Two central stations were characterized by a brackish water environment with a more diverse assemblage. These locations are found in a narrow channel section of Rincon Bayou that receives little freshwater input. The lower portion of the Nueces Bay produced a more diverse community of larger organisms because this area had the strongest marine influence with less disturbance from high flow velocities during flood events. Several studies cited by the authors have shown that diversity increases away from brackish water into the marine zone. Based on the results, the authors concluded that the upper Nueces Estuary and Rincon Bayou is an area of low diversity dominated by pioneering species colonizing newly-opened habitat and characterized by extensive periods of reverse estuary conditions. A stable freshwater community is non-existent due to intermittent and isolated freshwater volumes.

Area of Coverage: Rincon Bayou and Nueces Bay.

Key Words: Rincon Bayou, Nueces Overflow Channel, benthic characteristics, downstream benefits of freshwater inflow.

Powell, G.L., J. Matsumoto, and D.A. Brock. 2002. *Methods for determining minimum freshwater inflow needs of Texas bays and estuaries*. Estuaries 25(6B): 1262-1274.

Abstract: Instream flow needs have been a subject of research in Texas for several decades. Prior to 1975, little research was performed on Texas estuaries. The need for freshwater inflows to the Texas bays and estuaries was first recognized during the decade-long drought that lasted from 1948 to 1957. Due to the coastal climate, population growth, and scientific concerns for estuarine resources, the State began to concentrate on inflow issues. In 1975, the 64th Texas Legislature enacted Senate Bill 137, the first effort to comprehensively address the coast-wide problem of freshwater. This bill also mandated methods of providing and maintaining a suitable ecological environment. Since then, Texas agencies have investigated the various aspects of the estuary-inflow issue. In 2001, the Texas Legislature enacted Senate Bill 2 that mandated the Texas Water Development Board (TWDB) and the Texas Parks and

Wildlife Department (TPWD) to jointly establish and maintain a data collection and analytical study program focused on determining the effects of and needs for freshwater inflows into the state's 10 bay and estuary systems. Work was begun on improving the data bases on salinity and living resources through hydrographic surveys, hydrodynamic modeling of circulation and salinity patterns, sediment analyses, nutrient analyses, fisheries analyses, freshwater inflow optimization modeling, and verification of needs. Concurrent with data acquisition, modelers were confronting important problems in the use of mathematical analyses in inflow optimization. Martin (1987) developed a linear model for estimating monthly inflow needs but encountered problems with nonlinear relationships and uncertainty. Bao et al., (1989) and Tung et al., (1990) addressed Martin's problems with a nonlinear model that dealt with uncertainties of the regression equations. Matsumoto (1990) developed the Texas Estuarine Mathematical Programming model (TxEMP) Model by that expanded on modifying Bao and Tung's model through nonlinear equations, consideration of probability functions, and problem analysis through multi-objective analysis. The TxEMP model is described formally in Longley (1994) and Powell and Matsumoto (1994) is a modification of (Matsumoto, 1990). Both articles discuss the model's application to the Guadalupe Estuary and the latter describes a recent application to Corpus Christi Bay and the Nueces Estuary. The authors recommended long-term monitoring to ensure implementation of future water management strategies maintain the ecological health of estuaries and provide an early warning system of needs required for adaptive management strategies.

Area of Coverage: State of Texas rivers, bays and estuaries.

Key Words: TxEMP Inflow bounds, salinity bounds, salinity-inflow equations, quantification of inflow/fisheries relationships, statistical methods.

Tolan, J.M. 2008. *Larval fish assemblage response to freshwater inflows: a synthesis of five years of ichthyoplankton monitoring within Nueces Bay*. Bulletin of Marine Science 82(3): 275-296(22).

Abstract: This report presents a discussion of a comprehensive investigation pertaining to the spring season spatiotemporal dynamics of the ichthyofaunal assemblage structure and its relationship to freshwater inflows were investigated in the Nueces Estuary. A total of 499 plankton collections were collected over a six-calendar year period from four to six fixed stations. Sampling occurred during a fluctuation of hydrological conditions ranging from moderate drought to the watershed's flood of record. A total of 265,664 larval and juvenile fishes representing 21 families and 51 taxa were collected. Three families (Engraulidae, Gobiidae, and Clupeidae) dominated the total study catch accounting for 97.6% of the individuals. Despite sampling over a wide range of inflow conditions, the analysis of the larval fish assemblages revealed significant disparity only during periods of extreme salinity differences. During the mid- to late spring of each survey year, a similar temporal trend of maximal abundance in the distribution of plankton was noted. Peak ichthyoplankton abundance and composition were temporally modified by the timing of each inflow event. The taxonomic diversity of the ichthyofauna also responded to the inflow events, resulting in a greater phylogenetic diversity during a springtime-coincident flood event. Only during the most extreme recorded inflows did abiotic conditions appear to dramatically alter the larval fish assemblage as a peak in fisheries abundance coincided with record spring flooding.

Area of Coverage: Nueces Estuary.

Key Words: freshwater inflow, hydrological fluctuations, taxonomic diversity.

Tunnell, J. 2009. Fresh Water Inflow/Salinity Monitoring of Rincon Bayou Pipeline Discharge in the Nueces Delta. Summary Report of Rincon Bayou Diversion Pipeline Pumping, 22 October 2009. Coastal Bend Bays & Estuaries Program, Inc., Corpus Christi, Texas.

Abstract: Although salinity measurements at four locations were tentatively scheduled to begin upon TCEQ approval in the spring, the first substantial inflows recorded into the Reservoir System since completion of pipeline construction in the summer of 2008, did not occur until late August/early September 2009. The first eligible "pass through" pumping event mandated by the Agreed Order began on 28 September, 2009. Of the three pumps built, delivery of freshwater to Rincon Bayou via the diversion pipeline was accomplished by the operation of only one or two pumps. A change in salinity was observed in the bayou within a few hours of initial pumping. A total of 3,000 acft of water was pumped over a 24 day period ending on 21 October 2009. Salinity measurements at six stations installed with datasondes and telemetry equipment are recording real time data at 15-60 minute intervals, stored on-site and transmitted for internet access on the Division of Nearshore Research's website. The data collected for the period of 9-28-09 to 10-21-09 was used to calculate upstream acft loss to the Nueces River during the pass through pumping. Based on the data results, it was determined 682 acft of the total 3,000 acft pumped, or 22.73%, was lost to the Nueces River. Several websites are listed to access the various data sources used to observe salinity changes over time and calculations of water loss in reponse to the pass through freshwater inflows. Several bar charts were generated to illustrate the average daily discharge in cubic feet per second (cfs) to the Nueces River from Rincon Bayou during pumping, a comparison of daily upstream acft to total acft amounts, and a line chart showing the fall and eventual rise of salinities throughout the length of Rincon Bayou as recorded by the six continuous monitoring stations during the pumping event and one month beyond the end of pumping. These sites include:

USGS 08211503 Rincon Bayou Channel nr Calallen, TX
http://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=08211503

Sample location map, salinity and time at four monitoring stations on Rincon Bayou
http://lighthouse.tamucc.edu/RinconSalinity/RinconSalinity

Daily Flow Measurements at the Rincon Pump Stations including pumps in use, individual pump flow rates, and all total flow
http://www.nueces-ra.org/CP/CITY/rincon/

Access to Passthru Status Reports
http://www.nueces-ra.org/CP/CITY/passthru/index.php

Area of Coverage: The length of Rincon Bayou between the existing USGS gage near the weather station NUDEWX to Whites Point in Nueces Bay.

Key Words: Rincon Bayou Pipeline, first pumping event, salinity change, upstream acft loss calculation, Nueces River/

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Appendix K
Cumulative Effects of
Water Management Strategies

K.1 Cumulative Effects of Regional Water Plan Implementation

Available hydrologic models have been used to quantify the cumulative effects of implementation of the Coastal Bend Regional Water Plan (Region N) through the year 2060. Models include the South-Central Carrizo System model (SCCS),[1] Gulf Coast Groundwater Availability Models (Gulf Coast GAMs),[2,3] Nueces River Basin Water Availability Model (Nueces WAM),[4] and Corpus Christi Water Supply Model (formerly known as Lower Nueces River Basin Bay and Estuary Model (NUBAY)).[5]

The cumulative effects are quantified through long-term simulation of natural hydrologic processes including precipitation, streamflow, aquifer recharge, springflow, and evaporation as they are affected by human influences such as aquifer pumpage, reservoirs, sedimentation, diversions, and the discharge of treated effluent. Another complex component of this hydrologic system is the operation of the TCEQ Bay and Estuary Agreed Order that describes how the City of Corpus Christi operates the Choke Canyon Reservoir / Lake Corpus Christi System (CCR/LCC) with respect to reservoir levels and pass-through requirements for the Nueces bay and estuary.

K.1.1 Groundwater

Cumulative effects of plan implementation on the groundwater supplies for the Coastal Bend Region were evaluated as part of the planning process and are addressed in Section 4C.7 of the report. The maximum drawdown in the Evangeline Aquifer near the SPMWD and the City of Corpus Christi well fields is approximately 71-feet in Bee and 82-feet in San Patricio Counties as shown in Figure 4C.7-14 and on the hydrographs in Figure 4C.7-15. The proposed export projects do not exceed the drawdown criteria adopted by the CBRWPG.

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[1] HDR Engineering, Inc., "South Central Carrizo System Groundwater Model, SAWS Gonzales-Carrizo Project," San Antonio Water System, November 2004.
[2] Texas Water Development Board, Groundwater Availability Model for the Central Gulf Coast Aquifer System: Final Report and Numerical Simulations Through 1999," Texas Water Development Board, 2004.
[3] Waterstone Environmental Hydrology and Engineering. Inc., "Groundwater Availability of the Central Gulf Coast Aquifer – Numerical Simulations to 2050, Central Gulf Coast, Texas," Contract Draft Report, 2003.
[4] HDR Engineering, Inc., "Water Availability in the Nueces River Basin," TNRCC, October 1999.
[5] HDR Engineering, Inc., "Water Supply Update for City of Corpus Christi Service Area," City of Corpus Christi, January 1999.

K.1.2 Surface Water

Potential cumulative effects of implementation of the 2011 Coastal Bend Regional Water Plan on instream flows and freshwater inflows to bays and estuaries have been assessed for selected locations in the Nueces River Basin. These locations are shown in Figure K-1 and include Nueces River at Cotulla, Frio River at Choke Canyon, Reservoir, Nueces River at Three Rivers, Nueces River at Mathis and the Nueces Estuary. The cumulative effects are shown for the following three conditions:

- Baseline conditions
- Year 2060 conditions without Region L's proposed recharge dams,
- Year 2060 conditions with Region L's proposed recharge dams.

<u>Baseline Conditions</u>

The baseline for consideration of effects on flows reflects current sedimentation conditions for CCR/LCC, full utilization of existing water rights, a safe yield demand of the CCR/LCC system (approximately 163,000 acft/yr leaving a 7% reserve of overall system storage), a Lake Texana supply delivered through the Mary Rhodes Pipeline of 41,840 acft/yr, and treated effluent discharge percentages representative of current conditions.

<u>Year 2060 Conditions without Region L's proposed recharge dams</u>

The implemented plan conditions include the Year 2060 sedimentation conditions for CCR/LCC, full utilization of existing water rights, a 2060 safe yield demand of the CCR/LCC system (approximately 158,000 acft/yr leaving a 7% reserve of overall system storage), a firm Lake Texana supply delivered through the Mary Rhodes Pipeline of 41,840 acft/yr plus the interruptible supply of 12,000 acft/yr, 35,000 acft/yr of supply from the Garwood project delivered through the Mary Rhodes pipeline, supplies from the Nueces Off-Channel Reservoir, and 18,000 acft/yr of supply from Refugio county groundwater delivered through the Mary Rhodes pipeline and treated effluent discharge representative of 2060 conditions.

Year 2060 Conditions with Region L's proposed recharge dams

Another aspect that was taken into consideration for 2060 conditions is the effect that the Edwards Aquifer Type II recharge enhancement projects under consideration by Region L could have on the reduction of streamflows in the Coastal Bend Region. The locations of the proposed recharge dams are shown on Figure K-2. The reduction of streamflows become evident in the reduced yield of the CCR/LCC system (approximately 5,600 acft/yr) and the reduction in inflows to the Nueces Bay and Estuary system and are shown in Figures K-3 to K-7. These reductions are made evident in the summarization graphs presented below for each of the control points evaluated and show that mitigation of these projects will be necessary.

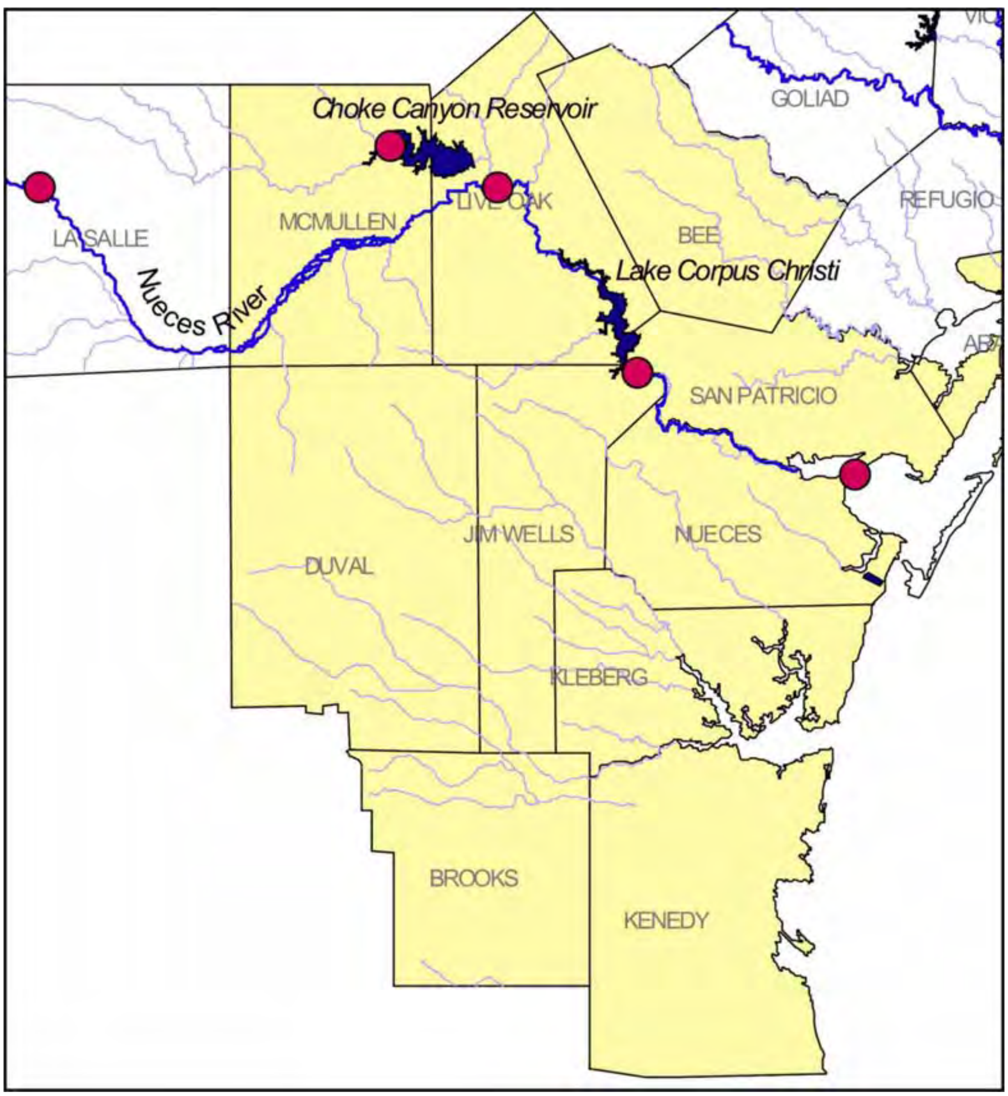


Figure K-1. Selected Locations for Evaluating Cumulative Effects

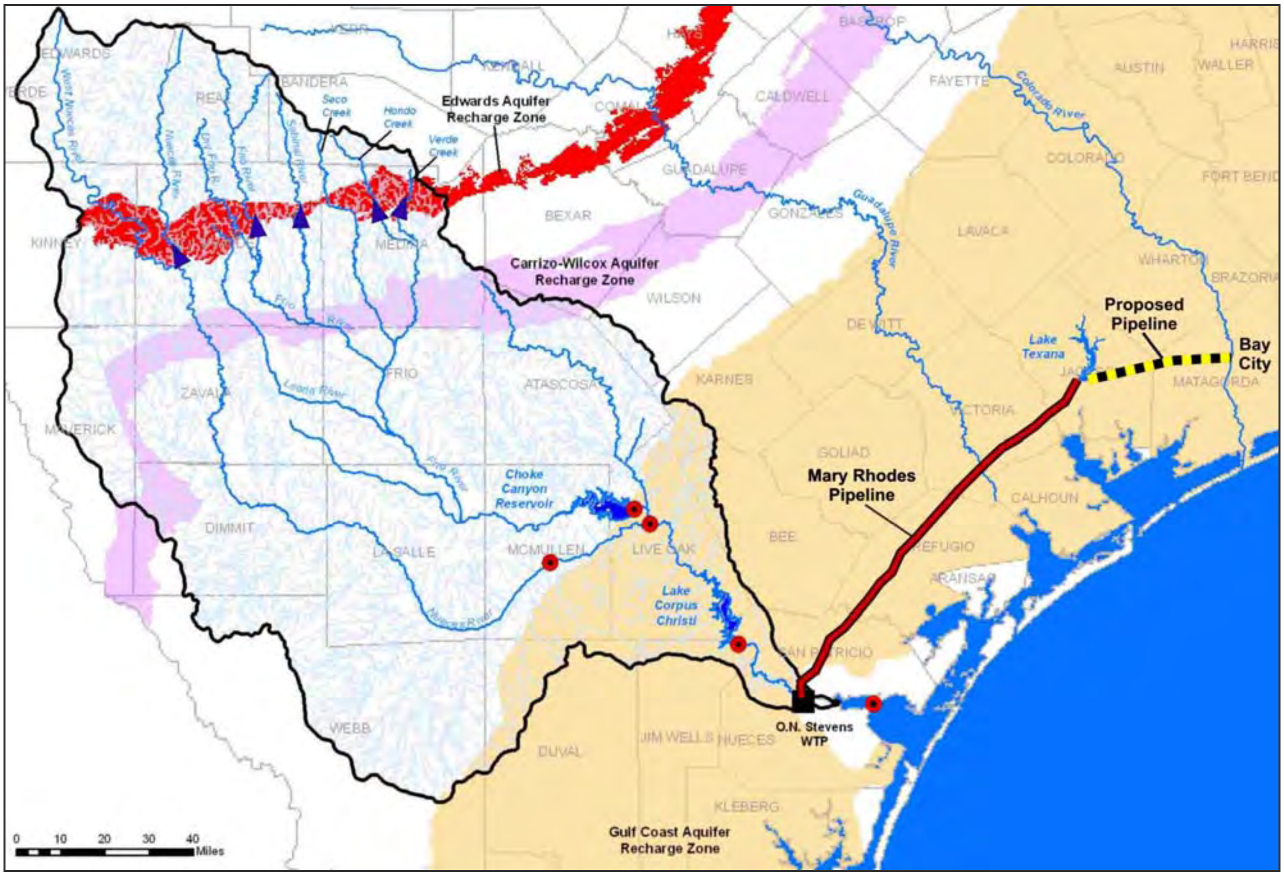


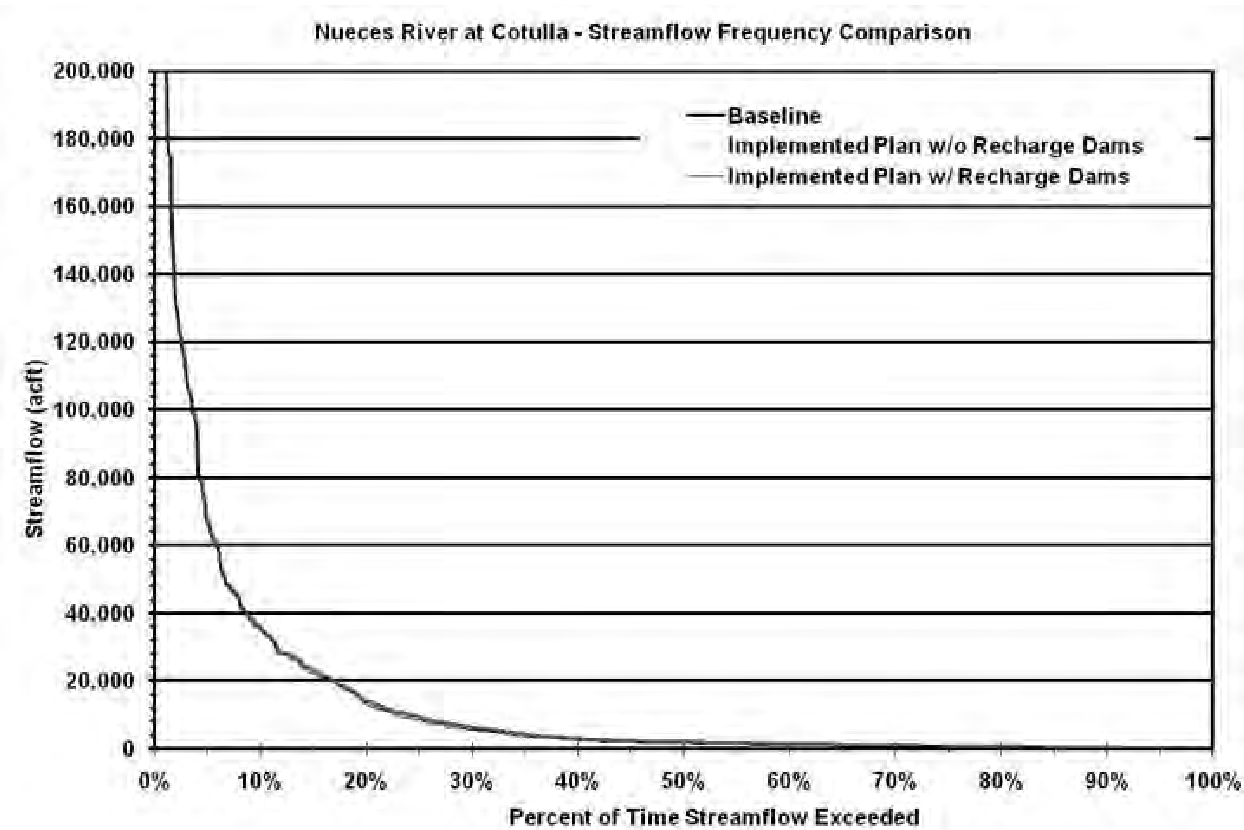
Figure K-2. Locations of Projects for Cumulative Effects Analysis

Many of the strategies being implemented for the 2011 Coastal Bend Regional Water Plan are unique in that they do not directly affect the hydrologic components of the Nueces River Basin. The Garwood water, the interruptible Texana water and the groundwater are all supplies that originate outside the basin. Therefore the only significant impacts seen from the implementation of these projects is the direct increase in flows to the bay and estuary from the increase in return flows. There are only minimal impacts from these projects on any of the streamflow locations previously mentioned. The significant factors impacting the streamflows in the Nueces basin are the reduction in storage capacity in the CCR/LCC reservoirs due to sedimentation, the implementation of the Lake Corpus Off-Channel Reservoir, and the resulting loss of yield, and from the implementation of the recharge enhancement structures in Region L. The reduction in reservoir yield reduces water supply releases made from the reservoirs and the volume of return flows entering the bay and estuary system. These impacts are shown in Figures K-3 through K-7. Figures K-3 through K-5 were generated using the output from the Nueces

WAM. This model at these control points highlights the changes from the implementation of the recharge dams in Region L. Figures K-6 through K-8 were developed using output from the Corpus Christi Water Supply model. This model was the tool used to evaluate the LCC Off-Channel Reservoir project, and the changes in the lower basin streamflow are better accounted for using this model. Figure K-8 shows a comparison of the percent storage trace of the combined storage of CCR and LCC for the baseline and the two 2060 plan scenarios.

K.1.3 Results

For all locations presented in the figures, except the Nueces River at the Nueces Estuary, the median monthly streamflow values generally show a reduction for the plans runs compared to the baseline run. These minor reductions in streamflows across the basin can be attributed to the impacts of Region L's proposed recharge enhancement projects in the uppermost part of the Nueces Basin. The Nueces River at Mathis and the Nueces Estuary control points are greatly influenced by the operation of the CCR/LCC/OCR system, as well as the increased demand in 2060. The frequency plots associated with these two locations show the greatest changes between the plan and the base run. For example, Figure K-6 shows that the percent of time that flows are greater than about 45,000 acft/mo is reduced as water is diverted into the OCR, whereas the streamflows are increased in the below 25,000 acft/mo range about 75% of the time. The estuary control point shows increases in the median monthly streamflow values for 11 out of the 12 months. The reason for the estuary increase is because the new out-of-basin sources brought online in the plan generate additional return flows, which are accounted for as inflow into the estuary. The two 2060 plan scenarios show a modest reduction in reservoir system storage that results from both the loss of capacity from increased sediment and loss of inflows from the recharge enhancement projects. These results show the importance of Region L and N's continuing to work on appropriate mitigation for the recharge dams prior to their implementation.



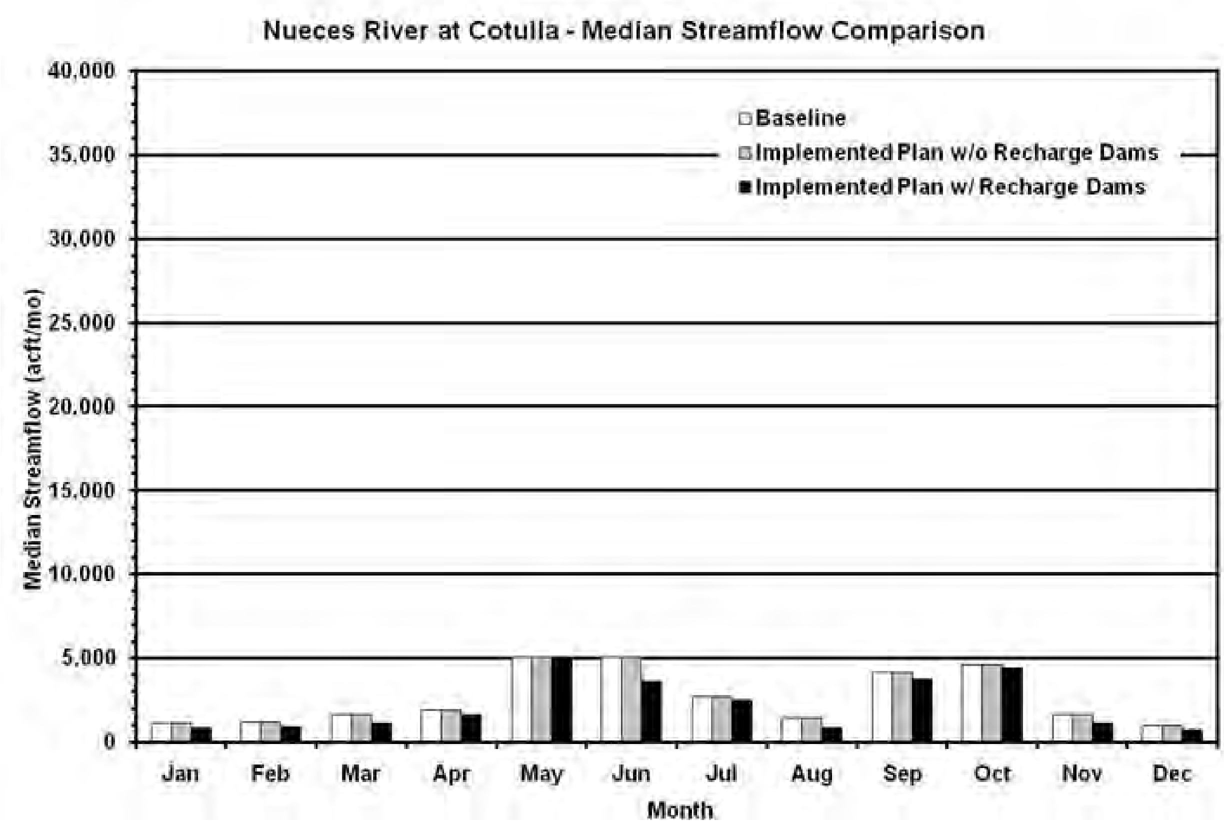
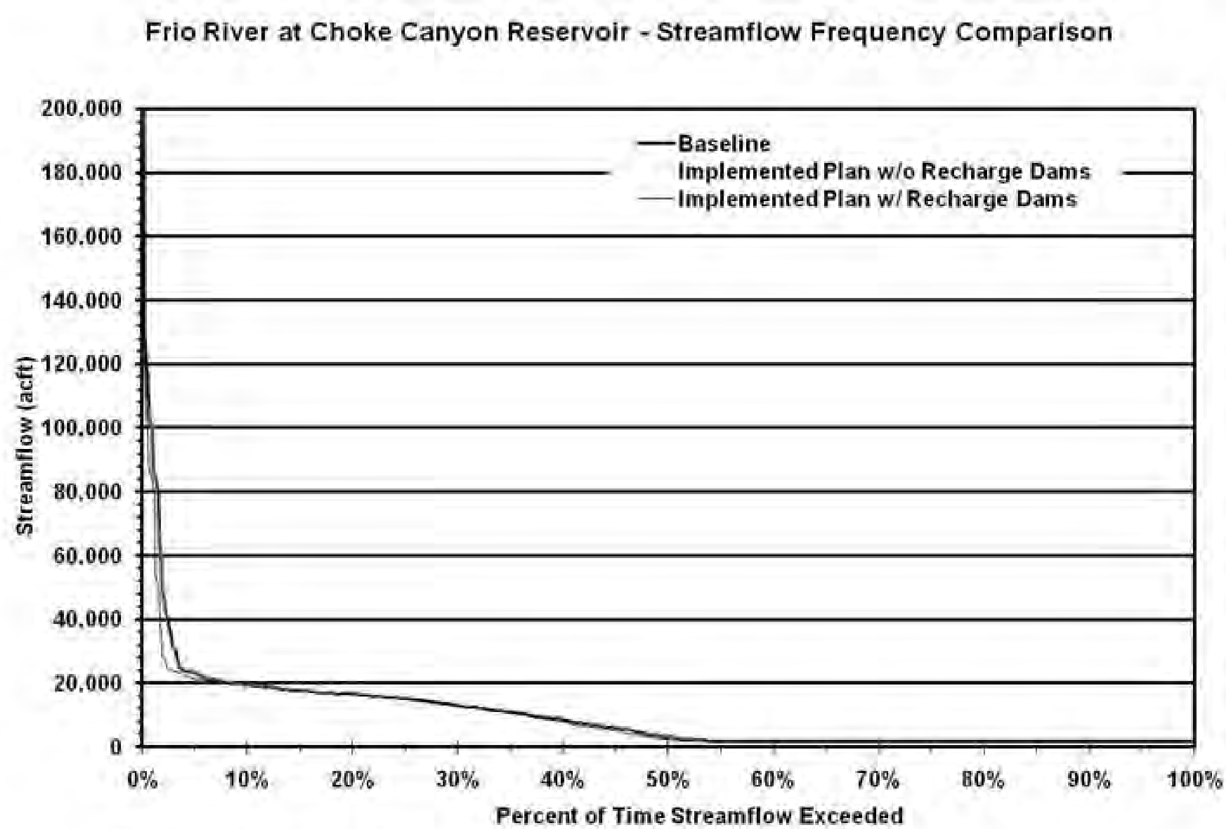


Figure K-3. Nueces River at Cotulla



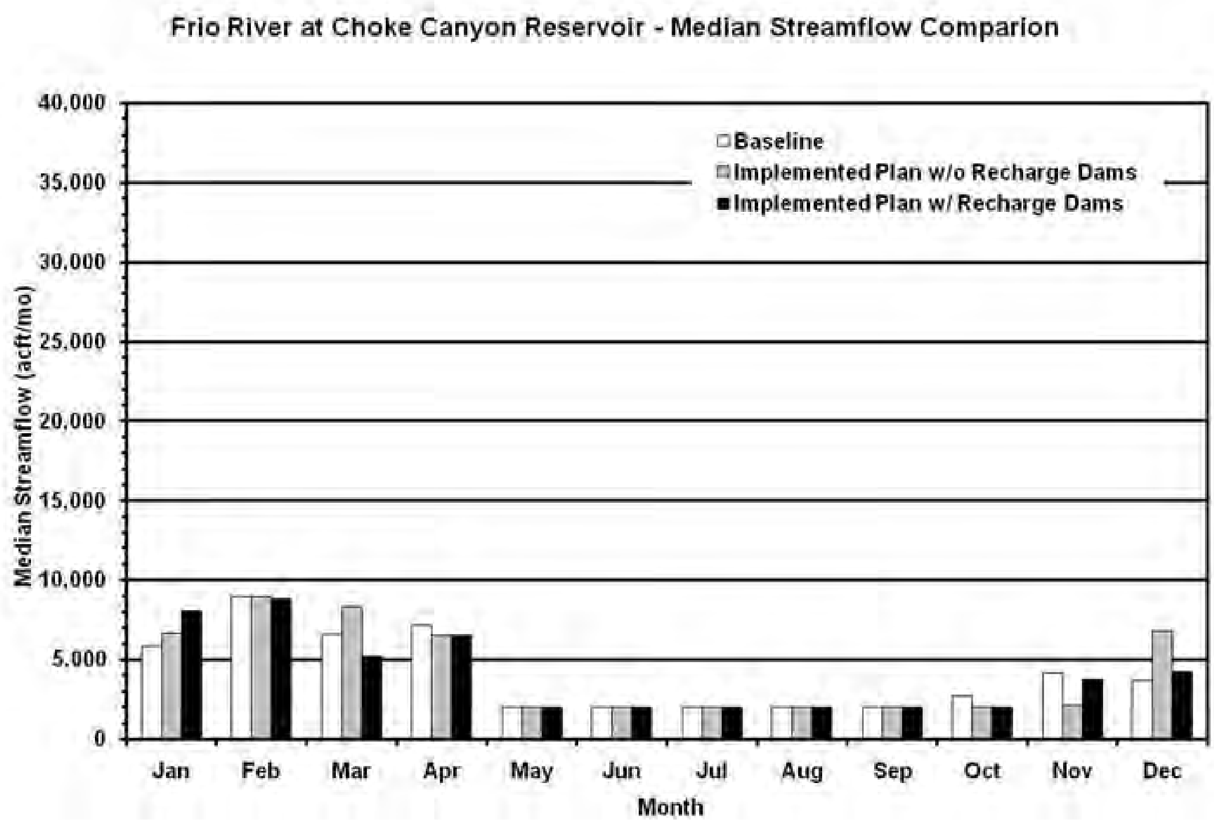
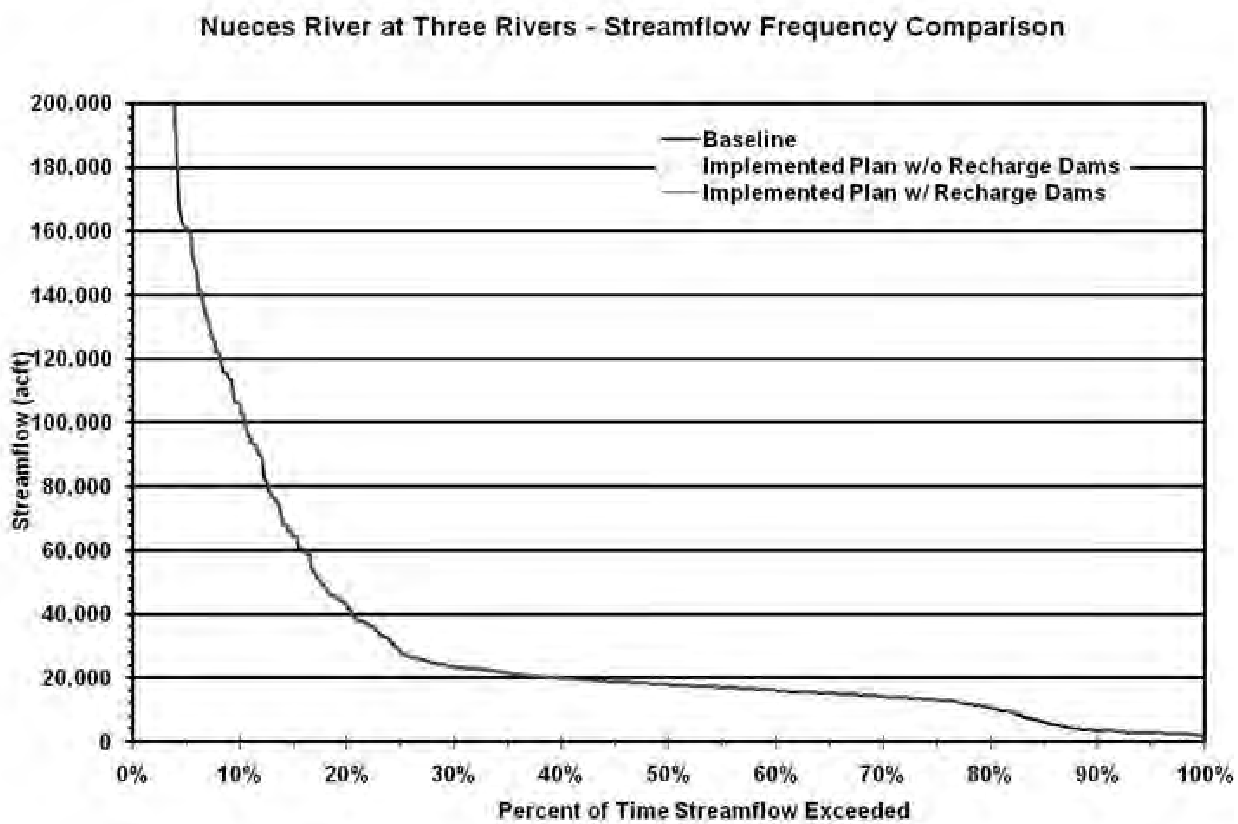


Figure K-4. Frio River at Choke Canyon Reservoir



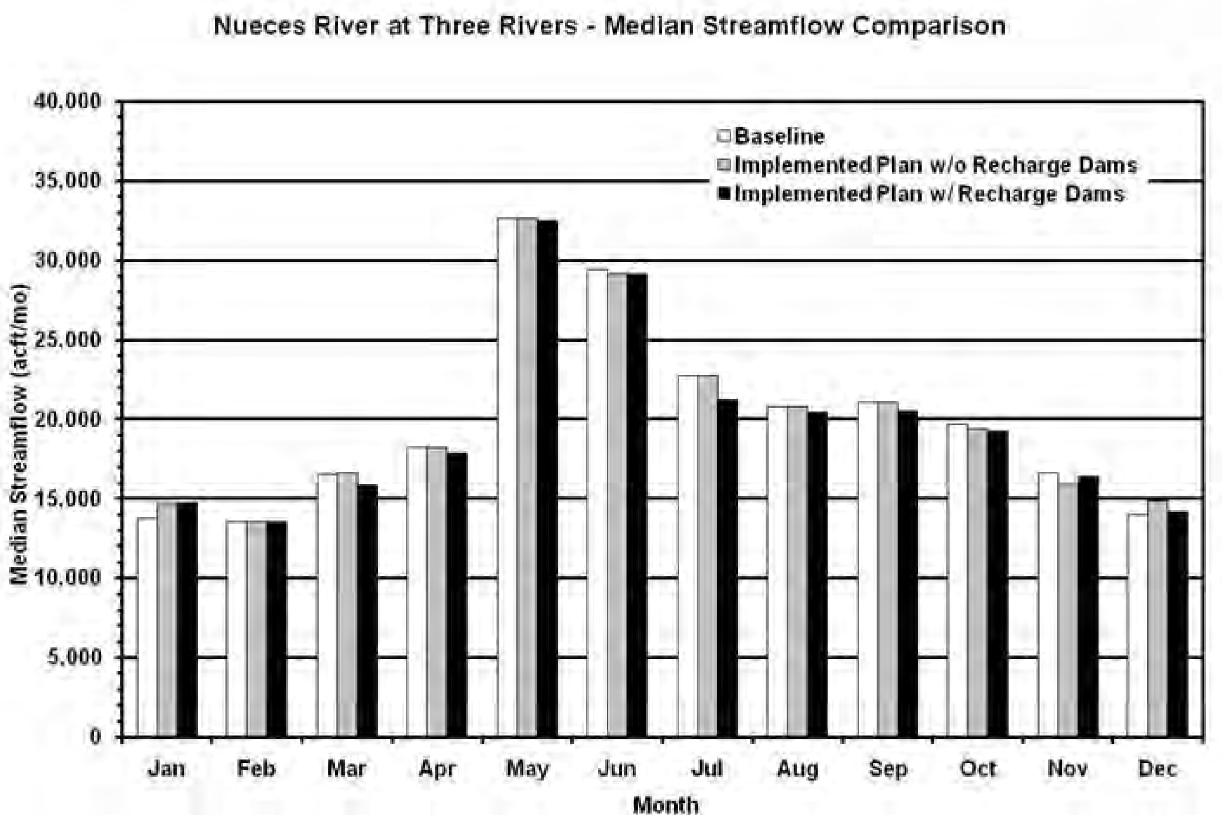
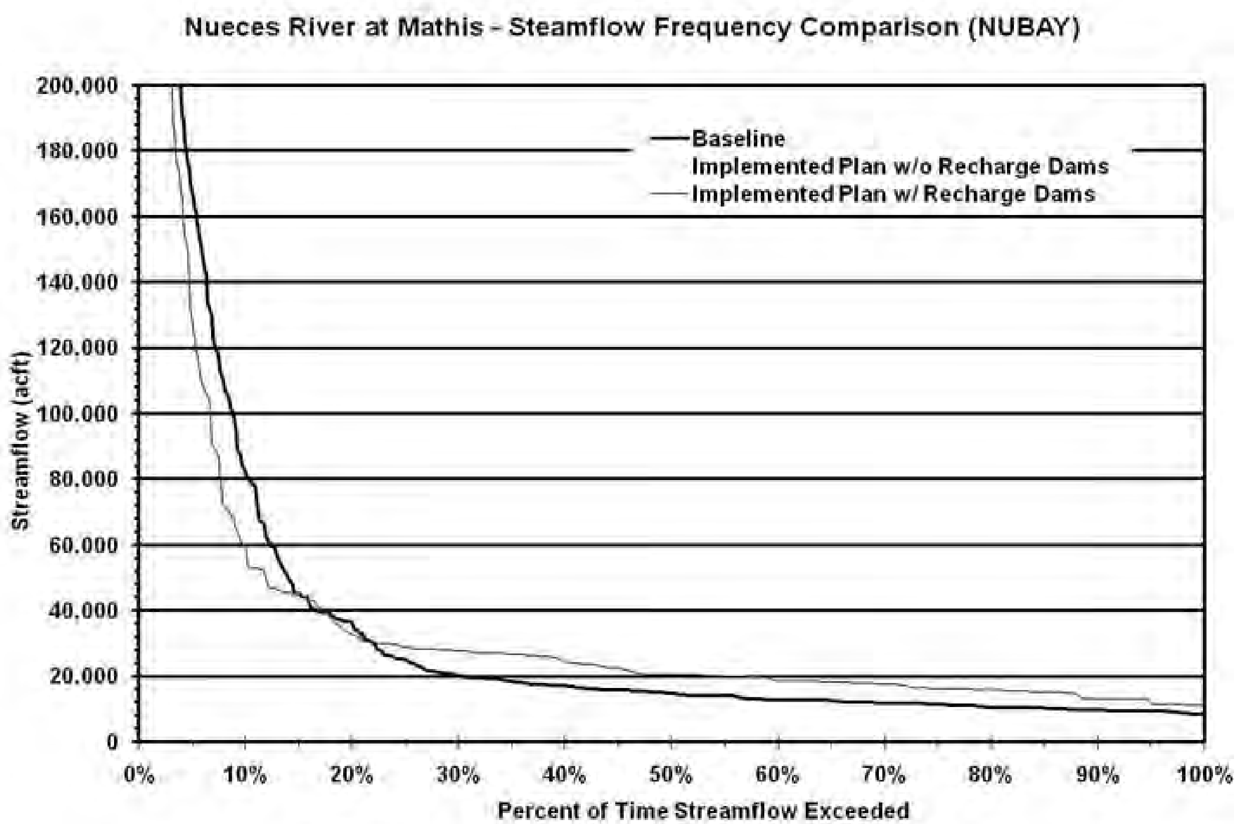


Figure K-5. Nueces River at Three Rivers



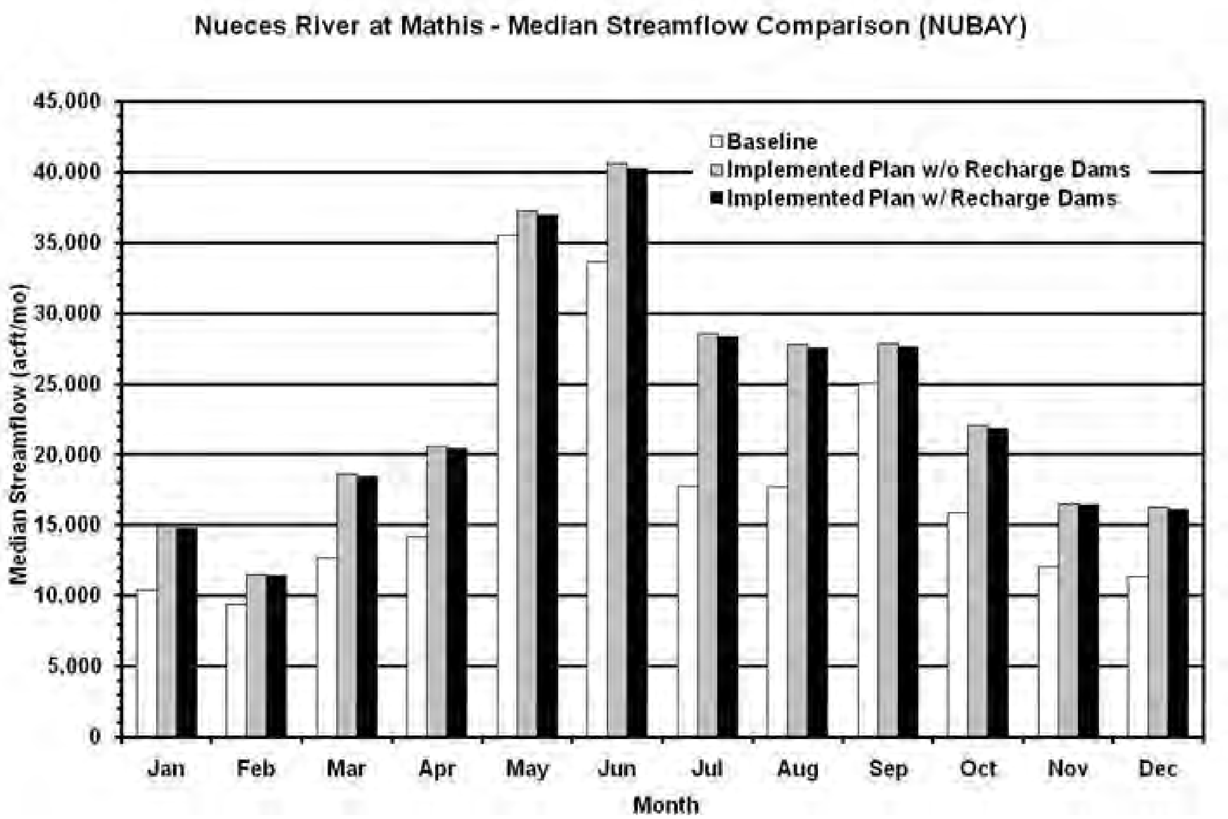
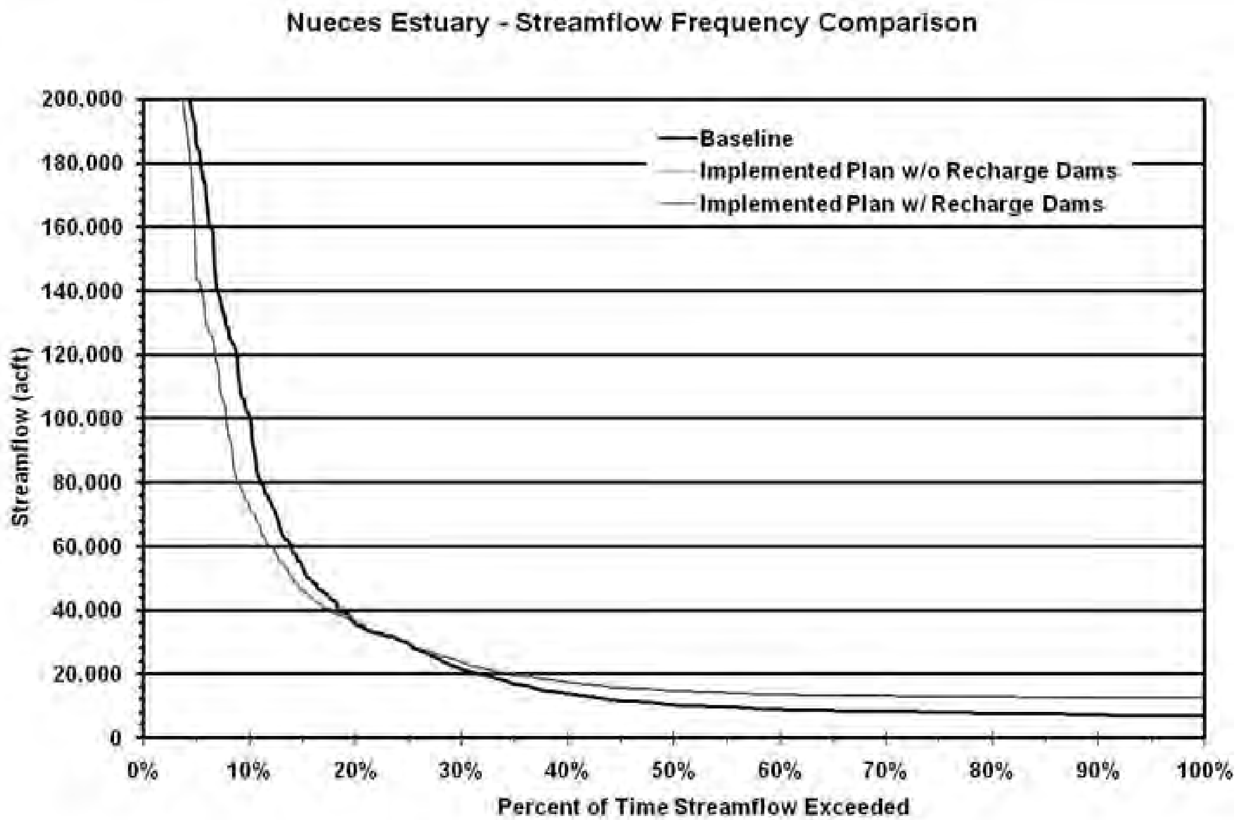


Figure K-6. Nueces River at Mathis



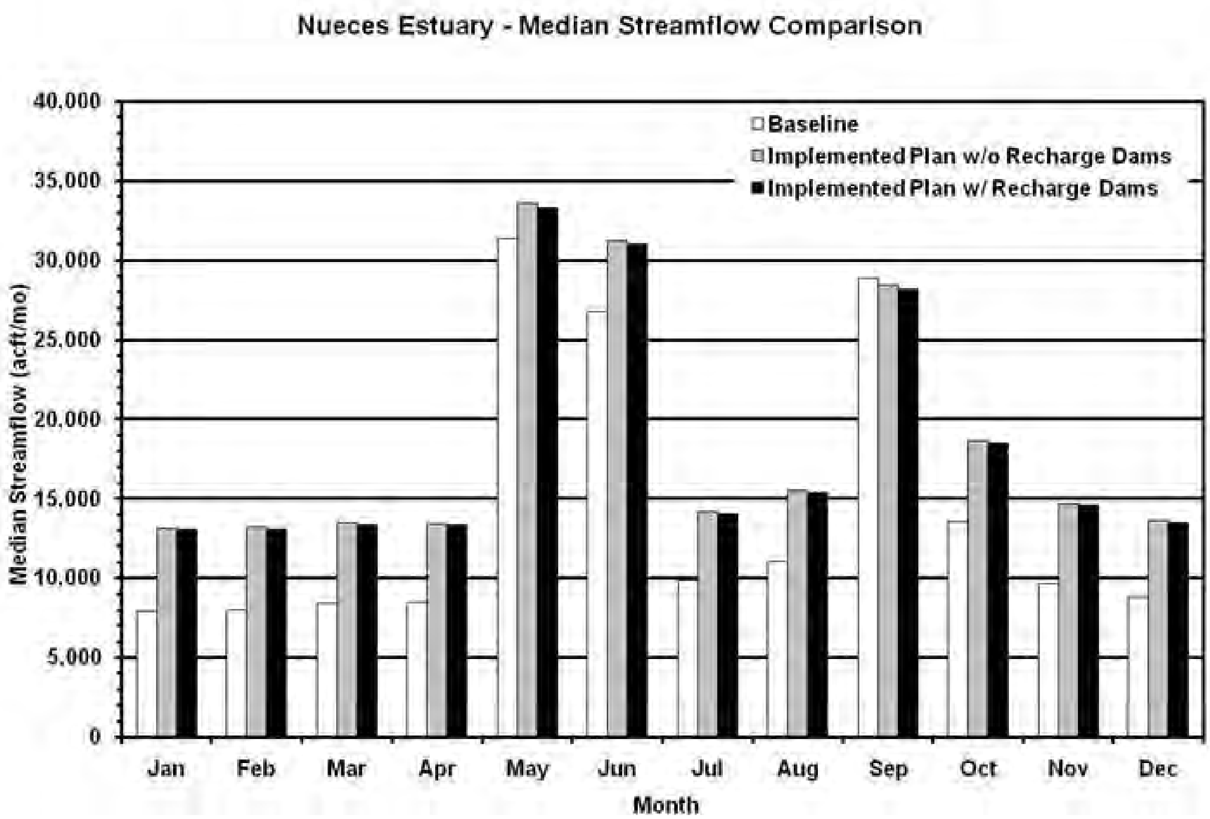


Figure K-7. Nueces River at the Nueces Estuary

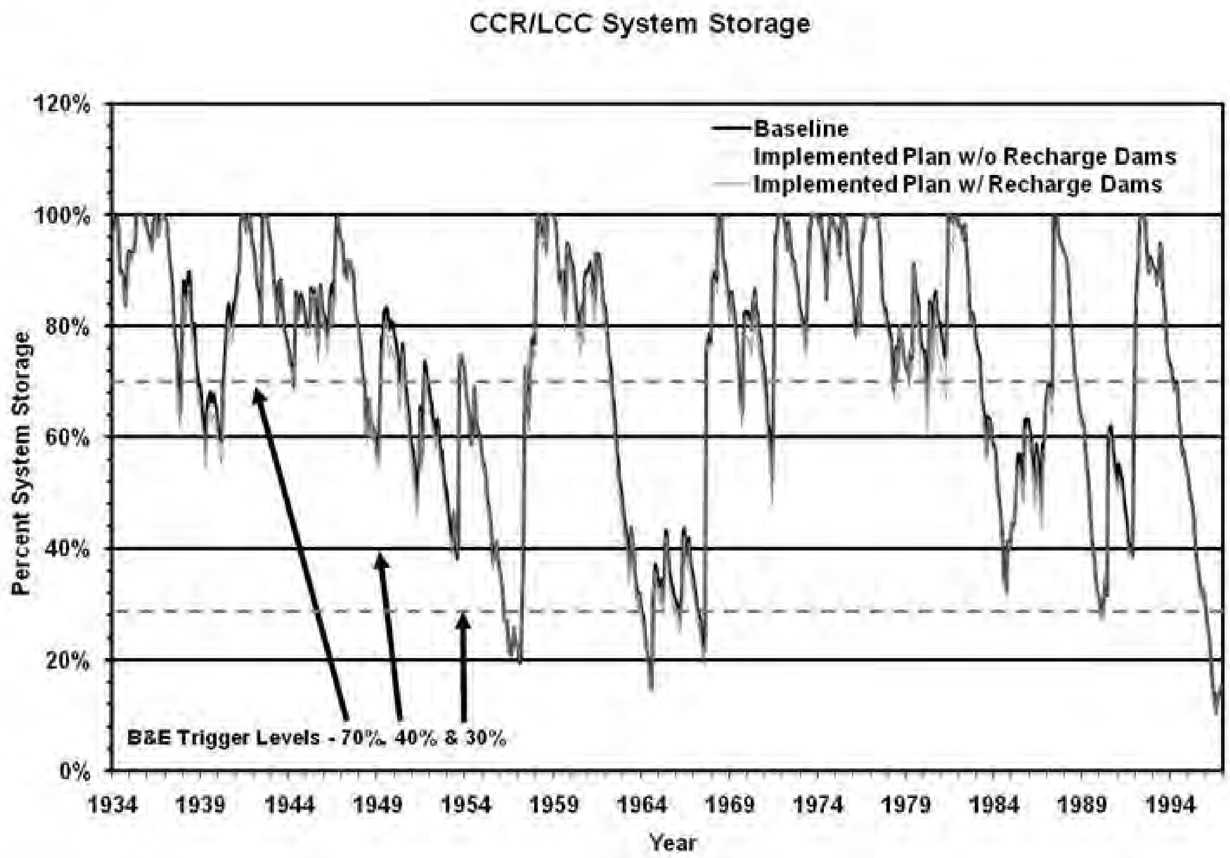


Figure K-8. CCR/LCC System Storage Comparison

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Appendix L

TWDB Infrastructure Financing Survey Responses

Returned Surveys

entityID	Name	Type	RWPG	County	Basin
34	CORPUS CHRISTI	BOTH	N	NUECES	NUECES-RIO GRANDE
1291	LAKE CITY	WUG	N	SAN PATRICIO	NUECES
128	SAN PATRICIO MWD	WWP	N	N/A	N/A

Survey Results

IFRProjectDataId	EntityID	Name	Type	RWPG	County	Basin	Funding Type	DBProjectID	Project Name	Cost	Year of Need	Date Submitted
1901	34	CORPUS CHRISTI	BOTH	N	NUECES	NUECES-RIO GRANDE	PLANNING, DESIGN, AND PERMITTING	86	GARWOOD PIPELINE AND OFF-CHANNEL RESERVOIR STORAGE	$ -	2010	8/10/10 12:06 PM
1902	34	CORPUS CHRISTI	BOTH	N	NUECES	NUECES-RIO GRANDE	ACQUISITION AND CONSTRUCTION	86	GARWOOD PIPELINE AND OFF-CHANNEL RESERVOIR STORAGE	$ 112,798,000.00	2018	8/10/10 12:06 PM
1903	34	CORPUS CHRISTI	BOTH	N	NUECES	NUECES-RIO GRANDE	EXCESS CAPACITY	86	GARWOOD PIPELINE AND OFF-CHANNEL RESERVOIR STORAGE	$ -	2010	8/10/10 12:06 PM
1904	34	CORPUS CHRISTI	BOTH	N	NUECES	NUECES-RIO GRANDE	RURAL	86	GARWOOD PIPELINE AND OFF-CHANNEL RESERVOIR STORAGE	$ -	2010	8/10/10 12:06 PM
1905	34	CORPUS CHRISTI	BOTH	N	NUECES	NUECES-RIO GRANDE	DISADVANTAGED	86	GARWOOD PIPELINE AND OFF-CHANNEL RESERVOIR STORAGE	$ -	2010	8/10/10 12:06 PM
1906	34	CORPUS CHRISTI	BOTH	N	NUECES	NUECES-RIO GRANDE	PLANNING, DESIGN, AND PERMITTING	731	O.N. STEVENS WATER TREATMENT PLANT IMPROVEMENTS	$ -	2010	8/10/10 12:06 PM
1907	34	CORPUS CHRISTI	BOTH	N	NUECES	NUECES-RIO GRANDE	ACQUISITION AND CONSTRUCTION	731	O.N. STEVENS WATER TREATMENT PLANT IMPROVEMENTS	$ 21,125,500.00	2010	8/10/10 12:06 PM
1908	34	CORPUS CHRISTI	BOTH	N	NUECES	NUECES-RIO GRANDE	EXCESS CAPACITY	731	O.N. STEVENS WATER TREATMENT PLANT IMPROVEMENTS	$ -	2010	8/10/10 12:06 PM
1909	34	CORPUS CHRISTI	BOTH	N	NUECES	NUECES-RIO GRANDE	RURAL	731	O.N. STEVENS WATER TREATMENT PLANT IMPROVEMENTS	$ -	2010	8/10/10 12:06 PM
1910	34	CORPUS CHRISTI	BOTH	N	NUECES	NUECES-RIO GRANDE	DISADVANTAGED	731	O.N. STEVENS WATER TREATMENT PLANT IMPROVEMENTS	$ -	2010	8/10/10 12:06 PM
1896	34	CORPUS CHRISTI	BOTH	N	NUECES	NUECES-RIO GRANDE	PLANNING, DESIGN, AND PERMITTING	83	OFF-CHANNEL RESERVOIR NEAR LAKE CORPUS CHRISTI	$ -	2010	8/10/10 12:06 PM
1897	34	CORPUS CHRISTI	BOTH	N	NUECES	NUECES-RIO GRANDE	ACQUISITION AND CONSTRUCTION	83	OFF-CHANNEL RESERVOIR NEAR LAKE CORPUS CHRISTI	$ 105,201,950.00	2030	8/10/10 12:06 PM
1898	34	CORPUS CHRISTI	BOTH	N	NUECES	NUECES-RIO GRANDE	EXCESS CAPACITY	83	OFF-CHANNEL RESERVOIR NEAR LAKE CORPUS CHRISTI	$ -	2010	8/10/10 12:06 PM
1899	34	CORPUS CHRISTI	BOTH	N	NUECES	NUECES-RIO GRANDE	RURAL	83	OFF-CHANNEL RESERVOIR NEAR LAKE CORPUS CHRISTI	$ -	2010	8/10/10 12:06 PM
1900	34	CORPUS CHRISTI	BOTH	N	NUECES	NUECES-RIO GRANDE	DISADVANTAGED	83	OFF-CHANNEL RESERVOIR NEAR LAKE CORPUS CHRISTI	$ -	2010	8/10/10 12:06 PM
2043	1291	LAKE CITY	WUG	N	SAN PATRICIO	NUECES	PLANNING, DESIGN, AND PERMITTING	80	GULF COAST AQUIFER SUPPLIES	$ -	2010	8/12/10 4:14 PM
2044	1291	LAKE CITY	WUG	N	SAN PATRICIO	NUECES	ACQUISITION AND CONSTRUCTION	80	GULF COAST AQUIFER SUPPLIES	$ -	2010	8/12/10 4:14 PM
2045	1291	LAKE CITY	WUG	N	SAN PATRICIO	NUECES	EXCESS CAPACITY	80	GULF COAST AQUIFER SUPPLIES	$ -	2010	8/12/10 4:14 PM
2046	1291	LAKE CITY	WUG	N	SAN PATRICIO	NUECES	RURAL	80	GULF COAST AQUIFER SUPPLIES	$ -	2010	8/12/10 4:14 PM
2047	1291	LAKE CITY	WUG	N	SAN PATRICIO	NUECES	DISADVANTAGED	80	GULF COAST AQUIFER SUPPLIES	$ -	2010	8/12/10 4:14 PM
1728	128	SAN PATRICIO MWD	WWP	N	N/A	N/A	PLANNING, DESIGN, AND PERMITTING	755	GULF COAST AQUIFER SUPPLIES (REGIONAL)	$ -	2010	8/4/10 1:33 PM
1729	128	SAN PATRICIO MWD	WWP	N	N/A	N/A	ACQUISITION AND CONSTRUCTION	755	GULF COAST AQUIFER SUPPLIES (REGIONAL)	$ -	2010	8/4/10 1:33 PM
1730	128	SAN PATRICIO MWD	WWP	N	N/A	N/A	EXCESS CAPACITY	755	GULF COAST AQUIFER SUPPLIES (REGIONAL)	$ -	2010	8/4/10 1:33 PM
1731	128	SAN PATRICIO MWD	WWP	N	N/A	N/A	RURAL	755	GULF COAST AQUIFER SUPPLIES (REGIONAL)	$ -	2010	8/4/10 1:33 PM
1732	128	SAN PATRICIO MWD	WWP	N	N/A	N/A	DISADVANTAGED	755	GULF COAST AQUIFER SUPPLIES (REGIONAL)	$ -	2010	8/4/10 1:33 PM

Appendix M

Comments Received on the Initially Prepared Regional Water Plan and Responses to Comments Received

<u>Contents</u>

Appendix M.1
Responses to Initially Prepared Plan Comments

<u>Public Hearing (April 8, 2010)-Oral Comments</u>

Pat Suter

- *Section 4C- Water Management Strategies*

Comment (1)[1]: Ms. Suter, chair of the Coastal Bend Environmental Coalition, commented on how water conservation is addressed in the IPP. Speaking on behalf the environmental community, she believes that more intensive plans for the future need to be addressed. Irrigation methods need to be more efficient, and a better system for water management needs to be developed. Debate over the allocation of water rights will become more pervasive as the SB 3 process continues, and the needs of the upper Nueces Basin are examined. The needs of the lower basin are fairly well understood. The 2007 State Plan called for water conservation to provide for one quarter of future supply demand. The 2011 IPP calls for water conservation to provide for one third of that supply due to increasing demands on the water.

Response (1): The Coastal Bend Regional Water Planning Group (CBRWPG) encourages water conservation for all municipal entities in the Coastal Bend Region and specifically recommends a 15% reduction in water consumption by 2060 for water groups with per capita rates exceeding 165 gallons per person per day (gpcd) as discussed in Section 4C.1. During Phase I studies to support development of the 2011 Plan, the CBRWPG conducted a survey of municipal users (for a range of utility sizes) to gather information for current water conservation programs in the Coastal Bend Region.

The CBRWPG recommended that counties with projected irrigation water needs reduce irrigation water consumption by 15% by 2060. Section 4C.2 in the Plan also identifies best management practices that could be implemented to achieve the irrigation water demand reduction. Many irrigators in Bee, San Patricio, and other counties in the Coastal Bend Region are already achieving maximum efficiencies in irrigation water application (at or above 80%) and it's likely that these water conservation practices will continue in the future.

The CBRWPG agrees that future needs of the region should continue to be addressed and has included a legislative and regional policy recommendation in Section 8 of the Plan "urging the Texas Legislature to continue funding the TWDB to provide support for state mandated regional water planning group activities." Future planning activities will include consideration of findings from the SB 3 process for Nueces River and Corpus Christi and Baffin Bays.

<u>Texas Water Development Board (Letter Dated June 28, 2010)</u>

Level 1 comments [2]- 12 comments

- *Executive Summary*

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[1] Excerpt obtained from meeting minutes for the April 8, 2010 public hearing to accept public comments on the Coastal Bend Region Initially Prepared Plan.

[2] Includes comments and questions to be addressed in order to meet statutory, agency rule, and/or contract requirements.

Comment (1): Page ES-6: The Yegua-Jackson is an official minor aquifer and covers parts of McMullen, Live Oak, and Bee counties within Region N. Please include the Yegua-Jackson as a minor aquifer that underlies the region.

Response (1): The following text will be added to Sections ES.2 and 1.2.2: "The Yegua-Jackson is an official minor aquifer and covers parts of McMullen, Live Oak, and Bee counties within the Coastal Bend Region."

- *Chapter 1*

Comment (2): Please include a discussion of major demand centers in the plan.

Response (2): Section 1.1 includes the following discussion of major demand centers: "The major water demand areas are primarily municipal systems in the greater Corpus Christi area, as well as large industrial users primarily located along the Corpus Christi and La Quinta Ship Channels. Agriculture (irrigation and livestock) is the third category of water use in the region." The following text will be added to Section 1.1 (from Section 3.1.7): "Based on recent water use records, the City of Corpus Christi supplies about 67 percent of the municipal and industrial water demand in the region (not including supplies to San Patricio Municipal Water District or South Texas Water Authority)."

Comment (3): Page 1-5, 1-27 to 1-28; pages 3-16 to 3-23: The plan does not document that groundwater availability models were used in assessing the Queen City, Sparta, and Carrizo-Wilcox aquifers. Please indicate the basis for these groundwater availability estimates.

Response (3): The groundwater availability estimates for the Queen City, Sparta, and Carrizo-Wilcox aquifers were based on the TWDB, Water for Texas report (1997), which in turn, were based on TWDB Report 238: Groundwater Availability in Texas estimates for the Nueces Basin prorated to applicable counties within the Coastal Bend Region by aquifer. According to projected groundwater use in 2060, less than 1% of the groundwater supplies in the Coastal Bend Region are estimated to be supplied by the Carrizo-Wilcox aquifer (about 500 acft/yr total combined for Live Oak and McMullen Counties) with no water use from Queen City or Sparta sources. The Queen City, Sparta, and Carrizo-Wilcox groundwater availability estimates in the 2011 Plan are the same as those reported in the 2006 and 2001 Coastal Bend Regional Water Plans, and the CBRWPG decided to await the outcome of the GMA process and resulting groundwater availability estimates to updated groundwater availability estimates for planning purposes. As discussed in Sections 1.11 and 3.4, local groundwater management areas (GMAs 13, 15 and GMA 16) are developing desired future conditions which utilize TWDB-approved groundwater availability models to determine managed available groundwater estimates which will be used for groundwater supplies in future planning efforts.

- *Chapter 2*

Comment (4): Page 2-6, Table 2-2 through Table 2-10: The plan presents population and categories of water use for water user groups by counties and river basins separately but not delineated by river basins in each county. Please present population and water demands by counties and river basin. For example, Duval County should be delineated by the Nueces and Nueces-Rio Grande Basins.

Response (4): The requested information will be added as an Appendix to the Plan, to consist of summary tables from the regional water planning database showing population and water use by river basin for each county.

Comment (5): Page 2-24, Table 2-11: The plan presents population and categories of water use for wholesale water providers by counties and river basins separately, but not delineated by river basins in each county. Please present water use by category and delineate by counties and river basins. For example, Nueces County should be delineated by the Nueces, Nueces-Rio Grande, and San Antonio-Nueces River Basins.

Response (5): The requested information will be added as an Appendix to the Plan, to consist of summary tables from the regional water planning database showing water use for wholesale water providers by river basin for each county.

- *Chapter 3*

Comment (6): Page 3-11, Section 3.1.7: Please present surface and groundwater availability, delineated by counties and river basins.

Response (6): The requested information will be added as an Appendix to the Plan, to consist of summary tables from the regional water planning database showing surface and groundwater availability delineated by counties and river basins.

Comment (7): Page 3-15, Section 3.3: It is not clear which water availability model runs were used in the plan.   Please reference the specific water availability model runs utilized to develop plan.

Response (7): As discussed in Section 3.3: "The City of Corpus Christi Water Supply Model (CCWSM, formerly known as the NUBAY model) was used to estimate the safe yield of the CCR/LCC/Lake Texana System and the TCEQ WRAP Model was used to determine the availability of water to other rights on the Nueces River." The TCEQ WRAP Model is part of the Water Availability Model (WAM). On October 1, 2008, the TWDB approved use of the CCWSM for use in estimating surface water availability for the CCR/LCC/Lake Texana System with all other water rights based on TCEQ WAM. On April 30, 2009, the TWDB approved continued use of safe yield of CCR/LCC/Lake Texana system for development of the 2011 Plan. According to contract provisions between the TWDB and Nueces River Authority, firm yield of the CCR/LCC/Lake Texana System is included in Section 4C.9.

Comment (8): Page 3-16, Section 3.4.1: The plan indicates that the Central Gulf Coast Aquifer Groundwater Availability Model extends through Jim Hogg, Brooks, and Kenedy Counties. Please clarify that the model extends approximately midway through these counties.

Response (8): The report text will be revised to read: "(The model) extends from the outcrop areas in the Jasper outcrop areas in the west to the Gulf of Mexico in the east, and from the groundwater divide to the north through Colorado, Fort Bend, and Brazoiria Counties to the south *approximately midway through* Jim Hogg, Brooks, and Kenedy Counties, as shown in Figure 3-6."

Comment (9): Page 3-16, Section 3.4: The plan estimates groundwater availability and projected groundwater use based on the 1997 State Water Plan and the Central Gulf Coast Groundwater Availability Model. Please clarify whether available Texas Water Development Board Groundwater Availability Models were used for calculating groundwater availability for all aquifers in the plan.

Response (9): The Central Gulf Coast Groundwater Availability Model (CGCGAM) was used to calculate groundwater availability for Gulf Coast Aquifer supplies. See Response (3) above for discussion on how groundwater availability was determined for other aquifers in the Coastal Bend Region.

Comment (10): Page 3-16, Section 3.4: Please confirm whether groundwater availability in the plan was calculated based on the largest amount of groundwater that can be pumped annually without violating the most restrictive physical, regulatory or policy condition. *[Contract Exhibit "C" Section 3.2]*

Response (10): Yes, groundwater availability was calculated without violating the most restrictive physical, regulatory, or policy condition. Section 3.4.1 discusses drawdown criteria adopted by the Coastal Bend Region and states that "these criteria were used to determine available groundwater for the planning region." The increased water use to meet revised irrigation water demands in Bee and San Patricio County were simulated using the CGCGAM and did not exceed the groundwater drawdown constraints. The estimated pumping for Live Oak Mining and Manufacturing and Duval Mining were prorated back so that drawdown did not exceed adopted drawdown criteria when determining groundwater availability (Sections 4A.3.8 and 4A.3.4).

- *Appendix D*

Comment (11): Section D.2: Please clarify how groundwater availability was assessed for the southern portions of Brooks and Kenedy counties. *[31 TAC §357.7(a)(3)(D)]*

Response (11): As discussed in Section D.2, historical and predictive annual pumping estimates by county were simulated using the CGCGAM. Other than Falfurrias, the water users groups identified by the TWDB for Brooks and Kenedy County were provided on a county basis. Falfurrias is located in north Brooks County and was therefore evaluated as a point source demand as discussed in Section D.3. Estimated groundwater pumping for county defined water user groups were apportioned in a diffuse pattern across the active model area (i.e. northern portions of Brooks and Kenedy counties). The maximum predictive pumping for Brooks and Kenedy counties did not violate the most drawdown criteria adopted by the Coastal Bend Region.

Comment (12): *(Attachment B)* Comments on the online planning database (i.e. DB12) are herein being provided in spreadsheet format. These Level 1 comments are based on a direct comparison of the online planning database against the Initially Prepared Regional Water Plan document as submitted. The table only includes numbers that do not reconcile between the plan (left side of spreadsheet) and online database (right side of spreadsheet). An electronic version of this spreadsheet will be provided upon request.

Response (12): Discrepancies presented by the TWDB in Attachment B between DB12 and the Initially Prepared Plan were resolved by updating the hard copy of the plan or database, where applicable.

Level 2 comments [3]- 4 comments

Comment (1): Please consider including base map source references (e.g. Figures 3-1 and 3-2.) *[Contract Exhibit "D" Section 2.3]*

Response (1): A reference will be added to Figure 3-1 indicating that the aquifer boundaries shapefile coverage was obtained from the TWDB. Figure 3-2 major water rights will be footnoted that information was obtained from the TCEQ.

- *Chapter 1*

Comment (2): Page 1-2: Plan indicates that the Live Oak Underground Water Conservation District was created February 1991. Texas Water Development Board records indicate that the district was created June 14, 1989 and confirmed November 7, 1989. Please consider clarifying this in the plan.

Response (2): The text in Section 1.10.5 will be revised as follows: "The Live Oak Underground Water Conservation District was created June 14, 1989 and confirmed November 7, 1989."

- *Sections 4B and 4C*

Comment (3): Pages 4B.5-4, 4B.9-7, and 4C.1-7: Water reuse is discussed as part of the conservation sub-section. Please consider discussing water reuse separately.

Response (3): The water reuse references indicated above on Pages 4B.5-4 and 4B.9-7 for Duval County-Mining and Live Oak County- Mining water supply plans, respectively, are included as possible best management practices that could be implemented to achieve the recommended water conservation savings. As mentioned in Section 4C.4.2, "since mining entities are presented on a county basis and are not individually identified, identification of specific water management strategies are not a reasonable expectation."

Comment (4): Page 4C.9-28, Section 4C.9.6: The Modification of Existing Reservoir Operations water management strategy states that better treatment of wastewater may be less effective than reduced treatment of wastewater in promoting ecological productivity in the Nueces Delta. Please consider explaining why reduced treatment of wastewater effluent would promote ecological productivity in the Nueces Delta.

Response (4): Section 4C.9.6 states that "higher levels of effluent treatment may not be as effective in promoting biological activity in the delta." Further discussion in Section 4C.5.4 and Appendix J explains that treated wastewater effluent contain nutrients that at managed levels can

[3] Includes comments and questions to be addressed in order to meet statutory, agency rule, and/or contract requirements.

increase ecological productivity. As referenced in Appendix J, the City of Corpus Christi's Allison Wastewater Treatment Plant Effluent Diversion Demonstration Project: Volume II- Concluding Report(2006) showed that "increases in nutrients associated with wastewater diversion appear to have locally enhanced primary productivity of both phytoplankton and emergent vegetation."

Texas Parks and Wildlife (Letter from Ross Melinchuk, Deputy Executive Director, Dated June 3, 2010)

- *Section 4C- Water Management Strategies*

Comment (1):   TPW staff encourages the planning group to consider the 140 gpcd goal identified by the Texas Water Conservation Implementation Task Force.

Response (1): The CBRWPG considered the Texas Water Conservation Implementation Task Force goal of 140 gpcd as discussed in Section 4C.1. Based on the success of the City's water conservation program, the CBRWPG recommends that water user groups, with and without shortages, exceeding 165 gpcd reduce consumption by 15% by 2060.

Comment (2):   Regarding manufacturing water conservation strategies considered in the Plan (4C.3), specifically a potential pipeline from Lake Corpus Christi to Calallen, TPW staff notes that any new pipelines will have direct impacts to habitat and wildlife resources in the right-of-way areas and instream flows in the Nueces River should be addressed.

Response (2): The potential pipeline from Lake Corpus Christi to Calallen was considered in the Plan, but not identified as a recommended or alternative water management strategy. Section 4C.3.7 of the Plan discusses environmental issues related to delivery of Lake Corpus Christi water through a pipeline to Calallen Dam and specifically addresses instream river flows: "The major environmental issues related to pumping water via a pipeline from Lake Corpus Christi to Calallen includes the effects of changes in Nueces River flows. The instream river flows would include pass throughs to the estuary from Lake Corpus Christi and natural inflows. Further studies would be needed to assess the required flows within the channel to maintain stream habitat and the project's impact on these flows." The following text will be added to Section 4C.3.7 regarding potential impacts to habitat and wildlife resources: "The construction of a 21- mile pipeline from LCC to Calallen Dam would result in soil and vegetation disturbance within the approximately 245 acre pipeline construction corridor. Longer-term terrestrial impacts would be confined to the 105-acre maintained right-of-way. Prior to implementation of this strategy, further studies to evaluate environmental impacts of the project will be required."

Comment (3): TPW staff questions the basis for multipliers as high as 5 related to bay and estuary inflow credits, thereby potentially further reducing freshwater inflows to the Nueces Estuary. While wastewater reuse is a strategy with significant merits, TPW staff recommends further evaluation of the potential impacts of an overall reduction in instream flows and freshwater inflows.

Response (3): As discussed in Section 4C.5.4, previous studies have shown that diversions of both river water and treated wastewater to the Nueces Delta can be expected to increase primary production by factors of about three to five, respectively, when compared to allowing these waters to enter Nueces Bay via the Nueces River. Section 4C.5.4 includes evaluation of four different productivity factors ranging from 2 to 5. Furthermore, Section 4C.5.5 discusses median estuary inflow reductions expected for the range of multipliers. As correctly stated in your comment letter, the application of any freshwater inflow multiplier greater than 1 would require approval by the Nueces Estuary Advisory Committee and TCEQ. The water supply plans for Nueces and San Patricio Manufacturing users include supplies from reclaimed wastewater *without* using productivity multipliers, as previously mentioned in the responses to comments for the 2006 Plan. The City of Corpus Christi continues to fund biological studies of the Nueces Bay and Delta, including responses to freshwater inflows.

Comment (4): The proposed Nueces Off-Channel Reservoir near Lake Corpus Christi has the potential for significant, adverse impacts to terrestrial and aquatic communities, both as a result of construction of the reservoir and pipeline as well as through reduced instream flows. TPW staff has similar concerns related to the proposed Lavaca River Diversion and Off-Channel Reservoir project.

Response (4): Section 4C.11.4 discusses impacts to terrestrial and aquatic communities associated with the Nueces Off-Channel Reservoir near Lake Corpus Christi, including a desktop environmental analysis consistent with RWPG guidelines. Project impacts to inflows to the Nueces Bay and Estuary are also discussed. The Plan also states that "prior to design and implementation of the project, a more detailed evaluation of the inundated area and habitats will be necessary." The Lavaca River Diversion and Off-Channel Reservoir project text was provided by the Lavaca Navidad River Authority (LNRA) on January 21, 2010 for inter-regional consistency with Regions P, L, and N. Section 4C.13.2.6 discusses environmental issues associated with the Lavaca River Diversion and Off-Channel Reservoir project and includes a desktop environmental analysis. Furthermore, Section 4C.13.2.10 states that "prior to commencement of construction of project, an application to TCEQ would need to be submitted to establish a schedule for the release of freshwater inflows. The existing water rights permits would need to be modified to incorporate changes associated with the proposed Lavaca River Off-Channel Reservoir project, including but not limited to a bay and estuary pass through schedule."

Comment (5): With respect to alternate water management strategies, the Choke Canyon Reservoir- Lake Corpus Christi pipeline could have significant, adverse impacts on terrestrial and aquatic resources. The Nueces River between these reservoirs includes one of only four known populations of the recently state-listed threatened mussel species Golden Orb, among other rare and endemic species.

Response (5): Section 4C.10.3 will be updated to be consistent with threatened and endangered species discussion for the Nueces Off-Channel Reservoir, which also has proposed project site in Live Oak County. The following text will also be added regarding the golden orb and sitings of endangered or rare species near the proposed pipeline corridor: "One rare species, the golden orb (*Quadrula aurea*) has been the reason for the designation of the Nueces River from the headwaters of Lake Corpus Christi upstream to US 59 in Live Oak County (within TNRCC classified stream segment 2103) as a significant stream segment by TPWD. This species is restricted to five rivers in Texas. This segment of the Nueces River contains one of only four known remaining populations of this endemic mollusk. Additionally, according to the TPWD Texas Natural Diversity Database, there have been sightings of the state and federally endangered jaguarundi in the immediate vicinity of the proposed pipeline route. Two rare plant species, the coastal gay-feather and the South Texas rushpea have been documented within two miles of the proposed pipeline area."

Comment (6): Both seawater and brackish groundwater desalination can be ecologically advantageous strategies, as long as such issues as impingement and entrainment at intake locations, and brine disposal options are carefully considered.

Response (6): The seawater desalination strategy assumes that the raw water feed would be obtained from the discharge of the Davis Power Station cooling water. The following text will be added: "If an alternate intake location is considered during project construction, additional environmental analyses including impingement and entrainment will need to be considered." Section 4C.20.4.5 for brackish groundwater desalination recognizes brine disposal issues and states "disposal of saline concentrate into Oso or Copano Bays should be carefully monitored in order to minimize any impacts this may have on aquatic species."

- *Section 8- Legislative Recommendations, Unique Stream Segments, and Reservoir Sites*

Comment (7): The Region N IPP does not recommend nomination of any stream segments as ecologically unique. TPW has identified several stream segments in the region that meet at least one of the criteria for classification as ecologically unique should the regional planning group decide to pursue nomination of an ecologically significant stream in the future.

Response (7): The CBRWPG considered TPWD's recommendations regarding the identification of river and stream segments as mentioned in Section 8.2. In December 2009, the Coastal Bend Region recommended that no river or stream segments within the Coastal Bend Region be identified at this time.

Comment (8): TPW's previous comments (for the 2006 Plan) regarding wastewater reuse multipliers and ecologically unique stream segments do not appear to have been addressed in the 2010 IPP.

Response (8): TPW's previous comments regarding wastewater reuse multipliers and ecologically unique stream segments were addressed in the 2006 Plan in Appendix N.1 on pages 2 and 3, respectively.

Public Comments Received (Mailed)

- *Section 4C- Water Management Strategies*

Comment (1): The Coastal Bend received several individual letters and numerous form letters opposing Stage II Lake Texana (Palmetto Bend). The letters were similar in nature, with opposition to Stage II Lake Texana (Palmetto Bend). No explicit opposition was noted for the Lavaca River Diversion and Off-Channel Reservoir Project.

Response (1): Stage II Lake Texana (Palmetto Bend) is only considered as an alternative water management strategy in the Initially Prepared Plan to meet Year 2060 industrial needs in Nueces and San Patricio Counties.

	REGION N			*Non-matching numbers*														
		IPP document		IPP document number							Online Planning Database (DB12) number							*Response*
Region IPP	Item	Page	Table	non-decadal number	2010	2020	2030	2040	2050	2060	non-decadal number	2010	2020	2030	2040	2050	2060	
N	Corpus raw water available from reservoir	ES-10			205,000							228,420						Unable to locate TWDB's DB12 value shown in this spreadsheet. IPP and DB12 match.
N	Surface water sources, check text on ES-10 and Table ES-2 on page ES-11, need to check by use type as well in table ES-2	ES-10,11	ES-2							198,816							198,800	DB12 revised to be consistent with IPP value.
N	Combined reliable yield of two major and two minor aquifers	ES-11			102,628					57,624		57,594					57,712	Values shown in TWDB table appear to be misinterpreted. IPP number in TWDB table indicates availability for 2010 number and GW use for 2060 number. 115,964 acft/yr (2060 availability); 57,580 acft/yr proposed 2010 use and 57,624 acft/yr proposed 2060 use (w/out WMS); 88,284 acft/yr proposed 2060 use (with recommended WMS)
N	Corpus Christi Service Area need	ES-14								54,357							54,366	DB12 revised to be consistent with IPP value.
N	SPMWD Service Area	ES-14								7,898							7,897	DB12 revised to be consistent with IPP value.
N	WMS in excess of Regional need in 2060	ES-18								75,744							53,636	TWDB table shows values that are not comparable. IPP number in TWDB table for 2060 is *projected regional need* not excess supplies.
N	WMS 2060 capital costs	ES-18								$ 546,164,950							$ 126,211,000	Unable to locate TWDB's DB12 value shown in this spreadsheet. IPP and DB12 match.
N	Revise costs and supplies for Table ES-3, Examples provided below:	ES-19	ES-3															
N	Garwood Pipeline supplies	ES-19	ES-3		35,000							34,998	34,998	34,998	34,998	34,998	34,998	DB12 revised to be consistent with IPP value.
N	Off-Channel Reservoir near Lake CC	ES-19	ES-3		30,340							30,339	30,339	30,339	30,339	30,339	30,339	DB12 revised to be consistent with IPP value.
N	Lavaca River off-channel project	ES-19	ES-3		26,262												16,242	Page ES-19 shows full project yield (26,242 acft/yr). Amt for Region N is 16,262 acft/yr. Text in Table ES-3 will be footnoted.
N	Reclaimed Wastewater Supplies	ES-19	ES-3		250							246						DB12 revised to be consistent with IPP value.
N	Mining Conservation supply	ES-19	ES-3	cost - highly variable	259						$ -	244	548	938	1,369	1,842	2,343	TWDB table shows values that are not comparable. IPP number in Table ES-3 is for wholesale water providers, and DB12 identified is total mining conservation for region.
N	Municipal Water Conservation Total Project Cost	ES-20	ES-4	$ 1,052,529							$ 1,052,530							DB12 revised to be consistent with IPP value.
N	Irrigation Water Conservation DB12 total costs	ES-20	ES-4	$ 1,095,700							$ -							IPP text revised to replace "$1,095,700" capital cost with "Variable".
N	Reclaimed Wastewater Supplies	ES-20	ES-4	250							246							DB12 revised to be consistent with IPP value.
N	Gulf Coast Aquifer Supplies Cost	ES-20	ES-4	Up to $20,360,000 (Cap) and $3,132,000 (AC)						na	$ -						0	Table ES-4 correct. Reflects sum of costs to drill additional well(s) for all applicable Region N entities.
N	Update Table ES-5, Water Plan Summary, Examples below	ES-22-25	ES-5															
N	Bee County- Other Demand	ES-22	ES-5				1,705							1,704				IPP revised to be consistent with DB12.
N	Bee County - Irrigation Needs	ES-22-25	ES-5							(890)							(802)	DB12 revised to be consistent with IPP value.
N	Manufacturing Conservation supply	ES-27	ES-6		1,260	1,418	1,576	1,734	1,892	2,050		0	0	0	0	0	0	Unable to locate TWDB's DB12 value shown in this spreadsheet. IPP and DB12 match.
N	Mining Conservation supply	ES-27	ES-6				878	1,246	1,653	2,084				938	1,369	1,842	2,343	Updated Table ES-6 to include Nueces County- Mining Water Conservation.

	REGION N	IPP document		*Non-matching numbers* IPP document number							Online Planning Database (DB12) number							*Response*
Region IPP	Item	Page	Table	non-decadal number	2010	2020	2030	2040	2050	2060	non-decadal number	2010	2020	2030	2040	2050	2060	
N	Reclaimed Wastewater Supply	ES-27	ES-6		250	250	250	250	250	250		246	246	246	246	246	246	DB12 revised to be consistent with IPP value.
N	Off-Channel Reservoir near Lake Corpus Christi	ES-27	ES-6		0	0	30,340	30,340	30,340	30,340		0	0	30,339	30,339	30,339	30,339	DB12 revised to be consistent with IPP value.
N	Voluntary redistribution of Three Rivers Surplus	ES-27	ES-6		475	738	914	1,060	1,179	1,354								DB12 revised to be consistent with IPP value.
N	Garwood Pipeline supply	ES-27	ES-6		0	35,000	35,000	35,000	35,000	35,000			34,998	34,998	34,998	34,998	34,998	DB12 revised to be consistent with IPP value.
N	Increase contracted amount from WWP	ES-27	ES-6		261	0	0	0	1,527	1,443		0	0	0	0	0	0	DB12 revised to be consistent with IPP value.
N	Lavaca River Diversion	ES-27	ES-6	###########	0	0	0	0	0	16,242	$ -	0	0	0	0	0	0	DB12 shows yield for Region N is 16,242 acft/yr.
N	CCR/LCC Pipeline	ES-28	ES-7					21,905	21,905	21,905					21,903	21,903	21,903	DB12 revised to be consistent with IPP value.
N	Stage II Lake Texana (On-Channel)	ES-28	ES-7	$232,828,000						12,964	$131,435,324						12,963	DB12 shows cost only to Region N. ES-7 has footnote indicating that full project cost is shown.
N	Seawater Desalination	ES-28	ES-7					28,000	28,000	28,000					27,999	27,999	27,999	DB12 revised to be consistent with IPP value.
N	Falfurrias, municipal conservation annual costs	4B.4-1		na	na	na	na	na	na	na	$ -	$ 283	$ 15,955	$ 40,021	$ 66,129	$ 96,639	$ 130,882	No needs. Added text to IPP water supply plan to include range of costs of municipal water conservation.
N	Benevides - groundwater desal capital and annual costs	4B.5-1, 5-2		$4,633,000 (Cap) $688,000 (AC)							na							No needs, therefore no recommended WMS. Costs in IPP are estimated if water supply deteriorates.
N	Freer - groundwater desal capital and annual costs	4B.5-2		$6,899,000 (Cap) $1,121,000 (AC)							na							No needs, therefore no recommended WMS. Costs in IPP are estimated if water supply deteriorates.
N	San Diego - groundwater desal captial and annual costs	4B.5-3		$6,304,000 (Cap) $1,000,000 (AC)							na							No needs, therefore no recommended WMS. Costs in IPP are estimated if water supply deteriorates.
N	Duval County-Other, muni conservation, capital and annual costs	4B.5-3		na	na	na	na	na	na	na	$ -	$ 2,431	$ 5,680	$ 8,838	$ 11,518	$ 18,466	$ 26,468	No needs. Added text to IPP water supply plan to include range of costs of municipal water conservation. Revised 2030 to $8,827 and 2060 to $26,467 in DB12.
N	Duval County, Mining conservation, no costs in IPP or online database	4B.5-4, 5-5	4B5-2, 5-3	na	na	na	na	na	na	na	na	na	na	na	na	na	na	Correct as presented. No costs available for mining conservation BMPs.
N	Alice, muni conservation, capital and annual costs	4B.6-1, 6-2		na	na	na	na	na	na	na	$ -	$ 21,240	$ 56,111	$ 92,762	$ 129,589	$ 185,382	$ 247,695	No needs. Added text to IPP water supply plan to include range of costs of municipal water conservation.
N	Orange Grove, muni conservation, capital and annual costs	4B.6-2		na	na	na	na	na	na	na	$ -	$ 1,087	$ 3,224	$ 5,744	$ 7,826	$ 11,905	$ 15,869	No needs. Added text to IPP water supply plan to include range of costs of municipal water conservation.
N	George West, muni conservation, capital and annual costs	4B.9-2		na	na	na	na	na	na	na	$ -	$ 1,961	$ 6,068	$ 10,446	$ 14,026	$ 19,008	$ 24,166	No needs. Added text to IPP water supply plan to include range of costs of municipal water conservation.
N	Three Rivers: muni conservation	4B.9-2		na	na	na	na	na	na	na	$ -	$ 1,068	$ 3,492	$ 5,797	$ 7,779	$ 11,332	$ 14,508	No needs. Added text to IPP water supply plan to include range of costs of municipal water conservation.
N	Live Oak County Mining, conservation, no costs in IPP or online database	4B.9-8	4B.9-8	na	na	na	na	na	na	na	na	na	na	na	na	na	na	Added text to IPP water supply plan to include range of costs of municipal water conservation.
N	Live Oak County Irrigation, conservation, annual cost listed under total project cost	4B.9-9	4B.9-9	$ 77,976							$ -							Revise to change annual cost of $77,976 to "variable" in Table 4B.9-9.
N	McMullen County-Other, muni conservation, capital and annual costs	4B.10-2		na	na	na	na	na	na	na	$ -	$ 272	$ 739	$ 1,421	$ 2,232	$ 2,894	$ 4,264	No needs. Added text to IPP water supply plan to include range of costs of municipal water conservation.

	REGION N			*Non-matching numbers*														
		IPP document		IPP document number							Online Planning Database (DB12) number							*Response*
Region IPP	Item	Page	Table	non-decadal number	2010	2020	2030	2040	2050	2060	non-decadal number	2010	2020	2030	2040	2050	2060	
N	Nueces County WCID#4, muni conservation, capital and annual costs	4B.11-3		na	na	na	na	na	na	na	$ -	$ -	$ -	$ 25,130	$ 60,508	$ 117,026	$ 171,880	No needs. Added text to IPP water supply plan to include range of costs of municipal water conservation.
N	Port Aransas, muni conservation, capital and annual costs	4B.11-3, 11-4		na	na	na	na	na	na	na	$ -	$ 12,682	$ 51,653	$ 106,749	$ 181,858	$ 275,709	$ 377,721	No needs. Added text to IPP water supply plan to include range of costs of municipal water conservation.
N	Nueces County Manufacturing, 11 WMSs - Capital and Annual costs, ex: O.N. Stevens WTP Improvements. Please delineate between Nueces and San Patricio Counties	4B.11-7(text), 11-8, 11-10, 11-11	4B.11-6, 11-7	$ 31,324,000	$ 7,554,000	$ 7,554,000	$ 7,554,000	$ 4,823,000	$ 4,823,000	$ 4,823,000	$ -	$ 2,492,820	$ 2,492,820	$ 2,492,820	$ 1,591,590	$ 1,591,590	$ 1,591,590	
N	O.N. Stevens WTP Improvements Supply	4B.11-10	4B.11.7		42,329	40,048	38,102	36,366	34,817	32,996		13,968	13,215	12,573	12,000	11,489	10,888	
N	Reclaimed Wastewater Supplies	4B.11-10	4B.11.7		250	250	250	250	250	250		82	82	82	82	82	82	
N	Garwood Pipeline Supply	4B.11-10	4B.11.7			35,000	35,000	35,000	35,000	35,000			11,666	11,666	11,666	11,666	11,666	
N	Off-Channel Reservoir Supply	4B.11-10	4B.11.7				30,340	30,340	30,340	30,340				10,113	10,113	10,113	10,113	
N	Lavaca River Diversion and OCR Supply	4B.11-10	4B.11.7							16,242							5,414	
N	Nueces County Steam-Electric, 10 WMSs - Capital and Annual costs, ex: O.N. Stevens WTP Improvements. Please delineate between Nueces and San Patricio Counties	4B.11-12, 11-14	4B.11-8, 11-9	$ 31,324,000	$ 7,554,000	$ 7,554,000	$ 7,554,000	$ 4,823,000	$ 4,823,000	$ 4,823,000	$ -	$ 2,492,820	$ 2,492,820	$ 2,492,820	$ 1,591,590	$ 1,591,590	$ 1,591,590	
N	Nueces County Steam-Electric, Gulf Coast Aquifer Groundwater Supplies	4B.11-12, 11-14	4B.11-8, 11-9	$59,245,000						18,000	na						na	
N	Nueces County Steam-Electric, 10 WMSs - Capital and Annual costs, ex: O.N. Stevens WTP Improvements. Please delineate between Nueces and San Patricio Counties	4B.11-12, 11-14	4B.11-8, 11-9	$ 31,324,000	$ 7,554,000	$ 7,554,000	$ 7,554,000	$ 4,823,000	$ 4,823,000	$ 4,823,000	$ -	$ 2,492,820	$ 2,492,820	$ 2,492,820	$ 1,591,590	$ 1,591,590	$ 1,591,590	
N	O.N. Stevens Water Treatment Plant Improvements	4B.11-14	4B.11.9		42,329	40,048	38,102	36,366	34,817	32,996		13,968	13,215	12,573	12,000	11,489	10,888	
N	Reclaimed Wastewater Supplies	4B.11-14	4B.11.9		250	250	250	250	250	250		82	82	82	82	82	82	
N	Garwood Pipeline	4B.11-14	4B.11.9			35,000	35,000	35,000	35,000	35,000			11,666	11,666	11,666	11,666	11,666	
N	Off-Channel Reservoir	4B.11-14	4B.11.9				30,340	30,340	30,340	30,340				10,113	10,113	10,113	10,113	
N	Gulf Coast Aquifer Groundwater Supplies	4B.11-14	4B.11.9				11,000	11,000	11,000	18,000				0	0	0	0	
N	Lavaca River Diversion and OCR	4B.11-14	4B.11.9							16,242							5,414	
N	Nueces County Mining, 11 WMSs - Capital and Annual costs, ex: O.N. Stevens WTP Improvements. Please delineate between Nueces and San Patricio Counties	4B.11-16, 11-18	4B.11-10, 11-11	$ 31,324,000	$ 7,554,000	$ 7,554,000	$ 7,554,000	$ 4,823,000	$ 4,823,000	$ 4,823,000	$ -	$ 2,492,820	$ 2,492,820	$ 2,492,820	$ 1,591,590	$ 1,591,590	$ 1,591,590	
N	Nueces County Mining, Gulf Coast Aquifer WMS	4B.11-16, 11-18	4B.11-10, 11-11	$ 59,245,000	0	0	9,383,000	9,383,000	9,383,000	10,188,000	na	na	na	na	na	na	na	
N	O.N. Stevens Water Treatment Plant Improvements	4B.11-18	4B.11.11		42,329	40,048	38,102	36,366	34,817	32,996		13,968	13,215	12,573	12,000	11,489	10,888	
N	Reclaimed Wastewater Supplies	4B.11-18	4B.11.11		250	250	250	250	250	250		82	82	82	82	82	82	
N	Garwood Pipeline	4B.11-18	4B.11.11			35,000	35,000	35,000	35,000	35,000			11,666	11,666	11,666	11,666	11,666	
N	Off-Channel Reservoir	4B.11-18	4B.11.11				30,340	30,340	30,340	30,340				10,113	10,113	10,113	10,113	
N	Gulf Coast Quifer Groundwater Supplies	4B.11-18	4B.11.11				11,000	11,000	11,000	18,000				0	0	0	0	
N	Lavaca River Diversion and OCR	4B.11-18	4B.11.11							16,242							5,414	
N	San Patricio Co. Manufacturing 11 WMSs - Capital and Annual costs, ex: O.N. Stevens WTP Improvements. Please delineate between Nueces and San Patricio Counties	4B.12-5(text), 4B.12-6, 12-8, 12-9	4B.12-4, 12-5	$ 31,324,000	$ 7,554,000	$ 7,554,000	$ 7,554,000	$ 4,823,000	$ 4,823,000	$ 4,823,000	$ -	$ 2,492,820	$ 2,492,820	$ 2,492,820	$ 1,591,590	$ 1,591,590	$ 1,591,590	Table shows incorrect amounts as supply from each project to each WUG and differ from what is in DB12. The sum of the supply volumes and costs to each WUG (as supplied from the City of Corpus Christi) match the total supply developed from that project. Appendix C in IPP delineates supplies and costs by WUG by county.
N	O.N. Stevens Water Treatment Plant Improvements	4B.12-8	4B.12.5		42,329	40,048	38,102	36,366	34,817	32,996		13,968	13,215	12,573	12,000	11,489	10,888	
N	Reclaimed Wastewater Supplies	4B.12-8	4B.12.5		250	250	250	250	250	250		82	82	82	82	82	82	
N	Garwood Pipeline	4B.12-8	4B.12.5			35,000	35,000	35,000	35,000	35,000			11,666	11,666	11,666	11,666	11,666	
N	Off-Channel Reservoir	4B.12-8	4B.12.5				30,340	30,340	30,340	30,340				10,113	10,113	10,113	10,113	
N	Lavaca River Diversion and OCR	4B.12-8	4B.12.5							16,242							5,414	

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Appendix M.2
Comment Letter No. 1
(TWDB)

June 28, 2010

Ms. Carola Serrato, Co-Chair
Coastal Bend Regional Water
Planning Group
c/o South Texas Water Authority
P.O. Box 1701
Kingsville, TX 78364

Ms. Rocky Freund
Nueces River Authority
1201 N. Shoreline Blvd.
Corpus Christi, TX 78401

Mr. Scott Bledsoe III, Co-Chair
Coastal Bend Regional Water
Planning Group
P.O. Box 3
c/o Live Oak UWCD
Oakville, TX 78060

Re: Texas Water Development Board Comments for the Coastal Bend Regional Water Planning Group (Region N) Initially Prepared Plan, Contract No. 0904830873

Dear Ms. Serrato, Mr Bledsoe and Ms. Freund:

Texas Water Development Board (TWDB) staff completed a review of the Initially Prepared Plan (IPP) submitted by March 1, 2010 on behalf of the Region N Regional Water Planning Group. The attached comments (Attachments A and B) follow this format:

- Level 1: Comments, questions, and online planning database revisions that must be satisfactorily addressed in order to meet statutory, agency rule, and/or contract requirements; and
- Level 2: Comments and suggestions for consideration that may improve the readability and overall understanding of the regional plan.

The TWDB's statutory requirement for review of potential interregional conflicts under Title 31, Texas Administrative Code (TAC) §357.14 will not be completed until submittal and review of adopted regional water plans.

Title 31, TAC §357.11(b) requires the regional water planning group to consider timely agency and public comment. Section 357.10(a)(3) of the TAC requires the final adopted plan include summaries of all timely written and oral comments received, along with a response explaining any resulting revisions or why changes are not warranted. Copies of TWDB's Level 1 and 2 written comments and the region's responses must be included in the final, adopted regional water plan.

If you have any questions, please do not hesitate to contact Virginia Sabia at (512) 936-9363.

Sincerely,

C L Brittin

Carolyn L. Brittin
Deputy Executive Administrator
Water Resources Planning and Information

Attachments (2)

c w/att: Ms. Kristine Shaw, HDR, Inc.

ATTACHMENT A

TWDB Comments on Initially Prepared 2011 Region N Regional Water Plan

LEVEL 1.	Comments and questions must be satisfactorily addressed in order to meet statutory, agency rule, and/or contract requirements.

Executive Summary

1. Page ES-6: The Yegua-Jackson is an official minor aquifer and covers parts of McMullen, Live Oak, and Bee counties within Region N. Please include the Yegua-Jackson as a minor aquifer that underlies the region. *[Title 31 Texas Administrative Code (TAC) §357.7(a)(1)(D)]*

Chapter 1

2. Please include a discussion of major demand centers in the plan. *[31 TAC §357.7(a)(1)(E)]*

3. Page 1-5, 1-27 to 1-28; pages 3-16 to 3-23: The plan does not document that groundwater availability models were used in assessing the Queen City, Sparta, and Carrizo-Wilcox aquifers. Please indicate the basis for these groundwater availability estimates. *[31 TAC §357.7(a)(3)(D)]*

Chapter 2

4. Page 2-6, Table 2-2 through Table 2-10: The plan presents population and categories of water use for water user groups by counties and river basins separately but not delineated by river basins in each county. Please present population and water demands by counties and river basin. For example, Duval County should be delineated by the Nueces and Nueces-Rio Grande Basins. *[31 TAC §357.7(a)(2)(A)(iv))]*

5. Page 2-24, Table 2-11: The plan presents population and categories of water use for wholesale water providers by counties and river basins separately, but not delineated by river basins in each county. Please present water use by category and delineate by counties and river basins. For example, Nueces County should be delineated by the Nueces, Nueces-Rio Grande, and San Antonio-Nueces River Basins. *[31 TAC §357.7(a)(2)(A)(iv) and (a)(2)(B)]*

Chapter 3

6. Page 3-11, Section 3.1.7: Please present surface and groundwater availability, delineated by counties and river basins. *[31 TAC §357.7(a)(3)(F)(iv); Contract Exhibit "D" 3.0]*

7. Page 3-15, Section 3.3: It is not clear which water availability model runs were used in the plan. Please reference the specific water availability model runs utilized to develop plan. *[31 TAC §357.7(a)(3)(C)]*

8. Page 3-16, Section 3.4.1: The plan indicates that the Central Gulf Coast Aquifer Groundwater Availability Model extends through Jim Hogg, Brooks, and Kenedy Counties. Please clarify that the model extends approximately midway through these counties. *[31 TAC §357.7(a)(3)(D)]*

9. Page 3-16, Section 3.4: The plan estimates groundwater availability and projected groundwater use based on the 1997 State Water Plan and the Central Gulf Coast Groundwater Availability Model. Please clarify whether available Texas Water Development Board Groundwater Availability Models were used for calculating groundwater availability for all aquifers in the plan. *[Contract Exhibit "D" 3.2]*

10. Page 3-16, Section 3.4: Please confirm whether groundwater availability in the plan was calculated based on the largest amount of groundwater that can be pumped annually without violating the most restrictive physical, regulatory or policy condition. *[Contract Exhibit "C" Section 3.2]*

Appendix D

11. Section D.2: Please clarify how groundwater availability was assessed for the southern portions of Brooks and Kenedy counties. *[31 TAC §357.7(a)(3)(D)]*

12. *(Attachment B)* Comments on the online planning database (i.e. DB12) are herein being provided in spreadsheet format. These Level 1 comments are based on a direct comparison of the online planning database against the Initially Prepared Regional Water Plan document as submitted. The table only includes numbers that do not reconcile between the plan (left side of spreadsheet) and online database (right side of spreadsheet). An electronic version of this spreadsheet will be provided upon request.

LEVEL 2. Comments and suggestions that might be considered to clarify or enhance the plan.

General Comment

1. Please consider including base map source references (e.g. Figures 3-1 and 3-2.) *[Contract Exhibit "D" Section 2.3]*

Chapter 1

2. Page 1-2: Plan indicates that the Live Oak Underground Water Conservation District was created February 1991. Texas Water Development Board records indicate that the district was created June 14, 1989 and confirmed November 7, 1989. Please consider clarifying

this in the plan.

Chapter 4

3. Pages 4B.5-4, 4B.9-7, and 4C.1-7: Water reuse is discussed as part of the conservation sub-section. Please consider discussing water reuse separately.

4. Page 4C.9-28, Section 4C.9.6: The Modification of Existing Reservoir Operations water management strategy states that better treatment of wastewater may be less effective than reduced treatment of wastewater in promoting ecological productivity in the Nueces Delta. Please consider explaining why reduced treatment of wastewater effluent would promote ecological productivity in the Nueces Delta.

REGION N

		IPP document reference:		Non-matching numbers: IPP document number							Online Planning Database (DB12) number						
Region IPP	Item	Page number	Table number	non-decadal number	2010	2020	2030	2040	2050	2060	non-decadal number	2010	2020	2030	2040	2050	2060
N	Corpus raw water available from reservoir	ES-10			205,000							228,420					
N	Surface water sources, check text on ES-10 and Table ES-2 on page ES-11, need to check by use type as well in table ES-2	ES-10,11	ES-2							198,816							198,800
N	Combined reliable yield of two major and two minor aquifers	ES-11			102,628					57,624		57,594					57,712
N	Corpus Christi Service Area need	ES-14								54,357							54,366
N	SPMWD Service Area	ES-14								7,898							7,897
N	WMS in excess of Regional need in 2060	ES-18								75,744							53,636
N	WMS 2060 capital costs	ES-18								$ 546,164,950							$ 126,211,000
N	Revise costs and supplies for Table ES-3, Examples provided below:	ES-19	ES-3														
N	Garwood Pipeline supplies	ES-19	ES-3		35,000							34,998	34,998	34,998	34,998	34,998	34,998
N	Off-Channel Reservoir near Lake CC	ES-19	ES-3		30,340							30,339	30,339	30,339	30,339	30,339	30,339
N	Lavaca River off-channel project	ES-19	ES-3		26,262												16,242
N	Reclaimed Wastewater Supplies	ES-19	ES-3		250							246					
N	Mining Conservation supply	ES-19	ES-3	cost - highly variable	259						$ -	244	548	938	1,369	1,842	2,343
N	Municipal Water Conservation Total Project Cost	ES-20	ES-4	$ 1,052,529							$ 1,052,530						
N	Irrigation Water Conservation DB12 total costs	ES-20	ES-4	$ 1,095,700							$ -						
N	Reclaimed Wastewater Supplies	ES-20	ES-4	250							246						
N	Gulf Coast Aquifer Supplies Cost	ES-20	ES-4	Up to $20,360,000 (Cap) and $3,132,000 (AC)						na	$ -						0
N	Update Table ES-5, Water Plan Summary, Examples below	ES-22-25	ES-5														
N	Bee County- Other Demand	ES-22	ES-5				1,705							1,704			
N	Bee County - Irrigation Needs	ES-22-25	ES-5							(890)							(802)
N	Manufacturing Conservation supply	ES-27	ES-6		1,260	1,418	1,576	1,734	1,892	2,050		0	0	0	0	0	0
N	Mining Conservation supply	ES-27	ES-6				878	1,246	1,653	2,084				938	1,369	1,842	2,343
N	Reclaimed Wastewater Supply	ES-27	ES-6		250	250	250	250	250	250		246	246	246	246	246	246
N	Off-Channel Reservoir near Lake Corpus Christi	ES-27	ES-6		0	0	30,340	30,340	30,340	30,340		0	0	30,339	30,339	30,339	30,339
N	Voluntary redistribution of Three Rivers Surplus	ES-27	ES-6		475	738	914	1,060	1,179	1,354							
N	Garwood Pipeline supply	ES-27	ES-6		0	35,000	35,000	35,000	35,000	35,000			34,998	34,998	34,998	34,998	34,998
N	Increase contracted amount from WWP	ES-27	ES-6		261	0	0	0	1,527	1,443		0	0	0	0	0	0
N	Lavaca River Diversion	ES-27	ES-6	$ 224,183,000	0	0	0	0	0	16,242	$ -	0	0	0	0	0	0
N	CCR/LCC Pipeline	ES-28	ES-7					21,905	21,905	21,905					21,903	21,903	21,903
N	Stage II Lake Texana (On-Channel)	ES-28	ES-7	$232,828,000						12,964	$131,435,324						12,963
N	Seawater Desalination	ES-28	ES-7					28,000	28,000	28,000					27,999	27,999	27,999
N	Falfurrias, municipal conservation annual costs	4B.4-1		na	na	na	na	na	na	na	$ -	$ 283	$ 15,955	$ 40,021	$ 66,129	$ 96,639	$ 130,882
N	Benevides - groundwater desal capital and annual costs	4B.5-1, 5-2		$4,633,000 (Cap) $688,000 (AC)							na						
N	Freer - groundwater desal capital and annual costs	4B.5-2		$6,899,000 (Cap) $1,121,000 (AC)							na						
N	San Diego - groundwater desal captial and annual costs	4B.5-3		$6,304,000 (Cap) $1,000,000 (AC)							na						
N	Duval County-Other, muni conservation, capital and annual costs	4B.5-3		na	na	na	na	na	na	na	$ -	$ 2,431	$ 5,680	$ 8,838	$ 11,518	$ 18,466	$ 26,468
N	Duval County, Mining conservation, no costs in IPP or online database	4B.5-4, 5-5	4B5-2, 5-3	na	na	na	na	na	na	na	na	na	na	na	na	na	na
N	Alice, muni conservation, capital and annual costs	4B.6-1, 6-2		na	na	na	na	na	na	na	$ -	$ 21,240	$ 56,111	$ 92,762	$ 129,589	$ 185,382	$ 247,695
N	Orange Grove, muni conservation, capital and annual costs	4B.6-2		na	na	na	na	na	na	na	$ -	$ 1,087	$ 3,224	$ 5,744	$ 7,826	$ 11,905	$ 15,869
N	George West, muni conservation, capital and annual costs	4B.9-2		na	na	na	na	na	na	na	$ -	$ 1,961	$ 6,068	$ 10,446	$ 14,026	$ 19,008	$ 24,166
N	Three Rivers: muni conservation	4B.9-2		na	na	na	na	na	na	na	$ -	$ 1,068	$ 3,492	$ 5,797	$ 7,779	$ 11,332	$ 14,508
N	Live Oak County Mining, conservation, no costs in IPP or online database	4B.9-8	4B.9-8	na	na	na	na	na	na	na	na	na	na	na	na	na	na
N	Live Oak County Irrigation, conservation, annual cost listed under total project cost	4B.9-9	4B.9-9	$ 77,976							$ -						

REGION N

		IPP document reference:		Non-matching numbers														
				IPP document number							Online Planning Database (DB12) number							
Region ID	Item	Page number	Table number	non-decadal number	2010	2020	2030	2040	2050	2060	non-decadal number	2010	2020	2030	2040	2050	2060
N	McMullen County-Other, muni conservation, capital and annual costs	4B.10-2		na	na	na	na	na	na	na	$ -	$ 272	$ 739	$ 1,421	$ 2,232	$ 2,894	$ 4,264
N	Nueces County WCID#4, muni conservation, capital and annual costs	4B.11-3		na	na	na	na	na	na	na	$ -	$ -	$ -	$ 25,130	$ 60,508	$ 117,026	$ 171,880
N	Port Aransas, muni conservation, capital and annual costs	4B.11-3, 11-4		na	na	na	na	na	na	na	$ -	$ 12,682	$ 51,653	$ 106,749	$ 181,858	$ 275,709	$ 377,721
N	Nueces County Manufacturing, 11 WMSs - Capital and Annual costs, ex: O.N. Stevens WTP Improvements. Please delineate between Nueces and San Patricio Counties	4B.11-7(text), 11-8, 11-10, 11-11	4B.11-6, 11-7	$ 31,324,000	$ 7,554,000	$ 7,554,000	$ 7,554,000	$ 4,823,000	$ 4,823,000	$ 4,823,000	$ -	$ 2,492,820	$ 2,492,820	$ 2,492,820	$ 1,591,590	$ 1,591,590	$ 1,591,590
N	O.N. Stevens WTP Improvements Supply	4B.11-10	4B.11.7		42,329	40,048	38,102	36,366	34,817	32,996		13,968	13,215	12,573	12,000	11,489	10,888
N	Reclaimed Wastewater Supplies	4B.11-10	4B.11.7		250	250	250	250	750	250		82	82	82	82	82	82
N	Garwood Pipeline Supply	4B.11-10	4B.11.7			35,000	35,000	35,000	35,000	35,000			11,666	11,666	11,666	11,666	11,666
N	Off-Channel Reservoir Supply	4B.11-10	4B.11.7				30,340	30,340	30,340	30,340				10,113	10,113	10,113	10,113
N	Lavaca River Diversion and OCR Supply	4B.11-10	4B.11.7							16,242							5,414
N	Nueces County Steam-Electric, 10 WMSs - Capital and Annual costs, ex: O.N. Stevens WTP Improvements. Please delineate between Nueces and San Patricio Counties	4B.11-12, 11-14	4B.11-8, 11-9	$ 31,324,000	$ 7,554,000	$ 7,554,000	$ 7,554,000	$ 4,823,000	$ 4,823,000	$ 4,823,000	$ -	$ 2,492,820	$ 2,492,820	$ 2,492,820	$ 1,591,590	$ 1,591,590	$ 1,591,590
N	Nueces County Steam-Electric, Gulf Coast Aquifer Groundwater Supplies	4B.11-12, 11-14	4B.11-8, 11-9	$59,245,000						18,000	na						na
N	Nueces County Steam-Electric, 10 WMSs - Capital and Annual costs, ex: O.N. Stevens WTP Improvements. Please delineate between Nueces and San Patricio Counties	4B.11-12, 11-14	4B.11-8, 11-9	$ 31,324,000	$ 7,554,000	$ 7,554,000	$ 7,554,000	$ 4,823,000	$ 4,823,000	$ 4,823,000	$ -	$ 2,492,820	$ 2,492,820	$ 2,492,820	$ 1,591,590	$ 1,591,590	$ 1,591,590
N	O.N. Stevens Water Treatment Plant Improvements	4B.11-14	4B.11.9		42,329	40,048	38,102	36,366	34,817	32,996		13,968	13,215	12,573	12,000	11,489	10,888
N	Reclaimed Wastewater Supplies	4B.11-14	4B.11.9		250	250	250	250	250	250		82	82	82	82	82	82
N	Garwood Pipeline	4B.11-14	4B.11.9			35,000	35,000	35,000	35,000	35,000			11,666	11,666	11,666	11,666	11,666
N	Off-Channel Reservoir	4B.11-14	4B.11.9				30,340	30,340	30,340	30,340				10,113	10,113	10,113	10,113
N	Gulf Coast Aquifer Groundwater Supplies	4B.11-14	4B.11.9				11,000	11,000	11,000	18,000				0	0	0	0
N	Lavaca River Diversion and OCR	4B.11-14	4B.11.9							16,242							5,414
N	Nueces County Mining, 11 WMSs - Capital and Annual costs, ex: O.N. Stevens WTP Improvements. Please delineate between Nueces and San Patricio Counties	4B.11-16, 11-18	4B.11-10, 11-11	$ 31,324,000	$ 7,554,000	$ 7,554,000	$ 7,554,000	$ 4,823,000	$ 4,823,000	$ 4,823,000	$ -	$ 2,492,820	$ 2,492,820	$ 2,492,820	$ 1,591,590	$ 1,591,590	$ 1,591,590
N	Nueces County Mining, Gulf Coast Aquifer WMS	4B.11-16, 11-18	4B.11-10, 11-11	$ 59,245,000	0	0	9,383,000	9,383,000	9,383,000	10,188,000	na	na	na	na	na	na	na
N	O.N. Stevens Water Treatment Plant Improvements	4B.11-18	4B.11.11		42,329	40,048	38,102	36,366	34,817	32,996		13,968	13,215	12,573	12,000	11,489	10,888
N	Reclaimed Wastewater Supplies	4B.11-18	4B.11.11		250	250	250	250	250	250		82	82	82	82	82	82
N	Garwood Pipeline	4B.11-18	4B.11.11			35,000	35,000	35,000	35,000	35,000			11,666	11,666	11,666	11,666	11,666
N	Off-Channel Reservoir	4B.11-18	4B.11.11				30,340	30,340	30,340	30,340				10,113	10,113	10,113	10,113
N	Gulf Coast Quifer Groundwater Supplies	4B.11-18	4B.11.11				11,000	11,000	11,000	18,000				0	0	0	0
N	Lavaca River Diversion and OCR	4B.11-18	4B.11.11							16,242							5,414
N	San Patricio Co. Manufacturing 11 WMSs - Capital and Annual costs, ex: O.N. Stevens WTP Improvements. Please delineate between Nueces and San Patricio Counties	4B.12-5(text), 4B.12-6, 12-8, 12-9	4B.12-4, 12-5	$ 31,324,000	$ 7,554,000	$ 7,554,000	$ 7,554,000	$ 4,823,000	$ 4,823,000	$ 4,823,000	$ -	$ 2,492,820	$ 2,492,820	$ 2,492,820	$ 1,591,590	$ 1,591,590	$ 1,591,590
N	O.N. Stevens Water Treatment Plant Improvements	4B.12-8	4B.12.5		42,329	40,048	38,102	36,366	34,817	32,996		13,968	13,215	12,573	12,000	11,489	10,888
N	Reclaimed Wastewater Supplies	4B.12-8	4B.12.5		250	250	250	250	250	250		82	82	82	82	82	82
N	Garwood Pipeline	4B.12-8	4B.12.5			35,000	35,000	35,000	35,000	35,000			11,666	11,666	11,666	11,666	11,666
N	Off-Channel Reservoir	4B.12-8	4B.12.5				30,340	30,340	30,340	30,340				10,113	10,113	10,113	10,113
N	Lavaca River Diversion and OCR	4B.12-8	4B.12.5							16,242							5,414

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Appendix M.3
Comment Letter No. 2
(Texas Parks and Wildlife)

TEXAS PARKS & WILDLIFE

Life's better outside.®

June 3, 2010

Ms. Rocky Freund
1201 N. Shoreline Blvd.
Corpus Christi, TX 78401

Re: 2010 Region N Initially Prepared Plan

Dear Ms. Freund:

Thank you for the opportunity to review and comment on the 2010 Initially Prepared Regional Water Plan (IPP) for Region N. Texas Parks and Wildlife (TPW) acknowledges the time, money and effort required to produce the regional water plan as mandated by Senate Bill 1 of the 75th Legislature. A number of positive steps have been taken since the first planning cycle to advance the issue of environmental protection. For example, the regional water planning groups are required by TAC §357.7(a)(8)(A), to perform a "quantitative reporting of environmental factors including effects on environmental water needs, wildlife habitat, cultural resources, and effect of upstream development on bays, estuaries, and arms of the Gulf of Mexico" when evaluating water management strategies (WMS). Quantification of environmental impacts is a critical step in planning for our state's future water needs while also protecting environmental resources.

TPW staff has reviewed the IPP with a focus on the following questions:

- Does the plan include a quantitative reporting of environmental factors including the effects on environmental water needs, and habitat?
- Does the plan include a description of natural resources and threats to natural resources due to water quantity or quality problems?
- Does the plan discuss how these threats will be addressed?
- Does the plan describe how it is consistent with long-term protection of natural resources?
- Does the plan include water conservation as a water management strategy? Reuse?
- Does the plan recommend any stream segments be nominated as ecologically unique?
- If the plan includes strategies identified in the 2006 regional water plan, does it address concerns raised by TPW at that time?

Population projections in the 2010 Region N IPP are unchanged from the 2006 regional water plan. With the exception of irrigation demands in Bee and San Patricio Counties, water demands are also unchanged from the 2006 plan. Most of the population growth is expected to occur in Nueces and San Patricio Counties, which encompass the City of Corpus Christi and other communities around Corpus Christi Bay. Eight of 11 counties in the region have at least one projected shortage during the planning horizon. The largest needs are associated with the Corpus Christi service area manufacturing and steam-electric demands (39,517 ac-ft/yr in raw water shortages).

4200 SMITH SCHOOL ROAD
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www.tpwd.state.tx.us

Water Management Strategies intended to address unmet needs include water conservation, use of reclaimed wastewater, groundwater pumping, off-channel reservoirs near Lake Corpus Christi and Lake Texana, voluntary redistribution of surplus water and increased contracts, a pipeline to the Colorado River to use the Garwood water right, and improvements to the O.N. Stevens water treatment plant. Proposed alternate strategies include a pipeline from Choke Canyon Reservoir to Lake Corpus Christi, Palmetto Bend Stage II Reservoir, seawater desalination, and brackish groundwater desalination.

Related to the recommended Water Management Strategies, TPW staff has the following comments.

TPW considers water conservation the most environmentally sound water management strategy and therefore commends the City of Corpus Christi for their recent conservation achievements (a decrease in municipal water use from 220 gallons per capita per day (gpcd) in 1990 to 179 gpcd in 2000). These recent achievements, combined with state and federally-mandated water conservation practices (e.g., low-flow fixtures) result in a predicted decrease in the municipal per capita use in the City of Corpus Christi to 165 gpcd by 2060. TPW staff is encouraged by the recommendations for advanced water conservation for the 10 water user groups with 2060 projected municipal gpcd usage above 165 gpcd. TPW staff encourages the planning group to consider the 140 gpcd goal identified by the Texas Water Conservation Implementation Task Force.

As described in the Region N IPP, some manufacturing water use increases when the quality of the source water is low. The manufacturing water conservation strategy recognizes this and proposes to improve the quality of water in the Calallen Pool by a variety of approaches, including a potential pipeline from Lake Corpus Christi to Calallen. TPW staff notes that any new pipelines will have direct impacts to habitat and wildlife resources in the right-of-way areas. Furthermore, to provide some protection to existing riverine and riparian habitat, instream flows in the Nueces River should be addressed.

In general, TPW staff encourages the responsible reuse of wastewater as a means of avoiding new projects that may have greater impacts to fish and wildlife. TPW staff also knows that in many cases, wastewater reuse makes excellent economic sense on its own merits. However, in the absence of additional data, TPW staff questions the basis for multipliers as high as 5 related to bay and estuary inflow credits, thereby potentially further reducing freshwater inflows to the Nueces Estuary. In addition, treated effluent lacks the necessary sediment component that is important for maintaining nursery function for important fish and shrimp species. The application of any freshwater inflow multiplier greater than 1:1 would require approval by the Nueces Estuary Advisory Committee, and ultimately the TCEQ. In summary, while wastewater reuse is a strategy with significant merits, TPW staff recommends further evaluation of the potential impacts of an overall reduction in instream flows and freshwater inflows, as are noted in Table 4C5-7. These comments are consistent with those made on the same issue by TPW in our comment letter (dated September 12, 2005) on the 2005 Region N IPP.

The proposed Nueces Off-Channel Reservoir near Lake Corpus Christi has the potential for significant, adverse impacts to terrestrial and aquatic communities, both as a result of construction of the reservoir and pipeline, as well as through reduced instream flows. TPW staff has similar concerns related to the proposed Lavaca River Diversion and Off-Channel Reservoir project.

With respect to alternate water management strategies, the Choke Canyon Reservoir – Lake Corpus Christi pipeline could have significant, adverse impacts on terrestrial and aquatic resources. The Nueces River between these reservoirs includes one of only four known populations of the recently state-listed threatened mussel species Golden Orb (*Quadrula aurea*), among other rare and endemic species. Both seawater and brackish groundwater desalination can be ecologically advantageous strategies, as long as such issues as impingement and entrainment at intake locations, and brine disposal options are carefully considered.

The Region N IPP does not recommend nomination of any stream segments as ecologically unique. TPW has identified several stream segments in the region that meet at least one of the criteria for classification as ecologically unique should the regional planning group decide to pursue nomination of an ecologically significant stream in the future.

In comparing the 2010 IPP with the 2005 IPP and the 2006 final regional water plan, TPW's previous comments regarding wastewater reuse multipliers and ecologically unique stream segments do not appear to have been addressed in the 2010 Region N IPP.

Thank you for your consideration of these comments. TPW looks forward to continuing to work with the planning group to develop water supply strategies that not only meet the future water supply needs of the region but also preserve the ecological health of the region's aquatic resources. Please contact Cindy Loeffler at (512) 389-8715 if you have any questions or comments.

Sincerely,

Ross Melinchuk
Deputy Executive Director, Natural Resources

RM:CL:ms

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Appendix M.4
Public Comments

RECEIVED
JUN 07 2010
TWDB

6/4/10

Dear Mr. Ward,
As a citizen + land owner in Jackson Co., I express the wishes of the majority of our County.

PLEASE DO NOT DAM THE LAVACA RIVER.

Thank you,
Carol Ann Lee

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Dear Coastal Bend Regional Water Planning Group,

Like many people in Jackson County, I have many memories of growing up on the river. As kids we used to splash around in its clean waters and roast hot dogs on the sandy banks. I've spent many a night camping on its shores and I've eaten fish and crab from its waters. It's a beautiful place. Likewise, like most of the other residents of this county, I've spent many sunny afternoons in a boat on Lake Texana and waterskiing in its waters. So this is an issue I feel very passionate about. We are in a unique position because there are few hypotheticals about what will happen if we dam up the Lavaca. Questions such as what kind of economic development it will create, how it will affect the natural habitat, what it will do to the landowners, and the quality of water it will contain have all been answered for us—that answer is Lake Texana. It is my opinion that no matter whether one believes Lake Texana is a good thing for this county or a bad thing, another lake like that is the wrong thing for this area and its people.

In 1969 the citizens of Jackson County voted yes to Stage I of the Palmetto Bend Reservoir, or what we now know as Lake Texana. I wasn't alive at the time but I've looked at the information that was being pushed by proponents of the dam and time has proven them to be false. When the people voted yes they were told by the Bureau of Reclamation that the creation of the lake would cause unprecedented growth in the county. They were told that the population would grow to 81,000 people. Today Jackson County has a population of 14,146 people only a slight increase in the 40 years since the people voted to dam up the beautiful Navidad River. I ask you: Where is the population growth that was promised? Where are the people?

In 1969 when the people voted yes they were told that the creation of Lake Texana would create jobs for 31, 000 people. THIRTY ONE THOUSAND PEOPLE! Now I'm not a genius at math but I know that Formosa employs 1,515 full-time employees and 477 contract labor employees. Inteplast employs around 1,400 and LNRA employs (including part-time and summer employment) 69 people. The Bureau also estimated a personal annual income of $327,000,000 based on 2010 economic conditions. Ask yourselves: If the people in 1969 had known the realities of how many jobs would be created and the current economic conditions of Jackson County, would they still have voted yes?

The people were promised that if they dammed up that river they would get all this economic development and life would be so much better for the residents of Jackson County. How is life better for us now than for the people who cast their vote in 1969? Where are the revenues from this lake? Where are the better roads? The better schools? While it is true that Lake Texana has brought some jobs and while it is true that we now have a place to water ski, the question still remains: Was it worth it? Was it worth destroying the natural beauty of the river and relocating families that had farmed and ranched that land for generations? Was it worth destroying the ghost town of Texana—a local and national cultural and heritage site? I think not.

So many of the questions of what will happen if we dam up this last free-flowing river in Texas are already answered. Just drive a few miles east and you'll find your answer. Stage II will not be the next Gardner State Park as Stage I was not. It will be unsightly. Lake Texana did not bring people to build condos and summer homes on its shores. It didn't attract sailing regala or tourists from afar. All it is is a watering hole for

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big cities and industries to drink from. And just like with Lake Texana, they want to dam up our river for their own interests and their own growth in other places. And just like with Lake Texana they will take our water and leave us with very little.

Please protect Jackson County and protect the last free flowing river in the State of Texas!

Sincerely,

Lindsey Lee Bradford

Lindsey Lee Bradford
101 E. Main St.
Edna, TX 77957
- Concerned citizen and voter,
-Vice President of the Jackson County Chamber of Commerce & Agriculture

Dear Coastal Bend Regional Water Planning Group (Region N),

PLEASE DON'T DESTROY THE LAVACA RIVER BY DAMMING IT! You hold in your hands the ability to let the Lavaca River basin live! You and we all have been given a sacred trust. Once the chainsaws and bulldozers come, we will never have a second chance to leave our precious river in the same condition for the next generation. The pristine forests will be bull dozed and burned, and the wildlife will die or be squeezed into a smaller and smaller habitat. THIS IS YOUR CHOICE!

I would like to voice my objections to adding yet another dam to the only river left in the county.
I grew up, like many others, exploring the woods of this river bottom. Generations before have been good stewards of this land, and it's up to us to continue that heritage for future generations. Friends' homes and livelihoods will be destroyed, and for what???? For a lake that in the grand scheme of things will silt in after 50 to 75 years?????? Jackson County already has one of those lakes that has dramatically changed to a waist land in the last few years. Look North of Highway 59 on Lake Texana to what a beautiful river bottom with a clear stream has turned into!

The residents of Jackson County have enjoyed, as long as I can remember , a wonderful small town and country life, and they would like to be able to pass that legacy on to their children and grandchildren. We have all long enjoyed hunting, fishing, and exploring the pristine forested areas in the county. The amount of these wildlife areas is shrinking more and more, and the dam will destroy much of this legacy. Jackson County is the most southwestern extension of the eastern forests. Pecan trees, great oaks, buckeyes, hawthorns and a variety of wildlife can be found along the Lavaca River. Wildlife we have observed include whitetail deer, turkeys, raccoons, opossums, foxes, grey wolves, coyotes, bobcats, squirrels, the American and Mexican Eagle, armadillos, jack rabbits, many ducks, Sand Hill Cranes, Blue Herons, egrets, and owls to name just a few.

In addition to destroying the habitat of numerous species of wildlife, the formation of the lake would also destroy virgin forested areas that provide protection from hurricanes. Rivers not only provide for forests, and wildlife, they sustain our estuaries. They provide fish and shrimp with fresh water and nutrients needed for their life cycle. Wetlands, bottom lands and forests provide maximum storage for carbon in plants and animals needed to prevent global warming and rising of sea levels. They are also carbon sinks, and they produce oxygen for our planet.

In addition to the loss of wildlife, loss of primary (uncut) forests, and displacement of people and their livelihoods, many of us are vehemently opposed to turning remaining rivers into reservoirs and dams to provide inexpensive, subsidized water to industries. Newer methods of using water for industries bordering the Gulf should be used such as desalinization plants which could convert salt water into usable water. We should have the choice of how our land is to be used. In the United States, Florida, and California have the most highly developed water management systems and are in the process of reversing decisions and embarking on restoration projects. Let us not make their mistakes. Once the bulldozers and the chain saws have come in and destroyed, we can never bring these areas back to their former glory. They are gone forever! And what will Jackson County get in return except yet another lake with valuable land, mineral, and wildlife resources taken off the tax rolls to subsidize a company not even located in the county.

Sincerely, Mary Gayle Prihoda

Mary Gayle Prihoda and Joe D. Prihoda

rec'd 6-14-10

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Mr. Con Mims III
Dear (Coastal Bend Regional Water Planning Group (Region N),

own property
I ~~live~~ in Jackson County and am very concerned about our county's future. The LNRA has the power to make some decisions that can positively or negatively affect the lives of the people who live and work in the county. They are not being responsive to our concerns and we need your help.

These are the issues I am deeply concerned about:

- I don't want or need another dam like the one we already have.
- We were taxed before on Stage I and will be taxed again on Stage II.
- We need more tax relief not more taxes.
- Where the water goes, the job goes. The water needs to stay in Jackson County and let the industries come to us.
- Damming the last remaining free river in Texas is simply the wrong thing to do when there are other choices.
- I do not believe in taking people's land just to help some private or public company in another county have more water to increase their own tax base.
- If the Lavaca River is dammed, eminent domain will be used to take the land. LNRA has already taken 17,000 acres and doesn't need more.
- As it stands, only LNRA will benefit from having a second dam. They will be able to hire more people and pay more to upper level management while Jackson County will continue to be one of the highest tax paying counties in the state.
- The estuaries are already in danger, especially since the BP oil spill. Cutting off the fresh water flow just doesn't make sense.

Personal Note Please see attached letter.

Signed: Mary Gayle Pohoda and Joe D Pohoda

CC: Senator Glenn Hegar
Representative Geanie Morrison
Region P Water Board
Region L Water Board
Region N Water Board

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RECEIVED

MAY 28 2010

TWDB

Marcus & Sharon Tomas
2303 CR 306
Edna, TX 77957

Lavaca Regional Water Planning Group (Region P)
J. Kevin Ward, Executive Administrator
Texas Water Development Board
P. O. Box 13231
Austin TX 78711-3231

May 26, 2010

I hear a lot ot talk as to why we need State II of the Palmetto Dam and the benefits will it bring to Jackson County. Unfortunately, most of what I hear is the same rethoric that was ballyhooed many years ago before Stage I of Palmetto Dam was built. Some of the claims were a huge rise in population, burgeoning retail business growth, a broader tax base resulting in lower taxes per capita, lots of new jobs, a beautiful recreational area for both residents and tourists and developement of a large industrial/manufacturing center.

Most of these pie-in-the-sky promises weren't true then and they still aren't true now. Our population barely grew, the jobs situation is still pretty stagnant, we have less retail businesses open now that before, taxes haven't been reduced, Formosa, etc. is actually located in Calhoun County and Lake Texana should have been named "Mud Lake."

The real question is: do we, the citizens of Jackson County want Stage II to happen? My opinion and the opinion of the majority of landowners/taxpayers is a resounding NO!!!

The Lavaca River is the last free-flowing river in Texas. The Navidad River was obiliterated years ago by the same people who are pushing Stage II of Palmetto Dam now. They didn't care all those years ago about perserving the rich history, the wild beauty of the river and its surrounding fertile river bottom and they don't care about destroying the Lavaca now.

Jackson County doesn't need Stage II. We have enough water for our use now and in the forseeable future. Stage II is about stealing our land, our livelihoods and our history in order to high-jack our water resources for use in other cities and counties. There must be other options available to develop water resources nearer these places that are looking to us for their water.

The citizens and taxpayers of Jackson County are concerned about losing the last free-flowing river in Texas, their homes, farms and ranches, and the destruction of family histories and the loss of many local historicial sites. They worry about losing their livelihoods and the freedom to continue to live their lives where and in the manner they and their forebearers chose many, many years ago.

We speak out now against Stage II of Palmetto Dam and the loss and destruction that it will bring to Jackson County. We speak out against Stage II of Palmetto Dam because it is our right, our duty and our priviledge to be involved in and protect the future of Jackson County. We speak out against Stage II of Palmetto Dam now because in less than four months the results of the feasibility study will be revealed and then it may be too late to speak out.

We hope that you will listen to us, take up our cause and speak out with us to "Save Our Lavaca" before it is too late for anything but regrets.

Thank you for your time.

Sincerely,

Marcus Tomas

Sharon Tomas

Marcus & Sharon Hamman Tomas

We Are Two Third-Generation Jackson County Residents.
We Live On the Banks of the Lavaca River.
We Appreciate It As It Was, As It Is and
As We Hope It Will Remain -
Wild, Open and Free!

rec'd 6-18-10

********************* *********************

JOHNNY E. BELICEK
Commissioner – Pct. 3 – Jackson County

4389 FM 1822
Edna, Texas 77957

361-782-2033
Fax 361-782-3707

June 15, 2010

Mr. Con Mims III
Executive Director
Coastal Bend Regional Water Planning Group
P. O. Box 349
Uvalde, Texas 78802-0349

Re: Against Stage 2

Dear Mr. Mims:

I am very aware of how important water is for the State of Texas. Jackson County has done its part by allowing the Stage 1 Dam to be built. As it turns out, the only entity profiting from this water is Lavaca-Navidad River Authority.

Since the citizens of Jackson County are very much against the damming of the Lavaca River, our last free-flowing river, I am asking you NOT to support another dam being built here just to profit LNRA.

Sincerely,

Johnny E. Belicek

JOHNNY E. BELICEK
JACKSON COUNTY COMMISSIONER
PRECINCT 3

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Rec'd 7-?-10

Kenneth & Carole Koop
1422 County Road 110
Edna, TX 77957
June 29, 2010

Com
FYI
Kent

Senator Glenn Hegar
P.O Box 12068
Capitol Station
Austin, TX 78711

Dear Senator Hegar: Reference: Lavaca-Navidad River Authority and their desire to dam the Lavaca River

This is not about water, but about a family heritage and livelihood. I live in Jackson County, on the Lavaca River, one mile North of US 59 in the El Toro area. My farm is a 6 generation farm being in my family since 1871. At least that is the earliest recorded deed I have. But, my Uncle William Putnam tells me that the old homestead home was built 12 years before the Civil War. The hardships of the past are recorded in various bank notes and land deals that were secured by my great grand parents and grand parents as they struggled to survive and hold on to the farm.

When my wife and I made a commitment to buy the farm, we had to purchase bits and pieces of inherited portions from different family members as we struggled to keep the old farm, especially the river bottom, in tack. Both being school teachers, we worked extra part time jobs for 25 years as we gradually took hold of about two thirds of the original 335 acres. We barely survived the Carter administration when interest rates on loans went from 8% to 12.5% plus. Over the years through hard work, we have transformed the overgrown thicket of huisache, rose hedge, and yaupons into beautiful river bottom grassland that sustains our cattle operation during winter or even a severe drought, as we just experienced.

Wildlife is abundant along the old river named by the explorer LaSalle. The river is no more than a creek during the summer, but the grand kids, neighborhood kids, local scout groups and church youth groups have a great time on the sand bars regardless of the water flow. Our trees are massive giants along the river and we are awed by God's creation, beauty and serenity as we walk or ride ATV's throughout the bottom lands.

Carole and I lived in the Hill Country near Boerne and sold everything we had seven years ago so we could move onto the farm. We have ZERO interest in having to sell any part of our farm for lake water. You can not put a price on family heritage. There are three generations of family wanting to hold it together and not let it be destroyed. You would not want someone to take your land for all the reasons listed on the form letter being sent out.

Most of the year I can walk or step across the Lavaca River without getting water above my knees. I have not seen much change over a 60 year period. I wonder if the evaporation rate for a 10,000 acre lake would be greater than the amount of water flowing from the river into the lake. I can see the benefit of an off channel reservoir for capturing and holding flood water. It would definitely affect fewer land owners.

If you confiscate my land through eminent domain, you will create another muddy waste land for water hyacinth, trash, driftwood and alligators. You can see a mirror image of what my property will look like when you drive down US 59 and look north as you cross Lake Texana.

Senator Hegar, we have heard you speak and visited with you on several occasions. We know you have a vested interest in your own family farm. I respectfully request your help. Please do not support the damning of the Lavaca River.

Respectfully Yours,

Kenneth & Carole Koop

CC: Region P, L, N Water Board

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rec'd. 7-1-10

From: Lois Kruschwitz eco@earthnet.net
Second Home Edna Address: 107 W. Gayle St 77957
Date: Sat, 26 Jun 2010 10:47:10 -0700
To: Lavaca Regional Water Planning Groups

DAMMING THE LAVACA RIVER

First, let me introduce myself. My family has lived in Jackson County since the 1830s. At that time, several family members fought in the Texas Revolution and, there is reason to believe, were given land in Jackson County for their service in lieu of pay. We have been ranchers and farmers and have cared for our land as a family treasure. Our land along the Lavaca includes bottomland and primary forest, scarred only by pipelines such as the Corpus water line, which insisted on clearing a very wide right-of-way. Previously, part of our land was taken for the I-59 right-of-way and for Lake Texana.

For 38 years, I have taught biology, ecology and environmental science. Currently, I am a professor emeritus and teach primarily environmental science. The inspiration for my career came from my roots in Jackson County. I wandered along the Lavaca and had science fair projects that dealt with subjects such as "Native Woods of Jackson County."

My thoughts and ideas on the Lavaca River project are below. They reflect my interests.

The Lavaca is the last free flowing river on the Texas coast and for many, many reasons should not be dammed or diverted. There are better choices, such as industrial recycling of water, commonly used all over the world. Industries along the Gulf coast already use significant amounts of fresh water, including water from Lake Texana. In an effort to "sell" such projects, the public has been misinformed and misled about the advantages of reservoirs. Reservoirs may seem economically desirable, but such projects are costly environmentally and economically over time. An analogy might be that when forests are cut down, there may be substantial economic gain, but over time the many economic and environmental services and benefits that an intact forest provides are missing. Forested areas provide protection from hurricanes. Rivers not only provide for forests and wildlife, they sustain estuaries and provide fish and shrimp with freshwater and nutrients. We take for granted many of their ecological services. For example, wetlands and bottomlands act like sponges, absorbing and releasing water as needed. They are carbon sinks. They provide maximum storage for carbon in plants and animals, preventing global warming. Equally important, they produce oxygen. And, of course, forests, wetlands, rivers and natural areas are important economically as meccas for birdwatchers, fisherman, hunters and outdoor activists that bring revenue to the county.

The Lavaca is a silt laden river. It will drop its load of suspended materials, including toxic pesticides, pollutants, and pathogens and fill in as little as 100 years. In comparison, free flowing streams cleanse themselves and can be enjoyed for their scenic beauty.

Dams and water transfer projects upset the natural balances of streams and ecosystems. Not only do they completely destroy the habitats that they inundate, but they allow for the introduction of invasive organisms such as water hyacinths, nutria, mussels and many others. (For example, introduced water hyacinths clog waterways and are a problem for recreational and other interests in eutrophic Lake Texana and are rare in free-flowing streams, such as the Lavaca.)

Invasive species displace native organisms and are major threats to biodiversity. The rate of species disappearance has increased dramatically in the last 150 years and more extinctions and ecosystem crashes are expected. Organisms are interconnected and depend on one another for survival. The elimination of key species leads to disruption and ecosystem collapse. Not only are habitats destroyed by inundation and invasive species, but estuaries downstream are effected by the reduction in freshwater and nutrients from Texas rivers. Populations of shrimp, crab and fish are in decline.

The diverse subtropical region of the Texas coast has lost top predators and many less obvious organisms and has much more to lose from continued environmental disruptions. Today, most residents and visitors to Jackson County enjoy hunting, fishing, and exploring the pristine forested areas of the county. However, there are growing concerns about toxic marine seafood and respiratory and other health problems emanating from polluting industries along the Gulf. The bases of these concerns are well documented.

The question arises whether the people of Jackson County should be forced to service and subsidize major international polluting industries along the coast. Our artesian wells dried up years ago and as wells for farming are redrilled deeper, there will be no future access to surface water for local use.

Jackson County has preserved some of its wild lands and natural areas and is interested in continuing to do so in the future. It supports remnants of the most southwestern extension of the eastern deciduous forest. Pecan trees, ancient oaks, buckeye and hawthorn intermingle with huisache and knock-away from drier areas further southwest. In LNRA's recent proposal (March 2010) environmental issues are discussed and inventories of endangered and threatened species are presented. The lists are very incomplete and seem to be based of very old surveys of the Texas Biotic Province. The reference from Frank Blair is 60 years old and is very general. An inventory and survey need to be done for the Lavaca River watershed. This is the last free flowing river in the region. It needs to be preserved for comparative purposes, so that we know what has been lost in other Texas watersheds. Please keep in mind that it is the less obvious "little creatures that run the world."

Water is "our most valuable and least appreciated resource." Protecting rivers and watersheds is far more economically important than the short term benefits from polluting industries. For a variety of reasons, such as loss of wildlife, loss of a free flowing river, loss of primary forest, and displacement of people and their livelihoods, the people of Jackson County are vehemently opposed to turning the remaining river into a reservoir to supply water for an international polluting industry. In the United States, Florida and California have the most highly developed water management systems and are in the process of reversing decisions and embarking on restoration projects. Let us not make their mistakes. Water has been called the "New Oil." It is even more precious. Please help us to use and manage it wisely.

Lois Kruschwitz

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Dear Region N Water board members,

I live in Jackson county and am also on the LNRA board. I am very opposed to damming up the Lavaca river for numerous reasons. There is no benefit to Jackson county to do this, only negative things can occur. Here is a list of reasons.

1. Jackson county cannot lose any more tax base, I know firsthand because I own a business here and the taxes are extreme for the fact that we have low population. Lnra's original position was that whoever purchases the water will make up the taxes but it is not clear if that can be done.
2. There will have to be Bonds issued to build the dam, you cannot issue municipal bonds without taxing the people, does not matter if you are a taxing entity. Bond issuers will not issue a A+ bond without taxing the people, they want them on the hook not LNRA. We cannot afford that, we are losing businesses everywhere as it is. It could well be the final blow to some businesses.
3. This water will be used for private enterprise to make money at the expense of Jackson county, land will have to be condemned which is going to lead to massive lawsuits since it is illegal in Texas to condemn land for a commodity. LNRA does not need this.
4. The orginal dam took 17,000 acres off of the taxrolls as well as the people paid $81,000,000 in taxes and that only goes back to 1980, there were no records previous to that. None of the water now benefits Jackson County at all, they have a trailer park and the people in the county donated most of the money to build the Brackenridge center, either in kind services or monetarily. We cannot afford that, we need to attract businesses to come here and you cannot do that with the taxing structure we will have.
5. This has already caused all kinds of problems within the county, I cannot imagine if it were to happen. People will leave this county if in fact they dam up the last free flowing river in Texas.
6. Our Bay and Estuaries cannot stand it either, it relies on the free flow of the Lavaca, damming the Navidad hurt it enough.
7. The damming of the river will be an huge eyesore on what was once beautiful pristine bottom land that is irreplaceable. There will be massive Dykes all around it which will prevent homes on the lake, all of this due to new regulations on new lakes. These regulations are to do with the maximum permissible flood, which will be the maximum amount rain that could occur in a period of time. Existing structures have to pass by holding 75% of the volume while any new structure will have to be 100% of the PMF. This will mean that the Dykes are going to be massive earthen structures that will be very unsightly.
8. There are many alternatives to the damming of this river, underground aquifers, desalinization, off channel storage, etc. Lnra has not even looked into these and that is what it needs to happen to keep Jackson county fiscally responsible. If the cost of the water is more for the alternative plans than private industry can certainly deal with it, that is a fact in business. None of these industries are located in Jackson county and pay 0 taxes here.

I appreciate your time at looking at this project as the people here feel they are being run over by big government and in fact they may be in this case. This is the reason for writing you and pleading for your help in the matter. I fully understand the value of water and how it will be a commodity at some point in time but I think the alternatives to a lake our much better for Jackson county. If you would like to call me and discuss or meet I would be more than happy.

Thank you,

Jon Bradford

Jon Bradford

361-782-1783

rec'd 6-28-10

Roy Aimone, M.D.
203 Fairway Street
Victoria, Texas 77904

June 24, 2010

Coastal Bend Regional Water Planning Group (Region N)
Con Mims III
Executive Director
First State Bank Bldg, Suite 206
200 E. Nopal---P.O. Box 349
Uvalde, Texas 78802

Dear Mr. Mims:

I am writing this letter in protest of damming the Lavaca River in Jackson County. Jackson County tax payers supported the 1st dam on the Navidad for over 25 years, but every drop of water being sold is going OUT of the county and that is exactly where the water from this proposed dam will go. We should keep this valuable resource in Jackson County until we can get an industry to locate IN Jackson County.

Please help us STOP the dam! I hate to displace the landowners in that area just for the benefit of Formosa, which is in Calhoun County, and Corpus Christi, which is in Nueces County.

Thank you, in advance, for your assistance.

Sincerely,

Roy Aimone +4 more

Roy Aimone

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rec'd 6-28-10

McHenry Lee, D.D.S.

118 N. Wells
Edna, TX 77957
Tel. (361) 782-7191
Fax (361) 782-5438

Coastal Bend Regional Water Planning Group
Con Mims III
Executive Director
First State Bank Bldg, Suite 2006
200 E Nopal – P.O. Box 349
Uvalde, Tx 78802

RE: Region N Water Board IPP

Dear Mims,

I am requesting that Stage II and the OCR in Jackson County be taken off your Region L Water Plan for the following reasons:

My comments are based on the spirit of SB 1 being a "bottoms up" piece of legislation. My great-great grandfather moved to Texas in 1832 and received a league and labor of land from the Mexican Government. The land was on the Lavaca River and our family has been on that river ever since. I am also a third generation dentist in Edna. A Lee dentist has been serving this community for over 100 years. By default, I represent LOLA, which stands for Leave Our Lavaca Alone. It is a grass roots movement, with a huge following of Jackson and surrounding counties citizens. I appreciate the opportunity to share my thoughts and feelings as an informed local citizen:

1. Region P's plan, 1.9.1, states that Palmetto Stage II was designated a Unique Reservoir Site and was evaluated for agriculture purposes. Texas Administrative Code 357.9 states in order to designate a URS there must be an expected beneficiary. Since there is no beneficiary for water from Stage II (it cannot be used for agriculture because of the expense), it should not be a part of the 2011 Regional P Water Plan. I suggest that Stage II be removed until there is a beneficiary within the region.

2. The Plan also states that the Unique Stream Segment classification was discussed but not voted on for lack of information. I feel strongly that attitude shows total disregard for a river that took thousands of years to make. It is a crime to dam up the last free flowing river in Texas.

3. According to an email from Patrick Brzozowski, General Manager of LNRA, Formosa has not made a formal, written request for additional water. This fact should negate the April 8th, 2009 interregional meeting between Regions P, L, and N in which Formosa's supposed request and Stage II was discussed and therefore placed on all three water plans. I suggest that Stage II be removed from all three water plans.

4. The environment is one of 9 proposed policies in Region P's IPP, but yet is not even mentioned in regards to Stage II. In addition, SB 3 was put into effect to protect our estuary systems. This critical information is at least a year from being completed and is not even referenced in the IPP. Putting Stage II on the books prior to the study is putting the cart before the horse. I am requesting that there be an environmental impact concerning Stage II. I am also requesting that there at least be contingency plans that will cover the outcome of the SB 3 results added to Region P's IPP.

5. Region P's IPP does not mention the negative impact that Palmetto Stage II reservoir would have on the vast majority of citizens in Jackson County. Stage II would destroy a way of life, a historical culture, livelihoods, etc. It would reopen old wounds created by the Stage I reservoir. There are people and lives attached to the decisions made by Region P's board that need to be discussed and appreciated.

6. Region P's IPP does not mention that eminent domain will be necessary to take the required land for Stage II. As a life long resident and as one with personal experience in losing land to Stage I, I can assure you that condemnation will be required. Texas is a state that frowns on eminent domain being used for a commodity, and in this case water is nothing but a commodity.

Summary:

I applaud the legislature for making SB 1 a "ground up" piece of legislation. By doing so, the state can get a true feeling of what is happening at a local level. My personal feeling, from living my life here and being actively involved in this issue is that Stage II found its way to Region P, L and N's Water Plans because of Patrick Brzozowski, General Manager of the LNRA via the April 8th, 2009 inter-regional meeting held at the LNRA headquarters for those three water boards. The notes of the meeting are included in this letter. It is at this meeting that Mr. Brzozowski told the group that Formosa Plastics was asking for 10,000 additional acre feet of water. To my knowledge, there was never a formal request from Formosa.

It is also disturbing that of the 14 people attending the meeting, all but three were associated with a Wholesale Water Supplier, or a consultant or engineer for the WWS. Placing Stage II on each Region's Plan afforded each WWS the potential to grow their own infrastructure and power base at the expense of the people of Jackson County. It would only be fair if the meeting took place again and was overseen by Water Board Members that were not associated with River Authorities and their consultants and engineers.

It is my understanding that if Stage II is NOT placed in Region P's 2011 IPP, it would jeopardize its Unique Reservoir Status making it subject to the 2015 deadline. If this is true, it would explain why the LNRA Board, in January 2010, had a continuous, emergency vote for feasibility studies for Stage II and the OCR after the studies were voted down twice before in November and December of 2009. Any GM of any River Authority would not want to lose the ability to have more water resources so it is understandable why Mr. Brzozowski pushed the concept at the April 8th, 2009 meeting and pushed the feasibility studies at LNRA. Just because it makes business sense to the LNRA doesn't mean it is right, legal or ethical.

For all of the above reasons, it only makes sense to remove Palmetto Stage II and the Off Channel Reservoir from the Region P IPP.

Dr. McHenry "Mac" Lee

June 20, 2010

Coastal Bend Regional Water Planning Group
c/o Con Mims, III
P.O. Box 349
Uvalde, TX 78802-0349

Dear Members of the Coastal Bend Regional Water Planning Group:

I was born and raised in Edna, Texas. After graduating from Texas A&M University, I decided to move to San Antonio to pursue my teaching career. When my husband and I got married and started thinking about a family, we agreed that the only place for us to raise our family was Jackson County so we moved home. I appreciate the extensive amount of work you have done to compile your region's IPP. I do, however, have some concerns about including Palmetto Bend Stage II as an alternative water management strategy for your region.

I understand that the Palmetto Bend Stage II reservoir is already permitted so it makes sense that you, as a region, would consider it as a possible management strategy. I, on the other hand, do not feel that it is a good management strategy for your region. The only water shortage projected for Region P is in agriculture which Palmetto Bend Stage II is not a feasible solution. *In chapter 4C.13-4 (last paragraph) you state, "There is currently an industrial need of approximately 10,000 acft for an existing industrial customer of LNRA in Calhoun County, leaving 12,964 acft of water supply for contract and/or project participation by other interested parties."* The general manager of LNRA has stated this request to be true, but the board of LNRA and the board of Region P have yet to see the formal written request from the existing industrial customer of LNRA. I have asked Region P to consider other management strategies besides the development of water supply on the Lavaca River by on-channel impoundment. I ask that you please consider other management strategies besides the Palmetto Bend Stage II Reservoir, and I ask that you remove Palmetto Bend Stage II from you list of alternative water management strategies.

Thank you for your consideration of these comments.

Sincerely,

Shelley Srp

Shelley Srp
407 Dennis St.
Edna, TX 77957
shelleyalee@yahoo.com

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rec'd 6-24-10

June 22, 2010

Con Mims III
Executive Director
Coast Bend Regional Water Planning Group (Region N)

I am very disappointed that LNRA is considering taking the Lavaca River and Lavaca River bottoms and turning it into another lake for Jackson County to furnish water to a Taiwan based Formosa company. Formosa could take their profits and furnish their own water by building their own desalination plant. I am a local rancher and depend on part of the Lavaca River bottom to run cattle on for my living. I really don't see having to give up my land to furnish someone else a way to make profits for their company.

I hope that you will consider my thoughts in this letter to help make your decision and others make decisions to not dam the Lavaca River.

Edna LaFour

Edna LaFour
P.O. Box 776
Edna, Texas 77957
361-782-7389
edna@icclink.net

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rec'd 6-18-10

Dear SENATOR HEGAR,

I live in Jackson County and am very concerned about our county's future. The LNRA has the power to make some decisions that can positively or negatively affect the lives of the people who live and work in the county. They are not being responsive to our concerns and we need your help.

These are the issues I am deeply concerned about:

- ✓ I don't want or need another dam like the one we already have.
- ✓ We were taxed before on Stage I and will be taxed again on Stage II.
- ✓ We need more tax relief not more taxes.
- ✓ Where the water goes, the job goes. The water needs to stay in Jackson County and let the industries come to us.
- ✓ Damming the last remaining free river in Texas is simply the wrong thing to do when there are other choices.
- ✓ I do not believe in taking people's land just to help some private or public company in another county have more water to increase their own tax base.
- ✓ If the Lavaca River is dammed, eminent domain will be used to take the land. LNRA has already taken 17,000 acres and doesn't need more.
- ✓ As it stands, only LNRA will benefit from having a second dam. They will be able to hire more people and pay more to upper level management while Jackson County will continue to be one of the highest tax paying counties in the state.
- ✓ The estuaries are already in danger, especially since the BP oil spill. Cutting off the fresh water flow just doesn't make sense.

Personal Note

we do Not Need Another Damm. period

Signed: [signature] [signature]

704 SUZANNE
EDNA, TX 77957

CC: Senator Glenn Hegar
Representative Geanie Morrison
Region P Water Board
Region L Water Board
Region N Water Board

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Form letter addressed to Senator Hegar and Con Mims				
Spelling	Name			Additional comments
	Clayte Adkins	Hwy 111 N	Edna, Tx 77957	
	Joetta Adkins	Hwy 111 N	Edna, Tx 77957	
	Maureen Andel	FM 234 N	Edna, Tx 77957	
	Patrick J Andel			Taxes are to high already. We don't need another damm in the county. More land will be taken out of tax base, we dont need more taxes, they sell the water and dont pay taxes on it thats hog wash.
	Susan Anderson			Its my land No one has a right to take it away. Been in our family over 50 years. Taxes are hgh enough in Jackson County.
	Bianca Arredondo	105 Cherry St.	Edna, Tx 77957	
	Cord Beard	9019 FM 822	Edna, Tx 77957	
	Heath Bednarz	1513 N. East St.	Edna, Tx 77957	
	Jaime Bednarz	1513 N. East St.	Edna, Tx 77957	Our current lake has no place for us to swim. It's like a swamp and we dont need another one!
	Robin Bedney	203 W. Main	Edna, Tx 77957	
	Lynn Birchum	511 Wilson	Edna, Tx 77957	
	Wade Birchum	511 Wilson	Edna, Tx 77957	
	Jayme Blackwell	2291 FM 2345	Edna, Tx 77957	
	Michael D. Blackwell			I do not personally live in Jackson County, but am concerned with the effects of daming the Lavaca will have on our ecosystem and the Lavaca / Matagorda Bay System. In general.
	David Blakenship	1465 CR 401	Edna, Tx 77957	
	Jan Bone	P.O. Box 560	Inez, Tx 77968	Do not dam the dam river and take 70 acres of my land
	Nick Bone	P.O. Box 560	Inez, Tx 77968	Stop the property theft!
	Patti Payne Bone	P.O. Box 560	Inez, Tx 77968	I am concerned that the citizens of Jackson County are being mislead and are not getting all of the facts.
	? Boyd, DVM	2395 St. Hwy. 111 S	Edna, Tx 77957	I served on the LNRA board for 5 years. Formosa Plastics had years of opportunity to buy the water Corpus Christi is currently receiving. Formosa should be leading industry toward a desalinization plant.
	Jon Bradford	507 S. Gilbert	Edna, Tx 77957	LNRA Board Member: Stage 1 did not benefit Jackson Co, quite the contrary, in the fact we lost land, taxes. Stage 2 is no different. Take peoples land to benefit Fomosa. It is illegal for immenient domain to be used for monetary gain
	Leanne Bridfel (sp?)	P.O. Box 1253	Ganado, Tx 77962	
?	Amy Brown	264 CR 131	Edna, Tx	No one needs to take any ones lands for this.
?	Andrew E. Brown			
	Tom Bryne	1107 Taos Dr.	Victoria, Tx 77904	Our family stands to lose close to 400 acres to the project. It makes no sense to damn this last free flowing river in our state for this minute amount of H2O for the foreigners in another county. By the way if you see Carper Kept tell him hello for me. Gig em 78
	Lisa C. Burris	109 W. Main	Edna, Tx	As a landowner, this will be deterimental to me. This will be the second time this has happened to our family!
?	Claxton Butler	521 E Cedar	Edna, Tx 77957	We don't need no more holes
	Ms. Pattie Butler	521 E Cedar	Edna, Tx 77957	Just leave us alone.
	Sylvia Butler			I don't want to lose my land.

	Joyce Campbell	504 susanne St.	Edna, Tx 77957	This in uncalled for.
	Mary Beth Caraway		Wildwood, Mo	I am a river bottom land owner and so not want my land taken from me for someone else to make money off of! This land has been in my family since the 1930s.
?	Kristin	Carreon		
?	Andy Casti?	307 S. Bryan	Edna, Tx 77957	Don't want another dam
	Mathew Charkalis	P.O. Box 707	El Campo, Tx 77437	
	Rachel Charkalis	P.O. Box 707	El Campo, Tx 77437	
	Layo Clowers	2594 FM 1822	Edna, Tx 77957	Leave us alone!!!
	Brooke Conner	1109 S. Second	Ganado, Tx 77962	
	Clara Conner	1109 S. Second	Ganado, Tx 77962	As a taxpayer and land owner in Jackson County I believd that we DO NOT NEED to damn the Lavaca River.
	James Corleu	P.O. Box 601	Edna, Tx 77957	
?	Hope and Tory Corrizon	113 E. Corde Le	Edna, Tx 77957	
	Shelby Cunningham			They need to leave our rivers alone. It's natural leave it that way.
	Alana Sue Curlee	P.O. Box 601	Edna, Tx 77957	Please don't take our land away!
	Barbara Curlee	904 Pin Oak	Edna, Tx 77957	
	Dennis Duane Curlee Jr.	904 Pin Oak	Edna, Tx 77957	
	Chico DeLeon	P.O. Box 454	Edna, Tx 77957	
	Jennifer Dierlam	3008 FM 1822	Edna, Tx 77957	
	Belinda Dodds	204 Dugger	Edna, Tx 77957	
	Michael Kyle Dodds	204 Dugger	Edna, Tx 77957	
	Lisa Downs			
	Tony Doyle	325 CR 306	Edna, Tx 77957	
	Henry & Lois Druskel	110 W Main	Edna, Tx 77957	
?	Johnny Dugger			
	Kathy Dugger	1918 co. Rd 303	Edna, Tx 77957	
	Larry & Sherri Ellis	P.O. Box 157	La Ward, Tx 77970	
	Cory Ellison	509 W. Division St.	Edna, Tx 77957	
	Zoe Ferguson			LNRA has the only fenced in lake that I have ever seen in our state. Taking 7,000 acres of land away from people that could have been used for persons to come into our county and have lake front houses, bringing more people into our county, also bringing in more taxes for our county. We need something to help our county, not bring more taxes and something else that will take land away from more families.
	Teresa & Frank Durham	P.O. Box 697	Edna, Tx 77957	
	Lu Egg	1209 St Hwy 111N	Edna, Tx 77957	Not only damming the last remaining free river in Texas. The land that was taken in Stage 1 & what will be taken in Stage 2 can never be replaced. We're taling homes & history.
	Shawn Egg	1480 CR 324	Edna, Tx 77957	
?	Belinda Emmeens			
	Marcus Farquhar	213 N. Wells	Edna, Tx 77957	
?	Paul D Fern	Box 759	Edna, Tx 77957	
?	Pamela Fien	P.O. Box 281	Edna, Tx 77957	
	Linda Foster	P.O. Box 299	Edna, Tx 77957	Please save
?	Rieb Gaft			
	Anastcia Garza		Edna, Tx	

	Odelia H. Garza		Edna, Tx	
	Darward Gates	402 Dennis	Edna, Tx 77957	
	Jane Gates	2955 St. Hwy 111 N.	Edna, Tx 77957-5051	Don't need it!!
	Maxine Gates	402 Dennis	Edna, Tx 77957	
	Ronald Gates	2955 St. Hwy 111 N.	Edna, Tx 77957-5051	
?	Susan Gnessom	509 Nancy	Edna, Tx 77957	How can you take people's land, home, livelyhood- Have you no respect -
?	Morbilla Gobellan		Edna, Tx	
?	Linette Goldman			
	Matthew Goldman	471 CR 284	Edna, Tx 77957	
	Michael Goldman	471 CR 284	Edna, Tx 77957	
	Adan Gonzales	P.O. 498	Lolita, Tx 77971	
	Jim Green	2214 County Road 306	Edna, Tx 77957	I own 45 acres on land on Jackson Cournty Road 306; if a dam is built a minimum of 25 acres will be flooded. The land that will be flooded has beautiful Oak, Pecan and many other trees. All that would be left of my homestead would be my house and about 20 acres of pasture that is above the flood plain. I am 61 years old and raised 3 kids on this land. I always assumed this would be a place for my grandchildren to come, spend time, and enjoy the beauty and wildlife of the Lavaca River. Now it appears that LNRA has decided it can make more money and to heck with what the people of Jackson County want. I appreciated you taking your time to read this letter.
?	Kelly Gregory			
?	Robert Gudhe, Jr.			Formosa Plastics does not need to be put into region P.
?	Lee Hafenick	3334 State Hwy 111 N	Edna, Tx 77957	
	Jamie Hajek			
	Sheila B. Hart	296 CR 307	Edna, Tx 77957	We have 1 dam already, need no more taxes. leave the Lavaca River alone and we bought our property close to the river for a reason. Leave us alone!
	Beatrice Hernandez	2486 Hwy 1115	Edna, Tx 77957	Don't need a dam.
	John J Hertz			
	Patricia Hertz			
	Charlotte Hicks	393 Co. Rd 131	Edna, Tx 77957	Dont mess with our Texas River! It cannot be replaced!! We don't want another mud pit!
	Clayton & Leah Hicks	509 Suzanne	Edna, Tx 77957	No Dam!
	H.J. Houck	521 Davies Rd.	Inez, Tx 77968	
	Virgie Houck	521 Davies Rd.	Inez, Tx 77968	
	Stan Hubenak	804 S. Allen	Edna, Tx 77957	
	Jackie Hudson	412 E. Rogers	Ganado, Tx 77962	We need to keep our water if we keep this up the lavaca river will dry up.
	Anthony & Kristin Hunt	701 CR 312	Inez, Tx 77968	
	Dennis Brian Hunt	P.O. Box 542	Edna, Tx 77957	It is not right for an entity to steal the land that people have worked so hard to obtain & cultivate. Not only will LNRA take the land away from Jackson County citizens, they then will ship the water out of the county.
	Diane Hunt	P.O. Box 3	La Ward, Tx 77970	
	Chelsea Hunt	P.O. Box 3	La Ward, Tx 77970	

	Jessica Hunt	P.O. Box 542	Edna, Tx 77957	It devastates me to think that future generations will not be able to experience the "magic" of the river bottoms. It is such a beautiful area.
	Norman Hurt	152 Co. Rd. 253	Ganado, Tx 77962	My family lost land to Lake Texana. Now we're stuck with a fence @ the back of our property that keeps us from even accessing the lke. LNRA uses our land that is not under water to grow hay. Don't take away any more land! Don't dam up the river.
?	Joleen Jackson	132 Koali	Bastrop, Tx 78602	
	? Jacobs			I am a feed store & we sell gas pecans chemicals and this would kill our business!
	Lucille Jacobs			
	Elisha James	14317 SH 111 N.	Edna, Tx 77957	
	Carol Janessen	Box 256	Ganado, Tx 77962	HELP! Please!
	Lisa Janica	1120 Gilbert Rd	Edna, Tx 77957	
	Jimmy Jansky	691 C.R. 283	Edna, Tx 77957	We need to keep our water here in Jackson County!!
?	Glenn Johns	6778 FM 822	Edna, Tx 77957	I believe we have at the present time, all the water that LNRA neds in the first stage!!
	Renee Johnson	1643 US Hwy 59 S	Edna, Tx 77957	Do not need another damn dam.
?	Malcob Johnston			
	Warren Johnston			
?	Weseleen Johnston			
	Darvis Ray Jones	205 1/2 Hanover	Edna, Tx 77957	
	Dianne Juroske	909 Co. Rd. 110	Edna, Tx 77957	
	Kamey Karl	616 CR 131	Edna, Tx 77957	Please hear our calling! They say power works with numbers so please don't let us down. This is not an issue to be brushed under the rug… it needs to be addressed and soon!
	Linda Karl	616 CR 131	Edna, Tx 77957	Are you listening???
?	Carolne Kizer	1606 Green St	Edna, Tx 77957	The present lake has no recreation for our kids. No swimming area etc. as promised. No one goes fising at the lake. Just a big mud hole.
?	? and Gloria Kop	704 Suzanne	Edna, Tx 77957	We do not need another dam. Period
	Jamie Koop Kinsfather	389 C. Rd. 309	Edna, Tx 77957	If Stage II comes through my family will lose the land that has been in our family for many generations. It makes me sick to think of them taking our homes, especially my 85 year old grandparents who would be at a loss trying to figure out what to do or where to go. I honestly think it would kill them.
	Jinnifer Koger	7512 Eastcrest Dr.	Austin, Tx 78752	Leave our river alone. Let it be natural, the way it was made.
	John Koop	340 Marshall Johnson Ave. S.	Port Alto, Tx 77979	We do not need to furnish more water to out of county users.
	Tracy McNeley			
	Lance and Melissa Koop	398 Co. Rd. 3011	Edna, Tx 77957	All water empounded in Jackson County needs to stay in Jackson Conty for industry in our county, so our countycan grow.
	Lesley A. Koop	202 Childers Dr. #442	Bastrop, Tx 78602	
	Linda S. Koop	340 Marshall Johnson Ave. S.	Port Alto, Tx 77979	We do not need to dam this river in order for out of county users to have our water. Please block this Stage II.

	Jill Kubecka	P.O. Box 573	Edna, Tx 77957	people are never paid the amount for the taking of their land. they are tax paying citizens who are just going to be taxed more for basically giving their land away
	Cynthia Kucera	405 Sunset Dr.	Edna, Tx 77957	I am a concerned tax payer and feel damming the Lavaca River will be detrimental to our community.
	Carol ?? Lee	118 N. Wells	Edna, Tx 77957	I live in Jackson County & strongly oppose the construction of Stage II - there are alternatives - off-site - desal - DO NOT DAM THE LAVACA!
	Jerra ? Lee			Please do not allow the LRNA to dam the last free flowing in Texas. Protect your district!
	Robert E. Lee III, DDS, FAGD			
	Jesse Jaymes Lopez	8059 St. Hwy 111 N	Edna, Tx 77957	leave our land alone
	Jimmy G Lopez Jr.	8059 St. Hwy 111 N	Edna, Tx 77957	Leave our land alone.
	Jimmy G Lopez Sr.	8059 St. Hwy 111 N	Edna, Tx 77957	Leave our land alone.
	Lupe Lopez	8059 St. Hwy 111 N	Edna, Tx 77957	We don't need no more dam dam's.
	Judy S. Lundy	403 W. Brackenridge	Edna, Tx 77957	
	Shae Mabry	P.O. Box 112	Edna, Tx 77957	
?	Jim Mahf			Taking land away from family we use to make a living. Plus off tax roll.
	Mitch Malek			Our family stands to lose over 700 hundreds acres of farm and ranch land we+E30 have had for over 20 years and cannot afford to lose.
	Judy Marek			Cities can not & should not starve our smaller ones just to grow larger - All cities have the right to grow where they are - Use what u have!
?	Melinda Manzanalez		Edna, Tx	
	Barbara Martin			
	Glenn T. Martin			My family and I supported Stage I, but I don't feel Stage II would benefit Jackson County
	Sherri Martin	8798 FM 3131	Lolita, Tx 77971	Please don’t dam the river
	Frances Martinez	507 North Kleas St.	Edna, Tx	We do not need another dam.
?	Mattew Martinez	507 North Kleas St.	Edna, Tx	We don’t need a dam.
	Tina McDonald	207 Dugger	Edna, Tx 77957	Taking peoples land that has been in there family for a very long time. The people do not need this.
	Karen Meador			I think that big cities are going to have to look at other options for water needs (desalination?) rather than looking to other counties for water needs
	Crystal Merchka	2315 Cty. Rd. 19a	Hallettsville, Tx 77964	Please do not destroy the natural habitas of the river! We do NOT need another river dammed, jus to help another county!
	Paula Meschalek			
	Dana Mickey			
	Bryan Miska	202 W. Main	Edna, Tx 77957	
	Holly Tegeler Morgan	P.O. Box 93	Ganado, Tx 77962	
	Shirley Koop Moyer	13919 Crooked Hollow Dr.	San Antonio, Tx 78232	
	Capt. Dwayne Newbern	410 Maxine St.	Edna, Tx 77957	
	Virginia Newbern	410 Maxine St.	Edna, Tx 77957	

	Ray Nickel	11093 FM 234	Edna, Tx	The Lavaca River is only a creek, not a river, so where will you get the water to fill a dam
>	Tyrol E. Norman	1205 N. East St.	Edna, Tx 77957	
	Michele / ? Orsak	901 S. Gilbert	Edna, Tx 77957	
	Alice M Payne	P.O. Box 245	Edna, Tx 77957	Stop the Dam, we don't need it!!!
	Daniel Peavy	403 W. Brackenridge	Edna, Tx 77957	
	Q. M. Peterson II	2740 Loop 521	Edna, Tx 77957	
	Caroline Pitzer	618 Hanover	Edna, Tx 77957	
?	Mary Kim Layden Plehan	602 Laura	Edna, Tx 77957	The Lavaca River bottom is an incredible ecosystem. It should not be allowed to disappear. I'm a life long resident+E32 of Jackson Co. and I'm against what is being forced upon us. PS. My land will be empacted. It is the most important legacy I want to leave for my childen. Please help us.
?	Ana Plotin	409 Maxine	Edna, Tx 77957	
	Lisa Porche	P.O. Box 442	Edna, Tx 77957	
	Mitzi J. Porche	207 W. Division	Edna, Tx 77957	
	Patsy Proche	P.O. Box 473	Edna, Tx 77957	
	? / Laura Prichoda			We don't live in Jackson County, but we have two pieces of family owned land in Jackson County. These two properties would be directly affected by the proposed dam. We are against it's construction.
	Fred I Prichoda			We don't live in Jackson County, but we have two pieces of family owned land in Jackson County. These two properties would be directly affected by the proposed dam. We are against it's construction.
	Mary Gayle & Joe D. Prihoda			
	Eric Quinn	1988 Hilltop Drive	Wimberly, Tx 78676	Our water and natural resources are far mor valuable than Formosas Greed. This Is not in the best interest of the citizens of Jackson and surrounding counties. Please note our sincere opposition to the LNRA decisions to dam the Lavaca River. Water is our most precious resource. Formosa has a negative environmental record.
	Sue Quinn	1079 Co. Rd 401	Edna, Tx 77957	LNRA was not developed to be a money/profit company. Jackson County gave enough land for the first Dam. Why should Jackson County be expected to furnish water for South Texas. San Antonio can conserve their own water. We love the Lavaca River bottoms and a Company doesn't need to control the River bottoms and destroy thme. Jackson County has wildlife and is like a jungle - we are blessed with grapevines and large oak trees. The first Dam was built for our benfit - remember? (Reminder of comment cut off when copied.)
	Troy Quinn	8583 State Hwy 111 North	Edna, Tx 77957	I have not seen any major positive results from the existing dam and I am against any project which takes land from landowners
	Loretta Lynn Ramirez	502 Fannin St.	Edna, Tx 77957	I don't want another dam. We don't need another dam.
?	Robert Ramirez	502 Fannin St.	Edna, Tx 77957	I don't want a dam.
?	Reyes Ratu		Edna, Tx	

	Dennis Ray	Box 1052 (?)	Edna, Tx 77957	
	Kathy Roddy	1003 W. Main	Edna, Tx 77957	Our water need to stay here - won't want to lose land just bought.
	Connie M. Rodriguez	315 Buffalo Street	Edna, Tx 77957	
	Joey Rodriguez			I grew up in Edna and now live in Houston; but I know the importance of the River in the community and the State of Texas; I am a firm beliver in keeping the Lavaca River in its natural state.
	Lucinda Rodriguez	401 S. Pumphrey	Edna, Tx 77957	
	J. A. Rogers	1006 Virginia St	Edna, Tx 77957	Don't steal my land!
	Bradly Ryan	454 CR 131	Edna, Tx 77957	Leave all the land alone
	Kaci Ryan	454 CR 131	Edna, Tx 77957	We don't want another dam
	Camelia Salazar	807 Ward St.	Edna, Tx 77957	
	Melissa Sappington	310 W. Cypross	Edna, Tx 77957	Taking hard earned family land away from families that built it for financial gain angers me to the core. The facility that we have now is useless, we don't need another!
	Erno L. Sattler	7828 FM 1833	Edna, Tx 77957-4746	LNRA says "water is gold" - if so land is platinum. Detriment to economy and environment; would only benefit Formosa.
	Gilbert Sattler	7828 FM 1833	Edna, Tx 77957	I am a property owner and taxpayer.
	Dorothy Schneider	504 Edinburgh	Victoria, Tx 77904	I have property in Jackson Co. and pay taxes.
	Robert Schroeter			The land that we own has been in my family fro three generations. A porivate enterprise, or even the state, has absolutely NO BUSINESS robbing Peter so Paul make more money at my loss!!!
	Kari Scott	601 Taylor Rd	Edna, Tx 77957	
	David W. Sheblak	P.O. Box 421	Edna, Tx 77957	I don't agree with the concept of damming the Lacava River. In my opinion, desalinization is the only viable option for longterm water supplies.
	Bob Short	1406 West Main	Edna, Tx 77957	
	Loine Simons	505 Suzanne	Edna, Tx 77957	Leave the Lavaca the way God created it - NO DAM
	M Sue Sims	P.O. Box 806	Ganado, Tx 77962	Jackson County receives no benefits from LNRA water sales.
?	Ira C. Sklen Jr.			We don't need another damn
	Loretta G. Sote	507 N Kleas St.	Edna, Tx 77957	To been honest, I really feel ? we don't need another dam. Also I believe that landowner should keep their land that has been in their family forever. Why take land for something that we don't have use for.
	Thomas Sowell	607 Jackson St.	Edna, Tx 77957	
	Jerry Soto	3305 FM 234 N.	Edna, Tx 77957	
?	Frances Wells Staw			As a landowner I can say this is going to raise our taxes and interfere with the basic right of ownership.
?	Fred Str? Jr.			You can't replace theland they take for ? ? they ? ? you for it
?	Freddie Tanner	204 W Main	Edna, Tx 77957	As a land owner and local business owner this will greatly affect my ???
	? Taylor	4988 FM 1822	Edna, Tx 77957	Very opposed to Stage II. There are other viable means of water conservation that are utilized in the world as alternatives to dam building - Its time we CATCH UP with the times and not follow old practices!
	Christen Thurmond	6878 CR 283	Edna, Tx 77957	

?	Kendall and Lana Tipton	206 Brazos Gardens Dr.	Richmond, TX 77968	
	Lesli Tipton	2030 CR 303	Edna, Tx 77957	
?	Marces Tomas & Sharon Hammen Tomas			We are concerned about all the issues above. We own land on the Lavaca, own a small business in Jackson County and are natives of Jackson County. We are not against "growth" in our area - we just want any growth and jobs to benefit Jackson County and its citizens including our 3 grown children and thier families who all live in Jackson County.
	Jesus Topia			
	Minera Topia			
	James R. Tuttle & Shirley Tuttle	342 FM 3131	Edna, Tx 77957	
	Kristin K. Tuttle			
	Sandy Twardowski	1008 S. Second St P.O. Box 194	Ganado, Tx 77962	
	Steve Twardowski	P.O. Box 194	Ganado, Tx 77962	
	Annavelle Villela	507 N Kleas	Edna, Tx 77957	
	? Webb			
	Robin Q Webb			
	August E. Westhoff			
	Fred Westhoff	P.O. Box 314	Edna, Tx 77957	Calhoun Conty should not be allowed in water district 8!
	? White	P.O. Box 111	LaWard, Tx 77970	I am a concerned citizen in the county & do not agree with the daming of the Lavaca River.
	Clay Whitley	209 Cottonwood St.	Edna, Tx 77957	Management of LNRA has intentionally mislead Regions L, P & N that the people of Jackson County are for Stage II… WE ARE NOT!!! Desalinaztionplants are the future & all water boards & River Authorities should focus on this technology…not damming a river!!!!!
	Harold Wilkins	209 Brown	Edna, Tx 77957	We really don't a dam please leave our Lavaca alone
	Thomas R. Wittenburg	P.O. Box 1005	Edna, Tx 77957	
	Genevieve Wolter	492 Live Oak	Inez, Tx 77968	
	? Wyatt	122 E. Main St.	Edna, Tx 77957	More land-grabbing!
	Anna Yaws	P.O. Box 115	Edna, Tx 77957	It is just not fair anymore. We have little say. Hopefully this will help
	Jeana Yendrey			
	Mindy Yendrey	501 Caroline	Edna, Tx 77957	I don't need our taxes going up anymore.
	Illegible #1			
	Illegible #2	411 Harris St.		Levae the ******* river alone.
	Illegible #3	1210 Cobb St.		
	Illegible #4			The Lavaca River is an important place in our county.
	Illegible #5 (John ??)	4988 FM 1833	Edna, Tx 77957	I am concerned that LNRA is not dealing in good faith with the public trust. It appears LNRA is being operated like a for profit business, subsidized by taking private land.
	Illegible #6 (Edna City Council District 1)	213 Sandra	Edna, Tx 77957	As a landowner, we do not need another entity using eminent domain and then taxing us more. Thanks,
	Illegible #7	7123 FM 234 S	Edna, Tx 77957	The citizens of Jackson Co. will not benefit at all from another dam.

	Illegible #8	568 Mueller Ln	Victoria, Tx 77905	-not a resident of Jackson Count. - still in opposition
	Illegible #9	P.O. Box 423	Edna, Tx 77957	More water equals more problems.
	Illegible #10	CR 306	Edna, Tx 77957	
	Illegible #11			
	Illegible #12 - Clyde ?			
	Illegible #13			
	Illegible #14 - Paul ?	3898 SH 111 N.	Edna, Tx 77957	
	Illegible #15			
	Illegible #16			
	Illegible #17 - C. J. ?			I am a business owner in Jackson Conty and do not want another dam. It does nothing for our community.
	Illegible #18 - Courtney M ?			
	Illegible #19 - M. ?			
	Illegible #20			
	Illegible #21			
	Illegible #22 - Marcos ?	P.O. Box 1331	Edna, Tx 77957	We don't need another dam
	Illegible #23	507 N Kleas	Edna, Tx 77957	I just believe we dont need another dam.
	Illegible #24 - Clinton ? Jackson County Farm Bureau Vice-President			Jackson County Farm Bureau opposes the dam. Together with the TFB, the Jackson County Farm Bureau wrote a resolution to be sent to LNRA. Please help us with this. Thanks

June 28, 2010

Coastal Bend Regional Water Planning Group (Region N)
Con Mims III
Executive Director
First State Bank Bldg, Suite 206
200 E. Nopal - P.O. Box 349
Uvalde, Texas 78802-0349

Dear Mr. Mims:

I am presenting you a petition signed by over 781 concerned Jackson County residents protesting the possibility of the construction of Palmetto Bend Dam Phase II. These citizens, like myself, are concerned with the broad and devastating impact that damming up the Lavaca River could cause on the environment, the ecology, and livelihoods of people who live in the area. This petition was presented to the Lavaca Navidad River Authority at their meeting last month and was received with no response. We feel it is important that our elected representatives and the public servants who are deciding what are the best uses of our water should take seriously how the people who will be impacted the most feel.

Sincerely,

Lindsey Lee Bradford

Lindsey Lee Bradford
Member
Leave Our Lavaca Alone (LOLA)

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Please sign this petition to try to Save the Lavaca River. We need to protect the last free flowing river in Texas!

Por Favor, hagan el favor de firmar esta petision para salvar el Rio de Lavaca. Es el ultimo en Texas!

Name	Address
Julia Schoellmann	PO BOX 142 Lolita TX 77971
Sharina Gason	P.O. Box 731 Edna, Tx 77957
[illegible]	409 OAK TERRACE, TX. 77957
Becky & Patrick Woods	202 Robinson, Edna, TX 77957
Sue Quinn	1 Cor. 2:3 1079 Co. Rd. 401, Edna
Becky Quinn	8583 State Hwy 111 N Edna
Brenda Koop	514 Wilson, Edna
George Miller	2601 Myatt Lane El Campo TX
[illegible] Miller	2601 Myatt Lane El Campo TX
Teresa Olivas	2442 Loop 521 Edna TX
Anabel Mejia	140 N Wells.
Josue Martinez	405 W Ash
Steven Cox	P.O Box 570 GANADO TX 77962
MaKayla [illegible]	8798 FM 3131 LOLITA TX 77971
Matt Martin	8798 FM 3131 LOLITA TX. 77971
Sheri Martin	8798 FM 3131 LOLITA TX. 77971
Dennis Jurek	909 CR 110 Edna Tx 77957
[illegible] Jurek	1569 CR 110 El Toro Tx 77957
Dianne Jureske	909 CR 110 Edna, Tx 77957
DJ Bell	299 County Road 110 Edna, Tx 77957
Debra Stewart	130 CR 307 Edna Tx
[illegible]	130 CR 307 Edna TX 77957
Andy Bell	299 CR 110 El Toro, TX 77957
Milford P. Cobb Jr	13709 FM 530 Edna, Tx 77957
Eric Caldwin Atch	" "
Jose Luis Molina	114 E main Edna TX. 77957
Yolanda Molina	205 W. Blackjack Edna TX 77957
Bernie [illegible]	P.O. Box 7[illegible] Schulenburg TX.
Judy ~~[illegible]~~ Vitolow	P.O. Box 460 Edna
[illegible]	P.O. Box 460 Edna
[illegible]	4755 FM 234 S. EDNA
Diane Matocha	1390 FM 1683 Ganado
John S. [illegible]	P.O Box 845 Edna

1

D'Anna Long P.O. Box 423 Edna Tx 77957
Becky Hudson Edna Tx 77957
Rickey Williams 506 Jackson Edna Tx 77957
Jeremy Delgado 512 Buffalo ST Edna Tx 77957
Mike Parson 215 Pinecake Vict TX 77905
Tommy Whitley 1445 CR123 Edna TX 77957
Leslie Williams P.O. Box 919 Ganado, TX 77962
[illegible] PO Box 151 Edna Tx 77957
Tammy Terry PO Bx 151 Edna Tx 77957
Brandy [illegible] 111 Ridge View Victoria, TX. 77904
[illegible] F. Robles 702 Ed. [illegible] Edna, Tx. 77957
Elizabeth Novak 1008 Hackberry Ganado, Tx 77962
Juliana Blevins 1003 Fredrick Edna
Ruth Delgado 512 buffalo st Edna TX
Todd Poole 509 JACKSON Edna TX 77957
Gary Armstrong PO Box 155 Louise TX 77970
Shelly Eppinett 1900 N. Wells St. Edna Tx 77957
Bertha Andrews 506 Frank White Edna Tx 77957
Raymond V. [illegible] 604 W. [illegible] Victoria Tx 77901
[illegible] 2100 C.R. 307 Edna TX 77957
Melinda Pierce 1247 Best Oaks Dr Inez, Tx 77968
[illegible] 1247 Best Oak Inez TX 77968
Brandy Vavlavich 1202 Dewberry lane Edna, TX 77957
Rhonda [illegible]
[illegible]
Teri Morgan 306 MaryRose St Ganado Tx 77962
Molly [illegible] 346 CR 304 Edna TX 77957
Judy Maree 209 W. TROTWOOD Edna TX 77957
Sharon Jones 2303 County Road Edna Tx 77957
Kimberly Blackmon 1630 Co. 239 Ganado TX 77962
Kimberly Martin 3959 FM 616 Victoria, Tx 77905
Mark C. [illegible] 208 P.R. 4044 EDNA, TX 77957
Deborah Casey 707 Miriam St Edna, TX 77957
Gail Lawrence 973 CR 239 Ganado, TX 77962
Cynthia Doyle 3012 Benbow Rd. Inez, TX 77968
Robert [illegible] Schumann 4890 old Hwy Rd. Inez, TX 77968
Jackie Knezek Schumann 4890 Old Hwy Rd. Inez, TX 77968
Terry Russell 803 S Allen Edna TX 77957
Tara Russell 803 S. Allen Edna TX 77957
Sandy Bell 299 Co Rd 110 Edna TX 77957

Jim Nickel 299 CoRd 110 Edna
Bryan Hurt Ganado
Krystal Diaz Inez
Amanda Martin Inez
Rachel Guidry Edna
Blake Hilgart Edna
Leticia Ramirez PO Box 603 Edna, TX
Michael Nikky Edna, TX
Betty Willis Edna, Tx
Billie Batterton Edna, Tex.
Luanne Kucera Edna, TX
Chriscelle Willis EDNA TX
Heath Bodnar EDNA TX
Will Pope La Salle Tx.
[illegible] Edna Tx
Albert [illegible] [illegible] Tex
Seren [illegible] 308 Rowlett, Edna, TX
Julie Glaar Ganado, Tx.
Erin [illegible] P O Box 134 - Ganado, TX
Michelle M. Sample P.O. Box 866 - Edna, Tx 77957
Nathaly Shelby Inez TX
[illegible] Hicks Edna, TX
Leah Hicks Edna, TX
Timiron William EDNA, TX
Carol Janssen Box 256 Ganado Tx 77962
[illegible] Shuddy 403 W. Brackenridge Edna, Tx
Gloria Manzanalez 310 N. Colorado, Edna, Tx
Donated 4/19/10 $20.00 Jason McGarrey 709 Sunset Dr. Edna
Patricia K. McFeron 985 Co. Rd. 312 Edna, Tx 77957
J. Bryce Dugger 114 Gentle Breeze Victoria, Tx 77905
Hope Wood 2124 CR 303 Edna, Tx 77957
Milam Simmons 1206 Dewberry Ln Edna, Tx 77957

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Por Favor, hagan el favor de firmar esta petision para salvar el Rio de Lavaca. Es el ultimo en Texas!

Name	Address Email
Deborah L. Harris	1400 N Wells #1201
Randy Waters	P.O. Box 572 Lolita, Tx. 77971
Rebecca Manzanales	P.O. Box 688 Edna, Tx 77957
Gilbert L. Darry Jr	PO BOX 1187 Edna, Tx. 77957
Violet Lewis	1400 N Wells #1103 Edna
Tina Vibrock	1400 N WELLS 1603 Edna
[illegible]	421 PR 3065 Edna
Charlotte Cooksey	700 W. Elm, #46, Edna
[illegible]	700 W. Elm # 48 Edna
[illegible]	130 CR 301 Edna TX
Sean P. Salinas	602 W. Division Edna Tx.
Kevin Turner	810 First Street Edna Tx 77957
Kathy Roddy	PO Box 268 Edna, TX 77957
[illegible] Marlow	Box 84 La Salle, TX
Kathy Shay	375, CR. 132 Hallettsville, TX 77964
L.J. Korenek	602 Brodie St. Apt 01 Edna 77957
Amber Weddle	305 Sample St. Edna TX 77957
Jade Dement	303 Sample St. Edna TX 77957
Dusty Weddle	305 Sample St Edna, Tx. 77957
Edwin Chew	710 HEATHERTON HILL LN HOUSTON TX, 7704
Wanda [illegible]	803 W. Cedar St Edna Tx
[illegible] Corley	803 W. Cedar St Edna Tx
Leonard [illegible]	1007 W main st Edna
Emelia [illegible]	SAME
Beth [illegible]	241 Len Bar Ln Leander, TX
[illegible]	322 BROOK FOREST TRAIL SUGARLAND TX

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Flood It!

Name	Address
Enrique Townley	Email rickperez65@yahoo.com
[illegible]	313 W. Gayle
Zachary D. Wittrelert	306 CR 306
[illegible] Keith	1403 Albers Edna
SILVIA RODRIGUEZ	1400 N WELLS APT 3706 EDNA TX 77957
CHRIS	
George Gregory	903 Fulton Edna, Tex
W. J. Vincik	3591 CR 324 Edna 77957
Jon Malek Wood	56 County Rd 248 Ganado 77962
Willard Frankl	1200 County Rd 416 Edna, 77957
John Rogers (361-308-0326)	806 Liveoak Edna TX 77957
D K Russell (Russell)	11288 FM 822 Edna 781-0384
Ernest New	921 Co Rd 17 Hallettsville 77964
Shirley New	921 Co. Rd 17 Hallettsville, TX 77964
Kathy J. [illegible]	382 FM 3131 EDNA TX 77957 361-781-2130
Henry Rolf	14145 ST. HWY 111 E. GANADO TX 77962
361 782-7238 W. H. & Mary M. Johnson	173 Private Rd. 3122 Edna TX 77957
Scott J. [illegible] Sr.	2903 Willow Creek El Campo, TX 77437
David J. [illegible]	14553 FM 530 EDNA, TX 77957
[illegible]	2030 CR 303 Edna Texas 77957
Ronnie [illegible]	2955 Hwy 111 N Edna

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Name	Address
Matthew Goldman	471 CR 284
Jim CARROLL	282 CR 122
[illegible]	6778 - FM 1822 EDNA, TX 77957
Jacob DeBord	4479 FM 822 Edna, TX 77957
HARLAN J. SPECHT	230 CR 1301 EDNA, TX 77957
AdAN GARZA	8155 St Hwy 111 N.
Chris Willis	303 S Pumphrey
Robert Volkmer	1798 FM
Josh Frankel	301 S Pumphrey
Kathy Dusser	303 FM EDNA
[illegible]	7370 FM 234 N.
Katherine Newman	1099 FM 1157 Ganado
Jeremy [illegible]	PO Box 113 francitas TX
NORVELL BUTLER	503 ERIC EDNA, TEX
Alex Cox	10893 CR 234 EDNA TX
Chris [illegible]	2183 CR. 130 Edna TX
[illegible]	285 CORd 230 Ganado
Bill Tipton	5224 FM 234 N EDNA, TX.
Clinton [illegible]	509 Suzanne St. Edna
Glenda Specht	230 C.R. 1301, Edna, TX
[illegible]	5653 CR 288 EDNA,
Betty [illegible]	782-3432 FM 234
Claxton Butler-Norman	6556 St Hwy 111 N
Lane Tipton	5001 Fm 822
Michael Marthiljohni	2646 FM 822
Sonny Strelec	470 C.R. 3011
DANIEL KLIMITCHEK	P.O. Box 436 LOLITA, TX. 77971
[illegible] JOHNSON	6714 FM 1822 Edna TX
[illegible]	497 CR 429 Lolita, TX 77971

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Name	Address
Brian Hicks	PO Box 149 Ganado, TX
Bryan Miska	203 W Main Edna
David Parker	P.O. Box 138 Ganado TX
Edward Covarrubias	1308 Green St
Russell Gary	414 Peabody St
Al Miska	3647 FM 234 South
J Bradley	210 Sample Edna
Denise Chiros	PO Box 725 Edna Tx
Vernon Hardaway	203 Edna Edna TX
Fred Westhoff	PO Box 314 Edna, TX

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Name	Address
Teresa Durham	PO Box 697 Edna TX 77957
Norman Hunt	152 CR 253 Ganado 77962
David Patek	606 Midway RDS Inez TX 77968
Joleen Jackson	132 Koali, Bastrop, TX 78602
Carol Ann Lee	118 N. Wells Edna TX 77957
Michael Farris	213 W. Gayle, Edna, Tx 77957
C Blue	407 Robinson St. Edna, TX 77957
Chad Burkosky	606 Midway Rd South Inez TX 77968
[illegible]	107 Charleston Dr. Victoria, TX 77904
[illegible]	27927 Wild Bloom San Antonio, Texas 78260
Claudia Braun	27927 Wild Bloom S.A, TX 78260
Linda Teague	4897 FM 2616 Hallettsville TX 77964
OM Teague	4897 FM 2616 Hallettsville TX 77964
Justin Rabks	1400 n Wells Edna Tx 77957
Ryan Blue	407 Robinson Street, Edna Tx 7795
Mary Beth LaPue	PO Box 69 EDNA, TX 77957
[illegible] Carter	PO Box 709 Ganado 77962
Susan Carter	PO Box 709 Ganado, TX 77962
Mac Lee	118 N Wells Edna, Tx 77957

Por favor hagan el favor the firmar esta petision para salvar el Rio De Lavaca. Necesitamos protejerlo es el ultimo en Texas. Gracias

Please sign this petition to try to Save the Lavaca River. We need to protect the last free flowing river in Texas!

Name	Address
Jerry Tapia	490 CO RD 120 Edna Tx.
Genoveva G. Almeda	108 E Cypress Edna 77957.
Christina Almeda	409 S Second Ganado Tx 77962
Victoria Govea	407 N 3rd St Ganado Tx 77962
[illegible]	803 S Second Ganado Tx 77962
Maria Almeda	211 Spalek Ganado Tx 77962
Minerva Tapia	490 CR 120 Edna Tx 77957
Angie Tapia	305 Buffalo St. Edna Tx 77957
Sergio Tapia	305 Buffalo st Edna Tx 77957
Teresa Trinidad	600 N Kleas St Apt 7 Edna Tx 77957
Angela Garcia	601 Neas St Edna Tx 77957
Claudia Olivares	557 CR 126 Edna Tx 77957
Armanda Olivares	557 CR 126 Edna Tx 77957
Maria Olivares	612 CR 126 Edna Tx 77957
Efain Arvizu	612 CR 126 Edna Tx 77957
Maria Vargas	557 CR 126 Edna Tx 77957
Edelmira Vargas	557 CR 126 Edna Tx 77957
Maria Garcia	1134 CR 126 " " "
Jose Garcia	" " " " " "
Melissa Ornega	612 CR 126 Edna Tx 77957
Alicia G. Olivares	612 CR 126 Edna, Tx 77957
Erin Tapia	490 cr 120 Edna, Tx 77957
Audelia M Vidal	1021 W Hickory Edna Tx 77957
Julio C Vidal	1021 W Hickory Edna Tx "
Yolanda Govea	306 S. Bryan st. Edna, Tx. 77957
Everardo Govea	306 S. Bryan St. Edna Tx 77957
Lisa Ochoa	408 S Bryan St. Edna, Tx 77957
Petra Ochoa	408 S. Bryan St. Edna T 77957
Anna Rodriguez	303 S Bryan St Edna Tx 77957
Jessica Segundo, castillo	202 Guadalupe Edna Tx. 77957
Benito DeLeon	199 FM 822 Edna Tx 77957
Jennifer Ramos	1413 W. Main Edna Tx 77957
Derrick Ramos	1413 W. Main Edna Tx 77957
Jacinto P. De Leon	665 Fm 822 Edna, Tx 77957
Nora De Leon	" " " Edna, Tx 77957
Marcelino DeLeon	899 Fm 822 Edna Tx 77957
[illegible]	756 FM 822 Edna Tx 77957

ALONZO P. CRUZ 118 ROSA EDNA TX. 77957
John Kalles 1077 ST. HWY 111 N. Edna tx. 77957
Ernesto Baez 610 W CHURCH ST EDNA TX 77957
John Gonzales 1303 N East EDNA TX 77957
John Gonzales Jr. 1303 N. East Edna Tx 77957
Luis Negrete 1305 NEast EDNA TX, 77957
[illegible] 413 YUBA DAM ST. EDNA TX 77957
Johnny A. Gonzales 411 Yuba DAM EDNA TX 77957
Antonio Gonzales ~~[illegible]~~ 827 Co Rd 411
Bonnie Gonzales 411 Yuba Dam Edna TX 77957

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Name	Address
Lindsey Lee Bradford	101 E Main St. Edna
Anna Plotini	409 Maxine Edna
Laura Miller	1002 Suzanne Edna
Skye Smith	109 CR 356 El Campo, TX 77437
Lynn Kaf	502 Fannin St. Edna, TX 77957
Karoa Arredondo	105 Cherry St. Edna, TX 77957
Kenny Meak	436 CR 417 Edna TX 77957
[illegible]	711 . 4th St Edna TX 77957
[illegible] Edwards	504 Carver St Edna TX 77957
Kayla Kallus	910 CR 284
Lisa Kallus	910 CR 284
Annabelle Villa	507 N. Kleas Edna, TX
Vicki Hessong	7727 St Hwy 111 N Edna TX 77957
Bill Hessong	7727 St Hwy 111 N Edna TX 77957
Tina Cherry	PO Box 557 Ganado TX
Amber Martinez	PO Box 656 Ganado TX
Cynthia Ybarra	405 Sunset Drive, Edna, Tx. 77957
[illegible]	P.O. Box 421, Edna, Tx 77957
Lupe Zapata	
Mad Kee	118 N. Wells, Edna, Tx 77957
Butch Olsovsky	1246 Co.RD. 423 Lolita Tx 77971
Lanail Olsovsky	1246 Co.RD. 423 Lolita Tx 77971
Ryan Ballin	405 Sunset Drive, Edna, Tx 77957
LEONARDO PLOTINI	409 MAXINE ST. EDNA, TX 77957
Brenna Dixon	109 E. Main St. Edna TX 77957
Jana Kubecka	P.O. Box 573 Edna, Tx 77957
Russell A. Hahn	3503 Hilltop LN Plano, TX 75023
Larry Reed	P.O. Box 549 Ganado, Tx 77962
Joseph P. Rodriguez	2003 DuBarry Ln Houston TX 77018
Francis Martinez	501 N. Kleas St.
Annalyn Duarte	2382 CR 302 Edna TX 77957
[illegible]	1465 CR 401 Edna TX 77957
Laurie Padron	1008 Fulton St. Edna, TX 77957
[illegible]	1406 W. Main Edna TX 77957
Dary Knox	1400 N. Wells Apt. 2607 Edna, Tx 77957
Cheryl Nelson	1400 N. Wells Apt. 2607 Edna, Tx 77957

Sign on next page -

Erica A. Andrade 214 S. Allen Edna Tx.
Tonia Prukop 601 N Wells Edna, TX
Lane Hedley
Connie Marthiljohni P.O. Box 105 Edna, Texas
Coy Rooks 1400 N W Apt 2505 EDNA TX 77957
Justin Rooks 1400 N W Apt 2505 EDNA Tx 77957
John Muschalek 950 Buffalo St Edna 77957
Kim Courville PO Box 409 Louise TX 77455
Mindy Currie 146 CR 122 Edna TX 77957
[illegible] 1207 [illegible] Hwy
Mary Ellen Holmes 416 Pear St
[illegible] Holmes 416 Pear St
Lisa Jones 1400 N. Wells Apt. 4313
BRENDA JACOBS 6341 FM 1822 EDNA
Cortney Hardaway 105 E. Cypress Street Edna, TX
Denice Callis Edna, TX 208 W. Elm
Kelvin Turner 208 W. Elm St.
[illegible] 1145 Fm 234 South
Debra Balizan 1480 Fm 1593 Ganado, TX 77962
Allison Infante 1479 CR 303 Edna, TX 77957
Claxton Butler

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Name	Address	Email
Renee Johnston	11643 US Hwy 59 South Edna	
Crystal Merechka	2315 Cty Rd. 11a Hallettsville	
Lorraine Clear	105 E. Main Edna	lowercaseletters@yahoo.com
Esperanza Sanchez	CR 313 LaSalle, TX 77969	
Melinda Martinez	801 Progress St Apt #3 Edna	
Roxanne Kohleffel	~~354 CR 126 Edna~~	
Vanessa Bullwinkle		
Haylee Brown		
Tammie Ramsey		
Linda Parr		
Brandon Bullwinkle		
Eric Ramsey		
Steve Parr		
Ana Lee Moore		
Peggy Williams		
Megan Clowers		
Tyler Dunn		
[illegible]		
Stephanie Muschalik		
Cynthia Muschalik		
Ronnie Muschalik		
Brandon Muschalik		
Marbella Gorezan	2193 CR 302 Edna, Tx 77957	
Bruce Merechka	2300 C.R 19 Hallettsville 77964	
Rudolf Merechka	CR 19	
Frank merecka	CR 19	
Jerry Soto	F.M. 234 N. Edna Tx.	
James Simons	607 Gilbert Bay, TX	
Scott Ortolon		
Lisa Vinet	3443 CR 331 Edna TX	
[illegible]		
[illegible]	210 CR 253 GANADO	

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Name	Address	Email
JAIME BEDNARZ	1513 N. EAST ST. EDNA TX 77957	Jliepe@yahoo.com
Shae mabry	PO BOX 112 Edna, TX	shae-shae_18@hotmail.com
Duane Curlee	904 Pin Oak Edna Tx 77957	duane-curlee@yahoo.com
Darvis Jones	205 Hanover st Edna TX 77957	
ERNO SATTLER	7828 FM 1822 EDNA TX 77957	e.sattler@hotmail.com
Lupana Resendez	505 W. Cypress St. Edna, Tx 77957	mslupana@yahoo.com
John A. [illegible]	407 Dennis Edna TX 77957	TalkSap@yahoo.com
James E. Glover Jr.	501 Mead Rd Victoria Texas 77904	jameseglover jr@y[illegible]
Jan Bone	1510 CR 103 Edna	jan-bone at sbcglobal.net
Patti Bone	1510 CR 103 Edna	jan-bone@sbcglobal.net
DEWITT PEASE	7653 FM 2718 Yorktown	
Sean Cunningham	1267 CR 123	ears-lee@yahoo.com

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Name	Address
Marbella Gobellan	914 W. main st
Artemia Hernandez	
Joe Garza	
Jessica Hernandez	
Natalia Ruiz	
Armando Hernandez	
Olivia Rodriguez	
Maria Rodriguez	
Cindy Hernandez	
Kristy Salazar	
Joshua Thompson	
Shawn Dodds	
Leslie Hernandez	
Wesley Ramirez	417 E Division
Abel Rodriguez	
[redacted]	[illegible]
Nicole Flournoy	106 E. Cypress
Sharon Neal	411 S. Progress
Brandon Williams	
Stephen Dodd	Hoan Wells
[illegible]	103 E. [illegible]
Carol Vickery	6816 Co Rd 426 Lolita
Davis Farquhar	707 W. Gayle St Edna, Tx
[illegible] Farquhar	313 W. Gayle St. " "
[illegible]	606 Vale St.
Linda King	606 Vale St.
Melissa Meador	
Miguel Barrera	Beeville, TX
Elisha James	Edna, TX
Jesse James	Edna TX
Skylar James	Edna TX
Jayden James	Edna TX

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Name	Address	Email
[illegible]	612 Davis Street	nuts-in-a-rut@hotmail
[illegible] Koop	859 CR 312 EDNA TX	[illegible]
[illegible] Koop	622 Fulton Edna	
[illegible]	804 Harris St Edna, TX 77957	dsilver44@hotmail
Kim B Hadley	8062 CR 283 Edna TX 77957	khadley0304@yahoo.com
[illegible]	208 Southeast St EDNA TX	
Charnicka Bradshaw	802 S. Colorado Edna TX	Charnickab@yahoo.com
Ayreona Turner	802 S. Colorado EDNA TX	
Amy Sanchez	612 Fannin Edna	
[illegible] Robinson	606 E Cedar Edna TX	
Gary Hupp	609 Jackson St EDNA TX	
[illegible]	802 W Cypress EDNA TX	
[illegible]	1341 C.R. 116 Edna TX	
[illegible]	205 Young St Edna TX	
Ramon [illegible] JR	P.O. Box 772 Lolita - ACCROSS CR 458	
Gray → Billy McCormack	816 Buttercup	
Joel Frankel		
Jessenia Silver	806 Harris St	jesseniasilver@yahoo.com
Douglas Kelley	205 S Colorado St Edna	dougkelley@sbcglobal.net
Robert D. [illegible]	P.O. Box 213	
Danny Zapata		
[illegible]	103 S Pumphrey	
[illegible]	452 Co Rd 412	
[illegible]	Po box 177 Edna TX	
Hugo Rana Sanchez		
WESLEY Koop	514 WILSON EDNA	
Tyler Koop	514 WILSON EDNA TX	
Wendell Hamilton	1020 Hanover Edna TX	
Benita Hernandez	313 Marvin Edna Tx	
[illegible]	312 Dennis St. Edna, TX.	
Curtis Elledge		
[illegible]	1612 South 3rd Ganado TX	
[illegible]	Jackson Co.	

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Name	Address Edna, Tx.
Rachel Tinsley	306 S. Colorado A4 77957
[illegible] (Cera Sears)	14 Live Oak Lolita Tx 77971
Vanessa Tristan	P.O. Box 990 Ganado, TX 77962
Andrew Townsend	3802 Run of the Oaks. Austin, TX 78704
[illegible]	316 EAST CALHOUN EL CAMPO 77437
Arnold + Rosalie Hengst	1913 FM 234 S, EDNA, TEX 77957
[illegible]	1040 CO 319 EDNA TX
Janet Floyd	1024 S. Wells EDNA Tx 77957
CORD BEHRD	9019 FM 822 EDNA TX
Michael Dambrosky	1560 HWY South Edna, TX 77957
Anna Dambrosky	1560 Hwy South Edna, TX 77957
Malinda Allen Rowlett	1617 CR 110 Edna TX 77957
Stephanie Nesloney	1825 CR 429 Lolita TX 77971
Carolyn Nesloney	704 W. Division #8 Edna TX. 77957
[illegible]	612 Elra Marie Edna, Tx 77957
Amanda Nesloney	710 Hanover St. Edna Tx 77957
Raymond Margaret Friedel	5201 City of Northern Rd [illegible]
W. E. Stark	608 apollo Dr. Edna Tx 77957
Shelley + Bryan Hurt	P.O. Box 242 Ganado 77962
Dana Miller	601 W. Division - Edna TX 77957
William Miller	601 W. Division - Edna TX 77957
Alexis Rios	710 Courtney - Edna TX 77957
Lauren Anderson	PO BOX 328 - Louise TX 77455
Amanda Sample	711 S. Progress, Edna, TX 77957
Suzanne Matak	300 S. Guadalupe Edna
Willie R Matak	300 S Guadalupe Edna
Brenda Roe	301 S. COLORADO EdnA
[illegible] Whitley	11248 FM 822 Edna, TX 77957
[illegible]	170 Roden Inez TX 77968
Sandra [illegible]	795 CR 312 Edna TX 77957
[illegible] Jennings	6876 CR 283 Edna TX 77957
Jason Jennings	6876 CR 283 Edna TX 77957
[illegible] Jennings	6878 CR 283 Edna TX 77957

Kristen Thurmond	6878 CR 283 Edna TX 77957
Lype Lovely	113 Brown St Edna, Tx 77957
Norman Glaze	113 Brown St Edna, Tx 77957
Chelsea Kerley	555 County Rd 406 Edna, TX 77957
Ricky Johnson	705 W. Ash Edna, Tx 77957
Rusty Johnson	705 W. Ash Edna, Tx 77957
Donald Johnson	211 6th St Louise, Tx 77455
Sara Kopp	622 Fulton Edna, TX 77957
Clyde Martin	18466 Fm 1300 Louise, Tx 77455
Dorothy Martin	18466 Fm 1300 Rd, Louise, Tx 77455
Sylvia Butler	P.O. Box 197 421 PR 3065
Jennifer Butler	421 PR 3065
Craig Mallory	421 PR 3065 Edna Tx 77957
[illegible]	P.O. Box 36, LaWard Tx 77970
Sue Hunt	PO Box 36, LaWard, TX 77970
April McLennan	precisionservices@ Rocketmail.com
Kenny McLennan	
Kerry Edwards	
Kevin Davis	112 W. Main
Wild Davis	909 Salem Edna
Sandra Robinson	306 S. Colorado
Samuel Rucker	816 E. Cedar
Eunice Rucker	816 E. Cedar

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Luis Martinez	El Campo TX
Sauw Lay	PORT LAVACA TX
Maria Figueroa	Port Lavaca TX
Emma Amaro	Palacios tx
Oscar Pizar	Port Lavaca
Esperanza Rodriguez	Port Lavaca TX
Janice Davis	Lolita, TX
Jose Perez	Port Lavaca Tx.
René Rodriguez	Port Lavaca Tx.
Omar Cabrera	Victoria TX.
David Journet	Victoria, Tx
Ismael Morales	Victoria, Tx
Santiago Castro	El Campo, tx.
Alberto Sanchez	Lolita TX
Jamie Girdy	Victoria, TX.
Raul Martinez	~~[illegible]~~ EDNA TX.
Chris Cortes	Edna TX
Martin Sanchez	Edna TX
Nicholas Cant	Victoria TX
Eddie Peña	Victoria Tx
Will Turner	Edna Tx
Tracey Moore-Sweeney	1043 Co. Rd. 312, Edna, TX 77957
[illegible]	Blessing Tx 77419 Tx
MARty Goedrich	Victoria TX 77904
[illegible]	Victoria Tx 77901
[illegible]	Victoria Tx 77904
John [illegible]	VICTORIA TX 77901
William W. Vickery Jr.	Lolita, TX 77971
John T Williams	PORT LAVACA TX 77979
[illegible]	Bloomington TX 77951
Eugene J Meyer	Victoria, TX 77905
Nina Cruz	PL TX
Darrell Morales	Victoria TX
Don [illegible]	Victoria TX
JOHN SWEENEY	1093 CO. RD. 312 EDNA TX

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Name	Address
PATSY GABRYSCH	P.O. BOX EDNA, TX
MICHAEL COBOS	PORT LAVACA, TX
LINDA TISLOW	PALACIOS, TX
Jeff Teng	Huston Tx
Ter Wan Lin	Houston TX
Kelly Fikes	EDNA Tx
Delores Lolagu	Edna, TX
Jose Gonzalez	Ganado, TX
AARON ESPINOSA	EDNA, TX
Brian Flores	Victoria Tx
Miguel Hernandez	Lolita Tx
Jessica Frazier	Lolita, TX
James Soetje	Lolita TX
JAMES HAUBERT	VICTORIA
LARRY DORNAK	El CAMPO
Norma Smith	Victoria, TX
CARL WEEKS	Ganado TX
Craig Kramme	Ganado TX
Mike LAW	VICTORIA, TX
Matthew Espinosa	Victoria, TX
DEAN HARLEY	PORT LAVAC, TX
Dale Sparkman	Lolita TX
Victor H. Leos	Victoria, TX
Lonnie Buerger	VICTORIA, TX
Shane Barker	El Campo, Tx
ROGELIO SALAS	POINT COMFORT, TX
Debra Hernandez	Port Lavaca TX
Ramiro Velazquez	El Campo TX
Joaquina Segovia	Port Lavaca. T.X.
Stephanie Escamilla	Bay City TX
Aaron Mercado	Victoria, TX
Luis R. Mahone	Port Lavaca TX
Doris Rosas	Victoria, TX.

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Name	Address
Danny Reckert	6201 old Towey Rd Inez TX 77968
[illegible]	9301 St Hwy 238 Port Lavaca TX 77979
[illegible]	P.O. Box 151 Lolita, Tx 77970
Kenneth Ford	5708 FM 1822 Edna Tx. 77957
Lauren Havorsky	501 Barbara Ganado TX 77962
Ysaura Nunez	P.O. Box 127 Vanderbilt, TX 77991
Jason Hessong	215 private road 3035
Ann Hessong	406 W Brackenridge Edna Tx 77957
Doc Mozawa	N/A Ganado TX
Tammy Lea	439 FM 2982 - Ganado TX
David E Johnson	907 Buttercup, Edna
Dorothy Johnson	907 Buttercup Edna
Barry Selcer	P.O. Box 37 Vanderbilt, TX 77991
[illegible] King	704 Suzanne St Edna Tx 77957
Gloria King	" " " " "
Dave [illegible]	505 Elizabeth, Edna, TX 77957
Doris DeBruhl	1000 CR 312 Edna
Kat Woodring	744 Co. Rd. 3091, Edna
Troy Wording	744 CR 3091 EDNA.
Hadley Young	5530 Ranch Rd 1 Stonewall, TX 78671
Terry Young	5530 Ranch Rd 1 Stonewall, TX 78671
S Bingfield	325 FM 430 Lolita Tx 77971
ADAM ANDERSON	Richmond TX
CINDY ANDERSON	
Josh Nelson	710 Hackberry Ganado TX
Mykel Dunn	710 Hackberry Ganado TX
Rhonda Svatek	El Campo, TX
Megan Gresham	Ganado, TX
B E Taylor	Yoakum, Tex.
Caralyn Taylor	Yoakum, TX.
Sam Matabe :)	EDNA TX
FELIZ NAVIDAD	" "
Kelli Miller (11)	

Tate [illegible]	Edna, TX
Ryan Tomas	~~[illegible]~~ Low Water, County Road 301
McCord	Low Water, TX
Dennis Barton	Edna, TX
Mary Tomas	2456 Co Rd 306 Edna
Debra Tomas	2456 CR 306 Edna
KEITH L. ORSAK	901 GILBERT ST EDNA
Michele Orsak	901 Gilbert st.
Kayla Darilek	2266 CR 414 Ganado
[illegible] Barton	EDNA, TX
[illegible]	Edna TX. "Low Water TX!"
[illegible]	LOLITA TX
J C TOWERS	64 WARSAW LANDING PORT ALTO 77979
[illegible]	64 WARSAW LANDING, PORT ALTO 77979
Kristen Carter	
Miranda Malek	2531 CR 311 Edna, TX
Patti Cook	8813 Hwy 111 N. Edna
Robert [illegible]	1730 Cty. Rd. 110 Edna
Billie Marshall	1730 Cty. Rd. 110 Edna
[illegible]	Hwy 172 S Ganado TX
[illegible]	Hwy 172 S Ganado TX
Sharon [illegible]	P.O. Box 198 Ganado TX 77962
Kyle Hrncir	P.O. Box 731 Edna, TX 77957
Rebecca [illegible]	625 Hanover, Edna
Phyllis [illegible]	305 Hudson, Edna

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Name	Address	Email
Sara Fiew	P.O. Box 161 Edna, 77957	saratiffany86@hotmail.c
Pamela Fiew	POB 281 Edna	rodeomama@hotmail.com
Valerie Callaway	2229 FM 822 Edna	valorie@ykewb.com
Doris [illegible]	313 W. Gayle Edna	
Brenda Coulter	1943 St. Hwy 111 S Edna	rocking1943@sbcglobal.net
Dodie Stuart	311 Live Oak Inez, TX	dodiestuart@yah
Pat Stuart	311 Live Oak Inez, Texas	
[illegible] Smith	707 CR 356 El Campo TX 77437	
Courtney Beard	9019 FM 822	clbeard24@sbcglobal.net
Levi Duarte	9019 FM 822	levibailey24@aol.com
Jeff Sublett	P.O. Box 863 Ganado TX 77962	
Cory Jacobs	6341 F.M. 1822	
Clarence Joines	PO Box 114 Lolita TX 77971	
Angie Joines	PO Box 114 Lolita, TX 77971	
Trish Mercer	1818 CR 267 Ganado TX 77962	
Kendall Doyle!	325 CR 306 Edna, TX 77957	
Jana Kolbe	2283 CR 418 Ganado TX 77962	
Patricia Revel	P.O. Box 177 Ganado TX 77962	
[illegible]	P.O. Box 608 Edna TX.	
[illegible]	1206 Cobb St. Edna, TX 77957	
Margaret Perez	305 Duggan Edna, TX 77957	
Homer Perez	305 Duggan Edna, TX 77957	
Mary Lou [illegible]	P.O. Box 302 Danevang TX 77432	
John Critchfield	P.O. Box 1273 El Campo TX. 77437	
Jane Putnam	1979 St Hwy 111 N Edna 77957	
Kristi Doyle	325 County Rd 306 Edna TX 77957	
[illegible]	513 [illegible] F Simons Edna TX 77957	
Donna [illegible]	109 W. Ash St. Edna TX 77957	
Charlene [illegible]	1834 CR 121 Edna TX 77957	
[illegible]	424 Ocelot Inez, TX 77968	
Johnny A [illegible]	411 Yuba Dam Edna Texas 77957	
[illegible]	411 Yuba Dam Edna TX 77957	
Patrick [illegible]	PO Box 161 Edna, TX 77957	

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Name	Address
Robert E. Lee	106 Prof Park Dr. Victoria, TX 77904
Tracy L. Mendez	106 Prof Park Dr Victoria, TX 77904
Jardie Petru	106 Prof Park Dr Victoria, TX 77904
Kristin Cameron	106 Prof Park Dr. Victoria TX 77904
[illegible]	108 W. Main Edna Tx 77957
[illegible]	43 Louisiana Ave Victoria, TX 77905
Jeremy Woldert	607 Country Club Drive Victoria TX 7790[illegible]
Graham Woldert	1006 Jeffrey Dr. Tyler, TX 75701
Jenna Lee	607 Country Club, Victoria, TX 77904
Joy Meador	795 Co. Rd. 312, Edna melodyjoymeador@yahoo.com
Becky d Patrick	
Barbara Blevins	311 Buffalo, Edna, TX
Clint Whittley	1195 CR 401
[illegible]	2594 FM 1822
Clay Whittley	
Vicki McDonald	207 Duggen
Melissa Sappington	310 W. Cypress
[illegible] Clowers	2594 Fm 1822 Edna
Charlie Rivera	179 3035 Edna TX
Shane Clowers	2594 Fm 1822 Edna
Travis Simons	PO Box 1186 Edna TX
Patti Sappington	310 W. Cypress
Lois Drushel	110 W Main Security@TKC.com
Carol Arter	P.O. Box 598, Edna TX
Henry Drushel	607 N Wells Edna TX

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Name	Address
Linda Snow	POB 434, EDNA TX 77957
Greg Laird	2285 Fm 822 Edna Tx 77957
Felicia Laird	2285-Fm 822 Edna Tx 77957
[illegible]	P.O. Box 622 Ganado Tx 77962
Amanda Hampton	214 E. Gayle St. Edna TX 77957
Doug GOBLE	619 CR 126 Edna TX 77957
[illegible] Sorensen	
Bill [illegible]	207 Hanover Edna Tx 77957
Keith [illegible]	614 E MAIN EDNA TX 77 TX
Andrea Laws	701 Ed Linn Edna TX
Jenni Lima	712 Frank White Edna tx 77957

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Name	Address
Shelley [illegible]	407 Dennis, Edna, Tx 77957
Julie A. Garza	305 Dennis, Edna TX 77957
Carol [illegible]	1005 S. Third, Ganado, Tx 77962
Leah Latimer	1505 n. East Edna, TX 77957
[illegible] Novak	305 Elm St., Ganado TX 77962
Samantha Gerdes	1643 CR 303 Edna TX 77957
Jessica [illegible]	89 CR 125 Edna TX 77957
Courtney Garretson	2358 Loop 521 Edna, TX 77957
[illegible] McGinn	910 Vanderbilt Rd TX 77957
Christine Rodriguez	203 S. Colorado St, Edna, TX 77957
Becky Mirza	245 CR 117 N Edna TX 77957
Shelly Miller	611 Washington Edna, TX 77957
Heather Bolton	801 Celestial Ln Edna TX 77957
Jake [illegible]	12650 FM 822 Edna
Johnny Driggers	1918 County Rd 303 Edna
Kenneth Kopf	1422 CR 110 Edna, 77957
Billy Atzenhoffer	109 E. Brackenridge Edna 77957
Rodney Gaspar	3043 Fm 234 South, Edna, Tex
[illegible]	2291 FM 234 South, Edna, Tx 77957
[illegible]	2358 Loop 521 Edna Tx 77957
[illegible] Johnston	P.O. Box 703 Edna Tx. 77957
Robin [illegible]	2358 Loop 521 Edna TX 77957
Theresa Whitehead	406 Dennis St. Edna, Tx 77957
Donald L. Bolton	801 Celestial Ln. Edna, TX. 77957
Maxine Gates	402 Dennis Edna 77957
Darward Gates	402 Dennis, Edna - 77957
Jesse Whitehead	406 Dennis Edna - 77957

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Name	Address
Bobby Gendke Jr.	P.O. Box 7 Vanderbilt, Tx 77991
Tammy Gendke	PO Box 7 Vanderbilt, TX 77991
Karen Matak	107 Norwich Glen Victoria, TX 77904
Amanda Gendke	15700 Lexington Blvd Apt 1021 Sugar Land, TX 77478
[illegible] Motley	732 CR 115 Edna, Tx 77957
John E Motley	732 CR 115 Edna Tx 77957
[illegible] Gendke	P.O. Box 487 Vanderbilt, Tx 77991
[illegible]	P.O. Box 487 Vanderbilt Tx 77991
[illegible]	446 CR 429
[illegible]	CR 238 La Salle, Tx 77969
[illegible]	446 CR 429 Lolita 77971
Jacqlyn Curlee	PO Box 519 Lolita Tx 77971
Linda Lugo	PO Box 132 Vanderbilt Tx 77991
Martin Lugo Sr	PO Box 132 Vanderbilt TX 77991
Celia [illegible]	P.O. Box 172 Vanderbilt Tx 77991
[illegible]	P.O. Box 132 Vanderbilt Tx 77991
James Yarborough	PO Box 484 Vanderbilt Tx 77991
[illegible]	PO Box 162 Lolita, TX 77991
[illegible]	PO Box 33 La Salle Tx 77969
[illegible]	PO Box 33 La Salle Tx 77969
Mike Garza	3342 FM 1822 Edna Tx 77957
Tiarra Malone	PO Box 5874 Vanderbilt, TX 77991
Kathy Malone	P.O. Box 5874 Vanderbilt Tx 77991
[illegible]	PO Box 114 La Salle, Tx 77969
[illegible]	PO Box 632, Lolita 77971
J.W. [illegible]	Box 527 Lolita
Georgia [illegible]	Box 374 [illegible] 77968
Barbara Thedford	Box 162 Lolita, Tx. 77971
[illegible]	Box 12 Vanderbilt TX 77991
R. [illegible]	1502 [illegible] Ave. Victoria, TX 77901
[illegible]	PO Box 132 Vanderbilt Tx 77991
Willie M. Bostomp	POB 179 - Ganado, Tex
Maranda Parker	11313 FM 1593 - Lolita TX
Bernice Fikes	1749 CR 429 Lolita TX
Mary Yarborough	Box 484 Vanderbilt, Tx 77991
John [illegible]	11342 US 59N Ganado Tx 77962