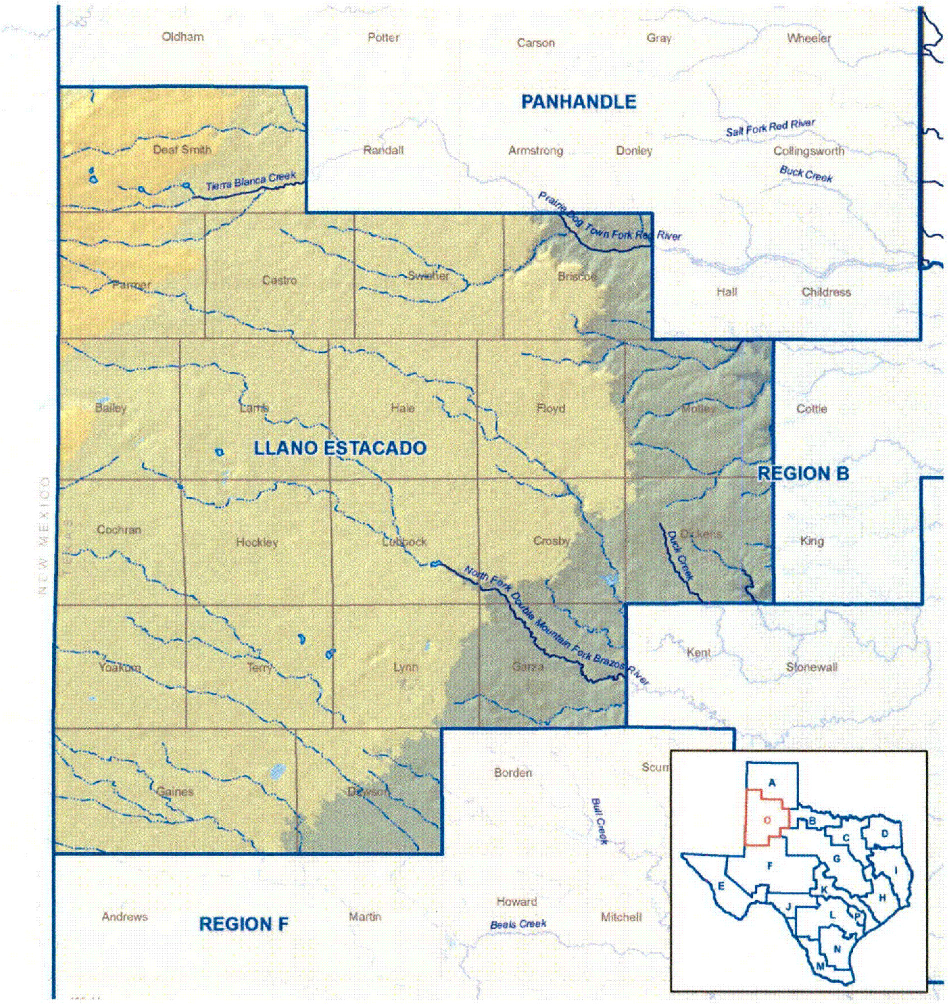
Llano Estacado (Region O)
2016 Regional Water Plan

December 1, 2015



Llano Estacado (Region O) 2016 Regional Water Plan

Prepared for

Texas Water Development Board

Prepared by

Llano Estacado Regional Water Planning Group

With administration by

High Plains Underground Water
Conservation District No. 1

And technical assistance by

Daniel B. Stephens & Associates, Inc.
RPS Espey
Parkhill, Smith & Cooper, Inc.

December 1, 2015

DEDICATION

2016 LLANO ESTACADO REGIONAL WATER MANAGEMENT PLAN

DELAINE BAUCUM
(*1952-2014*)

Delaine Baucum was appointed as a member of the Llano Estacado Regional Water Planning Group in March 1998. She represented agricultural water users for 16 years until her death on April 23, 2014.

Delaine owned Valley Irrigation and Pump Service in Seminole. Throughout her 40-year career, she developed a great understanding and appreciation of the importance of irrigated agriculture to the region. This expertise was extremely helpful in developing the 2001, 2006, 2011, and 2016 "Region O" water management plans.

It is for these reasons that the 2016 Llano Estacado Regional Water Management Plan is dedicated in loving memory to Delaine Baucum.

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Appendix

List of Acronyms

ac-ft/yr	acre-feet per year
ASR	aquifer storage and recovery
BCWF	Bailey County Well Field
BMP	best management practice
BPS	booster pump station
CCEFN	Consensus Criteria for Environmental Flow Needs (TCEQ)
CM	capacity maintenance
CRMWA	Canadian River Municipal Water Authority
DBS&A	Daniel B. Stephens & Associates, Inc.
EID	Environmental Information Document
ENR CCI	Engineering News Record Construction Cost Index
FM	Farm-to-Market road
ft msl	feet above mean sea level
GAM	groundwater availability model
gpcd	gallons per capita per day
gpm	gallons per minute
HDR	HDR Engineering, Inc.
HLAS	Hancock Land Application Site
hp	horsepower
kWh	kilowatt-hour
LAH	Lake Alan Henry
LAHPS	Lake Alan Henry Pump Station
LLAS	Lubbock Land Application Site
mgd	million gallons per day
North Fork	North Fork of the Double Mountain Fork of the Brazos River
NWTP	North Water Treatment Plant
PPS	Post Pump Station
PS	pump station
RDWF	Roberts County Well Field
RO	reverse osmosis
ROW	right-of-way

List of Acronyms (Continued)

SCADA	Supervisory Control and Data Acquisition
SEWRP	Southeast Water Reclamation Plant
SLPS	Southland Pump Station
South Fork	South Fork of the Double Mountain Fork of the Brazos River
SWSP	City of Lubbock 2013 *Strategic Water Supply Plan*
SWTP	South Water Treatment Plant
TAMU	Texas A&M University
TCEQ	Texas Commission on Environmental Quality
TDS	total dissolved solids
TPDES	Texas Pollutant Discharge Elimination System
TPWD	Texas Parks and Wildlife Department
TWDB	Texas Water Development Board
UCM	Unified Costing Model
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
WAM	water availability model
WRMWD	White River Municipal Water District

Executive Summary

Executive Summary

To better prepare for drought and increasing population, the 75th Texas Legislature passed Senate Bill 1 in 1997 to establish rules for Texas state water planning. The water planning process is designed to increase the amount of local participation and input. To accomplish this, 16 regional planning groups were established and tasked with developing a regional water plan every five years.

The 2016 Region O Plan contains the following chapters:

1. Planning Area Description
2. Population and Water Demand Projections
3. Water Availability and Existing Water Supplies
4. Identification of Water Needs
5. Water Management Strategies
6. Impacts of the Regional Water Plan
7. Drought Response Information, Activities, and Recommendations
8. Unique Stream Segments, Reservoir Sites, and Other Recommendations
9. Reporting of Financing Mechanisms for Water Management Strategies
10. Adoption of Plan and Public Participation
11. Implementation and Comparison to the Previous Regional Water Plan

Once the regional water plans are approved by the regional water planning groups, they are submitted to the Texas Water Development Board (TWDB), which compiles them all, along with other relevant information, into a State Water Plan. The 2017 State Water Plan will be the fourth state plan published under Senate Bill 1.

Planning Area Description

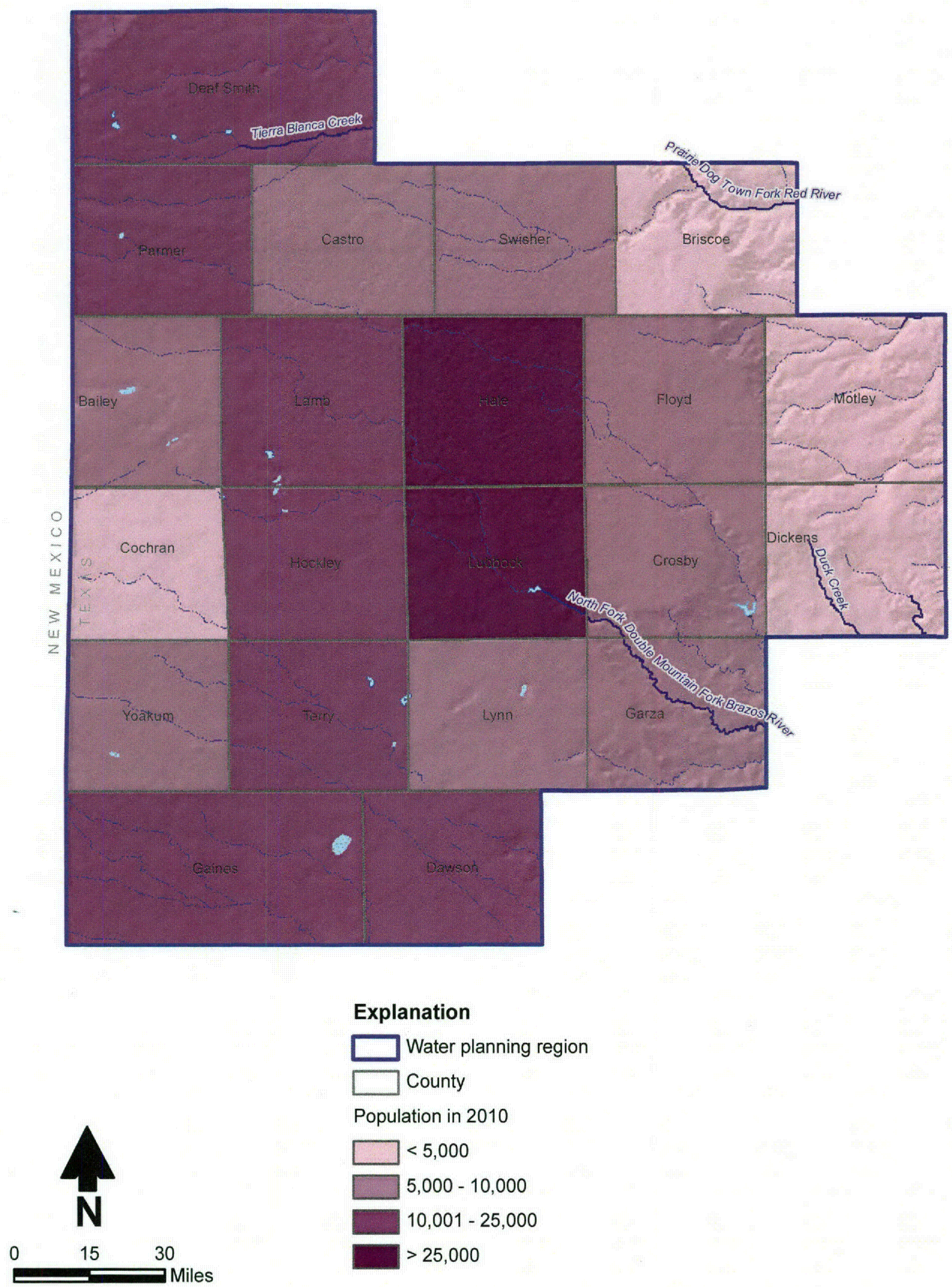
The Llano Estacado Regional Water Planning Group (LERWPG), or Region O, is located in the Panhandle of Texas and consists of 21 counties: Bailey, Briscoe, Castro, Cochran, Crosby, Dawson, Deaf Smith, Dickens, Floyd, Gaines, Garza, Hale, Hockley, Lamb, Lubbock, Lynn, Motley, Parmer, Swisher, Terry, and Yoakum. The locations of these counties along with their 2010 population ranges are shown in Figure ES-1. The combined 2010 population of the 21 counties was 489,926, accounting for 1.9 percent of the state's population. The majority of the region's population (57 percent) is located in Lubbock County. The second most populated county in the region is Hale County with just over 7 percent of the population.

Cultivated cropland comprises nearly half of the land area in the Llano Estacado region, and grassland comprises around a quarter of the region's land area. The main economic activity in Region O is agriculture, and the major crops grown are cotton, sorghum, corn, and winter wheat.

The region's largest water demand is for irrigated agriculture (95 percent). After agriculture, the next largest water demand is for municipalities. The region's 10-year average water use (2003 through 2012) is 3,787,711 acre-feet per year (ac-ft/yr), of which 98.6 percent is from groundwater sources and 1.4 percent is from surface water sources.

There are two major aquifers in Region O, the Ogallala and Seymour aquifers (Figure ES-2), and two minor aquifers, the Edwards-Trinity (High Plains) and Dockum (Santa Rosa) aquifers. Four river basins (Brazos, Canadian, Colorado, and Red) dissect the region, although there is very little streamflow within Region O. Four reservoirs (one in Region A and three in Region O) supply water to users in the Llano Estacado region. As of January 2015, three of the four reservoirs were less than 10 percent full and consequently not capable of supplying water to member cities. As of September 2015, reservoir storage was up to 21 percent in Lake Meredith, 95 percent in Lake Alan Henry, 16 percent in Mackenzie Reservoir, and 33 percent in White River Lake.

Playa lakes occur naturally in most counties. The region once had numerous active springs, but conversion of native grasslands to agriculture has caused many of the springs to become inactive due to declines in the water table caused by groundwater pumping for irrigation.



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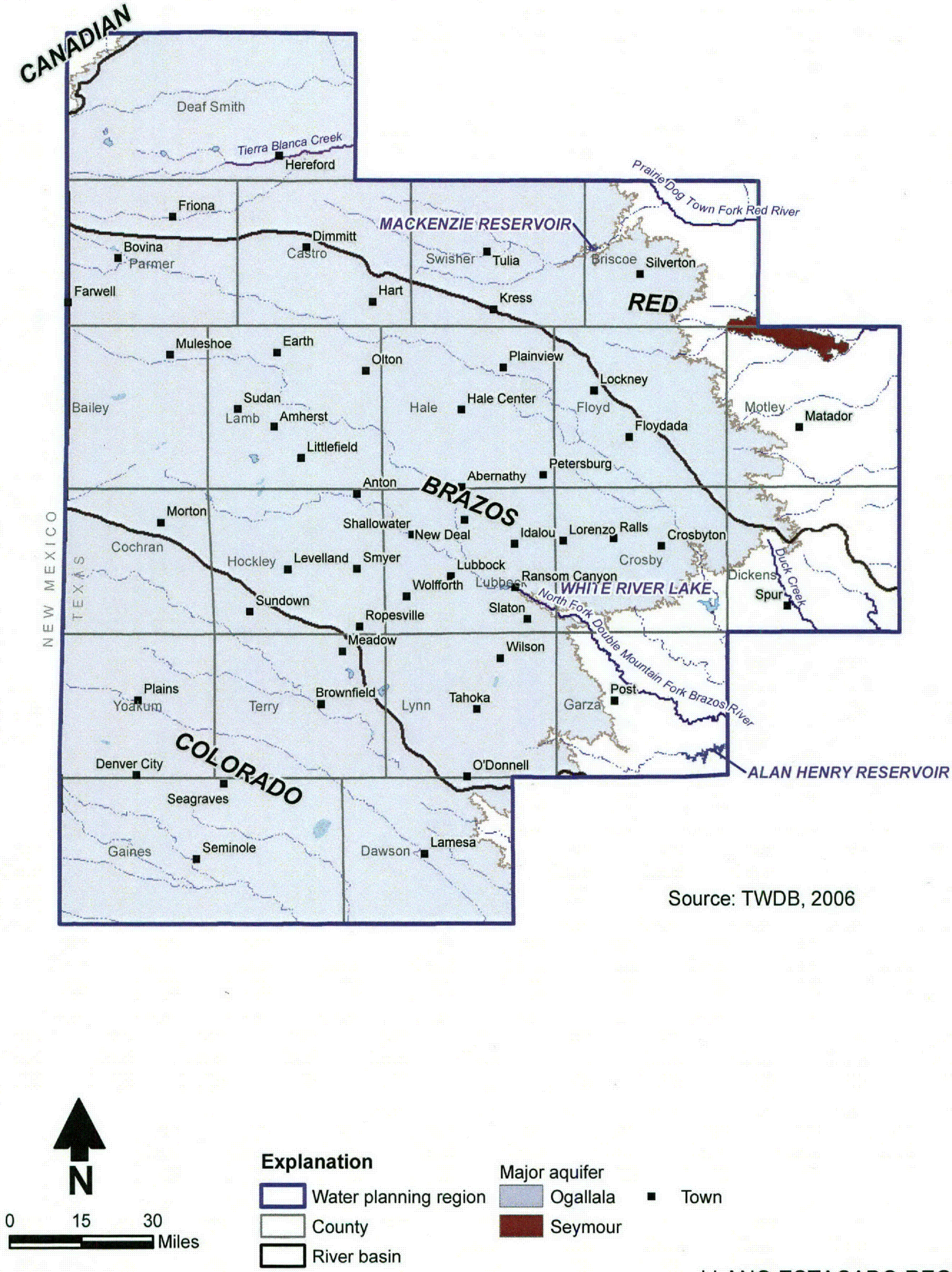
LLANO ESTACADO REGION
2010 Population

Daniel B. Stephens & Associates, Inc.
9/30/2015
JN WR11.0030

Figure ES-1



LLANO ESTACADO REGION
Major Aquifers

Daniel B. Stephens & Associates, Inc.
9/30/2015
JN WR11.0030

Figure ES-2

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Population and Water Demand Projections

Population and water demand projections lay the foundation for determining water needs for each county over the planning horizon. The TWDB provided county population projections based on projections developed by the Texas State Data Center and the Office of the State Demographer. The draft TWDB county-level population projections were revised by Region O based on local feedback, scaling where necessary to keep the total regional population unchanged. Population projections were calculated for 71 water user groups (WUGs), all of which are either city or County-other (urban areas with a population of less than 500) WUGs. There are 79 systems within the region's County-other category.

Region O also includes four wholesale water providers (WWP):

- Canadian River Municipal Water Authority (CRMWA)
- City of Lubbock
- Mackenzie Municipal Water Authority
- White River Municipal Water District

The attached WUG Category Summary contains the population and water demand projections by WUG category for Region O. By 2070, it is projected that the population of Region O will increase by 33 percent to 801,719, accounting for 1.6 percent of the state's population.

In regional water planning, water use is accounted for in the following WUG categories: municipal, industrial (further divided into manufacturing, mining, or steam-electric), irrigation, or livestock. The projected changes in water demand by WUG category for Region O over the 50-year planning period are:

- Municipal demand will increase by 40 percent.
- Manufacturing demand in 14 counties will increase by 26 percent.
- Mining demand will decrease by 42 percent.
- Steam-electric power demand in 4 counties will increase by 127 percent.

- Irrigation demand will account for 95 percent of the region's water use in 2020 and decrease slightly to 92 percent by 2070.
- Livestock demand will increase by 30 percent.

In 2020, Region O is projected to account for 20.1 percent of the state's water demand. By 2070, Region O is projected to account for 14.9 percent of the state's total water demand.

Water Availability and Existing Water Supplies

TWDB defines *water availability* as the maximum amount of water available from a given source during drought-of-record conditions, regardless of whether the supply is physically or legally accessible by a WUG or WWP. The term *existing water supplies* is defined as the maximum amount of water available from an existing source during drought-of-record conditions that is physically and legally obtainable for use by WUGs. Projections of future water availability are estimates of the amount of water physically present in a water body whether it is being used currently or not, while projections of future existing water supply include only water obtainable from current water sources given each WUG's or WWP's infrastructure and legal constraints.

During the current round of water planning, the annual amounts of water availability and existing water supplies in Region O have been estimated for decades 2020 through 2070. The estimates reflect the conditions that are expected to occur in the event of actual drought conditions and are considered reasonable for drought planning purposes. The majority of water available to Region O is groundwater, primarily from the Ogallala Aquifer, although some surface water and direct reuse water is also available. The total water available from surface water, groundwater, and direct reuse sources combined is projected to be more than 2.3 million ac-ft/yr in 2020 and to decrease by 45 percent, to approximately 1.3 million ac-ft/yr in 2070. In 2020, 12 counties are projected to have more than 100,000 ac-ft/yr of available water, but by 2070, only 5 counties will have more than 100,000 ac-ft/yr.

The attached WUG Category Summary provides existing water supply by WUG category and decade for Region O. Existing water supplies are projected to be approximately 2.0 million ac-ft/yr in 2020. This amount is projected to decrease to 0.98 million ac-ft/yr in 2070, a 51 percent reduction.

The Ogallala Aquifer provides the majority of water for the region's existing water supplies. CRMWA in Region A currently supplies water from the Ogallala Aquifer in Roberts County to eight WUGs in Region O. Several of these WUGs in turn sell a portion of their CRMWA allocation to other WUGs in Region O.

Surface water is limited in Region O. Under the drought of record conditions, no existing water supplies are projected to be available from any river basin for livestock local supplies. The only surface water sources associated with a WUG within the region that are projected to have existing water supplies greater than 0 during the 50-year planning period are Lake Alan Henry and Mackenzie Reservoir.

Irrigation WUGs have the largest existing water supplies in Region O, followed distantly by municipal WUGs and then livestock WUGs. In 2020, 92 percent of the region's existing water supplies are projected to belong to irrigation WUGs, with this decreasing to 82 percent in 2070. Existing water supplies for stream-electric power generation are projected to increase from 1.5 percent of the region's total water use in 2020 to 4.8 percent by 2070.

In locations where initial overdrafts were found, the allocations of available groundwater supplies to existing WUG supplies were decreased to adhere to the groundwater availability limit. This situation occurred where the groundwater availability amounts determined for the current round of water planning had decreased below the sum of the initially allocated WUG supplies for an individual source in one or more decades. In these cases, the existing WUG supplies were recalculated to minimize surpluses for all WUGs and needs for municipal WUGs.

Identification of Water Needs

A water need arises when water demand exceeds existing supply; a surplus occurs when supply exceeds demand. The TWDB made an initial calculation of water needs (first tier) based on projected demands and existing water supplies without implementation of any water management strategies and this is provided for each WUG category by decade in the attached WUG Category Summary. The two largest water needs determined in TWDB's analysis were the irrigation and municipal WUG categories:

- Irrigation WUGs account for the majority of the first tier water needs in the region, comprising at least 95 percent of the regional water needs in each decade. Dawson, Dickens, Garza, Lynn, Motley, and Terry counties are the only counties with a projected surplus in this category in 2020; Dickens, Garza, Lynn, and Motley are the only counties with a projected surplus in this category in 2070. Castro, Gaines, Hale, Lamb, and Parmer counties are projected to have first tier irrigation water needs of more than 100,000 ac-ft/yr in 2020 and more than 200,000 ac-ft/yr by 2070.

- The municipal WUG category consists of both individual cities or towns and County-other entities. Lubbock, the largest city in the region, has the largest predicted water needs, with a shortage of 10,352 ac-ft/yr in 2020 that increases to a shortage of 43,148 ac-ft/yr in 2070. Of the 21 County-other WUGs, 17 have a projected surplus in 2020, decreasing to 15 with predicted surpluses in 2070.

Second tier water needs are the water needs that remain if recommended conservation and direct reuse water management strategies (WMSs) are fully implemented. The results of this analysis are shown for each WUG category in the attached Second Tier Identified Water Needs Summary. Although there are reductions to the needs in the municipal, County-other, and irrigation WUG categories, significant needs remain after the implementation of the conservation and direct reuse WMSs.

Water Management Strategies

The TWDB requires that regional water plans identify and evaluate potentially feasible WMSs for each WUG and WWP with future water supply needs. The process used to identify potentially feasible WMSs included conducting WUG and WWP surveys, with necessary followup, and discussion at multiple LERWPG meetings. Several strategies that were identified as potentially feasible early on in the planning period could not be fully evaluated because no specific project or sponsor was identified, and these strategies are considered by the LERWPG to be no longer potentially feasible. General information that had been compiled on these strategies is included as best management practices in the final plan.

The recommended WMSs were evaluated based on criteria specified in 31 TAC §357.34 and 357.35, including water quantities generated by strategies, the reliability of strategies, financial costs, environmental impacts, and implementation issues. Table ES-1 contains the list of recommended WMSs for Region O and includes the strategy name, expected online decade, total annual yield of the strategy for each planning decade, the capital cost, and the unit cost. Costs were developed for the WMSs identified in this regional water plan using the TWDB's Unified Costing Model, unless a more in-depth project-specific cost was developed by the sponsor (e.g., City of Lubbock strategies). An impact matrix was developed to provide an initial evaluation of the potential environmental impacts of the Region O WMSs, and impacts were assessed for seven categories (acres impacted, threatened and endangered species, instream flows, agricultural resources, playa wetlands, springs, and cultural sites).

Any alternative WMSs that are included in the regional water plan may be substituted for one of the recommended strategies, should it become infeasible. The LERWPG has included evaluations for 9 alternative WMSs in the current plan, shown in the attached Alternative WUG WMSs and Associated Projects report.

Impacts of the Regional Water Plan

Potential agricultural impacts were quantitatively evaluated as a part of the WMS strategy evaluations, by assessing the number of agricultural acres impacted and the impact of strategy implementation on the water supply. The projects with the smallest agricultural impacts include the irrigation conservation projects and municipal conservation and water loss reduction strategies, because they do not reduce the acreage available for agriculture and they have no negative impacts on agricultural water supply. Agricultural impact scores for the local groundwater development projects varied, with the differences between projects occurring because of their locations and impacts to the water table. Local groundwater development projects receiving the highest agricultural impacts required use of agricultural land for project construction and drilling of numerous high-producing wells. Overall, the agricultural impact scores are highest for groundwater projects located in agricultural areas.

Table ES-1. Recommended Water Management Strategies and Cost Summary for Region O
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County	Entity	Recommended WMS	Online Decade	Total Capital Costs ($)	First Decade Unit Cost ($/ac-ft/yr)	Water Supply (ac-ft/yr)						2070 Unit Cost ($/ac-ft/yr)
						2020	2030	2040	2050	2060	2070	
Bailey	County-other	Local groundwater development	2040	771,000	493	0	0	150	150	150	150	60
	Irrigation	Irrigation water conservation	2020	3,625,325	42	1,846	1,846	2,652	2,652	2,752	2,752	42
	Muleshoe	Local groundwater development	2030	2,434,000	397	0	300	300	300	500	500	266
		Municipal water conservation	2020	0	770	59	64	70	76	83	89	770
Briscoe	County-other	Municipal water conservation	2020	0	770	15	15	14	14	14	14	770
	Irrigation	Irrigation water conservation	2020	3,020,000	42	1,667	1,667	1,899	1,899	2,474	2,474	42
	Silverton	Local groundwater development	2020	5,872,000	4,496	121	121	121	121	121	121	438
		Municipal water conservation	2020	0	770	6	6	2	2	2	2	770
Castro	Dimmitt	Local groundwater development	2040	1,297,000	427	0	0	300	300	300	300	63
		Municipal water conservation	2020	0	770	55	58	60	63	65	67	770
	Hart	Local groundwater development	2040	855,000	820	0	0	100	100	100	100	100
	Irrigation	Irrigation water conservation	2020	11,540,650	42	6,253	6,253	8,350	8,350	8,478	8,478	42
Cochran	County-other	Municipal water conservation	2020	0	770	25	27	28	28	29	29	770
	Irrigation	Irrigation water conservation	2020	4,193,725	42	1,768	1,768	2,977	2,977	3,642	3,642	42
	Morton	Municipal water conservation	2020	0	770	24	24	23	23	23	23	770
		Water loss reduction	2020	11,760,034	3,206	141	141	232	226	231	233	0
Crosby	Irrigation	Irrigation water conservation	2020	14,844,250	42	5,514	5,514	10,180	10,180	13,995	13,995	42
	Lorenzo	Municipal water conservation	2020	0	770	12	12	13	14	15	15	770
		Water loss reduction	2020	5,428,944	7,196	29	31	54	57	61	64	0
	White River MWD	Local groundwater development	2020	2,513,000	343	600	600	600	600	600	600	55
Dawson	County-other	Local groundwater development	2040	802,000	507	0	0	150	150	150	150	60
	Irrigation	Irrigation water conservation	2020	13,956,700	42	5,410	5,410	9,610	9,610	12,893	12,893	42
	Lamesa	Municipal water conservation	2020	0	770	114	115	116	116	119	121	770
Deaf Smith	Hereford	Municipal water conservation	2020	0	770	198	223	251	286	315	346	770
	Irrigation	Irrigation water conservation	2020	10,844,425	42	5,464	5,464	8,207	8,207	8,019	8,019	42
Dickens	Irrigation	Irrigation water conservation	2020	1,400,575	42	480	480	936	936	1,385	1,385	42
	Spur	Municipal water conservation	2020	0	770	9	9	9	8	8	8	770
Floyd	Floydada	Municipal water conservation	2020	0	770	29	30	30	31	32	33	770
	Irrigation	Irrigation water conservation	2020	15,990,325	42	6,121	6,121	11,027	11,027	14,833	14,833	42
	Lockney	Local groundwater development	2020	2,719,000	1,125	240	240	240	240	240	240	179
Gaines	County-other	Local groundwater development	2020	7,251,000	358	600	600	1,500	1,500	2,000	1,622	187
	Irrigation	Irrigation water conservation	2020	16,756,575	42	11,563	11,563	12,306	12,306	9,644	9,644	42
	Seagraves	Local groundwater development	2050	617,000	1,160	0	0	0	50	50	50	120
		Municipal water conservation	2020	0	770	20	9	0	0	0	0	0

ac-ft/yr = Acre-feet per year

Table ES-1. Recommended Water Management Strategies and Cost Summary for Region O
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County	Entity	Recommended WMS	Online Decade	Total Capital Costs ($)	First Decade Unit Cost ($/ac-ft/yr)	Water Supply (ac-ft/yr)						2070 Unit Cost ($/ac-ft/yr)
						2020	2030	2040	2050	2060	2070	
Gaines (cont.)	Seminole	Groundwater desalination	2020	31,572,000	7,822	500	500	500	500	500	500	2,538
		Local groundwater development	2030	32,754,000	3,108	0	1,000	1,000	1,000	1,000	1,000	367
		Municipal water conservation	2020	0	770	117	129	142	158	171	184	770
Garza	County-other	South Garza Water Supply	2020	7,672,000	3,879	270	270	270	270	270	270	1,501
	Irrigation	Irrigation water conservation	2020	1,503,750	42	584	584	1,033	1,033	1,391	1,391	42
Hale	Abernathy	Groundwater desalination	2020	10,100,000	9,253	150	150	150	150	150	150	3,620
		Municipal water conservation	2020	0	770	35	37	38	39	40	41	770
	Irrigation	Irrigation water conservation	2020	17,715,350	42	6,566	6,566	12,332	12,332	16,533	16,533	42
	Petersburg	Municipal water conservation	2020	0	770	16	17	17	16	17	17	770
	Plainview	Municipal water conservation	2020	0	770	218	222	221	217	223	225	770
Hockley	Anton	Municipal water conservation	2020	0	770	8	8	8	8	9	9	770
	County-other	Local groundwater development	2020	643,000	407	150	150	150	150	150	150	47
	Irrigation	Irrigation water conservation	2020	9,290,525	42	4,178	4,178	6,086	6,086	8,317	8,317	42
	Levelland	Municipal water conservation	2020	0	770	116	53	0	0	0	0	0
	Sundown	Local groundwater development	2070	690,000	650	0	0	0	0	0	100	650
		Municipal water conservation	2020	0	770	21	22	22	22	23	24	770
		Water loss reduction	2020	3,348,332	4,895	27	28	48	48	50	52	0
Lamb	Amherst	Local groundwater development	2020	487,000	900	50	50	50	50	50	50	80
		Municipal water conservation	2020	0	770	5	5	5	6	6	6	770
	Earth	Municipal water conservation	2020	0	770	10	10	9	9	8	8	770
	Irrigation	Irrigation water conservation	2020	10,951,300	42	6,305	6,305	8,430	8,430	7,167	7,167	42
	Littlefield	Municipal water conservation	2020	0	770	48	46	44	42	41	40	770
	Olton	Municipal water conservation	2020	0	770	23	23	23	22	22	22	770
	Sudan	Municipal water conservation	2020	0	770	12	13	14	14	15	15	770
Lubbock	Idalou	Local groundwater development	2030	2,534,000	2,330	0	100	100	100	100	100	210
		Municipal water conservation	2020	0	681	21	21	22	23	23	24	681
	Irrigation	Irrigation water conservation	2020	12,380,950	42	5,711	5,711	8,111	8,111	10,940	10,940	42
	Lubbock	Bailey County Well Field capacity maintenance	2020	25,518,000	2,028	997	1,143	2,822	3,120	3,120	3,120	160
		Brackish well field at the South Water Treatment Plant	2020	34,531,740	3,671	1,120	1,120	1,120	1,120	1,120	1,120	1,090
		CRMWA aquifer storage and recovery	2030	62,345,000	1,099	0	6,090	6,090	6,090	6,090	6,090	243
		Jim Bertram Lake 7	2020	82,066,000	614	13,800	13,800	13,800	13,800	13,800	13,800	179
		Lake Alan Henry Phase 2	2020	57,799,000	911	8,000	8,000	8,000	8,000	8,000	8,000	306
		Municipal water conservation	2020	0	600	2,287	2,478	2,674	2,915	3,139	3,382	600
		North Fork scalping operation	2020	119,825,000	1,342	10,390	9,790	9,220	8,660	8,110	7,890	513

ac-ft/yr = Acre-feet per year

Table ES-1. Recommended Water Management Strategies and Cost Summary for Region O

County	Entity	Recommended WMS	Online Decade	Total Capital Costs ($)	First Decade Unit Cost ($/ac-ft/yr)	Water Supply (ac-ft/yr)						2070 Unit Cost ($/ac-ft/yr)
						2020	2030	2040	2050	2060	2070	
Lubbock (cont.)	Lubbock	South Lubbock well field	2030	53,856,000	2,516	0	2,613	2,613	2,613	2,613	2,613	791
	Ransom Canyon	Municipal water conservation	2020	0	681	17	18	19	20	21	22	681
	Shallowater	Local groundwater development	2030	3,583,000	1,948	0	400	400	400	400	400	1,198
		Water loss reduction	2020	5,320,016	3,007	68	74	136	150	163	177	0
	Wolfforth	Local groundwater development	2030	8,383,000	1,142	0	726	726	726	726	726	175
		Municipal water conservation	2020	0	681	38	37	29	26	29	32	681
		Potable reuse	2030	21,822,000	5,121	0	560	560	560	560	560	1,861
Lynn	County-other	Local groundwater development	2020	598,000	560	100	100	100	100	100	100	60
	Irrigation	Irrigation water conservation	2020	10,989,425	42	4,230	4,230	7,577	7,577	10,173	10,173	42
	Tahoka	Municipal water conservation	2020	0	770	24	20	7	3	4	4	770
Motley	County-other	Municipal water conservation	2020	0	770	5	5	5	5	5	5	770
	Irrigation	Irrigation water conservation	2020	1,455,775	42	485	485	971	971	1,456	1,456	42
	Matador	Municipal water conservation	2020	0	770	11	10	10	10	10	10	770
Parmer	Bovina	Local groundwater development	2040	775,000	617	0	0	120	120	120	120	75
		Municipal water conservation	2020	0	770	19	20	21	23	25	27	770
	County-other	Local groundwater development	2060	621,000	1,160	0	0	0	0	50	50	1,160
		Municipal water conservation	2020	0	770	32	34	36	39	42	45	770
	Farwell	Local groundwater development	2050	815,000	632	0	0	0	125	125	125	88
		Municipal water conservation	2020	0	770	20	21	23	25	27	29	770
		Potable reuse	2020	5,196,000	10,656	64	64	64	64	64	64	3,859
	Friona	Local groundwater development	2050	555,000	663	0	0	0	80	80	80	88
		Municipal water conservation	2020	0	770	41	45	48	51	55	59	770
	Irrigation	Irrigation water conservation	2020	4,438,125	42	2,854	2,854	2,559	2,559	3,463	3,463	42
Swisher	Irrigation	Irrigation water conservation	2020	9,574,850	42	4,973	4,973	6,255	6,255	7,922	7,922	42
	Tulia	Local groundwater development	2020	1,733,000	885	200	200	200	200	200	200	160
		Municipal water conservation	2020	0	770	46	47	47	46	48	50	770
Terry	Brownfield	Municipal water conservation	2020	0	770	90	93	92	69	72	75	770
	Irrigation	Irrigation water conservation	2020	10,187,625	42	7,201	7,201	8,259	8,259	4,916	4,916	42
Yoakum	Denver City	Local groundwater development	2020	2,995,000	333	925	925	925	925	925	925	62
		Municipal water conservation	2020	0	770	71	79	86	94	103	112	770
	Irrigation	Irrigation water conservation	2020	4,158,250	42	2,771	2,771	3,048	3,048	2,497	2,497	42
	Plains	Local groundwater development	2020	4,923,000	1,954	500	500	500	500	500	500	1,130
		Municipal water conservation	2020	0	770	22	24	26	28	31	34	770

ac-ft/yr = Acre-feet per year

The regional water plan will have a positive impact on other water resources of the State, including other WMSs and groundwater and surface water interrelationships. The implementation of water conservation strategies will help to meet the region's water needs. Implementation of strategies by the wholesale water providers in the region (Canadian River Municipal Water Authority, the City of Lubbock, White River Municipal Water District, and Mackenzie Municipal Water Authority) will continue to benefit the region, particularly as they practice conjunctive management. The water resources are further conserved with the implementation of water reuse projects that use treated wastewater in place of additional potable water, desalination projects that provide new water supplies, and aquifer storage and recovery projects that store excess water when it is available for future use.

Drought, declining aquifer levels, and brackish groundwater are the main water quantity and quality threats to agriculture in Region O. These threats will be best addressed by implementing the agricultural water conservation strategies, which have the potential to reduce yields, but also to lengthen the time frame for continued irrigation due to the conservation of available supplies. The implementation of water conservation strategies will help to meet the region's water needs.

Most of the recommended WMSs for municipal WUGs will be developed using existing water rights, and where water rights need to be obtained, they will be purchased from willing sellers. Few water quality impacts are expected to occur as a result of implementing any of the recommended WMSs in the 2016 Region O plan, the plan does not propose any large transfers of water from agricultural and rural areas, and implementation of the recommended WMSs will not impact navigation.

No unmet municipal or County-other needs remain after the implementation of the recommended WMSs; however, there are unmet needs for other WUGs (e.g., agriculture, livestock, and industrial). The attached Unmet Needs Summary summarizes the unmet needs by WUG category for each decade.

At the formal request of the LERWPG, the TWDB completed a socioeconomic impact analysis for Region O, evaluating the social and economic impacts of not meeting the identified water needs. The evaluation focused on estimating income and job losses, and the results provide estimates of financial transfer impacts (e.g., tax losses, water trucking costs, and utility revenue losses) and social impacts (e.g., lost consumer surplus, population and school enrollment losses). The TWDB estimates that not meeting the identified water needs in Region O would result in an annual combined lost income impact of approximately $4 billion in 2020, increasing to $6 billion in 2070 (estimates are in year 2013 dollars). This would coincide with a loss of approximately 34,000 jobs in 2020, increasing to a loss of approximately 61,000 jobs in 2070.

Drought Response Information, Activities, and Recommendations

The Texas Commission on Environmental Quality (TCEQ) requires that all irrigation districts and wholesale and retail public water suppliers prepare drought contingency plans (DCPs). Within Region O, 53 entities have developed DCPs, and 52 of those were obtained and reviewed. Most of the DCPs were complete, outlining each water system's drought and emergency contingency procedures and identifying the triggering criteria for initiation and termination of drought response stages as well as other water use restrictions in effect during times of water shortages. The majority of DCPs in Region O include quantified water use reduction goals for each stage, notification procedures, and enforcement measures, and some also included allowable variances to the plan.

The LERWPG acknowledges that the DCPs are the best drought management tool for water supplies, and further recognizes that these triggers are subject to change as providers periodically reassess their needs; therefore, the LERWPG encourages both WWPs and other entities to examine their DCPs regularly and update them as needed. Other water users, such as agricultural or industrial users, do not have DCPs. To convey drought conditions to all users of these resources within the planning area, LERWPG proposes that entities who do not have an existing DCP use the U.S. Drought Monitor, and the current plan includes detailed recommendations regarding the drought triggers and responses for existing surface water supplies and groundwater sources that entities in Region O rely upon. Drought contingency planning is considered a critical component of water supply management to provide short-term benefits during severe drought conditions, but drought management alone is not recommended to replace any long-term WMSs.

Entities may experience localized drought conditions or infrastructure failure, temporary water quality impairment, or other unforeseen conditions that result in loss of existing water supplies. To prepare for such events, information on existing infrastructure connections between systems in the region was compiled, and a number of potential emergency connections were identified based on nearby infrastructure between potential suppliers and users, although the feasibility of an agreement between potential entities was not determined. Potential water supply options that can act as a guide for municipal WUGs most vulnerable in the event of a loss of water supply are provided with a high-level analysis of options. The LERWPG supports voluntary water transfers between willing buyers and sellers, but stresses that the governing bodies of each involved party would have to agree before any potential connections and/or transfers could be made.

Unique Stream Segments, Reservoir Sites, and Other Recommendations

The LERWPG does not recommend any stream segments within the planning area for designation as stream segments of unique ecological value. The LERWPG continues to support the designations of Post Reservoir and Jim Bertram Lake 7 as unique reservoir sites, but does not recommend any additional reservoir sites for this designation. LERWPG feels that continued funding for planning and implementation of WMSs is important and supports the following:

- Implementation of and additional funding for high priority WMS projects
- Control of salt cedar and other invasive species such as zebra mussels, quagga mussels, golden algae, milfoil and hydrilla, giant salvinia, and water hyacinth, which have the potential to negatively impact the State's lakes and reservoirs and existing infrastructure
- Development and voluntary use of best management practices to improve recharge and protect playa basins from siltation
- Voluntary protection of springs and seeps as they exist within the region
- Rule of Capture, as modified by the rules and regulations of existing underground water conservation districts, and the Common Law Doctrine of Groundwater Ownership

Reporting of Financing Mechanisms for Water Management Strategies

The LERPWG administered the Infrastructure Financing Report (IFR) survey developed by the TWDB to assess how local governments, regional authorities, and other political subdivisions will finance the implementation of recommended WMSs. IFR survey responses were sought from 45 WUGs that were identified as likely sponsors for 56 of the recommended WMSs and their associated projects. Responses were received from 43 of the 45 WUGs (96 percent) for 48 of the 56 recommended WMSs (86 percent). The IFR results indicate that funding may be sought for 42 of the 48 recommended WMSs with identified project sponsors who responded to the IFR survey. The surveyed WUGs indicated that they may request loans to cover 80 percent or more of the total project costs. Nearly all of the responses indicate that WUGs anticipate requesting funding for one or more project phases by 2020. The total projected capital costs of all recommended Region O WMSs is $814,288,541, including the costs for all project phases. The IFR survey results indicate that Region O project sponsors may seek $400,708,125 in low-interest loans from the TWDB.

Adoption of Plan and Public Participation

Surveys were prepared and information was collected from WWPs and WUGs within Region O to ascertain historical water use and confirm the projected water demands and choice of recommended WMSs. Planning regions that are adjacent to Region O were contacted to coordinate on the current planning effort, including Region A (Panhandle) to the north, Regions B and G (Brazos) to the east, and Region F to the south. Four of the LERWPG voting members also serve as liaisons to the adjacent planning regions.

The LERWPG conducted all regional water planning business in meetings held in accordance with the Texas Open Meetings Act. The meeting agendas and notices were posted on the LERWPG's web site at www.llanoplan.org. The LERWPG allowed for public participation in the regional water planning adoption process in accordance with TWDB regional water planning administrative rules, contract documents, statute, and LERWPG bylaws. Public participation activities that were conducted during this planning cycle included 22 regular regional water planning group meetings held between March 2011 and November 2015 and a public hearing that was held on June 18, 2015. Comments on the Initially Prepared Plan were received from the TWDB, Texas Parks and Wildlife Department, and members of the public, and responses to each of the comments are included in the final plan. The final 2016 Region O regional water plan was adopted by the LERWPG on November 12, 2015.

Implementation and Comparison to the Previous Regional Water Plan

The LERPWG administered the 2011 Implementation Survey developed by the TWDB to assess the level of implementation of the 2011 Region O regional water plan. The survey included questions regarding project description, level of implementation, project cost and funding, and volume of water supplied. For each of the recommended WMSs included in the 2011 plan, available information was compiled through phone and e-mail surveys. The 2011 Region O regional water plan recommended 78 WMSs representing 60 different WUGs. Information was collected for 98 percent of the WUGs (59 of 60). The majority of WMSs (71 percent, 54 of 76 WMSs) have been implemented at some level. Conservation strategies (municipal and irrigation) comprise 78 percent (42 of 54) of these partially or fully implemented strategies.

Most of the recommended strategies (77 percent, 60 of 78 WMSs) in the 2011 Region O regional plan are included in the 2016 Region O regional water plan. The strategies not included in the 2016 plan were either deemed unnecessary due to revised supply and/or demand projections or are no longer considered as a potential strategy for the WUG. A comparison of the data presented in the 2011 and 2016 Region O regional water plans found that:

- Projected demand has decreased about 12 percent from the previous plan due primarily to decreased irrigation demands.
- The drought that occurred from 1950 to 1957 underlies the water supply calculations in both plans; however, present reservoir storage volumes within Region O suggest that the region may be in or has recently experienced a new drought of record. Accordingly, firm surface water supplies within the region were reduced for planning purposes.

- Groundwater availability projected in the 2016 plan is much less than in the previous plan for decade 2020 and moderately to greatly increased in decades 2030 through 2060.

- Surface water availability projected in the 2016 plan is more than 10,000 acre-feet lower in every decade than in the 2011 plan.

- For most WUG categories, the water supplies in the 2016 plan have been reduced below the water supplies from the 2011 plan, some to a significant degree. The only exceptions are the mining and steam-electric categories, where supplies have increased slightly in decades 2030 through 2060 and 2020 through 2050, respectively.

- The projected regional water needs are less for all decades in the 2016 plan compared to the 2011 plan, due mainly to a decrease in the projected irrigation water demand. Compared to the 2011 plan, livestock, manufacturing, mining, and steam-electric power have increased water needs during all decades. Municipal water needs decrease in 2020, but increase from 2030 to 2060.

- The 2011 plan recommended municipal conservation for 25 WUGs. In 2016, municipal conservation projects were recommended for 39 municipal WUGs, including the City of Lubbock. The 2011 plan recommended 25 local groundwater development projects, and the 2016 plan recommends 27 local groundwater development projects. The list of WUGs with recommended local groundwater development projects has changed, and the scopes of the projects that were included in the 2011 plan have been updated. Additional potable water reuse and brackish groundwater desalination projects were added in 2016.

- Water importation was evaluated as a strategy in the 2001 and 2006 plans, but not in 2011. The 2016 plan re-evaluates water importation as a potential strategy, but it is not recommended.

- The City of Lubbock's strategies have been refined and added to since the 2011 plan was adopted, and the 2016 plan reflects the changes to these strategies.

- The only new strategy identified by the planning group during this planning round that has not been considered during previous planning periods was municipal water loss reduction.

Key Findings and Recommendations

The LERWPG acknowledges that agriculture uses the lion's share of water in Region O, but emphasizes that water in support of agricultural production is a worthwhile use of the resource. The region's agricultural production is of great economic benefit and those benefits are statewide. The towns and other sectors of water use and development exist because of agriculture, and the water needs in this region are distinctly different from those in other parts of the state. The small towns have existed because of water, but they are shrinking and many businesses have closed. The LERWPG supports a common sense approach to planning that takes into account the importance of agriculture to this region and the state.

The modeled available groundwater amounts for the 2016 plan are based on the adopted Desired Future Conditions for the groundwater resources within the groundwater management areas 2 and 6, established in 2010. To continue to meet water demands in Region O over the planning horizon, WUGs will need to expand existing water supply sources and/or build new water supply projects. The main threats and constraints to existing and future water supply sources in Region O are declining aquifer levels, permitting issues (related mainly to the availability of unappropriated water and environmental concerns), drought, and invasive species (especially salt cedar, juniper, zebra mussels, and golden algae).

The LERWPG recommends the following:

- Implementation of water conservation measures for all water users to conserve the region's water resources for the future

- Continuation and expansion of the ongoing agricultural conservation activities conducted under the Texas Alliance for Water Conservation program in Region O

- Implementation of the recommended WMSs listed in Table ES-1

- Review of the Texas Drought Preparedness Council Situation Reports by water providers in the region as part of their routine drought monitoring procedures

- Implementation of DCPs by water suppliers when appropriate to reduce demand during drought and to prolong current supplies and development of shortage sharing agreements

- Review of the planning process by a representative stakeholder group made up of planning group members from across the state, leading to revisions to better capture region-specific characteristics as part of the planning process

- Development of direct grants and/or cost-sharing arrangements in addition to the State Water Implementation Fund for Texas (SWIFT) loan program

- Ongoing dedication of funding for projects in the regional and state water plans so that future generations of Texans will have reliable, affordable, and sufficient water supplies

WUG Category Summary

Water User Group (WUG) Category Summary

REGION O	2020	2030	2040	2050	2060	2070
MUNICIPAL						
POPULATION	438,734	480,850	520,999	561,556	602,736	642,235
DEMANDS (acre-feet per year)	81,066	86,726	92,425	98,926	106,044	113,026
EXISTING SUPPLIES (acre-feet per year)	71,138	64,742	64,716	63,437	61,754	59,707
NEEDS (acre-feet per year)*	(12,950)	(23,955)	(29,596)	(37,249)	(45,600)	(54,279)
COUNTY-OTHER						
POPULATION	101,761	113,541	124,981	136,313	148,122	159,484
DEMANDS (acre-feet per year)	13,687	14,708	15,784	16,982	18,353	19,692
EXISTING SUPPLIES (acre-feet per year)	14,109	14,778	15,045	15,915	16,546	18,067
NEEDS (acre-feet per year)*	(283)	(601)	(1,341)	(1,728)	(2,323)	(2,092)
MANUFACTURING						
DEMANDS (acre-feet per year)	16,575	17,346	18,084	18,717	19,738	20,822
EXISTING SUPPLIES (acre-feet per year)	11,421	12,396	13,673	13,841	13,050	13,599
NEEDS (acre-feet per year)*	(5,224)	(4,968)	(4,462)	(4,935)	(6,769)	(7,316)
MINING						
DEMANDS (acre-feet per year)	16,011	17,373	15,729	13,236	10,986	9,333
EXISTING SUPPLIES (acre-feet per year)	7,787	6,759	4,922	2,938	2,363	2,001
NEEDS (acre-feet per year)*	(9,921)	(11,705)	(11,291)	(10,314)	(8,626)	(7,337)
STEAM ELECTRIC POWER						
DEMANDS (acre-feet per year)	25,981	30,376	35,732	42,261	50,221	58,976
EXISTING SUPPLIES (acre-feet per year)	29,376	34,133	41,981	46,373	48,293	47,183
NEEDS (acre-feet per year)*	(7,747)	(6,617)	(3,189)	(4,185)	(5,474)	(11,793)
LIVESTOCK						
DEMANDS (acre-feet per year)	38,828	44,965	46,265	47,638	49,072	50,617
EXISTING SUPPLIES (acre-feet per year)	27,903	31,205	34,138	32,098	30,926	33,632
NEEDS (acre-feet per year)*	(12,134)	(14,505)	(12,889)	(16,273)	(18,793)	(17,631)
IRRIGATION						
DEMANDS (acre-feet per year)	3,518,490	3,396,129	3,271,821	3,152,785	3,038,772	2,938,318
EXISTING SUPPLIES (acre-feet per year)	1,838,906	1,604,789	1,328,028	1,153,935	1,019,259	802,528
NEEDS (acre-feet per year)*	(1,683,573)	(1,795,897)	(1,948,130)	(2,003,648)	(2,024,629)	(2,139,648)
REGION TOTALS						
POPULATION	540,495	594,391	645,980	697,869	750,858	801,719
DEMANDS (acre-feet per year)	3,710,638	3,607,623	3,495,840	3,390,545	3,293,186	3,210,784
EXISTING SUPPLIES (acre-feet per year)	2,000,640	1,768,802	1,502,503	1,328,537	1,192,191	976,717
NEEDS (acre-feet per year)*	(1,731,832)	(1,858,248)	(2,010,898)	(2,078,332)	(2,112,214)	(2,240,096)

*WUG supplies and projected demands are entered for each of a WUG's region-county-basin divisions. The needs shown in the WUG Category Summary report are calculated by first deducting the WUG split's projected demand from its total existing water supply volume. If the WUG split has a greater existing supply volume than projected demand in any given decade, this amount is considered a surplus volume. Before aggregating the difference between supplies and demands to the WUG category level, calculated surpluses are updated to zero so that only the WUGs with needs in the decade are included with the Needs totals.

WUG Second Tier Identified Water Needs Summary

Water User Group (WUG) Second-Tier Identified Water Need Summary

REGION O

	2020	2030	2040	2050	2060	2070
MUNICIPAL	9,901	20,195	25,482	32,698	40,568	48,750
COUNTY-OTHER	253	575	1,310	1,696	2,262	2,024
MANUFACTURING	5,224	4,968	4,462	4,935	6,769	7,316
MINING	9,921	11,705	11,291	10,314	8,626	7,337
STEAM ELECTRIC POWER	7,747	6,617	3,189	4,185	5,474	11,793
LIVESTOCK	12,134	14,505	12,889	16,273	18,793	17,631
IRRIGATION	1,613,509	1,719,032	1,845,999	1,900,784	1,913,896	2,025,046

*Second-tier needs are WUG split needs adjusted to include the implementation of recommended demand reduction and direct reuse water management strategies.

Alternative WUG WMSs and Associated Projects

Alternative Water User Group (WUG) Water Management Strategies (WMS)

WUG Entity Primary Region: O

WUG Entity Name	WMS Sponsor Region	WMS Name	Source Name	2020	2030	2040	2050	2060	2070	Unit Cost 2020	Unit Cost 2070
				Water Management Strategy Supplies							
COUNTY-OTHER, HOCKLEY	O	HOCKLEY COUNTY - SMYER CRMWA LEASE FROM LEVELLAND	A | OGALLALA AQUIFER | ROBERTS COUNTY	30	30	30	30	30	30	$14333	$2867
LUBBOCK	O	LUBBOCK COUNTY - LUBBOCK DIRECT POTABLE REUSE TO NORTH WATER TREATMENT PLANT	O | DIRECT REUSE	10,089	10,089	10,089	10,089	10,089	10,089	$872	$296
LUBBOCK	O	LUBBOCK COUNTY - LUBBOCK DIRECT POTABLE REUSE TO SOUTH WATER TREATMENT PLANT	O | DIRECT REUSE	10,089	10,089	10,089	10,089	10,089	10,089	$1178	$436
LUBBOCK	O	LUBBOCK COUNTY - LUBBOCK NORTH FORK DIVERSION AT CR 7300	O | BRAZOS LUBBOCK COUNT INDIRECT REUSE	10,089	10,089	10,089	10,089	10,089	10,089	$629	$244
LUBBOCK	O	LUBBOCK COUNTY - LUBBOCK NORTH FORK DIVERSION TO LAKE ALAN HENRY PUMP STATION	O | BRAZOS GARZA COUNTY INDIRECT REUSE	7,510	7,510	7,510	7,510	7,510	7,510	$930	$428
LUBBOCK	O	LUBBOCK COUNTY - LUBBOCK POST RESERVOIR	O | POST LAKE/RESERVOIR	10,600	10,600	10,600	10,600	10,600	10,600	$903	$252
LUBBOCK	O	LUBBOCK COUNTY - LUBBOCK RECLAIMED WATER TO AQUIFER STORAGE AND RECOVERY	O | OGALLALA AQUIFER ASR | LUBBOCK COUNTY	8,071	8,071	8,071	8,071	8,071	8,071	$1377	$434
LUBBOCK	O	LUBBOCK COUNTY - LUBBOCK SOUTH FORK DISCHARGE	O | BRAZOS GARZA COUNTY INDIRECT REUSE	8,183	8,183	8,183	8,183	8,183	8,183	$1016	$423
TULIA	O	SWISHER COUNTY - TULIA LOCAL GROUNDWATER DEVELOPMENT (NEW LOCATION)	O | OGALLALA AQUIFER | SWISHER COUNTY	200	200	200	200	200	200	$1625	$285
			Region O Total Alternative WMS Supplies	64,861	64,861	64,861	64,861	64,861	64,861		

Alternative Projects Associated with Water Management Strategies

Project Sponsor Region: O

Sponsor Name	Is Sponsor a WWP?	Project Name	Project Description	Capital Cost	Online Decade
COUNTY-OTHER, HOCKLEY	N	HOCKLEY COUNTY - SMYER CRMWA LEASE FROM LEVELLAND	CONVEYANCE/TRANSMISSION PIPELINE; PUMP STATION; STORAGE TANK	$4,115,000	2020
LUBBOCK	Y	LUBBOCK COUNTY - LUBBOCK DIRECT POTABLE REUSE TO NORTH WATER TREATMENT PLANT	CONVEYANCE/TRANSMISSION PIPELINE; INJECTION WELL; PUMP STATION; WATER TREATMENT PLANT EXPANSION	$69,458,000	2020
LUBBOCK	Y	LUBBOCK COUNTY - LUBBOCK DIRECT POTABLE REUSE TO SOUTH WATER TREATMENT PLANT	CONVEYANCE/TRANSMISSION PIPELINE; INJECTION WELL; PUMP STATION; WATER TREATMENT PLANT EXPANSION; NEW WATER TREATMENT PLANT	$89,441,000	2020
LUBBOCK	Y	LUBBOCK COUNTY - LUBBOCK NORTH FORK DIVERSION AT CR 7300	CONVEYANCE/TRANSMISSION PIPELINE; NEW SURFACE WATER INTAKE; PUMP STATION; WATER TREATMENT PLANT EXPANSION	$46,378,000	2020
LUBBOCK	Y	LUBBOCK COUNTY - LUBBOCK NORTH FORK DIVERSION TO LAKE ALAN HENRY PUMP STATION	CONVEYANCE/TRANSMISSION PIPELINE; NEW SURFACE WATER INTAKE; PUMP STATION; WATER TREATMENT PLANT EXPANSION; NEW WATER RIGHT/PERMIT	$45,058,000	2020
LUBBOCK	Y	LUBBOCK COUNTY - LUBBOCK POST RESERVOIR	CONVEYANCE/TRANSMISSION PIPELINE; PUMP STATION; RESERVOIR CONSTRUCTION; WATER TREATMENT PLANT EXPANSION; NEW SURFACE WATER INTAKE; WATER RIGHT/PERMIT AMENDMENT; WATER RIGHT/PERMIT LEASE OR PURCHASE	$93,192,000	2020
LUBBOCK	Y	LUBBOCK COUNTY - LUBBOCK RECLAIMED WATER TO AQUIFER STORAGE AND RECOVERY	CONVEYANCE/TRANSMISSION PIPELINE; INJECTION WELL; MULTIPLE WELLS/WELL FIELD; PUMP STATION; STORAGE TANK; WATER TREATMENT PLANT EXPANSION; NEW WATER RIGHT/PERMIT	$90,935,000	2020
LUBBOCK	Y	LUBBOCK COUNTY - LUBBOCK SOUTH FORK DISCHARGE	CONVEYANCE/TRANSMISSION PIPELINE; NEW SURFACE WATER INTAKE; PUMP STATION; WATER TREATMENT PLANT EXPANSION; DIVERSION AND CONTROL STRUCTURE; WATER RIGHT/PERMIT AMENDMENT	$57,957,000	2020
TULIA	N	SWISHER COUNTY - TULIA LOCAL GROUNDWATER DEVELOPMENT (NEW LOCATION)	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD; NEW WATER TREATMENT PLANT; PUMP STATION	$3,204,000	2020

Region O Total Alternative Capital Cost	$499,738,000

*Projects with a capital cost of zero are excluded from the report list.

WUG Unmet Needs Summary

Water User Group (WUG) Unmet Needs Summary

REGION O

	2020	2030	2040	2050	2060	2070
MUNICIPAL	0	0	0	0	0	0
COUNTY-OTHER	0	0	0	0	0	0
MANUFACTURING	5,224	4,968	4,462	4,935	6,769	7,316
MINING	9,921	11,705	11,291	10,314	8,626	7,337
STEAM ELECTRIC POWER	7,747	6,617	3,189	4,185	5,474	11,793
LIVESTOCK	12,134	14,505	12,889	16,273	18,793	17,631
IRRIGATION	1,613,509	1,719,032	1,845,999	1,900,784	1,913,896	2,025,046

*WUG supplies and projected demands are entered for each of a WUG's region-county-basin divisions. The unmet needs shown in the WUG Unmet Needs Summary report are calculated by first deducting the WUG split's projected demand from the sum of its total existing water supply volume and all associated recommended water management strategy water volumes. If the WUG split has a greater future supply volume than projected demand in any given decade, this amount is considered a surplus volume. Before aggregating the difference between supplies and demands to the WUG category level, calculated surpluses are updated to zero so that only the WUGs with unmet needs in the decade are included with the Needs totals. Unmet needs water volumes are shown as absolute values.

Chapter 1

Chapter 1

Planning Area Description

1. Planning Area Description

1.1 State Water Planning

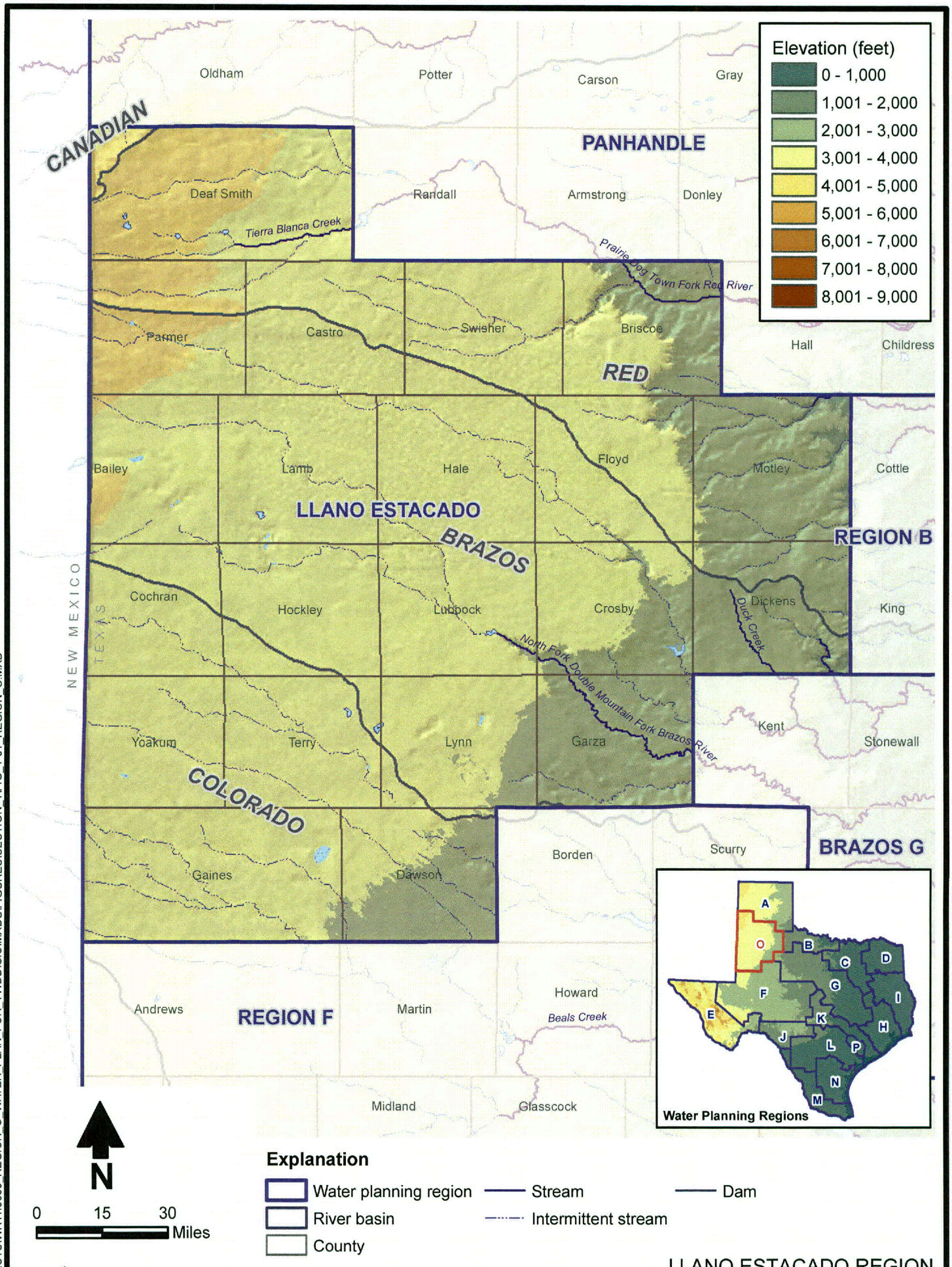
1.1.1 History and Current Status of Texas Water Planning

To better prepare for drought and increasing population, the 75th Texas Legislature passed Senate Bill 1 (SB1) in 1997 to establish rules for Texas state water planning. The water planning process as outlined in SB1 is designed to increase the amount of local participation and input. To accomplish this, SB1 established 16 regional planning groups that are tasked with developing a regional water plan every five years (Figure 1-1).

Regional water plans use a 50-year planning horizon and are required to have the following chapters:

- Planning Area Description
- Population and Water Demand Projections
- Water Availability and Existing Water Supplies
- Identification of Water Needs
- Water Management Strategies
- Impacts of the Regional Water Plan
- Drought Response Information, Activities and Recommendations
- Reporting of Financing Mechanisms for Water Management Strategies
- Adoption of Plan and Public Participation
- Implementation and Comparison to the Previous Regional Water Plan

Once the regional water plans are approved by the regional boards, they are submitted to the Texas Water Development Board (TWDB). The TWDB compiles all of the regional plans, as well as other relevant information, into a State Water Plan. The 2017 State Water Plan will be



LLANO ESTACADO REGION

Region O

Daniel B. Stephens & Associates, Inc.

9/30/2015

JN WR11.0030

Figure 1-1

S:\PROJECTS\WR11.0030_REGION_O_WATER_PLAN_FOR_TWDB\GIS\MXDS\FIGURES\SECTION_1\FIG_1-01_REGION_O.MXD the fourth plan published under SB1 and the tenth plan published in state history. Previous State Water Plans were published in 1961, 1968, 1984, 1990, 1992, 1997, 2002, 2007, and 2012.

1.1.2 Llano Estacado Regional Water Planning Group

The Llano Estacado Regional Water Planning Group (LERWPG), or Region O, is a 21-county area located in the Panhandle of Texas. Figure 1-1 shows a map of Region O, which consists of the following counties:

- Bailey
- Briscoe
- Castro
- Cochran
- Crosby
- Dawson
- Deaf Smith
- Dickens
- Floyd
- Gaines
- Garza
- Hale
- Hockley
- Lamb
- Lubbock
- Lynn
- Motley
- Parmer
- Swisher
- Terry
- Yoakum

SB1 requires that each regional board include representatives from different interest groups. Table 1-1 lists the voting and non-voting members of Region O and the interest group they represent. Region O has 22 voting members from 11 different interest groups. The non-voting members represent various state agencies and private consultants.

Shortly after its inception, Region O drafted a mission statement to highlight the regional importance of agribusiness to the economy and the importance that water has to this industry. The statement, adopted on April 16, 1998, is as follows:

> Develop, promote, and implement water conservation, augmentation, and management strategies to provide adequate water supplies for the Llano Estacado Regional Water Planning Area of the High Plains of Texas and to stabilize or improve the economic and social viability and longevity of the region through these activities.

Table 1-1. Llano Estacado Regional Water Planning Group Members

Interest Group	Name	Entity
Voting members		
Agriculture	H.P. Brown	Texas Cattle Feeders
	Delmon Ellison, Jr.	Agricultural producer
	Mark Kirkpatrick	Farming and ranching
	Jimmy Wedel	Agricultural producer
County governments	Charles (Charlie) Morris	Dickens County Commissioner
Electric generating utilities	Bill Harbin	Lighthouse Electric Coop
Environment	Jim Steiert	West Texas Rural Telephone
GMAs	Jack Campsey	Gateway GCD (GMA 6)
	Ronnie Hopper	Agricultural producer (GMA 2)
Industries (oil & gas)	vacant	—
Municipalities (large)	Aubrey A. Spear, P.E.	City of Lubbock
Municipalities (medium)	Tom Simons	City of Hereford
Municipalities (small)	John Taylor	City of Friona
Public	Dr. Melanie Barnes	Texas Tech University
	Dr. Ken Rainwater	Texas Tech University
River authority	Michael McClendon	Brazos River Authority
Small business	Don McElroy	Irrigation pumps and power
Water districts	Jason Coleman, P.E.	High Plains UWCD No. 1
	Harvey Everheart	Mesa UWCD
	Kent Satterwhite	CRMWA
Water utilities	Doug Hutcheson	City of Wolfforth
Non-voting members		
Regulatory	Sarah Backhouse	TWDB Project Manager
	John Clayton	Texas Parks and Wildlife Department
	Jason Lindeman	Texas Commission on Environmental Quality
	Matt Williams	Texas Department of Agriculture
Technical consultant	Amy Ewing, P.G.	Daniel B. Stephens & Associates, Inc.

GMA = Groundwater Management Area
GCD = Groundwater conservation district
UWCD = Underground water conservation district
TWDB = Texas Water Development Board

High Plains Underground Water Conservation District No. 1 is the political subdivision for the Llano Estacado region. The main technical consultant for this water plan is Daniel B. Stephens & Associates, Inc. (DBS&A). RPS Espey performed the surface water modeling, and Parkhill, Smith and Cooper provided local support.

1.2 Population

In 2010, the population of Texas was approximately 25.1 million (U.S. Census Bureau, 2015). The combined 2010 population of the 21 counties in Region O was 489,926, accounting for 1.9 percent of the state's population. By 2070, it is projected that the population of Region O will increase by 33 percent to 801,719, accounting for 1.6 percent of the state's population. Table 1-2 lists the 2010 population, area, and population density for all counties in Region O. Figure 1-2 shows the historical population of Region O from 1900 to 2010 as well as the projected population of the region from 2010 to 2070.

While Region O is predominately rural, there are several large urban centers. Table 1-3 lists all cities in the region that have a projected population greater than 5,000 at any time between 2020 and 2070. The majority of the region's population is located in Lubbock County. In 2010, this county accounted for roughly 57 percent of the region's population.

1.3 Economic Activity

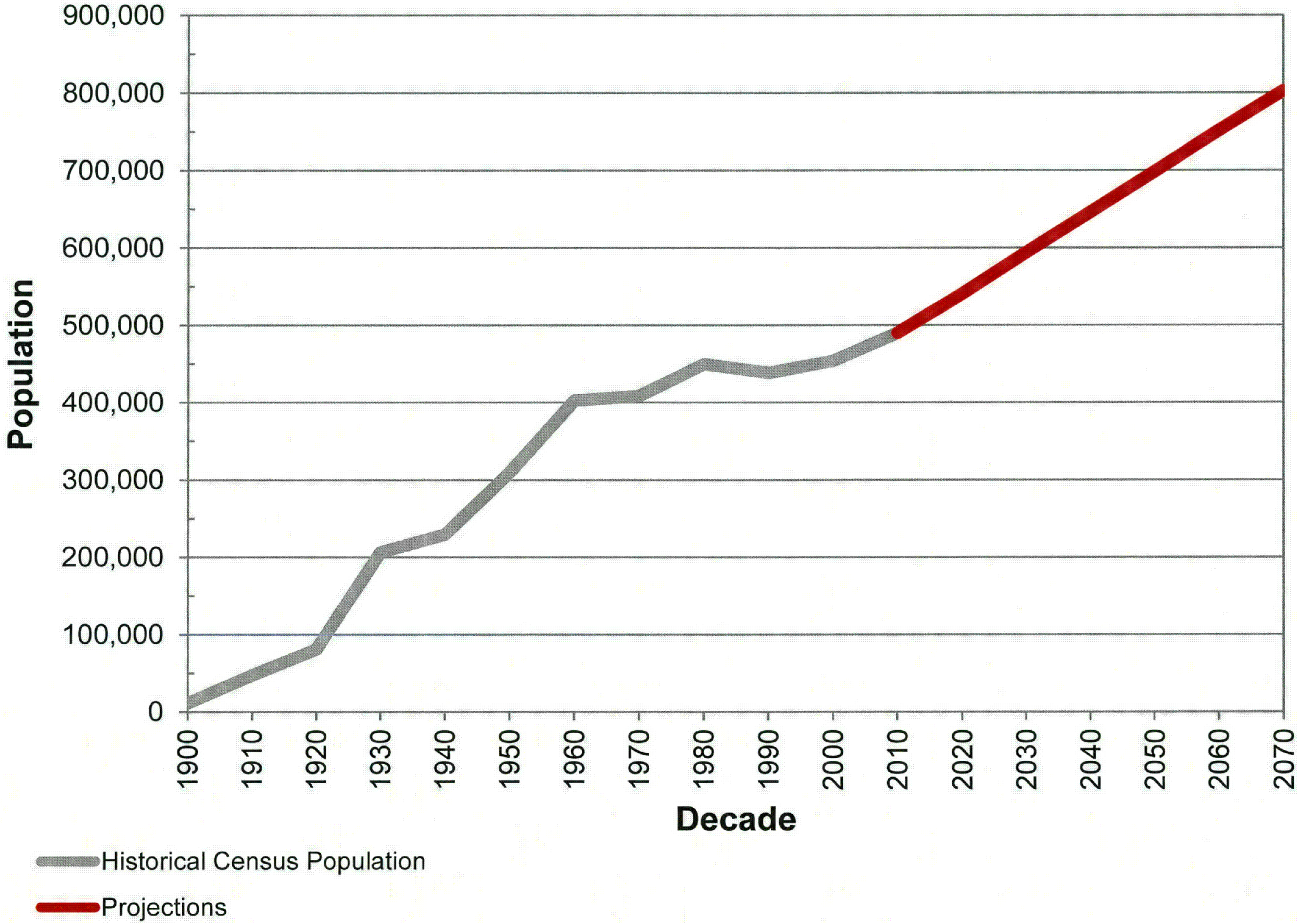
Table 1-4 shows the Region O water demand projections by economic sector for each decade in the planning period. The main economic activity in Region O is agriculture. Cotton, sorghum, corn, and winter wheat are the major crops grown in the Llano Estacado region. For all decades in the planning horizon, water used for agricultural irrigation is projected to account for more than 90 percent of regional water demand.

The U.S. Census Bureau conducts an economic census of all business services (excluding agricultural services) every five years. The most recent available economic census data are from 2007 (the 2012 data have not yet been released). Table 1-5 shows the retail sales, annual payroll, and per capita income by county.

Table 1-2. Region O Population, Area, and Density by County in 2010

County	2010 Census Population [a]	County Area (square miles)	Density per Square Mile
Bailey	7,165	827	8.7
Briscoe	1,637	900	1.8
Castro	8,062	894	9.0
Cochran	3,127	775	4.0
Crosby	6,059	900	6.7
Dawson	13,833	900	15.4
Deaf Smith	19,372	1,497	12.9
Dickens	2,444	902	2.7
Floyd	6,446	992	6.5
Gaines	17,526	1,502	11.7
Garza	6,461	893	7.2
Hale	36,273	1,005	36.1
Hockley	22,935	908	25.2
Lamb	13,977	1,016	13.8
Lubbock	278,831	896	311.3
Lynn	5,915	892	6.6
Motley	1,210	990	1.2
Parmer	10,269	881	11.7
Swisher	7,854	890	8.8
Terry	12,651	889	14.2
Yoakum	7,879	800	9.9
Total	489,926	20,149	24.3

[a] U.S. Census Bureau, 2015



LLANO ESTACADO REGION

Region O Population, 1900 to 2070

Figure 1-2

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Table 1-3. Cities with Populations Greater than 5,000

County	City	2010 Census Population	Projected Population by Decade						Percentage Increase from 2020 to 2070
			2020	2030	2040	2050	2060	2070	
Bailey	Muleshoe	5,158	5,769	6,452	7,131	7,833	8,527	9,208	37
Castro	Dimmitt	4,393	4,845	5,259	5,555	5,830	6,044	6,216	22
Dawson	Lamesa	9,422	9,903	10,251	10,490	10,535	10,840	11,039	10
Deaf Smith	Hereford	15,370	17,576	20,291	23,258	26,623	29,267	32,158	45
Gaines	Seminole	6,430	7,102	7,893	8,834	9,855	10,648	11,475	38
Garza	Post	5,376	6,012	6,452	6,841	7,098	7,466	7,770	23
Hale	Plainview	22,194	23,443	24,453	24,870	24,662	25,312	25,585	8
Hockley	Levelland	13,542	14,839	15,785	16,359	16,467	17,202	17,676	16
Lamb	Littlefield	6,372	6,406	6,366	6,249	6,034	5,984	5,874	–9
Lubbock	Lubbock	229,573	255,257	283,597	312,043	342,371	371,227	399,846	36
	Slaton	6,121	6,179	6,257	6,352	6,467	6,547	6,621	7
	Wolfforth	3,670	4,577	5,577	6,569	7,614	8,633	9,647	53
Parmer	Friona	4,123	4,587	5,079	5,520	5,953	6,462	6,924	34
Swisher	Tulia	4,967	5,222	5,483	5,564	5,530	5,803	5,932	12
Terry	Brownfield	9,657	10,381	11,036	11,696	12,296	12,860	13,386	22
Yoakum	Denver City	4,479	5,072	5,736	6,327	6,955	7,618	8,249	39

Table 1-4. Projected Water Demand by Economic Sector, 2020 through 2070

Category	Projected Water Demand (acre-feet per year)					
	2020	2030	2040	2050	2060	2070
Irrigation	3,518,490	3,396,129	3,271,821	3,152,785	3,038,772	2,938,318
Municipal	94,753	101,434	108,209	115,908	124,397	132,718
Manufacturing	16,575	17,346	18,084	18,717	19,738	20,822
Steam-electric power	25,981	30,376	35,732	42,261	50,221	58,976
Mining	16,011	17,373	15,729	13,236	10,986	9,333
Livestock	38,828	44,965	46,265	47,638	49,072	50,617
Region O Total	3,710,638	3,607,623	3,495,840	3,390,545	3,293,186	3,210,784
Texas Total	18,411,628	19,189,436	19,713,045	20,261,283	20,858,870	21,601,698

Table 1-5. Region O Retail Sales, Annual Payroll, and Per Capita Income by County

County	Retail Sales 2007 ($)	Annual Payroll 2007 ($)	Per Capita Income 2009-2013 ($)
Bailey	41,726,000	39,974,000	18,676
Briscoe	6,660,000	3,503,000	20,697
Castro	5,579,000	27,005,000	19,708
Cochran	26,876,000	10,867,000	17,371
Crosby	23,791,000	31,983,000	18,959
Dawson	148,370,000	74,110,000	17,677
Deaf Smith	224,228,000	167,267,000	17,532
Dickens	11,311,000	9,031,000	20,578
Floyd	40,010,000	28,379,000	21,655
Gaines	82,554,000	116,746,000	21,572
Garza	34,963,000	38,750,000	16,175
Hale	325,074,000	329,688,000	18,004
Hockley	201,686,000	195,205,000	21,984
Lamb	95,775,000	85,849,000	18,744
Lubbock	3,924,861,000	3,101,080,000	23,773
Lynn	19743000	21,431,000	21,639
Motley	5,220,000	4,260,000	18,828
Parmer	39,479,000	96,705,000	19,304
Swisher	35,247,000	26,470,000	17,880
Terry	133,700,000	70,566,000	21,201
Yoakum	36,959,000	88,047,000	21,389
Total	5,463,812,000	4,566,916,000	413,346
Average	260,181,524	217,472,190	19,683
Median	39,479,000	39,974,000	19,304

1.4 Current Water Use

The TWDB compiles historical water use estimates by county. Figure 1-3 and Table 1-6 show Region O's total water use from 2003 through 2012 (10 years) as well as the percentage of use from groundwater sources versus surface water sources. The region's 10-year average water use is 3,787,711 acre-feet per year, of which 98.6 percent (3,735,466 acre-feet) is from groundwater sources and 1.4 percent (52,245 acre-feet) is from surface water sources.

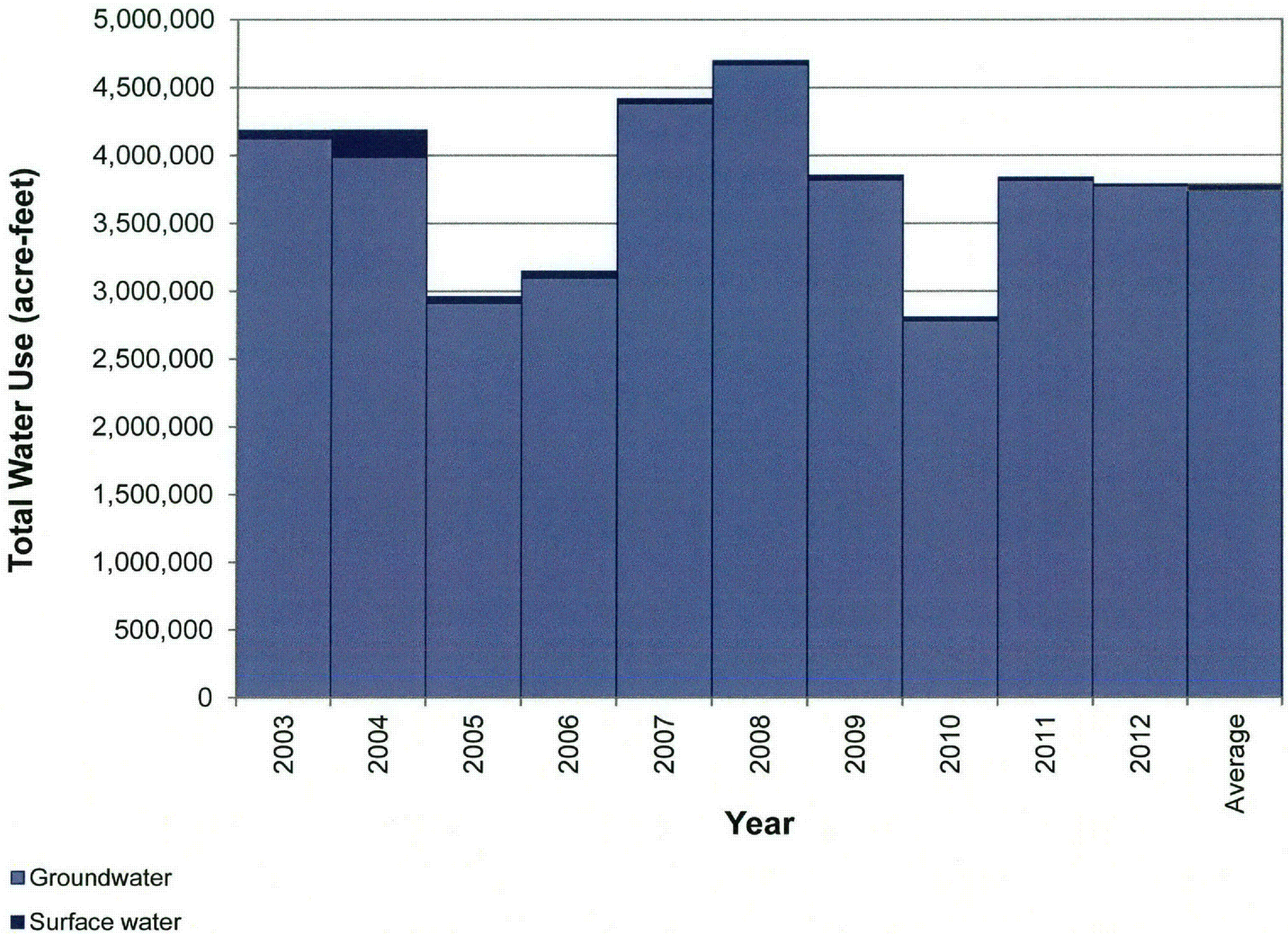

Figure 1-3

LLANO ESTACADO REGION

Total Water Use by Source, 2003 to 2012

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Table 1-6. Region O Total Water Use, 2003 to 2012

Year	Total Water Use (acre-feet)	Source (% of total)	
		Surface Water	Groundwater
2003	4,183,568	1.4	98.6
2004	4,186,601	4.8	95.2
2005	2,959,070	1.6	98.4
2006	3,147,336	1.6	98.4
2007	4,417,893	0.8	99.2
2008	4,697,179	0.6	99.4
2009	3,854,159	0.9	99.1
2010	2,808,422	1.1	98.9
2011	3,836,918	0.6	99.4
2012	3,785,966	0.4	99.6
Average	3,787,711	1.4	98.6

Table 1-7 and Figure 1-4 show Region O's water use by economic sector during this 10-year period. Unquestionably, the region's largest water demand has been for irrigated agriculture. On average, from 2003 to 2012, 95 percent of the region's water use was attributed to irrigated agriculture. Table 1-8 and Figure 1-5 show the historical and future irrigation water use by county in the region from 1980 to 2070. Castro, Hale, and Parmer counties have the largest irrigation water demands.

After agriculture, the next largest water demand is for municipalities. From 2003 to 2012, municipal water use accounted for 2.2 percent of the region's total demand. The City of Lubbock is the largest municipality, containing approximately 47 percent of the regional population during the 2010 Census. In 2010, the City of Lubbock used just over 1 percent of the total regional water demand (49 percent of the 2010 municipal water use).

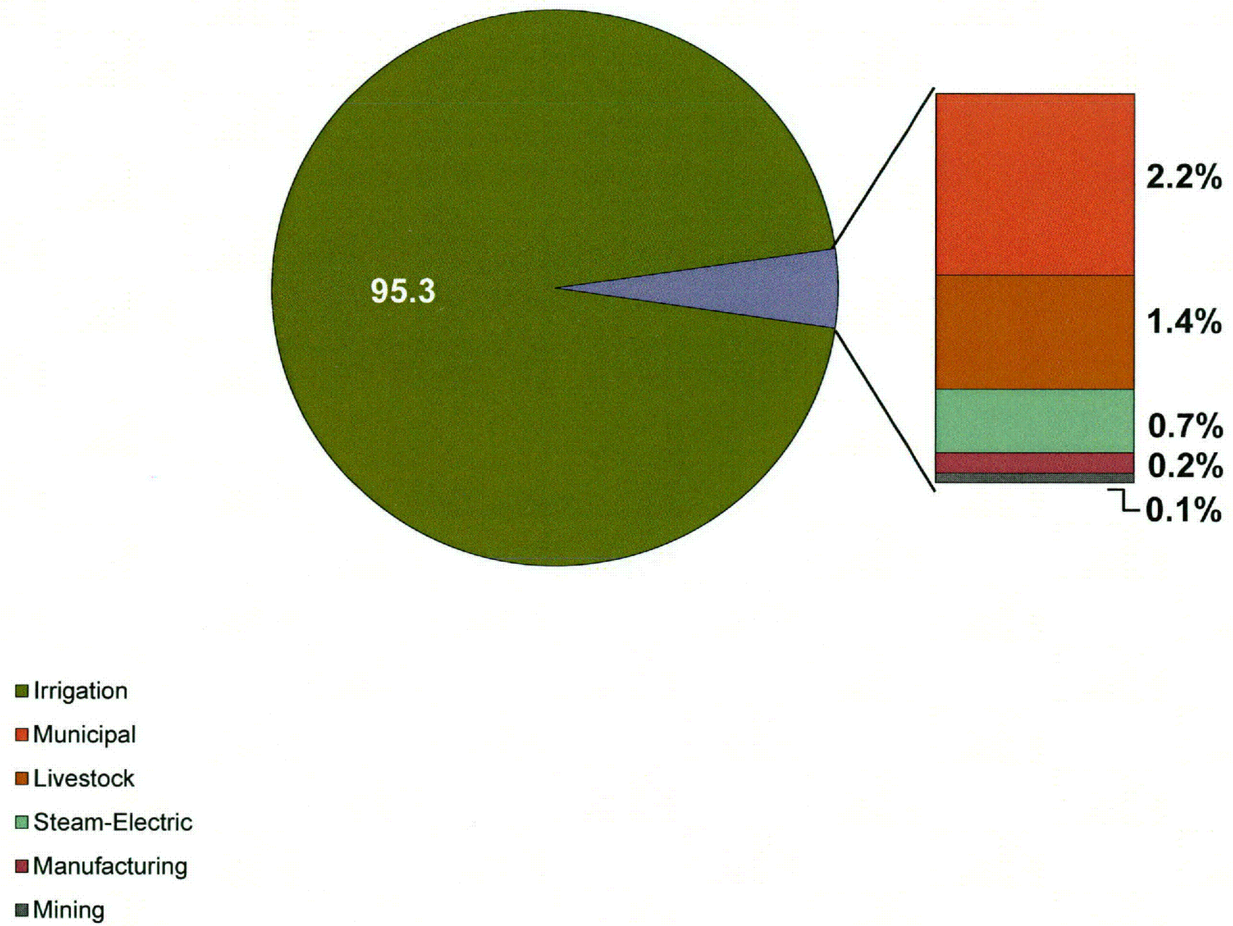
1.5 Current Water Supplies and Water Quality

Table 1-9 lists the current water supplies in the Llano Estacado region. Each supply is discussed in more detail in the following sub-sections.

Table 1-7. Region O Water Use by Economic Sector, 2003 to 2012

Year	Municipal		Manufacturing		Mining		Steam-Electric Power		Irrigation		Livestock		Total (acre-feet)
	(acre-feet)	(%) [a]	(acre-feet)	(%) [a]	(acre-feet)	(%) [a]	(acre-feet)	(%) [a]	(acre-feet)	(%) [a]	(acre-feet)	(%) [a]	
2003	90,534	2.2	9,372	0.2	2,124	0.1	16,002	0.4	4,027,280	96.3	38,256	0.9	4,183,568
2004	76,275	1.8	8,011	0.2	2,190	0.1	166,787	4.0	3,893,094	93.0	40,244	1.0	4,186,601
2005	80,258	2.7	6,663	0.2	2,202	0.1	15,037	0.5	2,810,044	95.0	44,866	1.5	2,959,070
2006	83,896	2.7	7,480	0.2	2,177	0.1	12,861	0.4	2,966,991	94.3	73,931	2.3	3,147,336
2007	70,155	1.6	6,553	0.1	2,040	0.0	11,952	0.3	4,281,381	96.9	45,812	1.0	4,417,893
2008	75,421	1.6	11,557	0.2	9,604	0.2	12,840	0.3	4,531,551	96.5	56,206	1.2	4,697,179
2009	75,533	2.0	11,587	0.3	7,757	0.2	11,855	0.3	3,692,892	95.8	54,535	1.4	3,854,159
2010	75,884	2.7	9,579	0.3	7,000	0.2	12,579	0.4	2,656,242	94.6	47,138	1.7	2,808,422
2011	97,406	2.5	9,922	0.3	6,977	0.2	12,036	0.3	3,656,689	95.3	53,888	1.4	3,836,918
2012	85,764	2.3	10,045	0.3	1,467	0.0	12,052	0.3	3,622,253	95.7	54,385	1.4	3,785,966
Average	81,113	2.2	9,077	0.2	4,354	0.1	28,400	0.7	3,613,842	95.3	50,926	1.4	3,787,711

[a] Percentage of Region O total water use



LLANO ESTACADO REGION

Total Water Use by Sector, 2003 to 2012

Figure 1-4

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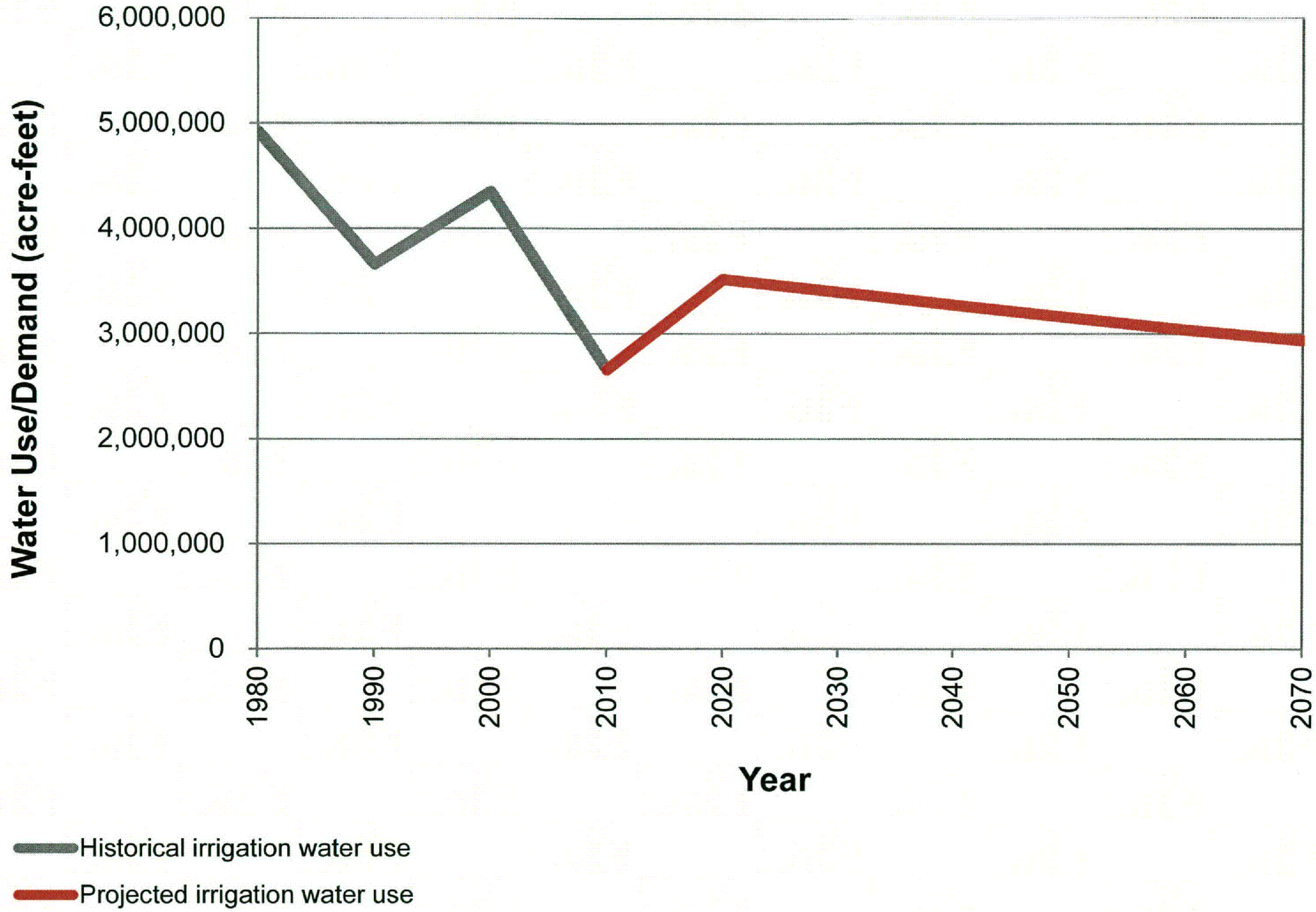
Table 1-8. Historical and Future Irrigation Water Demand by County

County	Historical Irrigation Water Use (acre-feet per year)				Projected Irrigation Water Demand (acre-feet per year)					
	1980	1990	2000	2010	2020	2030	2040	2050	2060	2070
Bailey	410,640	220,775	182,865	61,429	119,268	116,407	113,614	110,888	108,227	105,752
Briscoe	48,963	39,592	26,329	28,904	37,260	35,908	34,604	33,348	32,137	31,052
Castro	418,174	351,189	503,792	352,244	387,976	373,101	358,796	345,040	331,812	320,029
Cochran	97,313	32,679	119,985	66,485	102,229	98,284	94,489	90,841	87,334	84,214
Crosby	142,064	105,634	112,135	78,949	117,362	112,634	108,095	103,742	99,564	95,864
Dawson	58,083	39,097	146,039	78,974	106,630	100,619	94,945	89,594	84,544	80,286
Deaf Smith	309,193	285,459	372,827	178,570	193,410	187,282	181,349	175,604	170,041	164,985
Dickens	7,689	4,779	9,486	8,662	9,363	9,085	8,814	8,550	8,293	8,060
Floyd	303,154	131,706	237,020	102,458	147,725	141,841	136,191	130,767	125,559	120,941
Gaines	517,051	392,950	414,772	318,882	379,779	360,000	341,251	323,477	306,629	292,238
Garza	7,110	4,383	12,165	7,354	11,621	10,937	10,299	9,697	9,130	8,655
Hale	675,720	461,931	367,700	219,643	369,812	357,560	345,713	334,258	323,183	313,161
Hockley	135,358	92,968	174,996	98,943	131,207	126,077	121,146	116,409	111,858	107,813
Lamb	614,029	351,050	377,893	182,763	325,356	312,802	300,732	289,129	277,974	268,045
Lubbock	137,753	230,717	242,978	106,030	169,242	159,740	150,773	142,310	134,322	127,582
Lynn	71,586	39,988	120,372	53,247	84,566	80,019	75,711	71,641	67,790	64,515
Motley	3,558	3,883	9,168	6,067	9,439	9,159	8,884	8,617	8,359	8,123
Parmer	437,315	475,000	415,449	256,507	329,806	326,305	322,840	319,413	316,021	312,736
Swisher	212,835	139,650	171,706	113,473	196,895	203,171	202,011	200,857	199,709	198,581
Terry	134,576	131,901	203,141	137,221	143,461	136,107	129,129	122,508	116,226	110,848
Yoakum	179,008	122,409	127,059	199,437	146,083	139,091	132,435	126,095	120,060	114,838
Total	4,921,172	3,657,740	4,347,877	2,656,242	3,518,490	3,396,129	3,271,821	3,152,785	3,038,772	2,938,318



LLANO ESTACADO REGION

Historical and Projected Irrigation Water Use 1980 to 2070

Figure 1-5

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Table 1-9. Water Supplies in Region O

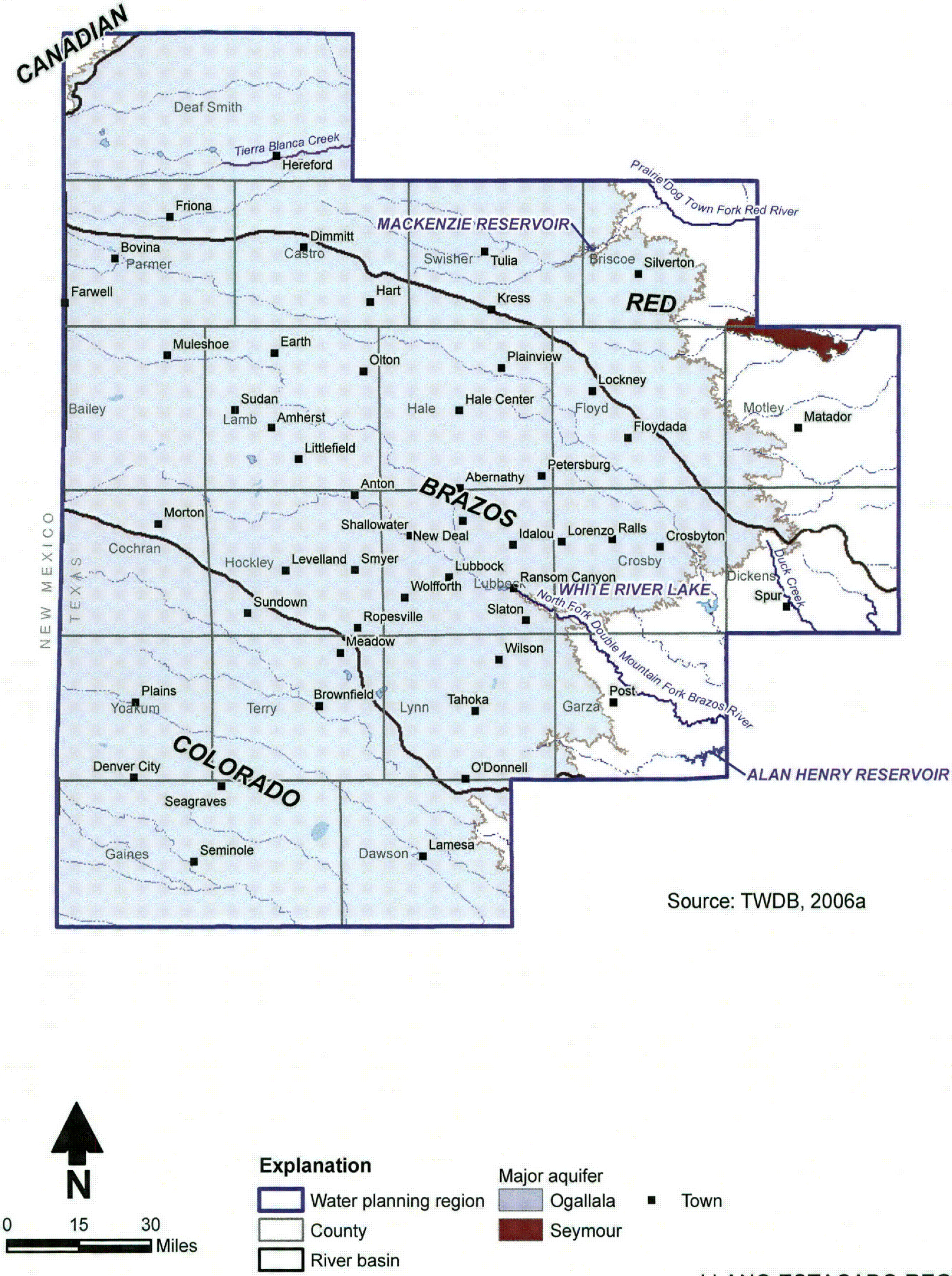
Source Type	Water Source
Groundwater (aquifers)	Ogallala
	Seymour
	Edwards-Trinity (High Plains)
	Dockum (Santa Rosa)
Springs	Hulsey
	Couch
	Buffalo
	Roaring
Surface water	Brazos River Basin
	Canadian River Basin
	Colorado River Basin
	Red River Basin
	Playa Lakes
Developed surface water	Lake Alan Henry
	Lake Meredith
	Lake Mackenzie
	White River Lake
Reuse	No active projects

1.5.1 Groundwater Sources

There are two major aquifers in Region O, the Ogallala and Seymour aquifers, and two minor aquifers, the Edwards-Trinity (High Plains) and the Dockum (Santa Rosa) aquifers (Figures 1-6a and 1-6b). Figure 1-7 depicts the major geologic formations in the region.

1.5.1.1 Ogallala Aquifer

The Ogallala Aquifer is the largest aquifer in the United States, providing water to portions of eight states in the Great Plains (South Dakota, Wyoming, Nebraska, Colorado, Kansas, Oklahoma, New Mexico, and Texas). In Texas, the Ogallala Aquifer covers 36,515 square miles in all or part of 48 counties. The Canadian River divides the formation into northern and southern portions, which are hydrologically unconnected. Region O is located in the southern portion.



Source: TWDB, 2006a

LLANO ESTACADO REGION
Major Aquifers

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Figure 1-6a

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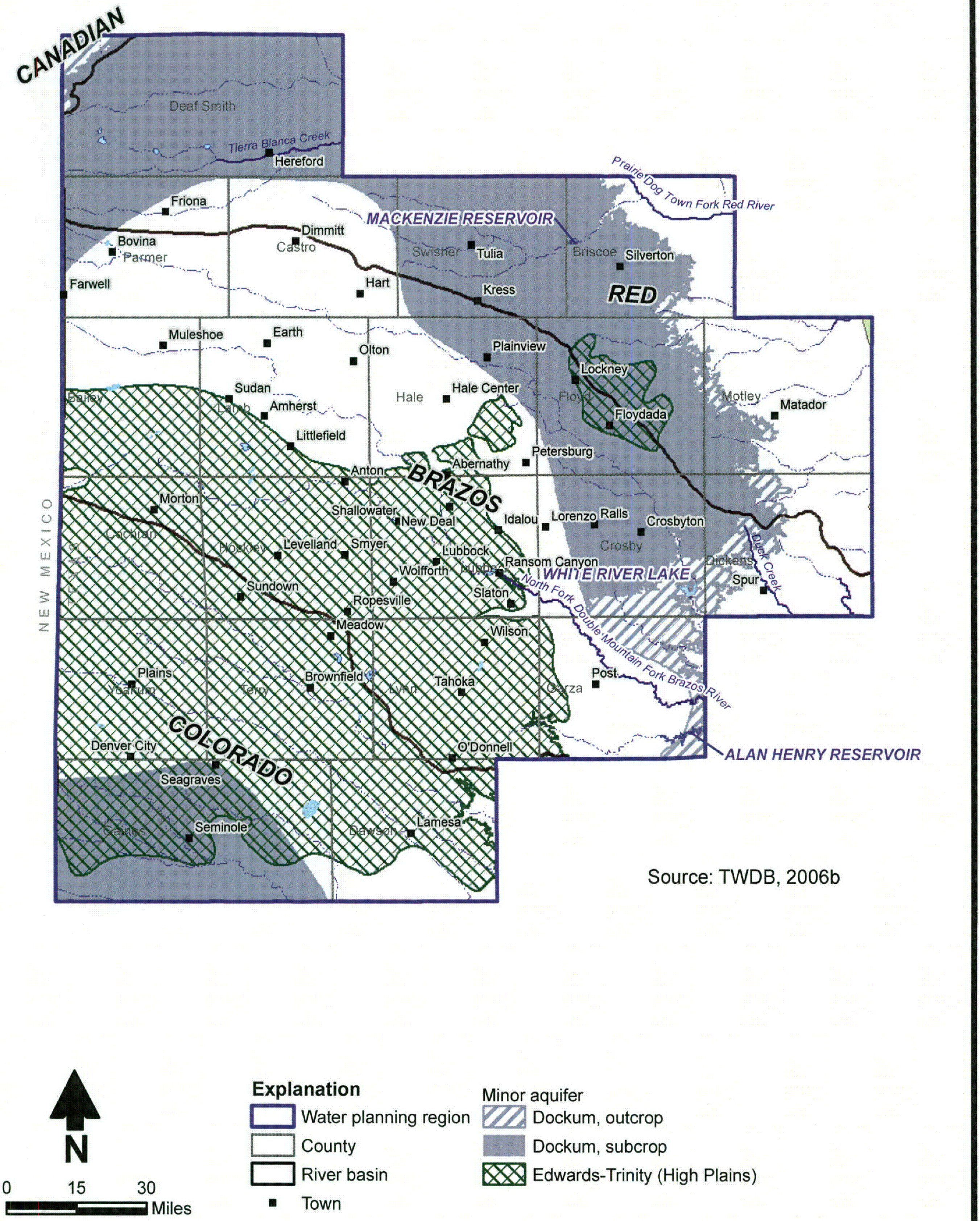

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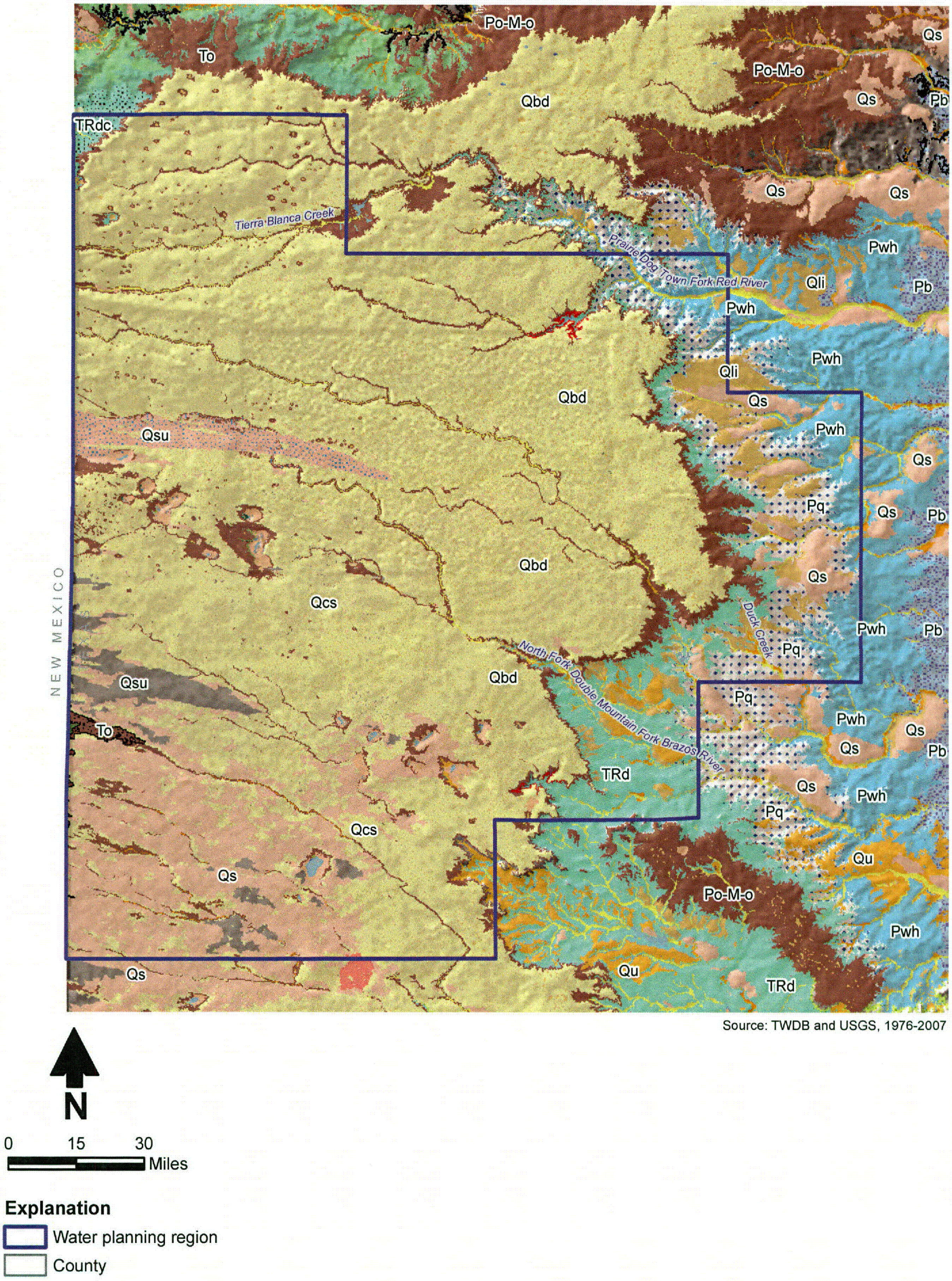
LLANO ESTACADO REGION
Minor Aquifers

Figure 1-6b



LLANO ESTACADO REGION

Regional Geology

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Figure 1-7 page 1 of 2

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Geology Explanation

- JR, Jurassic rocks undivided
- K, Cretaceous rocks undivided
- Ka, Antlers Sand
- Kcp, Comanche Peak Limestone
- Kdc, Duck Creek Formation
- Kdk, Duck Creek Shale and Kiamichi Shale undivided
- Ked, Edwards Limestone
- Kfr, Fredericksburg Group
- Kft, Fort Terrett Formation
- Kk, Kiamichi Formation
- Kki, Kiamichi Shale
- Pb, Blaine Formation
- Po-M-o, Ogallala Formation
- Pob, Blanco Formation
- Pq, Quartermaster Formation
- Pqw, Quartermaster Formation Cloud Chief Gypsum and Whitehorse Sandstone
- Pwh, Whitehorse Sandstone and Cloud Chief Gypsum
- Qal, Alluvium
- Qbd, Blackwater Draw Formation
- Qc, Other covering deposits
- Qcc, Caliche
- Qcd, Eolian deposits
- Qcs, Windblown cover sand
- Qds, Windblown sand
- Qhg, High terrace gravel
- Qla, Double Lakes Formation
- Qli, Lingos Formation
- Qp, Playa deposits
- Qpd, Pediment deposits
- Qs, Windblown sand: Sand and silt
- Qsd, Windblown Sand (dunes and dune ridges)
- Qse1, Seymour Formation: thin deposits
- Qsgc, Colluvial deposits
- Qsu, Windblown deposits
- Qt, Fluviatile Terrace deposits
- Qta, Tahoka Formation
- Qtu, Tule Formation
- Qu, Quaternary deposits undivided
- Qun, Pond deposits
- TR, Triassic rocks undivided
- TRc, Chinle Formation
- TRd, Dockum Group
- TRdc, Chinle Formation
- TRdj, Trujillo Formation
- TRdv, Tecovas Formation
- To, Ogallala Formation
- Wa, Water

Source: TWDB and USGS, 1976-2007

N

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LLANO ESTACADO REGION
Regional Geology Explanation

Figure 1-7 page 2 of 2

The Ogallala Formation consists of sand, gravel, clay, and silt deposited during the Tertiary Period. The maximum reported thickness is 800 feet, although the average freshwater saturated thickness is 95 feet. The average yield from an Ogallala well is 500 gallons per minute (gpm), with a maximum yield of 2,000 gpm. In general, the groundwater gradient is to the southeast.

Water in the Ogallala Aquifer is classified as fresh, but there is a significant difference in quality between the northern and southern portions of the aquifer. Generally, the northern Ogallala has a higher saturated thickness and water quality. In 1993, the TWDB conducted an extensive water quality study of the Ogallala Aquifer (Hopkins, 1993). Table 1-10 shows several different water quality parameters for the northern and southern Ogallala.

Table 1-10. Water Quality in the Ogallala

	Concentration (mg/L [b])			
	North		South	
Parameter [a]	Range [b]	Average	Range [b]	Average
Major Anions and Cations				
Calcium	16 – 562	49	26 – 573	104
Chloride	1 – 583	29	6 – 3,069	256
Fluoride	<0.1-5	1.6	0.2 – 12.1	3.5
Magnesium	2 – 131	26	9.5 – 524	78
Potassium	0.7 – 14	6.1	3-78	14.2
Sodium	3.6 – 261	36	13 – 1,340	156
Sulfate	3 – 1,882	46	19 – 2,262	285
Dissolved solids	98 – 2,732	366	319 – 6,642	1,132
Hardness [c]	98 – 1,956	230	151 – 3,585	421
Nutrients				
Nitrate	0.5% [c]	9.8	19.8% [c]	31.8
Orthophosphate [d]	NA	0.05	NA	0.06

Source: Hopkins, 1993
[a] Samples collected from 1989 to 1992
[b] Unless otherwise noted
[c] Hardness is measured as calcium carbonate
[d] Percentage exceeding the MCL
[e] Type of phosphate used in fertilizers

mg/L= Milligrams per liter
NA = Percentage exceeding the MCL not available

The Ogallala Aquifer is critical to the economy in Texas. Over 95 percent of the water pumped from the aquifer is used for irrigated agriculture. Additionally, the Ogallala is the sole source for many municipalities in the region. In Region O, the Ogallala Aquifer accounts for more than 85 percent of the total estimated water supplies (surface and groundwater) throughout the planning period (2020 to 2070).

1.5.1.2 Seymour Aquifer

The Seymour Aquifer is a major aquifer that extends across north and central Texas. This Quaternary-age aquifer consists of isolated pods of water-bearing alluvial sediments found in 23 counties. In general, water yields are higher in the lower portion of the aquifer. The average yield of a Seymour well is 300 gpm (range <100 gpm to 1,300 gpm). The water levels in the Seymour Aquifer have remained relatively constant in recent years. In Region O, the Seymour Aquifer accounts for less than half of 1 percent of the total estimated water supplies throughout the planning period (2020 to 2070). Approximately 90 percent of water pumped from the Seymour is used for irrigation, with the remaining 10 percent used for municipal water systems.

Water quality in the Seymour is highly dependent on location. In most areas, the groundwater ranges from fresh to slightly saline with total dissolved solids (TDS) concentrations ranging from 100 to 3,000 milligrams per liter (mg/L). However, in some localities, the water is considered highly saline, with TDS concentrations as high as 10,000 mg/L. In most areas of the Seymour Aquifer, nitrate concentrations exceed the state's primary drinking water standard of 10 mg/L. The Texas Water Resources Institute reports that the nitrate concentrations exceed the state's standard in more than 75 percent of Seymour wells tested, with a maximum reported nitrate concentration of 35 mg/L. Chloride concentrations are also high in most areas of the Seymour.

1.5.1.3 Edwards-Trinity (High Plains) Aquifer

The Edwards-Trinity (High Plains) Aquifer is a minor aquifer in the Texas Panhandle, covering more than 7,800 square miles across 14 counties. This aquifer lies between the Ogallala Aquifer (overlying) and the Dockum Aquifer (underlying). While similar in name, this aquifer is distinct from the Edwards, Trinity, Edwards-Trinity (Plateau), and High Plains aquifers (Ashworth and Hopkins, 1995).

The Edwards-Trinity (High Plains) Aquifer was formed in the Cretaceous Period and consists of three main water-bearing formations: the sandstone of the Antlers Formation (Trinity Group), the limestone of the Comanche Peak Formation, and the limestone of the Edwards Formation. Generally, water moves in a southeasterly direction. The average saturated thickness is 126 feet. Approximately 95 percent of water pumped from the Edwards-Trinity (High Plains) Aquifer is used for irrigation. The majority of recharge occurs through leakage from the overlying Ogallala Aquifer.

Groundwater in the Edwards-Trinity (High Plains) Aquifer is slightly saline. In most areas, TDS ranges from 1,000 to 2,000 mg/L; however, concentrations exceeding 3,000 mg/L have been reported. Higher TDS levels are found in areas where saline lakes or the gypsum-rich Tahoka and Double Lakes Formation overlie the aquifer (TWDB, 2015a). The USGS Groundwater Atlas (Ryder, 1996) reports that water in the Edwards-Trinity (High Plains) Aquifer is "slightly to moderately" hard. In Region O, the Edwards-Trinity (High Plains) Aquifer accounts for less than half of 1 percent of the total estimated water supplies throughout the planning period (2020 to 2070).

1.5.1.4 Dockum Aquifer

The Dockum Aquifer is a minor aquifer located in 46 counties in northwest Texas that supplies water for use in irrigation, public water supply, livestock, manufacturing, and the oil and gas industry. In Region O, the Dockum Aquifer accounts for close to 1 percent of the total estimated water supplies throughout the planning period (2020 to 2070). This Triassic-age aquifer includes all formations of the Dockum group (oldest to youngest): the Santa Rosa Formation, the Tecovas Formation, the Trujillo Sandstone, and the Cooper Canyon Formation. Sandstones near the base of the Dockum group produce the highest water yields and are often referred to collectively as the Santa Rosa Aquifer.

While freshwater exists in some outcrop areas, water quality in the Dockum Aquifer is generally poor and tends to decrease with depth. TDS concentrations range from less than 1,000 mg/L (freshwater) in outcrop areas to more than 60,000 mg/L (brine) in the depths of the aquifer (Bradley and Kalaswad, 2003). Throughout much of the aquifer, the concentrations of nitrate, radium-226, radium-228, and uranium exceed the state's primary drinking water standards. The average hardness of groundwater in the Dockum is 470 mg/L, ranging from less than 25 mg/L to more than 3,600 mg/L. In some areas, sodium concentrations in the Dockum are so high that the water causes crop damage if used for irrigation.

1.5.2 Major Springs

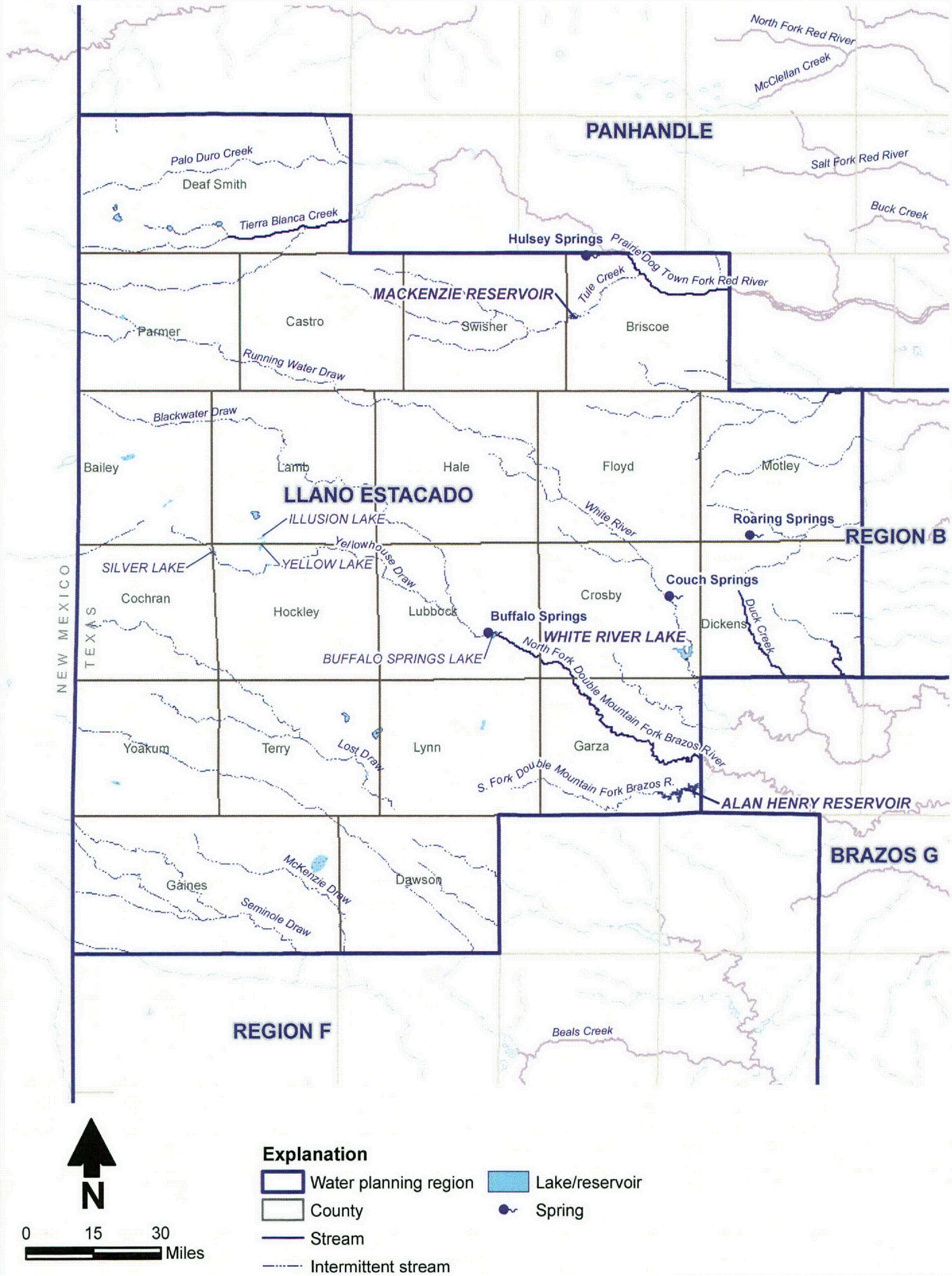
While the region once had numerous active springs, conversion of native grasslands to agriculture has caused the majority of springs to become inactive. Declines in the water table caused by groundwater pumping for irrigated agriculture is the main reason for the reduction in the number of active springs. To a lesser extent, sedimentation caused by loss of native groundcover is also cited as a cause of the reduced number of active springs. According to the TWDB (Brune, 1975), there are four major springs in Region O today (Figure 1-8):

- Hulsey Springs
- Couch Springs
- Buffalo Springs
- Roaring Springs

Hulsey Springs is a group of several springs located within Palo Duro Canyon in Briscoe County. Discharge rates at the springs have dropped significantly in the last century due to irrigation. The TWDB reports that in September 1946 the discharge rate was 2.1 cubic feet per second (cfs), but by June 1971, the discharge rate had dropped to 0.2 cfs. This spring produces water from the Santa Rosa Sandstone, part of the Dockum Aquifer.

Couch Springs is located 8 miles east of Crosbyton in Crosby County in the Brazos River Basin. This spring produces water from the Ogallala Aquifer. The flow rate was last measured in November 1938 at 1.9 cfs.

Buffalo Springs is a system of six springs located 9 miles southeast of the City of Lubbock in Lubbock County. Buffalo Springs produces water from the Comanche limestone in the Edwards-Trinity (High-Plains) Formation. The flow rate was last measured in 1976 at 1,347 gpm.



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LLANO ESTACADO REGION
Surface Water Features

Daniel B. Stephens & Associates, Inc.
9/30/2015
JN WR11.0030

Figure 1-8

Roaring Springs is located 4 miles south of the town of Roaring Springs in Motley County in the Red River Basin. This spring produces water from the Santa Rosa Sandstone and the Ogallala Aquifer. The TWDB reports that in 1937, the discharge rate was 1.1 cfs and remained relatively constant until 1973 when the rate was 1.3 cfs. No more current measurements are available.

As reported in *Springs and Seeps of the Llano Estacado Region* (prepared by LERWPG member Jim Steiert and provided in Appendix 1A), information collected through extensive phone interviews in 2004, 2005, and 2015 indicates that there are numerous smaller springs and seeps in the region. These springs and seeps provide local water for livestock and wildlife; however, many only revive after heavy rainfall.

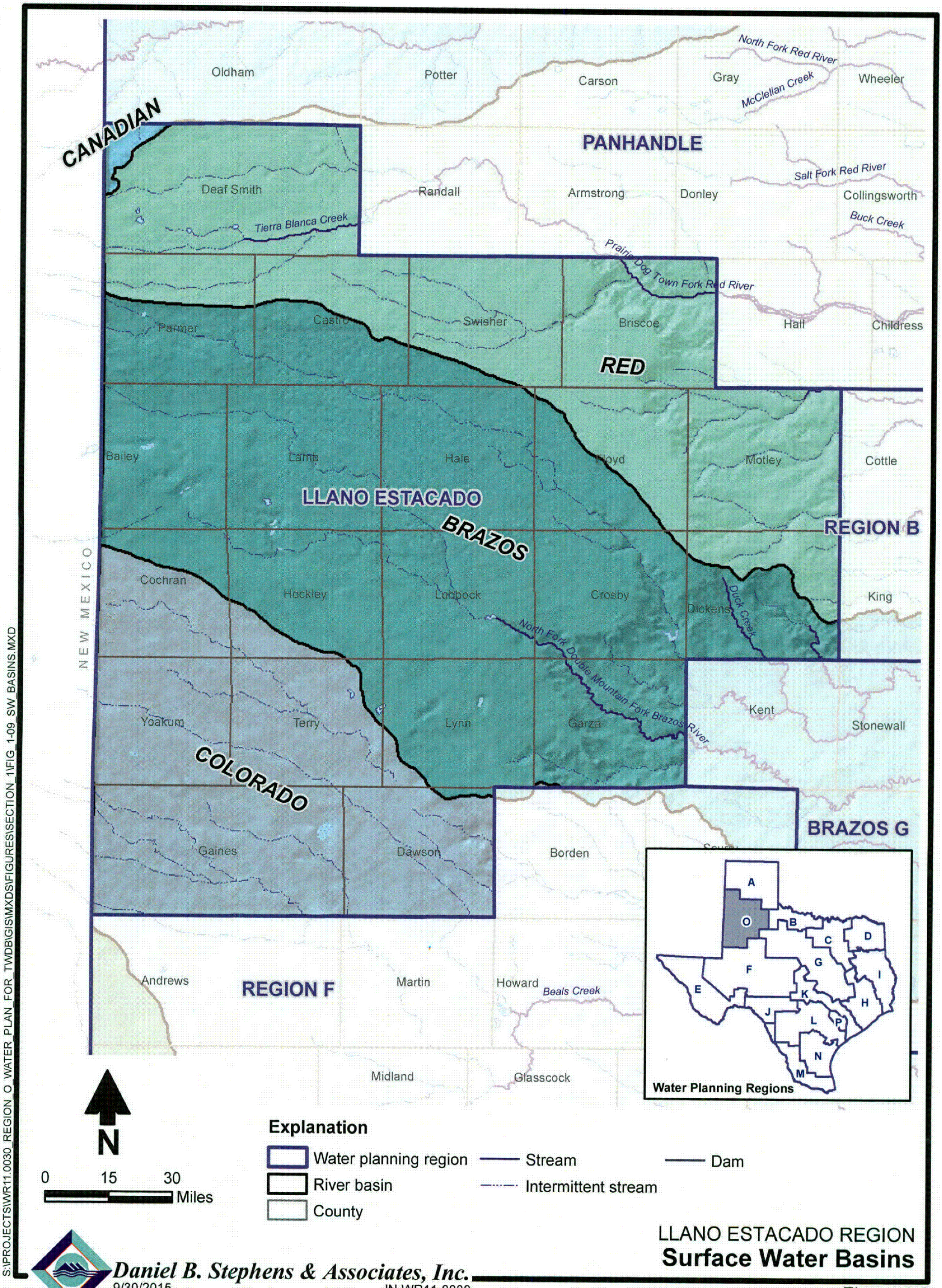
1.5.3 Surface Water

While there is very little surface water within Region O, four river basins dissect the region. Playa lakes also occur naturally in most counties in the region.

1.5.3.1 River Basins

The four river basins in Region O are the Brazos, Canadian, Colorado, and Red (Figure 1-9). Table 1-11 shows which counties are in each basin, and Table 1-12 shows the area, river length, and average flow of each basin. These four basins are discussed in detail below.

1.5.3.1.1 Brazos River Basin. The Brazos River Basin is the second largest river basin in Texas (behind the Rio Grande River Basin), encompassing more than 42,000 square miles in Texas. The Brazos River Authority identifies 14 different watersheds within the basin, of which only 2, the Caprock and the Salt and Double Mount Forks of the Brazos River are in Region O. The Caprock watershed is considered "non-contributing" to the Brazos River Basin due to a "lack of rainfall and high evaporative rates" (Brazos River Authority, 2012).



LLANO ESTACADO REGION
Surface Water Basins

Figure 1-9

Table 1-11. Counties within Region O River Basins

County	River Basin			
	Canadian	Red	Brazos	Colorado
Bailey			X	
Briscoe		X		
Castro		X	X	
Cochran			X	X
Crosby		X	X	
Dawson			X	X
Deaf Smith	X	X		
Dickens		X	X	
Floyd		X	X	
Gaines				X
Garza			X	X
Hale		X	X	
Hockley			X	X
Lamb			X	
Lubbock			X	
Lynn			X	X
Motley		X		
Parmer		X	X	
Swisher		X	X	
Terry			X	X
Yoakum				X
Number of whole or partial counties in basin	1	10	16	8

Table 1-12. Region O River Basin Area, Length, and Flow

River Basin	Basin Area (square miles)		River Length (miles)		Average Flow (ac-ft/yr)
	Total	In Texas	Total	In Texas	
Brazos	45,573	42,865	840	840	6,074,000
Canadian	47,705	12,865	906	213	196,000
Colorado	42,318	39,428	865	865	1,904,000
Red	93,450	24,297	1,360	695	3,464,000

Source: TWDB, 2015b

Of the 42 lakes that the TWDB lists in this basin, 3 (Buffalo Springs, Lake Alan Henry, and White River Lake) are located in the Llano Estacado region. Littlefield, Levelland, Plainview, and Lubbock are the major population centers located in the Region O portion of this basin. In the 2012 Basin Summary Report, three basin-wide water quality issues are identified (Brazos River Authority, 2012, Section 1.7):

- Elevated bacteria levels (may impact use for recreational purposes)
- Dissolved oxygen depletion (may impact aquatic life)
- Natural salt pollution (may impact potable water use)

1.5.3.1.2 Canadian River Basin. The Canadian River begins in the Sangre de Cristo Mountains of New Mexico and ends with its confluence with the Arkansas River in Oklahoma. Texas encompasses 27 percent (just over 12,800 square miles) of the basin. Only a small part of Region O, the northwest corner of Deaf Smith County, lies in the Canadian River Basin. Lake Meredith (in Region A) is located within this basin. The Canadian River is known to have high TDS and chloride levels (Section 1.5.4.2).

1.5.3.1.3 Colorado River Basin. The Colorado River flows from Dawson County, Texas to Matagorda Bay on the Gulf of Mexico, located in Calhoun and Matagorda counties. Consequently, over 90 percent of the Colorado River Basin is located in Texas (the rest of the basin is in New Mexico). No Region O reservoirs are located in the Colorado River Basin. The most upstream reservoir in the basin is J.B. Thomas, which is in Region F. Water quality in J.B. Thomas is considered good, although water quality in the basin declines downstream, with occasional elevated chloride concentrations, impacts from the oil industry, low dissolved oxygen levels, and elevated fecal coliform bacteria levels.

1.5.3.1.4 Red River Basin. The Red River Basin includes parts of New Mexico, Texas, Oklahoma, Arkansas, and Louisiana. The total basin area covers more than 93,000 square miles, 24,297 square miles of which are located in Texas. The TWDB lists 24 major state lakes in the Red River Basin; Lake Mackenzie is the only Region O reservoir in this basin. In parts of the basin, there are high concentrations of naturally-occurring chloride due to salt water springs, seeps, and gypsum outcrops. Under low-flow conditions, elevated concentrations of total dissolved solids and sulfate also occur.

1.5.3.2 Playa Lakes

Playa lakes are shallow, ephemeral wetlands that only hold water after precipitation events. They are typically less than 1 meter in depth and range in size from 0.8 hectares (ha) to 267 ha, although 87 percent of playas are less than 12 ha (Haukos and Smith, 1992). The Playa Lakes Joint Venture (2015) reports that 20,000 to 30,000 playa lakes are located in the high plains of the Llano Estacado subregion, or Southern High Plains (which encompasses the Region O water planning area). A member of the regional water planning group indicated that based on his conversations with Dave Haukos, the Playa Lakes Joint Venture figure may be an overestimate of the number of playa lakes remaining in the Southern High Plains (Steiert, 2015).

Table 1-13 shows the number and acres of playas per county in Region O, as reported by the Playa Lakes Joint Venture (2015). Over 99 percent of playas are located on private property.

While playas comprise only 2 percent of the landscape on the High Plains (Haukos and Smith, 1997), they are a focal point for biodiversity. As the main surface water source for the Great Plains, playas have been found to have over 300 percent more biodiversity than a comparable area of surrounding short-grass prairie (Smith et al., 2011). Close to 200 species of birds, 37 species of mammals, 9 species of amphibians, and 346 plant species have been documented at playa lakes across the Great Plains (Haukos and Smith, 1997). Reptiles and insects are also known to use these wetlands. Due to the ephemeral nature of playas, fish are not naturally present.

Playas can be delineated from surrounding areas by soil type. Playas bottoms are characterized by their hydric soils, typically Randall clay. When dry, the clay will crack and form deep gaps through which water can percolate down into underlying aquifers. This is the main method of recharge for the Ogallala Aquifer. In fact, it is estimated that playas are responsible for roughly 95 percent of the recharge to the Ogallala (Playa Lakes Joint Venture, 2015). After the clay becomes saturated, it expands and enables the playa to hold water.

Table 1-13. Playas in Region O

County	Number of Playas	Acres of Playas
Bailey	893	8,767
Briscoe	1,753	21,714
Castro	1,326	19,510
Cochran	275	1,390
Crosby	1,600	19,619
Dawson	697	7,423
Deaf Smith	530	11,285
Dickens	289	3,642
Floyd	2,366	33,739
Gaines	68	246
Garza	506	4,220
Hale	2,388	26,882
Hockley	1,197	8,225
Lamb	1,979	14,041
Lubbock	1,835	15,029
Lynn	1,113	10,455
Motley	52	599
Parmer	839	9,765
Swisher	1,723	26,182
Terry	300	2,063
Yoakum	37	184
Total in Region O	21,766	244,981

Source: Playa Lakes Joint Venture, 2015

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The Playa Lakes Joint Venture estimates that approximately 70 percent of playas have been altered from their natural state through tilling, pitting, or sedimentation (Playa Lakes Joint Venture, 2015), but a recent study of the physical loss and modification of Southern Great Plains (Texas, New Mexico, and Oklahoma) playas found that only 0.2 percent of playas had no wetland or watershed modification (Johnson et al., 2012). The study further estimated that between 17 percent and 60 percent of the historical playas that were recently still present on the landscape have been lost. Alterations to playas can significantly affect their ecological value by inhibiting a playa's recharge ability, shortening a playa's hydroperiod, and/or impacting water quality.

1.5.4 Developed Surface Water Resources

Four reservoirs (one in Region A and three in Region O) supply water to users in the Llano Estacado region (Sections 1.5.4.1 through 1.5.4.4).

1.5.4.1 Lake Alan Henry

Lake Alan Henry (LAH) is owned and operated by the City of Lubbock. The lake is located in Garza (Region O) and Kent (Region G) counties on the South Fork of the Double Mountain Fork of the Brazos River (Figure 1-8). It is 10 miles east of the town of Justiceburg and 65 miles southeast of the City of Lubbock.

To protect against drought and prepare for increases in population over time, the City of Lubbock began planning for Lake Alan Henry in the 1960s. Construction began on the John T. Montford Dam three decades later in 1991. Construction was completed in October 1993 and water officially began being impounded in January 1994. The John T. Montford Dam is an earthfill dam that is 3,600 feet long and reaches a maximum height of 138 feet. The drainage area for the lake is 394 square miles. The lake is roughly 11 miles long with 56 miles of shoreline. At the conservation pool elevation of 2,220 feet above mean sea level (ft msl), the capacity of the lake is 94,808 acre-feet with a surface area of 2,741 acres. A 2008 LAH Yield Model memorandum by HDR Engineering, Inc. found the firm yield of the lake to be 22,210 ac-ft/yr and the safe yield to be 16,080 ac-ft/yr.

In 2007, the City of Lubbock began the preliminary engineering on the water supply infrastructure necessary to deliver water from the lake to the city. This project was divided into two phases. Phase 1 was completed in 2012 and can supply Lubbock with up to 8,000 ac-ft/yr of water (peaking capacity of 15 million gallons per day [mgd]). Phase 2 is anticipated to begin in the near future and will double the capacity of the lake so that it can supply up to 16,000 ac-ft/yr (peaking capacity of 30 mgd), just under the lake's safe yield.

In addition to the City of Lubbock, LAH also provides the Lake Alan Henry Water Supply District and the South Garza Water Supply Corporation with water. The Lake Alan Henry Water Supply District can contractually use up to 520 ac-ft/yr and the South Garza Water Supply Corporation can use 20 ac-ft/yr. The two districts supply municipal water to communities around the lake.

The City of Lubbock's 2013 Strategic Water Supply Plan notes that the quality of LAH water is comparable to the quality of the groundwater the City uses (Roberts and Bailey County well fields). Water quality results reported by the City for 2010 are summarized in Table 1-14.

Due to higher-than-normal rainfall in 2010, the LAH spillway was engaged in July of that year. However, water levels have dropped in subsequent years due to low inflows and evaporation attributed to the drought. Reservoir storage at Lake Alan Henry was hovering around 60 percent in summer 2014, but as of September 30, 2015, the lake was approximately 95 percent full (TWDB, 2015c).

Table 1-14. Lake Alan Henry Water Quality

Parameter	Concentration (mg/L [a])
pH (S.U.)	7.8
Total alkalinity	167
Turbidity (NTU)	3.6
Conductivity (µS/cm)	1,160
Total dissolved solids	633
Fluoride	1.1
Chloride	234
Nitrate	0.06
Sulfate	84
Potassium	4.6
Sodium	210
Calcium	27.2
Magnesium	8.3

Source: City of Lubbock, 2013
[a] Unless otherwise noted.

S.U. = Standard units
NTU = Nephelometric turbidity units
µS/cm = MicroSiemens per centimeter

1.5.4.2 Lake Meredith

In the 1940s, interest arose in building a large reservoir on the Canadian River. President Truman signed Public Law 898-81 in 1950, authorizing the Canadian River Project, and in 1953, the Canadian River Municipal Water Authority (CRMWA) was created by the Texas Legislature. CRMWA consists of 11 member cities that own and operate Lake Meredith (and now the Roberts County Well Field). The drought of the 1950s slowed the Canadian River Project, but construction began in March of 1962. Water began being impounded in January 1965, and the last joint of pipe for the CRMWA aqueduct was laid in November 1966. Water deliveries to member cities began in April 1968. The lake was named after A.A. Meredith, one of the original visionaries and proponents of the Canadian River Project.

Lake Meredith is located in Region A in Hutchinson, Moore, and Potter counties. It has an extensive drainage area of 20,220 square miles (of which 4,172 is non-contributing). The Sanford Dam, located roughly 37 miles northeast of Amarillo, is an earthfill dam with a crest length of 6,380 feet and a structural height of 228 feet. At the conservation pool elevation of

2,936.5 ft msl, the lake is roughly 19 miles long with an average width of 1.5 miles. The lake's maximum depth is 118.5 feet. There are approximately 124.6 miles of shoreline. The lake's original volume was estimated to be 864,400 acre-feet with a surface area of 16,504 acres; however, a 1995 volumetric study by the TWDB adjusted these measurements to a storage capacity of 817,970 acre-feet with a surface area of 16,411 acres. The lake's aqueduct system consists of 323 miles of pipeline.

The quality of water in Lake Meredith has been an issue since deliveries began in 1968. In particular, the chloride concentrations have caused problems. Texas standards for chloride in drinking water are 300 mg/L, while at times, water produced from Lake Meredith contained chloride in excess of 1,500 mg/L. The chloride concentration measured in the lake in 2009 was 601 mg/L (Table 1-15). The declining water levels in the lake over the past decade have exacerbated the chloride issue.

Studies funded mainly by the U.S. Bureau of Reclamation identified a series of salt springs near Logan, New Mexico along the Canadian River that are estimated to be responsible for 70 percent of the chloride content in the lake. In 2001, CRMWA began the Lake Meredith Salinity Control Project. This project pumps water out of the shallow brine aquifer that supplies the salt springs and injects this brine water into a deep disposal well. The pumping prevents spring seepage into the Canadian River.

Table 1-15 presents TCEQ water quality data for Lake Meredith as reported by Burley et al. (2011).

Water levels in Lake Meredith began declining in 2001, and they declined steadily until conditions began to improve in May 2015. The 2011 drought caused the lake's water levels to drop so low that after using the lake for peaking in the summer of 2011, all deliveries from the lake ceased. The lake reached its lowest point, 26.14 feet, in August 2013. The cause of the decline is attributed to a number of causes, including changes in the groundwater to surface water ratio and land use changes (Freese & Nichols, Inc., 2009, as cited in City of Lubbock, 2013). Changes in precipitation amount and intensity were not found to be causes of decline. In January 2015, the lake was 5.1 percent full, but as of September 30, 2015, reservoir storage was up to approximately 21 percent (TWDB, 2015c).

Table 1-15. Lake Meredith Water Quality Data

Date	Parameter	Filtered?	Concentration (mg/L [a])	Depth (feet)
2002	Calcium	Yes	73.0	0.984
	Hardness [b]	NA	346.0	0.984
	Specific conductance (µS/cm)	No	2,593.3	0.984
2005	Potassium	No	9.0	0.984
	Sodium	No	392.0	0.984
2006	Magnesium	Yes	47.4	0.984
2009	Chloride	Yes	601.0	0.984
	Dissolved oxygen [c]	No	5.9	0.984 – 41.000
	Fluoride	No	0.6	0.984
	pH (standard units) [d]	No	8.3	0.984 – 41.000
	Phosphorus	No	0.1	0.984
	Sulfate	Yes	369.0	0.984

Source: Burley et al., 2011, Appendix 3
[a] Unless otherwise noted
[b] Hardness is measured as calcium carbonate
[c] 13 samples collected on July 14, 2009. Depths from 0 to 19.680 had levels greater than or equal to 8.0 mg/L. Range = 0.1 to 8.1 mg/L
[d] 13 samples collected on July 14, 2009. Range = 7.7 to 8.6.

mg/L = Milligrams per liter
NA = Information not available
µS/cm = MicroSiemens per centimeter

1.5.4.3 Lake Mackenzie

Lake Mackenzie (also called Mackenzie Reservoir) is located in Briscoe and Swisher counties on Tule Creek, a tributary of the Prairie Dog Fork of the Red River (Figure 1-8). The lake is 9 miles northwest of Silverton. Lake Mackenzie is owned and operated by the Mackenzie Municipal Water Authority, which supplies water to Floydada, Lockney, Silverton, and Tulia.

Construction began on Lake Mackenzie in September 1972 and was completed in April 1974. Impoundment of water began that same month (April 1974). According to the TWDB, at the conservation pool elevation of 3,100 ft msl, the storage capacity of the lake is 47,151 acre-feet with a surface area of 910 acres and a maximum depth of 150 feet. The lake has a drainage area of 188 square miles.

Since 2001, the reservoir storage of Lake Mackenzie has been under 10,000 acre-feet. Storage at Mackenzie Reservoir was at less than 5 percent in the summer of 2014, but as of September 30, 2015, the lake was approximately 16 percent full (TWDB, 2015c).

Table 1-16 presents TCEQ water quality data for Lake Mackenzie as reported by Burley et al. (2011).

Table 1-16. Lake Mackenzie Water Quality Data

Date	Parameter	Filtered?	Concentration (mg/L [a])	Depth (feet)
2001	Calcium	Yes	35.0	0.984
	Magnesium	Yes	24.3	0.984
2005	Potassium	No	14.5	0.984
	Sodium	No	39.3	0.984
2009	Chloride	Yes	17.0	0.984
	Dissolved oxygen [b]	No	1.7	0.984 – 59.040
	Fluoride	No	2.0	0.984
	pH (standard units) [c]	No	8.0	0.984 – 59.040
	Phosphorus	No	0.1	0.984
	Sulfate	Yes	181.0	0.984

Source: Burley et al., 2011, Appendix 3
[a] Unless otherwise noted.
[b] 18 samples collected on July 8, 2009. All depths below 19.680 had a level of 0.1 mg/L. Range = 0.1 to 7.7 mg/L.
[c] 18 samples collected on July 8, 2009. Range = 7.6 to 8.8.

mg/L= Milligrams per liter

1.5.4.4 White River Lake

White River Lake is a wishbone shaped lake located in Crosby County, 16 miles southeast of the town of Crosbyton. The lake is situated on the White River, a tributary of the Salt Fork of the Brazos River (Figure 1-8).

In 1955, the Texas Board of Water Engineers recommended a lake on the White River to impound water for the cities of Crosbyton, Post, Ralls, and Spur. The White River Municipal Water District was created in 1957 by the Texas Legislature. The District began construction on White River Lake in September 1962 and completed the work in November 1963. Deliberate impoundment began in October 1963. The earthfill dam stands 84 feet high and controls a drainage area of 172 square miles. Water deliveries to member cities began in August 1965.

A 2003 volumetric survey of the lake by the TWDB found that at the conservation pool elevation of 2,372 ft msl, the lake has a storage capacity of 31,846 acre-feet. The surface area is 1,642 acres. The mean depth is 11 feet, and the maximum depth is 65 feet. However, due to the drought, water levels have dropped significantly in recent years. On November 10, 2012, the District stopped pumping from the lake, citing low lake levels (Fulton, 2014). As of January 2015, the lake was 4.2 percent full (approximately 1,338 acre-feet). By September 30, 2015, conditions at White River Lake had improved, with reservoir storage at approximately 33 percent (TWDB, 2015c).

Table 1-17 presents TCEQ water quality data for White River Lake as reported by Burley et al. (2011).

Table 1-17. White River Lake Water Quality Data

Date	Parameter	Filtered?	Concentration (mg/L [a])	Depth (feet)
2001	Salinity [b]	No	0.6	0.984 – 26.240
2002	Calcium	Yes	24.8	0.984
	Magnesium	Yes	22.7	0.984
2003	Sodium	No	3.0	0.984
2009	Chloride	Yes	188.0	0.984
	Dissolved oxygen	No	4.7 [c]	0.984 – 15.416
	Fluoride	No	1.6	0.984
	pH (standard units)	No	8.0 [d]	0.984 – 15.416
	Sulfate	Yes	65.0	0.984

Source: Burley et al., 2011, Appendix 3
[a] Unless otherwise noted.
[b] Nine samples collected on March 13, 2001; all had the same value.
[c] Average of five samples collected on August 25, 2009 (range 3.5 to 5.3 mg/L)
[d] Average of five samples collected on August 25, 2009 (range 7.9 to 8.1)

mg/L= Milligrams per liter

1.5.5 Reuse

There are two main types of reuse supplies:

- *Direct reuse:* Water is pumped from a water reclamation plant through a pipeline to a water treatment plant. At both the reclamation plant and the water treatment plant, the water undergoes advanced treatment through multiple synthetic barriers.

- *Indirect reuse:* After treatment at a water reclamation plant, water is discharged into a natural water system (river, lake, wetland, etc.). After some time in the natural water system, the water is diverted and pumped to a water treatment plant.

Direct reuse supplies from water reclamation plants in the region are being used for land application (irrigation) in 12 counties and for steam-electric power generation in Lubbock County, but no indirect reuse supplies are used currently in Region O. Several direct and indirect reuse water management strategies are described and evaluated in Chapter 5.

1.6 Wholesale Water Providers

The TWDB defines a wholesale water provider as an entity that has contracts to sell more than 1,000 acre-feet of wholesale water in one year. Region O includes four wholesale water providers:

- Canadian River Municipal Water Authority (CRMWA)
- City of Lubbock
- Mackenzie Municipal Water Authority (MMWA)
- White River Municipal Water District (WRMWD)

1.6.1 Canadian River Municipal Water Authority

The CRMWA was created by the Texas Legislature in 1953. Today, the CRMWA consists of 11 member cities that own and operate Lake Meredith and the Roberts County Well Field. Of the 11 member cities, 8 are located in Region O, and the remaining 3 are located in Region A (Figure 1-10). Both water sources are located in Region A. Table 1-18 lists the member cities and their lake and well field allocations. Table 1-19 shows the total water deliveries from CRMWA to the member cities by source from 1968 (the year deliveries began) to 2014.

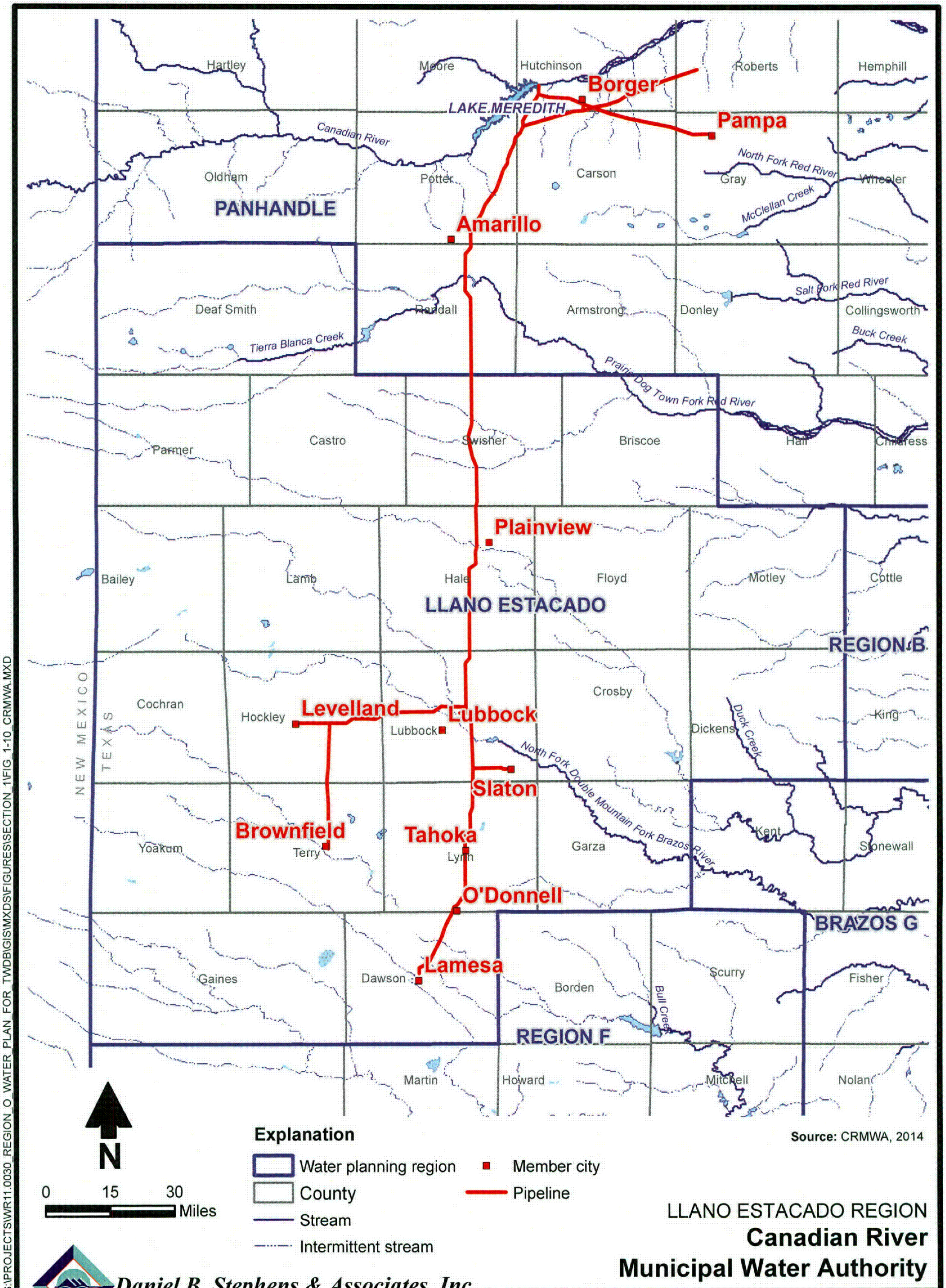
Table 1-18. Canadian River Municipal Water Authority Member City Allocations

Region	Member City	Allocation (%)	
		Lake Meredith	John C. Williams Well Field
A	Amarillo	37.058	40.621
A	Borger	5.549	5.549
O	Brownfield [a]	2.198	2.198
O	Lamesa	2.179	2.179
O	Levelland	2.790	2.790
O	Lubbock [b]	37.058	37.058
O	O'Donnell	0.278	0.278
A	Pampa	7.163	3.600
O	Plainview	3.691	3.691
O	Slaton [c]	1.576	1.576
O	Tahoka	0.460	0.460

[a] The City of Brownfield provides some of its CRMWA allocation to the City of Meadow.
[b] The City of Lubbock is a wholesale water provider to the customers listed in Section 1.6.2.
[c] The City of Slaton provides some of its CRMWA allocation to the City of New Deal and the City of Post.

1.6.2 City of Lubbock

The City of Lubbock has seven wholesale customers:



LLANO ESTACADO REGION
Canadian River Municipal Water Authority

Figure 1-10

Table 1-19. Historical Canadian River Municipal Water Authority Water Deliveries by Source
Page 1 of 2

Year	Supply (ac-ft/yr)		
	Lake Meredith	John C. Williams Well Field	Total
2014[a]	2,466	59,181	61,647
2013	0	63,786	63,786
2012	0	62,909	62,909
2011	8,287	61,039	69,326
2010	32,405	39,604	72,009
2009	35,540	36,242	71,782
2008	28,050	40,442	68,492
2007	33,430	37,676	71,106
2006	41,837	40,125	81,962
2005	47,215	35,501	82,716
2004	36,518	36,611	73,129
2003	57,899	33,728	91,627
2002	54,689	30,559	85,248
2001	78,842	0	78,842
2000	86,488	0	86,488
1999	80,474	0	80,474
1998	81,000	0	81,000
1997	73,058	0	73,058
1996	74,480	0	74,480
1995	70,686	0	70,686
1994	69,426	0	69,426
1993	70,982	0	70,982
1992	70,365	0	70,365
1991	70,028	0	70,028
1990	71,259	0	71,259
1989	67,841	0	67,841
1988	64,332	0	64,332
1987	62,516	0	62,516
1986	65,679	0	65,679
1985	72,810	0	72,810
1984	73,223	0	73,223

Source: CRMWA, 2015a (unless otherwise noted) ac-ft/yr = Acre-feet per year
[a] CRMWA, 2015b

Table 1-19. Historical Canadian River Municipal Water Authority Water Deliveries by Source Page 2 of 2

Year	Supply (ac-ft/yr)		
	Lake Meredith	John C. Williams Well Field	Total
1983	69,345	0	69,345
1982	66,128	0	66,128
1981	69,143	0	69,143
1980	77,241	0	77,241
1979	72,745	0	72,745
1978	69,053	0	69,053
1977	62,344	0	62,344
1976	63,820	0	63,820
1975	65,702	0	65,702
1974	66,959	0	66,959
1973	59,269	0	59,269
1972	60,954	0	60,954
1971	60,325	0	60,325
1970	58,922	0	58,922
1969	56,229	0	56,229
1968	29,292	0	29,292

Source: CRMWA, 2015a ac-ft/yr = Acre-feet per year

- Lubbock County Water Control & Improvement District No. 1 (Buffalo Springs Lake)
- Town of Ransom Canyon
- Lubbock Cooper Independent School District (Woodrow Campus only)
- Lubbock-Reese Redevelopment Authority
- City of Shallowater
- Texas Department of Criminal Justice - Montford Unit
- City of Littlefield (emergency-only)

The combined demand of these seven customers represented less than 2 percent of the City's 2014 water demand (Spear, 2015).

Although not wholesale water contracts (as they entail the sale of raw water, not wholesale water), the City of Lubbock also supplies the South Garza Water Supply and the Lake Alan Henry Water District with raw water from LAH.

1.6.3 Mackenzie Municipal Water Authority

The MMWA was created in 1965 by the Texas Legislature to manage and operate Lake Mackenzie. The MMWA has the following four member cities: Floydada, Lockney, Silverton, and Tulia.

The MMWA updates their contractual allocations annually. The 2014 contractual allocations were as follows:

- Floydada: 4,211,035 gallons per month
- Lockney: 2,033,085 gallons per month
- Silverton: 3,345,833 gallons per month
- Tulia: 5,700,000 gallons per month

Due to low lake levels, MMWA was unable to deliver the full 2014 contractual allocation to its member cities. Tulia and Floydada have existing city wells that were able to supply these cities with water in the reduction or absence of surface water allocations from Lake Mackenzie. Silverton and Lockney are in the process of developing additional city wells. Currently, Tulia is supplying part of Silverton's municipal supply using MMWA infrastructure. Silverton is using grant funding to reverse the direction of flow in the MMWA pipelines so that water can be run from Tulia to Silverton.

1.6.4 White River Municipal Water District

The WRMWD was created in 1957 by the Texas Legislature to manage and operate White River Lake. WRMWD also owns a well field and is capable of supplying groundwater. The WRMWD has the following four member cities: Crosbyton, Post, Ralls, and Spur. Spur has emergency connections with Dickens and the Valley Water Corporation, who supplies water to rural customers.

On October 1, 2012, the four member cities signed a 40-year contract with the following minimum allocations:

- Post 370,000 gallons per day
- Crosbyton 160,000 gallons per day
- Ralls 180,000 gallons per day
- Spur 200,000 gallons per day

Due to low lake levels, the District stopped pumping from the lake on November 10, 2012 (Fulton, 2014) and began fulfilling allocations with groundwater. In March 2014, the WRMWD well field had 12 active wells capable of providing 1.5 mgd. The District has plans to expand their well field to 19 wells by mid-2015.

1.7 Agricultural and Natural Resources

Land cover data from the 2011 National Land Cover Database are shown in Figure 1-11 and summarized in Table 1-20. Cultivated cropland comprises nearly half of the land area in the Llano Estacado region; grassland comprises around a quarter of the region's land area.

Table 1-20. Region O Land Cover

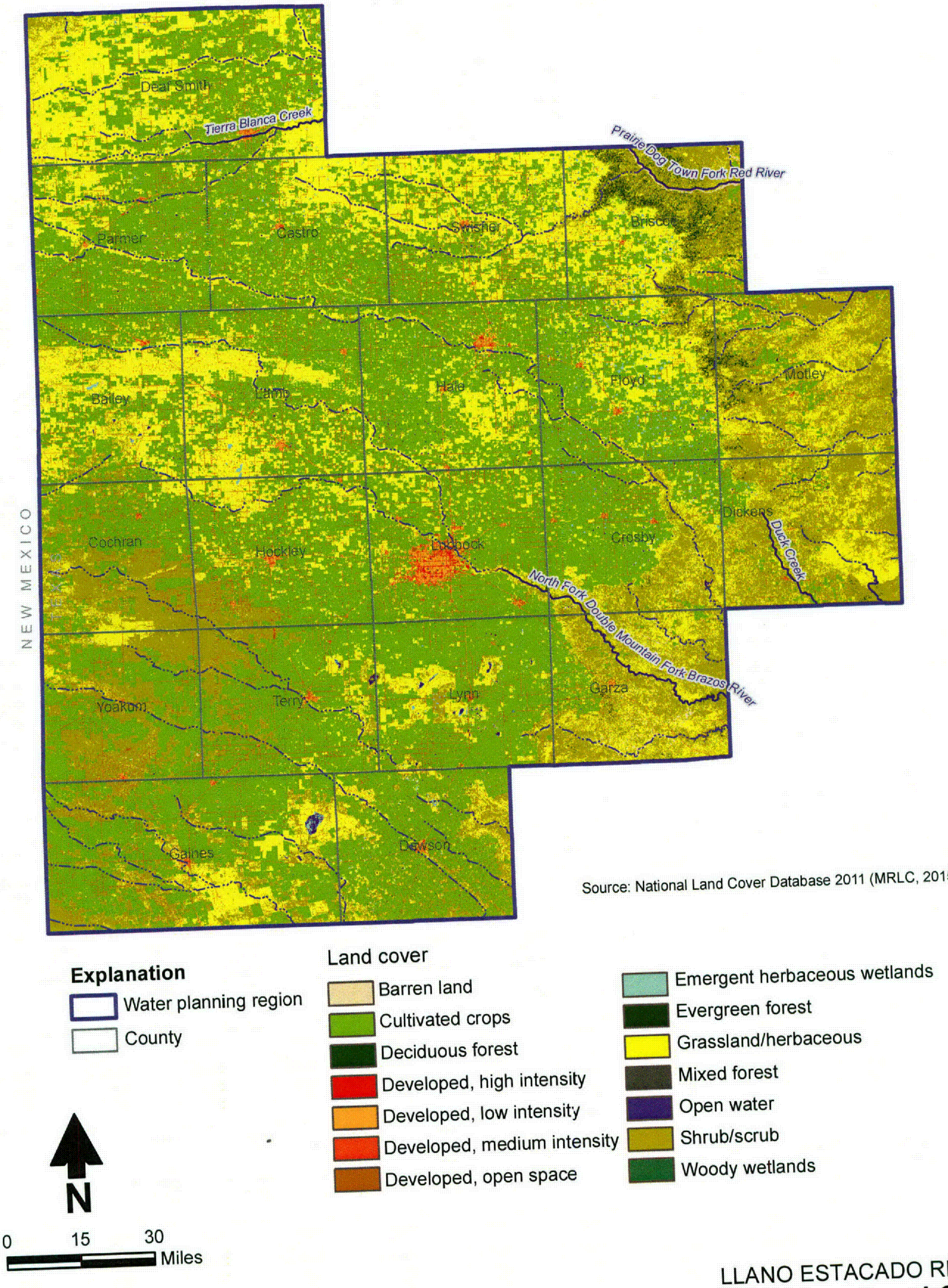
Land Cover	Area		Percentage of Total
	(acres)	(square miles)	
Cultivated crops	6,263,888	9,787	48.5
Grassland/herbaceous	3,396,435	5,307	26.3
Shrub/scrub	2,325,687	3,634	18.0
Developed	722,764	1,129	5.6
Forest	77,056	120	0.6
Wetlands	67,955	106	0.5
Barren land	36,804	58	0.3
Open water	34,994	55	0.3
Total	12,925,582	20,196	100.0

Source: MRLC, 2015

1.7.1 Agricultural Resources

As shown in Table 1-20 and Figure 1-11, Region O is highly agricultural (48.5 percent of the region is cultivated cropland). The main crops grown in Region O are cotton, corn, sorghum, wheat, peanuts, and other fruits and vegetables (such as apples, melons, potatoes, and cucumbers) (TSHA, 2015). Cattle (cow-calf, stocker, and dairy) are the main livestock raised; chickens, hogs, and sheep are also raised in the region.

The U.S. Department of Agriculture conducts a farm census every 5 years; the most recent census data available are for 2012. From 2002 to 2012, the amount of land in Texas farms remained relatively constant (129,877,666 acres in 2002 and 130,153,438 acres in 2012, a 0.2 percent increase), but the number of farms increased while the average farm size



Source: National Land Cover Database 2011 (MRLC, 2015)

LLANO ESTACADO REGION
Land Cover

Figure 1-11

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decreased. In 2002, there were 228,926 farms in Texas averaging 567 acres per farm; in 2012, there were 248,809 farms averaging 523 acres per farm, which is still more than double the state-wide average. In 2012, only 9 percent of the state's farmland was located in Region O, but the Region produced 28 percent of the state's market value of agriculture products sold. In 2012, 18 percent of farms in Region O were irrigated, compared to 3 percent statewide. In terms of area, Region O contains almost half (46 percent) of the state's irrigated farmland. Texas was ranked third among U.S. states for total agricultural sales, behind California and Iowa (Texas was first in livestock sales and eighth in crop sales). Table 1-21 shows 2012 USDA Agriculture Census statistics by county for Region O.

1.7.2 Natural Resources

The State of Texas is divided into ten different ecoregions, based on areas with similar ecology and geography. Region O includes portions of the High Plains and Rolling Plains (also referred to as the Southwestern Tablelands) ecoregions (Figure 1-12).

The High Plains is located on a plateau with elevations ranging from 3,000 to 4,500 feet. Historically, this ecoregion has been shortgrass prairie. The main surface water in this area is playa lakes (Section 1.5.3.2). Annual rainfall in the High Plains ranges from 15 to 22 inches (Figure 1-13).

The High Plains is divided from the Rolling Plains by the Caprock Escarpment. The Rolling Plains is characterized by canyons, mesas, badlands, and dissected river breaks (Griffith et al., 2007). It ranges in elevation from 800 to 3,000 feet (Figure 1-12) and has historically been mid- to tall-grass prairies, with rainfall ranging from 20 to 28 inches (Figure 1-13). Figure 1-14 depicts the various soil types in Region O.

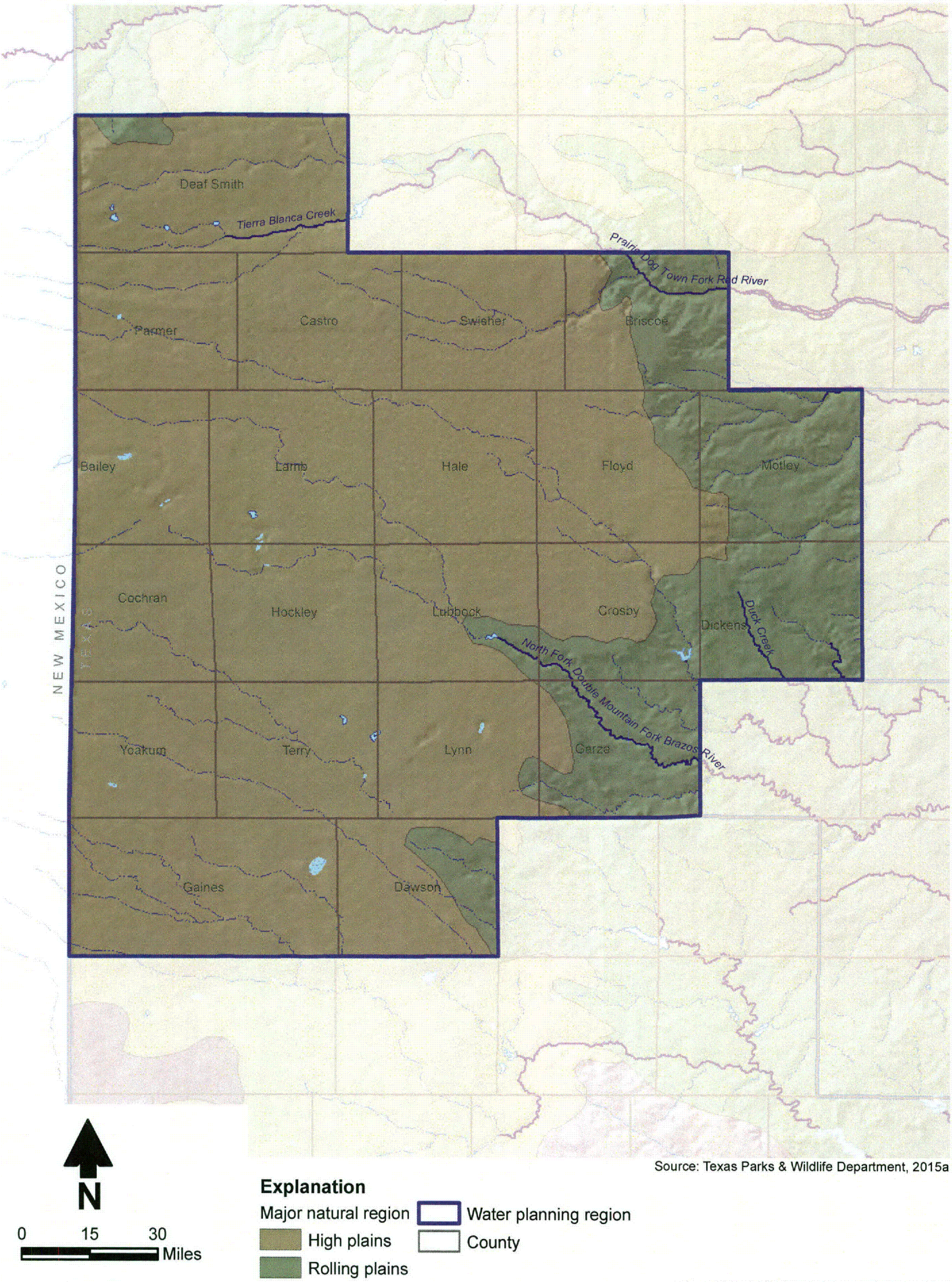
1.7.2.1 Wildlife Resources

Table 1-22 shows common flora (TPWD, 2015b) and fauna (USFS, 2015) in the two ecoregions.

Table 1-21. 2012 USDA Agriculture Census Statistics by County

County	Number of Farms	Total Acres in Farms	Farm Size (acres)		Number of Irrigated Farms	Irrigated Acres in Farms	Percentage of Land in Farms with Irrigation	Market Value of Agricultural Products Sold [a]
			Average	Median				
Bailey	494	471,624	955	320	144	48,543	10	292,448
Briscoe	282	524,239	1,859	433	49	22,824	4	20,435
Castro	532	548,142	1,030	565	262	154,877	28	1,312,140
Cochran	288	448,719	1,558	453	81	67,830	15	100,787
Crosby	431	558,372	1,296	425	173	111,723	20	71,589
Dawson	596	588,085	936	338	170	61,154	10	73,129
Deaf Smith	621	923,532	1,487	640	211	119,924	13	1,379,076
Dickens	437	572,617	1,310	312	61	13,412	2	18,526
Floyd	589	581,997	988	320	155	96,748	17	282,743
Gaines	644	774,822	1,203	500	317	226,992	29	180,470
Garza	277	455,569	1,645	401	34	8,112	2	12,385
Hale	899	640,609	713	317	370	202,238	32	409,930
Hockley	781	483,775	619	267	246	106,915	22	78,717
Lamb	933	616,260	661	329	369	179,531	29	575,286
Lubbock	1,116	502,571	450	150	404	155,462	31	174,800
Lynn	455	472,170	1,038	485	156	71,599	15	67,595
Motley	224	595,487	2,658	531	18	4,239	1	12,800
Parmer	570	553,724	971	480	243	162,971	29	1,329,538
Swisher	565	545,582	966	432	163	65,328	12	586,810
Terry	630	442,100	702	320	233	98,249	22	125,803
Yoakum	339	488,493	1,441	640	128	90,426	19	80,008
Region O	11,703	11,788,489	1,166	412	3,987	2,069,097	18	7,185,015
Texas	248,809	130,153,438	523	523	18,169	4,489,163	3	25,375,581

[a] This category represents the gross market value before taxes and production expenses of all agricultural products sold or removed from the place in 2012 regardless of who received the payment. It is equivalent to total sales and it includes sales by the operators as well as the value of any shares received by partners, landlords, contractors, or others associated with the operation. It includes value of direct sales and the value of commodities placed in the Commodity Credit Corporation (CCC) loan program. Market value of agricultural products sold does not include payments received for participation in other federal farm programs. Also, it does not include income from farm-related sources such as customwork and other agricultural services, or income from nonfarm sources.



Source: Texas Parks & Wildlife Department, 2015a

LLANO ESTACADO REGION
Natural Regions

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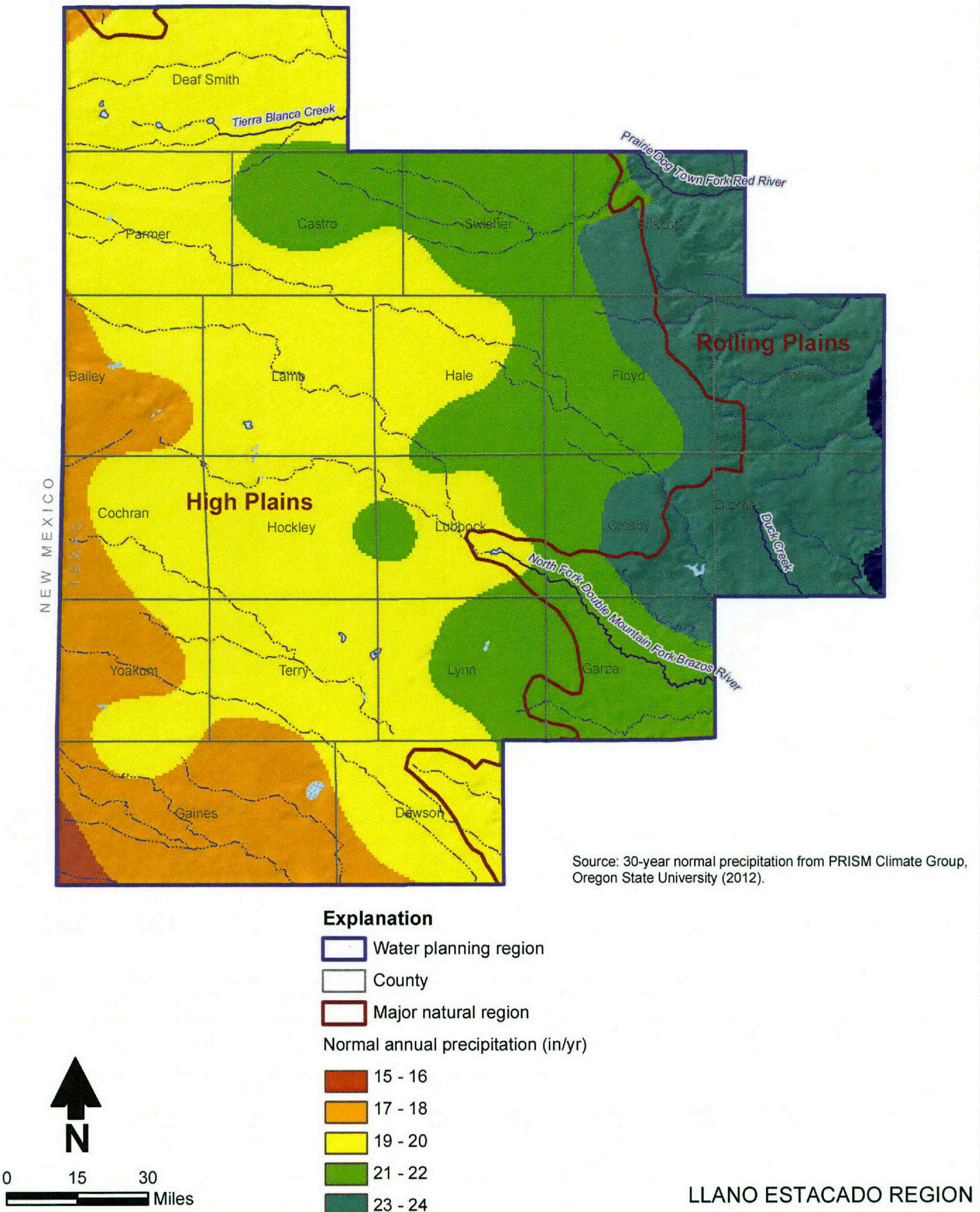
Figure 1-12

S:\PROJECTS\WR11.0030 REGION O WATER PLAN FOR TWDB\GIS\MXDS\FIGURES\SECTION 1\FIG 1-12 NATURAL REGIONS.MXD



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LLANO ESTACADO REGION

Mean Annual Precipitation 1981 through 2010

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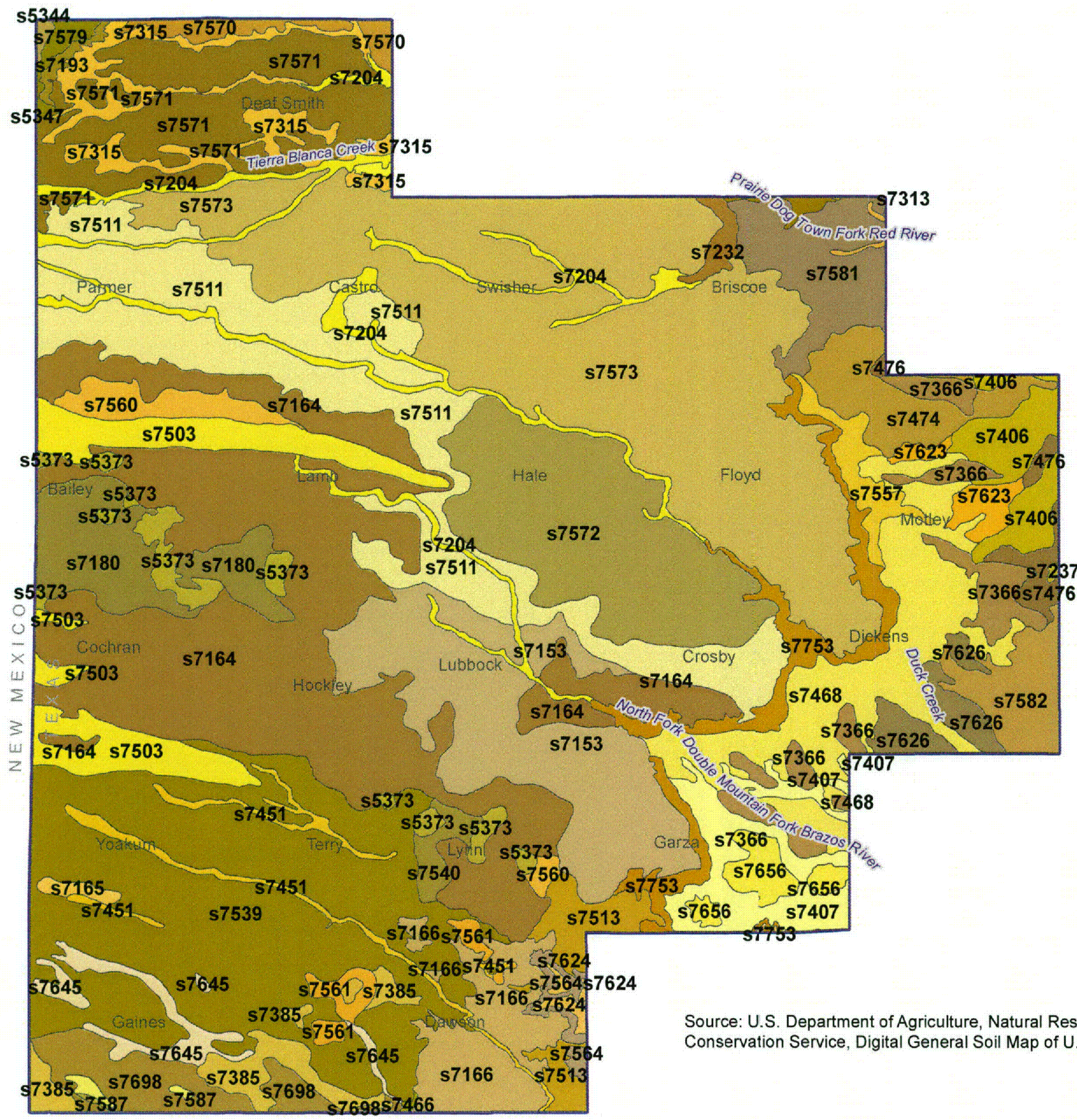
Figure 1-13



Source: U.S. Department of Agriculture, Natural Resources Conservation Service, Digital General Soil Map of U.S., 2006

Explanation

- Water planning region
- County

N

0 15 30 Miles

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LLANO ESTACADO REGION
Soils

Figure 1-14 page 1 of 2

Soil associations

s5344, Springer-San Jon-Redona-Quay-Ima (s5344)
s5347, Rock outcrop-Latom-Crews (s5347)
s5371, Olton-Amarillo-Acuff (s5371)
s5373, Potter-Portales-Mansker-Arch (s5373)
s7153, Olton-Amarillo-Acuff (s7153)
s7164, Amarillo (s7164)
s7165, Kimbrough-Arvana-Amarillo (s7165)
s7166, Amarillo (s7166)
s7180, Sharvana-Portales-Arvana-Amarillo (s7180)
s7193, Veal-Potter-Mobeetie-Berda (s7193)
s7204, Mansker-Estacado-Bippus-Berda (s7204)
s7232, Glenrio-Burson-Aspermont (s7232)
s7237, Woodward-St. Paul-Quinlan-Carey (s7237)
s7313, Tivoli-Lincoln-Enterprise (s7313)
s7315, Pullman-Olton-Estacado (s7315)
s7366, Springer-Nobscot-Heatly-Devol-Delwin (s7366)
s7381, Triomas-Ima (s7381)
s7385, Penwell-Jalmar (s7385)
s7400, Mansker-Kimbrough-Berda (s7400)
s7406, Quinlan-Knoco (s7406)
s7407, Vernon-Knoco (s7407)
s7451, Spur-Potter-Mansker (s7451)
s7466, Midessa-Drake (s7466)
s7468, Miles-Mansker-Delwin (s7468)
s7470, Woodward-Miles-Carey-Bukreek (s7470)
s7474, Motley-Miles-Hilgrave-Flomot (s7474)
s7476, Springer-Miles (s7476)
s7503, Springer-Nutivoli-Brownfield-Arch (s7503)
s7511, Olton-Amarillo-Acuff (s7511)
s7513, Rowena-Olton-Estacado-Acuff (s7513)
s7539, Patricia-Amarillo (s7539)
s7540, Patricia-Brownfield-Amarillo (s7540)
s7557, Polar-Mobeetie-Latom-Flomot-Berda (s75
s7560, Portales-Drake-Arch (s7560)
s7561, Zita-Midessa-Drake (s7561)
s7564, Potter-Mansker (s7564)
s7570, Pullman (s7570)
s7571, Pullman (s7571)
s7572, Pullman-Olton (s7572)
s7573, Randall-Pullman (s7573)
s7579, Quay-Montoya-Glenrio (s7579)
s7581, Quinlan-Obaro-Burson (s7581)
s7582, Woodward-Quinlan (s7582)
s7587, Ratliff (s7587)
s7623, Sagerton-Miles-Bukreek (s7623)
s7624, Sagerton-Rowena-Bukreek (s7624)
s7626, Weymouth-Sagerton-Abilene (s7626)
s7645, Simona-Kimbrough (s7645)
s7656, Stamford (s7656)
s7698, Wickett-Triomas (s7698)
s7753, Veal-Potter-Mobeetie-Berda (s7753)
s8369, Water (s8369)

Source: U.S. Department of Agriculture, Natural Resources Conservation Service, Digital General Soil Map of U.S., 2006

LLANO ESTACADO REGION
Soil Associations Explanation

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Figure 1-14 page 2 of 2

Table 1-22. Common Flora and Fauna of the High and Rolling Plains
Page 1 of 4

Type	Species	Rolling Plains (Ecoregion 8)	High Plains (Ecoregion 9)
Flora [a]			
Trees	Black willow	X	
	Bur oak		X
	Desert willow	X	
	Eastern cottonwood	X	
	Honey mesquite		X
	Lance-leaf sumac	X	X
	Little walnut	X	
	Mohr oak	X	X
	Net-leaf hackberry	X	X
	Pecan	X	
	Plains cottonwood		X
	Post oak	X	
	Prairie crabapple		X
	Scaly-bark oak	X	
	Silver leaf mountain mahogany	X	X
	Sugarberry	X	
	Texas persimmon	X	
	Texas redbud		X
	Western soapberry		X
Shrubs	Agarita	X	
	Autumn sage	X	
	Cenizo	X	
	Chicksaw plum	X	
	Common choke-cherry	X	X
	False indigo	X	
	Feather dalea		X
	Fourwing saltbush		X
	Harvard shin-oak		X
	Lead-plant amorpha	X	
	Little-leaf sumac		X
	Oklahoma plum	X	X
	Sand sage	X	X
	Silver agarita		X
	Winter fat		X

[a] Source: TPWD, 2015a

Table 1-22. Common Flora and Fauna of the High and Rolling Plains
Page 2 of 4

Type	Species	Rolling Plains (Ecoregion 8)	High Plains (Ecoregion 9)
Flora[a] (cont.)			
Conifers	Colorado pinyon pine	X	
	Colorado pinyon pine		X
	Eastern red cedar	X	X
	One-seed juniper	X	
	Pinchot juniper	X	
	Rocky mountain juniper		X
Grasses	Big bluestem	X	
	Blue grama	X	X
	Buffalograss	X	X
	Burrograss	X	
	Canada wildrye	X	
	Cane bluestem		X
	Curly mesquite	X	
	Ear muhly		X
	Hairy grama	X	
	Indiangrass	X	
	New Mexico little bluestem		X
	Sideoats grama	X	X
	Texas bluegrass	X	
	Western wheatgrass	X	X
Wildflowers	Blackfoot daisy		X
	Blue flax	X	
	Copper-mallow	X	X
	Englemann daisy		X
	Huisache-daisy	X	
	Indian blanket	X	X
	Mealy sage	X	X
	Mexican hat	X	
	Missouri evening primrose		X
	Pink plains penestemon	X	X
	Prairie verbena	X	X
	Purple coneflower		X
	Square-bud evening-primrose	X	
	Tahoka daisy	X	X
	Texas bluebonnet		X
	Winecup	X	X
	Yellow plainsman	X	

[a] Source: TPWD, 2015a

Table 1-22. Common Flora and Fauna of the High and Rolling Plains
Page 3 of 4

Type	Species	Rolling Plains (Ecoregion 8)	High Plains (Ecoregion 9)
Flora[a] *(cont.)*			
Vines	Coral honeysuckle	X	
	Canyon grape		X
	Old man's beard	X	X
	Panhandle grape	X	
	Snapdragon vine		X
	Trumpet-creeper	X	
	Vine mildweed		X
Succulents	Narrow-leaf yucca	X	X
	Plains yucca		X
	Prickly-pear	X	
	Red yucca	X	
	Teddy-bear cholla	X	X
Fauna[b]			
Large mammals	Collared peccary	X	
	Coyote	X	X
	Feral hog[c]	X	X
	Ocelot	X	X
	Pronghorn		X
	Ringtail	X	X
	Swift fox		X
Small herbivores	Black-tailed prairie dog		X
	Desert cottontail	X	X
	Desert shrew	X	X
	Hispid pocket mouse	X	X
	Plains mouse		X
	Rock squirrel	X	
	Silky pocket mouse		X
	Texas kangaroo rat	X	
	Texas mouse	X	
	White-throated woodrat		X
	Yellow-faced pocket gopher		X
Birds	Black-capped vireo	X	
	Bobwhite quail[d]	X	X
	Cedar waxwing		X
	Golden eagle		X

[a] Source: TPWD, 2015a
[b] Source: USFS, 2015
[c] Source: Texas A&M, AgriLife Extension, 2012

Table 1-22. Common Flora and Fauna of the High and Rolling Plains
Page 4 of 4

Type	Species	Rolling Plains (Ecoregion 8)	High Plains (Ecoregion 9)
Fauna [b] *(cont.)*			
Birds (cont.)	Golden-fronted woodpecker	X	
	Harris' sparrow	X	
	House finch		X
	Pyrrhuloxia	X	
	Roadrunner		X
	Scaled quail	X	
	Western kingbird		X
	Willow flycatcher		X
	Yellow warbler		X
Amphibians	Couche's spadefoot toad	X	X
	Great Plains narrow-mouthed frog	X	
	Great Plains toad		X
	Green toad	X	X
	Plains leopard frog		X
	Plains spadefoot toad		X
	Red-spotted toad	X	X
	Spotted chorus frog	X	X
	Texas map turtle	X	
	Texas toad	X	
	Western spadefoot toad		X
	Yellow-mud turtle	X	X
Reptiles	Checkered garter snake [e]	X	X
	Crevice spiny lizard	X	
	Four-lined skink	X	
	Great Plains skink	X	X
	Harter's water snake	X	
	Lesser earless lizard	X	
	Plains black-headed snake	X	X
	Plains hog-nosed snake [e]	X	X
	Prairie skink	X	
	Round-tailed horned lizard		X
	Texas blind snake		X
	Texas horned lizard		X
	Texas spotted whiptail	X	
	Western diamondback rattlesnake [e]	X	X
	Western hook-nosed snake	X	

[b] Source: USFS, 2015
[d] Source: TPWD, 2015c
[e] Source: Herps of Texas, 2015

1.7.2.2 Threatened and Endangered Species

Texas Parks and Wildlife Department is charged with monitoring threatened and endangered species within the state. Appendix 1B shows the threatened and endangered species in Region O.

The lesser prairie chicken, the smalleye shiner, and the sharpnose shiner are the three most recent USFWS listings in Region O, all listed in 2014 (the lesser prairie chicken as threatened and the two shiner species as endangered). These three species are discussed further in the following paragraphs.

1.7.2.2.1 Lesser Prairie Chicken. The lesser prairie chicken (*Tympanuchus pallidicinctus*) is a species of prairie grouse with dark brown and light tan feathering, typically weighing between 22 and 29 ounces (approximately 1.5 pounds). Males have bright yellow eyecombs and reddish-purple air sacs that they use to help attract mates during their characteristic mating dance. The lesser prairie chicken's current range spans prairie and rangelands in five southwestern states: Colorado, Kansas, New Mexico, Oklahoma, and Texas. It is estimated that 1,280 acres (2 square miles) of prime nesting habitat surrounded by 10,000 acres of foraging habitat is needed to maintain a breeding population.

Due to habitat loss, habitat fragmentation, and the recent drought, the bird's population has been in decline. Between 2012 and 2013, the population is estimated to have dropped 49 percent, from 34,440 birds in 2012 to 17,616 birds in 2013.

In response to the lesser prairie chicken's rapid decline in population in recent years, all five states in the bird's range have ongoing conservation efforts. The two largest coordinated efforts are occurring through the Western Association of Fish and Wildlife Agencies (WAFWA), an association of the five states' fish and wildlife agencies, and the U.S. Department of Agriculture's (USDA) Natural Resources Conservation Service's (NRCS) Lesser Prairie Chicken Initiative (LPCI).

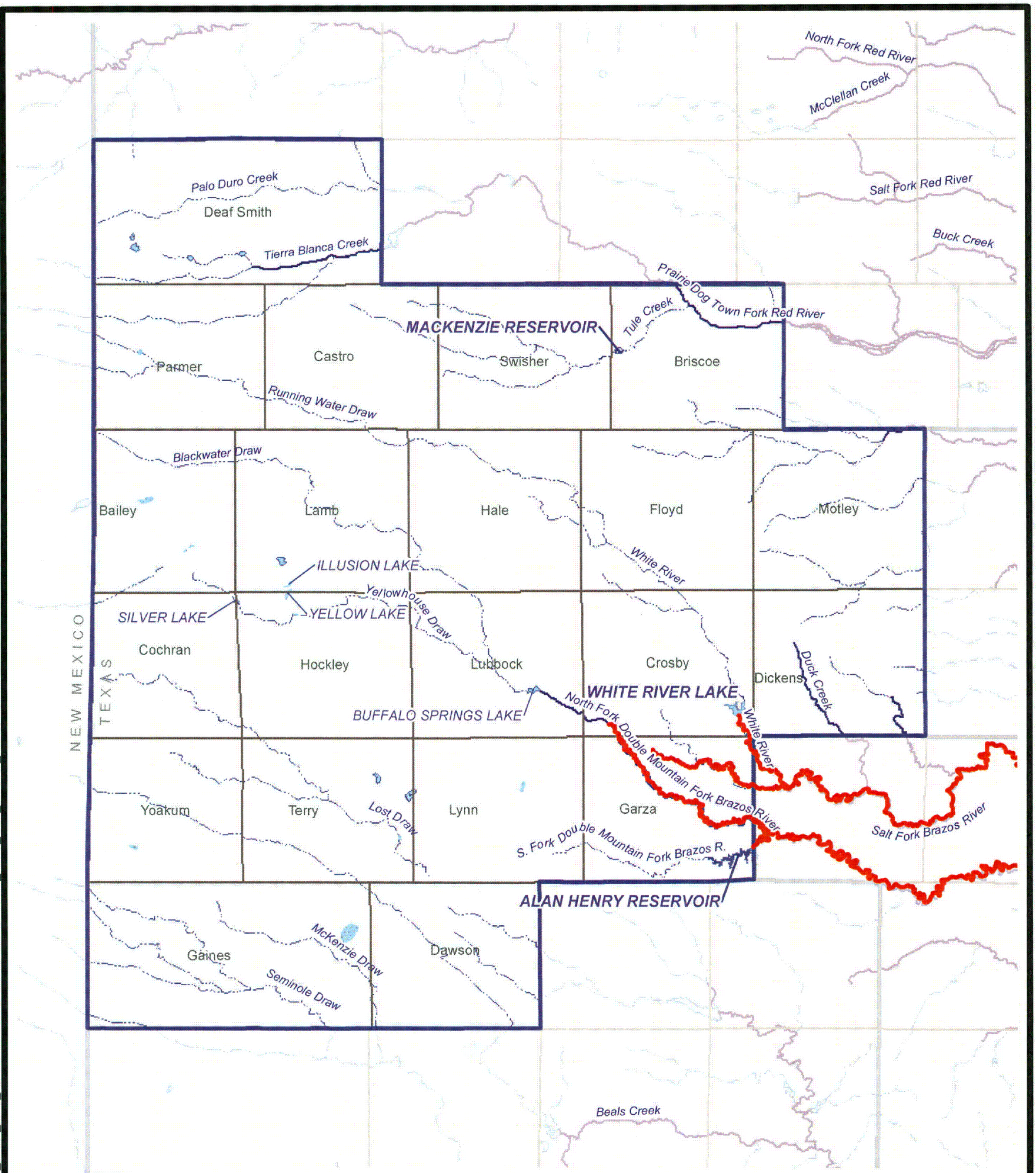
- WAFWA adopted a range-wide conservation plan for the lesser prairie chicken (available online at http://www.wafwa.org/documents/2013LPCRWPfinalfor4drule12092013.pdf) that sets goals for habitat restoration and population targets. The plan aims to increase the lesser prairie chicken's population to 67,000 by 2022.

- The USDA's LPCI works with farmers and ranchers to promote economic stability and sound ecological practices on land within the bird's current range.

The lesser prairie chicken had been on the U.S. Fish & Wildlife Service's (USFWS's) watch list since 1998. In May 2011, the federal government settled a case with WildEarth Guardians, requiring the USFWS to make final rulings on 251 species by September 30, 2016, and the lesser prairie chicken was one of the species in the case. On March 27, 2014, the USFWS listed the lesser prairie chicken as threatened under the Endangered Species Act (ESA) of 1973. In addition to the final rule, the USFWS applied a Final Special Rule under Section 4(d) acknowledging that the current efforts by WAFWA and the LPCI are in compliance with the ESA and are therefore not subject to additional regulation from the federal government. The listing of this species is under litigation.

1.7.2.2.2 Smalleye and Sharpnose Shiners. The smalleye shiner (*Notropis buccula*) and the sharpnose shiner (*Notropis oxyrhynchus*) have been candidates for listing under the ESA since 2002. Both species were listed on August 4, 2014, along with 623 miles of critical habitat of the upper Brazos River in Baylor, Crosby, Fisher, Garza, Haskell, Kent, King, Knox, Stonewall, Throckmorton, and Young counties (USFWS, 2014b). While once present in the Upper and Lower Brazos, the Wichita, and the Colorado rivers, both species are now confined to the Upper Brazos River. The smalleye shiner has lost more than 50 percent of its historical range, and the sharpnose shiner has lost more than 70 percent. Figure 1-15 shows the shiners' current range. Each species now has only one remaining population, leaving both shiners at a high risk for extinction in both the near- (10 years or less) and long-term (11 to 50 years).

Both shiner species were first described in the early 1950s. The smalleye shiner is a pale olive-green minnow averaging 1.4 to 1.7 inches in length. The sharpnose shiner is silvery-white with some olive-green coloring on its dorsal side; it averages 1.2 to 2 inches in length. Both species have lifespans of less than three years, usually including only one breeding season. Both species require wide, shallow (less than 1.6 feet), flowing riverine habitat with sandy bottoms.



Source: USFWS, 2014c

N

0 15 30 Miles

Explanation

- Water planning region
- County
- Stream
- Intermittent stream
- Lake/reservoir
- Current range of both species

LLANO ESTACADO REGION

Current Range of Smalleye and Sharpnose Shiners

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Daniel B. Stephens & Associates, Inc.
9/30/2015
JN WR11.0030

Figure 1-15

These two species reproduce through broadcast spawning. They breed asynchronously during times of low stream flow and synchronously during times of elevated streamflow, such as during pulse events after storms. The eggs of both species are buoyant in flowing water and float for one to two days after fertilization, at which point they hatch into larval fish. The larval fish float for another two to three days until they develop into free-swimming juvenile fish. Modeling reveals that the shiners require 171 miles (275 kilometers [km]) of uninterrupted streambed to reproduce successfully. Furthermore, sharpnose shiners require streamflow rates of 2.61 cubic meters per second (m^3/s) and smalleye shiners require stream flow rates of 6.43 m^3/s.

The USFWS identified two main threats to the viability of the shiners in the future:

- River fragmentation (due to new reservoir construction)
- Change in the streamflow regime (due to river impoundment and diversions, alteration of spring seepage due to groundwater pumping, climate change, and salt cedar encroachment)

In the extreme drought of 2011, the extant populations of both species were at high risk. Biologists from the Texas Parks and Wildlife Department (TPWD) and Texas Tech University captured individuals from both species in isolated pools in the Brazos before the river went completely dry due to the drought conditions and then maintained shiner populations in captivity until releasing them again in 2012. No natural breeding was documented in 2011.

In January 2015, the USFWS released a recovery outline for the sharpnose shiner and smalleye shiner (USFWS, 2015). This document discusses the recovery status assessment and preliminary recovery strategy for both species. The recovery status assessment includes an evaluation of species viability and threats to survival (USFWS, 2015). After evaluating individual, species, and population needs for survival, the recovery outline concludes that the main threat facing the shiners is habitat loss and modification which is occurring through river fragmentation (e.g., impoundments, low-water crossings, pipeline reinforcements, weirs) and the reduction/alteration of stream flow (e.g., impoundments, drought, groundwater withdrawal, salt cedar encroachment, in-channel projects) (USFWS, 2015). Secondary stressors are water quality degradation (point-source pollution, toxic golden alga blooms) and commercial bait harvesting (USFWS, 2015).

The recovery outline lays out a 10 step action plan to support recovery of the species. Listed actions include managing salt cedar encroachment along the upper Brazos River basin, identifying captive propagation requirements, developing a protocols for large-scale captive breeding and the release of captive bred individuals into occupied and historically occupied reaches, implementing water release strategies to aid fish reproduction during the spawning season, and implementing groundwater and surface water conservation strategies in the upper Brazos River basin to maximize surface water flows (USFWS, 2015).

1.8 Threats to Water Supply, Agriculture, and Natural Resources

1.8.1 Threats to Water Supply

To continue to meet water demands in Region O over the planning horizon, water user groups (WUGs) will need to expand existing water supply sources and/or build new water supply projects. The main threats and constraints to existing and future water supply sources in Region O are declining aquifer levels, permitting issues (mainly the availability of unappropriated water and environmental concerns), drought, and invasive species (especially salt cedar, juniper, zebra mussels, and golden algae). Chapter 5 contains a detailed discussion of each WUG's proposed water management strategies and the implementation concerns associated with each strategy.

1.8.2 Threats to Agriculture

Agriculture is the main economic activity in the Llano Estacado region and irrigation accounts for more than 90 percent of the projected water use in each decade of the planning period. Drought, declining aquifer levels, and brackish groundwater are the main water quantity and quality threats to agriculture in Region O. Chapter 5 contains information about current and proposed agricultural strategies used to address these threats.

1.8.3 Threats to Natural Resources

While limited, surface water in Region O is comprised of playa wetlands, rivers, and lakes. Many plant and animal species in the region are dependent on these water sources for their survival.

The main threats facing playas and the species that rely on these wetlands are drought, sedimentation, anthropogenic modifications and enhancements, and water quality changes due to pesticide and fertilizer runoff, livestock operations, and modification of native wetland vegetation. Section 1.5.3.2 discusses the issues threatening playa wetlands in more detail, and Section 5.10.4 contains information about playa best management practices (BMPs) that can be implemented to avoid and/or remedy these threats.

Drought, invasive species (especially salt cedar, juniper, zebra mussels, and golden algae), declining spring flow due mainly to aquifer drawdown, and changes in aquatic habitat due to impoundments, diversions, and alterations in streamflow are the major threats facing rivers and lakes and the species dependent on these water sources. Chapter 5 discusses water management strategies for Region O and, if applicable, describes how these strategies impact the region's rivers and lakes.

1.9 Existing Local and Regional Water Plans

In accordance with 31 TAC §357.22(a)(6), the LERWPG contacted the High Plains Underground Water Conservation District (which includes Hale and Swisher counties) and Briscoe, Swisher, and Hale counties and verified that no water availability requirements that are applicable to the Briscoe/Swisher/Hale County Priority Groundwater Management Area have been promulgated in the three counties by a county commissioners court pursuant to Texas Water Code §35.109.

The LERWPG conducted surveys of each WUG in the region to obtain information about their current and future water plans. These discussions were critical in the development of many of the water management strategies presented in Chapter 5. In addition to the WUG surveys, the following regional and local water planning documents exist for entities in Region O:

- 2012 State Water Plan
- 2011 Regional Water Plan
- The City of Lubbock's 2013 Strategic Water Supply Plan

Each of these documents is summarized below.

1.9.1 The 2012 State Water Plan

The 2012 State Water Plan (available at http://www.twdb.texas.gov/waterplanning/swp/2012) projects a Region O regional water shortage of 2,366,036 ac-ft/yr in 2060. The majority of this shortage (98.0 percent) is irrigation needs. Table 1-23 shows the projected supplies, demands, and needs for 2060 for Region O that were included in the 2012 State Water Plan.

Table 1-23. Region O Supplies, Demands, and Needs for 2060 Projected in 2012 State Water Plan

Source	Amount (ac-ft/yr)
Projected population	*551,758*
Existing Supplies	
Surface water	32,042
Groundwater	1,337,017
Reuse	39,213
Total water supplies	1,408,272
Demands	
Municipal	93,935
County-other	12,005
Manufacturing	19,919
Mining	258
Irrigation	3,474,163
Steam-electric	49,910
Livestock	73,965
Total water demands	3,724,155
Needs	
Municipal	30,458
Irrigation	2,318,004
Livestock	17,574
Total water needs	2,366,036

Source: TWDB, 2012

The 2012 State Water Plan identified 395,957 ac-ft/yr of potential new water supply in the year 2060, mostly in the form of existing supply freed up through conservation (71.5 percent irrigation conservation and 2.6 percent municipal conservation). New reservoirs (Jim Bertram Lake 7 and Post Reservoir) accounted for 11.0 percent, new groundwater supplies 7.0 percent, and other surface water strategies 6.5 percent. Groundwater desalination and reuse were each projected to account for less than 1.0 percent of the new regional water supplies in 2060.

1.9.2 The 2011 Regional Water Plan

Regional water plans form the basis of the State Water Plan. The LERWPG approved of the final 2011 Region O Plan on August 12, 2010, and it was submitted to the TWDB by September 1, 2010. The 2011 Region O Water Plan recommended the following strategies to meet projected shortages in the region (LERWPG, 2010, p. ES-16):

- Municipal and irrigation water conservation
- Water supply from nearby groundwater sources for cities projected to need additional municipal water supply
- Water supply from Lake Alan Henry, groundwater sources, and reclaimed water
- Jim Bertram Lake 7
- Post Reservoir
- Lubbock North Fork Diversion Operation
- Precipitation enhancement
- Brush control
- Desalination of brackish groundwater
- Research and development of drought-tolerant crops and new technology
- Stormwater capture and use
- Public education

1.9.3 The City of Lubbock's 2013 Strategic Water Supply Plan

The City of Lubbock completed a Strategic Water Supply Plan in February 2013. The City used a 100-year planning horizon and proposed 16 different water supply strategies (6 reuse, 6 groundwater and 4 surface water) that were capable of meeting the City's water needs under all demand scenarios (conservation, probable, and accelerated growth). This strategic plan is the source for the City of Lubbock water management strategies presented in Chapter 5 and for the projected Lubbock County direct reuse water availability amounts listed in Section 3.1.3.

1.10 Drought

1.10.1 Identified Historical Drought(s) of Record

Lowry (1959) found that there had been 11 significant droughts in Texas between the period of 1889 and 1957, with the most severe occurring from 1954 to 1956. The 1953 and 1950 to 1952 droughts were rated separately as the fifth and seventh most severe, although all three of these periods were later combined in the analysis to form the most severe drought (Texas Water Commission, 1965). The drought that occurred from 1950 to 1957 is the current drought of record for the planning region (Texas Water Resources Institute, 2011). Additional information on the drought of record and the recent drought conditions in Region O are provided in Section 7.2.

1.10.2 Current Preparations for Drought within Region O

In Region O, 52 drought contingency plans (DCPs) were obtained and reviewed. Most of the DCPs were complete, outlining each water system's drought and emergency contingency procedures and identifying the triggering criteria for initiation and termination of drought response stages as well as other water use restrictions in effect during time of water shortages. The majority of DCPs in Region O include quantified water use reduction goals for each stage, notification procedures, and enforcement measures, and some also included allowable variances to the plan. Section 7.1 and Appendix 7A provide detailed information on the DCPs in Region O as well as a summary of current drought preparations in the region.

1.11 Water Loss Audits

Due to a lack of information on water loss in the State of Texas, the 78th Texas Legislature passed House Bill 3338 in 2003, requiring the TWDB to develop a detailed water loss audit (WLA) to be completed every five years by all retail public water utilities in the state that provide potable water. In developing the WLA, the TWDB defined standard water loss categories and statistics, using methodology recommended by the International Water Association (IWA) and American Water Works Association (AWWA). The TWDB compiles the submitted WLA data and provides it to the regional water planning groups for consideration in their planning efforts (specifically water demand projections, water management strategies, and municipal conservation plans). To date, WLA datasets using this new methodology that include all retail public water utilities in the state are available for 2005 and 2010. Smaller datasets using this methodology are available for 2011, 2012 and 2013 and include data submitted by the following:

- Retail public water utilities that chose to voluntarily submit a WLA
- Retail public water utilities applying for financial assistance with the TWDB
- Starting in 2012, retail public water utilities with an outstanding financial obligation to the TWDB
- Starting in 2013, retail public water utilities with 3,300 or more connections

The WLA consists of over 40 questions regarding a WUG's water system and usage. Appendix 1C provides a subset of the 2010 WLA data for 44 retail public water utilities in Region O. The 2010 WLA dataset was selected for presentation in this plan because it includes more retail public water utilities than any of the other datasets. Of the 44 retail public water utilities included in this dataset, 15 serve populations of less than 500 and data for these entities are included in the County-other category in subsequent chapters. The 2010 WLA dataset provided by the TWDB does not contain any data for the following 21 Region O municipal WUGs: Anton, Crosbyton, Earth, Farwell, Hale Center, Happy, Hart, Lockney, Matador, Meadow, Muleshoe, O'Donnell, Petersburg, Plains, Plainview, Post, Seagraves, Slaton, Sudan, Tulia, and Wolfforth.

The 2010 WLA shows a regional total system input of 19.0 billion gallons and water loss of 1.7 billion gallons (8.7 percent). Table 1-24 shows the number of WUGs per water loss category, based on data reported in the 2010 WLA. The majority (61 percent) of the WUGs reported water loss under 15 percent. However, 20 percent (9 WUGs) experienced water loss over 30 percent, and 3 WUGs reported water loss exceeding 50 percent.

Table 1-24. Region O 2010 Water Loss Audit
Number of Water User Groups per Water Loss Category

Water Loss Category	Water User Groups	
	Number	Percentage of Total
Less than or equal to 5 percent	6	14
5.1 to 10 percent	9	20
10.1 to 15 percent	12	27
15.1 to 20 percent	5	11
20.1 to 30 percent	3	7
30.1 to 40 percent	5	11
40.1 to 50 percent	1	2
Greater than 50 percent	3	7
Total	44	100

The number of WUGs reporting significant water loss indicates a need for infrastructure improvement in the region, especially as some of the WUGs with the greatest water loss percentages have shortages starting in 2020. Municipal water loss reduction strategies have been recommended for some of the WUGs in Region O (Section 5.2.2).

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Appendix 1A

Springs in the Llano Estacado Region

Appendix 1A

Springs and Seeps of the Llano Estacado Region

by
Jim Steiert, Member
Llano Estacado Regional Water Planning Group

Springs and seeps historically existed in the Southern High Plains including Region O (the Llano Estacado Planning Region.) They never emitted water in quantities comparable to the high-volume springs noted elsewhere in Texas, but were of major significance in historic travel across the Llano and as water sources for both man and beast. Most of the region's springs and seeps disappeared as native grassland was cultivated and irrigated agriculture evolved. Ogallala aquifer pumpage that drew down the water table is usually blamed for the demise of springs. However, in his work "Springs of Texas," Gunnar Brune maintains that siltation that began when the native grass cover was removed from the land was also a factor. Topsoil that washed into creeks and draws choked many springs. Landscape lost capacity to absorb recharge water. Brune notes invasive brush species including salt cedar and juniper were commonly found adjacent to many defunct spring sites. Interception of recharge flow by brush species cannot be discounted as a factor in the loss of spring flow.

At least some springs and seeps still occur in the Llano Estacado Region. While their flow is minimal in comparison to historic times, some encouragement must surely be taken from the fact that they exist at all. While some springs pour water from the Ogallala aquifer, others flow only after prolonged, substantial rainfall. Water that soaks into surrounding lands still gradually feeds the springs. Many springs and seeps are located on private land and their presence can only be confirmed through frequent and close observation. Landowners may be reluctant to allow public access to these sites due to concern over liability, the wish to avoid damage to the landscape, etc. The flow from most of these springs is local and does not contribute to river flow. Spring water may travel a short distance and generally evaporates or runs back into the ground. Seeps are generally little more than small pools sustained by minimal flow from underground. Where springs and seeps still exist they are important to local wildlife and may be a source of livestock or recreational water.

Much of the Llano Estacado region experienced unusually heavy rainfall during 2004 that renewed spring and seep flows in some locations. Where normal annual rainfall is roughly 18 inches, 42 inches of more of precipitation fell on parts of the region. Renewed spring flows noted in 2004-2005 proved out-of-the-ordinary, localized, and a direct result of abundant rainfall.

According to "Major and Historical Springs of Texas" published by the Texas Water Development Board, and from information garnered by area residents, several active springs and seeps are located within the Llano Estacado Planning Region. Their flows can fluctuate substantially. Included here is a list of historic springs in the Llano Estacado Region, as well as information on any spring and seep sites still active. Material in this report is taken primary from "Springs of Texas" Volume 1 by Gunnar Brune, [1] and is supplemented with anecdotal information based on interviews with area residents and landowners.

Bold type in the descriptive text indicates currently active springs and seeps. *Italicized type in the text indicates updated information on inactive springs or seeps.*

BAILEY COUNTY: At the time of his 1978 documentation, Brune found that the springs of Bailey County had nearly all ceased flowing. Through history, several springs issued from Tertiary Ogallala sand and more recent sand and caliche, and from Cretaceous limestone. Springs were located primarily along Blackwater Draw and its larger tributaries, and adjacent to the larger lakes. Cultivation of grassland diminished the soil's ability to absorb recharge water and the springs along Blackwater Draw were largely gone by the 1930s. Among historic springs mentioned by Brune, and their location are Alkali Springs, 1.5 miles south of Baileyboro; Barnett Springs, 6.8 miles southeast of Coyote Lake and just over a half-mile northeast of Baileyboro; Blackwater Lake and Springs, 6.2 miles west of Muleshoe; Jumbo and Turnbo Springs, 1.8 miles northeast of Muleshoe; Butler Springs, in the northeast corner of the county on the Parmer County line and just over a half-mile west of the Lamb County line; and White Springs, in the Muleshoe National Wildlife Refuge 6.2 miles south of Needmore. In a telephone interview on March 24, 2005, Mr. Jim Young of Muleshoe reported that springs had consistently maintained seeps south of Baileyboro Lake just south of Baileyboro. These were not large flows but maintained standing water. Mr. Harold Beierman, past manager of the Muleshoe National Wildlife Refuge near Needmore said that abundant rainfall during 2004 caused seeps to moisten the ground at several sites on the refuge. Beierman said that spring flow also occurred at Paul's Lake on private property north of the refuge, and that water was present in Paul's Lake throughout the fall and winter of 2004-2005. The private property hosting a spring north of Paul's Lake was eventually purchased and made a part of the Muleshoe Refuge.

In a telephone interview conducted March 28, 2015, Mr. Jude Smith, present manager of the Muleshoe and Buffalo Lake wildlife refuges in the Texas Panhandle/South Plains and the Grulla Wildlife Refuge in eastern New Mexico

[1] Brune, Gunnar, Springs of Texas Vol 1, Texas A&M University Press, College Station, Texas, 2002

reported that a complex of six live springs remain on the Muleshoe Refuge in the present day, with a seventh coming back and the revival of some springs has occurred with the control of invasive salt cedar.

Surprisingly, a revival of springs seemed to occur as drought conditions worsened in 2010. A spring site mentioned as on private property in 2004-2005 is now a part of the refuge, and according to Mr. Smith a spring on the northwest side of the refuge remains wet year-round and flows periodically, particularly after rainfall. Mr. Smith noted that after salt cedar was controlled with the herbicide Arsenal, one of the springs resurfaced when dead cedar was being dug out and removed. Spring flow on the Muleshoe Refuge was enhanced by favorable summer rainfall in 2014.

Mr. Jordan Menge, Pheasants Forever Farm Bill Wildlife Biologist based at the Natural Resources Conservation Service office in Muleshoe, reported in a telephone interview April 1, 2015 that seeps are still active at Baileyboro Lake in light of winter and spring rains, and that favorable rainfall helps to maintain flows in that area.

BRISCOE COUNTY: Most of the historic springs in Briscoe County issued from Tertiary Ogallala sand and Quaternary sands and gravels such as the Tule, in the western part of the county. From 15,000 years ago, when Clovis man frequented the springs, until over a century ago, nearly all of the springs ran continuously. Remains of mammoths hunted by the Clovis people have been found in Briscoe County, hearths, projectile points, knives and scrapers and paintings on rock cliffs indicated that from Clovis to historic times, man and animal have associated with spring sites here. Irrigation caused a severe decline in the water table, a major cause of the failure of most springs, but extensive erosion also resulted in creeks being choked with sand and silt, and many springs were buried. Evidence indicates that Coronado followed the waters of Tule Creek in 1541 and stopped at **HULSEY SPRINGS**, located just below the Caprock Escarpment in Palo Duro Canyon, approximately 9 miles north of Vigo Park. This name evidently represented several small springs at that location. Brune documented springs still running on Deer, Turkey, and Cedar springs with flow rates of 20.5, 39.6, and 15.8 gallons per minute respectively on September 4, 1978. A telephone interview with Mrs. Dick Cogdell on February 2, 2005 revealed that Turkey Springs remained the primary active spring at that location. The spring did not flow during hot, dry summers. Any spring flow was dependent on abundant rainfall soaking into the surrounding landscape and feeding the spring, and water did not flow a large distance from the site when the spring was running.

A telephone interview on March 31, 2015 with Mr. Rank Cogdell disclosed that although springs do not run in this area as they formerly did, seeps still remain. Mr. Cogdell reported that when Mackenzie Lake holds a high level of water some of the

water apparently seeps out of the lake to strengthen the flow from local springs and seeps, but sadly, the lake level has been low for a prolonged period, impacting spring and seep flow. According to Mr. Cogdell, one of the pastures on family land located at a point before it transects the Prairie Dog Town Fork of the Red River harbors a seep that stands water in sufficient quantity for livestock use.

A number of other spring sites were also documented by Brune in Briscoe County. Some of these go by other localized names. In favorable seasons such as 2004, when abundant rainfall provides a recharge source, some of these springs revive, but run only a small distance before going back underground or evaporating. Mr. Rank Cogdell of the Vigo Park area reported in a phone interview on February 2, 2005, that he observed many active springs along Tule Canyon during a helicopter flight over the area in January of 2005. He reported that the Tule had numerous springs along its length, and that in the winter Tule Creek and Deer Creek were the only locations with spring flow sufficient to provide dependable livestock water, with flow from Deer Creek estimated at roughly 20 gallons per minute. The best of the small localized springs on the Tule was located within 2 miles of Highway 207 that runs between Claude and Silverton. Mr. Cogdell commented that a favorable fall and winter of rainfall had created spring flows in Briscoe County that likely would not be maintained once dryer weather set in. Water from these springs did not travel large distances or contribute to river flows.

Among other historic springs mentioned by Brune are Marting Springs, roughly 5 miles southwest of Brice; Burson Springs, 9.3 miles northwest of Turkey; Bell Springs, 6.2 miles northwest of Turkey; Gyp Springs, 5.5 miles northwest of Quitaque; Haynes Springs, 2.4 miles upstream from Gyp Springs on the South Prong of the Little Red River; Cottonwood and Red Rock Springs, 4.3 miles west-northwest of Quitaque on Little Cottonwood Creek; Las Lenguas Springs, 8.6 miles west-southwest of Quitaque; Rock Springs, 7.4 miles west-northwest of Silverton; and Mayfield Spring, 1.8 miles north-northeast of Rock Springs.

CASTRO COUNTY: As late as 1978 Brune indicated that no springs flowed in Castro County, although in historic times many issued from Ogallala sand, gravel, silt and caliche. Springs once maintained a flowing stream in Running Water Draw, but this has not been the case in modern times. Decline of the water table due to pumping from the Ogallala and siltation contributed to the failure of springs. Among historic spring sites and their locations was Flagg Springs, 3.1 miles south of the Flagg community and 6.8 miles upstream from Sunnyside on Running Water Draw. Jumbo Lake, 6.2 miles northeast of Easter, was once kept full by seeps from Ogallala silt and sand. Middle Tule Draw northeast of Nazareth held some pools of live water, as did the North Fork of the Running Water Draw. Running Water Draw was fed by springs near Sunnyside.

Mr. Chad Warminski, District Conservationist with the Castro County NRCS office reported in an April 9, 2015 telephone interview that he has not seen any spring or seep activity in Castro County in current times.

COCHRAN COUNTY: Brune documented in 1978 that hardly any springs still flowed in Cochran County, although they issued in abundance from the Ogallala when the water table was at or near the surface. Springs were especially numerous around Silver Lake and along the major draws. Historic spring sites include Morton Springs, 3.1 miles west of Morton, which dried up in 1907, and Silver Springs, on the northwest side of Silver Lake. Discharge of springs around the lake was impacted by irrigation pumping, and the presence of salt cedars could also account for some water loss. South-southeast of Lehman about 6.2 miles, springs or seeps may have flowed in former times. In the southeast corner of the county just over a half-mile north of the Yoakum County line and 8.6 miles west of the Hockley County line, springs formerly kept a draw running with water year-round.

In a telephone interview conducted April 10, 2015, Mr. Landon Kerby, District Conservationist with the Cochran County NRCS office in Morton reported that he is not familiar with a single spring or seep still remaining in Cochran County, but said there is the possibility that seeps could still be extent on some large ranches in that area. Additionally, he said that anecdotal information indicates at least one live spring is present in a draw in the northeast portion of Cochran County near Silver Lake, likely one of the historic spring sites mentioned in Brune's work. Mr. Kerby said he is uncertain if this live spring would be in Cochran or Bailey County, as these two counties intersect in the Silver Lake area. Mr. Kerby said favorable abundant rainfall could potentially reinvigorate some spring and seep activity in this area.

CROSBY COUNTY: Historically, Crosby County was abundantly endowed with springs, mostly in the canyon breaks below the caprock, with water flowing from Ogallala and Triassic Dockum sands. The springs declined markedly as the Ogallala water table dropped. Brune noted in 1978 that Crawfish Creek was dry except in times of heavy rainstorms. Among historic creeks and their location, as listed by Brune were Rock House Springs, near the junction of Highway 651 and 193 in northern Crosby County; Ericson Springs, 1.2 miles west-southwest of Mount Blanco, issuing in a ravine with vertical caliche cliffs, the site offered only a seep in 1978; Dewey Springs, a group of springs on the north side of Dewey Lake located 4.3 miles east- northeast of Crosbyton, now dry; Silver Falls, below the Highway 82 crossing of the White River, was once a source of water for White River Reservoir, but the spring flow diminished; Couch, or English Springs, 8 miles east of Crosbyton in Blanco Canyon, dry now; Davidson Springs, 4.9 miles southeast of Crosbyton; Cold Springs, 8 miles southeast of Crosbyton;

L7 Springs, 9.3 miles south-southeast of Crosbyton; Wilson Springs, 2.4 miles east-southeast of Cap Rock; Cottonwood Springs, 9.9 miles east- northeast of Slaton on Plum Creek; C Bar Springs, 8.6 miles east-southeast of Slaton; and Gholson Springs, 6.2 miles east-northeast of Slaton.

A couple of seeps still exist on the White River watershed in Blanco Canyon that still bubble enough water to the surface to occasionally provide a little livestock water, according to Mr. Gary Gowens, technician with the Crosby County NRCS office in Crosbyton, who was interviewed by telephone on April 7, 2015. Mr. Gowens relates that flash flood events are usually the only times there is any modern day water flow in the Blanco Canyon area, and that steady, favorable rains might give new life to seeps and possibly springs in that vicinity.

DAWSON COUNTY: The larger springs of Dawson County were in the breaks and canyons below the caprock such as TJF Draw, Tobacco Creek, and Gold Creek Canyons. Small springs on the plains such as those along Sulphur Springs Draw were the first to fail as the water table began declining. Many creeks also were filled with drifting sand during dust storms. Brune's field studies during 1975 showed the springs issuing from Pleistocene sand, Tertiary Ogallala sand and lower Cretaceous limestone. Among spring sites documented by Brune and their location are Sulphur Springs Draw, 3.1 miles south of Welch, where several small springs or seeps are speculated to have flowed during historic times; Rock Crusher or Turner Springs, 6.8 miles south of O'Donnell, where Brune metered a flow rate of 30.1 gallons per minute in October of 1978, with the water flow increasing greatly over that metered in June of 1938; Earl Springs, 1.2 miles north of Rock Crusher Springs; Tobacco Springs, at the head of Tobacco Creek, 8.6 miles south-southeast of O'Donnell; Indian Springs, 5.5 miles east-northeast of Tobacco Springs, where an historic people lived in caves and left pictographs on the walls; West Tobacco Springs, 4.9 miles south-southwest of Tobacco Springs; and Mullins Springs, 14.2 miles east of Lamesa and 3.7 miles northeast of the Midway community in a canyon. Mullins Springs flowed until 1969.

In a telephone interview on April 9, 2015, Mr. Hal Rogers, NRCS Resource Leader for Dawson, Gaines, and Yoakum counties reported that there is still some small spring activity in the Rock Crusher Springs area, and in the Indian Canyon Ranch area, where springs and seeps trickle up pools and occasionally run a little water during the winter months when vegetation is dormant, but these flows are essentially trickles. These springs and seeps can sometimes provide livestock water, and in 2011-2012 during a severe drought period heavy livestock use dried some of the sources up. Good rainfall percolating water into the soil can revive at least a little spring and seep activity.

DEAF SMITH COUNTY: Springs flowed along Tierra Blanca and Palo Duro creeks below the Caprock in the northwest corner, and at Garcia Lake and other large lakes or deep depressions. In nearly all cases historic springs flowed from Ogallala sand and caliche, with a few issuing from Dockum sandstone. Tierra Blanca Creek once flowed constantly and large blue holes of spring water flowed to the surface at the community of Blue Water, later named Hereford. While irrigation's drawdown of the Ogallala aquifer was a factor in the decline of spring flow, Brune's studies indicated the plowing of native grasslands loosened fragile topsoil that washed into Tierra Blanca Creek and smothered many springs. Ability of the soil to recharge water to the aquifer was also damaged. During studies in May of 1977, Brune documented historic spring sites and their locations. Based on his studies at that time, Brune concluded that Big Springs on the Gault Ranch along Tierra Blanca Creek, about 4.3 miles west of the Randall County line, was the only flowing spring in Deaf Smith County, with a flow of about 5 gallons per minute. Southeast of the Big Springs site about 3.1 miles, Parker Springs flowed from the base of caliche caprock. Most of the springs at this location had disappeared by April of 2002, but one small spring continued to seep, maintaining a small pool of water. Heavy rains in the area revitalized Devil's Canyon, south of Parker Springs. Seepage continued to maintain water in a cattle watering tank at that site. Sulphur Springs in Sulphur Park on the old L.R. Bradly farm, just upstream from the junction of Tierra Blanca Creek and Frio Draw was once the site of a lake popular for recreation. The Sulphur Springs area became part of the City of Hereford's farm, some 4.9 miles northeast of Hereford, and two or three springs still create seep sites there. Brune believed that Sulphur Springs failed by the 1940s. Recharge from rainfall or some other factor served to rejuvenate at least light flow, and several seeps could be found along Tierra Blanca Creek on the City of Hereford property. Spring flow in this area travels only a small distance before evaporating or going below ground. Just east of the Sulphur Springs area, several live springs were present on ranch property along the Tierra Blanca Creek. From 1972 through 1994 the flow of some 20 springs on the site did not stop, although it was often minimal. Most springs at this location flowed intermittently, declining during the heavy irrigation season. During the fall and winter months water might flow for a mile or more in the channel of Tierra Blanca Creek. **One spring at the site has flowed at a rate as high as 30 gallons per minute, but the flow has fallen off considerably since about 2008. There is some question as to whether this water originates from the Ogallala, or a local perched aquifer. Heavy rainfall during the summer of 2008 washed large amounts of detritus into some of the spring and seep sites along Tierra Blanca Creek east of Hereford and subsequently resulted in a massive bloom of duck weed in the standing water from springs and seeps. Since the time of this residue washing any spring flow has been considerably reduced. Cleaning out some of the spring and seep sites might possibly restore at least a small flow. A very small trickle of seep activity occurs beneath the South Main bridge in Hereford adjacent to the golf course—a minimal remnant of the legendary blue hole of water recorded as**

surfacing at that site in the community's early years. Additionally, an apparent seep kept water pooled in a small area adjacent to the Highway 385 bridge on Tierra Blanca Creek just south of the railroad overpass over Highway 385 on the edge of Hereford.

Bridwell Springs, on the Bridwell Ranch in the northwestern corner of the county have gone dry. Fowler Springs was found 1.8 miles west of the Randall County line on Palo Duro Creek, and Hodges Spring, 2.4 miles west of the Randall County line, are among springs that formerly flowed along Palo Duro Creek. Ojo Frio or Cold Spring was located in the Frio Draw upstream from its junction with Tierra Blanca Creek. Punta De Agua or Source of Water was 5.5 miles west of Hereford in Tierra Blanca Creek. Below this point Tierra Blanca Creek flowed constantly, but began to falter in 1925, well before massive development of irrigation, and after about 1940 there was no flow except from surface runoff. In western Deaf Smith County, 2.4 miles east of the New Mexico state line, the XIT Ranch used Escarbada Springs in historic times, but they are now dry. At least one small seep is still active in this area of western Deaf Smith County, adjacent to the New Mexico border. Ojo de Garcia or Little Garcia Springs formerly flowed from Dockum sandstone 1.2 miles west-northwest of Garcia Lake in western Deaf Smith County. Spring flow eventually declined to seeps, and water is only present in Garcia Lake now when large localized rainstorms cause runoff to flow to the lake.

DICKENS COUNTY: The northwest corner of Dickens County lies on the High Plains, underlain by Tertiary Ogallala sand, gravel, and caliche. Abundant springs once flowed from this formation all along the Caprock Escarpment, but most have disappeared due to heavy pumping for the Ogallala aquifer. The remainder of the county lies in the Rolling Plains, where springs trickle from Permian gypsum and sandstone. Some historic springs were choked by erosion and buried as early as 1914. Most springs declined permanently by 1979. Historic springs and their locations include Browning Springs, 3.1 miles northwest of Dickens in Hobble Scobble Canyon; another spring was 4.9 miles northwest of Dickens. Pecan Grove Spring was 5.5 miles southeast of McAdoo. On Grapevine Creek were White House Springs, 4.3 miles northeast of McAdoo. Cottonwood Springs were just over a half-mile west of Afton, and can still flow in the event of heavy local rainfall. Erosion choked the creek bed in this area. A half-mile north of Afton are Patton Springs, eventually covered by a lake; Jackson Springs, 6.2 miles north of Dickens, went dry and the creek channel filled with sand; Sanders Springs, east-northeast of Afton, is also subject to rainfall recharge, with Brune documenting a flow of 158.4 gallons per minute in August, 1979 after a heavy local rainstorm; Shinnery Springs 6.2 miles southwest of Dumont on the Pitchfork Ranch was still running year around in 2005 according to Wyman Meinzer of Benjamin, TX. Brune documented a flow of less than 5 gallons per minute in August, 1979. Meinzer reported the flow was not large but consistent. The water did not flow a long distance. Dripping Springs are 5.5 miles southwest of Dumont, and were termed similar to Shinnery Springs. Law Springs are 2.4 miles northeast of Dickens. Dickens or Crow Springs are less than a mile northeast of Dickens. Brune noted a flow of 38 gallons per minute in August, 1979 following heavy rain. Mitchell Springs are 1.8 miles east- southeast of Dickens.

In a telephone interview on March 31, 2015, Stella Carter, a 26-year veteran employee of the Pitchfork Ranch reported that Dripping Springs continues to flow in a pasture on the ranch. She related that Red River Water Supply has a well located near the spring site but that spring flow persists.

Mrs. LaNell Kendrick, a present-day resident of Hereford who grew up at Dickens stated in a personal interview March 31, 2015 that there were spring sites on the east side of Dickens and that at a site between Dickens and Roaring Springs on the northwest quarter of a land section a spring ran in a depressed area in sufficient volume to course water in a culvert under the road as late as 2006 and seeps may well still be present in that area.

FLOYD COUNTY: Brune pronounced the story of springs in Floyd County as largely one of water sources that were once important, but are no more due to decline of the water table. Springs formerly issued from sands and gravels of the Ogallala formation. Blue Hole Springs was on Quitaque Creek 6.2 miles east of South Plains. It had no water flow in July of 1978 and had been partially filled with cobbles and gravel. Likewise, Bain Springs, 8.6 miles southwest of Flomot, just below the caprock, was dry. Montgomery Springs, in Blanco Canyon, just north of the Crosby County line, ceased flowing in 1948. Massie Springs, 6.2 miles southwest of Floydada, ceased flowing about 1945.

During a telephone interview on April 8, 2015, Mr. Jim Bob Clary, District Conservationist with the Floyd county NRCS office, said he is not aware of any live springs or seeps in Floyd County, although there is some spring and seep activity to the east in Motley County.

GAINES COUNTY: Most of the springs here flowed from Ogallala and more recent sands. Decline of the Ogallala aquifer is cited as a cause for most springs drying up. Boar's Nest Springs in northwest Gaines County were dry by 1955. Cedar Lake or Laguna Sabinas in Northeastern Gaines County was once surrounded and fed by numerous fresh and saline springs. Buffalo Springs on the north side of the lake and Johnson Springs on the south side of the lake had only small flows by 1963, but none of the Cedar Lake springs were flowing by 1977, although a few seeps were still evident. Balch Springs on McKenzie Draw south of Cedar Lake was still yielding 39.6 gallons of water a minute when Brune measured in March, 1977. Bobby Tabor, soil conservationist with the Seminole Field office of NRCS, in a telephone interview on February 3, 2005, reported no flow in that area. A number of seeps were cited by Brune as existing along McKenzie Draw. Mr. Tabor related that a local landowner reported early in 2005 that at McKenzie Lake, 19.2 miles east of Seminole and south of Cedar Lake, two springs located on private property still ran into McKenzie Lake. The flow rate wasn't known, but probably wasn't large. South of Seminole 5.5 miles, Indian Wells was the site of as many as 20 seeps issuing from Ogallala sand. Downstream on Seminole Draw, six springs formerly flowed. Brune projects there were probably also seeps along Monument Draw in the southwestern corner of the county. Ward's Well at Hackberry Grove, 2.4 miles south of Seminole, was a former area of shallow water that could be hand-dipped, but the water table declined at this site.

In an April 1, 2015 telephone interview, Mr. Mark Lewis, District Conservationist with the NRCS Seminole field office related that virtually all springs and seeps in Gaines County were dry. He said that considerable favorable rainfall would be required to restore any of the seeps. Lori Barnes, manager of the Llano Estacado Underground Water Conservation District at Seminole concurred with Mr. Lewis' remarks in a telephone interview on March 7, 2015. Also, in an April 9, 2015 telephone interview, Mr. Hal Rogers, NRCS Resource Leader for Dawson, Gaines, and Yoakum counties, indicated that small historic springs are still present in the Cedar Lake area but considerable recharge from good rainfall is required to prompt any seepage or flow.

GARZA COUNTY: The western edge of the county lies on the High Plains and on the edge of these plains springs flowed from Tertiary sand, gravel, and caliche. Much of the county lies on the Red Bed or Gypsum Plains where some springs issued from Quaternary sand, gravel, and caliche and from Triassic Dockum sandstone. Many springs weakened or failed as groundwater declined and severe erosion filled many stream channels and buried springs. Mr. Glen Killough, district conservationist with the Post field office of the NRCS, related in 2005 that many seeps still existed off the Caprock. They were local and their waters did not contribute to in-stream flows. Seeps and any small spring flows remaining were highly dependent on rainfall. In the way of historic references: Post Springs, 3.1 miles west of Post, once a source of part of the water for that city, are now dry. Golf Course Springs, 3.1 miles northwest of Post, once discharged water over a mile downstream and were strong in the 1930s, declined to only a seep in 1975. Tipton Springs, 4.3 miles northwest of Post, have been dry since about 1945. Barnum Springs were 7.4 miles north-northwest of Post. Live water existed in holes until about 1975. Double U Springs were noted 3.7 miles southeast of Eastland. Brune measured a flow of 3.1 gallons per minute in June, 1979. Whiskey Springs, 3.1 miles northeast of Southland, were a tiny trickle of 0.79 gallons per minute in June of 1979 and a similar spring in Red Creek 1.2 miles south-southwest flowed even less. Llano Springs, 8 miles north of Post on the northeast side of the Brazos River, flowed until the 1940s, and seeps could still occur in the event of wet weather. Lane Springs, 6.2 miles southwest of Kalgary, had declined to seep status by the time of Brune's survey, and Indian Springs, 5.5 miles south-southeast of Kalgary, trickled at 1.9 gallons per minute when Brune measured it in August of 1979, and might be subject to some seepage in the event of favorable rainfall. Chimney Springs were noted less than a half-mile upstream. K Springs were located 3.7 miles east-southeast of Indian Springs. Southeast of Lane Springs some seeps were noted and 2.4 miles farther south Slick Nasty Springs were once an important watering site on the Spur Ranch, but reduced to seeps. OS Springs was cited 9.3 miles east of Post, south of the North Fork of the Double Mountain Fork of the Brazos River, characterized even in 1979 as only wet weather seeps. Reed Springs, 4.9 miles east of Justiceburg, was a seep from Dockum sandstone. Rocky Springs, 5.5 miles east-southeast of Justiceburg, fed Rocky Creek with slightly saline water from Dockum sandstone bluffs. Spring Creek Springs were 4.3 miles southeast of Grassland, and were about seven groups of springs that flowed 34.8 gallons per minute in the winter, but less in summer. Spring water flowed as much as 2 miles. Cooper Springs in Cooper's Canyon 4.3 miles south of Post were once strong but flowed only about 11 gallons per minute in 1979. Boy Scout Springs, 2.4 miles southwest of Post, stopped flowing about 1946 but there were still wet weather seeps in 1979. Box Canyon Springs, 2.4 miles west-southwest of Post, flowed at 13.1 gallons per minute in June of 1979.

In an updating interview on April 1, 2015, Mr. Killough said that seeps in Garza County are currently few and far between in light of extended drought. He said that historically there are many seeps just off the edge of the Caprock, with most bubbling just enough water for use by a few livestock. These seeps are enhanced when favorable rainfall occurs. No springs or seeps are contributing to river flow in the region.

HALE COUNTY: Brune noted no flowing springs in Hale County, although historically, springs and spring-fed creeks were abundant. Decline of the water table is a factor in the demise of the springs. Norfleet Springs were in the northwest corner of the county 1.2 miles from the Lamb County line on Running Water Draw and bubbled up in 12 or 13 springs in the 1930s, but failed by 1945. Downstream on Running Water Draw 6.2 miles west of Edmonson was Ojo de Agua Springs. These and other springs maintained a running stream in Running Water Draw. These springs dried up in the 1950s with some seepage until the 1960s. Jones Springs were 3.1 miles west of Edmonson. Running Water Springs were roughly 2.4 miles south of Edmonson, on the north side of the draw. Up to 12 feet of silt from erosion had filled the draw by the late 1970s. Crawfish Springs were on Crawfish Draw, 7.4 miles south of Hale Center; they dried up by 1920. Eagle Springs were 7.4 miles west-northwest of Abernathy on Blackwater Draw. It dried up in the 1930s and seeped intermittently until the 1940s.

In a telephone interview conducted on April 8, 2015, Mr. Robert Unterkircher, District Conservationist with the Hale County NRCS office, reported that there are no known springs or seeps remaining in Hale County.

HOCKLEY COUNTY: The springs of Hockley County issued from Tertiary Ogallala sand and gravel. Decline of the water table impacted local springs. Silver Springs was located at Silver Lake or Laguna Plata, in the northwest corner of the county, where springs issued at various points around the lake. The flow was less than a gallon per minute in October of 1978. The Devil's Ink Well was a pool of water in Sucker Rod Draw 3.7 miles east-southeast of Pep. Yellow House Springs were two small springs 4.3 miles east of Pep. Small springs once flowed 4.3 miles northeast of Pettit. Some seeps existed in Yellow House Draw until about 1920.

Mr. Kelly Attebury, NRCS Zone Soil Scientist at Lubbock reported in an April 10, 2015 telephone interview that seeps are possibly present at Yellow Lake on the northern end of Hockley County, but it is difficult to ground truth their presence. Abundant rainfall over an extended time period could likely restore at lest some flow to seeps and possibly small springs in the area.

LAMB COUNTY: The channel from Water Draw, 6.2 miles east-southeast of Sunnyside, has been choked with sand washed in by erosion. King Springs was 6.8 miles north of Olton. It fed into Running Water Draw, but failed in the 1950s, however there was some seepage into the 1960s. Many springs once flowed on Blackwater Draw. Alamosa Springs was 4.3 miles east of the Bailey County line on Blackwater Draw. Soda Lake and Springs were 2 miles farther south. Spring Lake was located on Blackwater Draw 4.9 miles west of Earth. Springs here lasted until 1942, with seeps persisting until the early 1960s. In the sandhills, many lakes were once fed by springs and seeps. Sod House Spring, 6.2 miles north of Amherst on Blackwater Draw, flowed until the 1950s. Rocky Ford Springs were just upstream from the Highway. Brune noted only a few springs still flowing here in the late 1970s. Springs formerly ran on County Road 385 crossing of Blackwater Draw 6.8 miles northeast of Amherst, but faltered in the 1940s and were gone in the 1950s. Fieldton Springs south of Fieldton were gone around 1949. Hart Springs were a little over a half mile southeast of Hart Camp, but the springs, draw and dried up in the 1930s. Bull Springs, at Bull Lake 8 miles west of Littlefield, were already only a seep by 1978. Rains could cause some seepage. Roland Springs formed a chain of pools in Bull Draw, and they were only seeps in October of 1978, although the springs ran a bit in the winter. Glumpler Springs were 3.1 miles north northeast of Pep and flowed about 8 gallons per minute in October, 1978. Just south of Glumpler Creek on Goat Creek Green Springs flowed 11.8 gallons per minute of slightly saline water in October, 1978. Illusion Springs on the north end of Illusion Lake flowed 25.3 gallons per minute of moderately saline water in October, 1978. At the end of Yellow Lake Yellow

Springs was part of a series of freshwater springs once present along the eastern shore of Yellow Lake, and flowed an intermittent 2.2 gallons per minute in October, 1978. Some saline springs were 1.8 miles west of Yellow Lake, near the Hockley County line, with one flowing 11.2 gallons per minute in 1978 and several others dry.

Mr. Kelly Attebury, NRCS Zone Soil Scientist at Lubbock reported in an April 10, 2015 telephone interview, that he is not familiar with any live springs or seeps remaining in Lamb County. If any still exist they could be in or adjacent to Bull Lake. As is the case all over the Llano Estacado region, prolonged, abundant, soaking rainfall that percolated sufficient water into the landscape could restore at least temporary flow to seeps and springs.

LUBBOCK COUNTY: Springs once flowed abundantly along Yellowhouse and Blackwater Draws, emerging chiefly from Ogallala sand and gravel. Lubbock Springs were at the Lubbock Lake archaeological site near the intersection of Highway 84 and Loop 289. These springs had failed to flow by the early 1950s. Buffalo Springs, in Yellow House Canyon 9.9 miles southeast of Lubbock, were immersed by a lake at the site. Brune reported that measurement of the flow of Buffalo Springs could be made only by comparing discharge above and below Buffalo Lake and allowing for evaporation. Discharge including all springs in the Buffalo Lake area was 1,246.9 gallons per minute as measured by Brune in 1976, and the historic high discharge was 1,521.2 gallons in 1969, when all spring flow combined was measured. Effluent from Lubbock of 1 to 2 million gallons per day flowed into Buffalo Lake. Johnson Spring at Lake Ransom Canyon downstream from Buffalo Lake possibly received some recharge from Buffalo Lake. Brune measured 15.8 gallons per minute in December, 1975, but the flow had declined to less than a gallon per minute by August, 1978. Tinsley Springs, 3.7 miles downstream in Yellow House Canyon, flowed 11.5 gallons per minute in August, 1978.

Interviewed by phone on April 1, 2015, Mr. Aubrey Spear, Director of Water Resources for the City of Lubbock reported that Lubbock continues to discharge 1.7 million gallons of treated effluent daily that flows into Buffalo Lake. He reported that an area below the dam on Buffalo Lake seemed to have some spring activity. According to Mr. Spear, nothing has changed upstream of Buffalo Lake for decades and this condition will remain the same for the foreseen future. Effluent water going to Buffalo Lake possibly is recharging springs in the area such as Johnson Springs at Lake Ransom Canyon just downstream from Buffalo Lake. According to Mr. Spear, a new treatment plant for the City of Lubbock will go online within three to four years and could discharge essentially double the effluent water, roughly two million gallons a day, which would work through Buffalo Lake and Ransom Canyon by 2019. This enhanced flow could further recharge springs in the downstream area.

LYNN COUNTY: In Lynn County, spring water flowed mainly from Ogallala sand and gravel, with some from Triassic Dockum sandstone, but spring output has been reduced due to the decline of the aquifer. Double Lakes Springs, 8.6 miles northwest of Tahoka on the north side of Double Lakes, issued 15.8 gallons per minute in December 1975. Spring sites were partially buried by sediment. Tahoka Springs on the west side of Tahoka Lake 6.21 miles north of Tahoka included a large spring near the north end of the lake that flowed 53.8 gallons per minute in December, 1974, and several other springs farther south combined for a flow of 95 gallons per minute at that time. Moore Springs, 2.4 miles southeast of Grassland in Moore's Draw, produced 25.3 gallons per minute in 1975. Guthrie Springs were in Chimney Draw northwest of Guthrie Lake, 3.7 miles southwest of Tahoka, but last flowed almost 100 years ago. Saleh Lake and Seeps were noted 3.7 miles southeast of New Moore. Gooch Springs about 1.2 miles farther west at Gooch Lake, and the largest spring flowed 12.3 gallons per minute in October 1978. Frost Lake, 4.3 miles south-southwest of New Moore, was fed by water from Frost Springs, which discharged 66.5 gallons per minute in October, 1978. New Moore Springs, 1.8 miles west-northwest of New Moore, were reported by Brune as being suddenly rejuvenated in 1968 by a combination of high rainfall and potential injection of water brought in from Rich Lake at the upstream Ozark-Mahoning mine. Brune measured a flow of 90.3 gallons per minute of moderately saline water in October of 1978. Historically, the flow at this location has been greater in the winter months. Mr. Pat Childress of O'Donnell reported in a telephone interview on February 6, 2005, that a lake had formed at the New Moore Springs site as the spring flow had been greatly enhanced by the heavy rainfall of 2004. The springs were at that time covered by the lake water and Mr. Childress estimated that the flow was probably comparable to past measurements, although spring flow had declined severely and the springs had about dried up prior to the high rainfall year of 2004. The lake at the location was filled with what Mr. Childress called "gyppy" water, not suitable for human consumption, but used by wildlife. Frost Springs was also reported by Mr. Childress to have regained strength thanks to the high rainfall. Brune noted in 1975 that water flowed into the swampy area at New Moore Springs from Ogallala sand and that salt cedars were numerous around the site, with flow increasing in the winter when salt cedars and other vegetation were dormant. Spring and seep-fed lakes and pools in this area have historically been important to large numbers of sandhill cranes as well as to wintering ducks.

In a follow-up telephone interview conducted on March 30, 2015, Mr. Childress, a veteran waterfowl and sandhill crane hunter and guide of long experience with great personal knowledge of Lynn County and its surrounding area, commented extensively on the continuing existence of springs and seeps. He reported that New Moore Springs 4 miles west of New Moore still seeps in sufficient quantity to form a pond. Gooch Lake, 7 miles west of O'Donnell still has three freshwater springs that flow into it, although the flow rate is not large. He related that a family hauled water in barrels from the springs for domestic use in the 1930s. According to Mr.

Childress, springs near the headwaters of the Colorado River 5 miles south of O'Donnell still bubble out of the ground and have maintained a 10- to 15-acre lake that has been present all of his adult life. Tahoka Lake, located northeast of Tahoka on the Wilson highway is a saline playa in that area that hosts wintering sandhill cranes. Mr. Childress also reported that Skeen Lake, north of O'Donnell is a salina that stands sufficient water to provide a roost for sandhill cranes if fall rainfall is favorable. According to Mr. Childress, Guthrie Lake, 3 miles south and west of Tahoka and inside the T-Bar Ranch, is a large alkali playa that sometimes holds water in years of good rainfall. Mr. Childress reiterated that spring fed playas, pools, and salinas of this region are of crucial importance to the wintering population of mid-continent lesser sandhill cranes.

MOTLEY COUNTY: Nearly all springs in the county flow from Ogallala sand and Triassic Dockum sandstone. Pumping from the Ogallala aquifer has caused a decline in the aquifer and lessened spring flow. Quitaque Creek, estimated in the 1940s to be capable of furnishing 3 million gallons per day, had greatly reduced flows by the mid-1970s. Roaring Springs, 3.1 miles south of the town of that name, once ranked among the crown jewels of spring flow in the Llano Estacado Region, although its flow is greatly diminished from historic levels. The area around the springs was developed with a golf course, camp ground, and RV parking. Spring waters fell with namesake sound over a sandstone ledge. The recharge area for Roaring Springs is 12 miles or more to the west, where rainfall runoff slowly seeps into Ogallala sands. By 2005, irrigation of pasture land just upstream from the spring site greatly diminished the flow when wells began operating in the summer. Brune noted, when measuring spring flow in 1978 at 633 gallons per minute, that very little decline in spring flow had occurred in the previous 40 years; i.e.; the flow was 664 gallons per minute in 1962, and the all-time high flow since records began in 1937 was 1,125 gallons per minute in 1946. However, heavy irrigation pumping wasn't occurring adjacent to the springs at that time. While anecdotal information was obtained via phone calls in February 2005, current flow measurements were not available. Anecdotes from local residents indicated that spring flow declined appreciably. One local resident related that filling a recreational swimming pool with flow from the springs was once accomplished overnight, but by 2005 the process took days. The pool at Roaring Springs was legendary with generations of swimmers for its frigid water coming straight out of the ground. Water from Roaring Springs feeding into a swimming pool ran only a short distance before entering the South Pease or Tongue River, where it quickly went underground. The South Pease merges with the Middle and North Pease to form the Pease River that eventually flows into the Red River. Scab Springs, 13.6 miles east of Matador on Highway 70, have been dry since 1945. Wolf Spring, 7.4 miles southwest of Roaring Springs, was the source of Wolf Creek, where the combined flow of several springs at the site amounted to 112.5 gallons per minute when Brune noted them in June of 1975. Anecdotal information taken in February 2005 indicated they do not flow now. Dutchman Springs on Dutchman Creek 6.21 miles west-northwest of Roaring Springs was measured by Brune at 36.4 gallons per minute in July, 1979. Anecdotal information gathered in February 2005 indicated that some seasonal seepage still occurred at the site, though little more than a trickle. The presence of several earthen dams along the headwaters of the spring drainage may be one of the reasons for the decline of this spring. Ballard Springs, 1.2 miles south of Matador, were measured at 13.4 gallons per minute in July, 1978, and fed an earthen stock tank. Priest Springs, 2.4 miles southwest of Matador, measured 20.5 gallons per minute in August 1978. Willow Springs, 3.7 miles southwest of Matador, flowed 15 gallons per minute in August 1978. Dripping Springs, now dry, were 6.21 miles west-southwest of Matador. Lost Canyon springs were 5.5 miles west of Matador in Lost Canyon. Mott Camp Springs were 10.5 miles west of Matador. Chimney Springs were 1.2 miles northwest of Mott Camp Springs and were only wet weather seeps in 1978. Burleson Springs, 8.6 miles west-southwest of Whiteflat, had ceased flowing by 1978. Chimney Springs, 1.2 miles northwest of Mott Camp Springs, were cited as wet weather seeps in 1978. Miller Springs, 7.4 miles west of Whiteflat, flowed only 1.5 gallons per minute in 1979.

In a March 30, 2015 telephone interview, Mr. James Gillespie of Matador reported that Dutchman Creek and Ballard Creek both still seep, and that four small springs located in draws still flow in Motley County at a rate of from five to 15 gallons per minute—sufficient volume to provide livestock water. Mr. Gillespie reported that the one-time resounding roar of Roaring Springs remains greatly reduced. While the swimming pool at the site still fills from spring flow, it is difficult to obtain a measurement of the volume of flow, but it is nothing like the flows of the 1930s and 1940s and in historic times.

PARMER COUNTY: Springs were once numerous along the county's major draws, but they began to disappear by 1900. On Frio Draw, about a half-mile east of the Texas-New Mexico state line, on the north side, a spring flowed intermittently from a cave in 1927. At Mustang Lake, 2.4 miles north-northwest of Bovina, springs flowed until the 1930s. A spring also once flowed intermittently 3.7 miles east of Bovina on Running Water Draw.

In a telephone interview on April 8, 2015, Mr. Mike Beauchamp, a director on the High Plains Underground Water Conservation District board as well as a farmer and landowner in the Hub vicinity south of Friona, who owns property on Running Water Draw, said he has not found any springs or seeps on this draw south of Friona and is not aware of any remnant springs or seeps in Parmer County. On the same date Mr. Earl Behrends, District Conservationist with the Parmer County NRCS office reported in a telephone interview that he also was not familiar with any remnant spring or seep activity in Parmer County.

SWISHER COUNTY: In Swisher County, springs once flowed along Tule Creek, and historically, spring water flowed in North, Middle, and South Tule Creeks. As the aquifer level declined, spring flow diminished. Some springs were also buried by silt from severe erosion. Rogers Springs in western Mackenzie Lake Park offered only seeps from Triassic sandstone when measured by Brune in September 1978. Prairie Dog Springs were at the Highway 2301 crossing of Tule Creek, but were only a seep. About a half-mile northwest of the bridge, JA or Anderson Springs once flowed, but they were dry when Brune noted them. Hackberry Springs were some 1,600 feet farther upstream. They dried up in 1974. Dawson Springs were 3.1 miles downstream from the Highway 1318 crossing of Tule Creek. They ran until the 1930s when some were buried by silt. Just over a half-mile downstream from the Highway 1318 crossing were Elkins Springs, now, long dry. Edwards Springs were 1.2 miles upstream from the Highway 1318 crossing. They flowed in winter until drying up in 1956. Poff Springs were 0.62 miles downstream from the Highway 146 crossing and 3.1 miles north-northeast of Tulia. They ceased flowing about 1940. Faulkner Springs were in Mackenzie Park in southeast Tulia, and flowed until the 1930s. Maupin Springs, 1.8 miles upstream from Highway 87, flowed until the 1920s. Hardy Springs, 3.1 miles past the Highway 87 crossing, are dry.

In a telephone interview on April 9, 2015, Mr. Kelly House, Civil Engineering Technician with the Swisher County NRCS reported that there is current day spring activity in eastern Swisher County some 15 to 16 miles east of Tulia adjacent to Briscoe County. He said that on a deer lease near Lake Mackenzie located partially in Swisher County that year-round spring flow maintains a fishing pond with overflow from that pond going to Lake Mackenzie. This spring location is in ranching country with deep breaks, and springs and seeps in that area are the only ones that he is familiar with in Swisher County, that the possibility exists that other seeps could exist in the rough break country.

TERRY COUNTY: Springs in Terry County issue primarily from Ogallala sand and caliche, and in modern times, are highly wet-weather dependent. Anecdotal information in February 2005 indicated abundant summer, fall, and early winter rainfall in 2004 contributed to a renewal of some springs and seeps that generally flowed from Ogallala sands. Some on the perimeter of saline lakes are not Ogallala, but flow from a Cretaceous outcrop exposed at the surface. Many observations were of pools only, without measurable flow, probably supported by slow seeps. One member of the South Plains UWCD board had several such seeps on his dryland farm on the Terry-Lynn County line. Another board member reported several seeps/springs near his house north of Wellman along Sulphur Springs Draw. This gentleman had not seen water standing in that draw for nearly 60 years prior to the 2004 wet-weather-related events. One section of Lost Draw running from southeast Terry County into Lynn County contained a small lake lying in Terry County, probably spring or seep-fed. Decline of the groundwater level has been a factor in the demise of most springs and seeps in this county. At Rich Springs at Rich Lake, 4.3 miles south-southeast of Meadow, water issued from Tahoka Sand on Duck Creek shale. Brune measured flow from springs at the north end of the lake totaling 19 gallons per minute in October 1978, and noted the presence of many other very small springs flowing around the lake. Rich Lake has historically been important to sandhill cranes as a roost site. Local anecdotal information indicated that in previous times, the lake rose before rains, indicating that springs and the lake were impacted by barometric pressure. Mound Springs at Mound Lake, 10.5 miles east- northeast of Brownfield, was documented by Brune as flowing 63.3 gallons per minute of highly saline water in December of 1975. This water fed into Mound Lake. On South Lost Draw, 10.5 miles southeast of Brownfield, Seven Lakes was fed by numerous springs and seeps, with the springs increasing flow before a rain when barometric pressure changed. Brune documented the historic presence of many small springs along Sulphur Springs Draw 6.21 miles east-southeast of Wellman. Many of these seep-fed lakes and pools have historically been important to wildlife including sandhill cranes and waterfowl.

In a follow-up telephone interview on March 30, 2015, Lindy Harris, manager of the South Plains Underground Water Conservation District at Brownfield reported that many of the springs and seeps mentioned in the 2005 documentation still exist, particularly east of Brownfield, and along Sulphur Springs Draw, with their presence enhanced by favorable rainfall conditions. She said that her husband reported that Sulphur Springs was running as recently as 2009, but flow had not been notable since October 2013, not surprising in the midst of ongoing drought.

YOAKUM COUNTY: Brune noted following studies in March 1977 that springs and seeps formerly existed along all of the major draws in Yoakum County, flowing mainly from Ogallala and more recent sands, but decline of the water table resulted in all of the springs of the county drying up. Oho Springs were in New Mexico, 3.1 miles west of Bronco, Texas. Ulou was downstream on Sulphur Springs Draw, about halfway between Bronco and Plains, where springs once likely existed. Other springs also likely existed farther downstream on Sulphur Springs Draw. Southwest of Plains 9.9 miles, INK Basin was once a seep-fed freshwater basin, but has been dry since 1949. Evidence of springs was also found present in Lost Draw in the northeast part of the county.

In a telephone interview on April 9, 2015, Mr. Hal Rogers, NRCS Resource Leader for Dawson, Gaines, and Yoakum counties, reported that it is questionable if any spring or seep activity remains in Yoakum County.

Appendix 1B

Threatened and Endangered Species in Llano Estacado Region

Appendix 1B. Threatened and Endangered Species of the Llano Estacado Region

Group	Common Name	Scientific Name	Listing USFWS	Listing TPWD	COUNTY																				
					Bailey	Briscoe	Castro	Cochran	Crosby	Dawson	Deaf Smith	Dickens	Floyd	Gaines	Garza	Hale	Hockley	Lamb	Lubbock	Lynn	Motley	Parmer	Swisher	Terry	Yoakum
Threatened and Endangered Species																									
Bird	Sprague's Pipit	*Anthus spragueii*	C							X		X			X										
Mammal	Gray wolf	*Canis lupus*	LE	E	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Mammal	Texas Kangaroo Rat	*Dipodomys elator*		T								X									X				
Bird	Peregrine Falcon	*Falco peregrinus*	DL	T	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bird	American Peregrine Falcon	*Falco peregrinus anatum*	DL	T	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bird	Whooping Crane	*Grus americana*	LE	E	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bird	Bald Eagle	*Haliaeetus leucocephalus*	DL	T	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Mammal	Black-footed Ferret	*Mustela nigripes*	LE		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fish	Smalleye Shiner	*Notropis buccula*	LE						X			X			X										
Fish	Sharpnose Shiner	*Notropis oxyrhynchus*	LE												X										
Mammal	Palo Duro Mouse	*Peromyscus truei comanche*		T		X			X			X	X		X					X	X				
Reptile	Texas Horned Lizard	*Phrynosoma cornutum*		T	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bird	White Faced Ibis	*Plegadis chihi*		T			X																		
Bird	Interior Least Tern	*Sterna antillarum athalassos*	LE	E		X				X															
Bird	Lesser Prairie Chicken	*Tympanuchus pallidicinctus*	T		X	X	X	X			X			X			X	X			X	X	X	X	X
Mammal	Black Bear	*Ursus americanus*	T/SA; NL	T	X		X				X											X			
				COUNTY TOTAL	9	10	10	8	9	9	9	11	8	8	11	7	8	8	7	8	10	9	8	8	8

Acronyms

LE, LT - Federally Listed Endangered/Threatened
PE, PT - Federally Proposed Endangered/Threatened
E/SA, T/SA - Federally Endangered/Threatened by Similarity of Appearance
C1 - Federal Candidate, Category 1; information supports proposing to list as endangered/threatened
DL, PDL - Federally Delisted/Proposed for Delisting
E, T - State Endangered/Threatened
"blank" - Rare, but with no regulatory listing status

Species appearing on these lists do not all share the same probability of occurrence. Some species are migrants or wintering residents only, or may be historic or considered extirpated.

Source: http://www.tpwd.state.tx.us/gis/ris/es/CountyList.aspx as of 10/7/2014

Source: http://tpwd.texas.gov/gis/rtest/ as of 9-19-2015

Appendix 1C

Water Loss Audit Data

2010 Water Loss Audit Data for Region O

<table>
<tr><th colspan="5">2010 Water Loss Audit Summary</th></tr>
<tr><td colspan="5">Region O Total

44 Audits Submitted</td></tr>
<tr><td rowspan="9">System Input Volume
19,025,145,589 gal</td><td rowspan="4">Authorized Consumption
17,375,285,004 gal
91.3%</td><td rowspan="2">Billed Consumption
16,427,064,450 gal
86.3%</td><td>Billed Metered
16,389,102,450 gal
86.1%</td><td rowspan="2">Revenue Water
16,427,064,450 gal
86.3%</td></tr>
<tr><td>Billed Unmetered
37,962,000 gal
0.2%</td></tr>
<tr><td rowspan="2">Unbilled Consumption
948,220,554 gal
5.0%</td><td>Unbilled Metered
705,886,676 gal
3.7%</td><td rowspan="7">Non-revenue Water
2,598,081,139 gal
13.7%</td></tr>
<tr><td>Unbilled Unmetered
242,333,878 gal
1.3%</td></tr>
<tr><td rowspan="5">Water Loss
1,649,860,585 gal
8.7%</td><td rowspan="3">Aparent Loss
1,103,374,368 gal
5.8%</td><td>Unauthorized Consumption
47,793,195 gal
0.3%</td></tr>
<tr><td>Customer Meter Accuracy Loss
467,309,118 gal
2.5%</td></tr>
<tr><td>Systematic Data Handling Discrepancy
588,272,055 gal
3.1%</td></tr>
<tr><td rowspan="2">Real Loss
546,486,217 gal
2.9%</td><td>Reported Breaks and Leaks
99,049,918 gal
0.5%</td></tr>
<tr><td>Unreported Loss
447,436,299 gal
2.4%</td></tr>
</table>

SOURCE: TWDB spreadsheet distributed via email to all regions on July 9, 2014

2010 Water Loss Audit Data for Region O

Utility	Population (retail + wholesale)	System Input Volume	Authorized Consumption (gallons)	Water Loss (gallons)	Percent Water Loss
Bovina Municipal Water System	1,845	95,889,583	94,054,000	1,835,583	1.9
City of Abernathy	2,500	152,071,000	125,957,890	26,113,110	17.2
City of Amherst	791	36,183,698	32,975,296	3,208,402	8.9
City of Brownfield	10,081	494,927,670	472,018,000	22,909,670	4.6
City of Denver City	5,000	348,007,370	304,447,000	43,560,370	12.5
City of Floydada	3,083	135,885,105	122,450,564	13,434,541	9.9
City of Hereford	15,370	1,488,217,710	1,483,851,720	4,365,990	0.3
City of Idalou	22,070	98,513,571	87,836,000	10,677,571	10.8
City of Lamesa	9,952	625,170,423	577,185,630	47,984,792	7.7
City of Levelland	13,542	598,650,000	553,480,000	45,170,000	7.5
City of Littlefield	6,507	409,697,980	402,941,220	6,756,760	1.6
City of Lorenzo	1,147	62,514,740	43,260,430	19,254,310	30.8
City of Morton	2,249	234,955,800	94,853,950	140,101,850	59.6
City of New Deal	794	30,600,996	22,326,043	8,274,952	27.0
City of New Home	405	10,221,443	9,283,768	937,675	9.2
City of Olton	2,288	70,480,000	64,880,000	5,600,000	7.9
City of Quitaque	450	26,660,370	22,838,250	3,822,120	14.3
City of Ralls	1,997	83,500,231	67,665,257	15,834,974	19.0
City of Ropesville	517	29,397,875	16,524,873	12,873,002	43.8
City of Seminole	6,800	614,140,000	541,680,000	72,460,000	11.8
City of Shallowater	2,484	161,306,732	101,899,000	59,407,732	36.8
City of Smyer	480	17,000,000	15,210,000	1,790,000	10.5
City of Spur	1,338	73,000,000	68,910,000	4,090,000	5.6
City of Sundown	1,500	94,950,000	75,190,000	19,760,000	20.8
Coronado Shores Water System	84	1,607,070	1,066,090	540,980	33.7
Cotton Center WSC	250	13,146,940	10,630,340	2,516,600	19.1

2010 Water Loss Audit Data for Region O

Utility	Population (retail + wholesale)	System Input Volume	Authorized Consumption (gallons)	Water Loss (gallons)	Percent Water Loss
Dimmit Municipal Water System	4,375	277,153,535	242,827,977	34,325,558	12.4
Dougherty Water Works	55	2,733,229	2,210,475	522,754	19.1
Friona Municipal Water System	3,538	209,718,947	183,734,487	25,984,461	12.4
Kress Municipal Water System	826	21,890,000	15,590,000	6,300,000	28.8
Lubbock County WCID 1	990	29,872,000	18,604,400	11,267,600	37.7
Lubbock Public Water System	234,450	11,820,192,000	10,981,380,400	838,811,600	7.1
Mackenzie Municipal Water Authority	10,037	205,050,000	179,000,000	26,050,000	12.7
Maple WSC	99	4,040,729	3,415,873	624,856	15.5
Nazareth Municipal Water System	365	33,146,244	29,408,738	3,737,506	11.3
North University Estates	600	22,631,579	20,232,895	2,398,684	10.6
Plott Acres	200	10,402,060	7,136,030	3,266,030	31.4
Rio Blanca Estates	78	924,800	927,200	(2,400)	-0.3
Silverston Municipal Water System	779	32,710,000	29,399,000	3,311,000	10.1
Tahoka Public Water System	2,645	125,530,980	115,396,437	10,134,542	8.1
Town North Village Water System	350	9,741,702	9,278,771	462,931	4.8
Town of Ransom Canyon	1,096	79,877,000	71,034,460	8,842,540	11.1
Valley WSC	270	14,908,000	4,915,350	9,992,650	67.0
White River Municipal Water District	9,953	117,926,476	47,377,188	70,549,288	59.8
Region O Total	**384,230**	**19,025,145,589**	**17,375,285,004**	**1,649,860,585**	**8.7**
SOURCE: TWDB spreadsheet distributed via email to all regions on July 9, 2014					

Chapter 2

Chapter 2

Population and Water Demand Projections

2. Population and Water Demand Projections

Population and water demand projections lay the foundation for determining water needs for each county over the planning horizon, and this section discusses the methodologies used as part of the Region O 2016 planning process to develop those projections. When applicable, the TWDB requires population and water demand projections to be presented in three ways: by county, by water user group (WUG), and by river basin. This section therefore presents population and water demand data by county, WUG, and river basin as applicable. Region O includes 21 counties and 71 WUGs, including 21 County-other WUGs, and four river basins: Canadian, Red, Brazos, and Colorado. Figure 2-1 shows a map of the counties and river basins in the planning region, and Table 2-1 lists which river basin(s) each county is located in.

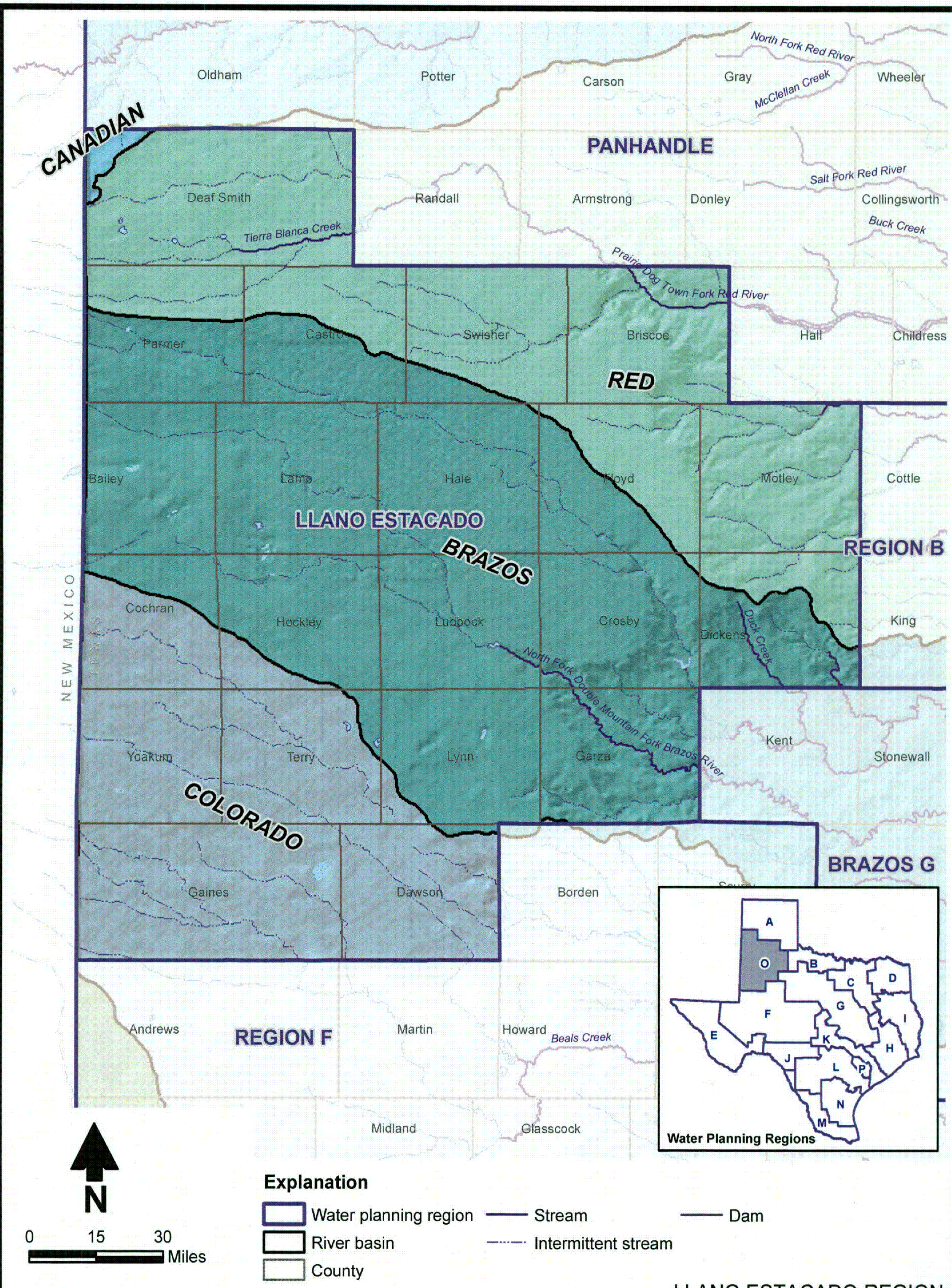
2.1 Population Projections

The population of Texas was 25.1 million in 2010 (U.S. Census Bureau, 2015), with Region O accounting for 489,926 people, or 1.9 percent of the State's population. By 2070, Region O is projected to account for 1.6 percent of the State's population. While Region O is predominantly rural, there are several major urban centers. Lubbock is the largest city in the region, consisting of 46.9 percent of the region's 2010 population. Plainview (4.5% of Region O's 2010 population), Hereford (3.1%), and Levelland (2.8%) are the next largest cities.

The TWDB has specific methodologies for determining population projections for each county, WUG, and river basin, as discussed in Sections 2.1.1 through 2.1.3.

2.1.1 County-Level Projections

The TWDB provided county population projections based on projections developed by the Texas State Data Center (TSDC) and the Office of the State Demographer. The TSDC and the Office of the Demographer used a model called the Cohort-Component Model to develop their county projections. As the name suggests, this model uses *cohorts* (a group of people with similar age, gender, and race/ethnicity) and *components of change* (those factors that cause population change: migration, births, and deaths) to project future population. Under this model:



LLANO ESTACADO REGION
Surface Water Basins

Daniel B. Stephens & Associates, Inc.
9/30/2015
JN WR11.0030

Figure 2-1

S:\PROJECTS\WR11.0030_REGION_O_WATER_PLAN_FOR_TWDB\GIS\MXDS\FIGURES\SECTION_2\FIG_2-01_SW_BASINS.MXD

Table 2-1. Location of Counties within River Basins

County	River Basin			
	Canadian	Red	Brazos	Colorado
Bailey			●	
Briscoe		●		
Castro		●	●	
Cochran			●	●
Crosby		●	●	
Dawson			●	●
Deaf Smith	●	●		
Dickens		●	●	
Floyd		●	●	
Gaines				●
Garza			●	●
Hale		●	●	
Hockley			●	●
Lamb			●	
Lubbock			●	
Lynn			●	●
Motley		●		
Parmer		●	●	
Swisher		●	●	
Terry			●	●
Yoakum				●
Number of whole or partial counties in basin	1	10	16	8

Population projection = Base population + Natural changes (births – deaths) + Net migration

The migration rate applied for a given county is based on a percentage of the historical migration rate observed for that county between 2000 and 2010. The TSDC prepares county-level population projections for three different scenarios: (1) no net migration (natural growth only), (2) net migration rates of 2000-2010 (full-migration scenario), and (3) 2000-2010 migration rates halved (half-migration scenario) (TWDB, 2013). The TSDC recommends use of the half-migration scenario for long-term-planning.

The TSDC county-level population projections extend only through 2050; therefore TWDB staff developed the half-migration scenario projections from 2050 to 2070 using the trend of average annual growth rates of the 2011-2050 TSDC projections (TWDB, 2013).

DBS&A obtained the TSDC county-level population projections for each of the three scenarios and evaluated which scenario best matched the feedback received on the WUG surveys. DBS&A revised the draft TWDB county-level population projections based on the local feedback, scaling where necessary to keep the total regional population unchanged. Table 2-2 shows the resulting migration scenario used for each county.

In the State of Texas, there are 60 instances where the population projection model predicts a decline in a county's population over the 50-year planning horizon. In these cases—which in Region O include Briscoe, Dickens, and Motley counties—the county's highest population projection was applied to all decades where a decline was predicted.

Table 2-3 shows the 2010 Census population, population projections by decade from 2020 to 2070, and the percentage increase in population from 2020 to 2070 for each of the 21 counties in Region O. Figure 2-2 shows the distribution of population by county for Region O based on the 2010 Census and the 2070 population projections.

2.1.2 WUG Projections

The TWDB calculates population projections for four categories of WUGs (Table 2-4).

Table 2-2. Migration Rate by County

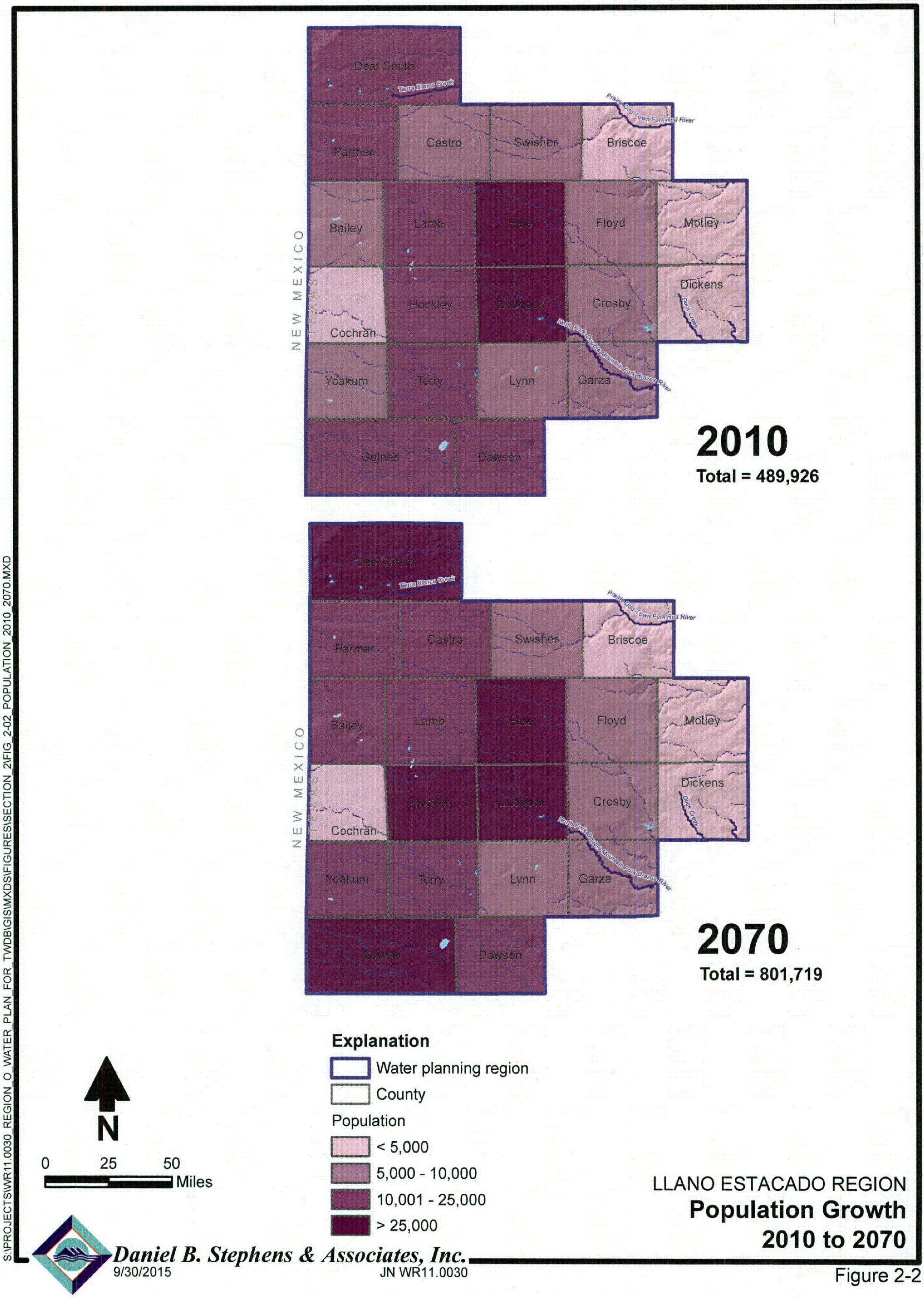
County	Migration Rate Applied (%)
Bailey	0
Briscoe	50 [a]
Castro	50 [a]
Cochran	100
Crosby	0
Dawson	100
Deaf Smith	0
Dickens	50 [a]
Floyd	50 [a]
Gaines	50
Garza	50
Hale	100
Hockley	100
Lamb	100
Lubbock	50
Lynn	100
Motley	50 [a]
Parmer	0
Swisher	100
Terry	50 [a]
Yoakum	0

[a] No change from draft TWDB migration rate.

Table 2-3. Population Projections by County

County	2010 Census Population [a]	Projected Population by Decade						Increase from 2020 to 2070 (%)
		2020	2030	2040	2050	2060	2070	
Bailey	7,165	8,012	8,962	9,906	10,880	11,844	12,790	60
Briscoe	1,637	1,673	1,673	1,673	1,673	1,673	1,673	0
Castro	8,062	8,890	9,650	10,194	10,698	11,091	11,407	28
Cochran	3,127	3,491	3,687	3,717	3,667	3,772	3,807	9
Crosby	6,059	6,526	7,023	7,433	7,850	8,299	8,715	34
Dawson	13,833	14,807	15,577	16,177	16,440	17,098	17,575	19
Deaf Smith	19,372	22,151	25,573	29,314	33,554	36,887	40,531	83
Dickens	2,444	2,164	2,164	2,164	2,164	2,164	2,164	0
Floyd	6,446	6,869	7,294	7,563	7,854	8,081	8,270	20
Gaines	17,526	21,316	25,746	30,997	36,654	41,666	46,886	120
Garza	6,461	7,077	7,510	7,899	8,166	8,569	8,905	26
Hale	36,273	38,314	39,965	40,647	40,307	41,369	41,814	9
Hockley	22,935	25,130	26,734	27,707	27,888	29,134	29,935	19
Lamb	13,977	14,615	15,175	15,438	15,419	15,791	15,975	9
Lubbock	278,831	309,769	343,977	378,320	414,938	449,770	484,316	56
Lynn	5,915	6,279	6,605	6,624	6,594	6,924	7,074	13
Motley	1,210	1,212	1,212	1,212	1,212	1,212	1,212	0
Parmer	10,269	11,424	12,648	13,748	14,827	16,091	17,244	51
Swisher	7,854	8,257	8,670	8,798	8,744	9,175	9,380	14
Terry	12,651	13,599	14,457	15,321	16,108	16,847	17,535	29
Yoakum	7,879	8,920	10,089	11,128	12,232	13,401	14,511	63
Total	489,926	540,495	594,391	645,980	697,869	750,858	801,719	48

[a] U.S. Census Bureau, 2015



LLANO ESTACADO REGION
Population Growth
2010 to 2070

Figure 2-2

Table 2-4. Water User Group Categories

WUG Category	Definition
City	Urban area with a 2010 population greater than 500
Utility	Utility (outside of a city) providing more than 280 ac-ft/yr of municipal water
Collection of utilities	Three or more utilities with a common source
County-other	Any remaining population in a county

ac-ft/yr = Acre-feet per year

In Region O, population projections were calculated for 71 WUGs, all of which are either City or County-other WUGs.

Projections for the individual WUGs were developed by allocating growth from the county projections down to the cities and rural areas; the sum of all WUG populations within a county equal the total county projection (TWDB, 2013). The draft municipal water demand projections used the draft population projections and a per-person water use volume for each city and rural area (County-other).

The draft WUG demand projections provided by the TWDB included 2011 per capita water use values (GPCD [gallons per capita per day]) as the initial "dry-year" water use estimate (Section 2.2) and applied future anticipated reductions in water use due to adoption of water-efficient fixtures and appliances as required by law (TWDB, 2013). The GPCD values in Table 2-5 were developed by the TWDB based on water use survey information.

The regional water planning group questioned the per capita values that the TWDB developed for Plainview and Slaton, because they were considerably lower than historical values. The TWDB reevaluated the values for Plainview and Slaton and found an error in the Plainview calculations that was fixed. This changed the Plainview per capita values from 116 gallons per day (gpd) in 2020 and 107 gpd in 2070 to 166 gpd in 2020 and 157 gpd in 2070. The TWDB did not find any errors in the calculations for Slaton, and so no changes were made to those values.

Table 2-5. Per Capita Water Use and Projections by Water-User Group
Page 1 of 2

County	Water-User Group	Per Capita Water Use (gallons per day)						
		Base (2010)	2020	2030	2040	2050	2060	2070
Bailey	County-other	121	110	105	103	103	102	102
	Muleshoe	191	182	178	175	174	173	173
Briscoe	County-other	294	284	279	276	276	276	276
	Silverton	161	151	147	143	142	142	142
Castro	County-other	141	130	125	123	123	123	123
	Dimmitt	212	202	198	194	193	193	193
	Hart	141	131	126	123	122	122	122
Cochran	County-other	344	333	328	326	326	326	326
	Morton	207	196	191	190	189	189	189
Crosby	County-other	117	106	101	101	101	100	100
	Crosbyton	150	140	135	132	131	131	131
	Lorenzo	174	164	159	156	155	155	155
	Ralls	144	134	129	126	125	125	125
Dawson	County-other	120	110	106	103	101	101	101
	Lamesa	215	205	200	197	196	196	196
	O'Donnell	134	123	118	117	116	116	116
Deaf Smith	County-other	116	105	101	98	97	96	96
	Hereford	211	201	196	193	192	192	192
Dickens	County-other	130	120	116	112	112	111	111
	Spur	165	154	149	148	147	147	147
Floyd	County-other	118	107	102	101	101	101	101
	Floydada	168	157	153	150	150	150	150
	Lockney	132	122	117	114	114	113	113
Gaines	County-other	117	107	104	102	101	101	101
	Seagraves	157	147	143	140	138	138	138
	Seminole	305	295	291	288	286	286	286
Garza	County-other	123	113	108	105	105	105	105
	Post	126	118	114	112	111	111	111
Hale	Abernathy	221	211	207	204	202	202	202
	County-other	126	116	112	109	107	107	107
	Hale Center	121	112	108	105	103	103	103
	Petersburg	239	229	225	221	220	220	220
	Plainview	176	166	162	159	157	157	157
Hockley	Anton	126	116	111	108	107	107	107
	County-other	119	109	105	103	101	101	101
	Levelland	157	147	143	139	138	138	138
	Sundown	253	242	237	235	235	235	235

Table 2-5. Per Capita Water Use and Projections by Water-User Group
Page 2 of 2

County	Water-User Group	Per Capita Water Use (gallons per day)						
		Base (2010)	2020	2030	2040	2050	2060	2070
Lamb	Amherst	124	114	109	106	105	105	105
	County-other	140	129	124	123	122	122	122
	Earth	165	155	151	147	147	146	146
	Littlefield	142	133	128	125	123	123	123
	Olton	194	185	181	178	176	176	175
	Sudan	224	214	209	206	205	205	205
Lubbock	Abernathy	221	211	207	204	202	202	202
	County-other	125	116	112	110	109	108	108
	Idalou	169	160	155	152	151	150	150
	Lubbock	169	160	156	153	152	151	151
	New Deal	125	116	113	110	109	109	109
	Ransom Canyon	265	256	252	250	248	248	248
	Shallowater	143	134	130	127	126	126	126
	Slaton	117	108	103	100	98	98	98
	Wolfforth	158	149	146	144	143	143	143
Lynn	County-other	113	103	99	96	95	94	94
	O'Donnell	134	123	118	117	116	116	116
	Tahoka	160	150	146	142	141	141	141
Motley	County-other	170	160	155	153	152	152	152
	Matador	321	311	306	304	303	303	303
Parmer	Bovina	170	160	156	153	151	151	151
	County-other	184	174	169	166	165	165	164
	Farwell	243	233	228	225	224	223	223
	Friona	171	161	157	154	153	152	152
Swisher	County-other	127	117	112	109	109	109	109
	Happy	145	136	132	129	127	127	127
	Kress	103	93	89	86	84	84	84
	Tulia	168	158	154	150	149	149	149
Terry	Brownfield	164	154	150	147	145	145	145
	County-other	121	110	106	103	103	103	103
	Meadow	142	132	128	124	123	123	123
Yoakum	County-other	119	110	106	103	102	102	102
	Denver City	261	250	246	243	242	242	242
	Plains	240	230	225	223	221	221	221

For each municipal WUG, the water demand values were calculated by multiplying the 2011 GPCD, minus the incremental anticipated savings for each future decade due to water-efficient fixtures/appliances, by the projected population (TWDB, 2013).

Urban areas with a population of less than 500 are included in the County-other category. The TWDB list of County-other systems includes 79 systems in Region O (Table 2-6; TWDB, 2014). The LERWPG noted that this information is different than the list of small public water systems that is maintained by TCEQ (2015). The TCEQ list is included in Appendix 2A.

Table 2-7 shows the 2010 Census populations, population projections by decade from 2020 to 2070, and the percentage increase in population from 2020 to 2070 for each WUG in the region, listed alphabetically by county. Appendix 2B contains the required Regional Water Planning Application (DB17) report for WUG population.

2.1.3 River Basin Projections

In 2020, 81 percent of the Region O population is projected to reside in the Brazos River Basin, 11 percent in the Colorado River Basin, and 8 percent in the Red River Basin. The only part of the region that falls in the Canadian River Basin is a portion of Deaf Smith County, and the population projections for this portion of the county are very small. Table 2-8 shows the population projections by decade from 2020 to 2070 and the percentage increase in population from 2020 to 2070 for each of the four river basins in the region.

2.2 Water Demand Projections

In regional water planning, water use is accounted for in one of six categories: municipal, industrial (further divided into mining, manufacturing, or steam-electric), irrigation, or livestock.

In 2020, Region O is projected to account for 20.1 percent of the State's water demand. By 2070, Region O is projected to account for 14.9 percent of the State's total water demand. Figure 2-3 shows the Region O water demand projections for 2020 to 2070 by decade.

Table 2-6. County-Other Systems within Region O
Page 1 of 3

County	System Name
Bailey	Maple WSC
Briscoe	City of Quitaque
	Coronado Shores Water System
	Mackenzie Municipal Water Authority
Castro	City of Hart [a]
	City of Nazareth
	Summerfield Mobile Manor
Cochran	Bledsoe WSC
	Cal Farley's GirlTown USA
	City of Morton [a]
	City of Whiteface
	Whiteface ISD
Crosby	City of Crosbyton [a]
	City of Ralls [a]
	Cone Water Supply
	Rio Blanca Estates
Dawson	City of Lamesa [a]
	City of Los Ybanez
	City of O'Donnell [a]
	Klondike ISD
	Welch WSC
Deaf Smith	Deaf Smith Co. FWSD 1
Dickens	City of Dickens
	Red River Authority-Guthrie Dumont WS
	Valley WSC
Floyd	City of Lockney [a]
	Dougherty Water Works
Gaines	City of Seagraves [a]
	Loop WSC
Garza	Caprock WSC
	Cedar Hills Subdivision
	South Garza WSC
	Southland ISD

Source: TWDB, 2014
[a] The TWDB estimated the population served in areas outside of city limits for this municipal WUG, including it in the County-other category

FWSD = Fresh water supply district
WS = Water system
WSC = Water supply corporation
ISD = Independent school district

Table 2-6. County-Other Systems within Region O
Page 2 of 3

County	System Name
Hale	City of Edmonson
	Cotton Center WSC
	Ebeling WSC
	Halfway WSC
	Loma Alta Water Supply, Inc.
Hockley	City of Ropesville
	City of Smyer
	City of Sundown [a]
	Town of Opdyke West
Lamb	City of Springlake
	Lower Colorado River Authority-Lometa Regional Water System [a]
	Spade WSC
	Sunnydale WSC
	Woodland Acres Water Association
Lubbock	Country Squire MHP 1
	Country Squire MHP 2
	Fay Ben MHP
	Lubbock Cooper ISD [b]
	Lubbock Country Club
	Lubbock County WCID 1 (Buffalo Springs Lake WSC) [c]
	North University Estates
	Pinkies
	RA and R Investments, LLC
	Roosevelt ISD [d]
	Smith Management Services-Cox Addition
	Smith Management Services-Plott Acres
	Smith Management Services-Town North Estates
	Smith Management Services-Town Village North and South
	SW Water Systems
	Valley Estates Water Company
	Wagon Wheel Mobile Village

Source: TWDB, 2014

[a] The TWDB estimated the population served in areas outside of city limits for this municipal WUG, including it in the County-other category

[b] System receives water from the City of Lubbock, but uses irrigation wells for landscaping and athletic fields

[c] System receives water from the City of Lubbock

[d] System receives water from Ransom Canyon, but uses irrigation wells for landscaping and athletic fields

WSC = Water supply corporation
ISD = Independent school district
MHP = Mobile home park
WCID = Water control and improvement district

Table 2-6. County-Other Systems within Region O
Page 3 of 3

County	System Name
Lubbock (cont.)	Whorton MHP
	Wolfforth Place
Lynn	City of New Home
	City of O'Donnell [a]
	City of Wilson
	Grassland WSC
Motley	City of Roaring Springs
	Flomot WSC
	Red River Authority-Carey Northfield WS
Parmer	City of Bovina [a]
	Farwell Country Club
	Lazbuddie ISD
Swisher	City of Plainview [a]
Terry	Wellman WSC
Yoakum	City of Plains [a]

Source: TWDB, 2014
[a] The TWDB estimated the population served in areas outside of city limits for this municipal WUG, including it in the County-other category

WSC = Water supply corporation
WS = Water system
ISD = Independent school district

Table 2-7. Population Projections by Water User Group
Page 1 of 4

County	Water User Group	River Basin	Projected Population by Decade					
			2020	2030	2040	2050	2060	2070
Bailey	County-other	Brazos	2,243	2,510	2,775	3,047	3,317	3,582
	Muleshoe	Brazos	5,769	6,452	7,131	7,833	8,527	9,208
Briscoe	County-other	Red	932	931	931	931	931	931
	Silverton	Red	741	742	742	742	742	742
Castro	County-other	Brazos	1,343	1,458	1,541	1,616	1,676	1,724
		Red	1,473	1,599	1,689	1,773	1,838	1,890
	Dimmitt	Brazos	4,845	5,259	5,555	5,830	6,044	6,216
	Hart	Brazos	1,229	1,334	1,409	1,479	1,533	1,577
Cochran	County-other	Brazos	1,009	1,130	1,167	1,170	1,215	1,233
		Colorado	332	351	353	349	359	362
	Morton	Brazos	2,150	2,206	2,197	2,148	2,198	2,212
Crosby	County-other	Brazos	1,303	1,391	1,462	1,533	1,606	1,696
		Red	6	6	6	7	7	8
	Crosbyton	Brazos	1,876	2,018	2,136	2,256	2,385	2,501
	Lorenzo	Brazos	1,258	1,377	1,477	1,580	1,701	1,783
	Ralls	Brazos	2,083	2,231	2,352	2,474	2,600	2,727
Dawson	County-other	Brazos	31	34	35	35	36	38
		Colorado	4,746	5,159	5,514	5,729	6,075	6,348
	Lamesa	Colorado	9,903	10,251	10,490	10,535	10,840	11,039
	O'Donnell	Brazos	127	133	138	141	147	150
Deaf Smith	County-other	Canadian	8	9	11	12	14	15
		Red	4,567	5,273	6,045	6,919	7,606	8,358
	Hereford	Red	17,576	20,291	23,258	26,623	29,267	32,158

Table 2-7. Population Projections by Water User Group
Page 2 of 4

County	Water User Group	River Basin	Projected Population by Decade 2020	2030	2040	2050	2060	2070
Dickens	County-other	Brazos	906	906	906	906	906	906
		Red	229	229	229	229	229	229
	Spur	Brazos	1,029	1,029	1,029	1,029	1,029	1,029
Floyd	County-other	Brazos	1,136	1,201	1,243	1,287	1,322	1,350
		Red	528	561	581	604	621	636
	Floydada	Brazos	3,242	3,447	3,577	3,718	3,828	3,920
	Lockney	Brazos	1,963	2,085	2,162	2,245	2,310	2,364
Gaines	County-other	Colorado	11,678	15,176	19,316	23,765	27,881	32,166
	Seagraves	Colorado	2,536	2,677	2,847	3,034	3,137	3,245
	Seminole	Colorado	7,102	7,893	8,834	9,855	10,648	11,475
Garza	County-other	Brazos	1,065	1,058	1,058	1,068	1,103	1,135
	Post	Brazos	6,012	6,452	6,841	7,098	7,466	7,770
Hale	Abernathy	Brazos	2,227	2,323	2,363	2,343	2,405	2,430
	County-other	Brazos	8,994	9,382	9,542	9,463	9,712	9,816
	Hale Center	Brazos	2,380	2,482	2,524	2,503	2,569	2,597
	Petersburg	Brazos	1,270	1,325	1,348	1,336	1,371	1,386
	Plainview	Brazos	23,443	24,453	24,870	24,662	25,312	25,585
Hockley	Anton	Brazos	1,235	1,313	1,361	1,370	1,431	1,470
	County-other	Brazos	7,273	7,739	8,021	8,072	8,433	8,665
		Colorado	252	268	278	280	293	300
	Levelland	Brazos	14,839	15,785	16,359	16,467	17,202	17,676
	Sundown	Colorado	1,531	1,629	1,688	1,699	1,775	1,824
Lamb	Amherst	Brazos	796	873	926	959	1,014	1,055
	County-other	Brazos	3,011	3,398	3,673	3,866	4,146	4,365

Table 2-7. Population Projections by Water User Group
Page 3 of 4

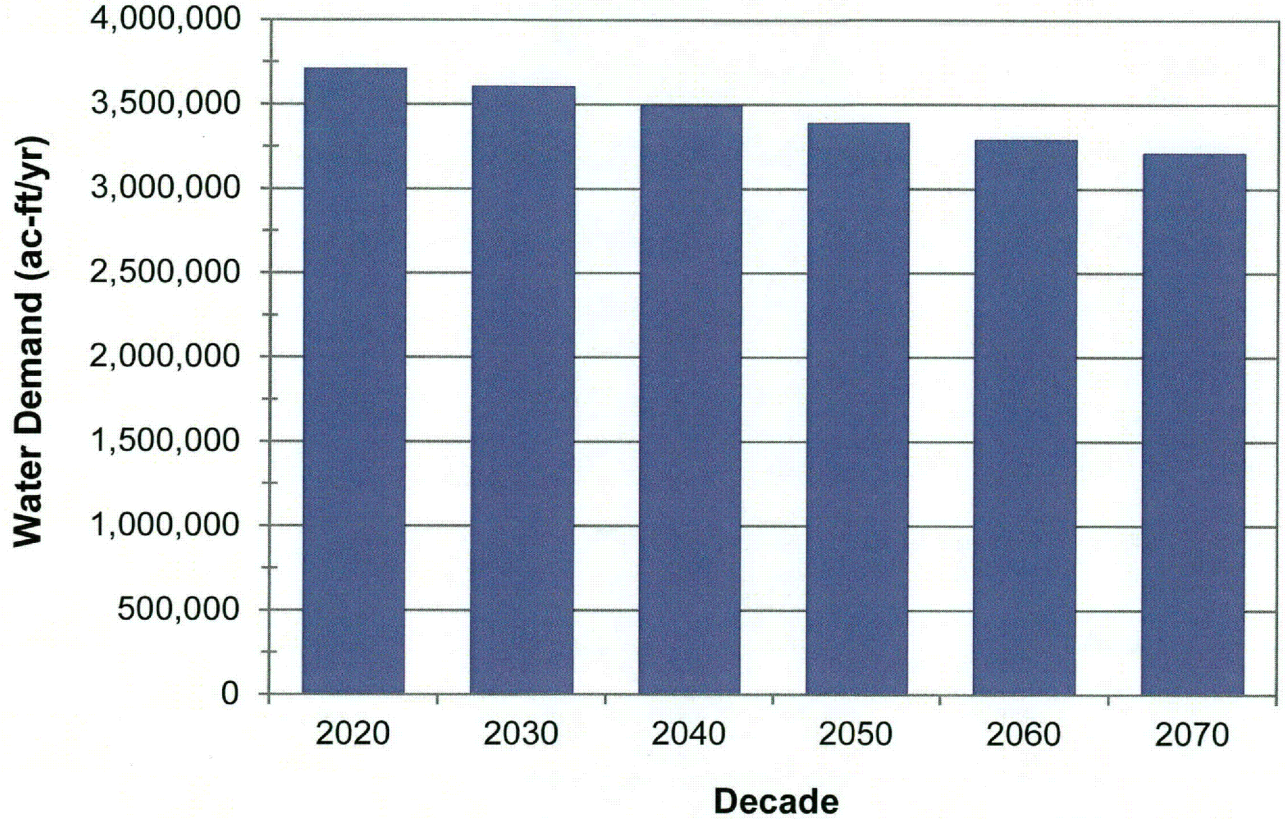
County	Water User Group	River Basin	Projected Population by Decade					
			2020	2030	2040	2050	2060	2070
Lamb (cont.)	Earth	Brazos	1,099	1,125	1,131	1,118	1,134	1,137
	Littlefield	Brazos	6,406	6,366	6,249	6,034	5,984	5,874
	Olton	Brazos	2,261	2,286	2,277	2,229	2,240	2,228
	Sudan	Brazos	1,042	1,127	1,182	1,213	1,273	1,316
Lubbock	Abernathy	Brazos	774	860	946	1,037	1,124	1,210
	County-other	Brazos	35,783	39,843	43,916	48,258	52,391	56,493
	Idalou	Brazos	2,341	2,446	2,555	2,676	2,783	2,889
	Lubbock	Brazos	255,257	283,597	312,043	342,371	371,227	399,846
	New Deal	Brazos	869	951	1,036	1,125	1,210	1,294
	Ransom Canyon	Brazos	1,172	1,258	1,345	1,439	1,526	1,613
	Shallowater	Brazos	2,817	3,188	3,558	3,951	4,329	4,703
	Slaton	Brazos	6,179	6,257	6,352	6,467	6,547	6,621
	Wolfforth	Brazos	4,577	5,577	6,569	7,614	8,633	9,647
Lynn	County-other	Brazos	2,603	2,738	2,745	2,734	2,871	2,933
		Colorado	81	85	86	85	89	91
	O'Donnell	Brazos	757	797	799	795	835	853
	Tahoka	Brazos	2,838	2,985	2,994	2,980	3,129	3,197
Motley	County-other	Red	603	603	603	603	603	603
	Matador	Red	609	609	609	609	609	609
Parmer	Bovina	Brazos	2,079	2,301	2,502	2,697	2,927	3,137
	County-other	Brazos	1,973	2,185	2,375	2,562	2,781	2,980
		Red	1,268	1,404	1,526	1,646	1,785	1,914
	Farwell	Brazos	1,517	1,679	1,825	1,969	2,136	2,289
	Friona	Red	4,587	5,079	5,520	5,953	6,462	6,924

Table 2-7. Population Projections by Water User Group
Page 4 of 4

County	Water User Group	River Basin	Projected Population by Decade 2020	2030	2040	2050	2060	2070
Swisher	County-other	Brazos	215	226	230	228	239	245
		Red	1,419	1,489	1,510	1,503	1,576	1,611
	Happy	Red	649	682	692	687	721	738
	Kress	Brazos	169	178	180	179	188	192
		Red	583	612	622	617	648	662
	Tulia	Red	5,222	5,483	5,564	5,530	5,803	5,932
Terry	Brownfield	Colorado	10,381	11,036	11,696	12,296	12,860	13,386
	County-other	Brazos	62	66	70	73	77	80
		Colorado	2,518	2,677	2,836	2,983	3,120	3,247
	Meadow	Colorado	638	678	719	756	790	822
Yoakum	County-other	Colorado	2,171	2,456	2,708	2,977	3,264	3,534
	Denver City	Colorado	5,072	5,736	6,327	6,955	7,618	8,249
	Plains	Colorado	1,677	1,897	2,093	2,300	2,519	2,728
		Total	540,495	594,391	645,980	697,869	750,858	801,719

Table 2-8. Population Projections by River Basin

River Basin	Projected Population by Decade						Increase from 2020 to 2070 (%)	Percentage of Total Regional Population in 2020
	2020	2030	2040	2050	2060	2070		
Brazos	438,877	480,820	520,057	559,283	600,128	638,943	46	81
Canadian	8	9	11	12	14	15	88	<1
Colorado	60,618	67,969	75,785	83,598	91,268	98,816	63	11
Red	40,992	45,593	50,127	54,976	59,448	63,945	56	8
Total	540,495	594,391	645,980	697,869	750,858	801,719	33	100



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Region O Water Demand Projections

Figure 2-3

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Region O's largest water demand category is irrigation, which is projected to account for 95 percent of the region's water use in 2020. Due to declining groundwater availability, improved technology, and an increase in conservation, agricultural water demand in the region is projected to decline slightly over the planning horizon, so that by 2070, agriculture is projected to account for 92 percent of the region's water use. Table 2-9 summarizes water demand projections by use category for the 50-year planning period, and Table 2-10 details those projections for each county. Figure 2-4 shows the division of water use among the categories in 2020 and 2070, and Figure 2-5 shows the Region O projected water demand by county for 2020 and 2070. Appendix 2C contains the required DB17 report for WUG demand.

2.2.1 Municipal Water Demand Projections

The municipal water use category consists of water use for residential and commercial purposes.

- *Residential water use*: Water for single-family and multi-family households
- *Commercial water use*: Water for businesses, public offices, and institutions, but not industry

Municipal water demand has been calculated by multiplying population by per capita water use (GPCD). GPCD is a measure of daily water consumption per person. The TWDB calculates a unique GPCD for each WUG (Table 2-5) based on the equation below:

$$\text{GPCD} = \text{Total annual water used} / \text{Total population} / 365 \text{ days}$$

To ensure that water demand projections are based on dry-year conditions, the TWDB uses a "Dry Year Designation," that is, the Board requires that the base year for GPCD calculations be the driest year on record from 2006 onward. For all counties in Region O, the base year is 2011, the driest year on record throughout the State of Texas. Accordingly, total annual water use and total population are based on a WUG's 2011 statistics.

Table 2-9. Region O Water Demand Projections

Water Use Category	Projected Water Demand by Decade (acre-feet per year)					
	2020	2030	2040	2050	2060	2070
Irrigation	3,518,490	3,396,129	3,271,821	3,152,785	3,038,772	2,938,318
Municipal	94,753	101,434	108,209	115,908	124,397	132,718
Manufacturing	16,575	17,346	18,084	18,717	19,738	20,822
Steam-electric	25,981	30,376	35,732	42,261	50,221	58,976
Mining	16,011	17,373	15,729	13,236	10,986	9,333
Livestock	38,828	44,965	46,265	47,638	49,072	50,617
Region O Total	3,710,638	3,607,623	3,495,840	3,390,545	3,293,186	3,210,784

Table 2-10. Region O Water Demand Projections by Water Use Category
Page 1 of 5

County	Water Use Category	Projected Water Demand by Decade (acre-feet per year)					
		2020	2030	2040	2050	2060	2070
Bailey	Municipal	1,451	1,580	1,718	1,874	2,037	2,198
	Irrigation	119,268	116,407	113,614	110,888	108,227	105,752
	Livestock	2,335	3,013	3,057	3,104	3,153	3,204
	Manufacturing	316	326	335	343	365	388
	Mining	0	0	0	0	0	0
	Steam electric power	0	0	0	0	0	0
	County total	123,370	121,326	118,724	116,209	113,782	111,542
Briscoe	Municipal	423	415	409	407	407	407
	Irrigation	37,260	35,908	34,604	33,348	32,137	31,052
	Livestock	302	310	319	328	338	348
	Manufacturing	0	0	0	0	0	0
	Mining	0	0	0	0	0	0
	Steam electric power	0	0	0	0	0	0
	County total	37,985	36,633	35,332	34,083	32,882	31,807
Castro	Municipal	1,687	1,783	1,850	1,930	1,997	2,053
	Irrigation	387,976	373,101	358,796	345,040	331,812	320,029
	Livestock	5,848	7,120	7,290	7,468	7,655	7,851
	Manufacturing	980	1,041	1,100	1,151	1,232	1,319
	Mining	0	0	0	0	0	0
	Steam electric power	0	0	0	0	0	0
	County total	396,491	383,045	369,036	355,589	342,696	331,252

Table 2-10. Region O Water Demand Projections by Water Use Category
Page 2 of 5

County	Water Use Category	Projected Water Demand by Decade (acre-feet per year) 2020	2030	2040	2050	2060	2070
Cochran	Municipal	973	1,018	1,023	1,012	1,041	1,052
	Irrigation	102,229	98,284	94,489	90,841	87,334	84,214
	Livestock	536	562	590	620	651	684
	Manufacturing	0	0	0	0	0	0
	Mining	154	208	210	163	115	81
	Steam electric power	0	0	0	0	0	0
	County total	103,892	100,072	96,312	92,636	89,141	86,031
Crosby	Municipal	993	1,035	1,074	1,128	1,192	1,250
	Irrigation	117,362	112,634	108,095	103,742	99,564	95,864
	Livestock	262	268	274	281	287	294
	Manufacturing	3	3	3	3	3	3
	Mining	994	980	871	757	656	568
	Steam electric power	0	0	0	0	0	0
	County total	119,614	114,920	110,317	105,911	101,702	97,979
Dawson	Municipal	2,881	2,936	2,971	2,991	3,092	3,166
	Irrigation	106,630	100,619	94,945	89,594	84,544	80,286
	Livestock	139	143	147	151	155	159
	Manufacturing	129	137	144	150	162	175
	Mining	954	1,164	1,023	703	423	255
	Steam electric power	0	0	0	0	0	0
	County total	110,733	104,999	99,230	93,589	88,376	84,041
Deaf Smith	Municipal	4,494	5,059	5,703	6,479	7,112	7,811
	Irrigation	193,410	187,282	181,349	175,604	170,041	164,985
	Livestock	12,555	14,304	14,807	15,335	15,889	16,471
	Manufacturing	3,834	3,950	4,061	4,157	4,295	4,438
	Mining	0	0	0	0	0	0
	Steam electric power	0	0	0	0	0	0
	County total	214,293	210,595	205,920	201,575	197,337	193,705
Dickens	Municipal	331	321	314	313	312	312
	Irrigation	9,363	9,085	8,814	8,550	8,293	8,060
	Livestock	375	383	392	402	412	422
	Manufacturing	0	0	0	0	0	0
	Mining	12	12	12	12	12	12
	Steam electric power	0	0	0	0	0	0
	County total	10,081	9,801	9,532	9,277	9,029	8,806

Table 2-10. Region O Water Demand Projections by Water Use Category
Page 3 of 5

County	Water Use Category	Projected Water Demand by Decade (acre-feet per year)					
		2020	2030	2040	2050	2060	2070
Floyd	Municipal	1,040	1,064	1,086	1,125	1,156	1,182
	Irrigation	147,725	141,841	136,191	130,767	125,559	120,941
	Livestock	738	775	814	854	897	942
	Manufacturing	0	0	0	0	0	0
	Mining	486	492	489	486	484	485
	Steam electric power	0	0	0	0	0	0
	County total	149,989	144,172	138,580	133,232	128,096	123,550
Gaines	Municipal	4,170	4,764	5,499	6,322	7,048	7,810
	Irrigation	379,779	360,000	341,251	323,477	306,629	292,238
	Livestock	238	250	262	276	289	304
	Manufacturing	2,278	2,386	2,489	2,578	2,722	2,874
	Mining	1,829	2,400	2,071	1,527	1,051	776
	Steam electric power	0	0	0	0	0	0
	County total	388,294	369,800	351,572	334,180	317,739	304,002
Garza	Municipal	927	957	986	1,010	1,058	1,098
	Irrigation	11,621	10,937	10,299	9,697	9,130	8,655
	Livestock	299	305	312	320	328	346
	Manufacturing	2	2	2	2	2	2
	Mining	395	544	438	334	234	164
	Steam electric power	0	0	0	0	0	0
	County total	13,244	12,745	12,037	11,363	10,752	10,265
Hale	Municipal	6,691	6,790	6,760	6,630	6,789	6,860
	Irrigation	369,812	357,560	345,713	334,258	323,183	313,161
	Livestock	2,045	2,660	2,697	2,736	2,778	2,821
	Manufacturing	2,830	2,944	3,052	3,144	3,322	3,510
	Mining	1,168	1,152	1,022	886	766	662
	Steam electric power	60	71	83	98	117	139
	County total	382,606	371,177	359,327	347,752	336,955	327,153
Hockley	Municipal	3,941	4,065	4,120	4,107	4,280	4,396
	Irrigation	131,207	126,077	121,146	116,409	111,858	107,813
	Livestock	238	250	262	276	289	304
	Manufacturing	1,185	1,188	1,191	1,193	1,198	1,203
	Mining	18	18	17	17	16	15
	Steam electric power	0	0	0	0	0	0
	County total	136,589	131,598	126,736	122,002	117,641	113,731

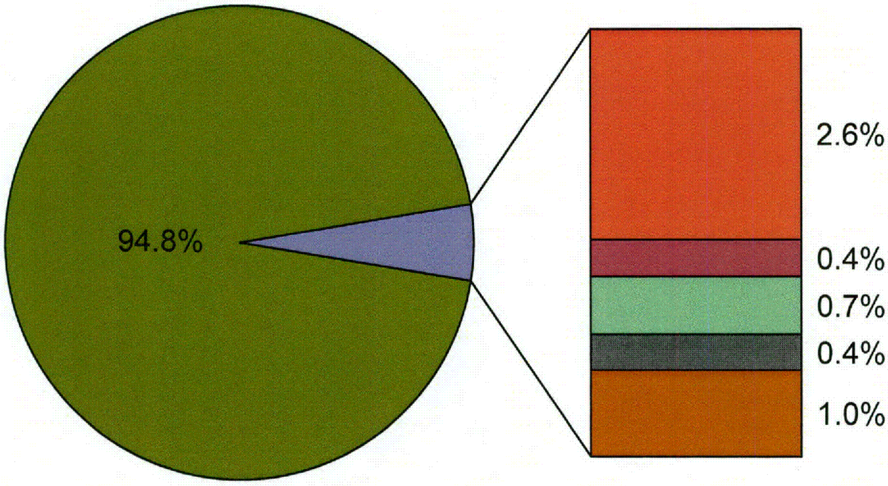
Table 2-10. Region O Water Demand Projections by Water Use Category
Page 4 of 5

County	Water Use Category	Projected Water Demand by Decade (acre-feet per year)					
		2020	2030	2040	2050	2060	2070
Lamb	Municipal	2,401	2,413	2,402	2,379	2,429	2,456
	Irrigation	325,356	312,802	300,732	289,129	277,974	268,045
	Livestock	2,969	3,136	3,204	3,275	3,349	3,427
	Manufacturing	616	642	667	688	733	781
	Mining	586	579	513	445	385	333
	Steam electric power	17,663	20,651	24,292	28,731	34,142	40,391
	County total	349,591	340,223	331,810	324,647	319,012	315,433
Lubbock	Municipal	53,257	57,639	62,278	67,701	73,249	78,851
	Irrigation	169,242	159,740	150,773	142,310	134,322	127,582
	Livestock	780	887	918	951	985	1,021
	Manufacturing	2,161	2,354	2,540	2,697	2,914	3,148
	Mining	6,354	6,425	5,913	5,302	4,763	4,314
	Steam electric power	4,540	5,308	6,244	7,385	8,776	9,906
	County total	236,334	232,353	228,666	226,346	225,009	224,822
Lynn	Municipal	894	908	889	875	916	935
	Irrigation	84,566	80,019	75,711	71,641	67,790	64,515
	Livestock	141	146	150	155	160	165
	Manufacturing	0	0	0	0	0	0
	Mining	1,166	1,327	1,255	1,033	826	660
	Steam electric power	0	0	0	0	0	0
	County total	86,767	82,400	78,005	73,704	69,692	66,275
Motley	Municipal	322	314	312	310	310	310
	Irrigation	9,439	9,159	8,884	8,617	8,359	8,123
	Livestock	481	490	499	509	519	529
	Manufacturing	6	6	6	6	6	6
	Mining	240	213	205	198	179	161
	Steam electric power	0	0	0	0	0	0
	County total	10,488	10,182	9,906	9,640	9,373	9,129
Parmer	Municipal	2,229	2,406	2,569	2,748	2,976	3,188
	Irrigation	329,806	326,305	322,840	319,413	316,021	312,736
	Livestock	5,634	6,908	7,067	7,234	7,409	7,593
	Manufacturing	2,233	2,365	2,492	2,603	2,782	2,973
	Mining	0	0	0	0	0	0
	Steam electric power	0	0	0	0	0	0
	County total	339,902	337,984	334,968	331,998	329,188	326,490

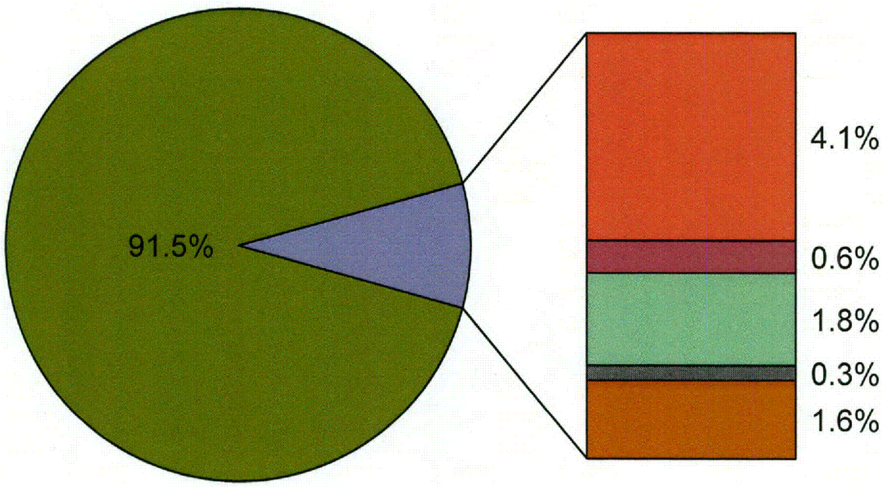
Table 2-10. Region O Water Demand Projections by Water Use Category
Page 5 of 5

County	Water Use Category	Projected Water Demand by Decade (acre-feet per year)					
		2020	2030	2040	2050	2060	2070
Swisher	Municipal	1,318	1,341	1,328	1,309	1,370	1,400
	Irrigation	196,895	203,171	202,011	200,857	199,709	198,581
	Livestock	2,362	2,481	2,605	2,735	2,872	3,015
	Manufacturing	0	0	0	0	0	0
	Mining	0	0	0	0	0	0
	Steam electric power	0	0	0	0	0	0
	County total	200,575	206,993	205,944	204,901	203,951	202,996
Terry	Municipal	2,208	2,276	2,361	2,458	2,564	2,668
	Irrigation	143,461	136,107	129,129	122,508	116,226	110,848
	Livestock	270	288	309	332	356	395
	Manufacturing	2	2	2	2	2	2
	Mining	355	525	543	416	293	206
	Steam electric power	0	0	0	0	0	0
	County total	146,296	139,198	132,344	125,716	119,441	114,119
Yoakum	Municipal	2,122	2,350	2,557	2,800	3,062	3,315
	Irrigation	146,083	139,091	132,435	126,095	120,060	114,838
	Livestock	281	286	290	296	301	322
	Manufacturing	0	0	0	0	0	0
	Mining	1,300	1,334	1,147	957	783	641
	Steam electric power	3,718	4,346	5,113	6,047	7,186	8,540
	County total	153,504	147,407	141,542	136,195	131,392	127,656
Region O Total		3,710,638	3,607,623	3,495,840	3,390,545	3,293,186	3,210,784

a. 2020



b. 2070



Irrigation
Municipal
Manufacturing
Steam-electric
Mining
Livestock

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LLANO ESTACADO REGION

Region O Projected Water Demand in 2020 and 2070

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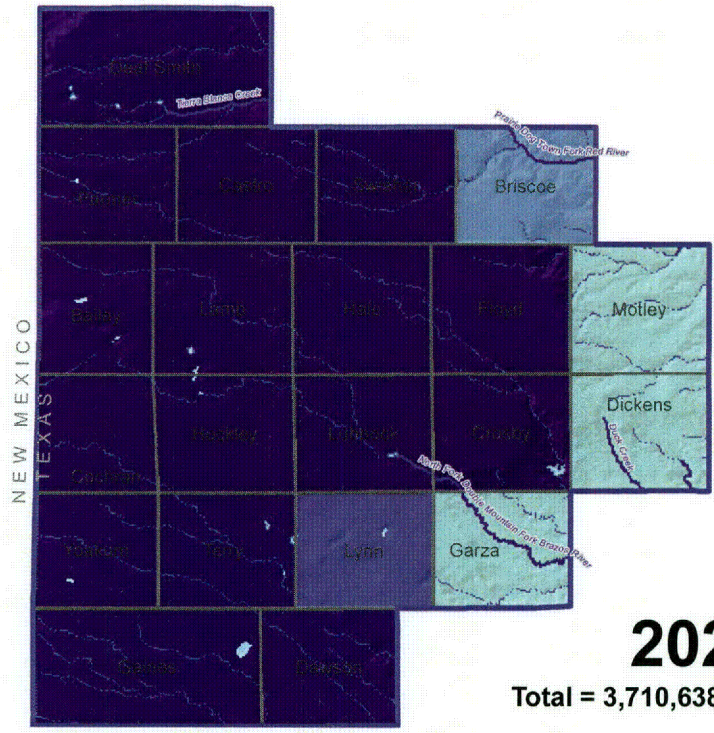
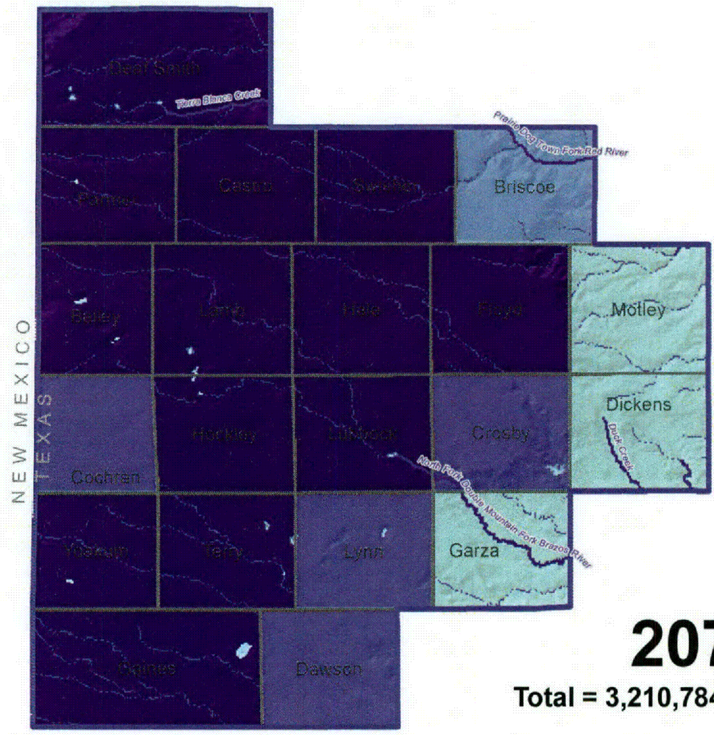
Figure 2-4



2020

Total = 3,710,638 acre-feet/year



2070

Total = 3,210,784 acre-feet/year

Explanation

- Water planning region
- County

Total projected water demand (ac-ft/yr)

- <25,000
- 25,001 - 50,000
- 50,001 - 100,000
- >100,000

N

0 25 50 Miles

LLANO ESTACADO REGION

Total Projected Water Demand 2020 and 2070

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9/30/2015 JN WR11.0030

Figure 2-5

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When calculating GPCD, the TWDB factors in conservation that will occur in the future due to use of water-efficient appliances. The federal and state governments have passed two main laws encouraging water conservation: the State Water-Efficient Plumbing Act, passed in 1991, and House Bill 2667, passed by the 81st Legislature in 2009. Due to these laws, the prevalence of water-efficient appliances will increase over time, reducing a WUG's GPCD. According to TWDB policy, however, no WUG is allowed to have a GPCD projection below 60.

In Region O, there is a 40 percent increase in municipal water demand over the planning period. Figure 2-6 shows the municipal water demand projections from 2020 to 2070.

Lubbock County has the largest municipal water demand projections. In 2020, Lubbock County accounts for 56 percent of Region O's municipal demand, and it is projected to account for 59 percent by 2070. Motley County has the smallest municipal demand projections, accounting for only 0.3 percent of the region's 2020 municipal demand and 0.2 percent of the region's projected 2070 municipal demand. A decline in municipal demand over the planning period is projected for three of the region's counties: Briscoe, Dickens, and Motley. Gaines County is projected to experience the largest percentage increase in water demand (87%). Figure 2-7 shows the projected municipal water demand by county for 2020 and 2070. Table 2-11 shows municipal water demand projections from 2020 to 2070 by county as well as the percentage increase in demand over the planning period. Tables 2-12 and 2-13 show municipal water demand projections from 2020 to 2070 by WUG (listed alphabetically by county) and by river basin, respectively.

2.2.2 Industrial (Manufacturing, Steam-Electric, Mining) Water Demand Projections

Industrial water use is water consumed in the production process of manufactured products, steam-electric power generation, and mining activities, including water used by employees for drinking and sanitation purposes. Water demand projections are presented individually for each of the industrial categories in Sections 2.3.1 through 2.3.3.

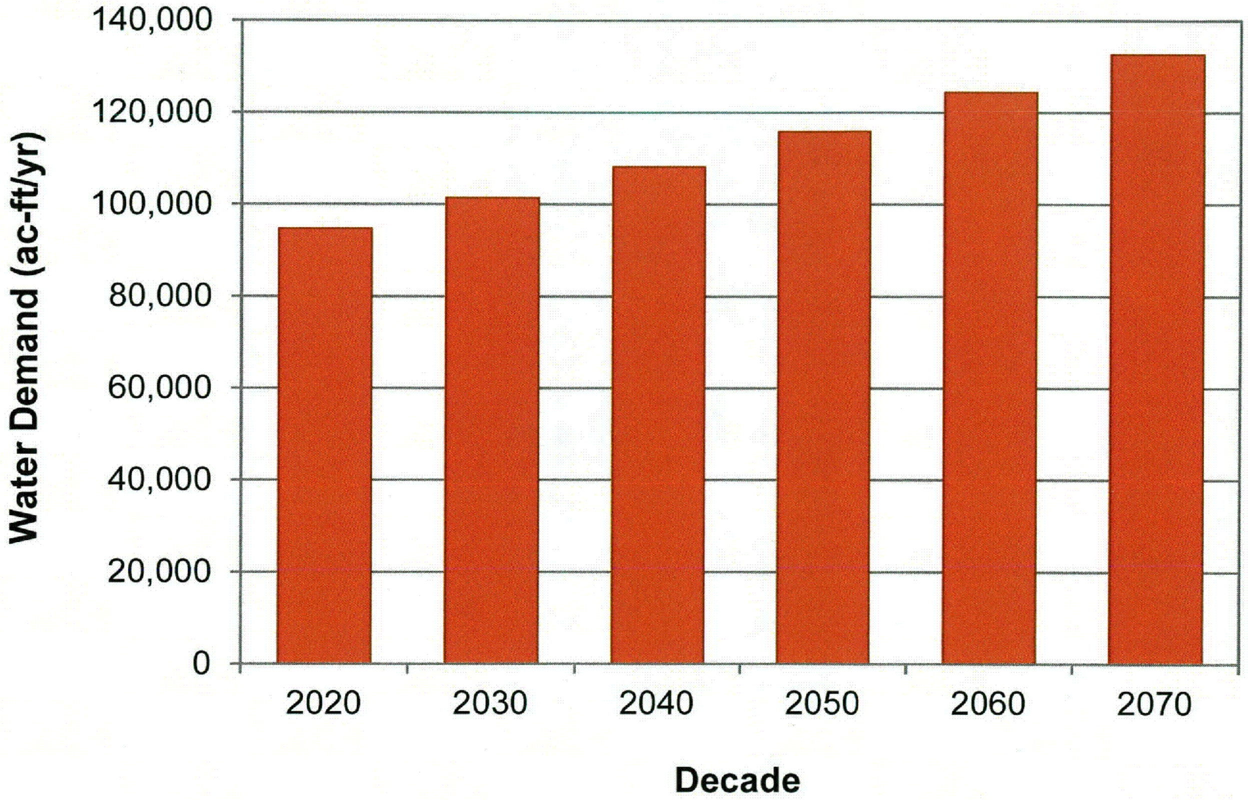

Figure 2-6

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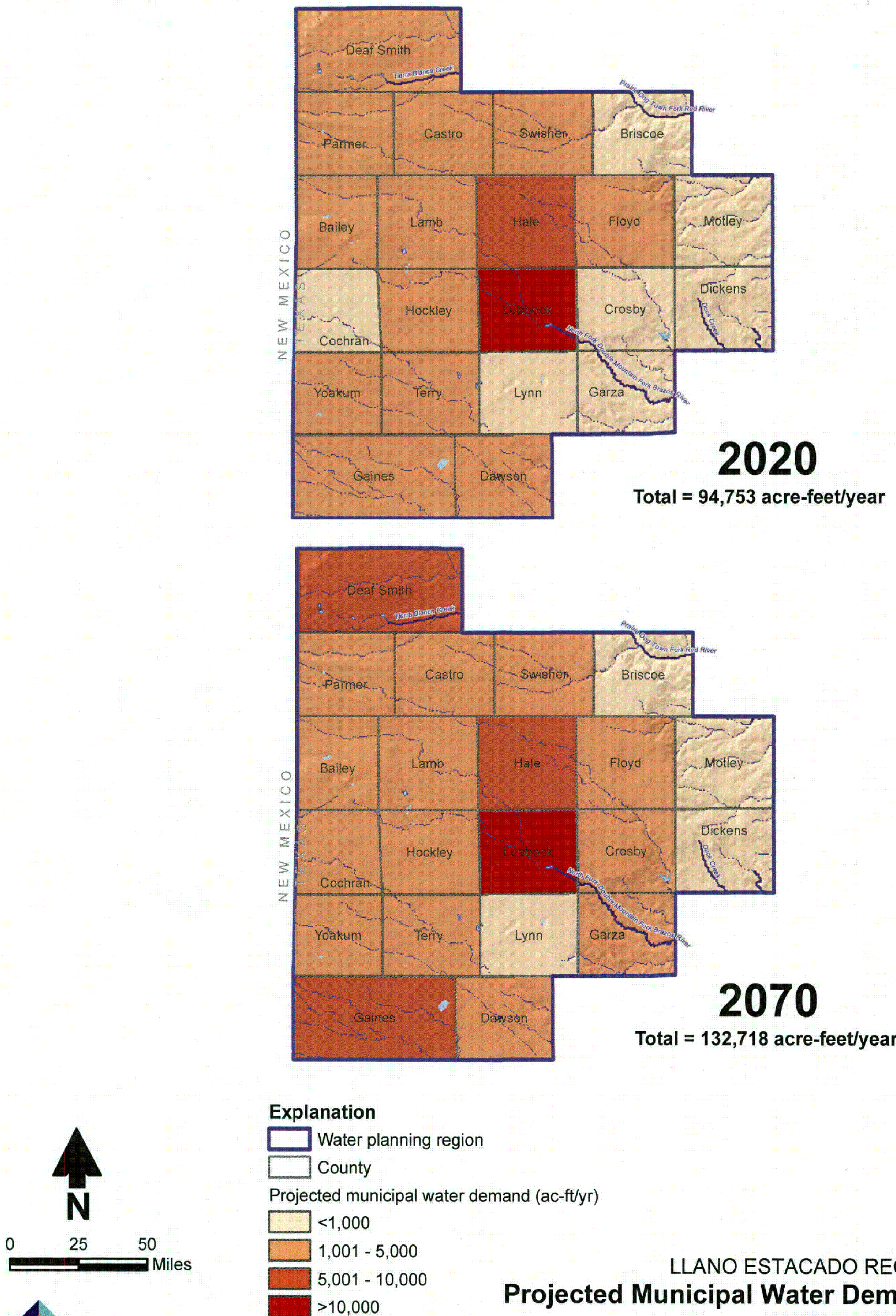
LLANO ESTACADO REGION

Region O Municipal Water Demand Projections



LLANO ESTACADO REGION

Projected Municipal Water Demand 2020 and 2070

Figure 2-7

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9/30/2015
JN WR11.0030

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Table 2-11. Municipal Water Demand Projections by County

County	Projected Water Demand by Decade (acre-feet per year)						Increase from 2020 to 2070 (%)
	2020	2030	2040	2050	2060	2070	
Bailey	1,451	1,580	1,718	1,874	2,037	2,198	51
Briscoe	423	415	409	407	407	407	–4
Castro	1,687	1,783	1,850	1,930	1,997	2,053	22
Cochran	973	1,018	1,023	1,012	1,041	1,052	8
Crosby	993	1,035	1,074	1,128	1,192	1,250	26
Dawson	2,881	2,936	2,971	2,991	3,092	3,166	10
Deaf Smith	4,494	5,059	5,703	6,479	7,112	7,811	74
Dickens	331	321	314	313	312	312	–6
Floyd	1,040	1,064	1,086	1,125	1,156	1,182	14
Gaines	4,170	4,764	5,499	6,322	7,048	7,810	87
Garza	927	957	986	1,010	1,058	1,098	18
Hale	6,691	6,790	6,760	6,630	6,789	6,860	3
Hockley	3,941	4,065	4,120	4,107	4,280	4,396	12
Lamb	2,401	2,413	2,402	2,379	2,429	2,456	2
Lubbock	53,257	57,639	62,278	67,701	73,249	78,851	48
Lynn	894	908	889	875	916	935	5
Motley	322	314	312	310	310	310	–4
Parmer	2,229	2,406	2,569	2,748	2,976	3,188	43
Swisher	1,318	1,341	1,328	1,309	1,370	1,400	6
Terry	2,208	2,276	2,361	2,458	2,564	2,668	21
Yoakum	2,122	2,350	2,557	2,800	3,062	3,315	56
Total	94,753	101,434	108,209	115,908	124,397	132,718	40

Table 2-12. Municipal Water Demand Projections by Water User Group
Page 1 of 3

County	Water User Group	River Basin	Projected Water Demand by Decade (acre-feet per year)					
			2020	2030	2040	2050	2060	2070
Bailey	County-other	Brazos	277	296	321	351	381	411
	Muleshoe	Brazos	1,174	1,284	1,397	1,523	1,656	1,787
Briscoe	County-other	Red	297	292	289	288	288	288
	Silverton	Red	126	123	120	119	119	119
Castro	County-other	Brazos	196	205	213	223	231	237
		Red	215	225	233	244	252	259
	Dimmitt	Brazos	1,096	1,164	1,210	1,260	1,304	1,341
	Hart	Brazos	180	189	194	203	210	216
Cochran	County-other	Brazos	376	415	427	428	444	451
		Colorado	124	129	129	128	131	132
	Morton	Brazos	473	474	467	456	466	469
Crosby	County-other	Brazos	154	158	166	173	181	191
		Red	1	1	1	1	1	1
	Crosbyton	Brazos	294	306	316	332	351	367
	Lorenzo	Brazos	231	246	258	275	295	310
	Ralls	Brazos	313	324	333	347	364	381
Dawson	County-other	Brazos	5	5	5	4	5	5
		Colorado	583	610	633	649	685	716
	Lamesa	Colorado	2,275	2,303	2,314	2,319	2,382	2,425
	O'Donnell	Brazos	18	18	19	19	20	20
Deaf Smith	County-other	Canadian	1	1	1	2	2	2
		Red	540	595	662	749	822	902
	Hereford	Red	3,953	4,463	5,040	5,728	6,288	6,907
Dickens	County-other	Brazos	123	118	114	114	113	113
		Red	30	30	29	29	29	29
	Spur	Brazos	178	173	171	170	170	170
Floyd	County-other	Brazos	136	137	141	145	149	152
		Red	64	64	66	69	70	72
	Floydada	Brazos	572	589	603	625	643	658
	Lockney	Brazos	268	274	276	286	294	300
Gaines	County-other	Colorado	1,403	1,763	2,205	2,692	3,152	3,633
	Seagraves	Colorado	419	430	447	470	485	502
	Seminole	Colorado	2,348	2,571	2,847	3,160	3,411	3,675
Garza	County-other	Brazos	135	129	125	126	130	133
	Post	Brazos	792	828	861	884	928	965

Table 2-12. Municipal Water Demand Projections by Water User Group
Page 2 of 3

County	Water User Group	River Basin	Projected Water Demand by Decade (acre-feet per year)					
			2020	2030	2040	2050	2060	2070
Hale	Abernathy	Brazos	528	539	540	532	545	550
	County-other	Brazos	1,171	1,177	1,162	1,135	1,161	1,173
	Hale Center	Brazos	298	299	296	289	296	299
	Petersburg	Brazos	326	334	335	330	338	342
	Plainview	Brazos	4,368	4,441	4,427	4,344	4,449	4,496
Hockley	Anton	Brazos	161	164	165	165	172	176
	County-other	Brazos	891	914	923	915	953	979
		Colorado	31	32	32	32	33	34
	Levelland	Brazos	2,442	2,521	2,554	2,547	2,655	2,727
	Sundown	Colorado	416	434	446	448	467	480
Lamb	Amherst	Brazos	102	107	110	113	119	124
	County-other	Brazos	435	471	505	530	567	596
	Earth	Brazos	192	190	187	184	186	187
	Littlefield	Brazos	953	917	873	833	824	809
	Olton	Brazos	469	463	453	440	441	438
	Sudan	Brazos	250	265	274	279	292	302
Lubbock	Abernathy	Brazos	184	200	217	236	255	274
	County-other	Brazos	4,647	5,010	5,402	5,869	6,354	6,847
	Idalou	Brazos	419	426	436	452	469	486
	Lubbock	Brazos	45,623	49,424	53,437	58,113	62,886	67,703
	New Deal	Brazos	114	121	128	138	148	158
	Ransom Canyon	Brazos	337	356	377	401	424	448
	Shallowater	Brazos	422	464	507	558	610	662
	Slaton	Brazos	746	726	712	711	718	726
	Wolfforth	Brazos	765	912	1,062	1,223	1,385	1,547
Lynn	County-other	Brazos	301	304	296	289	303	309
		Colorado	10	10	10	10	10	10
	O'Donnell	Brazos	105	106	105	104	109	111
	Tahoka	Brazos	478	488	478	472	494	505
Motley	County-other	Red	109	105	104	103	103	103
	Matador	Red	213	209	208	207	207	207
Parmer	Bovina	Brazos	373	402	429	458	496	531
	County-other	Brazos	384	414	442	474	512	549
		Red	247	266	284	304	330	353
	Farwell	Brazos	396	430	461	494	535	573
	Friona	Red	829	894	953	1,018	1,103	1,182

Table 2-12. Municipal Water Demand Projections by Water User Group
Page 3 of 3

County	Water User Group	River Basin	Projected Water Demand by Decade (acre-feet per year)					
			2020	2030	2040	2050	2060	2070
Swisher	County-other	Brazos	29	29	29	28	30	30
		Red	185	187	184	184	191	196
	Happy	Red	99	101	100	98	103	105
	Kress	Brazos	18	18	17	16	18	18
		Red	61	61	60	59	61	62
	Tulia	Red	926	945	938	924	967	989
Terry	Brownfield	Colorado	1,793	1,854	1,923	2,000	2,087	2,172
	County-other	Brazos	8	8	8	8	9	9
		Colorado	312	317	329	345	359	374
	Meadow	Colorado	95	97	101	105	109	113
Yoakum	County-other	Colorado	267	291	314	341	372	403
	Denver City	Colorado	1,423	1,579	1,721	1,889	2,066	2,237
	Plains	Colorado	432	480	522	570	624	675
		Total	94,753	101,434	108,209	115,908	124,397	132,718

Table 2-13. Municipal Water Demand Projections by River Basin

River Basin	Projected Water Demand by Decade (acre-feet per year)					
	2020	2030	2040	2050	2060	2070
Brazos	74,926	79,972	84,964	90,624	97,088	103,361
Canadian	1	1	1	2	2	2
Colorado	11,931	12,900	13,973	15,158	16,373	17,581
Red	7,895	8,561	9,271	10,124	10,934	11,774
Total	94,753	101,434	108,209	115,908	124,397	132,718

2.2.2.1 Manufacturing

In Region O, the largest manufacturing sectors requiring water are food processing, industrial machinery and equipment, and fabricated metals. Only 14 of the 21 counties in Region O have manufacturing activity and therefore water use projections. In the TWDB projections the region's manufacturing demand increases by 26 percent over the 50-year planning period (Figure 2-8).

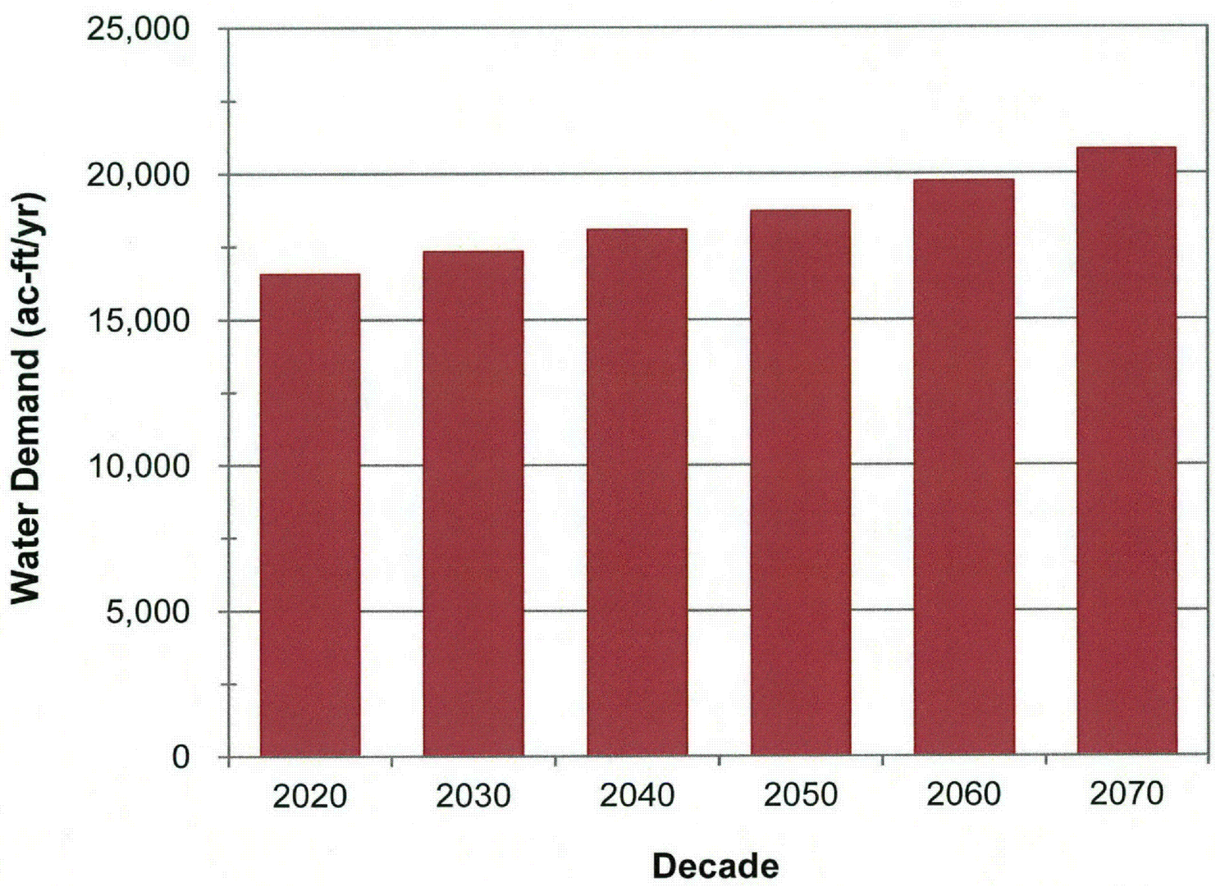
Deaf Smith County has the largest manufacturing demand, accounting for between approximately 21 and 23 percent of the manufacturing demand in the planning region. Hale and Lubbock counties make up approximately 17 percent and 13 to 15 percent of the manufacturing demand in the planning region, respectively. Figure 2-9 shows the projected manufacturing water demand by county for 2020 and 2070. Table 2-14 and 2-15 show the manufacturing water demand projections from 2020 to 2070 by county and by river basin, respectively.

2.2.2.2 Steam-Electric Power

In Region O, steam-electric power generation occurs in only four counties: Hale, Lamb, Lubbock, and Yoakum. The majority the steam-electric power demand (68%) occurs in Lamb County. In 2020, it is projected that 25,981 acre-feet per year (ac-ft/yr) of water will be needed for steam-electric power generation; by 2070, this projection will increase by 127 percent to 58,976 ac-ft/yr (Figure 2-10). Figure 2-11 shows the projected steam-electric water demand by county for 2020 and 2070. Tables 2-16 and 2-17 show the steam-electric water demand projections from 2020 to 2070 by county and by river basin, respectively.

2.2.2.3 Mining

In Region O, water for mining operations is needed in the oil and gas industry as well as in the production of gravel and sand. As shown in Figure 2-12, the TWDB projects that the water demand for mining will decrease dramatically (42%) over the planning period. Figure 2-13 shows the projected mining water demand in each county for 2020 and 2070. Tables 2-18 and 2-19 show the mining water demand projections from 2020 to 2070 by county and by river basin, respectively.



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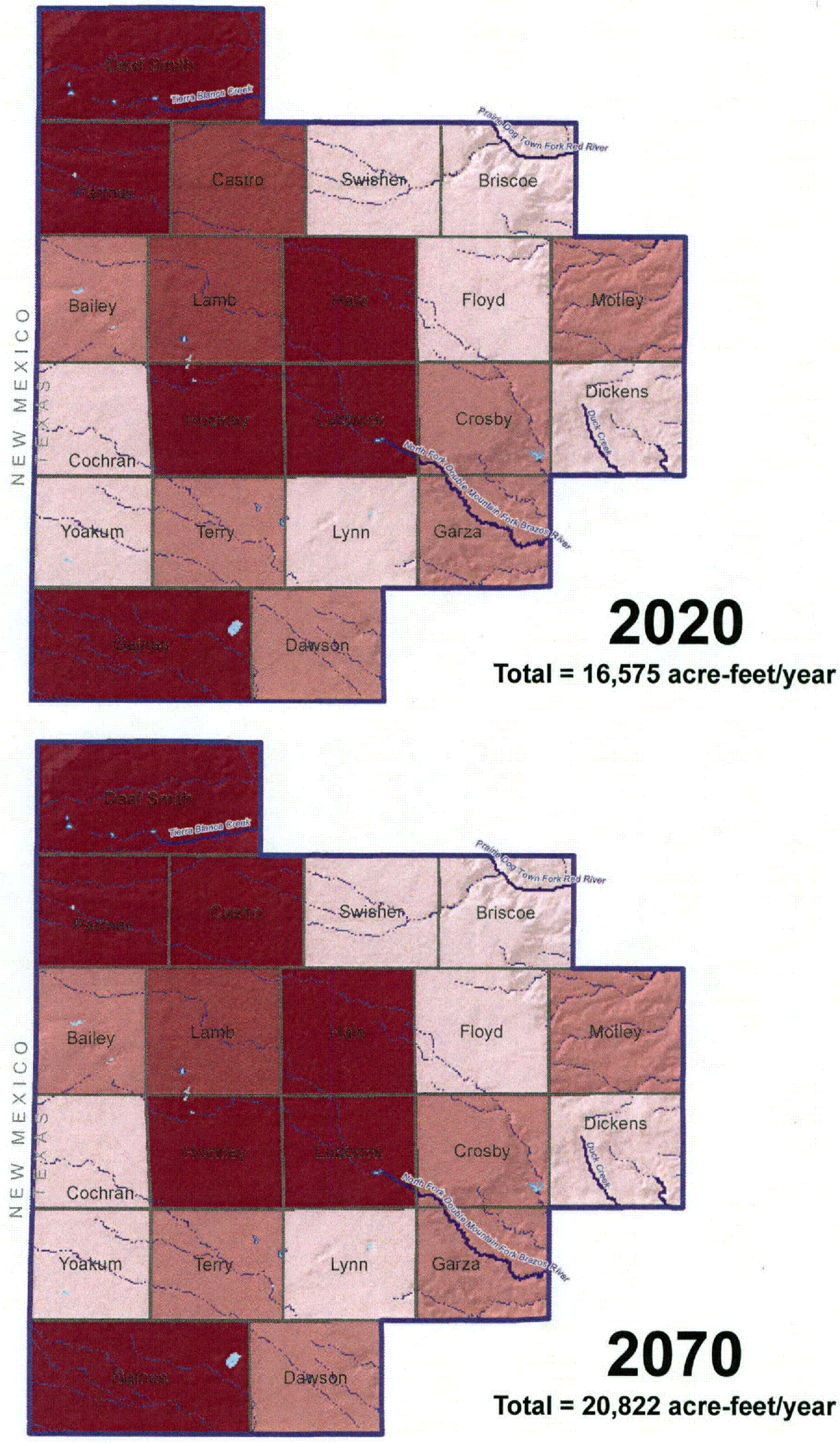
LLANO ESTACADO REGION

Region O Manufacturing Water Demand Projections

Figure 2-8



Explanation

- Water planning region
- County

Projected manufacturing water demand (ac-ft/yr)

- 0
- 1 - 500
- 501 - 1,000
- > 1,000

N

0 25 50 Miles

LLANO ESTACADO REGION

Projected Manufacturing Water Demand 2020 and 2070

Daniel B. Stephens & Associates, Inc.
9/30/2015 JN WR11.0030

Figure 2-9

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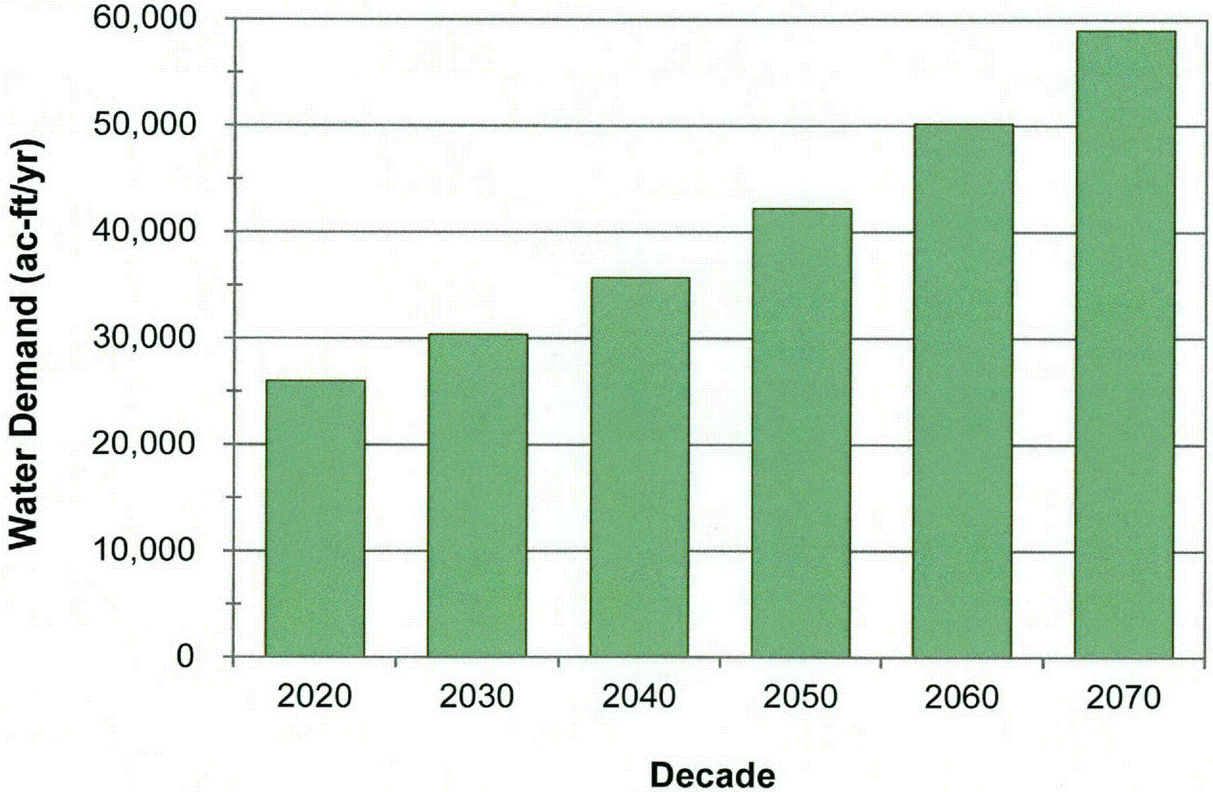
Table 2-14. Manufacturing Water Demand Projections by County

County	Projected Water Demand by Decade (acre-feet per year)					
	2020	2030	2040	2050	2060	2070
Bailey	316	326	335	343	365	388
Briscoe	0	0	0	0	0	0
Castro	980	1,041	1,100	1,151	1,232	1,319
Cochran	0	0	0	0	0	0
Crosby	3	3	3	3	3	3
Dawson	129	137	144	150	162	175
Deaf Smith	3,834	3,950	4,061	4,157	4,295	4,438
Dickens	0	0	0	0	0	0
Floyd	0	0	0	0	0	0
Gaines	2,278	2,386	2,489	2,578	2,722	2,874
Garza	2	2	2	2	2	2
Hale	2,830	2,944	3,052	3,144	3,322	3,510
Hockley	1,185	1,188	1,191	1,193	1,198	1,203
Lamb	616	642	667	688	733	781
Lubbock	2,161	2,354	2,540	2,697	2,914	3,148
Lynn	0	0	0	0	0	0
Motley	6	6	6	6	6	6
Parmer	2,233	2,365	2,492	2,603	2,782	2,973
Swisher	0	0	0	0	0	0
Terry	2	2	2	2	2	2
Yoakum	0	0	0	0	0	0
Total	16,575	17,346	18,084	18,717	19,738	20,822

Table 2-15. Manufacturing Water Demand Projections by River Basin

River Basin	Projected Water Demand by Decade (acre-feet per year)					
	2020	2030	2040	2050	2060	2070
Brazos	7,946	8,344	8,725	9,048	9,584	10,156
Canadian	0	0	0	0	0	0
Colorado	2,409	2,525	2,635	2,730	2,886	3,051
Red	6,220	6,477	6,724	6,939	7,268	7,615
Total	16,575	17,346	18,084	18,717	19,738	20,822



LLANO ESTACADO REGION

Region O Steam-Electric Power Water Demand Projections

Figure 2-10

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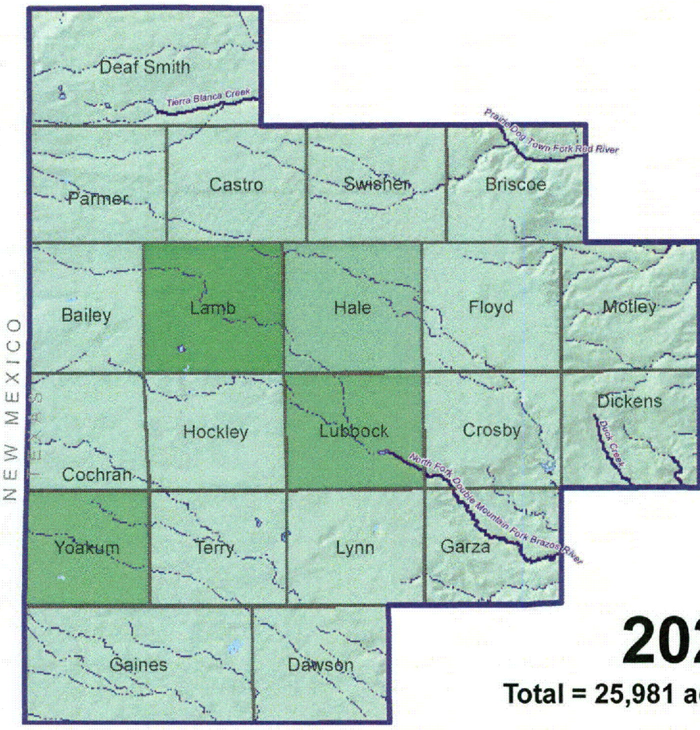
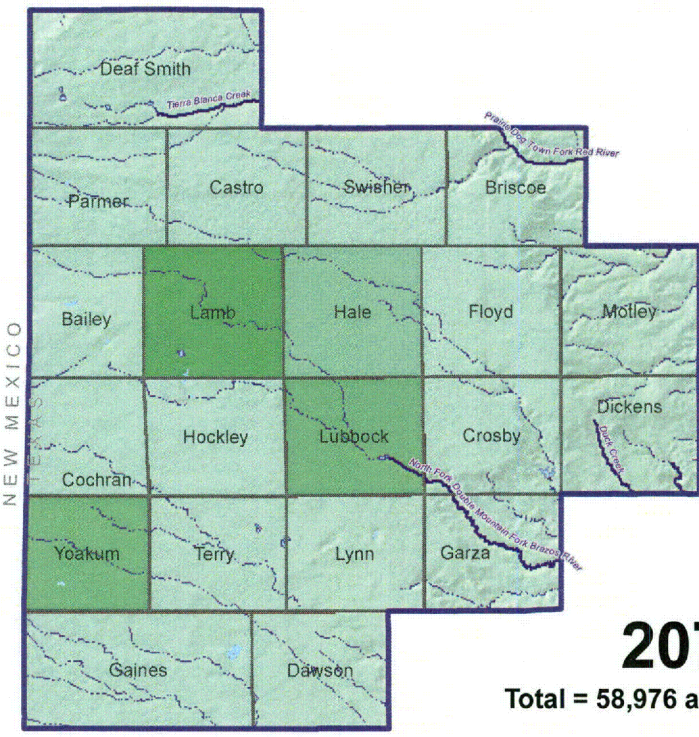


2020

Total = 25,981 acre-feet/year



2070

Total = 58,976 acre-feet/year

Explanation

Water planning region

County

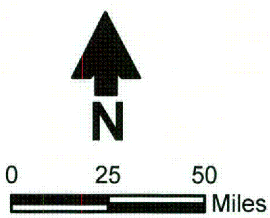
Projected steam-electric generation water demand (ac-ft/yr)

0

1 - 1,000

1,001 - 10,000

> 10,000



LLANO ESTACADO REGION

Projected Steam-Electric Generation Water Demand 2020 and 2070

Daniel B. Stephens & Associates, Inc.
9/30/2015
JN WR11.0030

Figure 2-11

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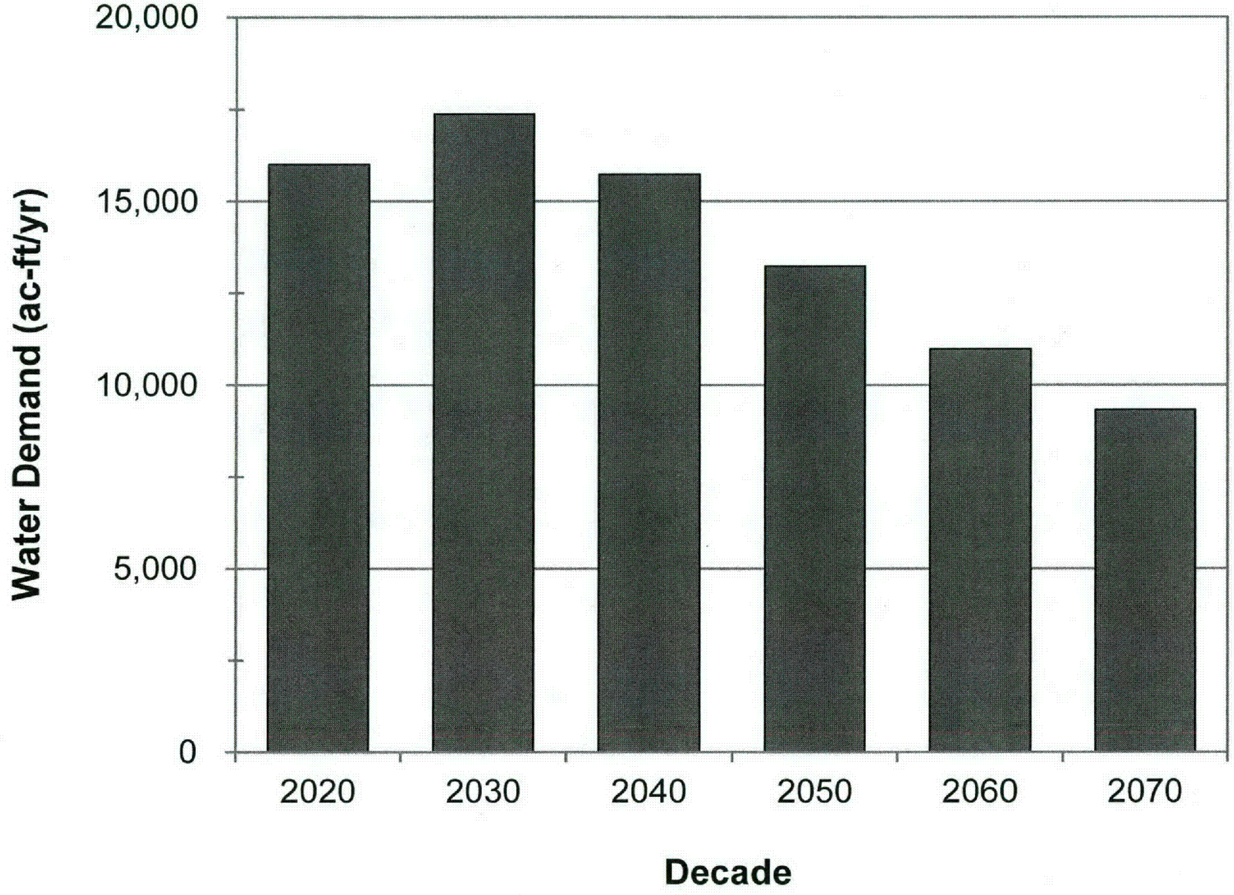
Table 2-16. Steam-Electric Power Water Demand Projections by County

County	Projected Water Demand by Decade (acre-feet per year)					
	2020	2030	2040	2050	2060	2070
Bailey	0	0	0	0	0	0
Briscoe	0	0	0	0	0	0
Castro	0	0	0	0	0	0
Cochran	0	0	0	0	0	0
Crosby	0	0	0	0	0	0
Dawson	0	0	0	0	0	0
Deaf Smith	0	0	0	0	0	0
Dickens	0	0	0	0	0	0
Floyd	0	0	0	0	0	0
Gaines	0	0	0	0	0	0
Garza	0	0	0	0	0	0
Hale	60	71	83	98	117	139
Hockley	0	0	0	0	0	0
Lamb	17,663	20,651	24,292	28,731	34,142	40,391
Lubbock	4,540	5,308	6,244	7,385	8,776	9,906
Lynn	0	0	0	0	0	0
Motley	0	0	0	0	0	0
Parmer	0	0	0	0	0	0
Swisher	0	0	0	0	0	0
Terry	0	0	0	0	0	0
Yoakum	3,718	4,346	5,113	6,047	7,186	8,540
Total	25,981	30,376	35,732	42,261	50,221	58,976

Table 2-17. Steam-Electric Power Water Demand Projections by River Basin

River Basin	Projected Water Demand by Decade (acre-feet per year)					
	2020	2030	2040	2050	2060	2070
Brazos	22,263	26,030	30,619	36,214	43,035	50,436
Canadian	0	0	0	0	0	0
Colorado	3,718	4,346	5,113	6,047	7,186	8,540
Red	0	0	0	0	0	0
Total	25,981	30,376	35,732	42,261	50,221	58,976



LLANO ESTACADO REGION

Region O Mining Water Demand Projections

Figure 2-12

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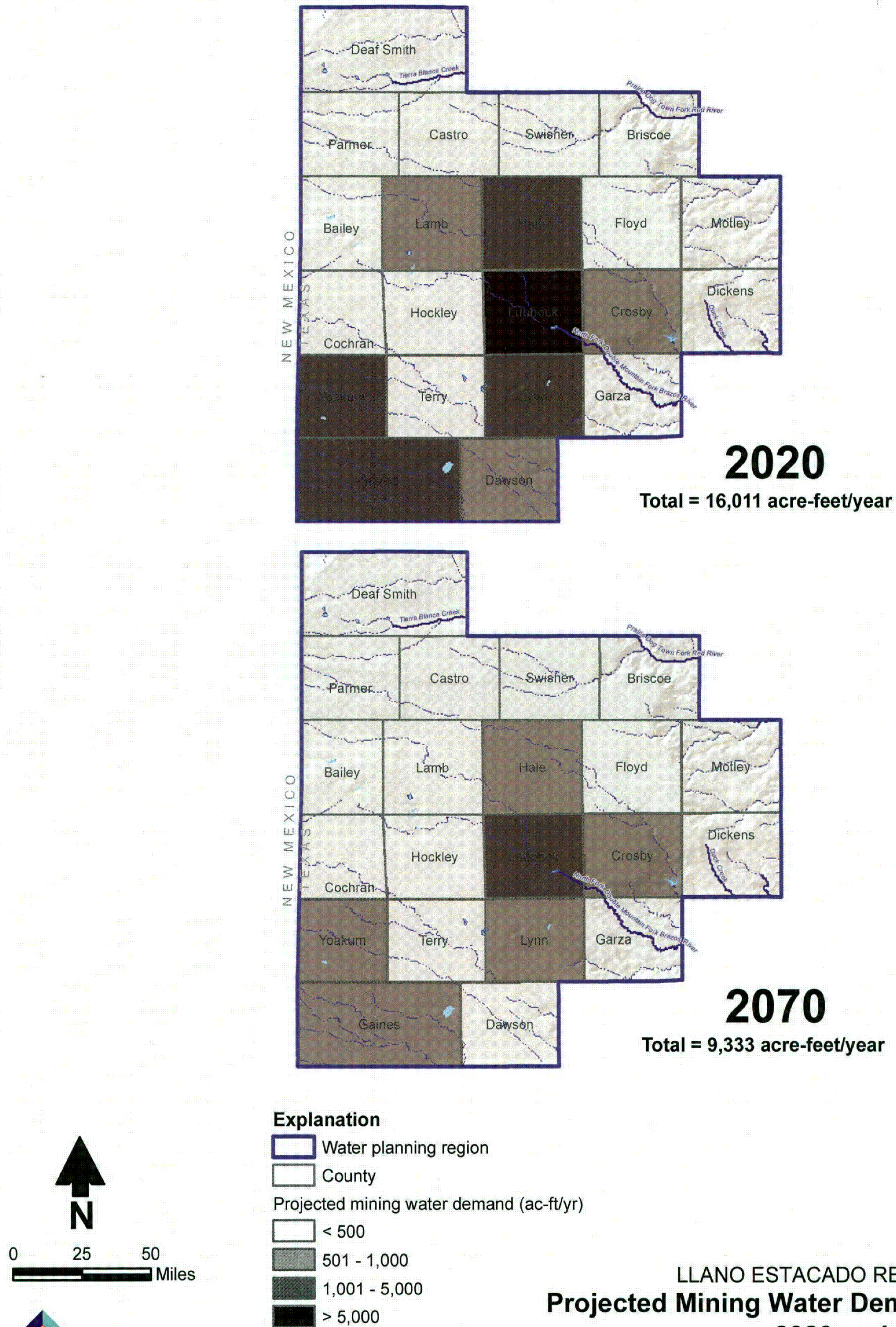

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LLANO ESTACADO REGION
Projected Mining Water Demand 2020 and 2070

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9/30/2015 JN WR11.0030

Figure 2-13

Table 2-18. Mining Water Demand Projections by County

County	Projected Water Demand by Decade (acre-feet per year)					
	2020	2030	2040	2050	2060	2070
Bailey	0	0	0	0	0	0
Briscoe	0	0	0	0	0	0
Castro	0	0	0	0	0	0
Cochran	154	208	210	163	115	81
Crosby	994	980	871	757	656	568
Dawson	954	1,164	1,023	703	423	255
Deaf Smith	0	0	0	0	0	0
Dickens	12	12	12	12	12	12
Floyd	486	492	489	486	484	485
Gaines	1,829	2,400	2,071	1,527	1,051	776
Garza	395	544	438	334	234	164
Hale	1,168	1,152	1,022	886	766	662
Hockley	18	18	17	17	16	15
Lamb	586	579	513	445	385	333
Lubbock	6,354	6,425	5,913	5,302	4,763	4,314
Lynn	1,166	1,327	1,255	1,033	826	660
Motley	240	213	205	198	179	161
Parmer	0	0	0	0	0	0
Swisher	0	0	0	0	0	0
Terry	355	525	543	416	293	206
Yoakum	1,300	1,334	1,147	957	783	641
Total	16,011	17,373	15,729	13,236	10,986	9,333

Table 2-19. Mining Water Demand Projections by River Basin

River Basin	Projected Water Demand by Decade (acre-feet per year)					
	2020	2030	2040	2050	2060	2070
Brazos	10,854	11,203	10,212	8,961	7,836	6,909
Canadian	0	0	0	0	0	0
Colorado	4,643	5,679	5,036	3,803	2,698	1,989
Red	514	491	481	472	452	435
Total	16,011	17,373	15,729	13,236	10,986	9,333

2.2.3 Irrigation Water Demand Projections

Irrigation water use is water used for agricultural purposes. The major crops grown in Region O are cotton, sorghum, corn, and winter wheat.

TWDB's annual irrigation water use estimates are produced by calculating a crop water need based on evapotranspiration and other climatic factors. This need per acre is then applied to irrigated acreage data obtained from the Farm Service Agency to determine estimated irrigation water use by TWDB crop category. Groundwater Conservation Districts are provided an opportunity to comment on these estimates.

Region O's largest water demand category is irrigation, which is projected to account for 95 percent (3,518,490 ac-ft/yr) of the region's water use in 2020. Due to declining groundwater levels, new regulations, and improvements in water-conservation technology, irrigation water use is projected to decline between 2020 and 2070. By 2070, the region's irrigation demand is projected to have dropped to 92 percent (2,938,318 ac-ft/yr) of the region's water use (Table 2-9). Figure 2-14 shows Region O's irrigation water demand projections over the planning period.

While all counties in the region have substantial irrigation water demand projections, Castro, Gaines, Hale, Parmer, and Lamb counties have the highest. Irrigation demands in Castro, Hale, and Parmer counties are projected to exceed 300,000 ac-ft/yr for all decades of the planning period. Garza, Motley, and Dickens counties have the lowest irrigation water demand projections in the region. Figure 2-15 shows irrigation water demand by county for 2020 and 2070. Tables 2-20 and 2-21 show irrigation water demand projections from 2020 to 2070 by county and by river basin, respectively.

2.2.4 Livestock Water Demand Projections

The livestock water use category is for water used in the production of livestock, including for drinking, cleaning, and environmental purposes. This category also includes water use by wildlife; for example, bigger game or quail often consume water from livestock sources.

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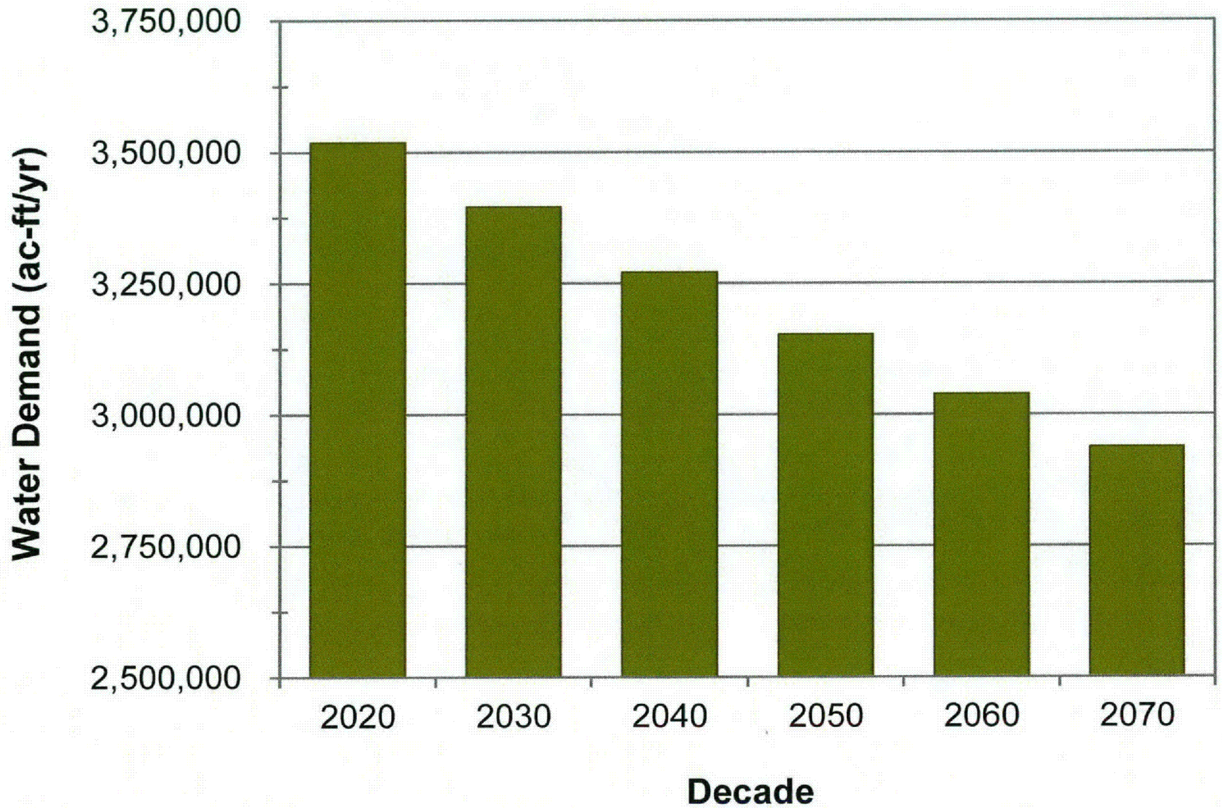

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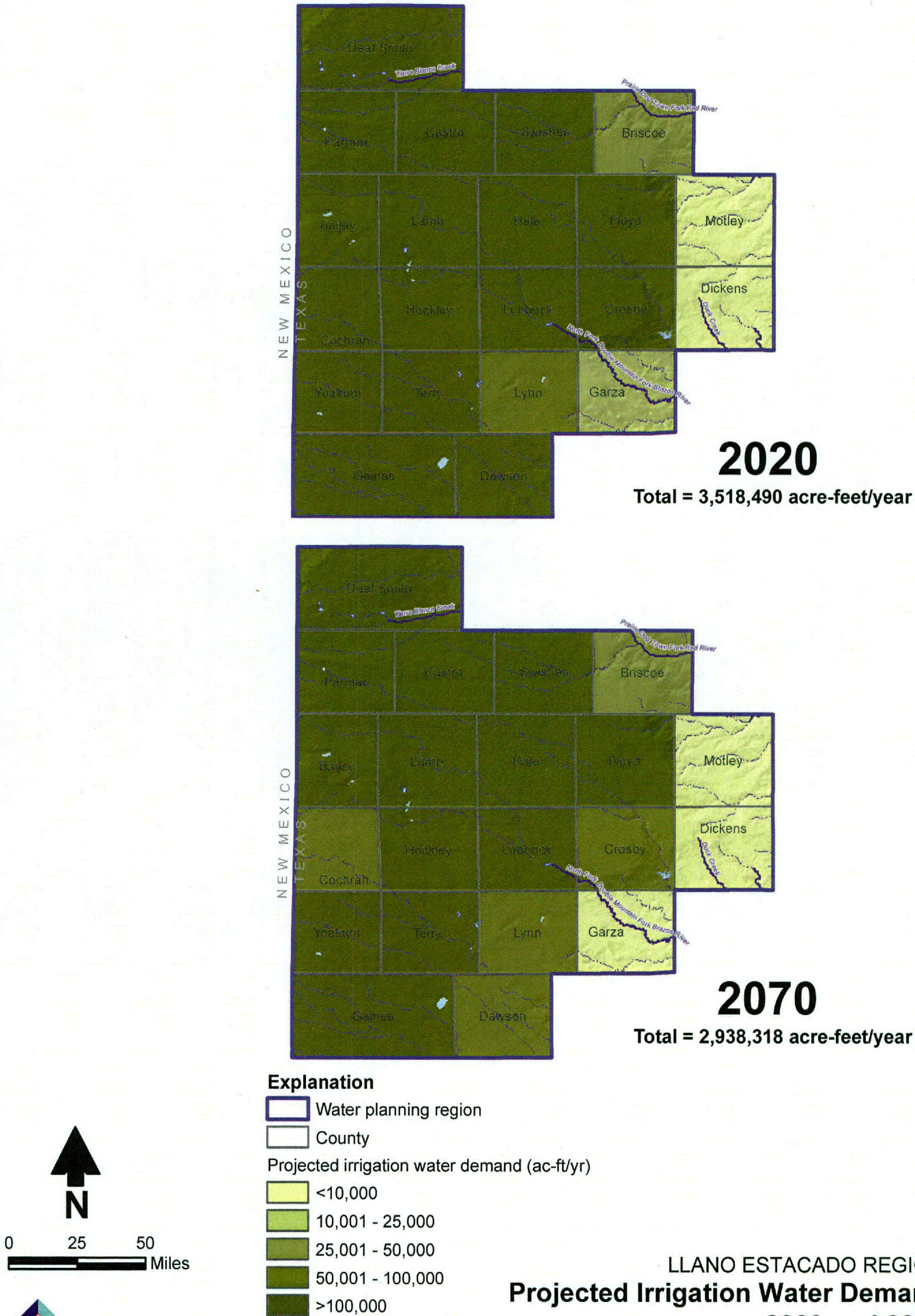
Region O Irrigation Water Demand Projections

Figure 2-14



LLANO ESTACADO REGION
Projected Irrigation Water Demand 2020 and 2070

Figure 2-15

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9/30/2015
JN WR11.0030

Table 2-20. Irrigation Water Demand Projections by County

County	Projected Water Demand by Decade (acre-feet per year)					
	2020	2030	2040	2050	2060	2070
Bailey	119,268	116,407	113,614	110,888	108,227	105,752
Briscoe	37,260	35,908	34,604	33,348	32,137	31,052
Castro	387,976	373,101	358,796	345,040	331,812	320,029
Cochran	102,229	98,284	94,489	90,841	87,334	84,214
Crosby	117,362	112,634	108,095	103,742	99,564	95,864
Dawson	106,630	100,619	94,945	89,594	84,544	80,286
Deaf Smith	193,410	187,282	181,349	175,604	170,041	164,985
Dickens	9,363	9,085	8,814	8,550	8,293	8,060
Floyd	147,725	141,841	136,191	130,767	125,559	120,941
Gaines	379,779	360,000	341,251	323,477	306,629	292,238
Garza	11,621	10,937	10,299	9,697	9,130	8,655
Hale	369,812	357,560	345,713	334,258	323,183	313,161
Hockley	131,207	126,077	121,146	116,409	111,858	107,813
Lamb	325,356	312,802	300,732	289,129	277,974	268,045
Lubbock	169,242	159,740	150,773	142,310	134,322	127,582
Lynn	84,566	80,019	75,711	71,641	67,790	64,515
Motley	9,439	9,159	8,884	8,617	8,359	8,123
Parmer	329,806	326,305	322,840	319,413	316,021	312,736
Swisher	196,895	203,171	202,011	200,857	199,709	198,581
Terry	143,461	136,107	129,129	122,508	116,226	110,848
Yoakum	146,083	139,091	132,435	126,095	120,060	114,838
Total	3,518,490	3,396,129	3,271,821	3,152,785	3,038,772	2,938,318

Table 2-21. Irrigation Water Demand Projections by River Basin

River Basin	Projected Water Demand by Decade (acre-feet per year)					
	2020	2030	2040	2050	2060	2070
Brazos	1,992,706	1,924,710	1,858,108	1,794,143	1,732,694	1,678,076
Canadian	1,934	1,873	1,813	1,756	1,700	1,650
Colorado	815,531	773,883	734,371	696,886	661,325	630,876
Red	708,319	695,663	677,529	660,000	643,053	627,716
Total	3,518,490	3,396,129	3,271,821	3,152,785	3,038,772	2,938,318

In Region O, the water demand for livestock use is projected to increase by 30 percent, from 38,828 ac-ft/yr in 2020 to 50,617 ac-ft/yr in 2070. Figure 2-16 shows Region O's livestock water demand projections over the planning period.

While all 21 counties in the region have livestock water demand for all projected decades, Deaf Smith County is projected to be the largest livestock water user, representing approximately 32 percent of the region's livestock demand. Figure 2-17 shows the projected livestock water demand by county for 2020 and 2070. Tables 2-22 and 2-23 show livestock water demand projections from 2020 to 2070 by county and by river basin, respectively.

2.2.5 Wholesale Water Provider Demand Projections

There are four wholesale water providers that supply water to WUGs within Region O:

- *Canadian River Municipal Water Authority (CRMWA):* Supplies water to eight entities in Region O and to three entities located in Region A, and is the sole source of water supply for Levelland, O'Donnell, Slaton, and Tahoka.
- *City of Lubbock:* Supplies water to four entities in Region O, in addition to the population supplied directly by the city's water system.
- *Mackenzie Municipal Water Authority:* Supplies water to four entities in Region O, and is the sole source of water supply for Silverton.
- *White River Municipal Water District:* Supplies water to four entities in Region O, and is the sole source of water supply for Ralls and Spur.

Table 2-24 provides the contractual obligations and projected demands for each Region O WUG that is a customer to a wholesale water provider. The projected demands shown in Table 2-24 are for municipal use and are presented by county and river basin as required by 31 TAC §357.31(b).

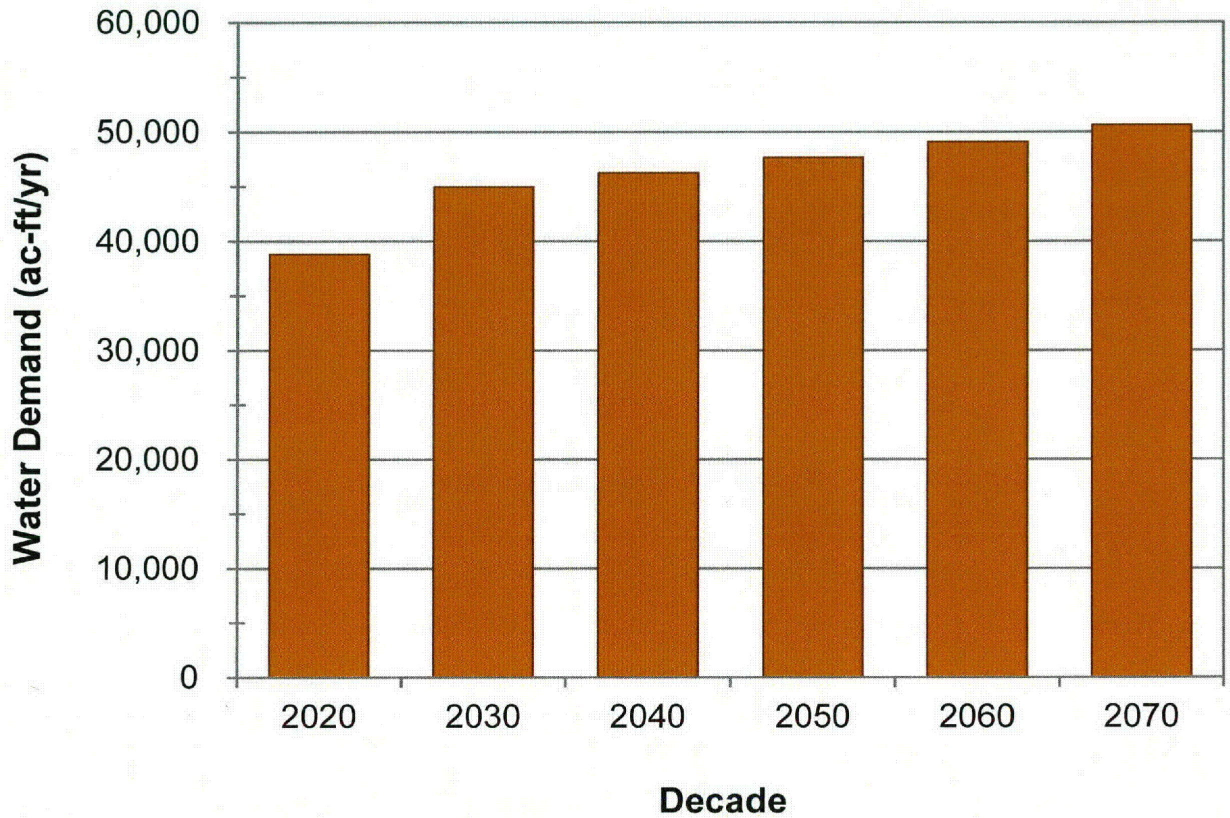


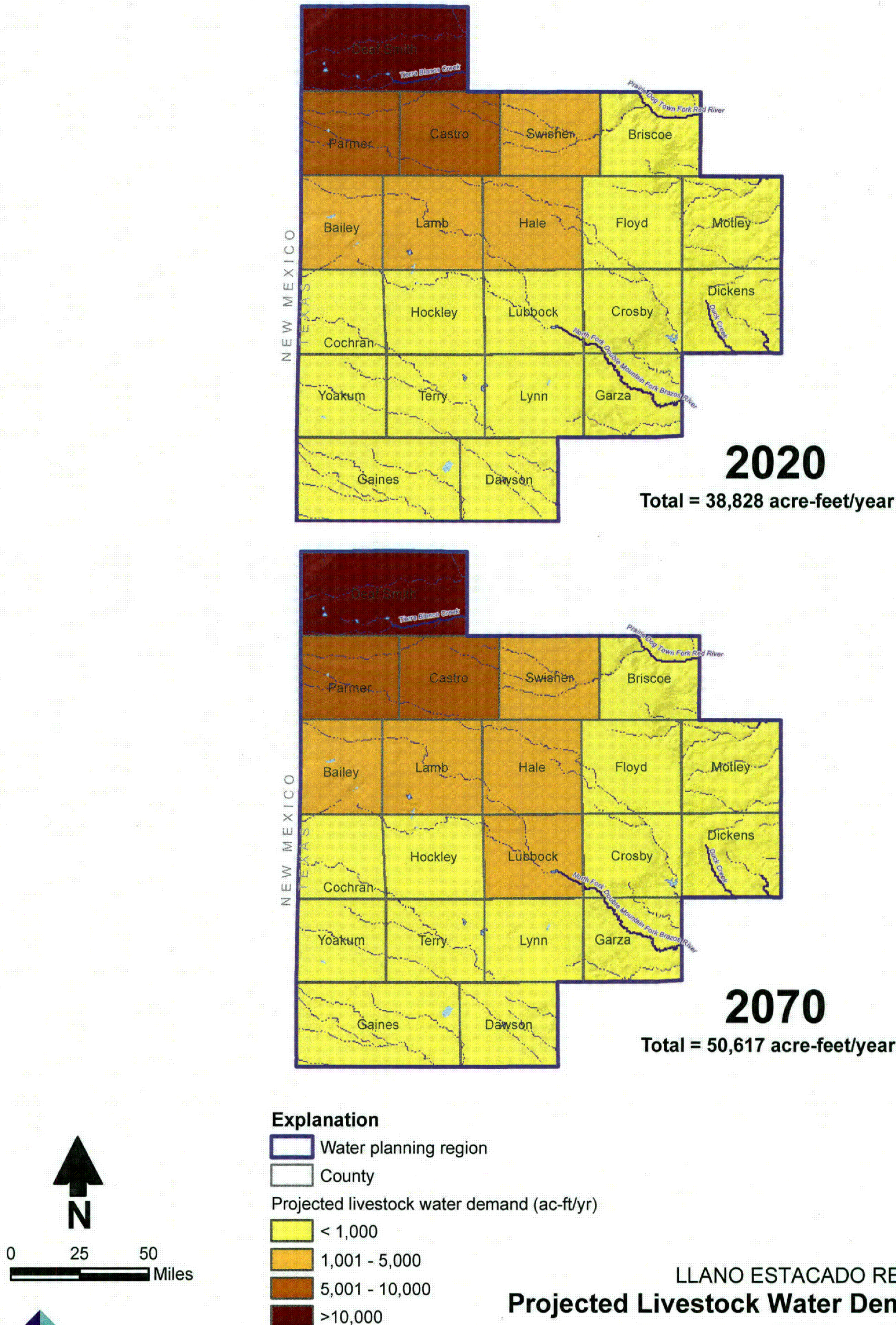
Figure 2-16

LLANO ESTACADO REGION

Region O Livestock Water Demand Projections

Daniel B. Stephens & Associates, Inc.

10/13/15



LLANO ESTACADO REGION
Projected Livestock Water Demand 2020 and 2070

Figure 2-17

Daniel B. Stephens & Associates, Inc.
9/30/2015
JN WR11.0030

S:\PROJECTS\WR11.0030_REGION_O_WATER_PLAN_FOR_TWDB\GIS\MXDS\FIGURES\SECTION_2\FIG_2-17_WATERDEMAND_2020_2070_LIVESTOCK.MXD

Table 2-22. Livestock Water Demand Projections by County

County	Projected Water Demand by Decade (acre-feet per year)					
	2020	2030	2040	2050	2060	2070
Bailey	2,335	3,013	3,057	3,104	3,153	3,204
Briscoe	302	310	319	328	338	348
Castro	5,848	7,120	7,290	7,468	7,655	7,851
Cochran	536	562	590	620	651	684
Crosby	262	268	274	281	287	294
Dawson	139	143	147	151	155	159
Deaf Smith	12,555	14,304	14,807	15,335	15,889	16,471
Dickens	375	383	392	402	412	422
Floyd	738	775	814	854	897	942
Gaines	238	250	262	276	289	304
Garza	299	305	312	320	328	346
Hale	2,045	2,660	2,697	2,736	2,778	2,821
Hockley	238	250	262	276	289	304
Lamb	2,969	3,136	3,204	3,275	3,349	3,427
Lubbock	780	887	918	951	985	1,021
Lynn	141	146	150	155	160	165
Motley	481	490	499	509	519	529
Parmer	5,634	6,908	7,067	7,234	7,409	7,593
Swisher	2,362	2,481	2,605	2,735	2,872	3,015
Terry	270	288	309	332	356	395
Yoakum	281	286	290	296	301	322
Total	38,828	44,965	46,265	47,638	49,072	50,617

Table 2-23. Livestock Water Demand Projections by River Basin

River Basin	Projected Water Demand by Decade (acre-feet per year)					
	2020	2030	2040	2050	2060	2070
Brazos	19,131	22,737	23,259	23,809	24,385	25,000
Canadian	126	143	148	153	159	165
Colorado	1,127	1,175	1,227	1,284	1,341	1,431
Red	18,444	20,910	21,631	22,392	23,187	24,021
Total	38,828	44,965	46,265	47,638	49,072	50,617

Table 2-24. Municipal Water Demand Projections by Wholesale Water Provider Customer
Page 1 of 2

Wholesale Water Provider Customer	River Basin	County	Contract Obligation (ac-ft/yr)	Projected Water Demand by Decade [a] (ac-ft/yr)					
				2020	2020	2020	2020	2020	2020
Canadian River Municipal Water Authority									
Amarillo (Region A)	Canadian	Potter	46,696	15,884	17,294	18,856	20,510	22,424	24,462
	Red	Potter		10,458	11,386	12,414	13,504	14,764	16,106
		Randall		21,389	23,430	25,540	27,846	30,443	33,171
Borger (Region A)	Canadian	Hutchinson	7,001	3,215	3,254	3,234	3,229	3,225	3,224
Brownfield	Colorado	Terry	2,766	1,793	1,854	1,923	2,000	2,087	2,172
Lamesa	Colorado	Dawson	2,758	2,275	2,303	2,314	2,319	2,382	2,425
Levelland	Brazos	Hockley	3,504	2,442	2,521	2,554	2,547	2,655	2,727
Lubbock	Brazos	Lubbock	46,696	45,623	49,424	53,437	58,113	62,886	67,703
O'Donnell	Brazos	Dawson	355	18	18	19	19	20	20
		Lynn		105	106	105	104	109	111
Pampa (Region A)	Canadian	Gray	9,028	3,711	3,991	4,360	4,926	5,377	5,855
Plainview	Brazos	Hale	4,648	4,368	4,441	4,427	4,344	4,449	4,496
Slaton	Brazos	Lubbock	1,984	746	726	712	711	718	726
Tahoka	Brazos	Lynn	572	478	488	478	472	494	505
		Region A subtotal	62,725	54,657	59,355	64,404	70,015	76,233	82,818
		Region O subtotal	63,283	57,848	61,881	65,969	70,629	75,800	80,885
		Total	126,008	112,505	121,236	130,373	140,644	152,033	163,703
City of Lubbock									
Buffalo Springs Lake [b]	Brazos	Lubbock	806	806	806	806	806	806	806
Lubbock	Brazos	Lubbock	NA	45,623	49,424	53,437	58,113	62,886	67,703

[a] Calculated from the per capita water use (GPCD) for water user group (WUG) customer's entire population, unless otherwise noted. WUGs may have additional source(s) of supply.
[b] Projected water demand based on contract amount.
[c] Projected water demand based on recent water use amount.

Table 2-24. Municipal Water Demand Projections by Wholesale Water Provider Customer
Page 2 of 2

Wholesale Water Provider Customer	River Basin	County	Contract Obligation (ac-ft/yr)	Projected Water Demand by Decade [a] (ac-ft/yr)					
				2020	2020	2020	2020	2020	2020
City of Lubbock (cont.)									
Ransom Canyon	Brazos	Lubbock	1,512	337	356	377	401	424	448
Shallowater	Brazos	Lubbock	250	422	464	507	558	610	662
South Garza Water System [c]	Brazos	Garza	520	25	25	25	25	25	25
		Total	3,088	47,213	51,075	55,152	59,903	64,751	69,644
Mackenzie Municipal Water Authority									
Floydada	Brazos	Floyd	155	572	589	603	625	643	658
Lockney	Brazos	Floyd	75	268	274	276	286	294	300
Silverton	Red	Briscoe	123	126	123	120	119	119	119
Tulia	Red	Swisher	210	926	945	938	924	967	989
		Total	563	1,892	1,931	1,937	1,954	2,023	2,066
White River Municipal Water District									
Crosbyton	Brazos	Crosby	179	294	306	316	332	351	367
Post	Brazos	Garza	414	792	828	861	884	928	965
Ralls	Brazos	Crosby	202	313	324	333	347	364	381
Spur	Brazos	Dickens	224	178	173	171	170	170	170
		Total	1,019	1,577	1,631	1,681	1,733	1,813	1,883

[a] Calculated from the per capita water use (GPCD) for water user group (WUG) customer's entire population, unless otherwise noted. WUGs may have additional source(s) of supply.
[b] Projected water demand based on contract amount.
[c] Projected water demand based on recent water use amount.

References

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TWDB. 2014. County-other systems in Region O. Spreadsheet obtained from Sarah Backhouse, TWDB Regional Water Planning Project Manager. July 30, 2014.

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Appendix 2A

TCEQ List of Small Public Water Supply Systems

Appendix 2A. TCEQ List of Small Public Water Supply Systems

Table 2-6 of the regional water plan lists the urban areas with a population of less than 500 that were included in the County-other category and used in developing demand projections. Members of the LERWPG noticed differences between this table and the list of small systems that TCEQ maintains; this appendix presents the TCEQ list and explains the differences between the two.

The TWDB County-other list (Table 2-6) includes some large municipal water user groups (WUGs) that are not included on the TCEQ list; these reflect areas served by the WUGs that are outside city limits and are therefore included by the TWDB in the County-other category (the population served by the WUGs that are within city limits have not been accounted for in the County-other category).

Systems that are included on the TCEQ list but not the TWDB list include most mobile home parks and non-community water systems, which are not surveyed by TWDB (TWDB focuses their water use survey on community public water systems). Some of the systems not surveyed by TWDB as part of the 2016 regional water planning cycle will be added during the next planning cycle, including:

- City of Ackerly (Dawson County)
- McAdoo WSC (Dickens County)
- Grubs Water Supply (Garza County)
- Whitharral WSC (Hockley County)
- Franklin Water Systems 1 and 3 (Lubbock County)

The other systems that are included on the TCEQ list but are not surveyed by the TWDB include:

- Texas Great Plains WSC (Gaines County, Wholesale PWS)
- Gaines County Water Company (Gaines County, Wholesale PWS)
- South Haven MHP (Hale County)
- Grand Castle Estates (Hale County)
- Triple J Mobile Home Park (Hale County)
- Hidden Tree Ranch (Lubbock County)
- Family Community Center MHP (Lubbock County)
- Green Mobile Home Park (Lubbock County)
- Pecan Grove Mobile Home Park (Lubbock County)
- Wildwood Mobile Home Village (Lubbock County)
- Fort Jackson Mobile Estates (Lubbock County)
- 114th Street Mobile Home Park (Lubbock County)
- Elm Grove Mobile Home Park (Lubbock County)
- Miller Mobile Home Park (Lubbock County)

Source: Kluge, 2015

- Seven Estates (Lubbock County)
- Terrells Mobile Home Park (Lubbock County)
- Country View MHP (Lubbock County)
- Cabazos Homes (Lubbock County)
- Southwest Garden Water (Lubbock County)
- Christian Life Center (Lubbock County)
- Fuller Mobile Home Park (Lubbock County)
- Heartland House (Lubbock County)

The TWDB accounts for the total County populations in their demand projections, so even though these systems were not included in the County-other category, the County-other projections do account for their populations.

Source: Kluge, 2015

TCEQ List of Region O Public Water Supply Systems Serving Populations of less than 500

Systems by County	Water System Number
Bailey	
Maple WSC	TX0090011
MINSA CORPORATION	TX0090019
Briscoe	
CITY OF QUITAQUE	TX0230002
CORONADO SHORES WATER SYSTEM	TX0230005
TPWD CAPROCK CANYON STATE PARK	TX0230003
Castro	
NAZARETH MUNICIPAL WATER SYSTEM	TX0350003
Cochran	
CITY OF WHITEFACE	TX0400002
GIRLSTOWN USA	TX0400003
BLEDSOE WSC	TX0400012
Crosby	
TXDOT CROSBYTON REST AREA	TX0540004
CAMP RIO BLANCO	TX0540005
CONE WSC	TX0540017
RIO BLANCA ESTATES	TX0540026
Dawson	
CITY OF ACKERLY	TX0580011
WELCH WSC	TX0580013
KLONDIKE ISD	TX0580025
Deaf Smith	
DEAF SMITH COUNTY FWSD 1	TX0590002
WALCOTT ISD	TX0590006
HEREFORD RENEWABLE ENERGY	TX0590012
TEJAS INDUSTRIES EAST PLANT	TX0590013
TEJAS INDUSTRIES DISTRIBUTION CENTER	TX0590014
Dickens	
CITY OF DICKENS	TX0630001
MCADOO WSC	TX0630011
VALLEY WSC	TX0630013
Floyd	
DOUGHERTY WATER WORKS	TX0770013

Source: TCEQ, 2015

TCEQ List of Region O Public Water Supply Systems
Serving Populations of less than 500

Systems by County	Water System Number
Gaines	
LOOP WSC	TX0830011
GAINES COUNTY PARK	TX0830018
GAINES COUNTY GOLF COURSE	TX0830019
TEXLAND GREAT PLAINS WSC	TX0830023
SEMINOLE GAS PROCESSING PLANT	TX0830031
H & H RV PARK	TX0830036
GAINES COUNTY WATER COMPANY	TX0830037
Garza	
SOUTHLAND ISD	TX0850002
GRUBS WATER SUPPLY	TX0850012
SOUTH GARZA WSC	TX0850014
LAKE ALAN HENRY BOAT & RV PARK	TX0850016
REEDS RV PARK	TX0850020
ZISKAS ON THE BRAZOS CORNER STORE	TX0850021
Hale	
COTTON CENTER WSC	TX0950014
CITY OF EDMONSON	TX0950015
HALFWAY WSC	TX0950016
SOUTH HAVEN MHP	TX0950047
TUNE MAYFIELD CAMP	TX0950049
DUPONT PIONEER	TX0950057
LOMA ALTA WSC	TX0950059
TXDOT HALE COUNTY SRA	TX0950066
AZTECA MILLING PLAINVIEW PLANT	TX0950067
GRAND CASTLE ESTATES	TX0950070
TRIPLE J MOBILE HOME PARK	TX0950071
PLAINVIEW BIOENERGY	TX0950073
PLAINVIEW SERENITY CENTER	TX0950074
Hockley	
CITY OF ROPESVILLE	TX1100004
PEP ALTER COOP HWY 303	TX1100005
CITY OF SMYER	TX1100010
WHITHARRAL WSC	TX1100011
OCCIDENTAL PERMIAN E SLAUGHTER	TX1100017
OCCIDENTAL PERMIAN LTD SOUTH PLAINS RMT	TX1100019
OCCIDENTAL PERMIAN SLAUGHTER GASOLINE PL	TX1100022
CITY OF OPDYKE WEST	TX1100030
WAYNEBOS STORE	TX1100034
OCCIDENTAL PERMIAN MALLET PLANT	TX1100039
WORLEY WELDING WORKS	TX1100040

Source: TCEQ, 2015

TCEQ List of Region O Public Water Supply Systems Serving Populations of less than 500

Systems by County	Water System Number
Lamb	
CITY OF SPRINGLAKE	TX1400007
SPADE WSC	TX1400010
SPRINGLAKE EARTH ISD	TX1400012
PLANT X POWER PLANT	TX1400013
TOLK STATION POWER PLANT	TX1400025
ALLSUPS 256	TX1400026
SUNNYDALE WSC	TX1400027
Lubbock	
LUBBOCK COUNTY WCID 1	TX1520006
HIDDEN TREE RANCH	TX1520009
FAMILY COMMUNITY CENTER MHP	TX1520026
WAYNES LIQUOR STORE	TX1520031
GREEN MOBILE HOME PARK	TX1520036
PECAN GROVE MOBILE HOME PARK	TX1520039
WILDWOOD MOBILE HOME VILLAGE	TX1520046
PLOTT ACRES	TX1520062
FORT JACKSON MOBILE ESTATES	TX1520064
114TH STREET MOBILE HOME PARK	TX1520067
TEXAS BOYS RANCH	TX1520072
TEXAS TECH NEW DEAL RESEARCH FARM	TX1520079
FRANKLIN WATER SYSTEMS 3	TX1520080
TOWN NORTH VILLAGE WATER SYSTEM	TX1520094
WOODYS GENERAL STORE	TX1520103
LUBBOCK KOA CAMPGROUND	TX1520104
COX ADDITION WATER SYSTEM	TX1520106
ACUFF STEAK HOUSE	TX1520120
SPIRIT RANCH	TX1520128
PINKIES MINI MART 53	TX1520135
SHORT ROAD WATER SUPPLY	TX1520147
WHORTON MOBILE HOME PARK	TX1520149
TOWN NORTH ESTATES	TX1520152
CHARLIE BROWNS LEARNING CENTER	TX1520154
ELM GROVE MOBILE HOME PARK	TX1520156
LUBBOCK WATER RAMPAGE	TX1520157
MILLER MOBILE HOME PARK	TX1520158
ADVENTURES USA	TX1520163
TECH CAFÉ	TX1520184
LUBBOCK RV PARK	TX1520185
SEVEN ESTATES	TX1520188
DAVES ROOFING SIDING & METAL BLDG	TX1520189
TERRELLS MOBILE HOME PARK	TX1520192
VALLEY ESTATES	TX1520198
GOULDS PUMPS	TX1520235

Source: TCEQ, 2015

TCEQ List of Region O Public Water Supply Systems
Serving Populations of less than 500

Systems by County	Water System Number
Lubbock (continued)	
PRATERS FOODS	TX1520236
STONE GATE GOLF COURSE	TX1520239
MANAGED CARE CENTER FOR ADDICTIVE AND OT	TX1520241
LUBBOCK STOCKYARD	TX1520242
COUNTRY VIEW MHP	TX1520247
SCOTT MANUFACTURING	TX1520250
MI TACO VILLAGE	TX1520251
STARS & STRIPES DRIVE-IN THEATER	TX1520252
JAGUARS GOLD CLUB LUBBOCK	TX1520263
CASH REGISTER SERVICES	TX1520265
THE RANCH AT DOVE TREE - THE NEST	TX1520266
CABAZOS HOMES	TX1520269
THUNDER ZONE FAMILY FUN	TX1520272
THE SHACK	TX1520273
PROFAB	TX1520274
AFFORDABLE RV STORAGE AND SHOPS	TX1520279
DAVE N DONS PIT N BBQ PATIO	TX1520281
WOLFFORTH PLACE	TX1520199
PINKIES MINI MART 51	TX1520204
BERNARDS LIQUOR STORE	TX1520208
APPLES PIZZA DELI	TX1520210
SHALLOWATER TRUCK STOP	TX1520212
SOUTHWEST GARDEN WATER	TX1520217
CHRISTIAN LIFE CENTER	TX1520219
COOPER DRIVE IN	TX1520222
FRANKLIN WATER SYSTEMS 1	TX1520224
FAY BEN MOBILE HOME PARK	TX1520225
FULLER MOBILE HOME PARK	TX1520232
RICKS CABARET	TX1520283
THE RANGE	TX1520284
DOLLAR GENERAL STORE 14889	TX1520286
SONNYS MART	TX1520287
LUBBOCK INDOOR COURTS	TX1520288
HEARTLAND HOUSE	TX1520292
DOLLAR GENERAL STORE 14227	TX1520293
SOCCER INDOORS	TX1520296
LUBBOCK COOPER STORAGE	TX1520297
Lynn	
POKA LAMBRO TELEPHONE HEADQUARTERS	TX1530011
GRASSLAND WSC	TX1530005
CITY OF NEW HOME	TX1530004
CITY OF WILSON	TX1530003

Source: TCEQ, 2015

TCEQ List of Region O Public Water Supply Systems Serving Populations of less than 500

Systems by County	Water System Number
Motley	
CITY OF ROARING SPRINGS	TX1730002
FLOMOT WATER ASSOCIATION	TX1730003
Parmer	
LAZBUDDIE ISD	TX1850023
Swisher	
NONE	
Terry	
CITY OF WELLMAN	TX2230003
Yoakum	
YOAKUM COUNTY PARK & GOLF COURSE	TX2510010
WASSON CO2 RECOVERY PLANT	TX2510023
MUSTANG STATION WS	TX2510025

Source: TCEQ, 2015

Appendix 2B

Water User Group Population

Water User Group (WUG) Population

REGION O	WUG POPULATION					
	2020	2030	2040	2050	2060	2070
BAILEY COUNTY						
BRAZOS BASIN						
MULESHOE	5,769	6,452	7,131	7,833	8,527	9,208
COUNTY-OTHER	2,243	2,510	2,775	3,047	3,317	3,582
BRAZOS BASIN TOTAL POPULATION	**8,012**	**8,962**	**9,906**	**10,880**	**11,844**	**12,790**
BAILEY COUNTY TOTAL POPULATION	**8,012**	**8,962**	**9,906**	**10,880**	**11,844**	**12,790**
BRISCOE COUNTY						
RED BASIN						
SILVERTON	741	742	742	742	742	742
COUNTY-OTHER	932	931	931	931	931	931
RED BASIN TOTAL POPULATION	**1,673**	**1,673**	**1,673**	**1,673**	**1,673**	**1,673**
BRISCOE COUNTY TOTAL POPULATION	**1,673**	**1,673**	**1,673**	**1,673**	**1,673**	**1,673**
CASTRO COUNTY						
BRAZOS BASIN						
DIMMITT	4,845	5,259	5,555	5,830	6,044	6,216
HART	1,229	1,334	1,409	1,479	1,533	1,577
COUNTY-OTHER	1,343	1,458	1,541	1,616	1,676	1,724
BRAZOS BASIN TOTAL POPULATION	**7,417**	**8,051**	**8,505**	**8,925**	**9,253**	**9,517**
RED BASIN						
COUNTY-OTHER	1,473	1,599	1,689	1,773	1,838	1,890
RED BASIN TOTAL POPULATION	**1,473**	**1,599**	**1,689**	**1,773**	**1,838**	**1,890**
CASTRO COUNTY TOTAL POPULATION	**8,890**	**9,650**	**10,194**	**10,698**	**11,091**	**11,407**
COCHRAN COUNTY						
BRAZOS BASIN						
MORTON	2,150	2,206	2,197	2,148	2,198	2,212
COUNTY-OTHER	1,009	1,130	1,167	1,170	1,215	1,233
BRAZOS BASIN TOTAL POPULATION	**3,159**	**3,336**	**3,364**	**3,318**	**3,413**	**3,445**
COLORADO BASIN						
COUNTY-OTHER	332	351	353	349	359	362
COLORADO BASIN TOTAL POPULATION	**332**	**351**	**353**	**349**	**359**	**362**
COCHRAN COUNTY TOTAL POPULATION	**3,491**	**3,687**	**3,717**	**3,667**	**3,772**	**3,807**
CROSBY COUNTY						
BRAZOS BASIN						
CROSBYTON	1,876	2,018	2,136	2,256	2,385	2,501
LORENZO	1,258	1,377	1,477	1,580	1,701	1,783
RALLS	2,083	2,231	2,352	2,474	2,600	2,727
COUNTY-OTHER	1,303	1,391	1,462	1,533	1,606	1,696
BRAZOS BASIN TOTAL POPULATION	**6,520**	**7,017**	**7,427**	**7,843**	**8,292**	**8,707**
RED BASIN						
COUNTY-OTHER	6	6	6	7	7	8

Water User Group (WUG) Population

REGION O	WUG POPULATION					
	2020	2030	2040	2050	2060	2070
CROSBY COUNTY						
RED BASIN TOTAL POPULATION	**6**	**6**	**6**	**7**	**7**	**8**
CROSBY COUNTY TOTAL POPULATION	**6,526**	**7,023**	**7,433**	**7,850**	**8,299**	**8,715**
DAWSON COUNTY						
BRAZOS BASIN						
O'DONNELL	127	133	138	141	147	150
COUNTY-OTHER	31	34	35	35	36	38
BRAZOS BASIN TOTAL POPULATION	**158**	**167**	**173**	**176**	**183**	**188**
COLORADO BASIN						
LAMESA	9,903	10,251	10,490	10,535	10,840	11,039
COUNTY-OTHER	4,746	5,159	5,514	5,729	6,075	6,348
COLORADO BASIN TOTAL POPULATION	**14,649**	**15,410**	**16,004**	**16,264**	**16,915**	**17,387**
DAWSON COUNTY TOTAL POPULATION	**14,807**	**15,577**	**16,177**	**16,440**	**17,098**	**17,575**
DEAF SMITH COUNTY						
CANADIAN BASIN						
COUNTY-OTHER	8	9	11	12	14	15
CANADIAN BASIN TOTAL POPULATION	**8**	**9**	**11**	**12**	**14**	**15**
RED BASIN						
HEREFORD	17,576	20,291	23,258	26,623	29,267	32,158
COUNTY-OTHER	4,567	5,273	6,045	6,919	7,606	8,358
RED BASIN TOTAL POPULATION	**22,143**	**25,564**	**29,303**	**33,542**	**36,873**	**40,516**
DEAF SMITH COUNTY TOTAL POPULATION	**22,151**	**25,573**	**29,314**	**33,554**	**36,887**	**40,531**
DICKENS COUNTY						
BRAZOS BASIN						
SPUR	1,029	1,029	1,029	1,029	1,029	1,029
COUNTY-OTHER	906	906	906	906	906	906
BRAZOS BASIN TOTAL POPULATION	**1,935**	**1,935**	**1,935**	**1,935**	**1,935**	**1,935**
RED BASIN						
COUNTY-OTHER	229	229	229	229	229	229
RED BASIN TOTAL POPULATION	**229**	**229**	**229**	**229**	**229**	**229**
DICKENS COUNTY TOTAL POPULATION	**2,164**	**2,164**	**2,164**	**2,164**	**2,164**	**2,164**
FLOYD COUNTY						
BRAZOS BASIN						
FLOYDADA	3,242	3,447	3,577	3,718	3,828	3,920
LOCKNEY	1,963	2,085	2,162	2,245	2,310	2,364
COUNTY-OTHER	1,136	1,201	1,243	1,287	1,322	1,350
BRAZOS BASIN TOTAL POPULATION	**6,341**	**6,733**	**6,982**	**7,250**	**7,460**	**7,634**
RED BASIN						
COUNTY-OTHER	528	561	581	604	621	636
RED BASIN TOTAL POPULATION	**528**	**561**	**581**	**604**	**621**	**636**
FLOYD COUNTY TOTAL POPULATION	**6,869**	**7,294**	**7,563**	**7,854**	**8,081**	**8,270**

Water User Group (WUG) Population

REGION O	WUG POPULATION					
	2020	2030	2040	2050	2060	2070
GAINES COUNTY						
COLORADO BASIN						
SEAGRAVES	2,536	2,677	2,847	3,034	3,137	3,245
SEMINOLE	7,102	7,893	8,834	9,855	10,648	11,475
COUNTY-OTHER	11,678	15,176	19,316	23,765	27,881	32,166
COLORADO BASIN TOTAL POPULATION	**21,316**	**25,746**	**30,997**	**36,654**	**41,666**	**46,886**
GAINES COUNTY TOTAL POPULATION	**21,316**	**25,746**	**30,997**	**36,654**	**41,666**	**46,886**
GARZA COUNTY						
BRAZOS BASIN						
POST	6,012	6,452	6,841	7,098	7,466	7,770
COUNTY-OTHER	1,065	1,058	1,058	1,068	1,103	1,135
BRAZOS BASIN TOTAL POPULATION	**7,077**	**7,510**	**7,899**	**8,166**	**8,569**	**8,905**
GARZA COUNTY TOTAL POPULATION	**7,077**	**7,510**	**7,899**	**8,166**	**8,569**	**8,905**
HALE COUNTY						
BRAZOS BASIN						
ABERNATHY	2,227	2,323	2,363	2,343	2,405	2,430
HALE CENTER	2,380	2,482	2,524	2,503	2,569	2,597
PETERSBURG	1,270	1,325	1,348	1,336	1,371	1,386
PLAINVIEW	23,443	24,453	24,870	24,662	25,312	25,585
COUNTY-OTHER	8,994	9,382	9,542	9,463	9,712	9,816
BRAZOS BASIN TOTAL POPULATION	**38,314**	**39,965**	**40,647**	**40,307**	**41,369**	**41,814**
HALE COUNTY TOTAL POPULATION	**38,314**	**39,965**	**40,647**	**40,307**	**41,369**	**41,814**
HOCKLEY COUNTY						
BRAZOS BASIN						
ANTON	1,235	1,313	1,361	1,370	1,431	1,470
LEVELLAND	14,839	15,785	16,359	16,467	17,202	17,676
COUNTY-OTHER	7,273	7,739	8,021	8,072	8,433	8,665
BRAZOS BASIN TOTAL POPULATION	**23,347**	**24,837**	**25,741**	**25,909**	**27,066**	**27,811**
COLORADO BASIN						
SUNDOWN	1,531	1,629	1,688	1,699	1,775	1,824
COUNTY-OTHER	252	268	278	280	293	300
COLORADO BASIN TOTAL POPULATION	**1,783**	**1,897**	**1,966**	**1,979**	**2,068**	**2,124**
HOCKLEY COUNTY TOTAL POPULATION	**25,130**	**26,734**	**27,707**	**27,888**	**29,134**	**29,935**
LAMB COUNTY						
BRAZOS BASIN						
AMHERST	796	873	926	959	1,014	1,055
EARTH	1,099	1,125	1,131	1,118	1,134	1,137
LITTLEFIELD	6,406	6,366	6,249	6,034	5,984	5,874
OLTON	2,261	2,286	2,277	2,229	2,240	2,228
SUDAN	1,042	1,127	1,182	1,213	1,273	1,316

Water User Group (WUG) Population

REGION O	WUG POPULATION					
	2020	2030	2040	2050	2060	2070
LAMB COUNTY						
BRAZOS BASIN						
COUNTY-OTHER	3,011	3,398	3,673	3,866	4,146	4,365
BRAZOS BASIN TOTAL POPULATION	**14,615**	**15,175**	**15,438**	**15,419**	**15,791**	**15,975**
LAMB COUNTY TOTAL POPULATION	**14,615**	**15,175**	**15,438**	**15,419**	**15,791**	**15,975**
LUBBOCK COUNTY						
BRAZOS BASIN						
ABERNATHY	774	860	946	1,037	1,124	1,210
IDALOU	2,341	2,446	2,555	2,676	2,783	2,889
LUBBOCK	255,257	283,597	312,043	342,371	371,227	399,846
NEW DEAL	869	951	1,036	1,125	1,210	1,294
RANSOM CANYON	1,172	1,258	1,345	1,439	1,526	1,613
SHALLOWATER	2,817	3,188	3,558	3,951	4,329	4,703
SLATON	6,179	6,257	6,352	6,467	6,547	6,621
WOLFFORTH	4,577	5,577	6,569	7,614	8,633	9,647
COUNTY-OTHER	35,783	39,843	43,916	48,258	52,391	56,493
BRAZOS BASIN TOTAL POPULATION	**309,769**	**343,977**	**378,320**	**414,938**	**449,770**	**484,316**
LUBBOCK COUNTY TOTAL POPULATION	**309,769**	**343,977**	**378,320**	**414,938**	**449,770**	**484,316**
LYNN COUNTY						
BRAZOS BASIN						
O'DONNELL	757	797	799	795	835	853
TAHOKA	2,838	2,985	2,994	2,980	3,129	3,197
COUNTY-OTHER	2,603	2,738	2,745	2,734	2,871	2,933
BRAZOS BASIN TOTAL POPULATION	**6,198**	**6,520**	**6,538**	**6,509**	**6,835**	**6,983**
COLORADO BASIN						
COUNTY-OTHER	81	85	86	85	89	91
COLORADO BASIN TOTAL POPULATION	**81**	**85**	**86**	**85**	**89**	**91**
LYNN COUNTY TOTAL POPULATION	**6,279**	**6,605**	**6,624**	**6,594**	**6,924**	**7,074**
MOTLEY COUNTY						
RED BASIN						
MATADOR	609	609	609	609	609	609
COUNTY-OTHER	603	603	603	603	603	603
RED BASIN TOTAL POPULATION	**1,212**	**1,212**	**1,212**	**1,212**	**1,212**	**1,212**
MOTLEY COUNTY TOTAL POPULATION	**1,212**	**1,212**	**1,212**	**1,212**	**1,212**	**1,212**
PARMER COUNTY						
BRAZOS BASIN						
BOVINA	2,079	2,301	2,502	2,697	2,927	3,137
FARWELL	1,517	1,679	1,825	1,969	2,136	2,289
COUNTY-OTHER	1,973	2,185	2,375	2,562	2,781	2,980
BRAZOS BASIN TOTAL POPULATION	**5,569**	**6,165**	**6,702**	**7,228**	**7,844**	**8,406**

Water User Group (WUG) Population

REGION O	WUG POPULATION					
	2020	2030	2040	2050	2060	2070
PARMER COUNTY						
RED BASIN						
FRIONA	4,587	5,079	5,520	5,953	6,462	6,924
COUNTY-OTHER	1,268	1,404	1,526	1,646	1,785	1,914
RED BASIN TOTAL POPULATION	**5,855**	**6,483**	**7,046**	**7,599**	**8,247**	**8,838**
PARMER COUNTY TOTAL POPULATION	**11,424**	**12,648**	**13,748**	**14,827**	**16,091**	**17,244**
SWISHER COUNTY						
BRAZOS BASIN						
KRESS	169	178	180	179	188	192
COUNTY-OTHER	215	226	230	228	239	245
BRAZOS BASIN TOTAL POPULATION	**384**	**404**	**410**	**407**	**427**	**437**
RED BASIN						
HAPPY	649	682	692	687	721	738
KRESS	583	612	622	617	648	662
TULIA	5,222	5,483	5,564	5,530	5,803	5,932
COUNTY-OTHER	1,419	1,489	1,510	1,503	1,576	1,611
RED BASIN TOTAL POPULATION	**7,873**	**8,266**	**8,388**	**8,337**	**8,748**	**8,943**
SWISHER COUNTY TOTAL POPULATION	**8,257**	**8,670**	**8,798**	**8,744**	**9,175**	**9,380**
TERRY COUNTY						
BRAZOS BASIN						
COUNTY-OTHER	62	66	70	73	77	80
BRAZOS BASIN TOTAL POPULATION	**62**	**66**	**70**	**73**	**77**	**80**
COLORADO BASIN						
BROWNFIELD	10,381	11,036	11,696	12,296	12,860	13,386
MEADOW	638	678	719	756	790	822
COUNTY-OTHER	2,518	2,677	2,836	2,983	3,120	3,247
COLORADO BASIN TOTAL POPULATION	**13,537**	**14,391**	**15,251**	**16,035**	**16,770**	**17,455**
TERRY COUNTY TOTAL POPULATION	**13,599**	**14,457**	**15,321**	**16,108**	**16,847**	**17,535**
YOAKUM COUNTY						
COLORADO BASIN						
DENVER CITY	5,072	5,736	6,327	6,955	7,618	8,249
PLAINS	1,677	1,897	2,093	2,300	2,519	2,728
COUNTY-OTHER	2,171	2,456	2,708	2,977	3,264	3,534
COLORADO BASIN TOTAL POPULATION	**8,920**	**10,089**	**11,128**	**12,232**	**13,401**	**14,511**
YOAKUM COUNTY TOTAL POPULATION	**8,920**	**10,089**	**11,128**	**12,232**	**13,401**	**14,511**
REGION O TOTAL POPULATION	**540,495**	**594,391**	**645,980**	**697,869**	**750,858**	**801,719**

Appendix 2C

Water User Group Demand

Water User Group (WUG) Demand

REGION O	WUG DEMAND (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
BAILEY COUNTY						
BRAZOS BASIN						
MULESHOE	1,174	1,284	1,397	1,523	1,656	1,787
COUNTY-OTHER	277	296	321	351	381	411
MANUFACTURING	316	326	335	343	365	388
LIVESTOCK	2,335	3,013	3,057	3,104	3,153	3,204
IRRIGATION	119,268	116,407	113,614	110,888	108,227	105,752
BRAZOS BASIN TOTAL DEMAND	**123,370**	**121,326**	**118,724**	**116,209**	**113,782**	**111,542**
BAILEY COUNTY TOTAL DEMAND	**123,370**	**121,326**	**118,724**	**116,209**	**113,782**	**111,542**
BRISCOE COUNTY						
RED BASIN						
SILVERTON	126	123	120	119	119	119
COUNTY-OTHER	297	292	289	288	288	288
LIVESTOCK	302	310	319	328	338	348
IRRIGATION	37,260	35,908	34,604	33,348	32,137	31,052
RED BASIN TOTAL DEMAND	**37,985**	**36,633**	**35,332**	**34,083**	**32,882**	**31,807**
BRISCOE COUNTY TOTAL DEMAND	**37,985**	**36,633**	**35,332**	**34,083**	**32,882**	**31,807**
CASTRO COUNTY						
BRAZOS BASIN						
DIMMITT	1,096	1,164	1,210	1,260	1,304	1,341
HART	180	189	194	203	210	216
COUNTY-OTHER	196	205	213	223	231	237
MANUFACTURING	833	885	935	978	1,047	1,121
LIVESTOCK	4,328	5,269	5,395	5,526	5,665	5,810
IRRIGATION	252,184	242,516	233,217	224,276	215,678	208,019
BRAZOS BASIN TOTAL DEMAND	**258,817**	**250,228**	**241,164**	**232,466**	**224,135**	**216,744**
RED BASIN						
COUNTY-OTHER	215	225	233	244	252	259
MANUFACTURING	147	156	165	173	185	198
LIVESTOCK	1,520	1,851	1,895	1,942	1,990	2,041
IRRIGATION	135,792	130,585	125,579	120,764	116,134	112,010
RED BASIN TOTAL DEMAND	**137,674**	**132,817**	**127,872**	**123,123**	**118,561**	**114,508**
CASTRO COUNTY TOTAL DEMAND	**396,491**	**383,045**	**369,036**	**355,589**	**342,696**	**331,252**
COCHRAN COUNTY						
BRAZOS BASIN						
MORTON	473	474	467	456	466	469
COUNTY-OTHER	376	415	427	428	444	451
MINING	8	10	10	8	6	4
LIVESTOCK	370	388	407	428	449	472
IRRIGATION	69,516	66,833	64,253	61,772	59,387	57,266
BRAZOS BASIN TOTAL DEMAND	**70,743**	**68,120**	**65,564**	**63,092**	**60,752**	**58,662**
COLORADO BASIN						
COUNTY-OTHER	124	129	129	128	131	132
MINING	146	198	200	155	109	77
LIVESTOCK	166	174	183	192	202	212
IRRIGATION	32,713	31,451	30,236	29,069	27,947	26,948
COLORADO BASIN TOTAL DEMAND	**33,149**	**31,952**	**30,748**	**29,544**	**28,389**	**27,369**
COCHRAN COUNTY TOTAL DEMAND	**103,892**	**100,072**	**96,312**	**92,636**	**89,141**	**86,031**

Water User Group (WUG) Demand

REGION O	WUG DEMAND (ACRE-FEET PER YEAR)					
	2020	**2030**	**2040**	**2050**	**2060**	**2070**
CROSBY COUNTY						
BRAZOS BASIN						
CROSBYTON	294	306	316	332	351	367
LORENZO	231	246	258	275	295	310
RALLS	313	324	333	347	364	381
COUNTY-OTHER	154	158	166	173	181	191
MANUFACTURING	3	3	3	3	3	3
MINING	626	617	549	477	413	358
LIVESTOCK	256	262	268	275	281	288
IRRIGATION	112,692	108,152	103,794	99,614	95,602	92,049
BRAZOS BASIN TOTAL DEMAND	**114,569**	**110,068**	**105,687**	**101,496**	**97,490**	**93,947**
RED BASIN						
COUNTY-OTHER	1	1	1	1	1	1
MINING	368	363	322	280	243	210
LIVESTOCK	6	6	6	6	6	6
IRRIGATION	4,670	4,482	4,301	4,128	3,962	3,815
RED BASIN TOTAL DEMAND	**5,045**	**4,852**	**4,630**	**4,415**	**4,212**	**4,032**
CROSBY COUNTY TOTAL DEMAND	**119,614**	**114,920**	**110,317**	**105,911**	**101,702**	**97,979**
DAWSON COUNTY						
BRAZOS BASIN						
O'DONNELL	18	18	19	19	20	20
COUNTY-OTHER	5	5	5	4	5	5
LIVESTOCK	2	2	2	2	2	2
IRRIGATION	1,066	1,006	949	896	845	803
BRAZOS BASIN TOTAL DEMAND	**1,091**	**1,031**	**975**	**921**	**872**	**830**
COLORADO BASIN						
LAMESA	2,275	2,303	2,314	2,319	2,382	2,425
COUNTY-OTHER	583	610	633	649	685	716
MANUFACTURING	129	137	144	150	162	175
MINING	954	1,164	1,023	703	423	255
LIVESTOCK	137	141	145	149	153	157
IRRIGATION	105,564	99,613	93,996	88,698	83,699	79,483
COLORADO BASIN TOTAL DEMAND	**109,642**	**103,968**	**98,255**	**92,668**	**87,504**	**83,211**
DAWSON COUNTY TOTAL DEMAND	**110,733**	**104,999**	**99,230**	**93,589**	**88,376**	**84,041**
DEAF SMITH COUNTY						
CANADIAN BASIN						
COUNTY-OTHER	1	1	1	2	2	2
LIVESTOCK	126	143	148	153	159	165
IRRIGATION	1,934	1,873	1,813	1,756	1,700	1,650
CANADIAN BASIN TOTAL DEMAND	**2,061**	**2,017**	**1,962**	**1,911**	**1,861**	**1,817**
RED BASIN						
HEREFORD	3,953	4,463	5,040	5,728	6,288	6,907
COUNTY-OTHER	540	595	662	749	822	902
MANUFACTURING	3,834	3,950	4,061	4,157	4,295	4,438
LIVESTOCK	12,429	14,161	14,659	15,182	15,730	16,306
IRRIGATION	191,476	185,409	179,536	173,848	168,341	163,335
RED BASIN TOTAL DEMAND	**212,232**	**208,578**	**203,958**	**199,664**	**195,476**	**191,888**
DEAF SMITH COUNTY TOTAL DEMAND	**214,293**	**210,595**	**205,920**	**201,575**	**197,337**	**193,705**

Water User Group (WUG) Demand

REGION O	WUG DEMAND (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
DICKENS COUNTY						
BRAZOS BASIN						
SPUR	178	173	171	170	170	170
COUNTY-OTHER	123	118	114	114	113	113
MINING	10	10	10	10	10	10
LIVESTOCK	231	236	242	248	254	260
IRRIGATION	5,337	5,178	5,024	4,873	4,727	4,594
BRAZOS BASIN TOTAL DEMAND	**5,879**	**5,715**	**5,561**	**5,415**	**5,274**	**5,147**
RED BASIN						
COUNTY-OTHER	30	30	29	29	29	29
MINING	2	2	2	2	2	2
LIVESTOCK	144	147	150	154	158	162
IRRIGATION	4,026	3,907	3,790	3,677	3,566	3,466
RED BASIN TOTAL DEMAND	**4,202**	**4,086**	**3,971**	**3,862**	**3,755**	**3,659**
DICKENS COUNTY TOTAL DEMAND	**10,081**	**9,801**	**9,532**	**9,277**	**9,029**	**8,806**
FLOYD COUNTY						
BRAZOS BASIN						
FLOYDADA	572	589	603	625	643	658
LOCKNEY	268	274	276	286	294	300
COUNTY-OTHER	136	137	141	145	149	152
MINING	214	216	215	214	213	213
LIVESTOCK	565	593	623	653	686	721
IRRIGATION	53,181	51,063	49,029	47,076	45,201	43,539
BRAZOS BASIN TOTAL DEMAND	**54,936**	**52,872**	**50,887**	**48,999**	**47,186**	**45,583**
RED BASIN						
COUNTY-OTHER	64	64	66	69	70	72
MINING	272	276	274	272	271	272
LIVESTOCK	173	182	191	201	211	221
IRRIGATION	94,544	90,778	87,162	83,691	80,358	77,402
RED BASIN TOTAL DEMAND	**95,053**	**91,300**	**87,693**	**84,233**	**80,910**	**77,967**
FLOYD COUNTY TOTAL DEMAND	**149,989**	**144,172**	**138,580**	**133,232**	**128,096**	**123,550**
GAINES COUNTY						
COLORADO BASIN						
SEAGRAVES	419	430	447	470	485	502
SEMINOLE	2,348	2,571	2,847	3,160	3,411	3,675
COUNTY-OTHER	1,403	1,763	2,205	2,692	3,152	3,633
MANUFACTURING	2,278	2,386	2,489	2,578	2,722	2,874
MINING	1,829	2,400	2,071	1,527	1,051	776
LIVESTOCK	238	250	262	276	289	304
IRRIGATION	379,779	360,000	341,251	323,477	306,629	292,238
COLORADO BASIN TOTAL DEMAND	**388,294**	**369,800**	**351,572**	**334,180**	**317,739**	**304,002**
GAINES COUNTY TOTAL DEMAND	**388,294**	**369,800**	**351,572**	**334,180**	**317,739**	**304,002**
GARZA COUNTY						
BRAZOS BASIN						
POST	792	828	861	884	928	965
COUNTY-OTHER	135	129	125	126	130	133
MANUFACTURING	2	2	2	2	2	2
MINING	395	544	438	334	234	164
LIVESTOCK	299	305	312	320	328	346

Water User Group (WUG) Demand

REGION O	WUG DEMAND (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
GARZA COUNTY						
BRAZOS BASIN						
IRRIGATION	11,621	10,937	10,299	9,697	9,130	8,655
BRAZOS BASIN TOTAL DEMAND	**13,244**	**12,745**	**12,037**	**11,363**	**10,752**	**10,265**
GARZA COUNTY TOTAL DEMAND	**13,244**	**12,745**	**12,037**	**11,363**	**10,752**	**10,265**
HALE COUNTY						
BRAZOS BASIN						
ABERNATHY	528	539	540	532	545	550
HALE CENTER	298	299	296	289	296	299
PETERSBURG	326	334	335	330	338	342
PLAINVIEW	4,368	4,441	4,427	4,344	4,449	4,496
COUNTY-OTHER	1,171	1,177	1,162	1,135	1,161	1,173
MANUFACTURING	2,830	2,944	3,052	3,144	3,322	3,510
MINING	1,168	1,152	1,022	886	766	662
STEAM ELECTRIC POWER	60	71	83	98	117	139
LIVESTOCK	2,027	2,636	2,673	2,711	2,753	2,796
IRRIGATION	366,115	353,986	342,257	330,917	319,952	310,031
BRAZOS BASIN TOTAL DEMAND	**378,891**	**367,579**	**355,847**	**344,386**	**333,699**	**323,998**
RED BASIN						
LIVESTOCK	18	24	24	25	25	25
IRRIGATION	3,697	3,574	3,456	3,341	3,231	3,130
RED BASIN TOTAL DEMAND	**3,715**	**3,598**	**3,480**	**3,366**	**3,256**	**3,155**
HALE COUNTY TOTAL DEMAND	**382,606**	**371,177**	**359,327**	**347,752**	**336,955**	**327,153**
HOCKLEY COUNTY						
BRAZOS BASIN						
ANTON	161	164	165	165	172	176
LEVELLAND	2,442	2,521	2,554	2,547	2,655	2,727
COUNTY-OTHER	891	914	923	915	953	979
MANUFACTURING	1,185	1,188	1,191	1,193	1,198	1,203
MINING	16	16	15	15	14	13
LIVESTOCK	203	213	223	235	246	259
IRRIGATION	122,023	117,252	112,666	108,260	104,028	100,266
BRAZOS BASIN TOTAL DEMAND	**126,921**	**122,268**	**117,737**	**113,330**	**109,266**	**105,623**
COLORADO BASIN						
SUNDOWN	416	434	446	448	467	480
COUNTY-OTHER	31	32	32	32	33	34
MINING	2	2	2	2	2	2
LIVESTOCK	35	37	39	41	43	45
IRRIGATION	9,184	8,825	8,480	8,149	7,830	7,547
COLORADO BASIN TOTAL DEMAND	**9,668**	**9,330**	**8,999**	**8,672**	**8,375**	**8,108**
HOCKLEY COUNTY TOTAL DEMAND	**136,589**	**131,598**	**126,736**	**122,002**	**117,641**	**113,731**
LAMB COUNTY						
BRAZOS BASIN						
AMHERST	102	107	110	113	119	124
EARTH	192	190	187	184	186	187
LITTLEFIELD	953	917	873	833	824	809
OLTON	469	463	453	440	441	438
SUDAN	250	265	274	279	292	302

Water User Group (WUG) Demand

REGION O	WUG DEMAND (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
LAMB COUNTY						
BRAZOS BASIN						
COUNTY-OTHER	435	471	505	530	567	596
MANUFACTURING	616	642	667	688	733	781
MINING	586	579	513	445	385	333
STEAM ELECTRIC POWER	17,663	20,651	24,292	28,731	34,142	40,391
LIVESTOCK	2,969	3,136	3,204	3,275	3,349	3,427
IRRIGATION	325,356	312,802	300,732	289,129	277,974	268,045
BRAZOS BASIN TOTAL DEMAND	**349,591**	**340,223**	**331,810**	**324,647**	**319,012**	**315,433**
LAMB COUNTY TOTAL DEMAND	**349,591**	**340,223**	**331,810**	**324,647**	**319,012**	**315,433**
LUBBOCK COUNTY						
BRAZOS BASIN						
ABERNATHY	184	200	217	236	255	274
IDALOU	419	426	436	452	469	486
LUBBOCK	45,623	49,424	53,437	58,113	62,886	67,703
NEW DEAL	114	121	128	138	148	158
RANSOM CANYON	337	356	377	401	424	448
SHALLOWATER	422	464	507	558	610	662
SLATON	746	726	712	711	718	726
WOLFFORTH	765	912	1,062	1,223	1,385	1,547
COUNTY-OTHER	4,647	5,010	5,402	5,869	6,354	6,847
MANUFACTURING	2,161	2,354	2,540	2,697	2,914	3,148
MINING	6,354	6,425	5,913	5,302	4,763	4,314
STEAM ELECTRIC POWER	4,540	5,308	6,244	7,385	8,776	9,906
LIVESTOCK	780	887	918	951	985	1,021
IRRIGATION	169,242	159,740	150,773	142,310	134,322	127,582
BRAZOS BASIN TOTAL DEMAND	**236,334**	**232,353**	**228,666**	**226,346**	**225,009**	**224,822**
LUBBOCK COUNTY TOTAL DEMAND	**236,334**	**232,353**	**228,666**	**226,346**	**225,009**	**224,822**
LYNN COUNTY						
BRAZOS BASIN						
O'DONNELL	105	106	105	104	109	111
TAHOKA	478	488	478	472	494	505
COUNTY-OTHER	301	304	296	289	303	309
MINING	1,084	1,234	1,167	961	768	614
LIVESTOCK	131	136	139	144	149	153
IRRIGATION	78,646	74,418	70,411	66,626	63,045	59,999
BRAZOS BASIN TOTAL DEMAND	**80,745**	**76,686**	**72,596**	**68,596**	**64,868**	**61,691**
COLORADO BASIN						
COUNTY-OTHER	10	10	10	10	10	10
MINING	82	93	88	72	58	46
LIVESTOCK	10	10	11	11	11	12
IRRIGATION	5,920	5,601	5,300	5,015	4,745	4,516
COLORADO BASIN TOTAL DEMAND	**6,022**	**5,714**	**5,409**	**5,108**	**4,824**	**4,584**
LYNN COUNTY TOTAL DEMAND	**86,767**	**82,400**	**78,005**	**73,704**	**69,692**	**66,275**
MOTLEY COUNTY						
RED BASIN						
MATADOR	213	209	208	207	207	207

Water User Group (WUG) Demand

REGION O	WUG DEMAND (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
MOTLEY COUNTY						
RED BASIN						
COUNTY-OTHER	109	105	104	103	103	103
MANUFACTURING	6	6	6	6	6	6
MINING	240	213	205	198	179	161
LIVESTOCK	481	490	499	509	519	529
IRRIGATION	9,439	9,159	8,884	8,617	8,359	8,123
RED BASIN TOTAL DEMAND	**10,488**	**10,182**	**9,906**	**9,640**	**9,373**	**9,129**
MOTLEY COUNTY TOTAL DEMAND	**10,488**	**10,182**	**9,906**	**9,640**	**9,373**	**9,129**
PARMER COUNTY						
BRAZOS BASIN						
BOVINA	373	402	429	458	496	531
FARWELL	396	430	461	494	535	573
COUNTY-OTHER	384	414	442	474	512	549
LIVESTOCK	4,507	5,526	5,654	5,787	5,927	6,074
IRRIGATION	263,845	261,044	258,272	255,530	252,817	250,189
BRAZOS BASIN TOTAL DEMAND	**269,505**	**267,816**	**265,258**	**262,743**	**260,287**	**257,916**
RED BASIN						
FRIONA	829	894	953	1,018	1,103	1,182
COUNTY-OTHER	247	266	284	304	330	353
MANUFACTURING	2,233	2,365	2,492	2,603	2,782	2,973
LIVESTOCK	1,127	1,382	1,413	1,447	1,482	1,519
IRRIGATION	65,961	65,261	64,568	63,883	63,204	62,547
RED BASIN TOTAL DEMAND	**70,397**	**70,168**	**69,710**	**69,255**	**68,901**	**68,574**
PARMER COUNTY TOTAL DEMAND	**339,902**	**337,984**	**334,968**	**331,998**	**329,188**	**326,490**
SWISHER COUNTY						
BRAZOS BASIN						
KRESS	18	18	17	16	18	18
COUNTY-OTHER	29	29	29	28	30	30
LIVESTOCK	118	124	130	137	144	151
IRRIGATION	35,441	36,571	36,362	36,154	35,948	35,745
BRAZOS BASIN TOTAL DEMAND	**35,606**	**36,742**	**36,538**	**36,335**	**36,140**	**35,944**
RED BASIN						
HAPPY	99	101	100	98	103	105
KRESS	61	61	60	59	61	62
TULIA	926	945	938	924	967	989
COUNTY-OTHER	185	187	184	184	191	196
LIVESTOCK	2,244	2,357	2,475	2,598	2,728	2,864
IRRIGATION	161,454	166,600	165,649	164,703	163,761	162,836
RED BASIN TOTAL DEMAND	**164,969**	**170,251**	**169,406**	**168,566**	**167,811**	**167,052**
SWISHER COUNTY TOTAL DEMAND	**200,575**	**206,993**	**205,944**	**204,901**	**203,951**	**202,996**
TERRY COUNTY						
BRAZOS BASIN						
COUNTY-OTHER	8	8	8	8	9	9
MINING	25	37	38	29	21	14
LIVESTOCK	12	13	14	15	16	18
IRRIGATION	7,173	6,805	6,456	6,125	5,811	5,542
BRAZOS BASIN TOTAL DEMAND	**7,218**	**6,863**	**6,516**	**6,177**	**5,857**	**5,583**

Water User Group (WUG) Demand

REGION O	WUG DEMAND (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
TERRY COUNTY						
COLORADO BASIN						
BROWNFIELD	1,793	1,854	1,923	2,000	2,087	2,172
MEADOW	95	97	101	105	109	113
COUNTY-OTHER	312	317	329	345	359	374
MANUFACTURING	2	2	2	2	2	2
MINING	330	488	505	387	272	192
LIVESTOCK	258	275	295	317	340	377
IRRIGATION	136,288	129,302	122,673	116,383	110,415	105,306
COLORADO BASIN TOTAL DEMAND	**139,078**	**132,335**	**125,828**	**119,539**	**113,584**	**108,536**
TERRY COUNTY TOTAL DEMAND	**146,296**	**139,198**	**132,344**	**125,716**	**119,441**	**114,119**
YOAKUM COUNTY						
COLORADO BASIN						
DENVER CITY	1,423	1,579	1,721	1,889	2,066	2,237
PLAINS	432	480	522	570	624	675
COUNTY-OTHER	267	291	314	341	372	403
MINING	1,300	1,334	1,147	957	783	641
STEAM ELECTRIC POWER	3,718	4,346	5,113	6,047	7,186	8,540
LIVESTOCK	281	286	290	296	301	322
IRRIGATION	146,083	139,091	132,435	126,095	120,060	114,838
COLORADO BASIN TOTAL DEMAND	**153,504**	**147,407**	**141,542**	**136,195**	**131,392**	**127,656**
YOAKUM COUNTY TOTAL DEMAND	**153,504**	**147,407**	**141,542**	**136,195**	**131,392**	**127,656**
REGION O TOTAL DEMAND	**3,710,638**	**3,607,623**	**3,495,840**	**3,390,545**	**3,293,186**	**3,210,784**

Chapter 3

Chapter 3

Water Availability and Existing Water Supplies

3. Water Availability and Existing Water Supplies

This section presents an evaluation of the quantity of water obtainable during drought-of-record conditions in the Llano Estacado region. The evaluation consists of two major components:

- An evaluation of available water from sources located within the region
- An evaluation of the amount of water that is currently available to water user groups (WUGs) within the region.

Availability is the maximum amount of water available from a given source during drought-of-record conditions, regardless of whether the supply is physically or legally accessible by a water user group (WUG) or wholesale water provider (WWP). This section identifies all sources within Region O, along with their associated availability volumes. Sources identified include (1) those that are currently connected and in use and (2) those that are not currently in use, but could be available in the future. Evaluating all sources gives a clear picture of the amount of water potentially available for use within the region both at present and in the future. Availability is a source-based analysis.

Section 3.1 describes water availability by water source type (surface water, reuse, and groundwater), regardless of physical or legal constraints, and presents water availability amounts by river basin and by county.

Existing water supply is the maximum amount of water available from an existing source during drought-of-record conditions that is physically and legally obtainable for use by WUGs. Existing water supply calculations are limited by:

- The portion of each water source's availability that could be accessed for supply by each WUG in the event of drought
- Legal or policy constraints regarding access to the water (e.g., by contract or water right)
- Physical constraints such as transmission or treatment facility capacity that would limit the delivery volume of treated supplies to WUGs.

Existing water supply is a WUG-based analysis. Section 3.2 discusses the determination of existing water supplies to WUGs and WWPs given the physical and legal constraints of these users.

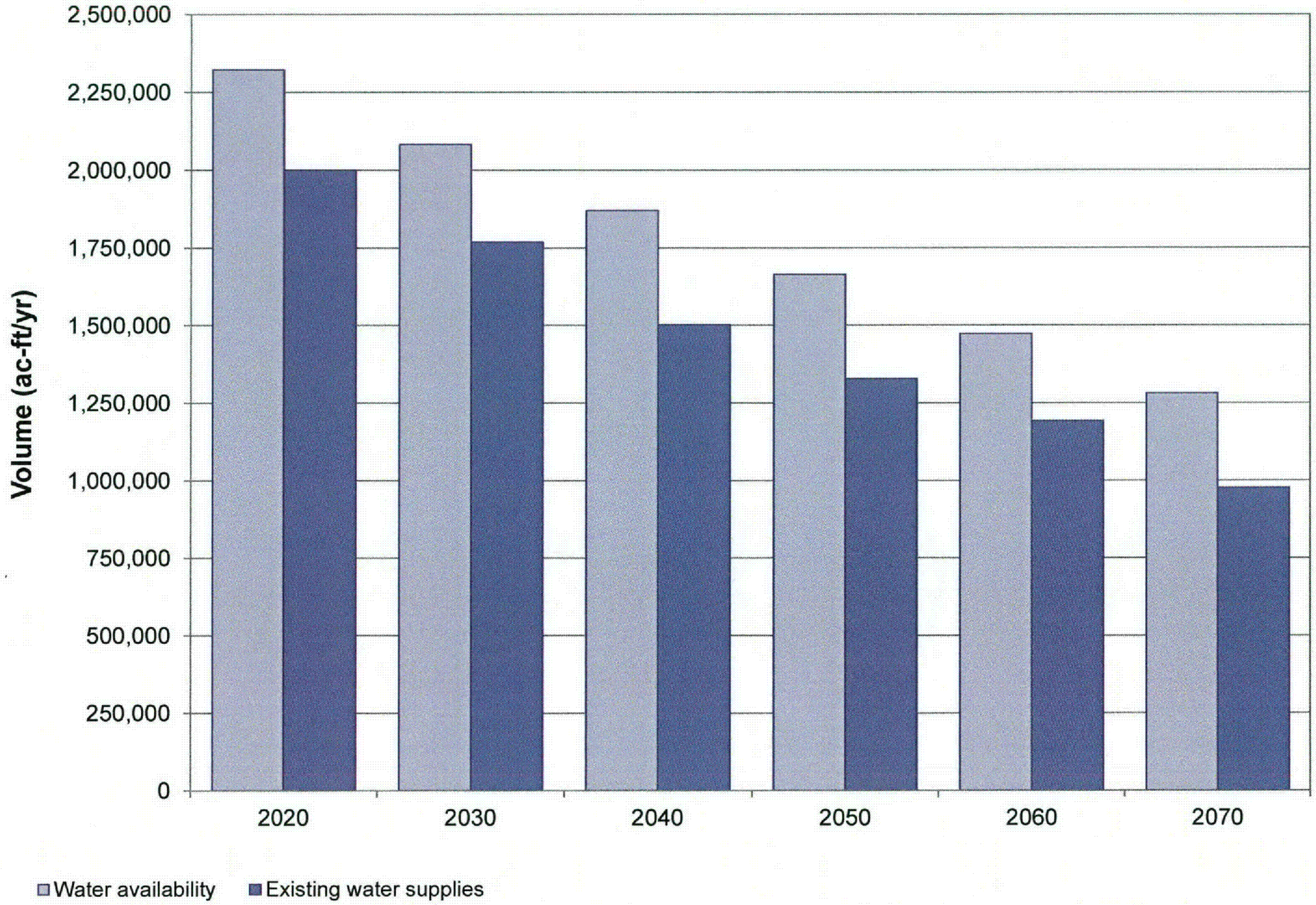
The use of both analyses—existing water supply and availability—is helpful. The existing water supply analysis reveals how much water can be obtained at a given time, while the water availability analysis identifies how much water is physically present. Figure 3-1 shows the Region O total water availability and existing water supply for each decade in the planning period. Section 1.5 provides a physical description and the location of each source of water, including:

- Surface water
  - Lake Alan Henry
  - Lake Mackenzie (also called Mackenzie Reservoir)
  - White River Lake
  - Run of river
  - Livestock local supply

- Groundwater
  - Dockum Aquifer
  - Edwards-Trinity (High Plains) Aquifer
  - Ogallala Aquifer
  - Seymour Aquifer
  - Other aquifer

- Direct reuse

Region O has estimated the amounts of water availability (Section 3.1) and existing water supplies (Section 3.2). During this round of water planning, the estimates reflect the conditions that are expected to occur in the event of actual drought conditions and are considered reasonable for drought planning purposes.



LLANO ESTACADO REGION

Existing Water Supplies and Water Availability

Daniel B. Stephens & Associates, Inc.

11/3/15

Figure 3-1

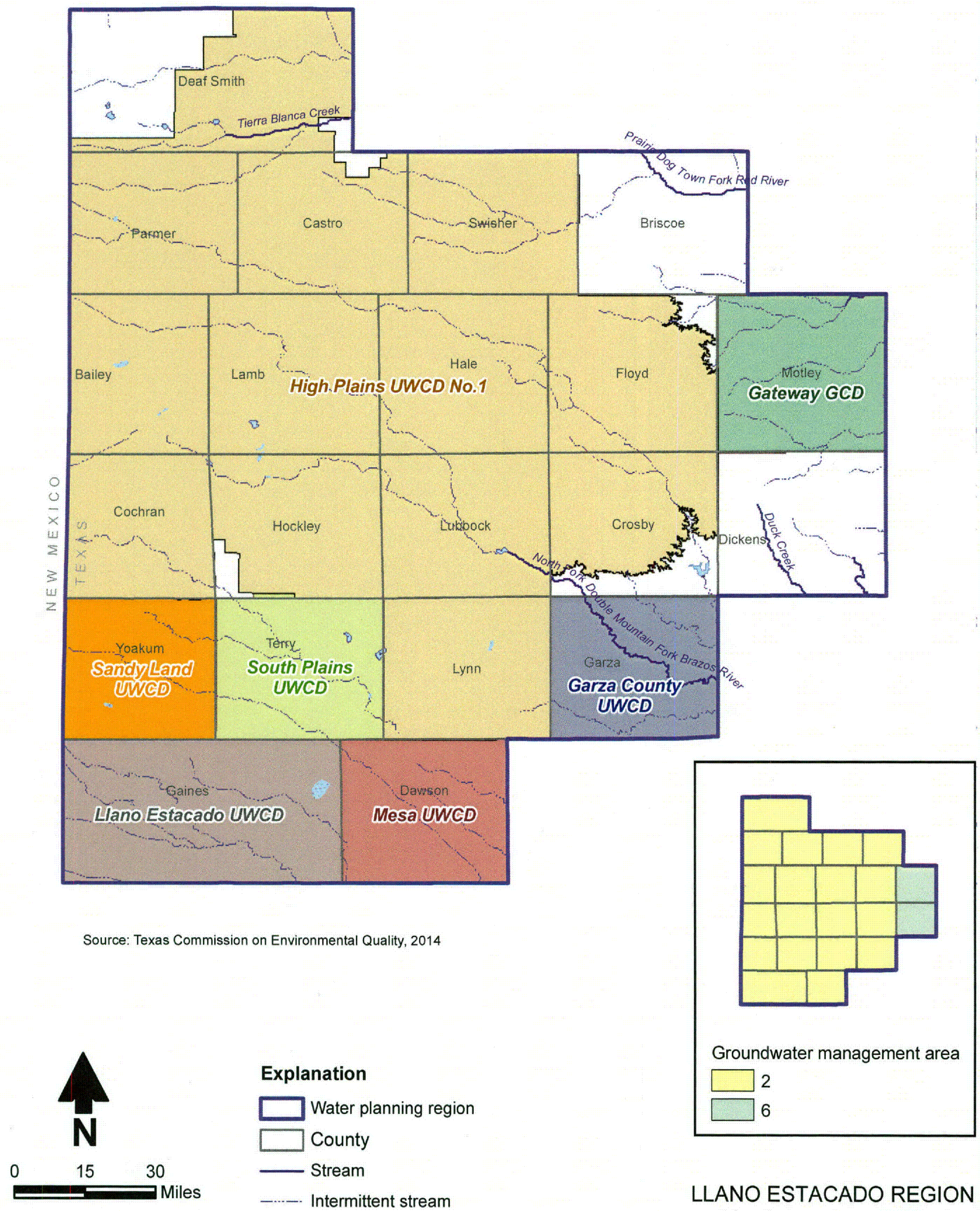
3.1 Evaluation of Water Availability

The majority of water available to Region O is groundwater, although some surface water and direct reuse water is also available. Groundwater conservation districts (GCDs) were created by the Texas Legislature in 1949 to manage groundwater use in the state. There are 98 GCDs in Texas today, 7 of which are in Region O (Figure 3-2). Table 3-1 lists each GCD within the region, the year it was established, and the county(ies) under its jurisdiction. Groundwater Management Areas (GMAs) were created in 2001 by the Texas Legislature to clarify the actions necessary for GCDs to manage and conserve groundwater resources. The state of Texas is divided into 16 GMAs, some of which contain multiple GCDs. The GMAs are based primarily on hydrogeologic and aquifer boundaries instead of political boundaries. Figure 3-2 shows the regulatory boundaries of the GMAs in Region O.

A law passed in 2005 by the Texas Legislature directed the GCDs within each GMA to meet and participate in joint groundwater planning efforts to determine the Desired Future Conditions (DFCs) for the groundwater resources within the GMA boundaries. The meetings were required to occur before September 1, 2010, and at least once each subsequent 5 years. DFCs are quantifiable management goals that reflect what the GCDs want to protect in their particular area. The adopted DFCs in Region O are established limits based on one of the following types of conditions: volume of groundwater in storage over time, statured thickness of the aquifer over time, or amount of decline in water level in the aquifer over time.

In accordance with 31 TAC §357.22(a)(6), the LERWPG contacted the High Plains Underground Water Conservation District (which includes Hale and Swisher counties) and Briscoe, Swisher, and Hale counties and verified that there are no water availability requirements promulgated by a county commissioners court pursuant to Texas Water Code §35.109 in Briscoe, Swisher, or Hale counties that are applicable to the Briscoe/Swisher/Hale County Priority Groundwater Management Area.

The quantities of available water in Region O are presented by source type in the following sections: groundwater (Section 3.1.1), surface water (3.1.2), and reuse water (Section 3.1.3). A detailed summary of water availability is provided in Section 3.1.4.



Source: Texas Commission on Environmental Quality, 2014

LLANO ESTACADO REGION
Underground Water Conservation Districts

Daniel B. Stephens & Associates, Inc.
10/1/2015
JN WR11.0030

Figure 3-2

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Table 3-1. Groundwater Conservation Districts

Groundwater Conservation District	Year of Establishment	Counties	
		Within Region O	In Other Region(s)
Garza County UWCD	1996	Garza	None
Gateway GCD	2003	Motley	Childress Cottle Foard Hardeman
High Plains UWCD No. 1	1951	Bailey Castro Cochran Crosby Deaf Smith Floyd Hale Hockley Lamb Lubbock Lynn Parmer Swisher	Armstrong Potter Randall
Llano Estacado UWCD	1998	Gaines	None
Mesa UWCD	1990	Dawson	None
Sandy Land UWCD	1989	Yoakum	None
South Plains UWCD	1992	Terry	None
None (full counties)	None	Briscoe Dickens	None
None (partial counties)	None	Castro Crosby Deaf Smith Floyd Hockley	None

UWCD = Underground water conservation district
GCD = Groundwater conservation district

3.1.1 Groundwater Availability

Groundwater comprises the largest portion of available water in Region O. The region includes the Ogallala, Dockum, Edwards-Trinity (High Plains), and Seymour aquifers, as well as several unknown aquifers, likely local alluvial aquifers, categorized as Other aquifers. Region O is covered almost entirely by GMA 2 with the exception of Dickens and Motley Counties, which are located in GMA 6 (Figure 3-2). The majority of groundwater availability data for the current planning round are based on the groundwater availability model runs and DFCs listed in Table 3-2.

Table 3-2. Summary of Desired Future Conditions

GMA	Aquifer	Model Run	Desired Future Condition Adopted
2	Dockum	GR 10-035 MAG Version 3	Average water level decline of no more than 40 feet between 2010 and 2060
	Ogallala and Edwards-Trinity (High Plains)	GR 10-030 MAG	For Bailey, Briscoe, Castro, Cochran, Crosby, Deaf Smith, Floyd, Hale, Hockley, Lamb, Lubbock, Lynn, Parmer, and Swisher counties, 50 percent of saturated thickness remaining after 50 years Average water level decline over 50 years for remaining counties: Dawson 74 feet, Gaines 70 feet, Garza 40 feet, Terry 42 feet, and Yoakum 18 feet
6	Dockum	GR 10-057 MAG	Total decline in water levels of no more than 40 feet over the next 50 years
	Ogallala	GR 10-031 MAG	50 percent of volume in storage remaining in 50 years
	Seymour	GR 10-058 MAG	Total decline in water levels of no more than 1 foot over 50 years

The modeling results provide the modeled available groundwater (MAG) based on DFCs for the decades 2020 through 2060. Decade 2070 availability volumes were calculated using a linear interpolation of all decades, except where volumes repeated from one decade to the next, in which case a linear interpolation was taken using the last repeated volume and all latter decades.

Region O requested 13 additional groundwater sources that do not have current groundwater availability model runs (Table 3-3). The available groundwater availability amounts for these additional groundwater sources were determined based on the following information:

- The Ogallala Aquifer in Deaf Smith County (Canadian River Basin) and Seymour Aquifer in Briscoe County (Red River Basin) were sources that were included in the 2011 Region O Water Plan but were not carried over into the current plan. Region O requested that these two sources be added in the current round of planning, and the request was approved by the TWDB on September 18, 2014. Decade 2020 through 2060 availability volumes were set equal to the amounts provided in the previous Region O water plan. Decade 2060 availability volumes were repeated for decade 2070.

- The Dockum Aquifer sources were included in a spreadsheet of "DFC-compatible groundwater availability," dated November 26, 2012, that was provided by the TWDB to regional water planning groups for some aquifer areas without MAGs. Decade 2020 through 2060 availability volumes were set equal to the amounts provided in the spreadsheet. Decade 2060 availability volumes were repeated for decade 2070.

- The Other aquifer sources were requested by Region O in a letter dated October 17, 2013. These aquifers produce limited quantities of groundwater insufficient for the state to formally designate them as minor aquifers, but they are present within seven counties in the Region O planning area and have previously been assigned availabilities in the regional water planning process. A review of historical groundwater production data in these counties indicates that a significant amount of groundwater has been and continues to be obtained from these aquifers. The Other aquifer sources listed in Table 3-3 were approved by the TWDB on September 18, 2014. Decade 2020 through 2070 availability volumes were assigned a conservative estimate of the annual available amount from each source based on annual production data from 2000 to 2011 for Other aquifers. For each source the availability volume is kept at a constant value for all planning decades.

Table 3-3. Summary of Non-MAG Sources for Groundwater Availability

Aquifer	County	River Basin	Non-MAG Data Source
Ogallala	Deaf Smith	Canadian	2011 Region O Water Plan
Seymour	Briscoe	Red	2011 Region O Water Plan
Dockum	Dawson	Colorado	TWDB spreadsheet
	Garza	Brazos	TWDB spreadsheet
		Colorado	TWDB spreadsheet
Other	Briscoe	Red	Historical pumping data
	Crosby	Brazos	Historical pumping data
	Dickens	Brazos	Historical pumping data
		Red	Historical pumping data
	Floyd	Red	Historical pumping data
	Garza	Brazos	Historical pumping data
	Hale	Brazos	Historical pumping data
	Motley	Red	Historical pumping data

The majority of groundwater in Region O is located in the Brazos River Basin (Table 3-4). The Colorado River Basin experiences a drastic decrease (79 percent) in available water over the 50-year planning horizon, primarily due to decreases in the availability amount from the Ogallala (all seven counties within basin) and Edwards-Trinity (Gaines County only) aquifers.

Table 3-4. Groundwater Availability by Source from 2020 to 2070

Source	Water Availability by Decade (acre-feet per year)						Decrease 2020-2070 (%)
	2020	2030	2040	2050	2060	2070	
River basin							
Brazos	1,079,119	1,038,948	988,198	913,151	845,530	790,160	27
Canadian	1,156	1,083	1,083	1,083	1,083	1,083	6
Colorado	768,344	595,924	464,965	361,528	264,568	158,314	79
Red	398,759	370,093	338,097	309,206	282,230	251,839	37
Aquifer							
Dockum	19,980	19,980	19,980	19,980	19,980	19,980	0
Edwards-Trinity	56,660	40,601	33,164	26,677	22,818	11,374	80
Ogallala	2,122,849	1,899,827	1,693,559	1,492,755	1,305,057	1,124,514	47
Other	42,050	42,050	42,050	42,050	42,050	42,050	0
Seymour	5,839	3,590	3,590	3,506	3,506	3,478	40
Total	2,247,378	2,006,048	1,792,343	1,584,968	1,393,411	1,201,396	47

The Ogallala Aquifer is the largest source of available water, groundwater or otherwise, in Region O (Table 3-4). The Ogallala Aquifer is projected to have more than 2.1 million acre-feet per year (ac-ft/yr) of available water in 2020 and slightly more than 1.1 million ac-ft/yr in 2070. The Edwards-Trinity Aquifer is the second largest source of available groundwater in the region in 2020 with 56,660 ac-ft/yr, although by 2070, water availability in the Edwards-Trinity is projected to drop by 80 percent, to 11,374 ac-ft/yr. The water availability in the Other aquifer category is projected to remain constant at 42,050 ac-ft/yr throughout the planning period; it is the second largest source of available groundwater in 2070. Of the groundwater sources, the Seymour Aquifer has the smallest amount of available water in Region O for all decades in the planning period (5,839 ac-ft/yr in 2020, declining 40 percent to 3,478 ac-ft/yr by 2070). Table 3-5 shows the water availability data for all groundwater water sources by county and river basin for 2020 to 2070.

Table 3-5. Groundwater Availability by Source and County from 2020 to 2070
Page 1 of 4

County	Source	River Basin	Water Availability by Decade (acre-feet per year)					
			2020	2030	2040	2050	2060	2070
Bailey	Dockum Aquifer	Brazos	1	1	1	1	1	1
	Edwards Trinity (High Plains) Aquifer	Brazos	279	279	279	279	279	279
	Ogallala Aquifer	Brazos	41,283	34,907	30,064	24,021	21,429	15,163
Briscoe	Dockum Aquifer	Red	231	231	231	231	231	231
	Ogallala Aquifer	Red	26,457	19,722	14,220	13,037	11,933	6,354
	Other aquifer	Red	4,000	4,000	4,000	4,000	4,000	4,000
	Seymour Aquifer	Red	4,063	1,821	1,821	1,821	1,821	1,821
Castro	Dockum Aquifer	Brazos	0	0	0	0	0	0
		Red	1	1	1	1	1	1
	Ogallala Aquifer	Brazos	90,367	90,367	90,367	88,630	84,458	81,909
		Red	36,936	36,141	35,449	34,650	33,540	32,858
Cochran	Dockum Aquifer	Brazos	0	0	0	0	0	0
		Colorado	0	0	0	0	0	0
	Edwards Trinity (High Plains) Aquifer	Brazos	137	137	137	137	137	137
		Colorado	127	127	127	127	127	127
	Ogallala Aquifer	Brazos	7,707	6,556	4,770	4,410	4,179	2,764
		Colorado	28,501	27,085	25,926	23,674	21,192	19,867
Crosby	Dockum Aquifer	Brazos	4,061	4,061	4,061	4,061	4,061	4,061
		Red	48	48	48	48	48	48
	Ogallala Aquifer	Brazos	133,058	133,058	133,058	133,058	133,058	133,058
		Red	1,624	1,624	1,624	1,624	1,624	1,624
	Other aquifer	Brazos	7,000	7,000	7,000	7,000	7,000	7,000
Dawson	Dockum Aquifer	Colorado	31	31	31	31	31	31
	Edwards Trinity (High Plains) Aquifer	Brazos	0	0	0	0	0	0
		Colorado	1,103	1,103	1,103	1,103	1,103	1,103

Table 3-5. Groundwater Availability by Source and County from 2020 to 2070
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County	Source	River Basin	Water Availability by Decade (acre-feet per year)					
			2020	2030	2040	2050	2060	2070
Dawson (cont.)	Ogallala Aquifer	Brazos	5,350	5,350	5,138	4,075	1,099	462
		Colorado	192,758	180,531	156,477	131,379	92,681	75,973
Deaf Smith	Dockum Aquifer	Canadian	1,082	1,082	1,082	1,082	1,082	1,082
		Red	3,630	3,630	3,630	3,630	3,630	3,630
	Ogallala Aquifer	Canadian	74	1	1	1	1	1
		Red	118,166	106,868	97,057	80,382	65,931	54,394
Dickens	Dockum Aquifer	Brazos	2,126	2,126	2,126	2,126	2,126	2,126
		Red	1,584	1,584	1,584	1,584	1,584	1,584
	Ogallala Aquifer	Brazos	5,939	5,939	5,939	5,939	5,939	5,939
		Red	6,400	6,400	6,181	6,181	5,655	5,546
	Other aquifer	Brazos	3,000	3,000	3,000	3,000	3,000	3,000
		Red	5,000	5,000	5,000	5,000	5,000	5,000
Floyd	Dockum Aquifer	Brazos	745	745	745	745	745	745
		Red	939	939	939	939	939	939
	Edwards Trinity (High Plains) Aquifer	Brazos	521	521	518	505	499	491
		Red	695	695	695	695	683	671
	Ogallala Aquifer	Brazos	93,749	92,041	90,930	86,458	84,300	82,151
		Red	55,617	53,320	47,453	43,351	40,061	35,636
	Other aquifer	Brazos	6,000	6,000	6,000	6,000	6,000	6,000
		Red	6,000	6,000	6,000	6,000	6,000	6,000
Gaines	Dockum Aquifer	Colorado	0	0	0	0	0	0
	Edwards Trinity (High Plains) Aquifer	Colorado	46,202	30,316	22,997	16,523	12,904	1,672
	Ogallala Aquifer	Colorado	240,110	175,175	130,951	97,498	71,544	32,706
Garza	Dockum Aquifer	Brazos	611	611	611	611	611	611
		Colorado	2	2	2	2	2	2

Table 3-5. Groundwater Availability by Source and County from 2020 to 2070
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County	Source	River Basin	Water Availability by Decade (acre-feet per year)					
			2020	2030	2040	2050	2060	2070
Garza (cont.)	Edwards Trinity (High Plains) Aquifer	Brazos	18	18	18	18	18	18
		Colorado	0	0	0	0	0	0
	Ogallala Aquifer	Brazos	19,073	18,942	18,812	18,032	17,121	16,952
	Other aquifer	Brazos	1,250	1,250	1,250	1,250	1,250	1,250
Hale	Dockum Aquifer	Brazos	734	734	734	734	734	734
		Red	4	4	4	4	4	4
	Edwards Trinity (High Plains) Aquifer	Brazos	3,523	3,523	3,523	3,523	3,419	3,315
	Ogallala Aquifer	Brazos	129,291	127,492	125,488	119,612	111,734	109,825
		Red	525	525	525	525	525	525
	Other aquifer	Brazos	800	800	800	800	800	800
Hockley	Dockum Aquifer	Brazos	571	571	571	571	571	571
		Colorado	0	0	0	0	0	0
	Edwards Trinity (High Plains) Aquifer	Brazos	96	96	96	96	96	96
		Colorado	0	0	0	0	0	0
	Ogallala Aquifer	Brazos	84,378	80,285	76,847	69,445	60,771	56,929
		Colorado	8,004	8,004	7,571	7,324	7,009	6,669
Lamb	Dockum Aquifer	Brazos	0	0	0	0	0	0
	Edwards Trinity (High Plains) Aquifer	Brazos	164	164	164	164	164	164
	Ogallala Aquifer	Brazos	137,304	125,466	111,509	95,696	85,190	70,834
Lubbock	Dockum Aquifer	Brazos	15	15	15	15	15	15
	Edwards Trinity (High Plains) Aquifer	Brazos	690	690	690	690	690	690
	Ogallala Aquifer	Brazos	120,044	115,348	108,699	100,762	91,073	85,427
Lynn	Dockum Aquifer	Brazos	5	5	5	5	5	5
		Colorado	0	0	0	0	0	0
	Edwards Trinity (High Plains) Aquifer	Brazos	221	221	221	221	221	221
		Colorado	9	9	9	9	9	9

Table 3-5. Groundwater Availability by Source and County from 2020 to 2070
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County	Source	River Basin	Water Availability by Decade (acre-feet per year)					
			2020	2030	2040	2050	2060	2070
Lynn (cont.)	Ogallala Aquifer	Brazos	97,740	96,954	94,600	86,945	78,543	76,436
		Colorado	6,020	6,020	6,020	6,020	5,925	5,830
Motley	Dockum Aquifer	Red	2,860	2,860	2,860	2,860	2,860	2,860
	Ogallala Aquifer	Red	9,936	9,936	9,936	9,936	9,576	9,216
	Other aquifer	Red	9,000	9,000	9,000	9,000	9,000	9,000
	Seymour Aquifer	Red	1,776	1,769	1,769	1,685	1,685	1,657
Parmer	Dockum Aquifer	Brazos	0	0	0	0	0	0
		Red	2	2	2	2	2	2
	Ogallala Aquifer	Brazos	45,572	39,624	35,624	29,978	27,692	22,076
		Red	17,493	16,960	16,525	15,642	13,289	13,064
Swisher	Dockum Aquifer	Brazos	83	83	83	83	83	83
		Red	614	614	614	614	614	614
	Ogallala Aquifer	Brazos	28,248	26,603	19,889	14,084	8,304	3,704
		Red	79,158	74,399	64,929	59,764	55,994	48,560
Terry	Edwards Trinity (High Plains) Aquifer	Brazos	23	23	23	23	23	23
		Colorado	959	922	922	922	922	922
	Ogallala Aquifer	Brazos	13,342	13,342	9,793	5,348	4,092	95
		Colorado	182,880	121,267	77,305	48,557	29,555	4,056
Yoakum	Edwards Trinity (High Plains) Aquifer	Colorado	1,893	1,757	1,642	1,642	1,524	1,436
	Ogallala Aquifer	Colorado	59,745	43,575	33,882	26,717	20,040	7,911
		Total	2,247,378	2,006,048	1,792,343	1,584,968	1,393,411	1,201,396

3.1.2 Surface Water Availability

To identify and evaluate the region's surface water sources, Region O used the Texas Commission on Environmental Quality's (TCEQ's) Water Availability Models (WAMs) for all the river basins within Region O. Surface water is limited in the region, including only four rivers, which can provide livestock local supplies and run-of-river supplies, and three reservoirs: Lake Alan Henry, Lake Mackenzie, and White River Lake.

The most current available TCEQ WAM Run 3 models (Table 3-6) were used to identify surface water sources that are 100 percent reliable during the historical drought of record within the model simulation period (Appendix 3A). Surface water availability is based on WAM periods of record, which cover roughly 1948 through 1998 of the historical hydrologic record; the drought of record occurred in the 1950s. Present reservoir storage volumes within Region O suggest that the region is within or has recently experienced a new drought of record (Section 7.2), and firm surface water supplies within the region should be reduced for planning purposes. This may require consideration of an expanded hydrological period within future WAM models of the region to reflect the variation in the basins' hydroclimatology.

Table 3-6. TCEQ WAM Models and Run Dates for Regional Water Planning

River Basin	WAM Version Date	Model Period of Record	Model Run Dates
Brazos	September 8, 2008	1940-1997	June 6, 2014
Canadian	January 7, 2013	1948-1998	Not run (no rights within Region O)
Colorado	August 1, 2007	1940-1998	April 9, 2014
Red	January 2, 2013	1948-1998	April 9, 2014

The consulting firm that ran the surface water models was RPS, located in Austin, Texas. The WAM input files for each river basin are provided in Appendix 3B (Note: Appendix 3B is more than 1,000 pages and is available only in the electronic version of this plan). The files for the Brazos River Basin include one file for each modeled decade due to the modeling of sedimentation.

As specified in Section 3.4.1.2 of the TWDB guidelines (2012) the following criteria were applied to estimate the availability associated with surface water firm yields that are 100 percent reliable during the historical drought of record within Region O:

- Available inflows to reservoirs are the remainder of naturalized streamflows after upstream (and downstream) senior water rights.
- Downstream senior water rights were met.
- Special conditions of water rights were considered.
- Minimum allowable reservoir levels were the top of dead pool.
- Maximum allowable reservoir levels were the top of conservation pool.
- Evaporative losses were based on evaporation rate data that best coincide with the location of the reservoir and the period of record and time steps for inflows.
- Annual water supply demands were held constant for all years.
- Model run time steps were no longer than one month.

Prior to using the TCEQ WAM Run 3 models for each river basin, sedimentation rates for each of the Region O reservoirs were calculated based on comparing original impoundment capacities and updated capacities from TWDB volumetric surveys, where available. The TWDB performed volumetric surveys of Lake Alan Henry and White River Lake in 2005 and 1992, and the average annual capacity loss rates were determined to be 1.66 and 0.61 percent, respectively. The White River Lake sedimentation rate was used in the modeling for both the White River Lake and Lake Alan Henry reservoirs, because the value was more realistic than the 1.66 percent estimated for Lake Alan Henry based on the 2005 volumetric survey. No volumetric surveys were found for Mackenzie Reservoir; therefore, it was assumed that the capacity of this reservoir will remain constant. This same assumption was adopted in previous Region O planning efforts.

Descriptions of the model run for each of the four river basins are provided in Sections 3.1.2.1 through 3.1.2.4, and a summary of surface water availability is presented in Section 3.1.2.5.

3.1.2.1 Brazos River Basin Model Run

Sources in Region O from the Brazos River are Lake Alan Henry, White River Lake, and a small volume of run-of-river supply from the Brazos River; Lake Alan Henry provides the largest supply.

The Brazos River Basin WAM Run 3 was modified to model Lake Alan Henry in a manner consistent with the Region G Brazos G WAM, as well as the modeling performed for the City of Lubbock's *Strategic Water Supply Plan* (City of Lubbock, 2013) and the *Yield Analyses of North and South Fork Water Supply Projects* (HDR, 2013). The following assumptions have been made in the Brazos River Basin modeling:

- Senate Bill 3 environmental flow standards with a priority date of March 1, 2012 have been implemented.
- Return flows are incorporated into the modeling in a manner consistent with analyses from previous rounds of planning for Region O.
- The Brazos Sys-Ops permit (priority date October 15, 2004) was modeled in the evaluations of Jim Bertram Lake 7 and the North Fork scalping operation.
- Model assumptions adopted in previous City of Lubbock model representations (City of Lubbock, 2013; HDR, 2013) are adopted in the present evaluation, including:
  - The flow distribution for the Lake Alan Henry control point is revised to use the Double Mountain Fork at Justiceburg U.S. Geological Survey gage control point for determination of flow
  - All inflows to Lake Alan Henry are held in the reservoir, in accordance with the subordination agreement that the City of Lubbock has with the Brazos River Authority

A total of 50 surface water rights have been identified within the Brazos River Basin within Region O, but modeled WAM results indicate that only 10 of those rights have a reliable supply during the drought of record. The source availabilities reported by the model for the Brazos River Basin are the supply volumes that were historically available during drought of record conditions for the period of record modeled in the water availability model.

3.1.2.2 Canadian River Basin Model Run

The Canadian River Basin WAM Run 3 was not modified, as no surface water rights have been identified within the Region O Planning area. The portion of the Canadian River Basin that falls in Region O is very small. As a result, very little surface water from the Canadian River Basin is available in Region O. This was reflected in the draft surface water availability information for the Canadian River Basin provided by the TWDB and confirmed by the lack of Canadian River Basin water right permits within Region O. Historically, portions of Region O have been supplied by Canadian River Basin surface water delivered through a pipeline from Lake Meredith in Region A, but Lake Meredith was dry for a portion of the current planning period, potentially indicating a new drought of record for the watershed. As of September 30, 2015, conditions at Lake Meredith had improved, with reservoir storage at approximately 21 percent (TWDB, 2015).

3.1.2.3 Colorado River Basin Model Run

The Colorado River Basin WAM Run 3 was not modified, as the only rights within the regional planning area are run-of-river authorizations, and they have no assumed sedimentation losses. Region O encompasses the headwaters of the Colorado River Basin, so very little surface water from the Colorado River Basin is available in Region O. Only two surface water rights have been identified within the region, and WAM modeling of those rights indicates that there is no reliable supply during the drought of record. Thus, no firm surface water sources are present in Region O within the Colorado River Basin.

3.1.2.4 Red River Basin Model Run

No modifications to the Red River Basin WAM Run 3 were made consistent with a 2013 letter to TWDB (LERWPG, 2013) regarding water supply assumptions, which specified the use of the original volumetric survey since updated elevation-area-capacity data were not available for Mackenzie Reservoir. Permitted surface water supply sources in the Red River Basin within Region O include Mackenzie Reservoir and a small volume of run of river supply from the Red River. A total of 31 Red River Basin surface water rights have been identified within Region O; however, WAM results indicate that only 7 of those rights have a reliable supply during the drought of record.

According to the 2011 Region O water plan, Mackenzie Reservoir is a 45,500-acre-foot impoundment and can supply approximately 5,200 ac-ft/yr when the reservoir is at conservation pool elevation; however, the report also indicates that Mackenzie Reservoir has been unable to meet contracted demands (LERWPG, 2010). The 2013 Red River WAM Run 3 models the firm yield of Mackenzie Reservoir at 4,520 ac-ft/yr, suggesting a reduction in the firm yield from the 2011 Region O Water Plan. The source availabilities reported by the model for the Red River Basin are the supply volumes that were historically available during drought of record conditions for the period of record modeled in the water availability model.

3.1.2.5 Summary of Surface Water Availability

The majority of surface water in Region O is located in the Brazos River Basin (Table 3-7). Reservoirs represent the largest source of surface water availability. Only nine counties have run of river water availability and they are projected to be the same for each decade in the planning horizon. None of the counties in Region O are projected to have local livestock water supply availability because there is no availability for this source during the current drought of record. Table 3-8 details the water availability data for all surface water sources by county and river basin for 2020 to 2070. The most current available TCEQ WAM Run 3 models were used to identify surface water sources that are 100 percent reliable during the historical drought of record within the model simulation period.

Table 3-7. Surface Water Availability by Source from 2020 to 2070

Source	Water Availability by Decade (acre-feet per year)					
	2020	2030	2040	2050	2060	2070
River basin						
Brazos [a]	20,820	20,540	20,240	19,920	19,600	18,940
Canadian	0	0	0	0	0	0
Colorado	0	0	0	0	0	0
Red [b]	4,630	4,630	4,630	4,630	4,630	4,630
Supply type						
Livestock local	0	0	0	0	0	0
Reservoirs [c]	25,120	24,840	24,540	24,220	23,900	23,240
Run of river	330	330	330	330	330	330
Total	25,450	25,170	24,870	24,550	24,230	23,570

[a] Sum of Lake Alan Henry and Brazos River Basin run of river water sources (White River Lake is projected to have no water availability)

[b] Sum of Mackenzie Reservoir and Red River Basin run of river water sources

[c] Sum of Mackenzie Reservoir and Lake Alan Henry (White River Lake is projected to have no water availability and Lake Meredith is in Region A)

Table 3-8. Surface Water Availability by County from 2020 to 2070
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County	Source Name	River Basin	Water Availability by Decade (acre-feet per year)					
			2020	2030	2040	2050	2060	2070
Bailey	Livestock local supply	Brazos	0	0	0	0	0	0
Briscoe	Livestock local supply	Red	0	0	0	0	0	0
	Run of river	Red	80	80	80	80	80	80
Castro	Livestock local supply	Brazos	0	0	0	0	0	0
		Red	0	0	0	0	0	0
Cochran	Livestock local supply	Brazos	0	0	0	0	0	0
	Livestock local supply	Colorado	0	0	0	0	0	0
Crosby	Livestock local supply	Brazos	0	0	0	0	0	0
		Red	0	0	0	0	0	0
	Run of river	Brazos	10	10	10	10	10	10
Dawson	Livestock local supply	Brazos	0	0	0	0	0	0
		Colorado	0	0	0	0	0	0
Deaf Smith	Livestock local supply	Canadian	0	0	0	0	0	0
		Red	0	0	0	0	0	0
Dickens	Livestock local supply	Brazos	0	0	0	0	0	0
		Red	0	0	0	0	0	0
	Run of river	Brazos	130	130	130	130	130	130
Floyd	Livestock local supply	Brazos	0	0	0	0	0	0
		Red	0	0	0	0	0	0
	Run of river	Red	10	10	10	10	10	10
Gaines	Livestock local supply	Colorado	0	0	0	0	0	0
Garza	Livestock local supply	Brazos	0	0	0	0	0	0
	Run of river	Brazos	30	30	30	30	30	30
Hale	Livestock local supply	Brazos	0	0	0	0	0	0
		Red	0	0	0	0	0	0

Table 3-8. Surface Water Availability by County from 2020 to 2070
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County	Source Name	River Basin	Water Availability by Decade (acre-feet per year)					
			2020	2030	2040	2050	2060	2070
Hockley	Livestock local supply	Brazos	0	0	0	0	0	0
		Colorado	0	0	0	0	0	0
Lamb	Livestock local supply	Brazos	0	0	0	0	0	0
Lubbock	Livestock local supply	Brazos	0	0	0	0	0	0
	Run of river	Brazos	20	20	20	20	20	20
Lynn	Livestock local supply	Brazos	0	0	0	0	0	0
		Colorado	0	0	0	0	0	0
	Run of river	Brazos	30	30	30	30	30	30
Motley	Livestock local supply	Red	0	0	0	0	0	0
	Run of river	Red	10	10	10	10	10	10
Parmer	Livestock local supply	Brazos	0	0	0	0	0	0
		Red	0	0	0	0	0	0
	Run of river	Red	10	10	10	10	10	10
Swisher	Livestock local supply	Brazos	0	0	0	0	0	0
		Red	0	0	0	0	0	0
Terry	Livestock local supply	Brazos	0	0	0	0	0	0
		Colorado	0	0	0	0	0	0
Yoakum	Livestock local supply	Colorado	0	0	0	0	0	0
Reservoirs	Lake Alan Henry	Brazos	20,600	20,320	20,020	19,700	19,380	18,720
	Mackenzie Reservoir	Red	4,520	4,520	4,520	4,520	4,520	4,520
	White River Lake	Brazos	0	0	0	0	0	0
		Total	25,450	25,170	24,870	24,550	24,230	23,570

Lake Alan Henry is by far the largest reservoir in Region O. This lake is projected to have 20,600 ac-ft/yr of available water in 2020 and, due to sedimentation, 18,720 ac-ft/yr in 2070. Reservoir storage at Lake Alan Henry was approximately 60 percent in summer 2014, but as of September 30, 2015, the lake was approximately 95 percent full (TWDB, 2015).

Mackenzie Reservoir is much smaller and has a projected water availability of 4,520 ac-ft/yr for all decades in the planning period. Storage at Mackenzie Reservoir was less than 5 percent in summer 2014, but as of September 30, 2015, the lake was approximately 16 percent full (TWDB, 2015).

Due to the recent drought, lake levels in White River Lake have dropped significantly, rendering the lake unavailable for use for almost 2 years during the current water planning cycle. As of September 30, 2015, conditions at White River Lake had improved, with reservoir storage at approximately 33 percent (TWDB, 2015). The WAM Run 3 model period of record for this reservoir is 1940 to 1997; therefore, the years since 1997 are not modeled, and due to the recent drought that has occurred, the WAM Run 3 model results do not represent a firm yield available during times of drought for this reservoir. Consequently, White River Lake is projected to have no water availability for any decade in the planning period.

3.1.3 Reuse Availability

Reuse water is classified as either indirect or direct:

- Indirect reuse is process water that re-enters rivers or stream systems and is diverted and used again downstream. Indirect reuse availability is based on currently permitted reuse projects that have the infrastructure in place to divert and use this water in accordance with permits issued by the TCEQ. Currently there are no indirect reuse supplies in Region O.

- Direct reuse is process water recirculated within a given system. Direct reuse availability is the amount of water from direct reuse sources that is expected to be available during drought of record conditions from currently installed wastewater reclamation infrastructure.

Table 3-9 provides the direct reuse water availability by county for 2020 to 2070. In the Llano Estacado Region, 12 counties have water availability from direct reuse. Lubbock County has the largest direct reuse water availability: 22,728 ac-ft/yr in 2020, increasing to 30,759 ac-ft/yr in 2070. Lubbock County is the only county with an increasing amount of direct reuse water availability based on the City of Lubbock 2013 *Strategic Water Supply Pla*n (City of Lubbock, 2013); all other counties' direct reuse water availability remains constant and is based on their permit amount. Cochran, Floyd, and Lynn counties have the smallest amount of direct reuse water availability, each with less than 500 ac-ft/yr for each decade in the planning period.

Table 3-9. Direct Reuse Water Availability by County from 2020 to 2070

County	Water Availability by Decade (acre-feet per year)					
	2020	2030	2040	2050	2060	2070
Bailey	825	825	825	825	825	825
Castro	4,031	4,031	4,031	4,031	4,031	4,031
Cochran	294	294	294	294	294	294
Crosby	583	583	583	583	583	583
Deaf Smith	2,810	2,810	2,810	2,810	2,810	2,810
Floyd	449	449	449	449	449	449
Hale	5,477	5,477	5,477	5,477	5,477	5,477
Hockley	1,521	1,521	1,521	1,521	1,521	1,521
Lamb	7,199	7,199	7,199	7,199	7,199	7,199
Lubbock	22,728	25,136	27,029	28,508	29,762	30,759
Lynn	346	346	346	346	346	346
Parmer	2,887	2,887	2,887	2,887	2,887	2,887
Total	49,150	51,558	53,451	54,930	56,184	57,181

3.1.4 Summary of Water Availability

Appendix 3C contains the required Regional Water Planning Application (DB17) report for source availability. The total water available from surface water, groundwater, and direct reuse sources combined is summarized below:

- The available water is projected to be more than 2.3 million ac-ft/yr in 2020 (Tables 3-10 through 3-12). This amount decreases by 45 percent to approximately 1.3 million ac-ft/yr in 2070.

- The majority of available water in Region O is groundwater, specifically groundwater from the Ogallala Aquifer (Figure 3-3, Table 3-10). The Ogallala Aquifer consists of just over 91 percent of the region's available water in 2020 and decreases to about 88 percent in 2070.

- Table 3-11 provides water availability by river basin during the planning horizon. The Brazos River Basin has the largest proportion of available water in each decade during the planning period. In 2020, slightly less than 50 percent of the available water in Region O is projected to be in the Brazos River Basin. By 2070, the Brazos River Basin is projected to hold roughly 67 percent of the region's available water.

- Table 3-12 provides the total water availability for each county during the planning horizon. In 2020, 12 counties have over 100,000 ac-ft/yr of available water, but by 2070, only 5 counties have more than 100,000 ac-ft/yr (Figure 3-4). Gaines County, with 286,312 ac-ft/yr, has the most available water in the region in 2020. However, Gaines County is projected to experience a significant decrease in water availability so that by 2070, the county ranks 13 out of the 21 counties in the amount of available water. In 2070, Crosby County has the most available water (146,384 ac-ft/yr).

3.2 Existing Water Supplies

In estimating the existing water supplies, Region O considered all the items outlined in Section 3.3 of the *First Amended General Guidelines for Regional Water Plan Development* (TWDB, 2012). Existing water supplies were allocated based on the most limiting factor to deliver or use the water for each WUG. The existing water supply for each source for every WUG in Region O was limited by one of the following:

Table 3-10. Water Availability by Source from 2020 to 2070

Source	Water Availability by Decade (acre-feet per year)					
	2020	2030	2040	2050	2060	2070
Direct reuse	49,150	51,558	53,451	54,930	56,184	57,181
Dockum Aquifer	19,980	19,980	19,980	19,980	19,980	19,980
Edwards Trinity Aquifer	56,660	40,601	33,164	26,677	22,818	11,374
Lake Alan Henry	20,600	20,320	20,020	19,700	19,380	18,720
Mackenzie Reservoir	4,520	4,520	4,520	4,520	4,520	4,520
Ogallala Aquifer	2,122,849	1,899,827	1,693,559	1,492,755	1,305,057	1,124,514
Other aquifer	42,050	42,050	42,050	42,050	42,050	42,050
Run of river – Brazos	220	220	220	220	220	220
Run of river – Red	110	110	110	110	110	110
Seymour Aquifer	5,839	3,590	3,590	3,506	3,506	3,478
Livestock local supply – Brazos	0	0	0	0	0	0
Livestock local supply – Canadian	0	0	0	0	0	0
Livestock local supply – Colorado	0	0	0	0	0	0
Livestock local supply – Red	0	0	0	0	0	0
White River Lake	0	0	0	0	0	0
Total	2,321,978	2,082,776	1,870,664	1,664,448	1,473,825	1,282,147

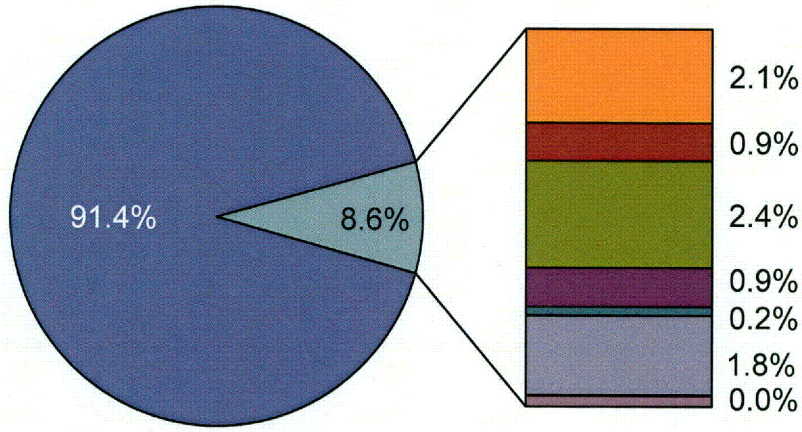
Table 3-11. Water Availability by River Basin from 2020 to 2070

River Basin	Water Availability by Decade (acre-feet per year)					
	2020	2030	2040	2050	2060	2070
Brazos	1,143,604	1,105,561	1,056,404	982,516	915,829	860,796
Canadian	1,156	1,083	1,083	1,083	1,083	1,083
Colorado	768,533	596,113	465,154	361,717	264,757	158,503
Red	408,685	380,019	348,023	319,132	292,156	261,765
Total	2,321,978	2,082,776	1,870,664	1,664,448	1,473,825	1,282,147

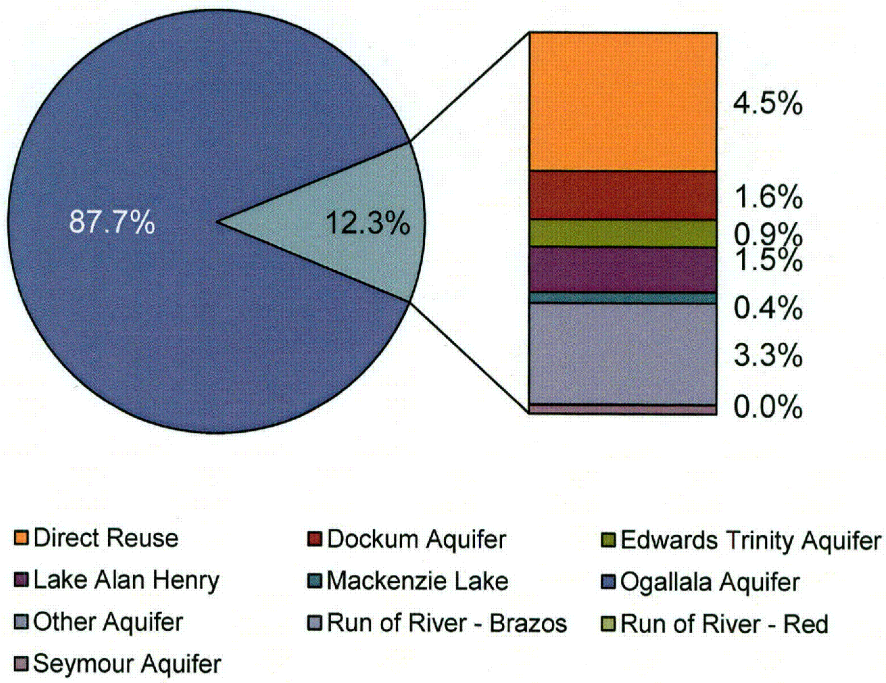
Table 3-12. Water Availability by County from 2020 to 2070

County	Water Availability by Decade (acre-feet per year)					
	2020	2030	2040	2050	2060	2070
Bailey	42,388	36,012	31,169	25,126	22,534	16,268
Briscoe	34,831	25,854	20,352	19,169	18,065	12,486
Castro	131,335	130,540	129,848	127,312	122,030	118,799
Cochran	36,766	34,199	31,254	28,642	25,929	23,189
Crosby	146,384	146,384	146,384	146,384	146,384	146,384
Dawson	199,242	187,015	162,749	136,588	94,914	77,569
Deaf Smith	125,762	114,391	104,580	87,905	73,454	61,917
Dickens	24,179	24,179	23,960	23,960	23,434	23,325
Floyd	164,725	160,720	153,739	145,152	139,686	133,092
Gaines	286,312	205,491	153,948	114,021	84,448	34,378
Garza	20,984	20,853	20,723	19,943	19,032	18,863
Hale	140,354	138,555	136,551	130,675	122,693	120,680
Hockley	94,570	90,477	86,606	78,957	69,968	65,786
Lamb	144,667	132,829	118,872	103,059	92,553	78,197
Lubbock	143,497	141,209	136,453	129,995	121,560	116,911
Lynn	104,371	103,585	101,231	93,576	85,079	82,877
Motley	23,582	23,575	23,575	23,491	23,131	22,743
Parmer	65,964	59,483	55,048	48,519	43,880	38,039
Swisher	108,103	101,699	85,515	74,545	64,995	52,961
Terry	197,204	135,554	88,043	54,850	34,592	5,096
Yoakum	61,638	45,332	35,524	28,359	21,564	9,347
Reservoirs	25,120	24,840	24,540	24,220	23,900	23,240
Total	2,321,978	2,082,776	1,870,664	1,664,448	1,473,825	1,282,147

a. 2020



b. 2070



LLANO ESTACADO REGION

Water Availability by Source as a Percentage of Total in 2020 and 2070

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11/2/15

Figure 3-3

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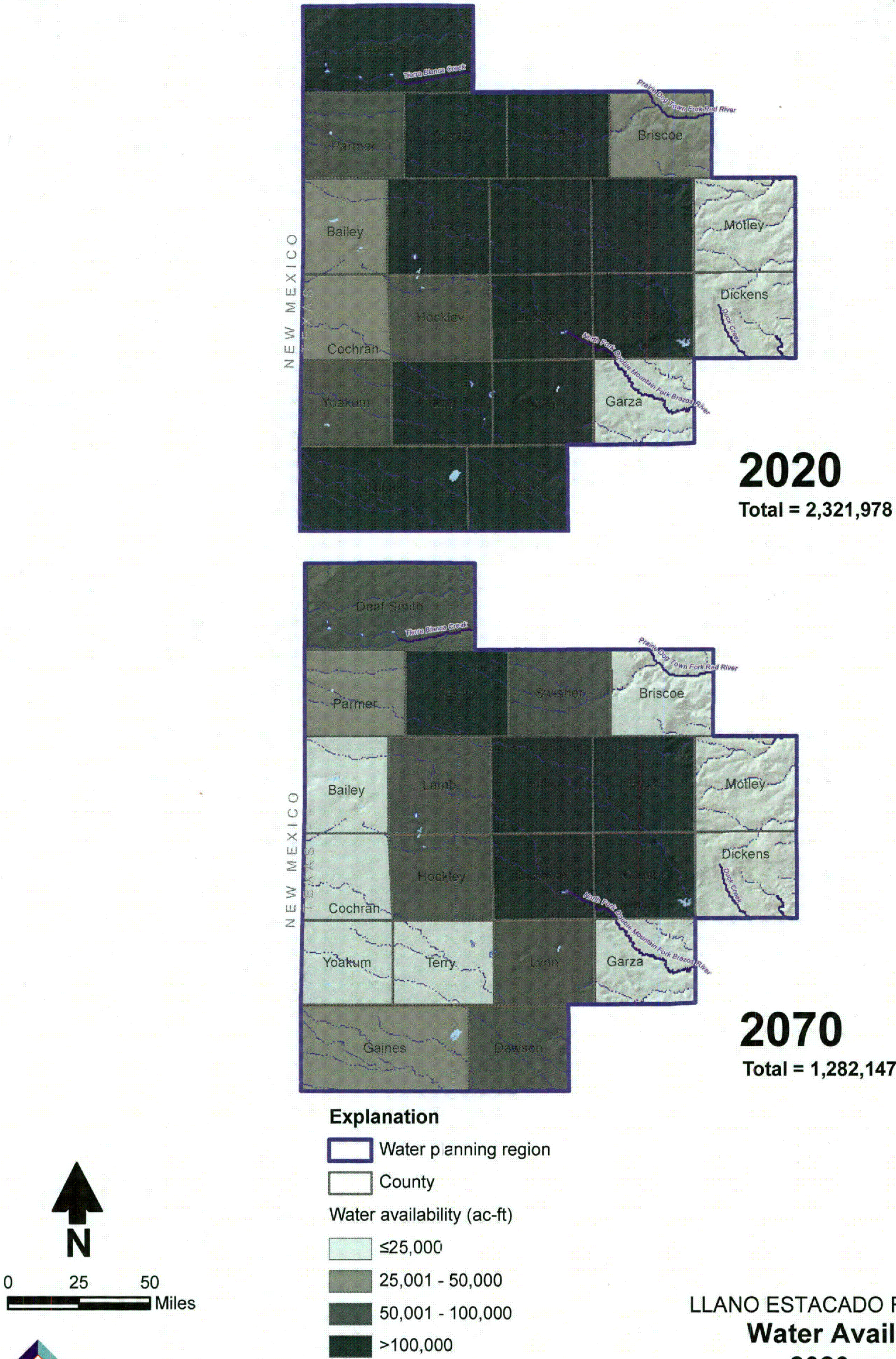

LLANO ESTACADO REGION
Water Availability
2020 and 2070

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10/1/2015 JN WR11 0030

Figure 3-4

- WUG ability to access a water source for supply during the drought of record (such as firm yield of a reservoir or available aquifer storage due to adopted DFCs).
- Legal or policy constraints regarding access to the water (e.g., contract or water right); current contract agreements were assumed to renew upon a contract's termination date.
- Physical constraints, such as well field capacity, water quality, or transmission or treatment facility capacity, that limit the volume of delivery of treated supplies; existing supplies in future decades are based on the assumption that current infrastructure does not change through time and is adequately maintained.

The MAG annual volumes (groundwater availability) are not exceeded during any decade or for any aquifer source by existing water supplies. In locations where initial overdrafts were found, the allocations of available groundwater supplies to existing WUG supplies were decreased to adhere to the MAG limit. This situation occurred where the MAG data determined for the current round of water planning had decreased below the sum of the initially allocated WUG supplies for an individual source in one or more decades. In these cases, the existing WUG supplies were recalculated to minimize surpluses for all WUGs and needs for municipal WUGs.

In some areas the groundwater availability volumes increased since the last planning round. Where existing water supplies were limited by aquifer properties in the previous plan, the current estimates were increased to either the WUG's system capacity or by multiplying the current estimates by the percentage increase in the new MAG volume. If no updated information was available, existing water supplies from the 2011 Region O water plan were used during the current planning round.

In Region O, existing water supplies are projected to be approximately 2.0 million ac-ft/yr in 2020. This amount decreases to 0.98 million ac-ft/yr in 2070, a 51 percent reduction. The Ogallala Aquifer provides the majority of water for the region's existing water supplies (Figure 3-5). Surface water is limited in Region O. Under the drought of record conditions, no existing water supplies are projected to be available from any river basin for livestock local supplies. The only surface water sources associated with a water user within the region that are projected to have existing water supplies greater than 0 during the 50-year planning period are

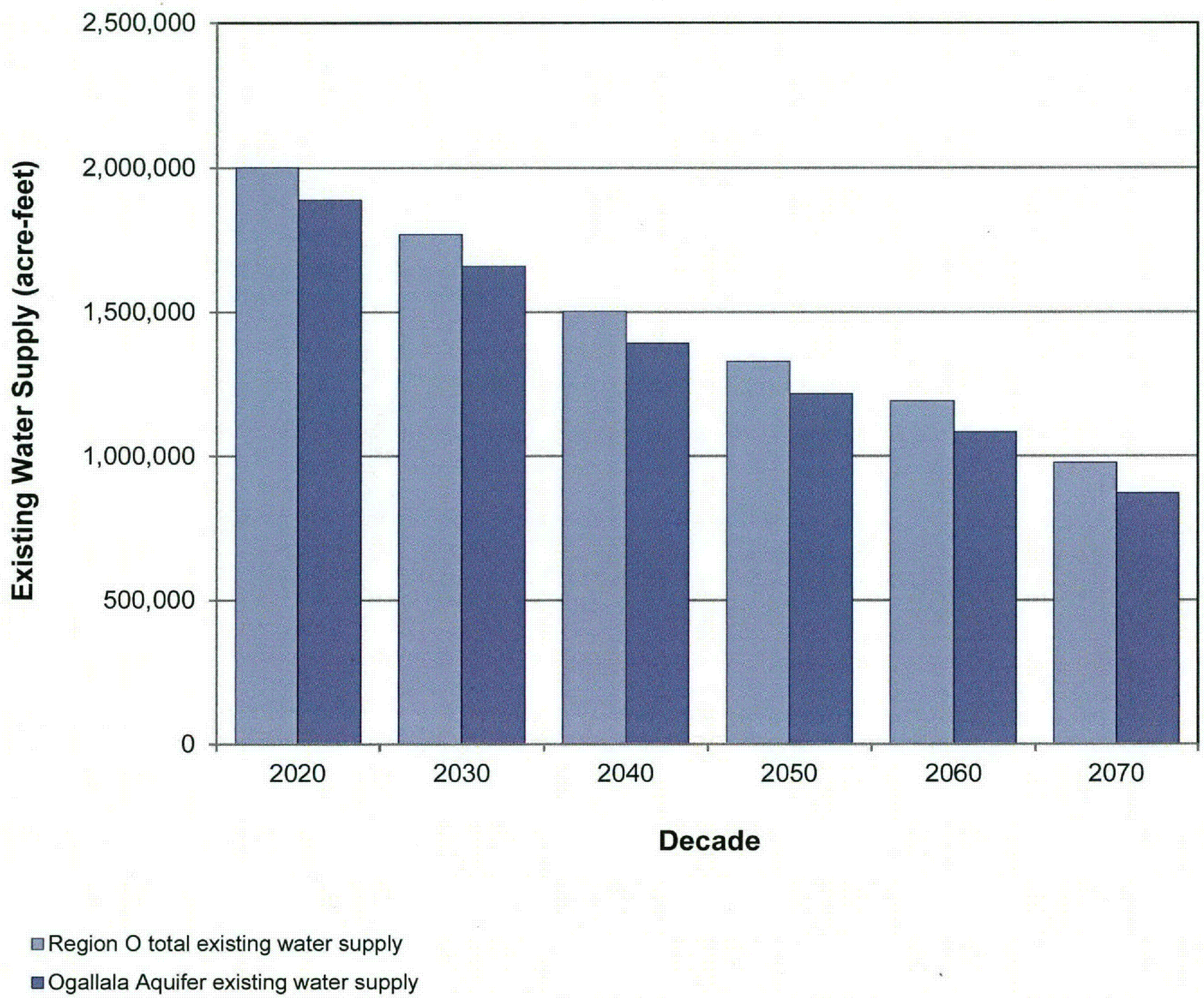

Figure 3-5

LLANO ESTACADO REGION

Ogallala Aquifer Share of Region O Existing Water Supplies from 2020 to 2070

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11/3/15

Lake Alan Henry and Mackenzie Reservoir. Lake Alan Henry is owned by the City of Lubbock and the current infrastructure can provide approximately 8,000 ac-ft/yr of water to the city and its wholesale water customers (the yield is approximately double this amount, but City deliveries are currently limited by the infrastructure capacity). Mackenzie Reservoir is owned and operated by the Mackenzie Municipal Water Authority and is a source of supply for the cities of Floydada, Lockney, Silverton, and Tulia. The current drought has led to record low water levels in Mackenzie Reservoir, limiting the amount of available supply for these cities (total of 145 ac-ft/yr) in 2013 and 2014.

3.2.1 Import and Export of Existing Water Supplies

Table 3-13 lists the existing water supplies located within Region O that are allocated to counties outside of Region O and vice versa. The Canadian River Municipal Water Authority (CRMWA) in Region A currently supplies water from the Ogallala Aquifer in Roberts County (Canadian River Basin) to eight WUGs in Region O. Several of these WUGs in turn sell a portion of their CRMWA allocation to other WUGs in Region O. The Town of Happy is a shared WUG between Region A and Region O. The town has two supply wells, one in Region O and the other in Region A. The majority of the population and water use for the Town of Happy is in Region O.

Table 3-13. Imported and Exported Existing Water Supplies from 2020 to 2070

County (Region)	Source (County)	Existing Water Supply by Decade (acre-feet per year)					
		2020	2030	2040	2050	2060	2070
Imported into Region O							
Swisher (A) [a]	Dockum (Randall)	50	50	50	50	50	50
Multiple counties (A)	Ogallala (Roberts)	34,658	27,778	26,857	24,818	22,431	20,039
Exported outside of Region O							
Randall (A)	Ogallala (Deaf Smith)	100	100	100	100	50	0
Randall (A)	Ogallala (Swisher)	10	12	12	13	12	10
King (B)	Other aquifer (Dickens)	86	86	86	86	86	86
Borden (F)	Ogallala (Dawson)	72	72	72	72	72	72
Ector (F)	Ogallala (Gaines)	2,000	2,000	2,000	2,000	2,000	2,000

[a] An estimated 5 to 7 ac-ft/yr of the imported supply will be returned to the Region A portion of the Town of Happy.

3.2.2 Existing Water Supplies by WUG Type

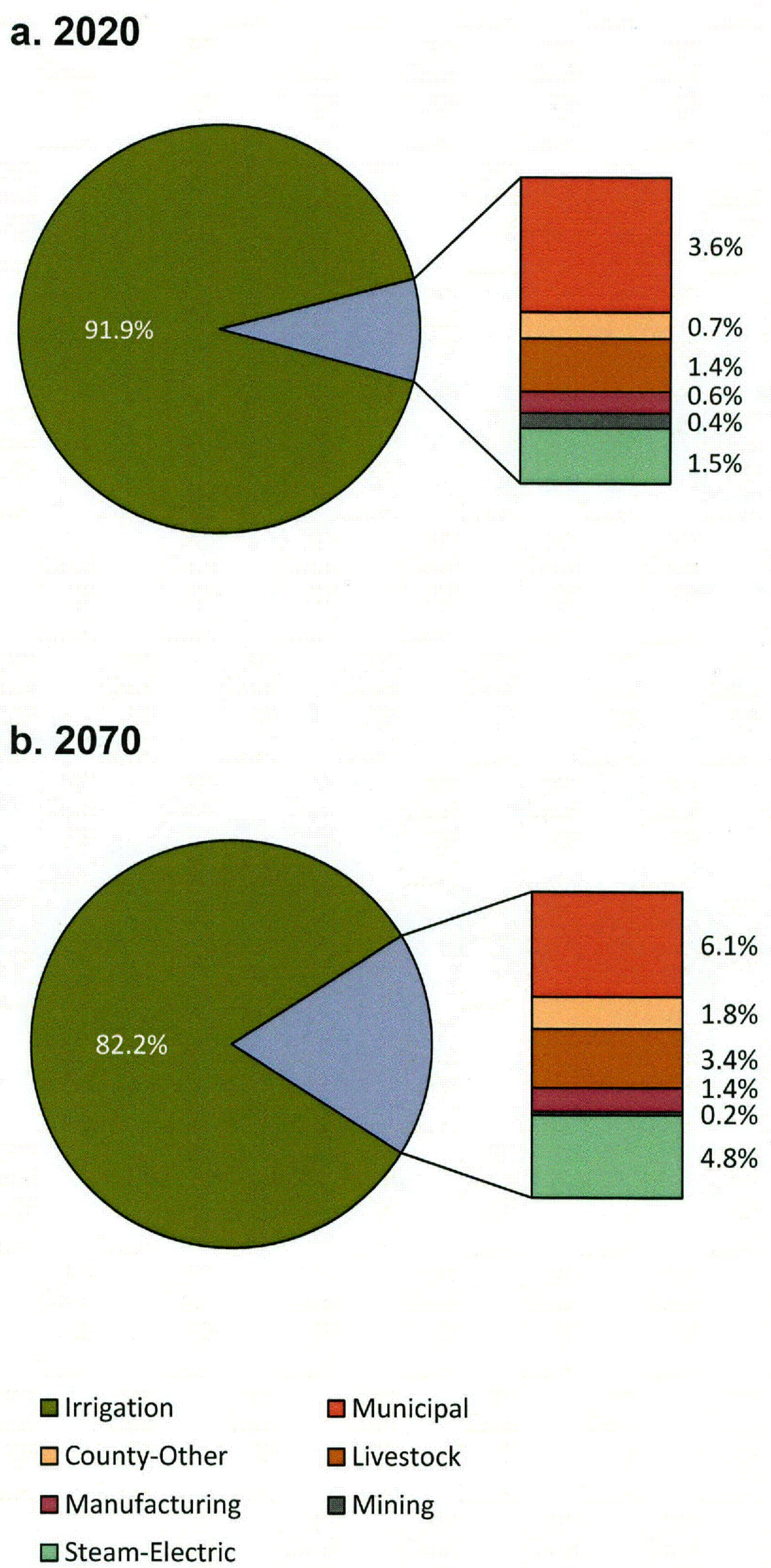
Irrigation WUGs have the largest existing water supplies in Region O, followed distantly by municipal WUGs and then livestock WUGs. Table 3-14 lists existing water supplies by WUG type for the Llano Estacado Region from 2020 to 2070. Figure 3-6 shows the division of existing water supplies by WUG type as a percentage of total supplies for 2020 and 2070. As shown in Figure 3-6, 92 percent of the region's existing water supplies belong to irrigation WUGs in 2020 and 82 percent in 2070. Existing water supplies for steam-electric power generation increase from 1.5 percent in 2020 to 4.8 percent by 2070.

Table 3-14. Existing Water Supplies by WUG Type from 2020 to 2070

WUG Type	Existing Water Supply by Decade (acre-feet per year)					
	2020	2030	2040	2050	2060	2070
County-other	14,109	14,778	15,045	15,915	16,546	18,067
Irrigation	1,838,906	1,604,789	1,328,028	1,153,935	1,019,259	802,528
Livestock	27,903	31,205	34,138	32,098	30,926	33,632
Manufacturing	11,421	12,396	13,673	13,841	13,050	13,599
Mining	7,787	6,759	4,922	2,938	2,363	2,001
Municipal	71,138	64,742	64,716	63,437	61,754	59,707
Steam-electric	29,376	34,133	41,981	46,373	48,293	47,183
Total	2,000,640	1,768,802	1,502,503	1,328,537	1,192,191	976,717

3.2.3 Existing Water Supplies by County

Figure 3-7 shows the amount of existing water supplies in 2020 and 2070 for each county. The county with the largest existing water supplies in 2020 is Gaines County with 238,460 ac-ft/yr, and in 2070 it is Hale County with 119,910 ac-ft/yr. Table 3-15 shows the existing water supplies in each county for every WUG from 2020 to 2070. Appendix 3D contains the required DB17 report for existing water supply and is presented by county.



LLANO ESTACADO REGION

Existing Water Supplies by WUG Type as a Percentage of Total in 2020 and 2070

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11/3/15

Figure 3-6

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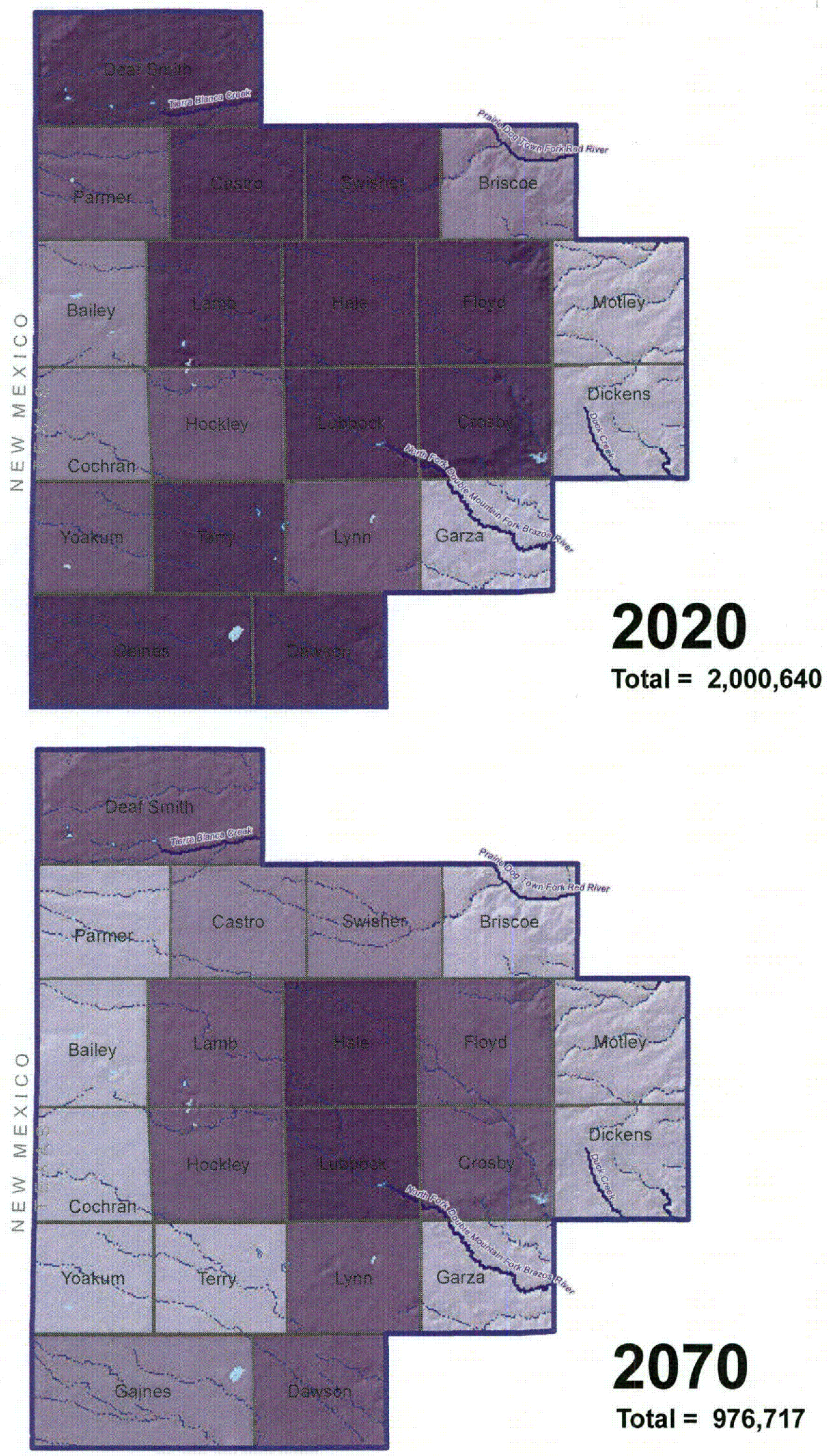

Explanation

Water planning region

County

Existing water supply (ac-ft)

<25,000

25,001 - 50,000

50,001 - 100,000

>100,000

N

0 25 50 Miles

LLANO ESTACADO REGION

Existing Water Supplies 2020 and 2070

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10/30/2015
JN WR11.0030

Figure 3-7

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**Table 3-15. Existing Water Supplies by County and WUG from 2020 to 2070
Page 1 of 7**

County	WUG Type	Existing Water Supply by Decade (acre-feet per year)					
		2020	2030	2040	2050	2060	2070
Bailey	County-other	280	300	200	225	250	265
	Irrigation	36,926	31,094	26,520	20,805	18,349	12,715
	Livestock	1,286	1,216	1,178	1,059	1,064	753
	Manufacturing	133	120	110	93	91	64
	Muleshoe	1,125	950	1,050	1,150	1,100	1,200
	Bailey Total	39,750	33,680	29,058	23,332	20,854	14,997
Briscoe	County-other	295	295	295	295	295	295
	Irrigation	33,335	24,493	18,993	17,493	16,493	10,993
	Livestock	273	273	273	273	273	273
	Silverton	71	71	71	71	71	71
	Briscoe Total	33,974	25,132	19,632	18,132	17,132	11,632
Castro	County-other	420	440	460	480	500	520
	Dimmitt	1,053	1,110	1,012	1,012	1,012	1,012
	Hart	191	191	191	191	191	191
	Irrigation	125,052	124,131	83,504	66,112	56,522	33,519
	Livestock	3,656	3,665	2,765	2,542	2,569	2,429
	Manufacturing	962	1,002	1,036	1,042	1,052	1,059
	Castro Total	131,334	130,539	88,968	71,379	61,846	38,730
Cochran	County-other	485	530	540	540	555	560
	Irrigation	35,366	32,695	29,767	26,957	24,283	21,693
	Livestock	149	159	132	369	366	242
	Mining	152	201	201	162	111	80
	Morton	350	350	350	350	350	350
	Cochran Total	36,502	33,935	30,990	28,378	25,665	22,925

Table 3-15. Existing Water Supplies by County and WUG from 2020 to 2070
Page 2 of 7

County	WUG Type	Existing Water Supply by Decade (acre-feet per year)					
		2020	2030	2040	2050	2060	2070
Crosby	County-other	238	238	238	243	243	248
	Crosbyton	344	356	366	382	401	417
	Irrigation	110,280	105,789	101,795	97,300	93,300	89,800
	Livestock	155	155	155	155	155	155
	Lorenzo	270	270	270	270	270	270
	Manufacturing	6	6	6	6	6	6
	Mining	650	631	555	480	415	360
	Ralls	338	349	358	372	389	406
	Crosby Total	112,281	107,794	103,743	99,208	95,179	91,662
Dawson	County-other	633	637	628	608	586	582
	Irrigation	108,203	102,203	96,103	91,003	85,953	76,137
	Lamesa	2,011	1,541	1,529	1,513	1,364	1,205
	Livestock	149	154	154	159	164	159
	Manufacturing	129	137	144	150	162	168
	Mining	779	455	195	0	0	0
	O'Donnell	28	11	11	9	9	8
	Dawson Total	111,932	105,138	98,764	93,442	88,238	78,259
Deaf Smith	County-other	603	641	716	791	841	941
	Hereford	4,000	4,430	5,104	5,815	6,307	6,756
	Irrigation	109,276	96,002	82,065	66,365	53,457	36,547
	Livestock	8,080	10,238	13,265	12,534	11,599	15,673
	Manufacturing	1,600	1,350	2,000	2,100	1,000	1,800
	Deaf Smith Total	123,559	112,661	103,150	87,605	73,204	61,717

Table 3-15. Existing Water Supplies by County and WUG from 2020 to 2070
Page 3 of 7

County	WUG Type	Existing Water Supply by Decade (acre-feet per year)					
		2020	2030	2040	2050	2060	2070
Dickens	County-other	294	291	286	283	281	277
	Irrigation	9,608	9,483	9,358	9,358	9,233	9,233
	Livestock	305	305	305	305	305	305
	Mining	12	12	12	12	12	12
	Spur	178	173	171	170	170	170
	Dickens Total	10,397	10,264	10,132	10,128	10,001	9,997
Floyd	County-other	292	289	284	272	258	253
	Floydada	745	742	734	706	672	665
	Irrigation	122,428	118,128	110,265	104,169	98,885	92,461
	Livestock	798	798	848	898	898	948
	Lockney	233	233	233	233	233	233
	Mining	486	492	489	486	484	485
	Floyd Total	124,982	120,682	112,853	106,764	101,430	95,045
Gaines	County-other	1,150	1,200	1,050	1,200	1,200	2,020
	Irrigation	231,255	166,599	123,060	89,980	64,296	25,401
	Livestock	240	250	265	280	290	158
	Manufacturing	1,968	1,700	1,482	1,283	1,118	494
	Mining	1,627	1,796	1,294	835	520	313
	Seagraves	420	430	450	470	470	470
	Seminole	1,800	1,500	1,500	1,600	1,800	2,000
	Gaines Total	238,460	173,475	129,101	95,648	69,694	30,856
Garza	County-other	195	189	180	171	162	154
	Irrigation	11,675	11,025	10,325	9,775	9,275	8,775
	Livestock	68	68	68	68	68	68

Table 3-15. Existing Water Supplies by County and WUG from 2020 to 2070
Page 4 of 7

County	WUG Type	Existing Water Supply by Decade (acre-feet per year)					
		2020	2030	2040	2050	2060	2070
Garza (cont.)	Manufacturing	2	2	2	2	2	2
	Mining	395	544	438	334	234	164
	Post	1,098	1,134	1,167	1,190	1,234	1,271
	Garza Total	13,433	12,962	12,180	11,540	10,975	10,434
Hale	Abernathy	452	491	489	488	494	501
	County-other	1,190	1,200	1,200	1,200	1,200	1,200
	Hale Center	300	300	300	300	300	300
	Irrigation	131,321	127,635	123,321	118,321	110,217	108,113
	Livestock	1,107	1,492	2,349	1,411	1,303	1,016
	Manufacturing	1,603	2,603	3,100	3,200	3,400	3,600
	Mining	14	13	0	0	0	0
	Petersburg	322	324	330	330	340	340
	Plainview	5,670	5,197	5,110	4,985	4,843	4,701
	Steam electric power	26	47	83	98	117	139
	Hale Total	142,005	139,302	136,282	130,333	122,214	119,910
Hockley	Anton	253	253	253	253	253	253
	County-other	1,048	1,056	1,056	1,055	1,051	1,052
	Irrigation	83,565	71,980	60,862	59,218	55,444	52,686
	Levelland	2,706	2,114	1,996	1,856	1,782	1,698
	Livestock	468	497	528	561	595	625
	Manufacturing	1,185	1,188	1,191	1,193	1,198	1,200
	Mining	1,707	1,104	500	25	0	0
	Sundown	398	398	398	398	398	398
	Hockey Total	91,330	78,590	66,784	64,559	60,721	57,912

Table 3-15. Existing Water Supplies by County and WUG from 2020 to 2070
Page 5 of 7

County	WUG Type	Existing Water Supply by Decade (acre-feet per year)					
		2020	2030	2040	2050	2060	2070
Lamb	Amherst	102	102	102	102	102	102
	County-other	450	475	510	540	570	600
	Earth	200	200	200	200	200	200
	Irrigation	126,104	107,927	84,304	62,026	47,780	28,179
	Littlefield	1,026	976	926	876	876	826
	Livestock	2,080	2,456	2,134	1,708	1,377	788
	Manufacturing	336	429	562	580	618	635
	Mining	16	12	6	0	0	0
	Olton	500	500	500	500	500	500
	Steam electric power	11,436	16,384	24,292	28,731	34,142	37,407
	Sudan	300	300	300	300	300	300
	Lamb Total	142,550	129,761	113,836	95,563	86,465	69,537
Lubbock	Abernathy	158	182	196	217	231	249
	County-other	4,656	5,056	5,406	5,906	6,406	6,906
	Idalou	400	400	400	400	400	400
	Irrigation	114,222	102,704	81,110	77,699	72,932	53,637
	Livestock	800	900	950	1,000	1,000	1,050
	Lubbock	35,271	31,324	30,822	28,887	26,867	24,555
	Manufacturing	1,929	2,291	2,472	2,625	2,836	3,005
	Mining	93	59	25	0	0	0
	New Deal	193	193	193	193	193	193
	Ransom Canyon	569	569	569	569	569	569
	Shallowater	387	387	387	387	387	387
	Slaton	628	336	249	156	95	35
	Steam electric power	15,682	15,682	15,682	15,682	12,322	8,961

Table 3-15. Existing Water Supplies by County and WUG from 2020 to 2070
Page 6 of 7

County	WUG Type	Existing Water Supply by Decade (acre-feet per year)					
		2020	2030	2040	2050	2060	2070
Lubbock (cont.)	Wolfforth	750	750	750	750	750	750
	Lubbock Total	175,738	160,833	139,211	134,471	124,988	100,697
Lynn	County-other	316	307	297	282	264	255
	Irrigation	84,592	80,072	75,767	71,682	67,817	64,587
	Livestock	159	159	159	159	159	159
	Mining	483	483	483	483	483	483
	O'Donnell	164	66	58	52	47	43
	Tahoka	483	431	401	372	356	339
	Lynn Total	86,197	81,518	77,165	73,030	69,126	65,866
Motley	County-other	110	110	105	105	105	105
	Irrigation	9,701	9,701	9,706	9,706	9,706	9,706
	Livestock	320	320	320	320	320	320
	Manufacturing	6	6	6	6	6	6
	Matador	219	219	219	219	219	219
	Mining	104	104	104	104	104	104
	Motley Total	10,460	10,460	10,460	10,460	10,460	10,460
Parmer	Bovina	376	400	400	400	400	400
	County-other	625	670	720	765	790	810
	Farwell	380	380	400	400	400	400
	Friona	800	850	910	1,000	1,055	1,055
	Irrigation	57,086	42,541	25,592	23,004	23,085	14,451
	Livestock	5,125	5,325	5,375	5,375	5,425	5,475
	Manufacturing	1,560	1,560	1,560	1,560	1,560	1,560
	Parmer Total	65,952	51,726	34,957	32,504	32,715	24,151

Table 3-15. Existing Water Supplies by County and WUG from 2020 to 2070
Page 7 of 7

County	WUG Type	Existing Water Supply by Decade (acre-feet per year)					
		2020	2030	2040	2050	2060	2070
Swisher	County-other	220	220	220	220	225	230
	Happy	139	143	140	132	123	112
	Irrigation	99,462	73,506	62,545	56,702	52,814	45,034
	Kress	184	165	149	134	120	102
	Livestock	2,370	2,485	2,605	2,740	2,875	3,020
	Tulia	754	754	754	754	754	754
	Swisher Total	103,129	77,273	66,413	60,682	56,911	49,252
Terry	Brownfield	1,799	1,115	1,060	1,009	938	868
	County-other	339	339	339	389	389	389
	Irrigation	144,022	127,133	82,585	52,973	32,771	3,381
	Livestock	315	290	310	182	121	16
	Manufacturing	2	2	2	1	1	0
	Meadow	98	98	103	108	113	113
	Mining	355	525	543	0	0	0
	Terry Total	146,930	129,502	84,942	54,662	34,333	4,767
Yoakum	County-other	270	295	315	345	375	405
	Denver City	664	810	950	1,100	1,200	1,200
	Irrigation	55,427	39,948	30,481	23,287	16,647	5,480
	Livestock	0	0	0	0	0	0
	Mining	914	328	77	17	0	0
	Plains	238	174	135	106	106	150
	Steam electric power	2,232	2,020	1,924	1,862	1,712	676
	Yoakum Total	59,745	43,575	33,882	26,717	20,040	7,911
Region O Total		2,000,640	1,768,802	1,502,503	1,328,537	1,192,191	976,717

3.2.4 Existing Water Supplies for WWPs

Four wholesale water providers (WWPs) supply water to WUGs within Region O. Table 3-16 provides the existing water supplies for each WWP.

Table 3-16. Existing Water Supplies for WWPs from 2020 to 2070

Source (County)	Existing Water Supply by Decade (acre-feet per year)					
	2020	2030	2040	2050	2060	2070
Canadian River Municipal Water Authority [a]						
Lake Meredith (Reservoir)	0	0	0	0	0	0
Ogallala (Roberts)	69,000	60,043	55,502	50,483	45,590	40,697
Region A subtotal	34,342	32,685	28,645	25,665	23,159	20,658
Region O subtotal	34,658	27,778	26,857	24,818	22,431	20,039
Total	69,000	60,043	55,502	50,483	45,590	40,697
City of Lubbock						
Lake Alan Henry (Reservoir)	8,025	8,025	8,025	8,025	8,025	8,025
Ogallala (Bailey)	2,358	1,752	1,531	1,214	900	491
Ogallala (Lamb)	906	1,411	1,700	1,700	1,900	1,900
Ogallala (Roberts)	25,569	21,723	21,153	19,535	17,629	15,726
Total	36,858	32,911	32,409	30,474	28,454	26,142
Mackenzie Municipal Water Authority						
Lake Mackenzie (Reservoir)	216	216	216	216	216	216
White River Municipal Water District						
Ogallala (Crosby)	1,627	1,681	1,731	1,783	1,863	1,933
White River Lake (Reservoir)	0	0	0	0	0	0
Total	1,627	1,681	1,731	1,783	1,863	1,933

[a] Provides to WUGs in Region A and Region O.

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Appendix 3A

Surface Water Sources Analysis

RPS

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MEMORANDUM

TO: Amy Ewing, P.G. and Andrew Donnelly

FROM: Michael Pinckney, P.E. and Tony Smith, P.E.

SUBJECT: Region O Surface Water Sources Evaluation for 2016 Regional Water Plan

DATE: June 6, 2014

Espey Consultants, Inc. dba RPS (RPS) is contracted with Daniel B. Stephens & Associates, Inc. to evaluate the surface water sources located within the Llano Estacado Regional Water Planning Area (Region O) for the 2016 Regional Water Plan. Per Texas Water Development Board (TWDB) guidelines regarding development of a Regional Water Plan and assumptions and approaches identified in the October 17, 2013 water supply assumptions letter approved December 9, 2013, RPS has identified all currently available surface water supply sources which are 100% reliable during the historical drought of record.

To identify and evaluate surface water sources within Region O, the Texas Commission on Environmental Quality's (TCEQ) Water Availability Models (WAM) have been utilized for all river basins within Region O. Past regional planning efforts have utilized TCEQ WAM Run 3, which is the most conservative representation of water availability in a river basin. Run 3 assumes full utilization of permitted diversion volumes and full consumptive use of diverted water, i.e. no return flows. The present regional water planning effort utilized the most current available WAM Run 3 from TCEQ for the Canadian, Red, Brazos, and Colorado River Basins.

Table 1 presents the available WAMs which have been utilized and their version dates. Recently, TCEQ has been in the process of updating all WAMs. Presently, only the Canadian and Red WAMs have been updated to a 2013 version and are available for download from the TCEQ (http://www.tceq.state.tx.us/permitting/water_rights/wam.html/#GIS); thus, updated Brazos and Colorado WAMs are not currently available. Previously available versions of the Brazos and Colorado WAMs have been utilized; however, these models do not reflect the most recent appropriations in the basin nor do they reflect potential environmental flow standards developed pursuant to the Senate Bill 3 rulemaking process.

Table 1: TCEQ WAM Run3 models presently available for Regional Planning

River Basin	WAM Version Date	Model Period of Record
Canadian	January 7, 2013	1948 - 1998
Red	January 2, 2013	1948 - 1998
Brazos	September 8, 2008	1940 - 1997
Colorado	August 1, 2007	1940 - 1998

ESTIMATION OF RESERVOIR SEDIMENTATION RATES FOR USE IN WAM MODEL SCENARIOS

Prior to utilization of the TCEQ WAM Run3 models for each river basin, sedimentation rates for each of the Region O reservoirs were calculated based on original impoundment capacities and updated capacities from TWDB volumetric surveys. No volumetric surveys were found for Mackenzie Reservoir; therefore, it has been assumed that the capacity of this reservoir will remain constant. This same assumption was adopted in previous Region O planning efforts.

Alan Henry Reservoir Estimated Sedimentation

Alan Henry Reservoir was constructed in 1994 with a design capacity of 115,937 ac-ft at the conservation pool elevation and a surface area of 2,884 acres. The TWDB performed a volumetric survey of Alan Henry in 2005, which reports an estimated capacity of 94,808 ac-ft at the conservation pool elevation with a surface area of 2,741 acres. No other sedimentation studies have been located for Alan Henry. From the information found, between 1994 and 2005 Alan Henry has had an 18.2% (21,129 ac-ft) reduction in storage and a 5.0% (143 acre) reduction in surface area. This represents an average annual capacity loss rate of 1.66% per year, 16.6% per decade and an annual average surface area loss of 0.45%, 4.5% per decade. The estimated average annual capacity loss rate of 1.66% per year suggests that Lake Alan Henry will have lost all storage capacity due to sedimentation by 2060. The City of Lubbock believes that the estimated sedimentation rate for Lake Alan Henry is too extreme to use for planning purposes. In lieu of the estimated sedimentation rate calculated as the loss of storage capacity from the original date of impoundment to the 2005 volumetric survey, a sedimentation rate of 0.61% per year from the 2005 Area-Capacity curve has been utilized. This rate is approximate to the sedimentation rate calculated for White River Reservoir, discussed below.

The TCEQ WAM utilizes a pair of records, Surface Area (SA) and Storage Volume (SV), to model the Storage-Area-Capacity curve of a reservoir. In order to model a loss of reservoir capacity due to sedimentation within the Brazos River WAM Run3, the SA and SV records within the WAM have been modified. It has been assumed that the SA SV records for Alan Henry in the unmodified Brazos WAM Run3 represent the area and capacity of Alan Henry at the time of impoundment (i.e. no loss of storage due to sedimentation). Thus, the modified WAM Run3 models developed to represent decadal surface water supplies from 2020 – 2070 have the SA and SV records commensurately reduced to account for sedimentation from the original impoundment date. Table 2 presents a table of the original and decadal SA and SV records for Alan Henry which have been utilized in all of the firm yield estimations for the present regional planning effort. The modifications to the WAM regarding modeling of Lake Alan Henry are presented in Attachment A.

Table 2: Base and Decadal Surface Area and Storage Volume WAM records of Alan Henry Reservoir

	Base	0	46	608	2,407	6,187	12,515	33,417	67,065	89,414	115,937	148,069	189,268
	2005	0	19	468	3,523	8,322	28,641	50,773	63,969	74,805	81,929	89,497	94,808
	2020	0	17	425	3,201	7,561	26,020	46,127	58,116	67,960	74,432	81,308	86,133
SV	2030	0	16	397	2,986	7,053	24,273	43,030	54,214	63,397	69,435	75,849	80,350
(Ac-ft)	2040	0	15	368	2,771	6,545	22,526	39,933	50,312	58,834	64,437	70,389	74,566
	2050	0	14	340	2,556	6,038	20,779	36,836	46,410	54,271	59,439	64,930	68,783
	2060	0	13	311	2,341	5,530	19,032	33,739	42,507	49,708	54,442	59,471	63,000
	2070	0	11	282	2,126	5,022	17,285	30,642	38,605	45,145	49,444	54,011	57,217
	Base	0	22	108	253	506	765	1,330	2,045	2,437	2,884	3,589	4,784
	2005	0	27	253	496	714	1,239	1,746	2,038	2,296	2,450	2,598	2,741
	2020	0	26	241	472	680	1,180	1,662	1,940	2,186	2,332	2,473	2,609
SA	2030	0	25	233	456	657	1,140	1,606	1,875	2,112	2,254	2,390	2,522
(Acres)	2040	0	24	225	440	634	1,100	1,550	1,810	2,039	2,176	2,307	2,434
	2050	0	23	217	425	611	1,061	1,495	1,745	1,965	2,097	2,224	2,346
	2060	0	22	208	409	588	1,021	1,439	1,679	1,892	2,019	2,141	2,259
	2070	0	21	200	393	565	981	1,383	1,614	1,818	1,940	2,058	2,171

White River Reservoir Estimated Sedimentation

White River Reservoir was constructed in 1963 with a design capacity of 38,650 ac-ft at the conservation pool elevation and a surface area of 1,808 acres. The TWDB performed a volumetric survey of White River in 1992, which reports an estimated capacity of 31,846 ac-ft at the conservation pool elevation with a surface area of 1,642 acres. White River's impoundment was increase in 1985 to 44,950 ac-ft with a surface area of 2,020 acres at the conservation pool elevation. From the information found, between 1963 and 1992 White River has had an 17.6% (6,804 ac-ft) reduction in storage and a 9.2% (166 acre) reduction in surface area. This represents an average annual capacity loss rate of 0.61% per year, 6.1% per decade and an annual average surface area loss of 0.32%, 3.2% per decade[1].

In order to model a loss of reservoir capacity in White River Reservoir due to sedimentation within the Brazos River WAM Run3, the SA and SV records within the WAM have been modified. It has been assumed that the SA SV records for White River in the unmodified Brazos WAM Run3 represent the area and capacity of White River at the time of impoundment (i.e. no loss of storage due to sedimentation) but extends high enough to model in the increased impoundment as of 1985. Thus the modified WAM Run3 models developed to model decadal surface water supplies from 2020 – 2070 have the SA and SV records commensurately reduced to account for sedimentation from the original impoundment date. Table 3 presents a table of the original and decadal SA and SV records for White River which have been utilized in all the firm yield estimations of this regional planning effort.

[1] Sedimentation loss estimated between the increased impoundment in 1985 to the 1992 TWDB volumetric survey suggests a drastically larger loss of capacity due to sedimentation. 29.2% loss of storage between 1985-1992 for an annual average capacity loss rate of 4.16%, 41.6% per decade, which suggests that White River Lake would have no storage capacity prior to 2020.

Table 3: Base and Decadal Surface Area and Storage Volume WAM records of White River Reservoir

SV (Ac-ft)	Base	0	900	3,800	5,700	18,000	31,000	38,600	40,000	44,910	71,600	74,000	105,000
	2020	0	589	2,485	3,728	11,772	20,274	25,244	26,160	29,371	46,826	48,395	68,669
	2030	0	534	2,254	3,382	10,679	18,392	22,901	23,731	26,644	42,479	43,903	62,295
	2040	0	479	2,024	3,036	9,586	16,510	20,558	21,303	23,918	38,133	39,411	55,921
	2050	0	425	1,793	2,690	8,494	14,628	18,214	18,875	21,192	33,786	34,919	49,547
	2060	0	370	1,562	2,344	7,401	12,746	15,871	16,447	18,466	29,440	30,427	43,173
	2070	0	315	1,332	1,998	6,308	10,865	13,528	14,019	15,740	25,094	25,935	36,799
SA (Acres)	Base	0	150	400	550	1,170	1,600	1,808	1,900	2,020	2,673	2,800	3,500
	2020	0	123	328	451	959	1,311	1,482	1,557	1,655	2,191	2,295	2,868
	2030	0	118	315	433	922	1,261	1,424	1,497	1,592	2,106	2,206	2,758
	2040	0	113	302	416	885	1,210	1,367	1,437	1,528	2,021	2,117	2,647
	2050	0	109	290	399	848	1,159	1,310	1,377	1,464	1,937	2,029	2,536
	2060	0	104	277	381	811	1,109	1,253	1,317	1,400	1,852	1,940	2,425
	2070	0	99	264	364	774	1,058	1,196	1,256	1,336	1,767	1,851	2,314

CANADIAN RIVER BASIN SURFACE WATER AVAILABILITY

Region O encompasses a very small area of the Canadian River Basin. As a result, there is very little surface water from the Canadian River Basin available in Region O. This was reflected in the draft surface water availability for the Canadian River Basin provided by the TWDB and confirmed by the lack of water right permits in the Canadian River basin within Region O. Historically, portions of Region O are supplied surface water via pipeline from Lake Meredith in Region A. According to the 2011 Region O water plan, Lake Meredith is a 920,300 ac-ft impoundment with a firm yield of 69,750 ac-ft per year and a safe yield of 63,750 ac-ft per year. Lake Meredith is currently dry and no longer producing any firm yield, indicating a new drought of record for the watershed.

RED RIVER BASIN SURFACE WATER AVAILABILITY

The Red River Basin within Region O has several permitted surface water supply sources, the largest of which is Mackenzie Reservoir. A total of 31 surface water rights have been identified within Region O; however, WAM results indicate that only seven of those rights have a reliable supply during the drought of record. Sources in Region O from the Red River are Mackenzie Reservoir and a small volume of run-of-river supply from the Red River. Identified source permits, permitted uses and modeled firm supply are summarized in Table 4.

Table 4: TCEQ WAM Run3 modeled firm supply in Red River Basin by Water Right

Red River			Calculate Firm Yield (Acre-Feet/Year)					
Water Right	Source	Uses	2020	2030	2040	2050	2060	2070
02-5099	Run-of-river	IRR	40	40	40	40	40	40
02-5100	Run-of-river	IRR	0	0	0	0	0	0
02-5101	Run-of-river	IRR	10	10	10	10	10	10
02-5102	Run-of-river	IRR	10	10	10	10	10	10
02-5103	Run-of-river	IRR	0	0	0	0	0	0
02-5104	Run-of-river	IRR	0	0	0	0	0	0
02-5105	Run-of-river	IRR	0	0	0	0	0	0
02-5106	Run-of-river	IRR	0	0	0	0	0	0
02-5179	Run-of-river	IRR	0	0	0	0	0	0

Table 4 (continued): TCEQ WAM Run3 modeled firm supply in Red River Basin by Water Right

Red River			Calculate Firm Yield (Acre-Feet/Year)					
Water Right	Source	Uses	2020	2030	2040	2050	2060	2070
02-5182	Run-of-river	IRR	0	0	0	0	0	0
02-5184	Run-of-river	IRR	0	0	0	0	0	0
02-5185	Run-of-river	IRR	0	0	0	0	0	0
02-5186	Run-of-river	IRR	10	10	10	10	10	10
02-5187	Run-of-river	IRR	0	0	0	0	0	0
02-5196	Run-of-river	IRR	0	0	0	0	0	0
02-5197	Run-of-river	IRR	0	0	0	0	0	0
02-5198	Run-of-river	IRR	0	0	0	0	0	0
02-5199	Run-of-river	IRR	0	0	0	0	0	0
02-5200	Run-of-river	IRR	0	0	0	0	0	0
02-5202	Run-of-river	IRR	0	0	0	0	0	0
02-5203	Run-of-river	IRR	0	0	0	0	0	0
02-5204	Run-of-river	IRR	0	0	0	0	0	0
02-5206	Run-of-river	IRR	0	0	0	0	0	0
02-5207	Run-of-river	IRR	0	0	0	0	0	0
02-5208	Run-of-river	IRR	0	0	0	0	0	0
02-5209	Run-of-river	IRR	0	0	0	0	0	0
02-5210	Run-of-river	IRR	0	0	0	0	0	0
02-5211	Mackenzie Reservoir	MUN	4,520	4,520	4,520	4,520	4,520	4,520
02-5212	Run-of-river	IRR	20	20	20	20	20	20
02-5220	Run-of-river	MUN	20	20	20	20	20	20
02-5267	Run-of-river	IRR	0	0	0	0	0	0

According to the 2011 Region O water plan Mackenzie Reservoir is a 45,500 ac-ft impoundment and can supply approximately 5,200 ac-ft per year when the reservoir is at conservation pool elevation. However, the report also indicates that Mackenzie Reservoir has been unable to meet contracted demands. The 2013 Red River WAM Run3 models the firm yield of Mackenzie reservoir at 4,520 ac-ft per year, suggesting a reduction in the firm yield of Mackenzie Reservoir from the 2011 Regional Water Plan. There has been no volumetric survey performed on Mackenzie Reservoir; thus, consistent with the 2013 Water Supply Assumptions Letter, the original area capacity relations have been used for all planning decades. Therefore, no modification of the TCEQ WAM Run3 representing sedimentation in Mackenzie Reservoir has been performed. Table 5 presents a summary of the surface water sources within the Red River Basin in Region O. Table 6 presents a summary of the run-of-river sources by county within the Red River Basin in Region O.

Table 5: TCEQ WAM Run3 modeled firm supply in Red River Basin

RED RIVER	Calculated Firm Yield (Acre-Feet/Year)					
Surface Water Source	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
MACKENZIE LAKE/RESERVOIR	4,520	4,520	4,520	4,520	4,520	4,520
RED RIVER COMBINED RUN-OF-RIVER IRRIGATION	90	90	90	90	90	90
RED RIVER COMBINED RUN-OF-RIVER	20	20	20	20	20	20

Table 6: TCEQ WAM Run3 modeled 100% reliable run-of-river supply in in Red River Basin

RED RIVER		Calculated Firm Yield (Acre-Feet/Year)					
Surface Water Source	**County**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
RED RIVER COMBINED RUN-OF-RIVER IRRIGATION	Briscoe	60	60	60	60	60	60
RED RIVER COMBINED RUN-OF-RIVER	Briscoe	20	20	20	20	20	20
RED RIVER COMBINED RUN-OF-RIVER IRRIGATION	Floyd	10	10	10	10	10	10
RED RIVER COMBINED RUN-OF-RIVER IRRIGATION	Motley	10	10	10	10	10	10
RED RIVER COMBINED RUN-OF-RIVER IRRIGATION	Parmer	10	10	10	10	10	10

BRAZOS RIVER BASIN SURFACE WATER AVAILABILITY

The Brazos River Basin within Region O has some surface water supply sources permitted, the largest of which is Lake Alan Henry. A total of 50 surface water rights have been identified within Region O. Modeled WAM results indicate that only ten of those rights have a reliable supply during the drought of record. Sources in Region O from the Brazos River are Alan Henry and White River Reservoirs and a small volume of run-of-river supply from the Brazos River. Identified source permits, permitted uses and modeled firm supply are summarized in Table 7. Modeling of Alan Henry has been modified from the official TCEQ WAM Run3 for the Brazos River Basin based on modeling assumptions from the 2003 Technical Memorandum Analysis of yield of Lake Alan Henry by Freese and Nichols, Inc. and the 2013 report *Yield Analyses of North and South Fork Water Projects* by HDR Engineering, Inc. The modifications are shown in Attachment A, and include:

1. Revision to the flow distribution file to utilize the USGS Gauge at Justiceberg as the gauge used to model inflows the Lake Alan Henry.
2. An assumption that Lake Alan Henry holds all inflows due to high channel losses downstream of the reservoir resulting in high water loss when inflows are released; and a subordination agreement between the City of Lubbock and the Brazos River Authority which subordinates Lake Possum Kingdom to Lake Alan Henry.

Table 7: TCEQ WAM Run3 modeled firm supply in Brazos River Basin by Water Right

Brazos			Calculate Firm Yield (Acre-Feet/Year)					
Water Right	Source	Uses	2020	2030	2040	2050	2060	2070
12-3675	Run-of-river	IRR	0	0	0	0	0	0
12-3676	Run-of-river	IRR	0	0	0	0	0	0
12-3677	Run-of-river	IRR	0	0	0	0	0	0
12-3678	Run-of-river	IRR	0	0	0	0	0	0
12-3679	Run-of-river	IRR	0	0	0	0	0	0
12-4064	Run-of-river	IRR	0	0	0	0	0	0
12-3664	Run-of-river	IRR	0	0	0	0	0	0

Table 7 (continued): TCEQ WAM Run3 modeled firm supply in Brazos River Basin by Water Right

Brazos			Calculate Firm Yield (Acre-Feet/Year)					
Water Right	Source	Uses	2020	2030	2040	2050	2060	2070
12-3665	Run-of-river	IRR	0	0	0	0	0	0
12-3666	Run-of-river	IRR	0	0	0	0	0	0
12-3667	Run-of-river	IRR	0	0	0	0	0	0
12-3668	Run-of-river	IRR	0	0	0	0	0	0
12-3670	Run-of-river	IRR	0	0	0	0	0	0
12-3671	Run-of-river	IRR	0	0	0	0	0	0
12-3672	Run-of-river	IRR	0	0	0	0	0	0
12-3673	Run-of-river	IRR	0	0	0	0	0	0
12-3674	Run-of-river	IRR	0	0	0	0	0	0
12-3690	Run-of-river	IRR	0	0	0	0	0	0
12-3680	Run-of-river	IRR	0	0	0	0	0	0
12-3681	Run-of-river	IRR	0	0	0	0	0	0
12-3682	Run-of-river	IRR	0	0	0	0	0	0
12-3683	Run-of-river	IRR	0	0	0	0	0	0
12-3684	Run-of-river	IRR	0	0	0	0	0	0
12-3685	Run-of-river	IRR	0	0	0	0	0	0
12-3686	Run-of-river	IRR	0	0	0	0	0	0
12-3687	Run-of-river	IRR	0	0	0	0	0	0
12-3688	Run-of-river	IRR	0	0	0	0	0	0
12-3689	Run-of-river	IRR	0	0	0	0	0	0
12-3704	Run-of-river	IRR	0	0	0	0	0	0
12-3813	Run-of-river	IRR	0	0	0	0	0	0
12-3915	Run-of-river	IRR	0	0	0	0	0	0
12-4035	Run-of-river	IRR	0	0	0	0	0	0
12-5405	Run-of-river	IRR	0	0	0	0	0	0
12-3703	Run-of-river	IRR	0	0	0	0	0	0
12-3715	Run-of-river	MUN	30	30	30	30	30	30
12-4146	Alan Henry Reservoir	MUN	20,600	20,320	20,020	19,700	19,380	18,720
12-5359	Run-of-river	MIN	0	0	0	0	0	0
12-3713	Run-of-river	IRR	30	30	30	30	30	30
12-3696	Run-of-river	IRR	50	50	50	50	50	50
12-3698	Run-of-river	IRR	60	60	60	60	60	60
12-3699	Run-of-river	IRR	20	20	20	20	20	20
12-3700	Run-of-river	IRR	0	0	0	0	0	0
12-3691	Run-of-river	IRR	0	0	0	0	0	0
12-3692	Run-of-river	IRR	0	0	0	0	0	0
12-3693	White River Reservoir	MUN, MIN	3,650	3,560	3,440	3,290	3,090	2,830
12-3694	Run-of-river	IRR	0	0	0	0	0	0
12-3695	Run-of-river	IRR	0	0	0	0	0	0
12-3708	Run-of-river	IRR	10	10	10	10	10	10
12-3705	Run-of-river	IRR	0	0	0	0	0	0
12-3707	Run-of-river	MUN, IRR	20	20	20	20	20	20

Available supply within the Brazos River Basin has been modeled using the 2008 version of the Brazos River WAM Run3 from the TCEQ modified to reflect sedimentation in Alan Henry and White River Reservoirs. Table 8 presents a summary of the surface water sources within the Brazos River Basin in Region O. Table 9 presents a summary of the run-of-river sources by county within the Brazos River Basin in Region O.

Table 8: TCEQ WAM Run3 modeled firm supply in Brazos River Basin

BRAZOS	Calculated Firm Yield (Acre-Feet/Year)					
Surface Water Source	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
ALAN HENRY LAKE/RESERVOIR	20,600	20,320	20,020	19,700	19,380	18,720
WHITE RIVER LAKE/RESERVOIR	3,650	3,560	3,440	3,290	3,090	2,830
BRAZOS RIVER COMBINED RUN-OF-RIVER IRRIGATION	170	170	170	170	170	170
BRAZOS RIVER COMBINED RUN-OF-RIVER	50	50	50	50	50	50

Table 9: TCEQ WAM Run3 modeled 100% reliable run-of-river supply in Brazos River Basin

BRAZOS		Calculated Firm Yield (Acre-Feet/Year)					
Surface Water Source	**County**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
BRAZOS RIVER COMBINED RUN-OF-RIVER IRRIGATION	Crosby	10	10	10	10	10	10
BRAZOS RIVER COMBINED RUN-OF-RIVER IRRIGATION	Dickens	130	130	130	130	130	130
BRAZOS RIVER COMBINED RUN-OF-RIVER	Garza	30	30	30	30	30	30
BRAZOS RIVER COMBINED RUN-OF-RIVER	Lubbock	20	20	20	20	20	20
BRAZOS RIVER COMBINED RUN-OF-RIVER IRRIGATION	Lynn	30	30	30	30	30	30

A third reservoir, Post Reservoir, is permitted and modeled in the Brazos WAM Run3, however this reservoir has not been constructed and is therefore considered a Water Management Strategy. The WAM Run3 modeled firm yield for Post Reservoir is 5,750 ac-ft per year through the planning horizon of 2020-2070.

COLORADO RIVER BASIN SURFACE WATER AVAILABILITY

Region O encompasses the head waters of the Colorado River Basin. As a result, there is very little surface water from the Colorado River Basin available in Region O. Only two surface water rights have been identified within Region O. WAM modeling of those rights indicates that there is no reliable supply during the drought of record. Thus, there are no firm surface water sources in Region O within the Colorado River Basin. Identified source permits, permitted uses and modeled firm supply are summarized in Table 10.

Table 10: TCEQ WAM Run3 modeled firm supply in Colorado River Basin by Water Right

Colorado			Calculate Firm Yield (Acre-Feet/Year)					
Water Right	Source	Uses	2020	2030	2040	2050	2060	2070
14-3150	Run-of-river	IRR	0	0	0	0	0	0
14-3122	Run-of-river	IRR	0	0	0	0	0	0

SURFACE WATER SOURCES IN REGION O

To summarize, the most current available TCEQ WAM Run3 models have been utilized to identify surface water sources which are 100% reliable during the historical drought of record. The WAM Run3 models utilized are listed in Table 1. Where data are available, the TCEQ WAM Run3 models have been modified to represent loss of storage due to sedimentation in Region O reservoirs. Alan Henry, and White River reservoirs have had at least one volumetric survey and have therefore had a loss rate due to sedimentation estimated and modeled in the WAM for determining Firm Yield. The modeled average annual sedimentation rate for Alan Henry and White River is 0.61%. Mackenzie Reservoir has no data available with which to estimate storage loss, and is assumed to have a constant storage. Table 11 presents a summary of the surface water sources available in Region O, where 'Local Irrigation' represents the firm run-of-river sources permitted for irrigation use and 'Other Local Supply' represents the firm run-of-river water sources permitted for non-irrigation uses. Table 12 presents the water user groups/wholesale water providers (WUG/WWP) and their surface water sources by basin in Region O.

Table 11: Region O modeled firm surface water supplies

	Calculated Firm Yield (Acre-Feet/Year)					
Summary	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Reservoirs in Region O	28,770	28,400	27,980	27,510	26,990	26,070
Local Irrigation	260	260	260	260	260	260
Other Local Supply	70	70	70	70	70	70

Table 12: Region O modeled firm surface water supplies

Basin	WUG/WWP	Source
Red	Mackenzie MWA	Mackenzie Reservoir
Red	TPWD	5220
Brazos	City of Lubbock	Alan Henry
Brazos	White River MWD	White River
Brazos	Post ISD	3715
Brazos	Town of Lake Ransom Canyon	3707

Surface Water availability is based on WAM period of records which covers roughly 1948-1998 of the historical hydrologic record, within which the drought of record occurred in the 1950s. Present reservoir storage volumes within Region O suggest that the region is within or has recently experienced a new drought of record and firm surface water supplies within the region should be reduced for planning purposes. This may require consideration of an expanded hydrological period within future WAM models in the region in order to reflect this variation in the basins' hydroclimatology.

RPS

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MEMORANDUM

Attachment A

WAM Model of Alan Henry

TCEQ Brazos WAM Run3 9/08/2008 model code for Lake Alan Henry:

```
**FD4146P1  DMAS09       1  DMJU08  BSLU07
FD4146P1  DMJU08      -1

** RPS Modify Alan Henry modeling based on FNI March 27,2003 Memo Analysis of the Yield of Lake
Alan Henry
** Modifications include revised DIS so that flow at Alan Henry Control Point based on Double
Mountain Fork at Justiceberg USGS Gauge, and assumption of all inflows held due to waste of
releases from high channel losses.
WR4146P1  35000.    MUN117811005   1   2  0.0000                         P4146_1   P414614146001
WSALANHN 115937.                              0
** Secondary use of treated wastewater is authorized but not modeled.
**WR4146P1  21000.    IRR119811005   1   2  0.0000                         P4146_2
P414614146001
**WSALANHN 115937.                              0
WR4146P1     0.0    IND117811005   1   2  0.0000                         P4146_3   P414614146001
WSALANHN 115937.                              0
```

Appendix 3B

Water Availability Modeling Input Files

Appendix 3B. Water Availability Modeling Input Files

Appendix 3B is available only in the electronic version of this plan

Appendix 3C

Source Availability

Source Availability

REGION O

GROUNDWATER	COUNTY	BASIN	SALINITY	SOURCE AVAILABILITY (ACRE-FEET PER YEAR)					
				2020	2030	2040	2050	2060	2070
DOCKUM AQUIFER	BAILEY	BRAZOS	FRESH	1	1	1	1	1	1
DOCKUM AQUIFER	BRISCOE	RED	FRESH	231	231	231	231	231	231
DOCKUM AQUIFER	CASTRO	BRAZOS	FRESH	0	0	0	0	0	0
DOCKUM AQUIFER	CASTRO	RED	FRESH	1	1	1	1	1	1
DOCKUM AQUIFER	COCHRAN	BRAZOS	FRESH	0	0	0	0	0	0
DOCKUM AQUIFER	COCHRAN	COLORADO	FRESH	0	0	0	0	0	0
DOCKUM AQUIFER	CROSBY	BRAZOS	FRESH	4,061	4,061	4,061	4,061	4,061	4,061
DOCKUM AQUIFER	CROSBY	RED	FRESH	48	48	48	48	48	48
DOCKUM AQUIFER	DAWSON	COLORADO	FRESH	31	31	31	31	31	31
DOCKUM AQUIFER	DEAF SMITH	CANADIAN	FRESH	1,082	1,082	1,082	1,082	1,082	1,082
DOCKUM AQUIFER	DEAF SMITH	RED	FRESH	3,630	3,630	3,630	3,630	3,630	3,630
DOCKUM AQUIFER	DICKENS	BRAZOS	FRESH	2,126	2,126	2,126	2,126	2,126	2,126
DOCKUM AQUIFER	DICKENS	RED	FRESH	1,584	1,584	1,584	1,584	1,584	1,584
DOCKUM AQUIFER	FLOYD	BRAZOS	FRESH	745	745	745	745	745	745
DOCKUM AQUIFER	FLOYD	RED	FRESH	939	939	939	939	939	939
DOCKUM AQUIFER	GAINES	COLORADO	FRESH	0	0	0	0	0	0
DOCKUM AQUIFER	GARZA	BRAZOS	BRACKISH	611	611	611	611	611	611
DOCKUM AQUIFER	GARZA	COLORADO	FRESH	2	2	2	2	2	2
DOCKUM AQUIFER	HALE	BRAZOS	FRESH	734	734	734	734	734	734
DOCKUM AQUIFER	HALE	RED	FRESH	4	4	4	4	4	4
DOCKUM AQUIFER	HOCKLEY	BRAZOS	FRESH	571	571	571	571	571	571
DOCKUM AQUIFER	HOCKLEY	COLORADO	FRESH	0	0	0	0	0	0
DOCKUM AQUIFER	LAMB	BRAZOS	FRESH	0	0	0	0	0	0
DOCKUM AQUIFER	LUBBOCK	BRAZOS	FRESH	15	15	15	15	15	15
DOCKUM AQUIFER	LYNN	BRAZOS	FRESH	5	5	5	5	5	5
DOCKUM AQUIFER	LYNN	COLORADO	FRESH	0	0	0	0	0	0
DOCKUM AQUIFER	MOTLEY	RED	FRESH	2,860	2,860	2,860	2,860	2,860	2,860
DOCKUM AQUIFER	PARMER	BRAZOS	FRESH	0	0	0	0	0	0
DOCKUM AQUIFER	PARMER	RED	FRESH	2	2	2	2	2	2
DOCKUM AQUIFER	SWISHER	BRAZOS	FRESH	83	83	83	83	83	83
DOCKUM AQUIFER	SWISHER	RED	FRESH	614	614	614	614	614	614
EDWARDS-TRINITY-HIGH PLAINS AQUIFER	BAILEY	BRAZOS	FRESH	279	279	279	279	279	279
EDWARDS-TRINITY-HIGH PLAINS AQUIFER	COCHRAN	BRAZOS	FRESH	137	137	137	137	137	137
EDWARDS-TRINITY-HIGH PLAINS AQUIFER	COCHRAN	COLORADO	FRESH	127	127	127	127	127	127
EDWARDS-TRINITY-HIGH PLAINS AQUIFER	DAWSON	BRAZOS	FRESH	0	0	0	0	0	0
EDWARDS-TRINITY-HIGH PLAINS AQUIFER	DAWSON	COLORADO	FRESH	1,103	1,103	1,103	1,103	1,103	1,103
EDWARDS-TRINITY-HIGH PLAINS AQUIFER	FLOYD	BRAZOS	FRESH	521	521	518	505	499	491
EDWARDS-TRINITY-HIGH PLAINS AQUIFER	FLOYD	RED	FRESH	695	695	695	695	683	671

Source Availability

REGION O									
GROUNDWATER	COUNTY	BASIN	SALINITY	SOURCE AVAILABILITY (ACRE-FEET PER YEAR)					
				2020	2030	2040	2050	2060	2070
EDWARDS-TRINITY-HIGH PLAINS AQUIFER	GAINES	COLORADO	FRESH	46,202	30,316	22,997	16,523	12,904	1,672
EDWARDS-TRINITY-HIGH PLAINS AQUIFER	GARZA	BRAZOS	FRESH	18	18	18	18	18	18
EDWARDS-TRINITY-HIGH PLAINS AQUIFER	GARZA	COLORADO	FRESH	0	0	0	0	0	0
EDWARDS-TRINITY-HIGH PLAINS AQUIFER	HALE	BRAZOS	FRESH	3,523	3,523	3,523	3,523	3,419	3,315
EDWARDS-TRINITY-HIGH PLAINS AQUIFER	HOCKLEY	BRAZOS	FRESH	96	96	96	96	96	96
EDWARDS-TRINITY-HIGH PLAINS AQUIFER	HOCKLEY	COLORADO	FRESH	0	0	0	0	0	0
EDWARDS-TRINITY-HIGH PLAINS AQUIFER	LAMB	BRAZOS	FRESH	164	164	164	164	164	164
EDWARDS-TRINITY-HIGH PLAINS AQUIFER	LUBBOCK	BRAZOS	FRESH	690	690	690	690	690	690
EDWARDS-TRINITY-HIGH PLAINS AQUIFER	LYNN	BRAZOS	FRESH	221	221	221	221	221	221
EDWARDS-TRINITY-HIGH PLAINS AQUIFER	LYNN	COLORADO	FRESH	9	9	9	9	9	9
EDWARDS-TRINITY-HIGH PLAINS AQUIFER	TERRY	BRAZOS	FRESH	23	23	23	23	23	23
EDWARDS-TRINITY-HIGH PLAINS AQUIFER	TERRY	COLORADO	FRESH	959	922	922	922	922	922
EDWARDS-TRINITY-HIGH PLAINS AQUIFER	YOAKUM	COLORADO	FRESH	1,893	1,757	1,642	1,642	1,524	1,436
OGALLALA AQUIFER	BAILEY	BRAZOS	FRESH	41,283	34,907	30,064	24,021	21,429	15,163
OGALLALA AQUIFER	BRISCOE	RED	FRESH	26,457	19,722	14,220	13,037	11,933	6,354
OGALLALA AQUIFER	CASTRO	BRAZOS	FRESH	90,367	90,367	90,367	88,630	84,458	81,909
OGALLALA AQUIFER	CASTRO	RED	FRESH	36,936	36,141	35,449	34,650	33,540	32,858
OGALLALA AQUIFER	COCHRAN	BRAZOS	FRESH	7,707	6,556	4,770	4,410	4,179	2,764
OGALLALA AQUIFER	COCHRAN	COLORADO	FRESH	28,501	27,085	25,926	23,674	21,192	19,867
OGALLALA AQUIFER	CROSBY	BRAZOS	FRESH	133,058	133,058	133,058	133,058	133,058	133,058
OGALLALA AQUIFER	CROSBY	RED	FRESH	1,624	1,624	1,624	1,624	1,624	1,624
OGALLALA AQUIFER	DAWSON	BRAZOS	FRESH	5,350	5,350	5,138	4,075	1,099	462
OGALLALA AQUIFER	DAWSON	COLORADO	FRESH	192,758	180,531	156,477	131,379	92,681	75,973
OGALLALA AQUIFER	DEAF SMITH	CANADIAN	BRACKISH	74	1	1	1	1	1
OGALLALA AQUIFER	DEAF SMITH	RED	FRESH	118,166	106,868	97,057	80,382	65,931	54,394
OGALLALA AQUIFER	DICKENS	BRAZOS	FRESH	5,939	5,939	5,939	5,939	5,939	5,939
OGALLALA AQUIFER	DICKENS	RED	FRESH	6,400	6,400	6,181	6,181	5,655	5,546
OGALLALA AQUIFER	FLOYD	BRAZOS	FRESH	93,749	92,041	90,930	86,458	84,300	82,151
OGALLALA AQUIFER	FLOYD	RED	FRESH	55,617	53,320	47,453	43,351	40,061	35,636
OGALLALA AQUIFER	GAINES	COLORADO	FRESH	240,110	175,175	130,951	97,498	71,544	32,706
OGALLALA AQUIFER	GARZA	BRAZOS	FRESH	19,073	18,942	18,812	18,032	17,121	16,952
OGALLALA AQUIFER	HALE	BRAZOS	FRESH	129,291	127,492	125,488	119,612	111,734	109,825
OGALLALA AQUIFER	HALE	RED	FRESH	525	525	525	525	525	525
OGALLALA AQUIFER	HOCKLEY	BRAZOS	FRESH	84,378	80,285	76,847	69,445	60,771	56,929
OGALLALA AQUIFER	HOCKLEY	COLORADO	FRESH	8,004	8,004	7,571	7,324	7,009	6,669
OGALLALA AQUIFER	LAMB	BRAZOS	FRESH	137,304	125,466	111,509	95,696	85,190	70,834

Source Availability

REGION O

GROUNDWATER	COUNTY	BASIN	SALINITY	SOURCE AVAILABILITY (ACRE-FEET PER YEAR) 2020	2030	2040	2050	2060	2070
OGALLALA AQUIFER	LUBBOCK	BRAZOS	FRESH	120,044	115,348	108,699	100,762	91,073	85,427
OGALLALA AQUIFER	LYNN	BRAZOS	FRESH	97,740	96,954	94,600	86,945	78,543	76,436
OGALLALA AQUIFER	LYNN	COLORADO	FRESH	6,020	6,020	6,020	6,020	5,925	5,830
OGALLALA AQUIFER	MOTLEY	RED	FRESH	9,936	9,936	9,936	9,936	9,576	9,216
OGALLALA AQUIFER	PARMER	BRAZOS	FRESH	45,572	39,624	35,624	29,978	27,692	22,076
OGALLALA AQUIFER	PARMER	RED	FRESH	17,493	16,960	16,525	15,642	13,289	13,064
OGALLALA AQUIFER	SWISHER	BRAZOS	FRESH	28,248	26,603	19,889	14,084	8,304	3,704
OGALLALA AQUIFER	SWISHER	RED	FRESH	79,158	74,399	64,929	59,764	55,994	48,560
OGALLALA AQUIFER	TERRY	BRAZOS	FRESH	13,342	13,342	9,793	5,348	4,092	95
OGALLALA AQUIFER	TERRY	COLORADO	FRESH	182,880	121,267	77,305	48,557	29,555	4,056
OGALLALA AQUIFER	YOAKUM	COLORADO	FRESH	59,745	43,575	33,882	26,717	20,040	7,911
OTHER AQUIFER	BRISCOE	RED	FRESH	4,000	4,000	4,000	4,000	4,000	4,000
OTHER AQUIFER	CROSBY	BRAZOS	BRACKISH	7,000	7,000	7,000	7,000	7,000	7,000
OTHER AQUIFER	DICKENS	BRAZOS	BRACKISH	5,000	5,000	5,000	5,000	5,000	5,000
OTHER AQUIFER	DICKENS	RED	BRACKISH	3,000	3,000	3,000	3,000	3,000	3,000
OTHER AQUIFER	FLOYD	RED	FRESH	12,000	12,000	12,000	12,000	12,000	12,000
OTHER AQUIFER	GARZA	BRAZOS	FRESH	1,250	1,250	1,250	1,250	1,250	1,250
OTHER AQUIFER	HALE	BRAZOS	FRESH	800	800	800	800	800	800
OTHER AQUIFER	MOTLEY	RED	BRACKISH	9,000	9,000	9,000	9,000	9,000	9,000
SEYMOUR AQUIFER	BRISCOE	RED	BRACKISH	4,063	1,821	1,821	1,821	1,821	1,821
SEYMOUR AQUIFER	MOTLEY	RED	FRESH	1,776	1,769	1,769	1,685	1,685	1,657
GROUNDWATER TOTAL SOURCE AVAILABILITY				**2,247,378**	**2,006,048**	**1,792,343**	**1,584,968**	**1,393,411**	**1,201,396**

REGION O

REUSE	COUNTY	BASIN	SALINITY	SOURCE AVAILABILITY (ACRE-FEET PER YEAR) 2020	2030	2040	2050	2060	2070
DIRECT REUSE	BAILEY	BRAZOS	FRESH	825	825	825	825	825	825
DIRECT REUSE	CASTRO	BRAZOS	FRESH	4,031	4,031	4,031	4,031	4,031	4,031
DIRECT REUSE	COCHRAN	BRAZOS	FRESH	267	267	267	267	267	267
DIRECT REUSE	COCHRAN	COLORADO	FRESH	27	27	27	27	27	27
DIRECT REUSE	CROSBY	BRAZOS	FRESH	583	583	583	583	583	583
DIRECT REUSE	DEAF SMITH	RED	FRESH	2,810	2,810	2,810	2,810	2,810	2,810
DIRECT REUSE	FLOYD	BRAZOS	FRESH	449	449	449	449	449	449
DIRECT REUSE	HALE	BRAZOS	FRESH	5,477	5,477	5,477	5,477	5,477	5,477
DIRECT REUSE	HOCKLEY	BRAZOS	FRESH	1,359	1,359	1,359	1,359	1,359	1,359
DIRECT REUSE	HOCKLEY	COLORADO	FRESH	162	162	162	162	162	162
DIRECT REUSE	LAMB	BRAZOS	FRESH	7,199	7,199	7,199	7,199	7,199	7,199
DIRECT REUSE	LUBBOCK	BRAZOS	FRESH	22,728	25,136	27,029	28,508	29,762	30,759
DIRECT REUSE	LYNN	BRAZOS	FRESH	346	346	346	346	346	346
DIRECT REUSE	PARMER	BRAZOS	FRESH	401	401	401	401	401	401
DIRECT REUSE	PARMER	RED	FRESH	2,486	2,486	2,486	2,486	2,486	2,486
REUSE TOTAL SOURCE AVAILABILITY				**49,150**	**51,558**	**53,451**	**54,930**	**56,184**	**57,181**

Source Availability

REGION O									
				SOURCE AVAILABILITY (ACRE-FEET PER YEAR)					
SURFACE WATER	COUNTY	BASIN	SALINITY	2020	2030	2040	2050	2060	2070
ALAN HENRY LAKE/RESERVOIR	RESERVOIR	BRAZOS	FRESH	20,600	20,320	20,020	19,700	19,380	18,720
BRAZOS LIVESTOCK LOCAL SUPPLY	BAILEY	BRAZOS	FRESH	0	0	0	0	0	0
BRAZOS LIVESTOCK LOCAL SUPPLY	CASTRO	BRAZOS	FRESH	0	0	0	0	0	0
BRAZOS LIVESTOCK LOCAL SUPPLY	COCHRAN	BRAZOS	FRESH	0	0	0	0	0	0
BRAZOS LIVESTOCK LOCAL SUPPLY	CROSBY	BRAZOS	FRESH	0	0	0	0	0	0
BRAZOS LIVESTOCK LOCAL SUPPLY	DAWSON	BRAZOS	FRESH	0	0	0	0	0	0
BRAZOS LIVESTOCK LOCAL SUPPLY	DICKENS	BRAZOS	FRESH	0	0	0	0	0	0
BRAZOS LIVESTOCK LOCAL SUPPLY	FLOYD	BRAZOS	FRESH	0	0	0	0	0	0
BRAZOS LIVESTOCK LOCAL SUPPLY	GARZA	BRAZOS	FRESH	0	0	0	0	0	0
BRAZOS LIVESTOCK LOCAL SUPPLY	HALE	BRAZOS	FRESH	0	0	0	0	0	0
BRAZOS LIVESTOCK LOCAL SUPPLY	HOCKLEY	BRAZOS	FRESH	0	0	0	0	0	0
BRAZOS LIVESTOCK LOCAL SUPPLY	LAMB	BRAZOS	FRESH	0	0	0	0	0	0
BRAZOS LIVESTOCK LOCAL SUPPLY	LUBBOCK	BRAZOS	FRESH	0	0	0	0	0	0
BRAZOS LIVESTOCK LOCAL SUPPLY	LYNN	BRAZOS	FRESH	0	0	0	0	0	0
BRAZOS LIVESTOCK LOCAL SUPPLY	PARMER	BRAZOS	FRESH	0	0	0	0	0	0
BRAZOS LIVESTOCK LOCAL SUPPLY	SWISHER	BRAZOS	FRESH	0	0	0	0	0	0
BRAZOS LIVESTOCK LOCAL SUPPLY	TERRY	BRAZOS	FRESH	0	0	0	0	0	0
BRAZOS RUN-OF-RIVER | COMBINED IRRIGATION WR 12-3708	CROSBY	BRAZOS	FRESH	10	10	10	10	10	10
BRAZOS RUN-OF-RIVER | COMBINED IRRIGATION WR 12-3696, 12-3698, 12-3699	DICKENS	BRAZOS	FRESH	130	130	130	130	130	130
BRAZOS RUN-OF-RIVER | COMBINED IRRIGATION WR 12-3713	LYNN	BRAZOS	FRESH	30	30	30	30	30	30
BRAZOS RUN-OF-RIVER | COMBINED MUNICIPAL WR 12-3715 POST ISD	GARZA	BRAZOS	FRESH	30	30	30	30	30	30
BRAZOS RUN-OF-RIVER | MUNICIPAL WR 12-3707 TOWN OF LAKE RANSON CANYON	LUBBOCK	BRAZOS	FRESH	20	20	20	20	20	20
CANADIAN LIVESTOCK LOCAL SUPPLY	DEAF SMITH	CANADIAN	FRESH	0	0	0	0	0	0
COLORADO LIVESTOCK LOCAL SUPPLY	COCHRAN	COLORADO	FRESH	0	0	0	0	0	0
COLORADO LIVESTOCK LOCAL SUPPLY	DAWSON	COLORADO	FRESH	0	0	0	0	0	0
COLORADO LIVESTOCK LOCAL SUPPLY	GAINES	COLORADO	FRESH	0	0	0	0	0	0

Source Availability

REGION O

SURFACE WATER	COUNTY	BASIN	SALINITY	SOURCE AVAILABILITY (ACRE-FEET PER YEAR) 2020	2030	2040	2050	2060	2070
COLORADO LIVESTOCK LOCAL SUPPLY	HOCKLEY	COLORADO	FRESH	0	0	0	0	0	0
COLORADO LIVESTOCK LOCAL SUPPLY	LYNN	COLORADO	FRESH	0	0	0	0	0	0
COLORADO LIVESTOCK LOCAL SUPPLY	TERRY	COLORADO	FRESH	0	0	0	0	0	0
COLORADO LIVESTOCK LOCAL SUPPLY	YOAKUM	COLORADO	FRESH	0	0	0	0	0	0
MACKENZIE LAKE/RESERVOIR	RESERVOIR	RED	FRESH	4,520	4,520	4,520	4,520	4,520	4,520
RED LIVESTOCK LOCAL SUPPLY	BRISCOE	RED	FRESH	0	0	0	0	0	0
RED LIVESTOCK LOCAL SUPPLY	CASTRO	RED	FRESH	0	0	0	0	0	0
RED LIVESTOCK LOCAL SUPPLY	CROSBY	RED	FRESH	0	0	0	0	0	0
RED LIVESTOCK LOCAL SUPPLY	DEAF SMITH	RED	FRESH	0	0	0	0	0	0
RED LIVESTOCK LOCAL SUPPLY	DICKENS	RED	FRESH	0	0	0	0	0	0
RED LIVESTOCK LOCAL SUPPLY	FLOYD	RED	FRESH	0	0	0	0	0	0
RED LIVESTOCK LOCAL SUPPLY	HALE	RED	FRESH	0	0	0	0	0	0
RED LIVESTOCK LOCAL SUPPLY	MOTLEY	RED	FRESH	0	0	0	0	0	0
RED LIVESTOCK LOCAL SUPPLY	PARMER	RED	FRESH	0	0	0	0	0	0
RED LIVESTOCK LOCAL SUPPLY	SWISHER	RED	FRESH	0	0	0	0	0	0
RED RUN-OF-RIVER | IRRIGATION WR 02-5099, 02-5212	BRISCOE	RED	FRESH	60	60	60	60	60	60
RED RUN-OF-RIVER | IRRIGATION WR 02-5101	FLOYD	RED	FRESH	10	10	10	10	10	10
RED RUN-OF-RIVER | IRRIGATION WR 02-5102	MOTLEY	RED	FRESH	10	10	10	10	10	10
RED RUN-OF-RIVER | IRRIGATION WR 02-5186	PARMER	RED	FRESH	10	10	10	10	10	10
RED RUN-OF-RIVER | MUNICIPAL WR 02-5220 TPWD CAPROCK CANYONS STATE PARK	BRISCOE	RED	FRESH	20	20	20	20	20	20
WHITE RIVER LAKE/RESERVOIR	RESERVOIR	BRAZOS	FRESH	0	0	0	0	0	0
SURFACE WATER TOTAL SOURCE AVAILABILITY				**25,450**	**25,170**	**24,870**	**24,550**	**24,230**	**23,570**
REGION O TOTAL SOURCE AVAILABILITY				**2,321,978**	**2,082,776**	**1,870,664**	**1,664,448**	**1,473,825**	**1,282,147**

Appendix 3D

Existing Water Supply

Water User Group (WUG) Existing Water Supply

REGION O	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR) 2020	2030	2040	2050	2060	2070
BAILEY COUNTY							
BRAZOS BASIN							
MULESHOE	O | OGALLALA AQUIFER | BAILEY COUNTY	1,125	950	1,050	1,150	1,100	1,200
COUNTY-OTHER	O | OGALLALA AQUIFER | BAILEY COUNTY	280	300	200	225	250	265
MANUFACTURING	O | OGALLALA AQUIFER | BAILEY COUNTY	133	120	110	93	91	64
LIVESTOCK	O | BRAZOS LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
LIVESTOCK	O | OGALLALA AQUIFER | BAILEY COUNTY	1,286	1,216	1,178	1,059	1,064	753
IRRIGATION	O | DIRECT REUSE	825	825	825	825	825	825
IRRIGATION	O | OGALLALA AQUIFER | BAILEY COUNTY	36,101	30,269	25,695	19,980	17,524	11,890
BRAZOS BASIN TOTAL EXISTING SUPPLY		**39,750**	**33,680**	**29,058**	**23,332**	**20,854**	**14,997**
BAILEY COUNTY TOTAL EXISTING SUPPLY		**39,750**	**33,680**	**29,058**	**23,332**	**20,854**	**14,997**
BRISCOE COUNTY							
RED BASIN							
SILVERTON	O | MACKENZIE LAKE/RESERVOIR	71	71	71	71	71	71
SILVERTON	O | OGALLALA AQUIFER | BRISCOE COUNTY	0	0	0	0	0	0
COUNTY-OTHER	O | OTHER AQUIFER | BRISCOE COUNTY	295	295	295	295	295	295
LIVESTOCK	O | DOCKUM AQUIFER | BRISCOE COUNTY	37	37	37	37	37	37
LIVESTOCK	O | OGALLALA AQUIFER | BRISCOE COUNTY	103	103	103	103	103	103
LIVESTOCK	O | OTHER AQUIFER | BRISCOE COUNTY	133	133	133	133	133	133
LIVESTOCK	O | RED LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
IRRIGATION	O | DOCKUM AQUIFER | BRISCOE COUNTY	100	100	100	100	100	100
IRRIGATION	O | OGALLALA AQUIFER | BRISCOE COUNTY	25,600	19,000	13,500	12,000	11,000	5,500
IRRIGATION	O | OTHER AQUIFER | BRISCOE COUNTY	3,572	3,572	3,572	3,572	3,572	3,572
IRRIGATION	O | SEYMOUR AQUIFER BRACKISH | BRISCOE COUNTY	4,063	1,821	1,821	1,821	1,821	1,821
RED BASIN TOTAL EXISTING SUPPLY		**33,974**	**25,132**	**19,632**	**18,132**	**17,132**	**11,632**
BRISCOE COUNTY TOTAL EXISTING SUPPLY		**33,974**	**25,132**	**19,632**	**18,132**	**17,132**	**11,632**
CASTRO COUNTY							
BRAZOS BASIN							
DIMMITT	O | OGALLALA AQUIFER | CASTRO COUNTY	1,053	1,110	1,012	1,012	1,012	1,012
HART	O | OGALLALA AQUIFER | CASTRO COUNTY	191	191	191	191	191	191
COUNTY-OTHER	O | OGALLALA AQUIFER | CASTRO COUNTY	200	210	220	230	240	250
MANUFACTURING	O | OGALLALA AQUIFER | CASTRO COUNTY	900	900	900	900	900	900
LIVESTOCK	O | BRAZOS LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
LIVESTOCK	O | OGALLALA AQUIFER | CASTRO COUNTY	1,431	1,440	540	317	344	204
IRRIGATION	O | DIRECT REUSE	4,031	4,031	4,031	4,031	4,031	4,031
IRRIGATION	O | OGALLALA AQUIFER | CASTRO COUNTY	86,592	86,516	56,082	40,914	34,238	21,999
BRAZOS BASIN TOTAL EXISTING SUPPLY		**94,398**	**94,398**	**62,976**	**47,595**	**40,956**	**28,587**
RED BASIN							
COUNTY-OTHER	O | OGALLALA AQUIFER | CASTRO COUNTY	220	230	240	250	260	270
MANUFACTURING	O | OGALLALA AQUIFER | CASTRO COUNTY	62	102	136	142	152	159
LIVESTOCK	O | OGALLALA AQUIFER | CASTRO COUNTY	2,225	2,225	2,225	2,225	2,225	2,225
LIVESTOCK	O | RED LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
IRRIGATION	O | OGALLALA AQUIFER | CASTRO COUNTY	34,429	33,584	23,391	21,167	18,253	7,489

Water User Group (WUG) Existing Water Supply

REGION O	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR) 2020	2030	2040	2050	2060	2070
CASTRO COUNTY							
RED BASIN TOTAL EXISTING SUPPLY		**36,936**	**36,141**	**25,992**	**23,784**	**20,890**	**10,143**
CASTRO COUNTY TOTAL EXISTING SUPPLY		**131,334**	**130,539**	**88,968**	**71,379**	**61,846**	**38,730**
COCHRAN COUNTY							
BRAZOS BASIN							
MORTON	O | OGALLALA AQUIFER | COCHRAN COUNTY	350	350	350	350	350	350
COUNTY-OTHER	O | OGALLALA AQUIFER | COCHRAN COUNTY	360	400	410	410	425	430
MINING	O | OGALLALA AQUIFER | COCHRAN COUNTY	2	1	1	2	1	0
LIVESTOCK	O | BRAZOS LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
LIVESTOCK	O | OGALLALA AQUIFER | COCHRAN COUNTY	149	159	132	369	366	242
IRRIGATION	O | DIRECT REUSE	267	267	267	267	267	267
IRRIGATION	O | OGALLALA AQUIFER | COCHRAN COUNTY	6,846	5,646	3,877	3,279	3,037	1,742
BRAZOS BASIN TOTAL EXISTING SUPPLY		**7,974**	**6,823**	**5,037**	**4,677**	**4,446**	**3,031**
COLORADO BASIN							
COUNTY-OTHER	O | OGALLALA AQUIFER | COCHRAN COUNTY	125	130	130	130	130	130
MINING	O | OGALLALA AQUIFER | COCHRAN COUNTY	150	200	200	160	110	80
LIVESTOCK	O | COLORADO LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
IRRIGATION	O | DIRECT REUSE	27	27	27	27	27	27
IRRIGATION	O | OGALLALA AQUIFER | COCHRAN COUNTY	28,226	26,755	25,596	23,384	20,952	19,657
COLORADO BASIN TOTAL EXISTING SUPPLY		**28,528**	**27,112**	**25,953**	**23,701**	**21,219**	**19,894**
COCHRAN COUNTY TOTAL EXISTING SUPPLY		**36,502**	**33,935**	**30,990**	**28,378**	**25,665**	**22,925**
CROSBY COUNTY							
BRAZOS BASIN							
CROSBYTON	O | OGALLALA AQUIFER | CROSBY COUNTY	344	356	366	382	401	417
LORENZO	O | OGALLALA AQUIFER | CROSBY COUNTY	270	270	270	270	270	270
RALLS	O | OGALLALA AQUIFER | CROSBY COUNTY	338	349	358	372	389	406
COUNTY-OTHER	O | DOCKUM AQUIFER | CROSBY COUNTY	10	10	10	10	10	10
COUNTY-OTHER	O | OGALLALA AQUIFER | CROSBY COUNTY	221	221	221	226	226	231
COUNTY-OTHER	O | OTHER AQUIFER BRACKISH | CROSBY COUNTY	5	5	5	5	5	5
MANUFACTURING	O | OGALLALA AQUIFER | CROSBY COUNTY	6	6	6	6	6	6
MINING	O | OGALLALA AQUIFER | CROSBY COUNTY	630	620	550	480	415	360
LIVESTOCK	O | BRAZOS LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
LIVESTOCK	O | DOCKUM AQUIFER | CROSBY COUNTY	55	55	55	55	55	55
LIVESTOCK	O | OGALLALA AQUIFER | CROSBY COUNTY	50	50	50	50	50	50
LIVESTOCK	O | OTHER AQUIFER BRACKISH | CROSBY COUNTY	45	45	45	45	45	45
IRRIGATION	O | DIRECT REUSE	583	583	583	583	583	583
IRRIGATION	O | DOCKUM AQUIFER | CROSBY COUNTY	2,900	2,900	2,900	2,900	2,900	2,900
IRRIGATION	O | OGALLALA AQUIFER | CROSBY COUNTY	98,500	94,000	90,000	85,500	81,500	78,000
IRRIGATION	O | OTHER AQUIFER BRACKISH | CROSBY COUNTY	6,700	6,700	6,700	6,700	6,700	6,700
BRAZOS BASIN TOTAL EXISTING SUPPLY		**110,657**	**106,170**	**102,119**	**97,584**	**93,555**	**90,038**
RED BASIN							
COUNTY-OTHER	O | OGALLALA AQUIFER | CROSBY COUNTY	2	2	2	2	2	2
MINING	O | OGALLALA AQUIFER | CROSBY COUNTY	20	11	5	0	0	0

Water User Group (WUG) Existing Water Supply

REGION O	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR)					
		2020	2030	2040	2050	2060	2070
CROSBY COUNTY							
RED BASIN							
LIVESTOCK	O | OGALLALA AQUIFER | CROSBY COUNTY	5	5	5	5	5	5
LIVESTOCK	O | RED LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
IRRIGATION	O | OGALLALA AQUIFER | CROSBY COUNTY	1,597	1,606	1,612	1,617	1,617	1,617
RED BASIN TOTAL EXISTING SUPPLY		**1,624**	**1,624**	**1,624**	**1,624**	**1,624**	**1,624**
CROSBY COUNTY TOTAL EXISTING SUPPLY		**112,281**	**107,794**	**103,743**	**99,208**	**95,179**	**91,662**
DAWSON COUNTY							
BRAZOS BASIN							
O'DONNELL	A | OGALLALA AQUIFER | ROBERTS COUNTY	28	11	11	9	9	8
COUNTY-OTHER	O | OGALLALA AQUIFER | DAWSON COUNTY	15	15	15	15	15	15
LIVESTOCK	O | BRAZOS LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
IRRIGATION	O | OGALLALA AQUIFER | DAWSON COUNTY	1,100	1,100	1,000	900	850	447
BRAZOS BASIN TOTAL EXISTING SUPPLY		**1,143**	**1,126**	**1,026**	**924**	**874**	**470**
COLORADO BASIN							
LAMESA	A | OGALLALA AQUIFER | ROBERTS COUNTY	1,503	1,084	1,118	1,143	1,031	920
LAMESA	O | OGALLALA AQUIFER | DAWSON COUNTY	508	457	411	370	333	285
COUNTY-OTHER	O | DOCKUM AQUIFER | DAWSON COUNTY	6	6	6	6	6	6
COUNTY-OTHER	O | OGALLALA AQUIFER | DAWSON COUNTY	612	616	607	587	565	561
MANUFACTURING	O | OGALLALA AQUIFER | DAWSON COUNTY	129	137	144	150	162	168
MINING	O | OGALLALA AQUIFER | DAWSON COUNTY	779	455	195	0	0	0
LIVESTOCK	O | COLORADO LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
LIVESTOCK	O | DOCKUM AQUIFER | DAWSON COUNTY	9	9	9	9	9	9
LIVESTOCK	O | OGALLALA AQUIFER | DAWSON COUNTY	140	145	145	150	155	150
IRRIGATION	O | EDWARDS-TRINITY-HIGH PLAINS AQUIFER | DAWSON COUNTY	1,103	1,103	1,103	1,103	1,103	1,103
IRRIGATION	O | OGALLALA AQUIFER | DAWSON COUNTY	106,000	100,000	94,000	89,000	84,000	74,587
COLORADO BASIN TOTAL EXISTING SUPPLY		**110,789**	**104,012**	**97,738**	**92,518**	**87,364**	**77,789**
DAWSON COUNTY TOTAL EXISTING SUPPLY		**111,932**	**105,138**	**98,764**	**93,442**	**88,238**	**78,259**
DEAF SMITH COUNTY							
CANADIAN BASIN							
COUNTY-OTHER	O | DOCKUM AQUIFER | DEAF SMITH COUNTY	15	15	15	15	15	15
COUNTY-OTHER	O | OGALLALA AQUIFER BRACKISH | DEAF SMITH COUNTY	1	1	1	1	1	1
LIVESTOCK	O | CANADIAN LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
LIVESTOCK	O | DOCKUM AQUIFER | DEAF SMITH COUNTY	50	50	50	50	50	50
IRRIGATION	O | DOCKUM AQUIFER | DEAF SMITH COUNTY	1,017	1,017	1,017	1,017	1,017	1,017
CANADIAN BASIN TOTAL EXISTING SUPPLY		**1,083**	**1,083**	**1,083**	**1,083**	**1,083**	**1,083**
RED BASIN							
HEREFORD	O | DOCKUM AQUIFER | DEAF SMITH COUNTY	1,800	2,200	2,500	3,630	3,630	3,630
HEREFORD	O | OGALLALA AQUIFER | DEAF SMITH COUNTY	2,200	2,230	2,604	2,185	2,677	3,126
COUNTY-OTHER	O | OGALLALA AQUIFER | DEAF SMITH COUNTY	587	625	700	775	825	925
MANUFACTURING	O | OGALLALA AQUIFER | DEAF SMITH COUNTY	1,600	1,350	2,000	2,100	1,000	1,800
LIVESTOCK	O | OGALLALA AQUIFER | DEAF SMITH COUNTY	8,030	10,188	13,215	12,484	11,549	15,623
LIVESTOCK	O | RED LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0

Water User Group (WUG) Existing Water Supply

REGION O	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR) 2020	2030	2040	2050	2060	2070
DEAF SMITH COUNTY							
RED BASIN							
IRRIGATION	O | DIRECT REUSE	2,810	2,810	2,810	2,810	2,810	2,810
IRRIGATION	O | OGALLALA AQUIFER | DEAF SMITH COUNTY	105,449	92,175	78,238	62,538	49,630	32,720
RED BASIN TOTAL EXISTING SUPPLY		**122,476**	**111,578**	**102,067**	**86,522**	**72,121**	**60,634**
DEAF SMITH COUNTY TOTAL EXISTING SUPPLY		**123,559**	**112,661**	**103,150**	**87,605**	**73,204**	**61,717**
DICKENS COUNTY							
BRAZOS BASIN							
SPUR	O | OGALLALA AQUIFER | CROSBY COUNTY	178	173	171	170	170	170
COUNTY-OTHER	O | OGALLALA AQUIFER | DICKENS COUNTY	12	12	12	12	12	12
COUNTY-OTHER	O | OTHER AQUIFER BRACKISH | DICKENS COUNTY	140	140	140	140	140	140
MINING	O | OGALLALA AQUIFER | DICKENS COUNTY	10	10	10	10	10	10
LIVESTOCK	O | BRAZOS LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
LIVESTOCK	O | DOCKUM AQUIFER | DICKENS COUNTY	35	35	35	35	35	35
LIVESTOCK	O | OGALLALA AQUIFER | DICKENS COUNTY	40	40	40	40	40	40
LIVESTOCK	O | OTHER AQUIFER BRACKISH | DICKENS COUNTY	130	130	130	130	130	130
IRRIGATION	O | OGALLALA AQUIFER | DICKENS COUNTY	825	800	775	775	750	750
IRRIGATION	O | OTHER AQUIFER BRACKISH | DICKENS COUNTY	4,730	4,730	4,730	4,730	4,730	4,730
BRAZOS BASIN TOTAL EXISTING SUPPLY		**6,100**	**6,070**	**6,043**	**6,042**	**6,017**	**6,017**
RED BASIN							
COUNTY-OTHER	O | OGALLALA AQUIFER | DICKENS COUNTY	41	38	33	30	28	24
COUNTY-OTHER	O | OTHER AQUIFER BRACKISH | DICKENS COUNTY	101	101	101	101	101	101
MINING	O | OGALLALA AQUIFER | DICKENS COUNTY	2	2	2	2	2	2
LIVESTOCK	O | DOCKUM AQUIFER | DICKENS COUNTY	25	25	25	25	25	25
LIVESTOCK	O | OGALLALA AQUIFER | DICKENS COUNTY	15	15	15	15	15	15
LIVESTOCK	O | OTHER AQUIFER BRACKISH | DICKENS COUNTY	60	60	60	60	60	60
LIVESTOCK	O | RED LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
IRRIGATION	O | OGALLALA AQUIFER | DICKENS COUNTY	1,300	1,200	1,100	1,100	1,000	1,000
IRRIGATION	O | OTHER AQUIFER BRACKISH | DICKENS COUNTY	2,753	2,753	2,753	2,753	2,753	2,753
RED BASIN TOTAL EXISTING SUPPLY		**4,297**	**4,194**	**4,089**	**4,086**	**3,984**	**3,980**
DICKENS COUNTY TOTAL EXISTING SUPPLY		**10,397**	**10,264**	**10,132**	**10,128**	**10,001**	**9,997**
FLOYD COUNTY							
BRAZOS BASIN							
FLOYDADA	O | MACKENZIE LAKE/RESERVOIR	49	49	49	49	49	49
FLOYDADA	O | OGALLALA AQUIFER | FLOYD COUNTY	696	693	685	657	623	616
LOCKNEY	O | MACKENZIE LAKE/RESERVOIR	35	35	35	35	35	35
LOCKNEY	O | OGALLALA AQUIFER | FLOYD COUNTY	198	198	198	198	198	198
COUNTY-OTHER	O | OGALLALA AQUIFER | FLOYD COUNTY	185	183	180	172	163	160
MINING	O | OGALLALA AQUIFER | FLOYD COUNTY	214	216	215	214	213	213
LIVESTOCK	O | BRAZOS LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
LIVESTOCK	O | OGALLALA AQUIFER | FLOYD COUNTY	600	600	650	700	700	750
IRRIGATION	O | DIRECT REUSE	449	449	449	449	449	449

Water User Group (WUG) Existing Water Supply

REGION O	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR) 2020	2030	2040	2050	2060	2070
FLOYD COUNTY							
BRAZOS BASIN							
IRRIGATION	O | OGALLALA AQUIFER | FLOYD COUNTY	54,000	52,000	50,000	48,000	46,000	44,000
BRAZOS BASIN TOTAL EXISTING SUPPLY		**56,426**	**54,423**	**52,461**	**50,474**	**48,430**	**46,470**
RED BASIN							
COUNTY-OTHER	O | OGALLALA AQUIFER | FLOYD COUNTY	107	106	104	100	95	93
MINING	O | OGALLALA AQUIFER | FLOYD COUNTY	272	276	274	272	271	272
LIVESTOCK	O | DOCKUM AQUIFER | FLOYD COUNTY	53	53	53	53	53	53
LIVESTOCK	O | OGALLALA AQUIFER | FLOYD COUNTY	120	120	120	120	120	120
LIVESTOCK	O | OTHER AQUIFER | FLOYD COUNTY	25	25	25	25	25	25
LIVESTOCK	O | RED LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
IRRIGATION	O | DOCKUM AQUIFER | FLOYD COUNTY	886	886	886	886	886	886
IRRIGATION	O | OGALLALA AQUIFER | FLOYD COUNTY	55,118	52,818	46,955	42,859	39,575	35,151
IRRIGATION	O | OTHER AQUIFER | FLOYD COUNTY	11,975	11,975	11,975	11,975	11,975	11,975
RED BASIN TOTAL EXISTING SUPPLY		**68,556**	**66,259**	**60,392**	**56,290**	**53,000**	**48,575**
FLOYD COUNTY TOTAL EXISTING SUPPLY		**124,982**	**120,682**	**112,853**	**106,764**	**101,430**	**95,045**
GAINES COUNTY							
COLORADO BASIN							
SEAGRAVES	O | OGALLALA AQUIFER | GAINES COUNTY	420	430	450	470	470	470
SEMINOLE	O | OGALLALA AQUIFER | GAINES COUNTY	1,800	1,500	1,500	1,600	1,800	2,000
COUNTY-OTHER	O | OGALLALA AQUIFER | GAINES COUNTY	1,150	1,200	1,050	1,200	1,200	2,020
MANUFACTURING	O | OGALLALA AQUIFER | GAINES COUNTY	1,968	1,700	1,482	1,283	1,118	494
MINING	O | OGALLALA AQUIFER | GAINES COUNTY	1,627	1,796	1,294	835	520	313
LIVESTOCK	O | COLORADO LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
LIVESTOCK	O | OGALLALA AQUIFER | GAINES COUNTY	240	250	265	280	290	158
IRRIGATION	O | OGALLALA AQUIFER | GAINES COUNTY	231,255	166,599	123,060	89,980	64,296	25,401
COLORADO BASIN TOTAL EXISTING SUPPLY		**238,460**	**173,475**	**129,101**	**95,648**	**69,694**	**30,856**
GAINES COUNTY TOTAL EXISTING SUPPLY		**238,460**	**173,475**	**129,101**	**95,648**	**69,694**	**30,856**
GARZA COUNTY							
BRAZOS BASIN							
POST	A | OGALLALA AQUIFER | ROBERTS COUNTY	306	306	306	306	306	306
POST	O | OGALLALA AQUIFER | CROSBY COUNTY	792	828	861	884	928	965
COUNTY-OTHER	O | ALAN HENRY LAKE/RESERVOIR	25	25	25	25	25	25
COUNTY-OTHER	O | DOCKUM AQUIFER BRACKISH | GARZA COUNTY	36	36	36	36	36	36
COUNTY-OTHER	O | OGALLALA AQUIFER | GARZA COUNTY	134	128	119	110	101	93
MANUFACTURING	O | OGALLALA AQUIFER | GARZA COUNTY	2	2	2	2	2	2
MINING	O | OGALLALA AQUIFER | GARZA COUNTY	395	544	438	334	234	164
LIVESTOCK	O | BRAZOS LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
LIVESTOCK	O | DOCKUM AQUIFER BRACKISH | GARZA COUNTY	31	31	31	31	31	31
LIVESTOCK	O | EDWARDS-TRINITY-HIGH PLAINS AQUIFER | GARZA COUNTY	4	4	4	4	4	4
LIVESTOCK	O | OGALLALA AQUIFER | GARZA COUNTY	13	13	13	13	13	13
LIVESTOCK	O | OTHER AQUIFER | GARZA COUNTY	20	20	20	20	20	20

Water User Group (WUG) Existing Water Supply

REGION O	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR) 2020	2030	2040	2050	2060	2070
GARZA COUNTY							
BRAZOS BASIN							
IRRIGATION	O | DOCKUM AQUIFER BRACKISH | GARZA COUNTY	182	182	182	182	182	182
IRRIGATION	O | OGALLALA AQUIFER | GARZA COUNTY	10,400	9,750	9,050	8,500	8,000	7,500
IRRIGATION	O | OTHER AQUIFER | GARZA COUNTY	1,093	1,093	1,093	1,093	1,093	1,093
BRAZOS BASIN TOTAL EXISTING SUPPLY		**13,433**	**12,962**	**12,180**	**11,540**	**10,975**	**10,434**
GARZA COUNTY TOTAL EXISTING SUPPLY		**13,433**	**12,962**	**12,180**	**11,540**	**10,975**	**10,434**
HALE COUNTY							
BRAZOS BASIN							
ABERNATHY	O | OGALLALA AQUIFER | HALE COUNTY	452	491	489	488	494	501
HALE CENTER	O | OGALLALA AQUIFER | HALE COUNTY	300	300	300	300	300	300
PETERSBURG	O | OGALLALA AQUIFER | HALE COUNTY	322	324	330	330	340	340
PLAINVIEW	A | OGALLALA AQUIFER | ROBERTS COUNTY	2,547	1,667	1,580	1,455	1,313	1,171
PLAINVIEW	O | OGALLALA AQUIFER | HALE COUNTY	3,123	3,530	3,530	3,530	3,530	3,530
COUNTY-OTHER	O | OGALLALA AQUIFER | HALE COUNTY	1,190	1,200	1,200	1,200	1,200	1,200
MANUFACTURING	O | OGALLALA AQUIFER | HALE COUNTY	1,603	2,603	3,100	3,200	3,400	3,600
MINING	O | OGALLALA AQUIFER | HALE COUNTY	14	13	0	0	0	0
STEAM ELECTRIC POWER	O | OGALLALA AQUIFER | HALE COUNTY	26	47	83	98	117	139
LIVESTOCK	O | BRAZOS LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
LIVESTOCK	O | OGALLALA AQUIFER | HALE COUNTY	1,103	1,488	2,345	1,407	1,299	1,012
IRRIGATION	O | DIRECT REUSE	5,477	5,477	5,477	5,477	5,477	5,477
IRRIGATION	O | EDWARDS-TRINITY-HIGH PLAINS AQUIFER | HALE COUNTY	3,523	3,523	3,523	3,523	3,419	3,315
IRRIGATION	O | OGALLALA AQUIFER | HALE COUNTY	119,790	116,141	111,870	106,921	99,000	97,021
IRRIGATION	O | OTHER AQUIFER | HALE COUNTY	800	800	800	800	800	800
BRAZOS BASIN TOTAL EXISTING SUPPLY		**140,270**	**137,604**	**134,627**	**128,729**	**120,689**	**118,406**
RED BASIN							
LIVESTOCK	O | OGALLALA AQUIFER | HALE COUNTY	4	4	4	4	4	4
LIVESTOCK	O | RED LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
IRRIGATION	O | OGALLALA AQUIFER | HALE COUNTY	1,731	1,694	1,651	1,600	1,521	1,500
RED BASIN TOTAL EXISTING SUPPLY		**1,735**	**1,698**	**1,655**	**1,604**	**1,525**	**1,504**
HALE COUNTY TOTAL EXISTING SUPPLY		**142,005**	**139,302**	**136,282**	**130,333**	**122,214**	**119,910**
HOCKLEY COUNTY							
BRAZOS BASIN							
ANTON	O | OGALLALA AQUIFER | HOCKLEY COUNTY	253	253	253	253	253	253
LEVELLAND	A | OGALLALA AQUIFER | ROBERTS COUNTY	1,926	1,334	1,216	1,076	1,002	918
LEVELLAND	O | OGALLALA AQUIFER | HOCKLEY COUNTY	780	780	780	780	780	780
COUNTY-OTHER	O | OGALLALA AQUIFER | HOCKLEY COUNTY	1,016	1,016	1,016	1,016	1,016	1,016
MANUFACTURING	O | OGALLALA AQUIFER | HOCKLEY COUNTY	1,185	1,188	1,191	1,193	1,198	1,200
MINING	O | OGALLALA AQUIFER | HOCKLEY COUNTY	1,510	981	378	19	0	0
LIVESTOCK	O | BRAZOS LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
LIVESTOCK	O | OGALLALA AQUIFER | HOCKLEY COUNTY	468	497	528	561	595	625
IRRIGATION	O | DIRECT REUSE	1,359	1,359	1,359	1,359	1,359	1,359
IRRIGATION	O | OGALLALA AQUIFER | HOCKLEY COUNTY	74,667	63,016	52,330	50,816	47,347	45,181

Water User Group (WUG) Existing Water Supply

REGION O	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR)					
		2020	2030	2040	2050	2060	2070
HOCKLEY COUNTY							
BRAZOS BASIN TOTAL EXISTING SUPPLY		**83,164**	**70,424**	**59,051**	**57,073**	**53,550**	**51,332**
COLORADO BASIN							
SUNDOWN	O | OGALLALA AQUIFER | HOCKLEY COUNTY	398	398	398	398	398	398
COUNTY-OTHER	O | OGALLALA AQUIFER | HOCKLEY COUNTY	32	40	40	39	35	36
MINING	O | OGALLALA AQUIFER | HOCKLEY COUNTY	197	123	122	6	0	0
LIVESTOCK	O | COLORADO LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
IRRIGATION	O | DIRECT REUSE	162	162	162	162	162	162
IRRIGATION	O | OGALLALA AQUIFER | HOCKLEY COUNTY	7,377	7,443	7,011	6,881	6,576	5,984
COLORADO BASIN TOTAL EXISTING SUPPLY		**8,166**	**8,166**	**7,733**	**7,486**	**7,171**	**6,580**
HOCKLEY COUNTY TOTAL EXISTING SUPPLY		**91,330**	**78,590**	**66,784**	**64,559**	**60,721**	**57,912**
LAMB COUNTY							
BRAZOS BASIN							
AMHERST	O | OGALLALA AQUIFER | LAMB COUNTY	102	102	102	102	102	102
EARTH	O | OGALLALA AQUIFER | LAMB COUNTY	200	200	200	200	200	200
LITTLEFIELD	O | OGALLALA AQUIFER | LAMB COUNTY	1,026	976	926	876	876	826
OLTON	O | OGALLALA AQUIFER | LAMB COUNTY	500	500	500	500	500	500
SUDAN	O | OGALLALA AQUIFER | LAMB COUNTY	300	300	300	300	300	300
COUNTY-OTHER	O | OGALLALA AQUIFER | LAMB COUNTY	450	475	510	540	570	600
MANUFACTURING	O | OGALLALA AQUIFER | LAMB COUNTY	336	429	562	580	618	635
MINING	O | OGALLALA AQUIFER | LAMB COUNTY	16	12	6	0	0	0
STEAM ELECTRIC POWER	O | OGALLALA AQUIFER | LAMB COUNTY	11,436	16,384	24,292	28,731	34,142	37,407
LIVESTOCK	O | BRAZOS LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
LIVESTOCK	O | OGALLALA AQUIFER | LAMB COUNTY	2,080	2,456	2,134	1,708	1,377	788
IRRIGATION	O | DIRECT REUSE	7,199	7,199	7,199	7,199	7,199	7,199
IRRIGATION	O | OGALLALA AQUIFER | LAMB COUNTY	118,905	100,728	77,105	54,827	40,581	20,980
BRAZOS BASIN TOTAL EXISTING SUPPLY		**142,550**	**129,761**	**113,836**	**95,563**	**86,465**	**69,537**
LAMB COUNTY TOTAL EXISTING SUPPLY		**142,550**	**129,761**	**113,836**	**95,563**	**86,465**	**69,537**
LUBBOCK COUNTY							
BRAZOS BASIN							
LUBBOCK	A | OGALLALA AQUIFER | ROBERTS COUNTY	25,227	21,381	20,811	19,193	17,287	15,384
LUBBOCK	O | ALAN HENRY LAKE/RESERVOIR	7,655	7,655	7,655	7,655	7,655	7,655
LUBBOCK	O | OGALLALA AQUIFER | BAILEY COUNTY	1,827	1,221	1,000	683	369	0
LUBBOCK	O | OGALLALA AQUIFER | LAMB COUNTY	562	1,067	1,356	1,356	1,556	1,516
ABERNATHY	O | OGALLALA AQUIFER | HALE COUNTY	158	182	196	217	231	249
IDALOU	O | OGALLALA AQUIFER | LUBBOCK COUNTY	400	400	400	400	400	400
NEW DEAL	A | OGALLALA AQUIFER | ROBERTS COUNTY	153	153	153	153	153	153
NEW DEAL	O | OGALLALA AQUIFER | LUBBOCK COUNTY	40	40	40	40	40	40
RANSOM CANYON	A | OGALLALA AQUIFER | ROBERTS COUNTY	142	142	142	142	142	142
RANSOM CANYON	O | ALAN HENRY LAKE/RESERVOIR	143	143	143	143	143	143
RANSOM CANYON	O | OGALLALA AQUIFER | BAILEY COUNTY	142	142	142	142	142	142
RANSOM CANYON	O | OGALLALA AQUIFER | LAMB COUNTY	142	142	142	142	142	142
SHALLOWATER	O | OGALLALA AQUIFER | BAILEY COUNTY	187	187	187	187	187	187

Water User Group (WUG) Existing Water Supply

REGION O	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR)					
		2020	2030	2040	2050	2060	2070
LUBBOCK COUNTY							
BRAZOS BASIN							
SHALLOWATER	O | OGALLALA AQUIFER | LUBBOCK COUNTY	200	200	200	200	200	200
SLATON	A | OGALLALA AQUIFER | ROBERTS COUNTY	628	336	249	156	95	35
WOLFFORTH	O | OGALLALA AQUIFER | LUBBOCK COUNTY	750	750	750	750	750	750
COUNTY-OTHER	A | OGALLALA AQUIFER | ROBERTS COUNTY	200	200	200	200	200	200
COUNTY-OTHER	O | ALAN HENRY LAKE/RESERVOIR	202	202	202	202	202	202
COUNTY-OTHER	O | OGALLALA AQUIFER | BAILEY COUNTY	202	202	202	202	202	162
COUNTY-OTHER	O | OGALLALA AQUIFER | LAMB COUNTY	202	202	202	202	202	242
COUNTY-OTHER	O | OGALLALA AQUIFER | LUBBOCK COUNTY	3,850	4,250	4,600	5,100	5,600	6,100
MANUFACTURING	O | OGALLALA AQUIFER | LUBBOCK COUNTY	1,929	2,291	2,472	2,625	2,836	3,005
MINING	O | OGALLALA AQUIFER | LUBBOCK COUNTY	93	59	25	0	0	0
STEAM ELECTRIC POWER	O | DIRECT REUSE	15,682	15,682	15,682	15,682	12,322	8,961
LIVESTOCK	O | BRAZOS LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
LIVESTOCK	O | OGALLALA AQUIFER | LUBBOCK COUNTY	800	900	950	1,000	1,000	1,050
IRRIGATION	O | DIRECT REUSE	2,240	2,240	2,240	2,240	2,240	2,240
IRRIGATION	O | OGALLALA AQUIFER | LUBBOCK COUNTY	111,982	100,464	78,870	75,459	70,692	51,397
BRAZOS BASIN TOTAL EXISTING SUPPLY		**175,738**	**160,833**	**139,211**	**134,471**	**124,988**	**100,697**
LUBBOCK COUNTY TOTAL EXISTING SUPPLY		**175,738**	**160,833**	**139,211**	**134,471**	**124,988**	**100,697**
LYNN COUNTY							
BRAZOS BASIN							
O'DONNELL	A | OGALLALA AQUIFER | ROBERTS COUNTY	164	66	58	52	47	43
TAHOKA	A | OGALLALA AQUIFER | ROBERTS COUNTY	317	265	235	206	190	173
TAHOKA	O | OGALLALA AQUIFER | LYNN COUNTY	166	166	166	166	166	166
COUNTY-OTHER	O | OGALLALA AQUIFER | LYNN COUNTY	301	292	282	267	249	240
MINING	O | OGALLALA AQUIFER | LYNN COUNTY	450	450	450	450	450	450
LIVESTOCK	O | BRAZOS LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
LIVESTOCK	O | OGALLALA AQUIFER | LYNN COUNTY	150	150	150	150	150	150
IRRIGATION	O | DIRECT REUSE	346	346	346	346	346	346
IRRIGATION	O | EDWARDS-TRINITY-HIGH PLAINS AQUIFER | LYNN COUNTY	221	221	221	221	221	221
IRRIGATION	O | OGALLALA AQUIFER | LYNN COUNTY	78,100	73,900	69,900	66,100	62,500	59,500
BRAZOS BASIN TOTAL EXISTING SUPPLY		**80,215**	**75,856**	**71,808**	**67,958**	**64,319**	**61,289**
COLORADO BASIN							
COUNTY-OTHER	O | OGALLALA AQUIFER | LYNN COUNTY	15	15	15	15	15	15
MINING	O | OGALLALA AQUIFER | LYNN COUNTY	33	33	33	33	33	33
LIVESTOCK	O | COLORADO LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
LIVESTOCK	O | OGALLALA AQUIFER | LYNN COUNTY	9	9	9	9	9	9
IRRIGATION	O | OGALLALA AQUIFER | LYNN COUNTY	5,925	5,605	5,300	5,015	4,750	4,520
COLORADO BASIN TOTAL EXISTING SUPPLY		**5,982**	**5,662**	**5,357**	**5,072**	**4,807**	**4,577**
LYNN COUNTY TOTAL EXISTING SUPPLY		**86,197**	**81,518**	**77,165**	**73,030**	**69,126**	**65,866**
MOTLEY COUNTY							
RED BASIN							
MATADOR	O | OTHER AQUIFER BRACKISH | MOTLEY COUNTY	219	219	219	219	219	219

Water User Group (WUG) Existing Water Supply

REGION O	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR)					
		2020	2030	2040	2050	2060	2070
MOTLEY COUNTY							
RED BASIN							
COUNTY-OTHER	O | OTHER AQUIFER BRACKISH | MOTLEY COUNTY	75	75	70	70	70	70
COUNTY-OTHER	O | SEYMOUR AQUIFER | MOTLEY COUNTY	35	35	35	35	35	35
MANUFACTURING	O | OGALLALA AQUIFER | MOTLEY COUNTY	6	6	6	6	6	6
MINING	O | OGALLALA AQUIFER | MOTLEY COUNTY	104	104	104	104	104	104
LIVESTOCK	O | DOCKUM AQUIFER | MOTLEY COUNTY	50	50	50	50	50	50
LIVESTOCK	O | OGALLALA AQUIFER | MOTLEY COUNTY	20	20	20	20	20	20
LIVESTOCK	O | OTHER AQUIFER BRACKISH | MOTLEY COUNTY	250	250	250	250	250	250
LIVESTOCK	O | RED LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
IRRIGATION	O | DOCKUM AQUIFER | MOTLEY COUNTY	910	910	910	910	910	910
IRRIGATION	O | OGALLALA AQUIFER | MOTLEY COUNTY	250	250	250	250	250	250
IRRIGATION	O | OTHER AQUIFER BRACKISH | MOTLEY COUNTY	8,456	8,456	8,461	8,461	8,461	8,461
IRRIGATION	O | SEYMOUR AQUIFER | MOTLEY COUNTY	85	85	85	85	85	85
RED BASIN TOTAL EXISTING SUPPLY		**10,460**	**10,460**	**10,460**	**10,460**	**10,460**	**10,460**
MOTLEY COUNTY TOTAL EXISTING SUPPLY		**10,460**	**10,460**	**10,460**	**10,460**	**10,460**	**10,460**
PARMER COUNTY							
BRAZOS BASIN							
BOVINA	O | OGALLALA AQUIFER | PARMER COUNTY	376	400	400	400	400	400
FARWELL	O | OGALLALA AQUIFER | PARMER COUNTY	380	380	400	400	400	400
COUNTY-OTHER	O | OGALLALA AQUIFER | PARMER COUNTY	390	415	450	475	475	475
LIVESTOCK	O | BRAZOS LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
LIVESTOCK	O | OGALLALA AQUIFER | PARMER COUNTY	3,925	3,925	3,925	3,925	3,925	3,925
IRRIGATION	O | DIRECT REUSE	401	401	401	401	401	401
IRRIGATION	O | OGALLALA AQUIFER | PARMER COUNTY	40,501	26,759	10,370	8,775	11,339	3,000
BRAZOS BASIN TOTAL EXISTING SUPPLY		**45,973**	**32,280**	**15,946**	**14,376**	**16,940**	**8,601**
RED BASIN							
FRIONA	O | OGALLALA AQUIFER | PARMER COUNTY	800	850	910	1,000	1,055	1,055
COUNTY-OTHER	O | OGALLALA AQUIFER | PARMER COUNTY	235	255	270	290	315	335
MANUFACTURING	O | OGALLALA AQUIFER | PARMER COUNTY	1,560	1,560	1,560	1,560	1,560	1,560
LIVESTOCK	O | OGALLALA AQUIFER | PARMER COUNTY	1,200	1,400	1,450	1,450	1,500	1,550
LIVESTOCK	O | RED LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
IRRIGATION	O | DIRECT REUSE	2,486	2,486	2,486	2,486	2,486	2,486
IRRIGATION	O | OGALLALA AQUIFER | PARMER COUNTY	13,698	12,895	12,335	11,342	8,859	8,564
RED BASIN TOTAL EXISTING SUPPLY		**19,979**	**19,446**	**19,011**	**18,128**	**15,775**	**15,550**
PARMER COUNTY TOTAL EXISTING SUPPLY		**65,952**	**51,726**	**34,957**	**32,504**	**32,715**	**24,151**
SWISHER COUNTY							
BRAZOS BASIN							
KRESS	O | OGALLALA AQUIFER | SWISHER COUNTY	102	82	68	55	44	27
COUNTY-OTHER	O | OGALLALA AQUIFER | SWISHER COUNTY	30	30	30	30	30	30
LIVESTOCK	O | BRAZOS LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
LIVESTOCK	O | OGALLALA AQUIFER | SWISHER COUNTY	120	125	130	140	145	155
IRRIGATION	O | OGALLALA AQUIFER | SWISHER COUNTY	23,248	2,167	789	229	236	18

Water User Group (WUG) Existing Water Supply

REGION O	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR)					
		2020	2030	2040	2050	2060	2070
SWISHER COUNTY							
BRAZOS BASIN TOTAL EXISTING SUPPLY		**23,500**	**2,404**	**1,017**	**454**	**455**	**230**
RED BASIN							
HAPPY	A | DOCKUM AQUIFER | RANDALL COUNTY	45	45	44	44	44	43
HAPPY	O | OGALLALA AQUIFER | SWISHER COUNTY	94	98	96	88	79	69
KRESS	O | OGALLALA AQUIFER | SWISHER COUNTY	82	83	81	79	76	75
TULIA	O | DOCKUM AQUIFER | SWISHER COUNTY	493	493	493	493	493	493
TULIA	O | MACKENZIE LAKE/RESERVOIR	61	61	61	61	61	61
TULIA	O | OGALLALA AQUIFER | SWISHER COUNTY	200	200	200	200	200	200
COUNTY-OTHER	O | OGALLALA AQUIFER | SWISHER COUNTY	190	190	190	190	195	200
LIVESTOCK	O | OGALLALA AQUIFER | SWISHER COUNTY	2,250	2,360	2,475	2,600	2,730	2,865
LIVESTOCK	O | RED LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
IRRIGATION	O | OGALLALA AQUIFER | SWISHER COUNTY	76,214	71,339	61,756	56,473	52,578	45,016
RED BASIN TOTAL EXISTING SUPPLY		**79,629**	**74,869**	**65,396**	**60,228**	**56,456**	**49,022**
SWISHER COUNTY TOTAL EXISTING SUPPLY		**103,129**	**77,273**	**66,413**	**60,682**	**56,911**	**49,252**
TERRY COUNTY							
BRAZOS BASIN							
COUNTY-OTHER	O | OGALLALA AQUIFER | TERRY COUNTY	9	9	9	9	9	9
MINING	O | OGALLALA AQUIFER | TERRY COUNTY	25	37	38	0	0	0
LIVESTOCK	O | BRAZOS LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
LIVESTOCK	O | OGALLALA AQUIFER | TERRY COUNTY	15	15	15	2	0	0
IRRIGATION	O | OGALLALA AQUIFER | TERRY COUNTY	7,315	7,311	6,767	5,337	4,083	86
BRAZOS BASIN TOTAL EXISTING SUPPLY		**7,364**	**7,372**	**6,829**	**5,348**	**4,092**	**95**
COLORADO BASIN							
BROWNFIELD	A | OGALLALA AQUIFER | ROBERTS COUNTY	1,499	815	760	709	638	568
BROWNFIELD	O | OGALLALA AQUIFER | TERRY COUNTY	300	300	300	300	300	300
MEADOW	A | OGALLALA AQUIFER | ROBERTS COUNTY	18	18	18	18	18	18
MEADOW	O | OGALLALA AQUIFER | TERRY COUNTY	80	80	85	90	95	95
COUNTY-OTHER	O | EDWARDS-TRINITY-HIGH PLAINS AQUIFER | TERRY COUNTY	30	30	30	30	30	30
COUNTY-OTHER	O | OGALLALA AQUIFER | TERRY COUNTY	300	300	300	350	350	350
MANUFACTURING	O | OGALLALA AQUIFER | TERRY COUNTY	2	2	2	1	1	0
MINING	O | OGALLALA AQUIFER | TERRY COUNTY	330	488	505	0	0	0
LIVESTOCK	O | COLORADO LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
LIVESTOCK	O | OGALLALA AQUIFER | TERRY COUNTY	300	275	295	180	121	16
IRRIGATION	O | OGALLALA AQUIFER | TERRY COUNTY	136,707	119,822	75,818	47,636	28,688	3,295
COLORADO BASIN TOTAL EXISTING SUPPLY		**139,566**	**122,130**	**78,113**	**49,314**	**30,241**	**4,672**
TERRY COUNTY TOTAL EXISTING SUPPLY		**146,930**	**129,502**	**84,942**	**54,662**	**34,333**	**4,767**
YOAKUM COUNTY							
COLORADO BASIN							
DENVER CITY	O | OGALLALA AQUIFER | YOAKUM COUNTY	664	810	950	1,100	1,200	1,200
PLAINS	O | OGALLALA AQUIFER | YOAKUM COUNTY	238	174	135	106	106	150
COUNTY-OTHER	O | OGALLALA AQUIFER | YOAKUM COUNTY	270	295	315	345	375	405
MINING	O | OGALLALA AQUIFER | YOAKUM COUNTY	914	328	77	17	0	[illegible]

Water User Group (WUG) Existing Water Supply

REGION O	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR) 2020	2030	2040	2050	2060	2070
YOAKUM COUNTY							
COLORADO BASIN							
STEAM ELECTRIC POWER	O | OGALLALA AQUIFER | YOAKUM COUNTY	2,232	2,020	1,924	1,862	1,712	676
LIVESTOCK	O | COLORADO LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
IRRIGATION	O | OGALLALA AQUIFER | YOAKUM COUNTY	55,427	39,948	30,481	23,287	16,647	5,480
COLORADO BASIN TOTAL EXISTING SUPPLY		**59,745**	**43,575**	**33,882**	**26,717**	**20,040**	**7,911**
YOAKUM COUNTY TOTAL EXISTING SUPPLY		**59,745**	**43,575**	**33,882**	**26,717**	**20,040**	**7,911**
REGION O TOTAL EXISTING SUPPLY		**2,000,640**	**1,768,802**	**1,502,503**	**1,328,537**	**1,192,191**	**976,717**

Chapter 4

Chapter 4

Identification of Water Needs

4. Identification of Water Needs

This chapter identifies water needs and surpluses for each water user group (WUG) and wholesale water provider (WWP) in Region O. A water need arises when water demand exceeds existing supply; a surplus occurs when supply exceeds demand. The following formula is used to calculate a water need (negative value) or surplus (positive value):

(Needs) or Surplus = Existing water supply – Water demand

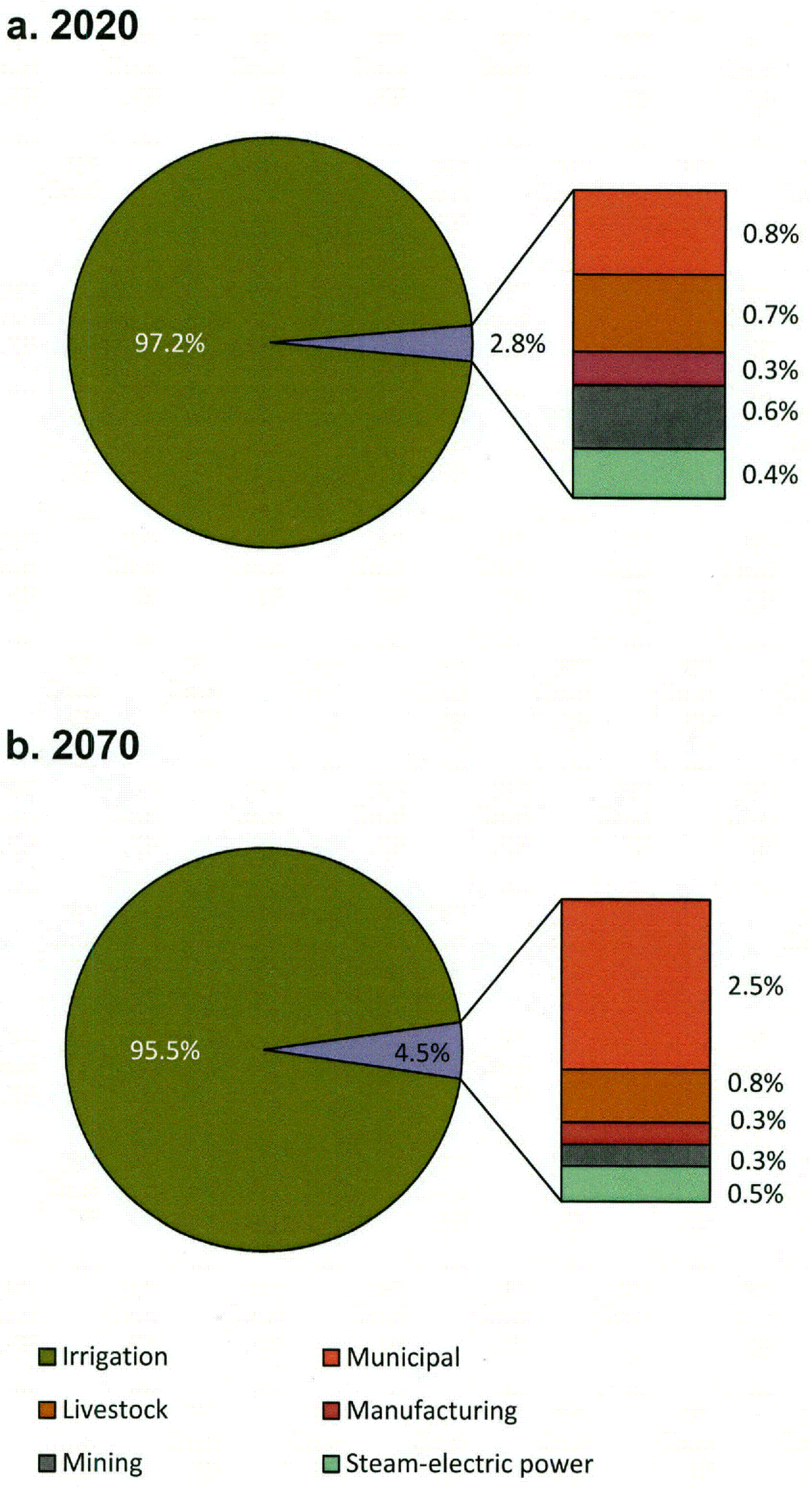
Chapter 2 of this document discusses water demand projections for the Llano Estacado region, and Chapter 3 of this document presents existing water supplies. The TWDB requires two levels of water needs analysis:

- The TWDB makes an initial calculation of water needs based on projected demands and existing water supplies without implementation of any water management strategies (WMSs). The results of the first tier analysis are presented in Section 4.1.

- A second tier calculation is performed after conservation and direct reuse water management strategies (WMSs) are identified and recommended by the regional water planning group. This analysis determines what water needs would remain if recommended conservation and direct reuse strategies were fully implemented. The results of the second-tier water needs analysis are presented in Section 4.2.

4.1 First Tier Water Needs

For analysis and presentation, WUGs are divided into categories based on water use: municipal (city and County-other), irrigation, livestock, and industrial (manufacturing, mining, and steam-electric power). Irrigation WUGs account for the majority of the water needs in the region, comprising at least 95 percent of the regional water needs in each decade. Figure 4-1 provides the division of water shortages by WUG category in 2020 and 2070. Table 4-1 summarizes the first tier water needs by WUG category over the planning period, and Table 4-2 provides the total first tier water needs for each county. Individual WUGs with a surplus were set to zero before compiling the water needs by WUG category and county as shown in Tables 4-1 and 4-2, and Figure 4-1.



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LLANO ESTACADO REGION

First Tier Water Needs by Water User Group Category 2020 and 2070

Figure 4-1

Table 4-1. First Tier Water Needs by WUG Category from 2020 to 2070

WUG Category	First Tier Water Needs by Decade (acre-feet per year)					
	2020	2030	2040	2050	2060	2070
Municipal	13,233	24,556	30,937	38,977	47,923	56,371
Irrigation	1,683,573	1,795,897	1,948,130	2,003,648	2,024,629	2,139,648
Livestock	12,134	14,505	12,889	16,273	18,793	17,631
Industrial						
Manufacturing	5,224	4,968	4,462	4,935	6,769	7,316
Mining	9,921	11,705	11,291	10,314	8,626	7,337
Steam-electric power	7,747	6,617	3,189	4,185	5,474	11,793
Total	1,731,832	1,858,248	2,010,898	2,078,332	2,112,214	2,240,096

Table 4-2. First Tier Water Needs by County from 2020 to 2070

County	First Tier Water Needs by Decade (acre-feet per year)					
	2020	2030	2040	2050	2060	2070
Bailey	83,623	87,650	89,666	92,877	92,928	96,545
Briscoe	4,011	11,504	15,706	15,958	15,757	20,182
Castro	265,949	252,907	280,412	284,506	281,102	292,730
Cochran	67,395	66,140	65,323	64,265	63,477	63,109
Crosby	7,537	7,310	6,736	6,853	6,664	6,453
Dawson	441	1,480	1,643	1,577	1,568	5,794
Deaf Smith	90,843	97,979	102,887	114,097	124,169	132,025
Dickens	70	78	87	97	107	117
Floyd	26,600	25,140	27,389	28,027	27,996	29,480
Gaines	149,837	196,325	222,477	238,536	248,046	273,146
Garza	231	237	244	252	260	278
Hale	241,924	232,655	223,818	218,192	215,258	207,566
Hockley	47,695	54,577	60,929	57,973	57,415	56,301
Lamb	207,218	210,607	218,118	229,234	232,683	245,992
Lubbock	72,078	82,238	99,186	100,481	103,824	124,369
Lynn	684	954	912	726	599	486
Motley	297	279	280	283	274	266
Parmer	274,032	286,277	300,056	299,498	296,491	302,370
Swisher	97,605	129,856	139,650	144,325	147,108	153,782
Terry	0	10,219	47,718	71,093	85,133	109,358
Yoakum	93,762	103,836	107,661	109,482	111,355	119,747
Region O Total	1,731,832	1,858,248	2,010,898	2,078,332	2,112,214	2,240,096

Appendix 4A contains the required Regional Water Planning Application (DB17) report for WUG needs or surplus and provides the water needs or surplus by county and river basin for every WUG. The first tier water needs or surplus for each WUG category are summarized in Sections 4.1.1 through 4.1.5.

4.1.1 Municipal Needs

The municipal WUG category consists of both individual cities or towns and County-other entities. Lubbock, the largest city in the region, has the largest predicted first tier water needs, with a shortage of 10,352 acre-feet per year (ac-ft/yr) in 2020 that increases to a shortage of 43,148 ac-ft/yr in 2070. Plainview, the second most populated city in the region, has the largest predicted surplus in most decades of the planning period, from 1,302 ac-ft/yr in 2020 to 205 ac-ft/yr in 2070. Overall, in 2020, 26 cities have predicted surpluses, 20 with a predicted need, and 2 that show neither a surplus or a need. By 2070, there are 15 cities with a predicted surplus, 31 with a predicted need, and 2 with neither a surplus nor need.

Of the 21 County-other WUGs, 17 have a projected surplus in 2020, decreasing to 15 that have a predicted surplus in 2070. The County-other WUG in Gaines County has the largest water needs for this category, projecting a shortage of 1,613 ac-ft/yr in 2070.

4.1.2 Irrigation Needs

Irrigation accounts for more than 90 percent of Region O's water demand and, similarly, more than 90 percent of the water needs. All counties in the region have irrigation water demand. Dawson, Dickens, Garza, Lynn, Motley, and Terry counties are the only counties with a projected surplus in this category in 2020; Dickens, Garza, Lynn, and Motley are the only counties with a projected surplus in this category in 2070. Castro, Gaines, Hale, Lamb, and Parmer counties are projected to have first tier irrigation water needs of more than 100,000 ac-ft/yr in 2020, and more than 200,000 ac-ft/yr by 2070.

4.1.3 Livestock Needs

All counties have livestock water demand. Five of these counties (Floyd, Gaines, Lubbock, Swisher, and Terry) are projected to have a surplus in 2020, and Lubbock and Swisher counties maintain their projected surplus throughout the 50-year planning horizon. Livestock first tier water needs in 2020 range from 1 ac-ft/yr in Lynn County (Colorado Basin) to 4,475 ac-ft/yr in Deaf Smith County (Canadian and Red River basins). In 2070, Dawson County is projected to have the smallest need at 2 ac-ft/yr (Brazos Basin) and Castro County to have the largest, at 5,606 ac-ft/yr (Brazos Basin).

4.1.4 Industrial Needs

There are 14 counties in Region O with water demand in the manufacturing category. Of these, 4 counties (Crosby, Dawson, Hockley, and Terry) are within 10 ac-ft/yr (either surplus or shortage) of meeting their demand for all decades in the planning period. Garza and Motley counties have neither a surplus nor a need. Deaf Smith County (Red River Basin) is projected to have the largest shortage in both 2020 and 2070 (2,234 and 2,638 ac-ft/yr, respectively).

There are 15 counties with water demand in the mining category. In 2020, 5 of these counties (Dickens, Floyd, Garza, Hockley, and Terry) are projected to meet or exceed their mining water demands. By 2070, all mining WUGs are projected to have a water shortage with the exception of Dickens, Floyd, and Garza counties, all of which show neither a need nor a surplus. In 2070, the projected shortages range from 4ac-ft/yr in Cochran County (Brazos Basin) to 4,314 ac-ft/yr in Lubbock County (Brazos Basin).

There are 4 counties with water demand in the steam-electric power category. Lubbock County has a projected surplus of 11,142 ac-ft/yr in 2020, but the other 3 counties (Hale, Lamb, and Yoakum) have projected shortages in 2020, ranging from 34 to 6,227 ac-ft/yr. Yoakum County is projected to have an increasing water need in steam-electric power generation, increasing from 1,486 ac-ft/yr in 2020 to 7,864 ac-ft/yr in 2070. The surplus in Lubbock County is projected to decrease each decade and become a need of 945 ac-ft/yr by 2070.

4.1.5 Wholesale Water Provider Needs

Four wholesale water providers (WWPs) supply water to WUGs within Region O. Table 4-3 summarizes the first tier water needs for each WWP, by county, basin, and category of use. Three of the WWPs—Canadian River Municipal Water Authority, City of Lubbock, and Mackenzie Municipal Water Authority—are projected to have shortages within the planning period, and the shortages are projected to increase over the planning period. For most of the WUG customers, the WWP is only one of their sources of supply, but WWPs are the sole source of supply for the following customers:

- Canadian River Municipal Water Authority: Levelland, O'Donnell, Slaton, and Tahoka
- Mackenzie Municipal Water Authority: Silverton
- White River Municipal Water District: Ralls and Spur

In recent years White River Municipal Water District has developed wells in Crosby County to compensate for the lack of water supply from White River Lake. Their current well field has an estimated surplus of 50 acre-feet over the planning period.

4.2 Second Tier Water Needs

The TWDB requires a second tier water needs calculation that takes conservation and direct reuse WMSs into consideration. This second tier water needs analysis determines what water needs would remain if recommended conservation and direct reuse strategies (Chapter 5) were fully implemented. Table 4-4 and Figure 4-2 summarize the second tier water needs by WUG category over the planning period. Individual WUGs with a surplus were set to zero before compiling the second tier water needs for each overall WUG category.

Appendix 4B contains the required DB17 report for the second tier water needs for every WUG, by county and by river basin. The second tier water needs for each applicable WUG category are discussed in Sections 4.2.1 through 4.2.3.

Table 4-3. First Tier Water Needs by Wholesale Water Provider, County, Basin, and Category of Use
Page 1 of 2

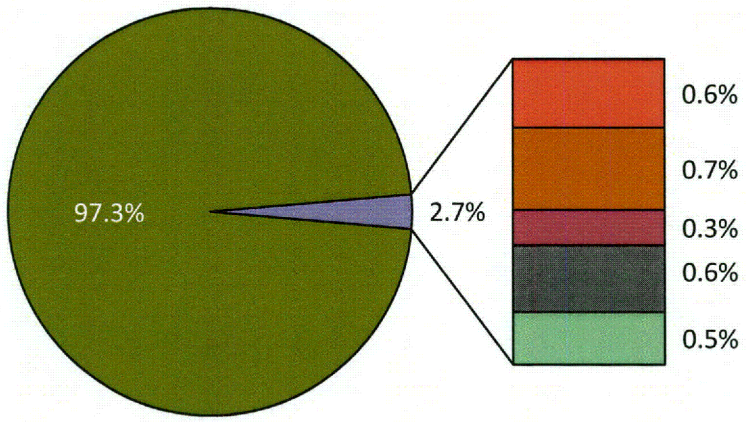
WWP/Entity	County	Basin	Category of Use	Entity Sub-Type	2020	2030	2040	2050	2060	2070
CRMWA [a]										
Brownfield	Terry	Colorado	Municipal	City	0	739	863	991	1,149	1,304
Lamesa	Dawson	Colorado	Municipal	City	264	762	785	806	1,018	1,220
Levelland	Hockley	Brazos	Municipal	City	0	407	558	691	873	1,029
Lubbock	Lubbock	Brazos	Municipal	City	10,352	18,100	22,615	29,226	36,019	43,148
O'Donnell	Dawson	Brazos	Municipal	City	0	7	8	10	11	12
O'Donnell	Lynn	Brazos	Municipal	City	0	40	47	52	62	68
Plainview	Hale	Brazos	Municipal	City	0	0	0	0	0	0
Slaton	Lubbock	Brazos	Municipal	City	118	390	463	555	623	691
Tahoka	Lynn	Brazos	Municipal	City	0	57	77	100	138	166
				CRMWA Region O total	10,734	20,502	25,416	32,431	39,893	47,638
City of Lubbock										
Buffalo Springs Lake [b]	Lubbock	Brazos	Municipal	County-other	0	0	0	0	0	0
Lubbock	Lubbock	Brazos	Municipal	City	10,352	18,100	22,615	29,226	36,019	43,148
Ransom Canyon	Lubbock	Brazos	Municipal	City	0	0	0	0	0	0
Shallowater	Lubbock	Brazos	Municipal	City	35	77	120	171	223	275
South Garza Water System [c]	Garza	Brazos	Municipal	County-other	0	0	0	0	0	0
				City of Lubbock total	10,387	18,177	22,735	29,397	36,242	43,423
Mackenzie Municipal Water Authority										
Floydada	Floyd	Brazos	Municipal	City	0	0	0	0	0	0
Lockney	Floyd	Brazos	Municipal	City	35	41	43	53	61	67
Silverton	Briscoe	Red	Municipal	City	55	52	49	48	48	48
Tulia	Swisher	Red	Municipal	City	172	191	184	170	213	235
				Mackenzie MWA total	262	284	276	271	322	350

[a] Presenting only the 8 member cities that are located in Region O (3 member cities are located in Region A).
[b] Values shown reflect the total needs for the County-other category in Lubbock County.
[c] Values shown reflect the total needs for the County-other category in Garza County.

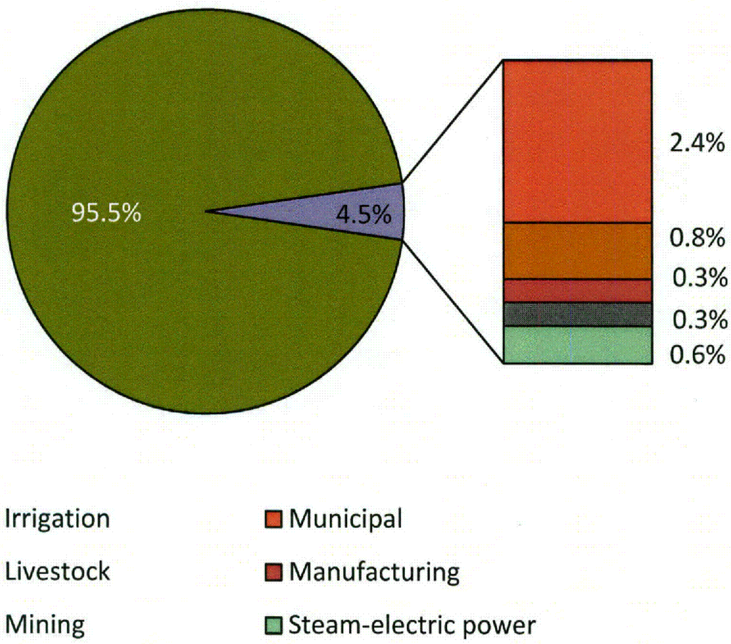
Table 4-3. First Tier Water Needs by Wholesale Water Provider, County, Basin, and Category of Use
Page 2 of 2

WWP/Entity	County	Basin	Category of Use	Entity Sub-Type	2020	2030	2040	2050	2060	2070
White River Municipal Water District										
Crosbyton	Crosby	Brazos	Municipal	City	0	0	0	0	0	0
Post	Garza	Brazos	Municipal	City	0	0	0	0	0	0
Ralls	Crosby	Brazos	Municipal	City	0	0	0	0	0	0
Spur	Dickens	Brazos	Municipal	City	0	0	0	0	0	0
				White River MWD total	0	0	0	0	0	0

a. 2020



b. 2070



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Second Tier Water Needs by Water User Group Category 2020 and 2070

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Figure 4-2

Table 4-4. Second Tier Water Needs by WUG Category from 2020 to 2070

WUG Category	Second Tier Water Needs by Decade (acre-feet per year)					
	2020	2030	2040	2050	2060	2070
Municipal	10,154	20,770	26,792	34,394	42,830	50,774
Irrigation	1,613,509	1,719,032	1,845,999	1,900,784	1,913,896	2,025,046
Livestock [a]	12,134	14,505	12,889	16,273	18,793	17,631
Industrial [a]						
Manufacturing	5,224	4,968	4,462	4,935	6,769	7,316
Mining	9,921	11,705	11,291	10,314	8,626	7,337
Steam-electric power	7,747	6,617	3,189	4,185	5,474	11,793
Total	1,658,689	1,777,597	1,904,622	1,970,885	1,996,388	2,119,897

[a] Second tier water needs are the same as first tier needs because no conservation or direct reuse WMSs are recommended for these categories.

4.2.1 Municipal Needs

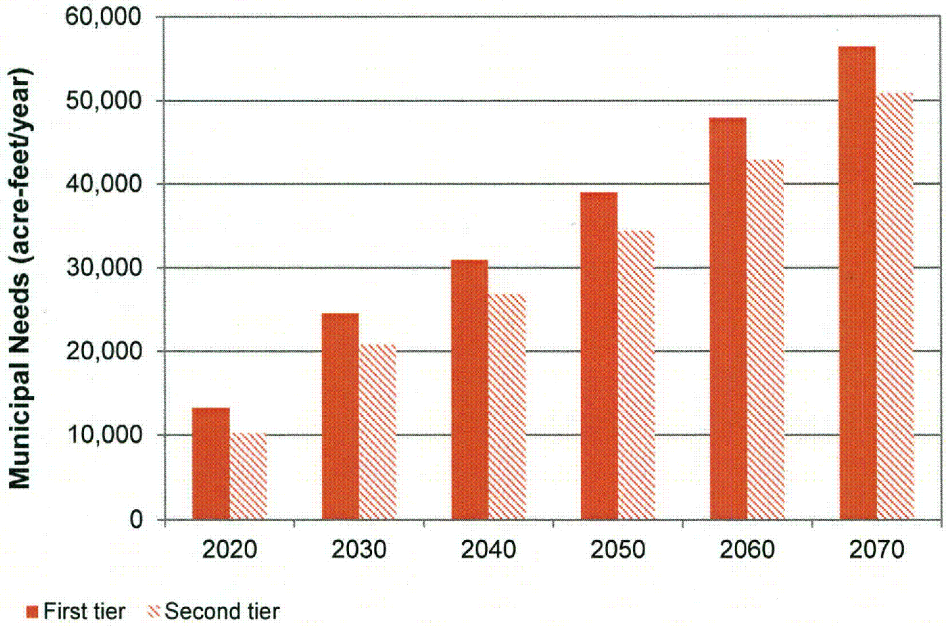
Figure 4-3a shows a comparison of the first and second tier needs for the municipal WUG category. The reduction in municipal needs ranges between 23 percent of the first tier needs in 2020 and 10 percent of the first tier needs in 2070. The reduction is due to the implementation of conservation and direct reuse WMSs in the municipal WUG category. The specific WMSs that cause the reduction in municipal needs include:

- Municipal conservation for 39 WUGs (Abernathy, Amherst, Anton, Bovina, Brownfield, Denver City, Dimmitt, Earth, Farwell, Floydada, Friona, Hereford, Idalou, Lamesa, Levelland, Littlefield, Lorenzo, Lubbock, Matador, Morton, Muleshoe, Olton, Petersburg, Plains, Plainview, Ransom Canyon, Seagraves, Seminole, Silverton, Spur, Sudan, Sundown, Tahoka, Tulia, Wolfforth, and the County-other categories in Briscoe, Cochran, Motley, and Parmer counties)

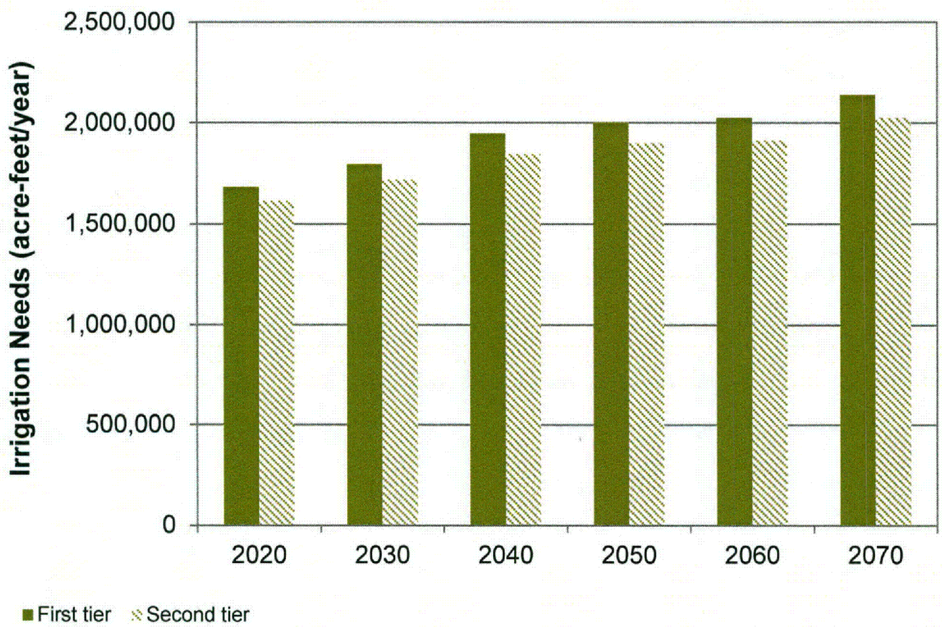
- Water loss reduction for 4 WUGs (Lorenzo, Morton, Shallowater, and Sundown)

- Direct potable reuse for 2 WUGs (Farwell and Wolfforth)

a. Municipal



b. Irrigation



LLANO ESTACADO REGION

Comparison of First and Second Tier Municipal and Irrigation Water Needs

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Figure 4-3

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4.2.2 Irrigation Needs

Figure 4-3b shows a comparison of the first and second tier needs for the irrigation WUG category. The reduction in irrigation needs ranges between 4 percent of the first tier needs in 2020 and 5 percent of the first tier needs in 2070. The reduction is due to the implementation of conservation WMSs in the irrigation WUG category (irrigation conservation for each of the 21 counties in the region).

4.2.3 Wholesale Water Provider Needs

Table 4-5 shows the second tier needs for the WWPs in Region O. The differences noted by comparing the first and second tier water needs for the WWPs in Region O are discussed below.

- For the CRMWA member cities in Region O, the reduction in needs ranges between 22 percent of the first tier needs in 2020 and 8 percent of the first tier needs in 2070, and the reductions are due to the implementation of the municipal conservation WMSs for Brownfield, Lamesa, Levelland, Lubbock, Plainview, and Tahoka (municipal conservation is not recommended for O'Donnell or Slaton as their per capita use is already below 140 gpd).

- For the City of Lubbock, the reduction in needs ranges between 22 percent of the first tier needs in 2020 and 8 percent of the first tier needs in 2070, and the reductions are due to the implementation of the municipal conservation WMS for the City of Lubbock and Ransom Canyon (municipal conservation is not recommended for Buffalo Springs Lake or Shallowater as their per capita use is already below 140 gpd) and the water loss reduction WMS for Shallowater.

- For the Mackenzie Municipal Water Authority, the reduction in needs ranges between 20 percent of the first tier needs in 2020 and 15 percent of the first tier needs in 2070, and the reductions are due to the implementation of the municipal conservation WMSs for Floydada, Silverton, and Tulia (municipal conservation is not recommended for Lockney as its per capita use is already below 140 gpd).

Table 4-5. Second Tier Water Needs by Wholesale Water Provider, County, Basin, and Category of Use
Page 1 of 2

WWP/Entity	County	Basin	Category of Use	Entity Sub-Type	2020	2030	2040	2050	2060	2070
CRMWA [a]										
Brownfield	Terry	Colorado	Municipal	City	0	646	771	922	1,077	1,229
Lamesa	Dawson	Colorado	Municipal	City	150	647	669	690	899	1,099
Levelland	Hockley	Brazos	Municipal	City	0	354	558	691	873	1,029
Lubbock	Lubbock	Brazos	Municipal	City	8,065	15,622	19,941	26,311	32,880	39,766
O'Donnell	Dawson	Brazos	Municipal	City	0	7	8	10	11	12
O'Donnell	Lynn	Brazos	Municipal	City	0	40	47	52	62	68
Plainview	Hale	Brazos	Municipal	City	0	0	0	0	0	0
Slaton	Lubbock	Brazos	Municipal	City	118	390	463	555	623	691
Tahoka	Lynn	Brazos	Municipal	City	0	37	70	97	134	162
				CRMWA Region O total	8,333	17,743	22,527	29,328	36,559	44,056
City of Lubbock										
Buffalo Springs Lake [b]	Lubbock	Brazos	Municipal	County-other	0	0	0	0	0	0
Lubbock	Lubbock	Brazos	Municipal	City	8,065	15,622	19,941	26,311	32,880	39,766
Ransom Canyon	Lubbock	Brazos	Municipal	City	0	0	0	0	0	0
Shallowater	Lubbock	Brazos	Municipal	City	0	3	0	21	60	98
South Garza Water System [c]	Garza	Brazos	Municipal	County-other	0	0	0	0	0	0
				City of Lubbock total	8,065	15,625	19,941	26,332	32,940	39,864
Mackenzie Municipal Water Authority										
Floydada	Floyd	Brazos	Municipal	City	0	0	0	0	0	0
Lockney	Floyd	Brazos	Municipal	City	35	41	43	53	61	67
Silverton	Briscoe	Red	Municipal	City	49	46	47	46	46	46
Tulia	Swisher	Red	Municipal	City	126	144	137	124	165	185
				Mackenzie MWA total	210	231	227	223	272	298

[a] Presenting only the 8 member cities that are located in Region O (3 member cities are located in Region A).

[b] Values shown reflect the total needs for the County-other category in Lubbock County.

[c] Values shown reflect the total needs for the County-other category in Garza County.

Table 4-5. Second Tier Water Needs by Wholesale Water Provider, County, Basin, and Category of Use
Page 2 of 2

WWP/Entity	County	Basin	Category of Use	Entity Sub-Type	2020	2030	2040	2050	2060	2070
White River Municipal Water District										
Crosbyton	Crosby	Brazos	Municipal	City	0	0	0	0	0	0
Post	Garza	Brazos	Municipal	City	0	0	0	0	0	0
Ralls	Crosby	Brazos	Municipal	City	0	0	0	0	0	0
Spur	Dickens	Brazos	Municipal	City	0	0	0	0	0	0
White River MWD total					0	0	0	0	0	0

- The White River Municipal Water District is not projected to have water needs (surpluses are projected for Crosbyton, Post, and Ralls in all decades, and Spur has neither a surplus or a need in any decade), and so there is no reduction in their first tier needs due to conservation.

4.3 Socioeconomic Impact of Unmet Needs

At the formal request of the LERWPG, the TWDB completed a socioeconomic impact analysis for Region O, evaluating the social and economic impacts of not meeting the identified water needs. The TWDB estimates that not meeting the identified water needs in Region O would result in an annually combined lost income impact of approximately $4 billion in 2020, increasing to $6 billion in 2070 (estimates are in year 2013 dollars). This would coincide with a loss of approximately 34,000 jobs in 2020, increasing to a loss of approximately 61,000 jobs in 2070 (TWDB, 2015). The socioeconomic impact analysis is discussed further in Chapter 6, and the full TWDB report is provided in Appendix 6A.

References

Texas Water Development Board (TWDB). 2015. Socioeconomic impacts of projected water shortages for the Region O Regional Water Planning Area. Prepared in support of the 2016 regional water plan. September 2015.

Appendix 4A

First Tier
WUG Needs Report

Water User Group (WUG) Needs/Surplus

REGION O	WUG (NEEDS)/SURPLUS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
BAILEY COUNTY						
BRAZOS BASIN						
MULESHOE	(49)	(334)	(347)	(373)	(556)	(587)
COUNTY-OTHER	3	4	(121)	(126)	(131)	(146)
MANUFACTURING	(183)	(206)	(225)	(250)	(274)	(324)
LIVESTOCK	(1,049)	(1,797)	(1,879)	(2,045)	(2,089)	(2,451)
IRRIGATION	(82,342)	(85,313)	(87,094)	(90,083)	(89,878)	(93,037)
BRISCOE COUNTY						
RED BASIN						
SILVERTON	(55)	(52)	(49)	(48)	(48)	(48)
COUNTY-OTHER	(2)	3	6	7	7	7
LIVESTOCK	(29)	(37)	(46)	(55)	(65)	(75)
IRRIGATION	(3,925)	(11,415)	(15,611)	(15,855)	(15,644)	(20,059)
CASTRO COUNTY						
BRAZOS BASIN						
DIMMITT	(43)	(54)	(198)	(248)	(292)	(329)
HART	11	2	(3)	(12)	(19)	(25)
COUNTY-OTHER	4	5	7	7	9	13
MANUFACTURING	67	15	(35)	(78)	(147)	(221)
LIVESTOCK	(2,897)	(3,829)	(4,855)	(5,209)	(5,321)	(5,606)
IRRIGATION	(161,561)	(151,969)	(173,104)	(179,331)	(177,409)	(181,989)
RED BASIN						
COUNTY-OTHER	5	5	7	6	8	11
MANUFACTURING	(85)	(54)	(29)	(31)	(33)	(39)
LIVESTOCK	705	374	330	283	235	184
IRRIGATION	(101,363)	(97,001)	(102,188)	(99,597)	(97,881)	(104,521)
COCHRAN COUNTY						
BRAZOS BASIN						
MORTON	(123)	(124)	(117)	(106)	(116)	(119)
COUNTY-OTHER	(16)	(15)	(17)	(18)	(19)	(21)
MINING	(6)	(9)	(9)	(6)	(5)	(4)
LIVESTOCK	(221)	(229)	(275)	(59)	(83)	(230)
IRRIGATION	(62,403)	(60,920)	(60,109)	(58,226)	(56,083)	(55,257)
COLORADO BASIN						
COUNTY-OTHER	1	1	1	2	(1)	(2)
MINING	4	2	0	5	1	3
LIVESTOCK	(166)	(174)	(183)	(192)	(202)	(212)
IRRIGATION	(4,460)	(4,669)	(4,613)	(5,658)	(6,968)	(7,264)
CROSBY COUNTY						
BRAZOS BASIN						
CROSBYTON	50	50	50	50	50	50
LORENZO	39	24	12	(5)	(25)	(40)
RALLS	25	25	25	25	25	25
COUNTY-OTHER	82	78	70	68	60	55
MANUFACTURING	3	3	3	3	3	3
MINING	4	3	1	3	2	2
LIVESTOCK	(106)	(112)	(118)	(125)	(131)	(138)
IRRIGATION	(4,009)	(3,969)	(3,611)	(3,931)	(3,919)	(3,866)

Water User Group (WUG) Needs/Surplus

REGION O	WUG (NEEDS)/SURPLUS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
CROSBY COUNTY						
RED BASIN						
COUNTY-OTHER	1	1	1	1	1	1
MINING	(348)	(352)	(317)	(280)	(243)	(210)
LIVESTOCK	(1)	(1)	(1)	(1)	(1)	(1)
IRRIGATION	(3,073)	(2,876)	(2,689)	(2,511)	(2,345)	(2,198)
DAWSON COUNTY						
BRAZOS BASIN						
O'DONNELL	10	(7)	(8)	(10)	(11)	(12)
COUNTY-OTHER	10	10	10	11	10	10
LIVESTOCK	(2)	(2)	(2)	(2)	(2)	(2)
IRRIGATION	34	94	51	4	5	(356)
COLORADO BASIN						
LAMESA	(264)	(762)	(785)	(806)	(1,018)	(1,220)
COUNTY-OTHER	35	12	(20)	(56)	(114)	(149)
MANUFACTURING	0	0	0	0	0	(7)
MINING	(175)	(709)	(828)	(703)	(423)	(255)
LIVESTOCK	12	13	9	10	11	2
IRRIGATION	1,539	1,490	1,107	1,405	1,404	(3,793)
DEAF SMITH COUNTY						
CANADIAN BASIN						
COUNTY-OTHER	15	15	15	14	14	14
LIVESTOCK	(76)	(93)	(98)	(103)	(109)	(115)
IRRIGATION	(917)	(856)	(796)	(739)	(683)	(633)
RED BASIN						
HEREFORD	47	(33)	64	87	19	(151)
COUNTY-OTHER	47	30	38	26	3	23
MANUFACTURING	(2,234)	(2,600)	(2,061)	(2,057)	(3,295)	(2,638)
LIVESTOCK	(4,399)	(3,973)	(1,444)	(2,698)	(4,181)	(683)
IRRIGATION	(83,217)	(90,424)	(98,488)	(108,500)	(115,901)	(127,805)
DICKENS COUNTY						
BRAZOS BASIN						
SPUR	0	0	0	0	0	0
COUNTY-OTHER	29	34	38	38	39	39
MINING	0	0	0	0	0	0
LIVESTOCK	(26)	(31)	(37)	(43)	(49)	(55)
IRRIGATION	218	352	481	632	753	886
RED BASIN						
COUNTY-OTHER	112	109	105	102	100	96
MINING	0	0	0	0	0	0
LIVESTOCK	(44)	(47)	(50)	(54)	(58)	(62)
IRRIGATION	27	46	63	176	187	287
FLOYD COUNTY						
BRAZOS BASIN						
FLOYDADA	173	153	131	81	29	7
LOCKNEY	(35)	(41)	(43)	(53)	(61)	(67)
COUNTY-OTHER	49	46	39	27	14	8
MINING	0	0	0	0	0	0
LIVESTOCK	35	7	27	47	14	29

Water User Group (WUG) Needs/Surplus

REGION O	WUG (NEEDS)/SURPLUS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
FLOYD COUNTY						
BRAZOS BASIN						
IRRIGATION	1,268	1,386	1,420	1,373	1,248	910
RED BASIN						
COUNTY-OTHER	43	42	38	31	25	21
MINING	0	0	0	0	0	0
LIVESTOCK	25	16	7	(3)	(13)	(23)
IRRIGATION	(26,565)	(25,099)	(27,346)	(27,971)	(27,922)	(29,390)
GAINES COUNTY						
COLORADO BASIN						
SEAGRAVES	1	0	3	0	(15)	(32)
SEMINOLE	(548)	(1,071)	(1,347)	(1,560)	(1,611)	(1,675)
COUNTY-OTHER	(253)	(563)	(1,155)	(1,492)	(1,952)	(1,613)
MANUFACTURING	(310)	(686)	(1,007)	(1,295)	(1,604)	(2,380)
MINING	(202)	(604)	(777)	(692)	(531)	(463)
LIVESTOCK	2	0	3	4	1	(146)
IRRIGATION	(148,524)	(193,401)	(218,191)	(233,497)	(242,333)	(266,837)
GARZA COUNTY						
BRAZOS BASIN						
POST	306	306	306	306	306	306
COUNTY-OTHER	60	60	55	45	32	21
MANUFACTURING	0	0	0	0	0	0
MINING	0	0	0	0	0	0
LIVESTOCK	(231)	(237)	(244)	(252)	(260)	(278)
IRRIGATION	54	88	26	78	145	120
HALE COUNTY						
BRAZOS BASIN						
ABERNATHY	(76)	(48)	(51)	(44)	(51)	(49)
HALE CENTER	2	1	4	11	4	1
PETERSBURG	(4)	(10)	(5)	0	2	(2)
PLAINVIEW	1,302	756	683	641	394	205
COUNTY-OTHER	19	23	38	65	39	27
MANUFACTURING	(1,227)	(341)	48	56	78	90
MINING	(1,154)	(1,139)	(1,022)	(886)	(766)	(662)
STEAM ELECTRIC POWER	(34)	(24)	0	0	0	0
LIVESTOCK	(924)	(1,148)	(328)	(1,304)	(1,454)	(1,784)
IRRIGATION	(236,525)	(228,045)	(220,587)	(214,196)	(211,256)	(203,418)
RED BASIN						
LIVESTOCK	(14)	(20)	(20)	(21)	(21)	(21)
IRRIGATION	(1,966)	(1,880)	(1,805)	(1,741)	(1,710)	(1,630)
HOCKLEY COUNTY						
BRAZOS BASIN						
ANTON	92	89	88	88	81	77
LEVELLAND	264	(407)	(558)	(691)	(873)	(1,029)
COUNTY-OTHER	125	102	93	101	63	37
MANUFACTURING	0	0	0	0	0	(3)
MINING	1,494	965	363	4	(14)	(13)
LIVESTOCK	265	284	305	326	349	366
IRRIGATION	(45,997)	(52,877)	(58,977)	(56,085)	(55,322)	(53,726)

Water User Group (WUG) Needs/Surplus

REGION O	WUG (NEEDS)/SURPLUS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
HOCKLEY COUNTY						
COLORADO BASIN						
SUNDOWN	(18)	(36)	(48)	(50)	(69)	(82)
COUNTY-OTHER	1	8	8	7	2	2
MINING	195	121	120	4	(2)	(2)
LIVESTOCK	(35)	(37)	(39)	(41)	(43)	(45)
IRRIGATION	(1,645)	(1,220)	(1,307)	(1,106)	(1,092)	(1,401)
LAMB COUNTY						
BRAZOS BASIN						
AMHERST	0	(5)	(8)	(11)	(17)	(22)
EARTH	8	10	13	16	14	13
LITTLEFIELD	73	59	53	43	52	17
OLTON	31	37	47	60	59	62
SUDAN	50	35	26	21	8	(2)
COUNTY-OTHER	15	4	5	10	3	4
MANUFACTURING	(280)	(213)	(105)	(108)	(115)	(146)
MINING	(570)	(567)	(507)	(445)	(385)	(333)
STEAM ELECTRIC POWER	(6,227)	(4,267)	0	0	0	(2,984)
LIVESTOCK	(889)	(680)	(1,070)	(1,567)	(1,972)	(2,639)
IRRIGATION	(199,252)	(204,875)	(216,428)	(227,103)	(230,194)	(239,866)
LUBBOCK COUNTY						
BRAZOS BASIN						
ABERNATHY	(26)	(18)	(21)	(19)	(24)	(25)
IDALOU	(19)	(26)	(36)	(52)	(69)	(86)
LUBBOCK	(10,352)	(18,100)	(22,615)	(29,226)	(36,019)	(43,148)
NEW DEAL	79	72	65	55	45	35
RANSOM CANYON	232	213	192	168	145	121
SHALLOWATER	(35)	(77)	(120)	(171)	(223)	(275)
SLATON	(118)	(390)	(463)	(555)	(623)	(691)
WOLFFORTH	(15)	(162)	(312)	(473)	(635)	(797)
COUNTY-OTHER	9	46	4	37	52	59
MANUFACTURING	(232)	(63)	(68)	(72)	(78)	(143)
MINING	(6,261)	(6,366)	(5,888)	(5,302)	(4,763)	(4,314)
STEAM ELECTRIC POWER	11,142	10,374	9,438	8,297	3,546	(945)
LIVESTOCK	20	13	32	49	15	29
IRRIGATION	(55,020)	(57,036)	(69,663)	(64,611)	(61,390)	(73,945)
LYNN COUNTY						
BRAZOS BASIN						
O'DONNELL	59	(40)	(47)	(52)	(62)	(68)
TAHOKA	5	(57)	(77)	(100)	(138)	(166)
COUNTY-OTHER	0	(12)	(14)	(22)	(54)	(69)
MINING	(634)	(784)	(717)	(511)	(318)	(164)
LIVESTOCK	19	14	11	6	1	(3)
IRRIGATION	21	49	56	41	22	68
COLORADO BASIN						
COUNTY-OTHER	5	5	5	5	5	5
MINING	(49)	(60)	(55)	(39)	(25)	(13)
LIVESTOCK	(1)	(1)	(2)	(2)	(2)	(3)
IRRIGATION	5	4	0	0	5	4

Water User Group (WUG) Needs/Surplus

REGION O	WUG (NEEDS)/SURPLUS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
MOTLEY COUNTY						
RED BASIN						
MATADOR	6	10	11	12	12	12
COUNTY-OTHER	1	5	1	2	2	2
MANUFACTURING	0	0	0	0	0	0
MINING	(136)	(109)	(101)	(94)	(75)	(57)
LIVESTOCK	(161)	(170)	(179)	(189)	(199)	(209)
IRRIGATION	262	542	822	1,089	1,347	1,583
PARMER COUNTY						
BRAZOS BASIN						
BOVINA	3	(2)	(29)	(58)	(96)	(131)
FARWELL	(16)	(50)	(61)	(94)	(135)	(173)
COUNTY-OTHER	6	1	8	1	(37)	(74)
LIVESTOCK	(582)	(1,601)	(1,729)	(1,862)	(2,002)	(2,149)
IRRIGATION	(222,943)	(233,884)	(247,501)	(246,354)	(241,077)	(246,788)
RED BASIN						
FRIONA	(29)	(44)	(43)	(18)	(48)	(127)
COUNTY-OTHER	(12)	(11)	(14)	(14)	(15)	(18)
MANUFACTURING	(673)	(805)	(932)	(1,043)	(1,222)	(1,413)
LIVESTOCK	73	18	37	3	18	31
IRRIGATION	(49,777)	(49,880)	(49,747)	(50,055)	(51,859)	(51,497)
SWISHER COUNTY						
BRAZOS BASIN						
KRESS	84	64	51	39	26	9
COUNTY-OTHER	1	1	1	2	0	0
LIVESTOCK	2	1	0	3	1	4
IRRIGATION	(12,193)	(34,404)	(35,573)	(35,925)	(35,712)	(35,727)
RED BASIN						
HAPPY	40	42	40	34	20	7
KRESS	21	22	21	20	15	13
TULIA	(172)	(191)	(184)	(170)	(213)	(235)
COUNTY-OTHER	5	3	6	6	4	4
LIVESTOCK	6	3	0	2	2	1
IRRIGATION	(85,240)	(95,261)	(103,893)	(108,230)	(111,183)	(117,820)
TERRY COUNTY						
BRAZOS BASIN						
COUNTY-OTHER	1	1	1	1	0	0
MINING	0	0	0	(29)	(21)	(14)
LIVESTOCK	3	2	1	(13)	(16)	(18)
IRRIGATION	142	506	311	(788)	(1,728)	(5,456)
COLORADO BASIN						
BROWNFIELD	6	(739)	(863)	(991)	(1,149)	(1,304)
MEADOW	3	1	2	3	4	0
COUNTY-OTHER	18	13	1	35	21	6
MANUFACTURING	0	0	0	(1)	(1)	(2)
MINING	0	0	0	(387)	(272)	(192)
LIVESTOCK	42	0	0	(137)	(219)	(361)
IRRIGATION	419	(9,480)	(46,855)	(68,747)	(81,727)	(102,011)

Water User Group (WUG) Needs/Surplus

REGION O	WUG (NEEDS)/SURPLUS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
YOAKUM COUNTY						
COLORADO BASIN						
DENVER CITY	(759)	(769)	(771)	(789)	(866)	(1,037)
PLAINS	(194)	(306)	(387)	(464)	(518)	(525)
COUNTY-OTHER	3	4	1	4	3	2
MINING	(386)	(1,006)	(1,070)	(940)	(783)	(641)
STEAM ELECTRIC POWER	(1,486)	(2,326)	(3,189)	(4,185)	(5,474)	(7,864)
LIVESTOCK	(281)	(286)	(290)	(296)	(301)	(322)
IRRIGATION	(90,656)	(99,143)	(101,954)	(102,808)	(103,413)	(109,358)

Appendix 4B

Second Tier WUG Needs Report

Water User Group (WUG) Second-Tier Identified Water Need

REGION O	WUG SECOND-TIER NEEDS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
BAILEY COUNTY						
BRAZOS BASIN						
MULESHOE	0	270	277	297	473	498
COUNTY-OTHER	0	0	121	126	131	146
MANUFACTURING	183	206	225	250	274	324
LIVESTOCK	1,049	1,797	1,879	2,045	2,089	2,451
IRRIGATION	80,496	83,467	84,442	87,431	87,126	90,285
BRISCOE COUNTY						
RED BASIN						
SILVERTON	49	46	47	46	46	46
COUNTY-OTHER	0	0	0	0	0	0
LIVESTOCK	29	37	46	55	65	75
IRRIGATION	2,258	9,748	13,712	13,956	13,170	17,585
CASTRO COUNTY						
BRAZOS BASIN						
DIMMITT	0	0	138	185	227	262
HART	0	0	3	12	19	25
COUNTY-OTHER	0	0	0	0	0	0
MANUFACTURING	0	0	35	78	147	221
LIVESTOCK	2,897	3,829	4,855	5,209	5,321	5,606
IRRIGATION	157,497	147,905	167,677	173,903	171,898	176,478
RED BASIN						
COUNTY-OTHER	0	0	0	0	0	0
MANUFACTURING	85	54	29	31	33	39
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	99,174	94,812	99,265	96,675	94,914	101,554
COCHRAN COUNTY						
BRAZOS BASIN						
MORTON	0	0	0	0	0	0
COUNTY-OTHER	0	0	0	0	0	0
MINING	6	9	9	6	5	4
LIVESTOCK	221	229	275	59	83	230
IRRIGATION	61,201	59,718	58,085	56,202	53,606	52,780
COLORADO BASIN						
COUNTY-OTHER	0	0	0	0	0	0
MINING	0	0	0	0	0	0
LIVESTOCK	166	174	183	192	202	212
IRRIGATION	3,894	4,103	3,660	4,705	5,803	6,099
CROSBY COUNTY						
BRAZOS BASIN						
CROSBYTON	0	0	0	0	0	0
LORENZO	0	0	0	0	0	0
RALLS	0	0	0	0	0	0
COUNTY-OTHER	0	0	0	0	0	0
MANUFACTURING	0	0	0	0	0	0
MINING	0	0	0	0	0	0
LIVESTOCK	106	112	118	125	131	138
IRRIGATION	0	0	0	0	0	0

Water User Group (WUG) Second-Tier Identified Water Need

REGION O	WUG SECOND-TIER NEEDS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
CROSBY COUNTY						
RED BASIN						
COUNTY-OTHER	0	0	0	0	0	0
MINING	348	352	317	280	243	210
LIVESTOCK	1	1	1	1	1	1
IRRIGATION	2,854	2,657	2,284	2,106	1,788	1,641
DAWSON COUNTY						
BRAZOS BASIN						
O'DONNELL	0	7	8	10	11	12
COUNTY-OTHER	0	0	0	0	0	0
LIVESTOCK	2	2	2	2	2	2
IRRIGATION	0	0	0	0	0	227
COLORADO BASIN						
LAMESA	150	647	669	690	899	1,099
COUNTY-OTHER	0	0	20	56	114	149
MANUFACTURING	0	0	0	0	0	7
MINING	175	709	828	703	423	255
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	0	0	0	0	0	0
DEAF SMITH COUNTY						
CANADIAN BASIN						
COUNTY-OTHER	0	0	0	0	0	0
LIVESTOCK	76	93	98	103	109	115
IRRIGATION	862	801	714	657	603	553
RED BASIN						
HEREFORD	0	0	0	0	0	0
COUNTY-OTHER	0	0	0	0	0	0
MANUFACTURING	2,234	2,600	2,061	2,057	3,295	2,638
LIVESTOCK	4,399	3,973	1,444	2,698	4,181	683
IRRIGATION	77,808	85,015	90,363	100,375	107,962	119,866
DICKENS COUNTY						
BRAZOS BASIN						
SPUR	0	0	0	0	0	0
COUNTY-OTHER	0	0	0	0	0	0
MINING	0	0	0	0	0	0
LIVESTOCK	26	31	37	43	49	55
IRRIGATION	0	0	0	0	0	0
RED BASIN						
COUNTY-OTHER	0	0	0	0	0	0
MINING	0	0	0	0	0	0
LIVESTOCK	44	47	50	54	58	62
IRRIGATION	0	0	0	0	0	0
FLOYD COUNTY						
BRAZOS BASIN						
FLOYDADA	0	0	0	0	0	0
LOCKNEY	35	41	43	53	61	67
COUNTY-OTHER	0	0	0	0	0	0
MINING	0	0	0	0	0	0
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	0	0	0	0	0	0

Water User Group (WUG) Second-Tier Identified Water Need

REGION O	WUG SECOND-TIER NEEDS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
FLOYD COUNTY						
RED BASIN						
COUNTY-OTHER	0	0	0	0	0	0
MINING	0	0	0	0	0	0
LIVESTOCK	0	0	0	3	13	23
IRRIGATION	22,648	21,182	20,289	20,914	18,429	19,897
GAINES COUNTY						
COLORADO BASIN						
SEAGRAVES	0	0	0	0	15	32
SEMINOLE	431	942	1,205	1,402	1,440	1,491
COUNTY-OTHER	253	563	1,155	1,492	1,952	1,613
MANUFACTURING	310	686	1,007	1,295	1,604	2,380
MINING	202	604	777	692	531	463
LIVESTOCK	0	0	0	0	0	146
IRRIGATION	136,961	181,838	205,885	221,191	232,689	257,193
GARZA COUNTY						
BRAZOS BASIN						
POST	0	0	0	0	0	0
COUNTY-OTHER	0	0	0	0	0	0
MANUFACTURING	0	0	0	0	0	0
MINING	0	0	0	0	0	0
LIVESTOCK	231	237	244	252	260	278
IRRIGATION	0	0	0	0	0	0
HALE COUNTY						
BRAZOS BASIN						
ABERNATHY	50	21	24	18	24	22
HALE CENTER	0	0	0	0	0	0
PETERSBURG	0	0	0	0	0	0
PLAINVIEW	0	0	0	0	0	0
COUNTY-OTHER	0	0	0	0	0	0
MANUFACTURING	1,227	341	0	0	0	0
MINING	1,154	1,139	1,022	886	766	662
STEAM ELECTRIC POWER	34	24	0	0	0	0
LIVESTOCK	924	1,148	328	1,304	1,454	1,784
IRRIGATION	230,025	221,545	208,378	201,987	194,888	187,050
RED BASIN						
LIVESTOCK	14	20	20	21	21	21
IRRIGATION	1,900	1,814	1,682	1,618	1,545	1,465
HOCKLEY COUNTY						
BRAZOS BASIN						
ANTON	0	0	0	0	0	0
LEVELLAND	0	354	558	691	873	1,029
COUNTY-OTHER	0	0	0	0	0	0
MANUFACTURING	0	0	0	0	0	3
MINING	0	0	0	0	14	13
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	42,111	48,991	53,317	50,425	47,587	45,991
COLORADO BASIN						
SUNDOWN	0	0	0	0	0	6
COUNTY-OTHER	0	0	0	0	0	0

Water User Group (WUG) Second-Tier Identified Water Need

REGION O	WUG SECOND-TIER NEEDS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
HOCKLEY COUNTY						
COLORADO BASIN						
MINING	0	0	0	0	2	2
LIVESTOCK	35	37	39	41	43	45
IRRIGATION	1,353	928	881	680	510	819
LAMB COUNTY						
BRAZOS BASIN						
AMHERST	0	0	3	5	11	16
EARTH	0	0	0	0	0	0
LITTLEFIELD	0	0	0	0	0	0
OLTON	0	0	0	0	0	0
SUDAN	0	0	0	0	0	0
COUNTY-OTHER	0	0	0	0	0	0
MANUFACTURING	280	213	105	108	115	146
MINING	570	567	507	445	385	333
STEAM ELECTRIC POWER	6,227	4,267	0	0	0	2,984
LIVESTOCK	889	680	1,070	1,567	1,972	2,639
IRRIGATION	192,947	198,570	207,998	218,673	223,027	232,699
LUBBOCK COUNTY						
BRAZOS BASIN						
ABERNATHY	17	8	10	7	11	11
IDALOU	0	5	14	29	46	62
LUBBOCK	8,065	15,622	19,941	26,311	32,880	39,766
NEW DEAL	0	0	0	0	0	0
RANSOM CANYON	0	0	0	0	0	0
SHALLOWATER	0	3	0	21	60	98
SLATON	118	390	463	555	623	691
WOLFFORTH	0	0	0	0	46	205
COUNTY-OTHER	0	0	0	0	0	0
MANUFACTURING	232	63	68	72	78	143
MINING	6,261	6,366	5,888	5,302	4,763	4,314
STEAM ELECTRIC POWER	0	0	0	0	0	945
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	49,309	51,325	61,552	56,500	50,450	63,005
LYNN COUNTY						
BRAZOS BASIN						
O'DONNELL	0	40	47	52	62	68
TAHOKA	0	37	70	97	134	162
COUNTY-OTHER	0	12	14	22	54	69
MINING	634	784	717	511	318	164
LIVESTOCK	0	0	0	0	0	3
IRRIGATION	0	0	0	0	0	0
COLORADO BASIN						
COUNTY-OTHER	0	0	0	0	0	0
MINING	49	60	55	39	25	13
LIVESTOCK	1	1	2	2	2	3
IRRIGATION	0	0	0	0	0	0
MOTLEY COUNTY						
RED BASIN						
MATADOR	0	0	0	0	0	0

Water User Group (WUG) Second-Tier Identified Water Need

REGION O	WUG SECOND-TIER NEEDS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
MOTLEY COUNTY						
RED BASIN						
COUNTY-OTHER	0	0	0	0	0	0
MANUFACTURING	0	0	0	0	0	0
MINING	136	109	101	94	75	57
LIVESTOCK	161	170	179	189	199	209
IRRIGATION	0	0	0	0	0	0
PARMER COUNTY						
BRAZOS BASIN						
BOVINA	0	0	8	35	71	104
FARWELL	0	0	0	5	44	80
COUNTY-OTHER	0	0	0	0	11	47
LIVESTOCK	582	1,601	1,729	1,862	2,002	2,149
IRRIGATION	220,660	231,601	245,454	244,307	238,307	244,018
RED BASIN						
FRIONA	0	0	0	0	0	68
COUNTY-OTHER	0	0	0	0	0	0
MANUFACTURING	673	805	932	1,043	1,222	1,413
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	49,206	49,309	49,235	49,543	51,166	50,804
SWISHER COUNTY						
BRAZOS BASIN						
KRESS	0	0	0	0	0	0
COUNTY-OTHER	0	0	0	0	0	0
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	11,298	33,509	34,447	34,799	34,286	34,301
RED BASIN						
HAPPY	0	0	0	0	0	0
KRESS	0	0	0	0	0	0
TULIA	126	144	137	124	165	185
COUNTY-OTHER	0	0	0	0	0	0
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	81,162	91,183	98,764	103,101	104,687	111,324
TERRY COUNTY						
BRAZOS BASIN						
COUNTY-OTHER	0	0	0	0	0	0
MINING	0	0	0	29	21	14
LIVESTOCK	0	0	0	13	16	18
IRRIGATION	0	0	0	375	1,482	5,210
COLORADO BASIN						
BROWNFIELD	0	646	771	922	1,077	1,229
MEADOW	0	0	0	0	0	0
COUNTY-OTHER	0	0	0	0	0	0
MANUFACTURING	0	0	0	1	1	2
MINING	0	0	0	387	272	192
LIVESTOCK	0	0	0	137	219	361
IRRIGATION	0	2,639	39,009	60,901	77,057	97,341
YOAKUM COUNTY						
COLORADO BASIN						
DENVER CITY	688	690	685	695	763	925

Water User Group (WUG) Second-Tier Identified Water Need

REGION O	WUG SECOND-TIER NEEDS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
YOAKUM COUNTY						
COLORADO BASIN						
PLAINS	172	282	361	436	487	491
COUNTY-OTHER	0	0	0	0	0	0
MINING	386	1,006	1,070	940	783	641
STEAM ELECTRIC POWER	1,486	2,326	3,189	4,185	5,474	7,864
LIVESTOCK	281	286	290	296	301	322
IRRIGATION	87,885	96,372	98,906	99,760	100,916	106,861

***Second-tier needs are WUG split needs adjusted to include the implementation of recommended demand reduction and direct reuse water management strategies.**

Chapter 5

Chapter 5

Water Management Strategies

5. Water Management Strategies

The Texas Water Development Board (TWDB) requires that regional water plans (RWPs) identify and evaluate potentially feasible water management strategies (WMSs) for each water user group (WUG) and wholesale water provider (WWP) with future water supply needs. A need for water is identified when existing water supplies are less than projected water demands for that WUG or WWP within any planning decade.

This chapter addresses WMSs that have been identified and evaluated for the WUGs and/or WWPs in the planning area:

- Section 5.1 discusses the assumptions and methodology for the evaluation of potentially feasible WMSs.
- Sections 5.2 through 5.4 present the evaluations of the recommended WMSs for municipal WUGs, irrigation WUGs, and the City of Lubbock (a WWP), respectively.
- Section 5.5 summarizes Region A (Panhandle) recommended WMSs for the Canadian River Municipal Water Authority (CRMWA) that provide supplies for Region O WUGs.
- Section 5.6 presents the recommended strategy evaluation for White River MWD (a WWP).
- Sections 5.7 and 5.8 present the evaluations of alternative WMSs for the City of Lubbock (a WWP) and municipal WUGs, respectively.
- Section 5.9 summarizes potentially feasible strategies that were considered but not recommended.
- Section 5.10 describes best management practices identified for the region
- Section 5.11 provides recommendations regarding water conservation for all WUGs.

As required by Texas Water Code 16.053(d)(5), the regional water planning groups shall consider, but not be limited to, the following potentially feasible WMSs for all identified water needs:

- Improved conservation
- Reuse
- Management of existing water supplies
- Conjunctive use
- Acquisition of available existing water supplies
- Development of new water supplies
- Development of regional water supply facilities or providing regional management of water supply facilities
- Voluntary transfer of water within the region using regional water banks, sales, leases, options, subordination agreements, financing agreements, and other mechanisms as appropriate
- Emergency transfer of water under Section 11.139 of the Texas Water Code

To meet these requirements, a number of overall WMSs are considered as part of this RWP. The process used to identify potentially feasible WMSs included conducting WUG and WWP surveys, with necessary followup, and discussion at multiple Llano Estacado Regional Water Planning Group (LERWPG) meetings. As required by 31 TAC §357.12(b), a list of all identified WMSs that were considered potentially feasible for meeting a need in the region follows:

- Municipal conservation
- Agricultural conservation
- Manufacturing conservation
- Local groundwater development
- Water reuse (including direct reuse, indirect reuse, and graywater reuse)
- Watershed management (including brush management, playa best management practices, and rainwater harvesting)
- Drought management

- Brackish groundwater desalination
- Water transfers (includes voluntary and emergency transfers of water)
- Electric-dry power generation
- Infrastructure development (including specific strategies for the City of Lubbock, CRMWA, and South Garza Water Supply/Lake Alan Henry Water District)

Table 5-1 documents the WMSs that were considered to meet the needs that have been identified for WUGs and WWPs in each county in the region and notes those that are considered to be potentially feasible. WMSs identified in previous RWPs were updated to meet current rule and guidance requirements, reflect changed physical or socioeconomic conditions that have since occurred, reflect changes in water project configurations or conditions, consider newly identified WUGs or WWPs, and accommodate changes in identified water needs.

Several strategies that were included on the Region O Task 4D scope of work could not be fully evaluated and are considered to be no longer potentially feasible, as approved by the LERWPG at their September 10, 2015 meeting. Those strategies, along with the reasons for designating them as no longer potentially feasible, are:

- Evaluating whether there are any groundwater sources that could be brought in to augment the water supply available for irrigation, because no specific project, sponsor, or water source has been identified.
- Evaluating the Blaus Wasser (now BW Primoris) groundwater importation plans for municipal use, because BW Primoris has not sought involvement in the planning process (the current BW Primoris-Seminole water supply arrangement is discussed in Section 5.2.5, but no other customers have been identified to date).
- Implementing trench recharge to enhance aquifer recharge from precipitation events, because no specific project or sponsor has been identified.
- Implementing the CRMWA channel water supply enhancement project, because this is an operations and maintenance activity, not a water management strategy.

Table 5-1. Water Management Strategies Considered and Evaluated
Page 1 of 6

County	Water User Group	Maximum Need (acre-feet per year)	Water Management Strategies Required to be Considered by Statute											Additional Water Management Strategies Considered									
			Conservation	Drought Management	Reuse	Reallocation / Management of Existing Supplies	Voluntary Transfers	Conjunctive Use	Acquisition of Available Supplies	Development of New Supplies	Development of Regional Water Supply or Regional Management of Water Supply Facilities	Voluntary Transfer of Water (Including Regional Water Banks, Sales, Leases, Options Subordination agreements, and financing agreements)	Emergency Transfer of Water Under Section 11.139	New Groundwater Supply	New Surface Water Supply	Brush Management	Cloud Seeding	Playa BMPs	Rainwater Harvesting	Brackish Water Desalination	Water Importation	Electric-Dry Power Generation	Aquifer Storage and Recovery
Bailey	County-other	146	PF	nPF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Irrigation	93,037	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Livestock	2,451	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Manufacturing	324	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Muleshoe	587	PF	nPF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
Briscoe	County-other	2	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Irrigation	20,059	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Livestock	75	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Silverton	55	PF	nPF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
Castro	County-other	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Dimmitt	329	PF	nPF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Hart	25	PF	nPF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Irrigation	286,510	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Livestock	5,606	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Manufacturing	260	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
Cochran	County-other	23	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Irrigation	66,863	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Livestock	458	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Mining	9	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Morton	124	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
Crosby	County-other	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Crosbyton	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Irrigation	7,082	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Livestock	139	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Lorenzo	40	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF

nPF = Considered but determined 'not potentially feasible' (may include WMSs that were initially identified as potentially feasible)

PF = Considered 'potentially feasible' and therefore evaluated

Table 5-1. Water Management Strategies Considered and Evaluated
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County	Water User Group	Maximum Need (acre-feet per year)	Water Management Strategies Required to be Considered by Statute											Additional Water Management Strategies Considered									
			Conservation	Drought Management	Reuse	Reallocation / Management of Existing Supplies	Voluntary Transfers	Conjunctive Use	Acquisition of Available Supplies	Development of New Supplies	Development of Regional Water Supply or Regional Management of Water Supply Facilities	Voluntary Transfer of Water (Including Regional Water Banks, Sales, Leases, Options Subordination agreements, and financing agreements)	Emergency Transfer of Water Under Section 11.139	New Groundwater Supply	New Surface Water Supply	Brush Management	Cloud Seeding	Playa BMPs	Rainwater Harvesting	Brackish Water Desalination	Water Importation	Electric-Dry Power Generation	Aquifer Storage and Recovery
Crosby (cont.)	Manufacturing	0	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Mining	352	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Ralls	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	White River MWD	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
Dawson	County-other	149	PF	nPF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Irrigation	4,149	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Lamesa	1,220	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Livestock	2	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Manufacturing	7	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Mining	828	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	O'Donnell	12	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
Deaf Smith	County-other	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Hereford	151	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Irrigation	128,438	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Livestock	4,475	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Manufacturing	3,295	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
Dickens	County-other	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Irrigation	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Livestock	117	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Mining	0	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Spur	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
Floyd	County-other	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Floydada	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Irrigation	29,390	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Livestock	23	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF

nPF = Considered but determined 'not potentially feasible' (may include WMSs that were initially identified as potentially feasible)
PF = Considered 'potentially feasible' and therefore evaluated

Table 5-1. Water Management Strategies Considered and Evaluated
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County	Water User Group	Maximum Need (acre-feet per year)	Water Management Strategies Required to be Considered by Statute											Additional Water Management Strategies Considered									
			Conservation	Drought Management	Reuse	Reallocation / Management of Existing Supplies	Voluntary Transfers	Conjunctive Use	Acquisition of Available Supplies	Development of New Supplies	Development of Regional Water Supply or Regional Management of Water Supply Facilities	Voluntary Transfer of Water (Including Regional Water Banks, Sales, Leases, Options Subordination agreements, and financing agreements)	Emergency Transfer of Water Under Section 11.139	New Groundwater Supply	New Surface Water Supply	Brush Management	Cloud Seeding	Playa BMPs	Rainwater Harvesting	Brackish Water Desalination	Water Importation	Electric-Dry Power Generation	Aquifer Storage and Recovery
Floyd (cont.)	Lockney	67	PF	nPF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Mining	0	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
Gaines	County-other	1,952	PF	nPF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Irrigation	266,837	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Livestock	146	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Manufacturing	2,380	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Mining	777	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Seagraves	32	PF	nPF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Seminole	1,675	PF	nPF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF
Garza	County-other	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Irrigation	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Livestock	278	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Manufacturing	0	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Mining	0	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Post	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
Hale	Abernathy	76	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF
	County-other	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Hale Center	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Irrigation	238,491	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Livestock	1,805	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Manufacturing	1,227	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Mining	1,154	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Petersburg	10	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Plainview	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Steam-electric power	34	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF

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PF = Considered 'potentially feasible' and therefore evaluated

Table 5-1. Water Management Strategies Considered and Evaluated
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County	Water User Group	Maximum Need (acre-feet per year)	Water Management Strategies Required to be Considered by Statute											Additional Water Management Strategies Considered									
			Conservation	Drought Management	Reuse	Reallocation / Management of Existing Supplies	Voluntary Transfers	Conjunctive Use	Acquisition of Available Supplies	Development of New Supplies	Development of Regional Water Supply or Regional Management of Water Supply Facilities	Voluntary Transfer of Water (Including Regional Water Banks, Sales, Leases, Options Subordination agreements, and financing agreements)	Emergency Transfer of Water Under Section 11.139	New Groundwater Supply	New Surface Water Supply	Brush Management	Cloud Seeding	Playa BMPs	Rainwater Harvesting	Brackish Water Desalination	Water Importation	Electric-Dry Power Generation	Aquifer Storage and Recovery
Hockley	Anton	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	County-other	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Irrigation	60,284	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Levelland	1,029	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Livestock	45	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Manufacturing	3	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Mining	16	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Sundown	82	PF	nPF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
Lamb	Amherst	22	PF	nPF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	County-other	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Earth	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Irrigation	239,866	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Littlefield	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Livestock	2,639	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Manufacturing	280	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Mining	570	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Olton	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Steam electric power	6,227	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Sudan	2	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
Lubbock	Abernathy	26	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF
	County-other	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Idalou	86	PF	nPF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Irrigation	73,945	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Livestock	0	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Lubbock	43,148	PF	nPF	PF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	PF	PF	nPF	nPF	nPF	nPF	PF	nPF	nPF	PF

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Table 5-1. Water Management Strategies Considered and Evaluated
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County	Water User Group	Maximum Need (acre-feet per year)	Water Management Strategies Required to be Considered by Statute											Additional Water Management Strategies Considered									
			Conservation	Drought Management	Reuse	Reallocation / Management of Existing Supplies	Voluntary Transfers	Conjunctive Use	Acquisition of Available Supplies	Development of New Supplies	Development of Regional Water Supply or Regional Management of Water Supply Facilities	Voluntary Transfer of Water (Including Regional Water Banks, Sales, Leases, Options Subordination agreements, and financing agreements)	Emergency Transfer of Water Under Section 11.139	New Groundwater Supply	New Surface Water Supply	Brush Management	Cloud Seeding	Playa BMPs	Rainwater Harvesting	Brackish Water Desalination	Water Importation	Electric-Dry Power Generation	Aquifer Storage and Recovery
Lubbock (cont.)	Manufacturing	232	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Mining	6,366	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	New Deal	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Ransom Canyon	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Shallowater	275	PF	nPF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Slaton	691	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Steam electric power	945	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Wolfforth	797	PF	nPF	PF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
Lynn	County-other	69	PF	nPF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Irrigation	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Livestock	6	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Mining	844	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	O'Donnell	68	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Tahoka	166	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
Motley	County-other	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Irrigation	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Livestock	209	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Manufacturing	0	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Matador	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Mining	136	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
Parmer	Bovina	131	PF	nPF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	County-other	92	PF	nPF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Farwell	173	PF	nPF	PF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Friona	127	PF	nPF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Irrigation	298,285	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF

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PF = Considered 'potentially feasible' and therefore evaluated

Table 5-1. Water Management Strategies Considered and Evaluated
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County	Water User Group	Maximum Need (acre-feet per year)	Water Management Strategies Required to be Considered by Statute: Conservation	Drought Management	Reuse	Reallocation / Management of Existing Supplies	Voluntary Transfers	Conjunctive Use	Acquisition of Available Supplies	Development of New Supplies	Development of Regional Water Supply or Regional Management of Water Supply Facilities	Voluntary Transfer of Water (Including Regional Water Banks, Sales, Leases, Options Subordination agreements, and financing agreements)	Emergency Transfer of Water Under Section 11.139	Additional Water Management Strategies Considered: New Groundwater Supply	New Surface Water Supply	Brush Management	Cloud Seeding	Playa BMPs	Rainwater Harvesting	Brackish Water Desalination	Water Importation	Electric-Dry Power Generation	Aquifer Storage and Recovery
Parmer (cont.)	Livestock	2,149	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Manufacturing	1,413	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
Swisher	County-other	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Happy	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Irrigation	153,547	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Kress	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Livestock	0	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Tulia	235	PF	nPF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
Terry	Brownfield	1,304	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	County-other	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Irrigation	107,467	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Livestock	379	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Manufacturing	2	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Meadow	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Mining	416	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
Yoakum	County-other	0	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Denver City	1,037	PF	nPF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Irrigation	109,358	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Livestock	322	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Mining	1,070	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Plains	525	PF	nPF	nPF	nPF	nPF	nPF	nPF	PF	nPF	nPF	nPF	PF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF
	Steam electric power	7,864	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF	nPF

nPF = Considered but determined 'not potentially feasible' (may include WMSs that were initially identified as potentially feasible)
PF = Considered 'potentially feasible' and therefore evaluated

- Acquiring available supplies, because this information is either covered by other strategies that are included in the plan or is confidential.

Other WMSs identified as potentially feasible in the Region O Task 4D scope of work could not be recommended because no specific project or sponsor was identified (unless otherwise noted), but have been included as general best management practices:

- Manufacturing conservation
- Graywater reuse
- Treated wastewater reuse for energy production and/or irrigation
- Non-potable water reuse for hydraulic fracturing (fracking)
- Playa best management practices
- Rainwater harvesting
- Brush management
- Precipitation enhancement
- Drought management (proposed as an emergency tool and not an ongoing water management strategy)
- Electric-dry power generation
- Confined animal feeding operations groundwater development
- No-till farming techniques

A significant amount of document research was conducted and information compiled on these best management practices that may be beneficial to the region and is provided in Section 5.10.

The WMSs identified as potentially feasible in Table 5-1 have been fully evaluated. The methodology for these evaluations in summarized in Section 5.1, and evaluation results are provided in Sections 5.2 through 5.9. Recommendations for water conservation for all WUGs, particularly those with unmet needs, are provided in Section 5.11.

5.1 Strategy Evaluation

WMSs were evaluated based on criteria specified in 31 TAC §357.34 and 357.35, including water quantities generated by strategies, the reliability of strategies, financial costs, environmental impacts, and implementation issues. These criteria are discussed generally in Sections 5.1.1 through 5.1.3.

Each potentially feasible strategy has been evaluated, and WMSs are recommended on a WUG level for those WUGs with identified water needs, although some of the strategies may be implemented on a larger scale. The LERWPG has also made recommendations for WUGs where needs have not been identified. The LERWPG is not responsible for implementation of strategies for its individual members.

The list of recommended and alternative WMSs is provided on Table 5-2 and Table 5-3, respectively. The information provided includes each strategy name, an expected implementation date, the total yield of the strategy on a decadal basis, and the capital costs of the WMS. Any alternative WMSs included in the RWP may be substituted for one of the recommended strategies, should it become infeasible. The required DB17 reports are provided in Appendix 5A.

Appendix 5B provides a summary for each County regarding its location and population, water sources, water needs, potentially feasible WMSs, unallocated water availability, and recommended WMSs.

5.1.1 Quantity and Reliability

Water quantities are defined as the amounts of water that a given strategy would provide to a WUG for current and future demand. Water quantities are evaluated using units of acre-feet per year (ac-ft/yr).

Table 5-2. Recommended Water Management Strategies and Cost Summary for Region O
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County	Entity	Recommended WMS	Online Decade	Total Capital Costs ($)	First Decade Unit Cost ($/ac-ft/yr)	Water Supply (ac-ft/yr) 2020	2030	2040	2050	2060	2070	2070 Unit Cost ($/ac-ft/yr)
Bailey	County-other	Local groundwater development	2040	771,000	493	0	0	150	150	150	150	60
	Irrigation	Irrigation water conservation	2020	3,625,325	42	1,846	1,846	2,652	2,652	2,752	2,752	42
	Muleshoe	Local groundwater development	2030	2,434,000	397	0	300	300	300	500	500	266
		Municipal water conservation	2020	0	770	59	64	70	76	83	89	770
Briscoe	County-other	Municipal water conservation	2020	0	770	15	15	14	14	14	14	770
	Irrigation	Irrigation water conservation	2020	3,020,000	42	1,667	1,667	1,899	1,899	2,474	2,474	42
	Silverton	Local groundwater development	2020	5,872,000	4,496	121	121	121	121	121	121	438
		Municipal water conservation	2020	0	770	6	6	2	2	2	2	770
Castro	Dimmitt	Local groundwater development	2040	1,297,000	427	0	0	300	300	300	300	63
		Municipal water conservation	2020	0	770	55	58	60	63	65	67	770
	Hart	Local groundwater development	2040	855,000	820	0	0	100	100	100	100	100
	Irrigation	Irrigation water conservation	2020	11,540,650	42	6,253	6,253	8,350	8,350	8,478	8,478	42
Cochran	County-other	Municipal water conservation	2020	0	770	25	27	28	28	29	29	770
	Irrigation	Irrigation water conservation	2020	4,193,725	42	1,768	1,768	2,977	2,977	3,642	3,642	42
	Morton	Municipal water conservation	2020	0	770	24	24	23	23	23	23	770
		Water loss reduction	2020	11,760,034	3,206	141	141	232	226	231	233	0
Crosby	Irrigation	Irrigation water conservation	2020	14,844,250	42	5,514	5,514	10,180	10,180	13,995	13,995	42
	Lorenzo	Municipal water conservation	2020	0	770	12	12	13	14	15	15	770
		Water loss reduction	2020	5,428,944	7,196	29	31	54	57	61	64	0
	White River MWD	Local groundwater development	2020	2,513,000	343	600	600	600	600	600	600	55
Dawson	County-other	Local groundwater development	2040	802,000	507	0	0	150	150	150	150	60
	Irrigation	Irrigation water conservation	2020	13,956,700	42	5,410	5,410	9,610	9,610	12,893	12,893	42
	Lamesa	Municipal water conservation	2020	0	770	114	115	116	116	119	121	770
Deaf Smith	Hereford	Municipal water conservation	2020	0	770	198	223	251	286	315	346	770
	Irrigation	Irrigation water conservation	2020	10,844,425	42	5,464	5,464	8,207	8,207	8,019	8,019	42
Dickens	Irrigation	Irrigation water conservation	2020	1,400,575	42	480	480	936	936	1,385	1,385	42
	Spur	Municipal water conservation	2020	0	770	9	9	9	8	8	8	770
Floyd	Floydada	Municipal water conservation	2020	0	770	29	30	30	31	32	33	770
	Irrigation	Irrigation water conservation	2020	15,990,325	42	6,121	6,121	11,027	11,027	14,833	14,833	42
	Lockney	Local groundwater development	2020	2,719,000	1,125	240	240	240	240	240	240	179
Gaines	County-other	Local groundwater development	2020	7,251,000	358	600	600	1,500	1,500	2,000	1,622	187
	Irrigation	Irrigation water conservation	2020	16,756,575	42	11,563	11,563	12,306	12,306	9,644	9,644	42
	Seagraves	Local groundwater development	2050	617,000	1,160	0	0	0	50	50	50	120
		Municipal water conservation	2020	0	770	20	9	0	0	0	0	0

ac-ft/yr = Acre-feet per year

Table 5-2. Recommended Water Management Strategies and Cost Summary for Region O
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County	Entity	Recommended WMS	Online Decade	Total Capital Costs ($)	First Decade Unit Cost ($/ac-ft/yr)	Water Supply (ac-ft/yr)						2070 Unit Cost ($/ac-ft/yr)
						2020	2030	2040	2050	2060	2070	
Gaines (cont.)	Seminole	Groundwater desalination	2020	31,572,000	7,822	500	500	500	500	500	500	2,538
		Local groundwater development	2030	32,754,000	3,108	0	1,000	1,000	1,000	1,000	1,000	367
		Municipal water conservation	2020	0	770	117	129	142	158	171	184	770
Garza	County-other	South Garza Water Supply	2020	7,672,000	3,879	270	270	270	270	270	270	1,501
	Irrigation	Irrigation water conservation	2020	1,503,750	42	584	584	1,033	1,033	1,391	1,391	42
Hale	Abernathy	Groundwater desalination	2020	10,100,000	9,253	150	150	150	150	150	150	3,620
		Municipal water conservation	2020	0	770	35	37	38	39	40	41	770
	Irrigation	Irrigation water conservation	2020	17,715,350	42	6,566	6,566	12,332	12,332	16,533	16,533	42
	Petersburg	Municipal water conservation	2020	0	770	16	17	17	16	17	17	770
	Plainview	Municipal water conservation	2020	0	770	218	222	221	217	223	225	770
Hockley	Anton	Municipal water conservation	2020	0	770	8	8	8	8	9	9	770
	County-other	Local groundwater development	2020	643,000	407	150	150	150	150	150	150	47
	Irrigation	Irrigation water conservation	2020	9,290,525	42	4,178	4,178	6,086	6,086	8,317	8,317	42
	Levelland	Municipal water conservation	2020	0	770	116	53	0	0	0	0	0
	Sundown	Local groundwater development	2070	690,000	650	0	0	0	0	0	100	650
		Municipal water conservation	2020	0	770	21	22	22	22	23	24	770
		Water loss reduction	2020	3,348,332	4,895	27	28	48	48	50	52	0
Lamb	Amherst	Local groundwater development	2020	487,000	900	50	50	50	50	50	50	80
		Municipal water conservation	2020	0	770	5	5	5	6	6	6	770
	Earth	Municipal water conservation	2020	0	770	10	10	9	9	8	8	770
	Irrigation	Irrigation water conservation	2020	10,951,300	42	6,305	6,305	8,430	8,430	7,167	7,167	42
	Littlefield	Municipal water conservation	2020	0	770	48	46	44	42	41	40	770
	Olton	Municipal water conservation	2020	0	770	23	23	23	22	22	22	770
	Sudan	Municipal water conservation	2020	0	770	12	13	14	14	15	15	770
Lubbock	Idalou	Local groundwater development	2030	2,534,000	2,330	0	100	100	100	100	100	210
		Municipal water conservation	2020	0	681	21	21	22	23	23	24	681
	Irrigation	Irrigation water conservation	2020	12,380,950	42	5,711	5,711	8,111	8,111	10,940	10,940	42
	Lubbock	Bailey County Well Field capacity maintenance	2020	25,518,000	2,028	997	1,143	2,822	3,120	3,120	3,120	160
		Brackish well field at the South Water Treatment Plant	2020	34,531,740	3,671	1,120	1,120	1,120	1,120	1,120	1,120	1,090
		CRMWA aquifer storage and recovery	2030	62,345,000	1,099	0	6,090	6,090	6,090	6,090	6,090	243
		Jim Bertram Lake 7	2020	82,066,000	614	13,800	13,800	13,800	13,800	13,800	13,800	179
		Lake Alan Henry Phase 2	2020	57,799,000	911	8,000	8,000	8,000	8,000	8,000	8,000	306
		Municipal water conservation	2020	0	600	2,287	2,478	2,674	2,915	3,139	3,382	600
		North Fork scalping operation	2020	119,825,000	1,342	10,390	9,790	9,220	8,660	8,110	7,890	513

ac-ft/yr = Acre-feet per year

Table 5-2. Recommended Water Management Strategies and Cost Summary for Region O
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County	Entity	Recommended WMS	Online Decade	Total Capital Costs ($)	First Decade Unit Cost ($/ac-ft/yr)	Water Supply (ac-ft/yr)						2070 Unit Cost ($/ac-ft/yr)
						2020	2030	2040	2050	2060	2070	
Lubbock (cont.)	Lubbock	South Lubbock well field	2030	53,856,000	2,516	0	2,613	2,613	2,613	2,613	2,613	791
	Ransom Canyon	Municipal water conservation	2020	0	681	17	18	19	20	21	22	681
	Shallowater	Local groundwater development	2030	3,583,000	1,948	0	400	400	400	400	400	1,198
		Water loss reduction	2020	5,320,016	3,007	68	74	136	150	163	177	0
	Wolfforth	Local groundwater development	2030	8,383,000	1,142	0	726	726	726	726	726	175
		Municipal water conservation	2020	0	681	38	37	29	26	29	32	681
		Potable reuse	2030	21,822,000	5,121	0	560	560	560	560	560	1,861
Lynn	County-other	Local groundwater development	2020	598,000	560	100	100	100	100	100	100	60
	Irrigation	Irrigation water conservation	2020	10,989,425	42	4,230	4,230	7,577	7,577	10,173	10,173	42
	Tahoka	Municipal water conservation	2020	0	770	24	20	7	3	4	4	770
Motley	County-other	Municipal water conservation	2020	0	770	5	5	5	5	5	5	770
	Irrigation	Irrigation water conservation	2020	1,455,775	42	485	485	971	971	1,456	1,456	42
	Matador	Municipal water conservation	2020	0	770	11	10	10	10	10	10	770
Parmer	Bovina	Local groundwater development	2040	775,000	617	0	0	120	120	120	120	75
		Municipal water conservation	2020	0	770	19	20	21	23	25	27	770
	County-other	Local groundwater development	2060	621,000	1,160	0	0	0	0	50	50	1,160
		Municipal water conservation	2020	0	770	32	34	36	39	42	45	770
	Farwell	Local groundwater development	2050	815,000	632	0	0	0	125	125	125	88
		Municipal water conservation	2020	0	770	20	21	23	25	27	29	770
		Potable reuse	2020	5,196,000	10,656	64	64	64	64	64	64	3,859
	Friona	Local groundwater development	2050	555,000	663	0	0	0	80	80	80	88
		Municipal water conservation	2020	0	770	41	45	48	51	55	59	770
	Irrigation	Irrigation water conservation	2020	4,438,125	42	2,854	2,854	2,559	2,559	3,463	3,463	42
Swisher	Irrigation	Irrigation water conservation	2020	9,574,850	42	4,973	4,973	6,255	6,255	7,922	7,922	42
	Tulia	Local groundwater development	2020	1,733,000	885	200	200	200	200	200	200	160
		Municipal water conservation	2020	0	770	46	47	47	46	48	50	770
Terry	Brownfield	Municipal water conservation	2020	0	770	90	93	92	69	72	75	770
	Irrigation	Irrigation water conservation	2020	10,187,625	42	7,201	7,201	8,259	8,259	4,916	4,916	42
Yoakum	Denver City	Local groundwater development	2020	2,995,000	333	925	925	925	925	925	925	62
		Municipal water conservation	2020	0	770	71	79	86	94	103	112	770
	Irrigation	Irrigation water conservation	2020	4,158,250	42	2,771	2,771	3,048	3,048	2,497	2,497	42
	Plains	Local groundwater development	2020	4,923,000	1,954	500	500	500	500	500	500	1,130
		Municipal water conservation	2020	0	770	22	24	26	28	31	34	770

ac-ft/yr = Acre-feet per year

Table 5-3. Alternative Water Management Strategies and Cost Summary for Region O

County	Entity	Alternative WMS	Online Decade	Total Capital Costs ($)	First Decade Unit Cost ($/ac-ft/yr)	Water Supply (ac-ft/yr)						2070 Unit Cost ($/ac-ft/yr)
						2020	2030	2040	2050	2060	2070	
Hockley	County-other	Smyer CRMWA Lease from Levelland	2020	4,115,000	14,333	30	30	30	30	30	30	2,867
Lubbock	Lubbock	Direct potable reuse to North Water Treatment Plant	2020	69,458,000	872	10,089	10,089	10,089	10,089	10,089	10,089	296
		Direct potable reuse to South Water Treatment Plant	2020	89,441,000	1,178	10,089	10,089	10,089	10,089	10,089	10,089	436
		North Fork diversion at CR 7300	2020	46,378,000	629	10,089	10,089	10,089	10,089	10,089	10,089	244
		North Fork diversion to Lake Alan Henry pump station	2020	45,058,000	930	7,510	7,510	7,510	7,510	7,510	7,510	428
		Post Reservoir	2020	93,192,000	903	10,600	10,600	10,600	10,600	10,600	10,600	252
		Reclaimed water to aquifer storage and recovery	2020	90,935,000	1,377	8,071	8,071	8,071	8,071	8,071	8,071	434
		South Fork discharge	2020	57,957,000	1,016	8,183	8,183	8,183	8,183	8,183	8,183	423
Swisher	Tulia	Local groundwater development (new location)	2020	3,204,000	1,625	200	200	200	200	200	200	285

ac-ft/yr = Acre-feet per year

Reliability characterizes the consistency and availability of a source over time. Sources that provide a continuous, non-seasonal supply have a higher reliability than those impacted by seasonal changes or those that are available only during certain times of the year.

Region O WMSs include reductions in demand and increases to supply. The supply increases are based either on existing availability not allocated to a water user, as reported in Chapter 3, or estimated future increases in availability from new or existing sources. These sources include future reuse supply, desalination of brackish groundwater for potable use, surface water augmentation, and aquifer storage and recovery. In some cases, supplies for groundwater development WMSs were limited to the amount of unallocated groundwater available from the source. These limitations are due primarily to reductions in groundwater availability resulting from adopted Desired Future Conditions.

RPS used a modified TCEQ WAM Run 3 for the Brazos River Basin to model the surface water strategies, in order to evaluate their potential firm yields that will be 100 percent reliable during the historical drought of record. The WAM period of record was 1940 to 1997, reflecting naturalized flows based upon the historical hydrologic record of that period and the 1950s drought as the drought of record. Four scenarios were run: (1) Jim Bertram Lake 7, (2) North Fork Scalping Operation, (3) Jim Bertram Lake 7 and North Fork Scalping Operation together, and (4) Post Reservoir. The modeling of the surface water strategies was performed in an manner consistent with the Region G 'Brazos G' WAM, as well as the modeling performed as part of the City of Lubbock's Strategic Water Supply Plan (City of Lubbock, 2013) and the Yield Analyses of North and South Fork Water Supply Projects (HDR, 2013). The following assumptions were made in the evaluation of the surface water supply strategies:

- Senate Bill 3 environmental flow standards with a priority date of March 1, 2012 have been implemented.
- Return flows are incorporated into the modeling in a manner consistent with analyses from previous rounds of planning for Region O.
- The Brazos Sys-Ops permit (priority date October 15, 2004) was modeled in the evaluations of Jim Bertram Lake 7 and the North Fork scalping operation.

- A sedimentation rate of 0.61 percent per year was used for Lake Alan Henry, consistent with modeling of the existing surface water supply.
- Model assumptions adopted in previous City of Lubbock model representations (City of Lubbock, 2013; HDR, 2013) were adopted in the present evaluation, including:
  - The flow distribution for the Lake Alan Henry control point was revised to use the Double Mountain Fork at Justiceburg U.S. Geological Survey (USGS) gauge control point for determination of flow.
  - All inflows to Lake Alan Henry are held in the reservoir, in accordance with the subordination agreement that the City of Lubbock has with the Brazos River Authority

The modeled naturalized flow in the WAM was not modified and the City of Lubbock's return flows were added as modeled inflows separate from the naturalized flow of the WAM, so there is no double counting in the strategy volumes. The results of the modeling are discussed under each strategy evaluation (Sections 5.4.6, 5.4.7, and 5.7.7). The RPS surface water sources WMS memorandum is provided in Appendix 5C. The modeling input files are provided in Appendix 5D.

None of the recommended WMSs rely on the same volume of water. For example, the City of Lubbock has selected only one reuse strategy, since all of their alternative strategies rely on the same volume of available reuse water. The water losses associated with each strategy have been estimated and are included in the evaluations.

5.1.2 Financial Costs

Costs evaluated for the new and existing WMSs include capital costs, debt service, and annual operating and maintenance expenses for the planning period. Costs were developed for the WMSs identified in this RWP using the TWDB's Unified Costing Model (UCM), unless a more in-depth project-specific cost was developed by the sponsor (e.g., City of Lubbock strategies). The cost types are defined in the following subsections.

5.1.2.1 *Capital Costs*

Capital costs consist of (1) construction funds and other capital outlays for facility improvements such as wells, pipelines, pump stations, and treatment plants, and (2) administrative costs such as costs for engineering, contingencies, financial, legal, administration, environmental permitting and mitigation, land acquisition, and interest during construction.

5.1.2.2 *Debt Service*

For WMSs other than reservoirs, the length of debt service is 20 years, unless otherwise justified. For reservoirs, the period is 40 years. Level debt service applies to all projects, and the annual interest rate for project financing is 5.5 percent. The terms of debt service have been reported in the TWDB's Regional Water Planning Application (DB17).

5.1.2.3 *Annual Operating and Maintenance Costs*

Annual operations and maintenance (O&M) costs are calculated based on the quantity of water produced or delivered by a given WMS. Annual O&M costs are calculated as 1.0 percent of total estimated construction cost for pipelines, 2.5 percent of estimated construction costs for pump stations, and 1.5 percent of estimated construction costs for dams. In instances where actual project costs or estimates are available, these costs have been used. O&M costs include both labor and materials required for project maintenance and regular repair and/or replacement of equipment. Power costs are calculated using estimated horsepower requirements, when applicable, and a cost for power of $0.09 per kilowatt hour on an annual basis, as specified by TWDB guidance. If a WMS includes the purchase of raw or treated water (including leases of water rights), those annual costs are also included.

5.1.2.4 *Unit Costs of Water*

The unit cost provides the net volume of water to be delivered to water users on an annual basis in dollars per acre-foot. Unit costs of WMSs have been estimated for each of the WMSs evaluated and provided in a manner to allow direct comparison with other WMSs.

5.1.2.5 Infrastructure Costs

Costs for infrastructure required to develop, treat, and convey increased water supplies from water supply sources for end use are included. This infrastructure includes treatment either by a specific WUG or WWP at the delivery point. For instance, if the WWP treats water for a given

WMS prior to delivery to the WUG, costs for this infrastructure are included. Infrastructure costs are also estimated for conservation WMSs that include new infrastructure to address issues in an existing system. Costs that are directly associated with development of new water sources, increased supply from improvements to existing systems, or volumetric increases to existing water supplies for WUGs or WWPs are captured in this evaluation.

5.1.2.6 Costs Not Included

If an infrastructure component does not increase the treated water supply volume delivered to a WUG for a strategy, the component and its costs have not been included in the cost evaluations.

5.1.3 Environmental Impacts and Limitations on WMSs

Environmental impacts for WMSs are project-specific and are difficult to accurately quantify at a planning level. Projects may require specific permitting or investigatory work, including permits from the TCEQ, U.S. Environmental Protection Agency (U.S. EPA), or the U.S. Army Corps of Engineers (USACE). A full environmental study will be needed for each WMS before proceeding with strategy implementation.

For planning purposes, an impact matrix was developed and implemented to provide an initial evaluation of the potential environmental impacts of the Region O WMSs. The Region O impact matrix assesses each WMS in terms of seven categories (discussed in more detail in the following subsections):

1. Acres impacted
2. Threatened and endangered species
3. Instream flows
4. Agricultural resources
5. Playa wetlands
6. Springs
7. Cultural sites

A score of 1 to 5 is assigned for each of the seven categories, with 1 being the lowest impact and 5 the highest impact. The possible range of scores is 7 to 35; the lower the total score, the lower the anticipated impact. Table 5-4 shows the impact matrix categories, scoring criteria, and scoring calculation methods. The seven impact matrix categories were evaluated at a county level, rather than a site-specific level, unless more detailed information existed, as was the case with the City of Lubbock strategies. Information provided by the City of Lubbock allowed for a more detailed evaluation in two main ways:

- Several of the City of Lubbock strategies are located in areas that have already been disturbed due to urban development or existing water supply infrastructure, and the impact of these strategies will be less than construction of new infrastructure on previously undisturbed land.

- Lubbock's indirect reuse strategies rely upon use of the City's reclaimed wastewater. The City of Lubbock owns its reclaimed water and is not required to discharge it to the Brazos River. Therefore, the City's diversion of discharged effluent was not considered a decrease of streamflow.

Impact matrix scores for the Region O WMSs ranged between 7.0 and 24.3. The irrigation conservation strategies received the lowest scores (average score of 7.0), followed by the municipal conservation strategies (average score of 7.5). The surface water projects received the highest score (average score of 22.5). Table 5-5 shows the scoring for each of the seven categories by WMS. Appendix 5E provides the detailed scoring (scores for each subcategory) by WMS.

5.1.3.1 Acres Impacted

The number of acres impacted by a WMS is assessed in terms of permanently and temporarily impacted acres. The following assumptions were used in assessing this category:

- Wells and pipelines are considered temporary impacts.
  - One well impacts 1 acre.

Table 5-4. Criteria Used to Evaluate Water Management Strategies
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Category	Criterion	Calculation [a]	Score: Low impact → 1	2	3	4	High impact 5	Comments
Acres impacted	Temporarily impacted	Average	None	1–50	51–100	101–500	> 500	
	Permanently impacted	Average	None	1–50	51–100	101–500	> 500	
Threatened and endangered species	Critical habitat impact	— (Average)	No				Yes	Reflects whether the project would be located in an area that has been designated as critical habitat. Score will either be a 1 (no) or a 5 (yes).
	Number of species proposed for listing	Multiply (Average)	None	1–2	3–4	5	> 5	Number of species present in county of project implementation.
	Degree of impact for species proposed for listing [b]	Multiply (Average)	None (multiplier = 0) No direct or indirect impact.		Mild (multiplier = 0.5) Species survival/recovery is likely in direct response to project implementation.		Critical (multiplier = 1) Species survival/recovery is unlikely in direct response to project implementation.	Evaluates impact to species proposed for listing.
	Number of threatened species	Multiply (Average)	None	1	2–3	4–6	> 6	Number of species present in county of project implementation.
	Degree of impact for threatened species [b]	Multiply (Average)	None (multiplier = 0) No direct or indirect impact.		Mild (multiplier = 0.5) Species survival/recovery is likely in direct response to project implementation.		Critical (multiplier = 1) Species survival/recovery is unlikely in direct response to project implementation.	Evaluates impact to threatened species.
	Number of endangered species	Multiply (Average)	None	1	2–3	4–5	> 5	Number of species present in county of project implementation.
	Degree of impact for endangered species [b]	Multiply (Average)	None (multiplier = 0) No direct or indirect impact.		Mild (multiplier = 0.5) Species survival/recovery is likely in direct response to project implementation.		Critical (multiplier = 1) Species survival/recovery is unlikely in direct response to project implementation.	Evaluates impact to endangered species.
Instream flows	Origin of diverted water	Average	No water diversion OR 100% discharged effluent	New diversion from existing lake OR 0–10% use of native stream flows	11–20% use of native stream flows	21–50% diversion of native stream flows	> 50% diversion of native stream flows	If category is not applicable, then it is not used to calculate the average score.
	Streamflow impacts	Average	No stream flow impact OR Increases flows for >50 stream miles	New diversion from existing lake OR Decreases stream discharge/flow by 0–3.0 mgd	Decreases stream discharge/flows by 3.1–10.0 mgd	Decreases stream discharge/flows by >10.0 mgd	New impoundment	

[a] For each water management strategy, the individual scores for the applicable categories are summed to determine an overall score for the category.
[b] If there are multiple endangered species in the county of project implementation and any one of them qualifies as *critical*, the whole project is scored critical.

Table 5-4. Criteria Used to Evaluate Water Management Strategies
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Category	Criterion	Calculation [a]	Score: Low impact → 1	2	3	4	High impact 5	Comments
Agricultural resources	Number of acres temporarily impacted Number of acres permanently impacted	Average	None	0–250 and/or 0–50	251–500 and/or 51–100	> 500 and/or 101–500	— > 500	Score is based upon the highest category that applies (temporarily impacted or permanently impacted).
	Water supply impact		Increases supply	No impact	Decreases supply by 0-250 ac-ft/yr	Decreases supply by 251-500 ac-ft/yr	Decreases supply by >500 ac-ft/yr	
Playa wetlands	Estimated number of playas impacted	Average	None	1	2	3	> 3	Unless other info is available, the following calculation is used: Acres impacted / Density of playas per acre. Conservative (high) estimate: density of playas: 1 per 2.6 km^2 or 1 per 642 acres [c]
Springs	Spring impact	Average	No impact to the water table	Affects the water table (0-250 ac-ft/yr), BUT No currently active springs in county of project implementation	Affects the water table (>250 ac-ft/yr), BUT No currently active springs in county of project implementation	Affects the water table (0-250 ac-ft/yr), AND Potential impact to active springs in county of project implementation	Affects the water table (>250 ac-ft/yr), AND Potential impact to active springs in county of project implementation	
Cultural sites	Number of sites impacted	Average	0–5	6–15	16–25	26–50	> 50	Number of cultural sites present in county of project implementation. [d]

[a] For each water management strategy, the individual scores for the applicable categories are summed to determine an overall score for the category.
[c] Source: Haukos and Smith, 1997, p. 7
[d] Source: Texas Historical Commission database (THC, 2015)

Table 5-5. Ranking of Recommended Strategies
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Water User Group: County	Water User Group: Name	Water Management Strategy	County Location of Project	Rank[a]: Acres Impacted	Threatened and Endangered Species	Instream Flows	Agricultural Resources	Playa Wetland	Spring	Cultural Sites	Total Rank
Bailey	County-other	Local groundwater development	Bailey	1.5	2.0	1.0	2.5	2.0	2.0	3.0	14.0
	Irrigation	Irrigation water conservation	Bailey	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
	Muleshoe	Local groundwater development	Bailey	1.5	2.0	1.0	3.0	2.0	3.0	3.0	15.5
		Municipal water conservation	Bailey	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
Briscoe	County-other	Municipal water conservation	Briscoe	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
	Irrigation	Irrigation water conservation	Briscoe	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
	Silverton	Local groundwater development	Briscoe	2.5	2.0	1.0	2.5	2.0	4.0	3.0	17.0
		Municipal water conservation	Briscoe	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
Castro	Dimmitt	Local groundwater development	Castro	1.5	2.0	1.0	3.0	2.0	3.0	3.0	15.5
		Municipal water conservation	Castro	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
	Hart	Local groundwater development	Castro	1.5	2.0	1.0	2.5	2.0	2.0	3.0	14.0
	Irrigation	Irrigation water conservation	Castro	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
Cochran	County-other	Municipal water conservation	Cochran	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
	Irrigation	Irrigation water conservation	Cochran	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
	Morton	Local groundwater development	Cochran	1.5	2.0	1.0	2.5	2.0	2.0	2.0	13.0
		Municipal water conservation	Cochran	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
		Water loss reduction	Cochran	1.0	2.0	1.0	1.5	1.0	1.0	1.0	8.5
Crosby	Irrigation	Irrigation water conservation	Crosby	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
	Lorenzo	Municipal water conservation	Crosby	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
		Water loss reduction	Crosby	1.0	2.3	1.0	1.5	1.0	1.0	1.0	8.8
	White River MWD	Local groundwater development	Crosby	1.5	3.3	1.0	3.5	2.0	5.0	5.0	21.3
Dawson	County-other	Local groundwater development	Dawson	1.5	2.3	1.0	2.5	2.0	2.0	3.0	14.3
	Irrigation	Irrigation water conservation	Dawson	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
	Lamesa	Municipal water conservation	Dawson	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
Deaf Smith	Hereford	Municipal water conservation	Deaf Smith	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
	Irrigation	Irrigation water conservation	Deaf Smith	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
Dickens	Irrigation	Irrigation water conservation	Dickens	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
	Spur	Municipal water conservation	Dickens	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
Floyd	Floydada	Municipal water conservation	Floyd	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
	Irrigation	Irrigation water conservation	Floyd	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
	Lockney	Local groundwater development	Floyd	1.5	2.0	1.0	2.5	2.0	2.0	4.0	15.0
Gaines	County-other	Local groundwater development	Gaines	2.0	2.0	1.0	3.5	2.0	3.0	3.0	16.5
	Irrigation	Irrigation water conservation	Gaines	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
	Seagraves	Local groundwater development	Gaines	1.5	2.0	1.0	2.5	2.0	2.0	3.0	14.0

[a] Ranking criteria are provided in Table 5-4; ranking scores are detailed in Appendix 5E.

Table 5-5. Ranking of Recommended Strategies
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Water User Group: County	Water User Group: Name	Water Management Strategy	County Location of Project	Rank[a]: Acres Impacted	Threatened and Endangered Species	Instream Flows	Agricultural Resources	Playa Wetland	Spring	Cultural Sites	Total Rank
Gaines (cont.)	Seagraves (cont.)	Municipal water conservation	Gaines	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
	Seminole	Groundwater desalination	Gaines	2.5	2.0	1.0	2.0	2.0	3.0	3.0	15.5
		Local groundwater development	Gaines	3.5	2.0	1.0	4.5	2.0	3.0	3.0	19.0
		Municipal water conservation	Gaines	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
Garza	County-other	South Garza Water Supply	Garza	3.0	3.5	2.0	1.5	2.0	1.0	5.0	18.0
	Irrigation	Irrigation water conservation	Garza	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
Hale	Abernathy	Municipal water conservation	Hale	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
	Irrigation	Irrigation water conservation	Hale	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
	Petersburg	Municipal water conservation	Hale	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
	Plainview	Municipal water conservation	Hale	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
Hale, Lubbock	Abernathy	Groundwater desalination	Hale	2.5	2.0	1.0	2.0	2.0	2.0	5.0	16.5
Hockley	Anton	Municipal water conservation	Hockley	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
	Irrigation	Irrigation water conservation	Hockley	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
	Levelland	Municipal water conservation	Hockley	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
	Sundown	Local groundwater development	Hockley	1.5	2.0	1.0	2.5	2.0	2.0	3.0	14.0
		Municipal water conservation	Hockley	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
		Water loss reduction	Hockley	1.0	2.0	1.0	1.5	1.0	1.0	1.0	8.5
Lamb	Amherst	Local groundwater development	Lamb	1.5	2.0	1.0	2.5	2.0	2.0	4.0	15.0
		Municipal water conservation	Lamb	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
	Earth	Municipal water conservation	Lamb	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
	Irrigation	Irrigation water conservation	Lamb	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
	Littlefield	Municipal water conservation	Lamb	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
	Olton	Municipal water conservation	Lamb	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
	Sudan	Municipal water conservation	Lamb	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
Lubbock	Abernathy	Municipal water conservation	Lubbock	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
	Idalou	Local groundwater development	Lubbock	2.0	2.0	1.0	2.5	2.0	4.0	5.0	18.5
		Municipal water conservation	Lubbock	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
	Irrigation	Irrigation water conservation	Lubbock	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
	Lubbock	Bailey County Well Field capacity maintenance	Bailey	2.5	2.0	1.0	4.0	2.0	3.0	3.0	17.5
		Brackish well field at the South Water Treatment Plant	Lubbock	2.0	1.0	1.0	1.5	2.0	5.0	1.0	13.5
		CRMWA aquifer storage and recovery	Lubbock	3.0	2.0	1.0	1.5	2.0	1.0	5.0	15.5
		Jim Bertram Lake 7	Lubbock	4.0	2.0	4.0	3.5	3.0	1.0	5.0	22.5
		Lake Alan Henry Phase 2	Garza, Lubbock	1.5	2.3	2.0	2.0	2.0	1.0	5.0	15.8
		Municipal water conservation	Lubbock	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5

[a] Ranking criteria are provided in Table 5-4; ranking scores are detailed in Appendix 5E.

Table 5-5. Ranking of Recommended Strategies

Water User Group				Rank[a]							
County	Name	Water Management Strategy	County Location of Project	Acres Impacted	Threatened and Endangered Species	Instream Flows	Agricultural Resources	Playa Wetland	Spring	Cultural Sites	Total Rank
Lubbock (cont.)	Lubbock (cont.)	North Fork scalping operation	Garza, Lubbock	4.0	3.5	4.0	3.5	3.0	1.0	5.0	24.0
		South Lubbock well field	Lubbock	3.0	1.0	1.0	3.0	1.0	5.0	1.0	15.0
	Ransom Canyon	Municipal water conservation	Lubbock	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
	Shallowater	Local groundwater development	Lubbock	2.0	2.0	1.0	3.0	2.0	5.0	5.0	20.0
		Water loss reduction	Lubbock	1.0	2.0	1.0	1.5	1.0	1.0	1.0	8.5
	Wolfforth	Local groundwater development	Lubbock	2.5	2.0	1.0	3.5	2.0	5.0	5.0	21.0
		Municipal water conservation	Lubbock	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
		Potable reuse	Lubbock	2.0	2.0	1.5	1.5	2.0	1.0	5.0	15.0
Lynn	County-other	Local groundwater development	Lynn	1.5	2.0	1.0	2.5	2.0	2.0	3.0	14.0
	Irrigation	Irrigation water conservation	Lynn	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
	Tahoka	Municipal water conservation	Lynn	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
Motley	County-other	Municipal water conservation	Motley	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
	Irrigation	Irrigation water conservation	Motley	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
	Matador	Municipal water conservation	Motley	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
Parmer	Bovina	Local groundwater development	Parmer	1.5	2.0	1.0	2.5	2.0	2.0	4.0	15.0
		Municipal water conservation	Parmer	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
	County-other	Local groundwater development	Parmer	1.5	2.0	1.0	2.5	2.0	2.0	4.0	15.0
		Municipal water conservation	Parmer	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
	Farwell	Local groundwater development	Parmer	1.5	2.0	1.0	2.5	2.0	2.0	4.0	15.0
		Municipal water conservation	Parmer	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
		Potable reuse	Parmer	2.0	2.0	1.5	1.5	2.0	1.0	4.0	14.0
	Friona	Local groundwater development	Parmer	1.5	2.0	1.0	2.5	2.0	2.0	4.0	15.0
		Municipal water conservation	Parmer	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
	Irrigation	Irrigation water conservation	Parmer	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
Swisher	Irrigation	Irrigation water conservation	Swisher	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
	Tulia	Local groundwater development	Swisher	2.5	2.0	1.0	2.5	2.0	2.0	4.0	16.0
		Municipal water conservation	Swisher	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
Terry	Brownfield	Municipal water conservation	Terry	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
	Irrigation	Irrigation water conservation	Terry	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
Yoakum	Denver City	Local groundwater development	Yoakum	1.5	2.0	1.0	3.5	2.0	3.0	2.0	15.0
		Municipal water conservation	Yoakum	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5
	Irrigation	Irrigation water conservation	Yoakum	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
	Plains	Local groundwater development	Yoakum	1.5	2.0	1.0	3.0	2.0	3.0	2.0	14.5
		Municipal water conservation	Yoakum	1.0	1.0	1.0	1.5	1.0	1.0	1.0	7.5

[a] Ranking criteria are provided in Table 5-4; ranking scores are detailed in Appendix 5E.

Table 5-5. Ranking of Recommended Strategies
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Water User Group				Rank [a]							
County	Name	Water Management Strategy	County Location of Project	Acres Impacted	Threatened and Endangered Species	Instream Flows	Agricultural Resources	Playa Wetland	Spring	Cultural Sites	Total Rank
Alternate strategies											
Hockley	Smyer	Smyer CRMWA lease from Levelland	Hockley	2.0	2.0	1.0	2.0	2.0	1.0	3.0	13.0
Lubbock	Lubbock	Direct potable reuse to North Water Treatment Plant	Lubbock	2.5	2.0	1.0	2.0	2.0	1.0	5.0	15.5
		Direct potable reuse to South Water Treatment Plant	Lubbock	2.5	2.0	1.0	2.0	2.0	1.0	5.0	15.5
		North Fork diversion at CR 7300	Lubbock	2.5	2.0	1.0	2.0	2.0	1.0	5.0	15.5
		North Fork diversion to Lake Alan Henry pump station	Garza, Lubbock	2.5	3.5	1.0	2.0	2.0	1.0	5.0	17.0
		Post Reservoir	Garza, Lubbock	4.0	3.5	3.5	3.5	5.0	1.0	5.0	25.5
		Reclaimed water to aquifer storage and recovery	Lubbock	3.0	2.0	1.0	1.5	2.0	1.0	5.0	15.5
		South Fork discharge	Lubbock, Lynn	3.0	2.0	1.0	2.0	2.0	1.0	5.0	16.0
Swisher	Tulia	Local groundwater development	Swisher	2.0	2.0	1.0	2.5	2.0	2.0	4.0	15.5

[a] Ranking criteria are provided in Table 5-4; ranking scores are detailed in Appendix 5E.

- 1 linear mile of pipeline impacts 12 acres, assuming a disturbance width of 100 feet.
  - For a 100-foot-wide disturbance, a total of 528,000 square feet will be impacted per mile of pipeline (100 feet x 5,280 feet = 528,000 square feet).
  - This is equivalent to approximately 12 acres of disturbance per mile of pipeline (528,000 square feet ÷ 43,560 square feet per acre = 12 acres).

- All other infrastructure components are considered permanent impacts.
  - One water treatment plant impacts 5 acres.
  - One pump station impacts 2 acres.
  - One storage tank impacts 2 acres.
  - One intake structure impacts 1 acre.
  - One stilling basin impacts 1 acre.
  - For a reservoir, the number of acres impacted equals the reservoir's surface area.

The sub-scores for temporarily and permanently impacted acres are averaged together to produce an overall Acres Impacted score.

5.1.3.2 Threatened and Endangered Species

The impact to threatened and endangered species is assessed by considering the number of species proposed for listing or listed as threatened or endangered in the county of project implementation, as well as whether the project is proposed to be implemented in a county containing an area designated as critical habitat. The Degree of Impact multiplier is used in conjunction with the proposed, threatened, and endangered species sub-categories to account for the fact that different species will be affected to varying degrees by the implementation of different projects. The following assumptions were used in assessing this category:

- The threatened and endangered species assessment was conducted at a county level.
- The number of proposed, threatened and endangered species was based on lists developed by the U.S. Fish and Wildlife Service (USFWS) and the Texas Parks and Wildlife Department (TPWD), as detailed in Appendix 1B

- Degree of Impact:
  - All conservation strategies (municipal and irrigation) and water loss reduction strategies received a multiplier of 0.
  - All non-conservation and non-water loss reduction strategies implemented in counties with one or more endangered species present received a multiplier of 1.
  - All other strategies received a multiplier of 0.5.
- Water loss reduction and conservation WMSs do not impact critical habitat.
- Only one species that is proposed for listing is present in Region O (a bird with the common name of Sprague's pipit; Appendix 1B). The following multipliers were used as part of the Degree of Impact column for this sub-category:
  - 0 for conservation and water loss reduction projects
  - 0 if the species was not present in the county of project implementation
  - 0.5 if the species was present in the county of project implementation

The sub-scores for critical habitat and for proposed for listing, threatened, and endangered species are averaged together to produce an overall Threatened and Endangered Species score.

5.1.3.3 Instream Flows

The impact to instream flows is assessed by considering the origin of diverted water and the impact on streamflows. The sub-category Origin of Diverted Water gives the lowest scores to strategies that do not include a water diversion or use discharged effluent only. The higher the percentage of native streamflows diverted for project use, the higher the score. For Streamflow Impacts, the lowest score is for strategies that do not have a streamflow impact or those that increase streamflows for more than 50 miles. The middle three scores (2 to 5) are reserved for strategies that will reduce stream discharge/flows by increasing amounts. The highest score is for strategies proposing construction of a new reservoir.

The sub-scores for Origin of Diverted Water and Streamflow Impacts are averaged together to produce an overall Instream Flows score.

5.1.3.4 Agricultural Resources

The impact to agricultural resources is assessed by considering the number of agricultural acres impacted and the impact of strategy implementation on the water supply. The Agricultural Acres Impacted sub-category assesses the amount of agricultural land that will be disturbed, both temporarily and permanently, due to project implementation. The Water Supply Impact sub-category assesses the degree to which project implementation will affect the groundwater available for agricultural use.

The sub-scores for Agricultural Acres Impacted and Water Supply Impact are averaged together to produce an overall Agricultural Resources score.

5.1.3.5 Playa Wetlands

The impact to playa wetlands is assessed by estimating the number of playas that will be affected due to strategy implementation. The following formula was used to estimate the number of playas impacted:

Number of playas impacted = Acres impacted / Density of playa wetlands per acre

The average density of playa lakes on the Southern High Plains is 1 every 2.6 square kilometer (km^2) (Haukos and Smith, 1997), which is equivalent to approximately 1 per square mile or 1 every 642 acres. When estimating the number of playas impacted, all calculations were rounded up to the nearest integer.

5.1.3.6 Springs

As reported in *Springs and Seeps of the Llano Estacado Region* (prepared by LERWPG member Jim Steiert and provided in Appendix 1A), information collected through extensive phone interviews in 2004, 2005, and 2015 indicates that there are numerous small springs and seeps in the region. Although many springs and seeps in the region are still active, most have disappeared as native grassland was cultivated for irrigated agriculture, and flow is minimal in comparison to historical times. Some of the regional springs discharge year-round, and others flow only after prolonged, substantial rainfall. The springs and seeps that are still active in the region are summarized below; complete information regarding these springs and seeps is provided as Appendix 1A.

- A complex of six live springs on the Muleshoe Refuge (Bailey County)
- Baileyboro Lake seeps and Turkey Springs (Bailey County)
- Mackenzie Lake seeps (Briscoe County)
- Blanco Canyon seeps (Crosby County)
- Springs in the Rock Crusher and Indian Canyon Ranch areas (Dawson County)
- Tierra Blanca Creek spring and South Main Bridge seep (Deaf Smith County)
- Dripping Springs (Dickens County)
- Yellow Lake seeps (Hockley County)
- Buffalo Lake springs (Lubbock County)
- New Moore, Gooch Lake, and Colorado River headwaters springs (Lynn County)
- Dutchman Creek and Ballard Creek seeps, four small springs located in draws, and Roaring Springs (Motley County)
- Spring located east of Tulia (Swisher County)
- Springs and seeps located east of Brownfield, and Sulphur Springs (Terry County)

To assess the impact of project implementation on springs, both active and potentially active springs should be considered. Therefore, the impact to springs is assessed by looking at the magnitude of the impact of the project on the local water table as well as the presence or absence of an active spring in the county of project implementation. Appendix 1A (*Springs and Seeps in the Llano Estacado Region*) summarizes the occurrence of springs and seeps by county and was used as the reference for spring locations in the region. The number of springs impacted by strategies was estimated based on the locations of strategy implementation.

5.1.3.7 Cultural Sites

The Texas Historical Commission provides information about historical sites in the State of Texas. The database includes information on National Register Listings, cemeteries, historical markers, courthouses, museums, and state antiquities. This assessment excludes archaeological sites, because location data are not available for archaeological sites. Potential impacts to archaeological impacts will need to be evaluated as part of the in-depth environmental impact analyses done prior to WMS implementation.

The number of cultural sites impacted was assessed at the county level. The number of cultural sites impacted per county varied substantially, ranging from 10 sites in Yoakum County to 91 sites in Lubbock County. Historical markers constitute 63 percent of the 691 cultural sites present in Region O. In Lubbock County, 57 of the 91 cultural sites are historical markers.

5.2 Recommended Strategies for Municipal WUGs

5.2.1 Municipal Water Conservation

5.2.1.1 Background

The State of Texas Water Conservation Task Force (Task Force) was created in 2003 by Senate Bill 1094 to evaluate past implementation of water conservation strategies and propose ideas for future improvement. The Task Force defines conservation as "those practices, techniques, programs, and technologies that will protect water resources, 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" (TWDB, 2004a).

To achieve future water savings, the Task Force recommends that cities seek to achieve a total per capita demand of 140 gallons per day (gpd). For water utilities in Texas with more than 3,300 connections, the average per capita use in 2010 was 154 gpd, with a residential per capita use (including indoor and outdoor uses) of 140 gpd (TWDB and TSSWCB, 2012). These values exceed the Task Force's recommendation.

In order to close the gap, the Task Force recommends that every municipal water conservation plan include a goal of a "minimum annual reduction of one percent in total gpcd, based upon a five-year rolling average, until such time as the entity achieves a total gpcd of 140 or less" (TWDB, 2004a). The LERWPG feels that a 1 percent annual reduction is too aggressive for municipalities in the region, and that reductions of this magnitude would cause revenue issues that the WUGs are not prepared for. The LERWPG recommends an annual reduction of no more than 0.5 percent in total per capita use, based on a five-year rolling average, until such time as the entity achieves a total per capita use of 140 gpd or less.

A brief explanation of municipal water use calculations follows, along with an evaluation of the water savings that will be needed to meet the recommended 140 gallons per capita per day (gpcd).

As discussed in the Section 2.2.1, municipal water use consists of water used for residential and commercial purposes:

- *Residential water use*: Water for single-family and multi-family households
- *Commercial water use*: Water for businesses, public offices, and institutions, but not industry

Municipal water demand is calculated using a municipality's population and per capita use:

$$\text{Municipal water demand} = \text{Population} \times \text{Per capita use}$$

Water conservation leads to reductions in per capita use, lowering water demand. The TWDB calculates a unique per capita use for each WUG (Section 2.2) based on the following equation:

$$\text{Per capita use} = \text{Total annual water used} / \text{Total population} / 365 \text{ days}$$

Since water use tends to be higher in dry years, the TWDB uses a Dry Year Designation to ensure that per capita use projections are conservative; that is, it requires that the base year for per capita use calculations be the driest year on record from 2006 onward. For all counties in Region O, the base year is 2011, the driest year on record since 2006 in the State of Texas.

According to TWDB policy, no WUG is allowed to have a demand projection of less than 60 gpcd. This policy stems from calculations based on studies by DeOreo (2011) and Hermitte and Mace (2012).

The DeOreo study found that people living in standard new homes (built since 2001) retrofitted with high-water-efficient fixtures and appliances have an indoor use of 39 gpcd. The TWDB assumes that by 2070, all homes in Texas will meet this criterion. The Hermitte and Mace study found that in Texas homes, 69 percent of water use occurs indoors and 31 percent occurs outdoors, with this ratio applying to homes of all ages and types. Therefore, total water demand for the average Texas home is calculated to be 56.5 gpcd (an indoor use of 39 gpcd is 69 percent of 56.5 gpcd). Of this 56.5 gpcd total use, 39 gpcd is attributed to indoor use and 17.5 gpcd is attributed to outdoor use. Because municipal water use includes residential and commercial water use, the TWDB rounded the 56.5 gpcd up to 60.0 gpcd to account for commercial use. The LERWPG feels that the proportion of outdoor water use may be higher in west Texas than was shown in the Hermitte and Mace study.

After calculating water demand projections, WUGs should assess the role that water conservation can play in meeting their demand. Table 5-6 shows the population, per capita use, and water demand projections by decade for each municipality in Region O, as well as the reduction needed to achieve the target 140 gpcd set by the Task Force. Table 5-7 shows the same information for the County-other WUGs.

Seminole and Matador have the largest target per capita use reductions, each needing a reduction of 50 percent or more for each decade to reach the target 140 gpcd. Sundown, Ransom Canyon, and Denver City each need a reduction of between 40 percent and 50 percent for each decade. Out of the 49 municipalities in Region O, only 17 are projected to reach the goal of 140 gpcd during the planning period, and 15 of those (Amherst, Anton, Crosbyton, Hale Center, Happy, Hart, Kress, Lockney, Meadow, New Deal, O'Donnell, Post, Ralls, Shallowater, and Slaton) are projected to have per capita use below 140 gpd for all decades in the planning period. The other 2 of the 17 are projected to reach the target per capita use during the planning period without additional conservation efforts: Seagraves (2040) and Levelland (2040).

Table 5-6. Potential Water Savings Achievable with Water Conservation, by City
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County	City	Decade	Population	Water Demand (acre-feet)	Per Capita Demand (gpcd)		Target Reduction in Demand		
					Projected	Ideal	gpcd	ac-ft/yr	Percentage of Total Demand (%)
Bailey	Muleshoe	2020	5,769	1,174	182	140	42	268	23
		2030	6,452	1,284	178	140	38	271	21
		2040	7,131	1,397	175	140	35	279	20
		2050	7,833	1,523	174	140	34	295	19
		2060	8,527	1,656	173	140	33	318	19
		2070	9,208	1,787	173	140	33	343	19
Briscoe	Silverton	2020	741	126	151	140	11	10	8
		2030	742	123	147	140	7	6	5
		2040	742	120	143	140	3	3	2
		2050	742	119	142	140	2	2	2
		2060	742	119	142	140	2	2	1
		2070	742	119	142	140	2	2	1
Castro	Dimmit	2020	4,845	1,096	202	140	62	336	31
		2030	5,259	1,164	198	140	58	339	29
		2040	5,555	1,210	194	140	54	339	28
		2050	5,830	1,260	193	140	53	345	27
		2060	6,044	1,304	193	140	53	356	27
		2070	6,216	1,341	193	140	53	366	27
	Hart	2020	1,229	180	131	140	Target reached		
		2030	1,334	189	126	140			
		2040	1,409	194	123	140			
		2050	1,479	203	122	140			

gpcd = Gallons per capita per day
ac-ft/yr = Acre-feet per year

Table 5-6. Potential Water Savings Achievable with Water Conservation, by City
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County	City	Decade	Population	Water Demand (acre-feet)	Per Capita Demand (gpcd)		Target Reduction in Demand		
					Projected	Ideal	gpcd	ac-ft/yr	Percentage of Total Demand (%)
Castro (cont.)	Hart (cont.)	2060	1,533	210	122	140	(Target reached in 2020)		
		2070	1,577	216	122	140			
Cochran	Morton	2020	2,150	473	196	140	56	136	29
		2030	2,206	474	191	140	51	127	27
		2040	2,197	467	190	140	50	122	26
		2050	2,148	456	189	140	49	119	26
		2060	2,198	466	189	140	49	121	26
		2070	2,212	469	189	140	49	121	26
Crosby	Crosbyton	2020	1,876	294	140	140	Target reached		
		2030	2,018	306	135	140			
		2040	2,136	316	132	140			
		2050	2,256	332	131	140			
		2060	2,385	351	131	140			
		2070	2,501	367	131	140			
	Lorenzo	2020	1,258	231	164	140	24	33	14
		2030	1,377	246	159	140	19	29	12
		2040	1,477	258	156	140	16	26	10
		2050	1,580	275	155	140	15	27	10
		2060	1,701	295	155	140	15	28	10
		2070	1,783	310	155	140	15	29	10
	Ralls	2020	2,083	313	134	140	Target reached		
		2030	2,231	324	129	140			

gpcd = Gallons per capita per day
ac-ft/yr = Acre-feet per year

Table 5-6. Potential Water Savings Achievable with Water Conservation, by City
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County	City	Decade	Population	Water Demand (acre-feet)	Per Capita Demand (gpcd)		Target Reduction in Demand		
					Projected	Ideal	gpcd	ac-ft/yr	Percentage of Total Demand (%)
Crosby (cont.)	Ralls (cont.)	2040	2,352	333	126	140	(Target reached in 2020)		
		2050	2,474	347	125	140			
		2060	2,600	364	125	140			
		2070	2,727	381	125	140			
Dawson	Lamesa	2020	9,903	2,275	205	140	65	721	32
		2030	10,251	2,303	200	140	60	694	30
		2040	10,490	2,314	197	140	57	669	29
		2050	10,535	2,319	196	140	56	666	29
		2060	10,840	2,382	196	140	56	682	29
		2070	11,039	2,425	196	140	56	694	29
	O'Donnell	2020	127	18	123	140	Target reached		
		2030	133	18	118	140			
		2040	138	19	117	140			
		2050	141	19	116	140			
		2060	147	20	116	140			
		2070	150	20	116	140			
Deaf Smith	Hereford	2020	17,576	3,953	201	140	61	1,196	30
		2030	20,291	4,463	196	140	56	1,280	29
		2040	23,258	5,040	193	140	53	1,392	28
		2050	26,623	5,728	192	140	52	1,553	27
		2060	29,267	6,288	192	140	52	1,698	27
		2070	32,158	6,907	192	140	52	1,863	27

gpcd = Gallons per capita per day
ac-ft/yr = Acre-feet per year

Table 5-6. Potential Water Savings Achievable with Water Conservation, by City
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County	City	Decade	Population	Water Demand (acre-feet)	Per Capita Demand (gpcd)		Target Reduction in Demand		
					Projected	Ideal	gpcd	ac-ft/yr	Percentage of Total Demand (%)
Dickens	Spur	2020	1,029	178	154	140	14	16	9
		2030	1,029	173	149	140	9	11	6
		2040	1,029	171	148	140	8	9	5
		2050	1,029	170	147	140	7	8	5
		2060	1,029	170	147	140	7	8	5
		2070	1,029	170	147	140	7	8	5
Floyd	Floydada	2020	3,242	572	157	140	17	63	11
		2030	3,447	589	153	140	13	48	8
		2040	3,577	603	150	140	10	42	7
		2050	3,718	625	150	140	10	42	7
		2060	3,828	643	150	140	10	42	7
		2070	3,920	658	150	140	10	43	6
	Lockney	2020	1,963	268	122	140	Target reached		
		2030	2,085	274	117	140			
		2040	2,162	276	114	140	Target reached		
		2050	2,245	286	114	140			
		2060	2,310	294	113	140			
		2070	2,364	300	113	140			
Gaines	Seagraves	2020	2,536	419	147	140	7	21	5
		2030	2,677	430	143	140	3	10	2
		2040	2,847	447	140	140	Target reached		
		2050	3,034	470	138	140			

gpcd = Gallons per capita per day
ac-ft/yr = Acre-feet per year

Table 5-6. Potential Water Savings Achievable with Water Conservation, by City
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County	City	Decade	Population	Water Demand (acre-feet)	Per Capita Demand (gpcd)		Target Reduction in Demand		
					Projected	Ideal	gpcd	ac-ft/yr	Percentage of Total Demand (%)
Gaines (cont.)	Seagraves (cont.)	2060	3,137	485	138	140	(Target reached in 2040)		
		2070	3,245	502	138	140			
	Seminole	2020	7,102	2,348	295	140	155	1,234	53
		2030	7,893	2,571	291	140	151	1,333	52
		2040	8,834	2,847	288	140	148	1,462	51
		2050	9,855	3,160	286	140	146	1,614	51
		2060	10,648	3,411	286	140	146	1,741	51
		2070	11,475	3,675	286	140	146	1,875	51
Garza	Post	2020	6,012	792	118	140	Target reached		
		2030	6,452	828	114	140			
		2040	6,841	861	112	140			
		2050	7,098	884	111	140			
		2060	7,466	928	111	140	Target reached		
		2070	7,770	965	111	140			
Hale	Abernathy	2020	2,227	528	211	140	71	178	34
		2030	2,323	539	207	140	67	174	32
		2040	2,363	540	204	140	64	169	31
		2050	2,343	532	202	140	62	164	31
		2060	2,405	545	202	140	62	167	31
		2070	2,430	550	202	140	62	169	31
	Hale Center	2020	2,380	298	112	140	Target reached		
		2030	2,482	299	108	140			

gpcd = Gallons per capita per day
ac-ft/yr = Acre-feet per year

Table 5-6. Potential Water Savings Achievable with Water Conservation, by City
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County	City	Decade	Population	Water Demand (acre-feet)	Per Capita Demand (gpcd)		Target Reduction in Demand		
					Projected	Ideal	gpcd	ac-ft/yr	Percentage of Total Demand (%)
Hale (cont.)	Hale Center (cont.)	2040	2,524	296	105	140	(Target reached in 2020)		
		2050	2,503	289	103	140			
		2060	2,569	296	103	140			
		2070	2,597	299	103	140			
	Petersburg	2020	1,270	326	229	140	89	127	39
		2030	1,325	334	225	140	85	126	38
		2040	1,348	335	221	140	81	123	37
		2050	1,336	330	220	140	80	120	36
		2060	1,371	338	220	140	80	123	36
		2070	1,386	342	220	140	80	124	36
	Plainview	2020	23,443	4,368	166	140	26	691	16
		2030	24,453	4,441	162	140	22	605	14
		2040	24,870	4,427	159	140	19	527	12
		2050	24,662	4,344	157	140	17	476	11
		2060	25,312	4,449	157	140	17	479	11
		2070	25,585	4,496	157	140	17	483	11
Hockley	Anton	2020	1,235	161	116	140	Target reached		
		2030	1,313	164	111	140			
		2040	1,361	165	108	140			
		2050	1,370	165	107	140			
		2060	1,431	172	107	140			
		2070	1,470	176	107	140			

gpcd = Gallons per capita per day
ac-ft/yr = Acre-feet per year

Table 5-6. Potential Water Savings Achievable with Water Conservation, by City
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County	City	Decade	Population	Water Demand (acre-feet)	Per Capita Demand (gpcd)		Target Reduction in Demand		
					Projected	Ideal	gpcd	ac-ft/yr	Percentage of Total Demand (%)
Hockley (cont.)	Levelland	2020	14,839	2,442	147	140	7	114	5
		2030	15,785	2,521	143	140	3	45	2
		2040	16,359	2,554	139	140	Target reached		
		2050	16,467	2,547	138	140			
		2060	17,202	2,655	138	140			
		2070	17,676	2,727	138	140			
	Sundown	2020	1,531	416	242	140	102	175	42
		2030	1,629	434	237	140	97	178	41
		2040	1,688	446	235	140	95	180	40
		2050	1,699	448	235	140	95	181	40
		2060	1,775	467	235	140	95	188	40
		2070	1,824	480	235	140	95	194	40
Lamb	Amherst	2020	796	102	114	140	Target reached		
		2030	873	107	109	140			
		2040	926	110	106	140			
		2050	959	113	105	140			
		2060	1,014	119	105	140			
		2070	1,055	124	105	140			
	Earth	2020	1,099	192	155	140	15	19	10
		2030	1,125	190	151	140	11	13	7
		2040	1,131	187	147	140	7	9	5
		2050	1,118	184	147	140	7	8	4

gpcd = Gallons per capita per day
ac-ft/yr = Acre-feet per year

Table 5-6. Potential Water Savings Achievable with Water Conservation, by City
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County	City	Decade	Population	Water Demand (acre-feet)	Per Capita Demand (gpcd)		Target Reduction in Demand		
					Projected	Ideal	gpcd	ac-ft/yr	Percentage of Total Demand (%)
Lamb (cont.)	Earth (cont.)	2060	1,134	186	146	140	6	8	4
		2070	1,137	187	146	140	6	8	4
	Littlefield	2020	6,406	953	133	140	Target reached		
		2030	6,366	917	128	140			
		2040	6,249	873	125	140			
		2050	6,034	833	123	140			
		2060	5,984	824	123	140	Target reached		
		2070	5,874	809	123	140			
	Olton	2020	2,261	469	185	140	45	113	24
		2030	2,286	463	181	140	41	104	23
		2040	2,277	453	178	140	38	96	21
		2050	2,229	440	176	140	36	89	20
		2060	2,240	441	176	140	36	89	20
		2070	2,228	438	175	140	35	89	20
	Sudan	2020	1,042	250	214	140	74	86	35
		2030	1,127	265	209	140	69	88	33
		2040	1,182	274	206	140	66	88	32
		2050	1,213	279	205	140	65	88	32
		2060	1,273	292	205	140	65	92	32
		2070	1,316	302	205	140	65	95	31
Lubbock	Abernathy	2020	774	184	211	140	71	62	34
		2030	860	200	207	140	67	65	32

gpcd = Gallons per capita per day
ac-ft/yr = Acre-feet per year

Table 5-6. Potential Water Savings Achievable with Water Conservation, by City
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County	City	Decade	Population	Water Demand (acre-feet)	Per Capita Demand (gpcd)		Target Reduction in Demand		
					Projected	Ideal	gpcd	ac-ft/yr	Percentage of Total Demand (%)
Lubbock (cont.)	Abernathy (cont.)	2040	946	217	204	140	64	68	31
		2050	1,037	236	202	140	62	72	31
		2060	1,124	255	202	140	62	78	31
		2070	1,210	274	202	140	62	84	31
	Idalou	2020	2,341	419	160	140	20	51	12
		2030	2,446	426	155	140	15	42	10
		2040	2,555	436	152	140	12	35	8
		2050	2,676	452	151	140	11	32	7
		2060	2,783	469	150	140	10	32	7
		2070	2,889	486	150	140	10	33	7
	Lubbock	2020	255,257	45,623	160	140	20	5,593	12
		2030	283,597	49,424	156	140	16	4,949	10
		2040	312,043	53,437	153	140	13	4,502	8
		2050	342,371	58,113	152	140	12	4,422	8
		2060	371,227	62,886	151	140	11	4,670	7
		2070	399,846	67,703	151	140	11	4,998	7
	New Deal	2020	869	114	116	140	Target reached		
		2030	951	121	113	140			
		2040	1,036	128	110	140			
		2050	1,125	138	109	140			
		2060	1,210	148	109	140			
		2070	1,294	158	109	140			

gpcd = Gallons per capita per day
ac-ft/yr = Acre-feet per year

Table 5-6. Potential Water Savings Achievable with Water Conservation, by City
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County	City	Decade	Population	Water Demand (acre-feet)	Per Capita Demand (gpcd)		Target Reduction in Demand		
					Projected	Ideal	gpcd	ac-ft/yr	Percentage of Total Demand (%)
Lubbock (cont.)	Ransom Canyon	2020	1,172	337	256	140	116	152	45
		2030	1,258	356	252	140	112	158	44
		2040	1,345	377	250	140	110	165	44
		2050	1,439	401	248	140	108	174	44
		2060	1,526	424	248	140	108	184	44
		2070	1,613	448	248	140	108	195	43
	Shallowater	2020	2,817	422	134	140	Target reached		
		2030	3,188	464	130	140			
		2040	3,558	507	127	140			
		2050	3,951	558	126	140			
		2060	4,329	610	126	140			
		2070	4,703	662	126	140			
	Slaton	2020	6,179	746	108	140	Target reached		
		2030	6,257	726	103	140			
		2040	6,352	712	100	140			
		2050	6,467	711	98	140			
		2060	6,547	718	98	140			
		2070	6,621	726	98	140			
	Wolfforth	2020	4,577	765	149	140	9	47	6
		2030	5,577	912	146	140	6	37	4
		2040	6,569	1,062	144	140	4	31	3
		2050	7,614	1,223	143	140	3	29	2

gpcd = Gallons per capita per day
ac-ft/yr = Acre-feet per year

Table 5-6. Potential Water Savings Achievable with Water Conservation, by City
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County	City	Decade	Population	Water Demand (acre-feet)	Per Capita Demand (gpcd)		Target Reduction in Demand		
					Projected	Ideal	gpcd	ac-ft/yr	Percentage of Total Demand (%)
Lubbock (cont.)	Wolfforth (cont.)	2060	8,633	1,385	143	140	3	30	2
		2070	9,647	1,547	143	140	3	33	2
Lynn	O'Donnell	2020	757	105	123	140	Target reached		
		2030	797	106	118	140			
		2040	799	105	117	140			
		2050	795	104	116	140			
		2060	835	109	116	140			
		2070	853	111	116	140			
	Tahoka	2020	2,838	478	150	140	10	32	7
		2030	2,985	488	146	140	6	19	4
		2040	2,994	478	142	140	2	8	2
		2050	2,980	472	141	140	1	4	1
		2060	3,129	494	141	140	1	3	1
		2070	3,197	505	141	140	1	3	1
Motley	Matador	2020	609	213	311	140	171	117	55
		2030	609	209	306	140	166	113	54
		2040	609	208	304	140	164	112	54
		2050	609	207	303	140	163	111	54
		2060	609	207	303	140	163	111	54
		2070	609	207	303	140	163	111	54
Parmer	Bovina	2020	2,079	373	160	140	20	47	12
		2030	2,301	402	156	140	16	41	10

gpcd = Gallons per capita per day
ac-ft/yr = Acre-feet per year

Table 5-6. Potential Water Savings Achievable with Water Conservation, by City
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County	City	Decade	Population	Water Demand (acre-feet)	Per Capita Demand (gpcd)		Target Reduction in Demand		
					Projected	Ideal	gpcd	ac-ft/yr	Percentage of Total Demand (%)
Parmer (cont.)	Bovina (cont.)	2040	2,502	429	153	140	13	36	8
		2050	2,697	458	151	140	11	34	7
		2060	2,927	496	151	140	11	36	7
		2070	3,137	531	151	140	11	39	7
	Farwell	2020	1,517	396	233	140	93	158	40
		2030	1,679	430	228	140	88	166	39
		2040	1,825	461	225	140	85	174	38
		2050	1,969	494	224	140	84	185	37
		2060	2,136	535	223	140	83	199	37
		2070	2,289	573	223	140	83	214	37
	Friona	2020	4,587	829	161	140	21	109	13
		2030	5,079	894	157	140	17	97	11
		2040	5,520	953	154	140	14	87	9
		2050	5,953	1,018	153	140	13	84	8
		2060	6,462	1,103	152	140	12	89	8
		2070	6,924	1,182	152	140	12	95	8
Swisher	Happy	2020	649	99	136	140	Target reached		
		2030	682	101	132	140			
		2040	692	100	129	140	Target reached		
		2050	687	98	127	140			
		2060	721	103	127	140			
		2070	738	105	127	140			

gpcd = Gallons per capita per day
ac-ft/yr = Acre-feet per year

Table 5-6. Potential Water Savings Achievable with Water Conservation, by City
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County	City	Decade	Population	Water Demand (acre-feet)	Per Capita Demand (gpcd)		Target Reduction in Demand		
					Projected	Ideal	gpcd	ac-ft/yr	Percentage of Total Demand (%)
Swisher (cont.)	Kress	2020	752	79	93	140	Target reached		
		2030	790	79	89	140			
		2040	802	77	86	140			
		2050	796	75	84	140			
		2060	836	79	84	140			
		2070	854	80	84	140			
	Tulia	2020	5,222	926	158	140	18	106	11
		2030	5,483	945	154	140	14	85	9
		2040	5,564	938	150	140	10	65	7
		2050	5,530	924	149	140	9	56	6
		2060	5,803	967	149	140	9	57	6
		2070	5,932	989	149	140	9	58	6
Terry	Brownfield	2020	10,381	1,793	154	140	14	165	9
		2030	11,036	1,854	150	140	10	123	7
		2040	11,696	1,923	147	140	7	89	5
		2050	12,296	2,000	145	140	5	71	4
		2060	12,860	2,087	145	140	5	70	3
		2070	13,386	2,172	145	140	5	72	3
	Meadow	2020	638	95	132	140	Target reached		
		2030	678	97	128	140			
		2040	719	101	124	140			
		2050	756	105	123	140			

gpcd = Gallons per capita per day
ac-ft/yr = Acre-feet per year

Table 5-6. Potential Water Savings Achievable with Water Conservation, by City
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County	City	Decade	Population	Water Demand (acre-feet)	Per Capita Demand (gpcd)		Target Reduction in Demand		
					Projected	Ideal	gpcd	ac-ft/yr	Percentage of Total Demand (%)
Terry (cont.)	Meadow (cont.)	2060	790	109	123	140	(Target reached in 2020)		
		2070	822	113	123	140			
Yoakum	Denver City	2020	5,072	1,423	250	140	110	627	44
		2030	5,736	1,579	246	140	106	679	43
		2040	6,327	1,721	243	140	103	728	42
		2050	6,955	1,889	242	140	102	798	42
		2060	7,618	2,066	242	140	102	871	42
		2070	8,249	2,237	242	140	102	943	42
	Plains	2020	1,677	432	230	140	90	169	39
		2030	1,897	480	225	140	85	182	38
		2040	2,093	522	223	140	83	193	37
		2050	2,300	570	221	140	81	209	37
		2060	2,519	624	221	140	81	228	37
		2070	2,728	675	221	140	81	247	37

gpcd = Gallons per capita per day
ac-ft/yr = Acre-feet per year

Table 5-7. Potential Water Savings Achievable with Water Conservation, By County
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County	Decade	Population	Demand	Per Capita Demand (gcpd)		Potential Reduction in Demand		
				Projected	Ideal	gpcd	ac-ft/yr	Percentage of Total Demand (%)
Bailey	2020	2,243	277	110	140	*Reached target GPCD*		
	2030	2,510	296	105	140			
	2040	2,775	321	103	140			
	2050	3,047	351	103	140			
	2060	3,317	381	102	140			
	2070	3,582	411	102	140			
Briscoe	2020	932	297	284	140	144	150	51%
	2030	931	292	279	140	139	145	50%
	2040	931	289	276	140	136	142	49%
	2050	931	288	276	140	136	142	49%
	2060	931	288	276	140	136	142	49%
	2070	931	288	276	140	136	142	49%
Castro	2020	1,343	411	130	140	*Reached target GPCD*		
	2030	1,458	430	125	140			
	2040	1,541	446	123	140			
	2050	1,616	467	123	140			
	2060	1,676	483	123	140			
	2070	1,724	496	123	140			
Cochran	2020	1,009	500	333	140	193	218	44%
	2030	1,130	544	328	140	188	238	44%
	2040	1,167	556	326	140	186	244	44%

gpcd = Gallons per capita per day
ac-ft/yr = Acre-feet per year

Table 5-7. Potential Water Savings Achievable with Water Conservation, By County
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County	Decade	Population	Demand	Per Capita Demand (gcpd)		Potential Reduction in Demand		
				Projected	Ideal	gpcd	ac-ft/yr	Percentage of Total Demand (%)
Cochran (cont.)	2050	1,170	556	326	140	186	244	44%
	2060	1,215	575	326	140	186	253	44%
	2070	1,233	583	326	140	186	257	44%
Crosby	2020	1,309	155	106	140	*Reached target GPCD*		
	2030	1,397	159	101	140			
	2040	1,468	167	101	140			
	2050	1,540	174	101	140			
	2060	1,613	182	100	140			
	2070	1,704	192	100	140			
Dawson	2020	4,777	585	110	140	*Reached target GPCD*		
	2030	5,193	615	106	140			
	2040	5,549	638	103	140			
	2050	5,764	653	101	140			
	2060	6,111	690	101	140			
	2070	6,386	721	101	140			
Deaf Smith	2020	4,575	541	105	140	*Reached target GPCD*		
	2030	5,282	596	101	140			
	2040	6,056	663	98	140			
	2050	6,931	751	97	140			
	2060	7,620	824	96	140			
	2070	8,373	904	96	140			

gpcd = Gallons per capita per day
ac-ft/yr = Acre-feet per year

Table 5-7. Potential Water Savings Achievable with Water Conservation, By County
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County	Decade	Population	Demand	Per Capita Demand (gcpd) Projected	Per Capita Demand (gcpd) Ideal	Potential Reduction in Demand gpcd	Potential Reduction in Demand ac-ft/yr	Potential Reduction in Demand Percentage of Total Demand (%)
Dickens	2020	1,135	153	120	140	*Reached target GPCD*		
	2030	1,135	148	116	140			
	2040	1,135	143	112	140			
	2050	1,135	143	112	140			
	2060	1,135	142	111	140			
	2070	1,135	142	111	140			
Floyd	2020	1,664	200	107	140	*Reached target GPCD*		
	2030	1,762	201	102	140			
	2040	1,824	207	101	140			
	2050	1,891	214	101	140			
	2060	1,943	219	101	140			
	2070	1,986	224	101	140			
Gaines	2020	11,678	1,403	107	140	*Reached target GPCD*		
	2030	15,176	1,763	104	140			
	2040	19,316	2,205	102	140			
	2050	23,765	2,692	101	140			
	2060	27,881	3,152	101	140			
	2070	32,166	3,633	101	140			
Garza	2020	1,065	135	113	140	*Reached target GPCD*		
	2030	1,058	129	108	140			
	2040	1,058	125	105	140			

gpcd = Gallons per capita per day
ac-ft/yr = Acre-feet per year

Table 5-7. Potential Water Savings Achievable with Water Conservation, By County
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County	Decade	Population	Demand	Per Capita Demand (gcpd)		Potential Reduction in Demand		
				Projected	Ideal	gpcd	ac-ft/yr	Percentage of Total Demand (%)
Garza (cont.)	2050	1,068	126	105	140	*(Reached target GPCD by 2020)*		
	2060	1,103	130	105	140			
	2070	1,135	133	105	140			
Hale	2020	8,994	1,171	116	140	*Reached target GPCD*		
	2030	9,382	1,177	112	140			
	2040	9,542	1,162	109	140			
	2050	9,463	1,135	107	140			
	2060	9,712	1,161	107	140			
	2070	9,816	1,173	107	140			
Hockley	2020	7,525	922	109	140	*Reached target GPCD*		
	2030	8,007	946	105	140			
	2040	8,299	955	103	140			
	2050	8,352	947	101	140			
	2060	8,726	986	101	140			
	2070	8,965	1,013	101	140			
Lamb	2020	3,011	435	129	140	*Reached target GPCD*		
	2030	3,398	471	124	140			
	2040	3,673	505	123	140			
	2050	3,866	530	122	140			
	2060	4,146	567	122	140			
	2070	4,365	596	122	140			

gpcd = Gallons per capita per day
ac-ft/yr = Acre-feet per year

Table 5-7. Potential Water Savings Achievable with Water Conservation, By County
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County	Decade	Population	Demand	Per Capita Demand (gcpd)		Potential Reduction in Demand		
				Projected	Ideal	gpcd	ac-ft/yr	Percentage of Total Demand (%)
Lubbock	2020	35,783	4,647	116	140	*Reached target GPCD*		
	2030	39,843	5,010	112	140			
	2040	43,916	5,402	110	140			
	2050	48,258	5,869	109	140			
	2060	52,391	6,354	108	140			
	2070	56,493	6,847	108	140			
Lynn	2020	2,684	311	103	140	*Reached target GPCD*		
	2030	2,823	314	99	140			
	2040	2,831	306	96	140			
	2050	2,819	299	95	140			
	2060	2,960	313	94	140			
	2070	3,024	319	94	140			
Motley	2020	603	109	160	140	20	14	12%
	2030	603	105	155	140	15	10	10%
	2040	603	104	153	140	13	8	8%
	2050	603	103	152	140	12	8	8%
	2060	603	103	152	140	12	8	8%
	2070	603	103	152	140	12	8	8%
Parmer	2020	3,241	631	174	140	34	122	19%
	2030	3,589	680	169	140	29	117	17%
	2040	3,901	726	166	140	26	113	16%

gpcd = Gallons per capita per day
ac-ft/yr = Acre-feet per year

Table 5-7. Potential Water Savings Achievable with Water Conservation, By County
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County	Decade	Population	Demand	Per Capita Demand (gcpd)		Potential Reduction in Demand		
				Projected	Ideal	gpcd	ac-ft/yr	Percentage of Total Demand (%)
Parmer (cont.)	2050	4,208	778	165	140	25	117	15%
	2060	4,566	842	165	140	25	126	15%
	2070	4,894	902	164	140	24	134	15%
Swisher	2020	1,634	214	117	140	*Reached target GPCD*		
	2030	1,715	216	112	140			
	2040	1,740	213	109	140			
	2050	1,731	212	109	140			
	2060	1,815	221	109	140			
	2070	1,856	226	109	140			
Terry	2020	2,580	320	110	140	*Reached target GPCD*		
	2030	2,743	325	106	140			
	2040	2,906	337	103	140			
	2050	3,056	353	103	140			
	2060	3,197	368	103	140			
	2070	3,327	383	103	140			
Yoakum	2020	2,171	267	110	140	*Reached target GPCD*		
	2030	2,456	291	106	140			
	2040	2,708	314	103	140			
	2050	2,977	341	102	140			
	2060	3,264	372	102	140			
	2070	3,534	403	102	140			

gpcd = Gallons per capita per day
ac-ft/yr = Acre-feet per year

All County-other WUGs except for Briscoe, Cochran, Motley, and Parmer counties have per capita use values below the target 140 gpcd for all decades in the planning period.

A municipality or County-other WUG may be projected to reach the target of 140 gpcd but still be projected to have a shortage. This occurs in 9 counties in Region O (Table 5-8).

Table 5-8. Water User Groups with a 2070 Shortage and Projected Per Capita Use of Less Than 140 Gallons per Day

County	Water User Group	Projected 2070 Use (gpcd)	2070 Shortage (acre-feet)
Bailey	County-other	102	146
Castro	Hart	122	25
Dawson	County-other	101	149
	O'Donnell	116	12
Floyd	Lockney	113	67
Gaines	County-other	101	1,613
	Seagraves	138	32
Hockley	Levelland	138	1,029
Lamb	Amherst	105	22
Lubbock	Shallowater	126	275
	Slaton	98	691
Lynn	County-other	94	69
	O'Donnell	116	68

gpcd = Gallons per capita per day

5.2.1.2 Current Conservation Efforts

The livelihood of the High Plains is tied to water (as reflected in the LEWRPG mission statement quoted in Section 1.1.2), and there is an inherent acknowledgement of the need for conservation. Throughout the region, a variety of conservation efforts are underway, at the federal, state, and local levels, both mandatory and voluntary. This section highlights conservation efforts in the following areas:

- Federal and state efficiency standards
- Required state reporting for conservation and water use

- Regional and local water conservation programs
- Groundwater conservation district programs
- Municipal water conservation programs

5.2.1.2.1 Federal and State Efficiency Standards. When calculating per capita water use, the TWDB factors in conservation that will occur in the future due to water-efficient appliances and fixtures. In the last 25 years, the federal government and the State of Texas have passed legislation mandating the sale and installation of water-efficient appliances and fixtures, and due to this legislation, their prevalence will continue to increase over time. Since the legislation has already been passed at the federal and/or state level, the TWDB has applied these projected savings to all municipal WUGs in Texas.

The Texas Administrative Code §357.31(d) requires RWPGs to determine and report how changes in plumbing fixtures will affect projected municipal water demands using projections of plumbing code savings provided by the Board. The TWDB-projected savings for all municipal WUGs in Region O (Table 5-9) were calculated as the difference between the base per capita water use for municipal WUGs and the projected per capita water use values that include the expected conservation savings due to plumbing codes and water-efficient appliances. These conservation savings were taken into account by the TWDB before projecting municipal demands (Chapter 2).

5.2.1.2.2 Required State Reporting for Conservation and Water Use. The State of Texas requires certain entities to track and report their water conservation and use. This enables both the state and entity to determine the effectiveness of their current actions and assists in long-term water planning. Table 5-10 lists mandated reports, the frequency of submittal, and the entities that are required to comply.

Table 5-9. TWDB Projected Savings for Municipal Water User Groups in Region O
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County	Water User Group	Projected Savings (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Bailey	County-other, Bailey	27	45	56	62	69	75
	Muleshoe	61	97	129	153	169	183
	Bailey Total	89	142	184	215	238	258
Briscoe	County-other, Briscoe	11	16	18	19	19	19
	Silverton	8	12	15	15	16	16
	Briscoe Total	19	27	33	34	35	35
Castro	County-other, Castro	34	53	65	69	73	75
	Dimmitt	55	85	109	125	131	135
	Hart	14	22	29	31	33	34
	Castro Total	103	161	202	225	237	244
Cochran	County-other, Cochran	17	27	30	30	32	32
	Morton	26	38	43	42	44	45
	Cochran Total	43	65	73	73	76	77
Crosby	County-other, Crosby	17	24	26	28	30	32
	Crosbyton	22	34	44	47	51	53
	Lorenzo	15	23	30	33	37	38
	Ralls	23	36	47	53	56	59
	Crosby Total	76	118	147	161	173	183
Dawson	County-other, Dawson	54	84	109	122	132	138
	Lamesa	111	167	213	219	229	234
	O'Donnell	2	2	3	3	3	3
	Dawson Total	167	253	324	344	364	375
Deaf Smith	County-other, Deaf Smith	54	91	125	150	167	184
	Hereford	202	333	458	565	629	695
	Deaf Smith Total	256	424	582	715	796	879
Dickens	County-other, Dickens	12	18	23	23	24	24
	Spur	13	18	20	20	21	21
	Dickens Total	25	36	43	44	45	45
Floyd	County-other, Floyd	20	32	34	36	38	39
	Floydada	38	60	71	75	78	80
	Lockney	23	35	44	46	48	50
	Floyd Total	81	127	149	157	165	169
Gaines	County-other, Gaines	128	226	327	423	503	583
	Seagraves	27	41	54	64	67	69
	Seminole	79	126	171	207	227	246
	Gaines Total	233	393	552	694	797	898

ac-ft/yr = Acre-feet per year

Table 5-9. TWDB Projected Savings for Municipal Water User Groups in Region O
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County	Water User Group	Projected Savings (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Garza	County-other, Garza	12	18	21	22	23	23
	Post	57	84	105	118	127	132
	Garza Total	69	101	126	139	149	156
Hale	Abernathy	24	36	45	49	51	52
	County-other, Hale	99	148	185	201	210	213
	Hale Center	25	38	47	51	53	54
	Petersburg	14	21	27	28	29	30
	Plainview	254	381	476	519	542	548
	Hale Total	417	624	780	848	886	896
Hockley	Anton	14	22	28	29	31	32
	County-other, Hockley	81	122	152	167	177	182
	Levelland	168	256	324	349	371	382
	Sundown	18	29	33	34	36	37
	Hockley Total	282	427	537	579	615	633
Lamb	Amherst	9	14	19	20	22	23
	County-other, Lamb	38	62	72	77	84	89
	Earth	12	18	23	23	24	24
	Littlefield	67	96	121	127	129	126
	Olton	23	34	42	45	46	46
	Sudan	12	18	23	26	28	29
	Lamb Total	161	243	300	319	332	337
Lubbock	Abernathy	8	13	18	22	24	26
	County-other, Lubbock	364	569	748	889	982	1064
	Idalou	25	37	48	55	59	61
	Lubbock	2,699	4,263	5,634	6,700	7,389	7,990
	New Deal	9	13	17	20	22	24
	Ransom Canyon	12	18	23	27	29	31
	Shallowater	30	47	63	76	84	92
	Slaton	64	95	121	137	141	143
	Wolfforth	45	75	101	125	144	161
	Lubbock Total	3,255	5,131	6,774	8,050	8,873	9,591
Lynn	County-other, Lynn	29	44	53	58	62	64
	O'Donnell	9	14	16	16	17	17
	Tahoka	31	48	59	63	67	69
	Lynn Total	69	105	128	137	147	150

ac-ft/yr = Acre-feet per year

Table 5-9. TWDB Projected Savings for Municipal Water User Groups in Region O
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County	Water User Group	Projected Savings (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Motley	County-other, Motley	7	10	12	12	12	12
	Matador	7	10	12	12	12	12
	Motley Total	13	20	24	24	25	25
Parmer	Bovina	23	37	48	56	62	67
	County-other, Parmer	38	60	79	90	99	107
	Farwell	17	28	36	43	47	51
	Friona	51	80	105	122	135	145
	Parmer Total	129	204	268	312	343	370
Swisher	County-other, Swisher	19	29	35	35	38	38
	Happy	7	10	13	14	15	15
	Kress	8	12	16	17	18	19
	Tulia	57	87	109	117	125	128
	Swisher Total	91	139	172	183	196	200
Terry	Brownfield	114	174	226	260	276	288
	County-other, Terry	31	48	58	62	66	69
	Meadow	7	11	14	16	17	18
	Terry Total	152	232	298	338	359	374
Yoakum	County-other, Yoakum	23	37	48	57	63	69
	Denver City	60	98	129	145	161	175
	Plains	19	31	41	49	54	59
	Yoakum Total	102	166	218	250	279	303
Region O Total		5,833	9,139	11,914	13,840	15,128	16,195

ac-ft/yr = Acre-feet per year

Table 5-10. Required State Reporting for Conservation and Water Use

Report or Document	Frequency of Submittal	Entities Required to Submit
Texas Water Development Board (TWDB)		
Water conservation plan	5 years	• Applying for TWDB assistance >$500,000 • ≥3,300 connections • Non-irrigation surface water right >1,000 ac-ft/yr • Irrigation surface water right >10,000 ac-ft/yr
Water conservation plan annual report	Every year	• Same as those submitting a water conservation plan
Utility profile	5 years	• Applying for TWDB assistance > $500,000 • ≥3,300 connections
Water loss audit	5 years	• All retail public utilities providing potable water
Water use survey	Every year	• Entities using surface water or groundwater for municipal, industrial, power generation, or mining purposes
Texas Commission on Environmental Quality (TCEQ)		
Water conservation plan	5 years	• Non-irrigation surface water right >1,000 ac-ft/yr • Irrigation surface water right >10,000 ac-ft/yr • New municipal, industrial, and irrigation water right applicants
Five-year implementation report	5 years	• Non-irrigation surface water right >1,000 ac-ft/yr • Irrigation surface water right >10,000 ac-ft/yr
Drought contingency plan	5 years	• ≥3,300 connections • Wholesale public water suppliers • Irrigation districts • Water rights applicants for municipal use

Source: TWDB and TCEQ, 2012. ac-ft/yr = Acre-feet per year

In recent years, discrepancies in the definitions and calculations of various water use measures (especially per capita use) have sparked conversations throughout the water industry. In December 2012, the TWDB, TCEQ, and the Water Conservation Advisory Council published a document titled *Guidance and Methodology for Reporting on Water Conservation and Water Use* (TWDB et al., 2012) in an effort to standardize reporting across the state. This document provides precise definitions to industry-specific terms and practical step-by-step guidance for entities evaluating their water use and conservation efforts.

5.2.1.2.3 Regional and Local Water Conservation Programs. Various organizations, associations, and coalitions have become involved in water conservation in west Texas. The following discussion highlights some of these regional and local efforts.

Texas Water Smart (www.texaswatersmart.com) is a coalition of almost 300 businesses, institutions, professional associations, and state and local government officials who are committed to raising awareness about the importance of water conservation throughout the state of Texas.

Texas SmartScape (www.txsmartscape.com) is an online educational program promoting water-efficient landscaping, good stormwater practices, and proper use of herbicides and pesticides. This program was started by several municipalities in north-central Texas in 2001 and was expanded to west Texas in 2005. The website includes information about landscape design and lawn and plant maintenance, conservation tips, and a detailed, searchable plant database with more than 200 plants that are appropriate for the High Plains.

The Texas Master Gardener Program (mastergardener.tamu.edu) is run through the Texas AgriLife Extension Service, which is part of the Texas A&M System. Master Gardeners promote good horticulture practices, including waterwise landscaping, efficient irrigation, and rainwater harvesting. The Master Gardener program is organized by counties, although only 78 of the 254 counties in Texas have a program. Lubbock County is the only county in Region O to have a Master Gardener program.

The Lubbock Memorial Arboretum is active in horticulture and landscape education within the City of Lubbock. The Arboretum maintains a 93-acre site within the City that houses demonstration gardens and preserves native habitat. The Arboretum hosts a variety of educational events including public school presentations, landscaping seminars and classes, garden tours, and media awareness campaigns.

The Lubbock Chamber of Commerce has a Water-Smart Task Force that highlights the importance of commercial water conservation. Every quarter the Task Force presents a Water Smart Award to a Lubbock business that has exemplary waterwise landscaping or highly efficient indoor water use.

5.2.1.2.4 Groundwater Conservation District Programs. There are seven groundwater conservation districts (GCDs) in Region O (Table 5-11). To encourage the most efficient use of groundwater, GCDs may become involved in municipal water conservation and education. Table 5-11 shows the municipal conservation efforts currently underway in each of the GCDs in Region O.

Table 5-11. Municipal Water Conservation Programs Offered by Groundwater Conservation Districts in Region O

Groundwater Conservation District	Education Coordinator	School Education Program	Public Education Presentations and/or Workshops	Online Conservation Resources	Newsletter	Scientific Research	Rainwater Harvesting	Encourage Water Wise Landscapes
Garza County UWCD [a]					X			
Gateway GCD [b]							X	
High Plains UWCD No. 1 [c]	X	X	X	X	X	X	X	X
Llano Estacado UWCD [d, e]	X	X	X	X		X	X	
Mesa UWCD [f]			X					
Sandy Land UWCD [e]	X	X	X	X		X	X	
South Plains UWCD [e, g]	X	X	X	X	X	X	X	X

Sources:
[a] Garza County UWCD, 2015 <http://www.twdb.texas.gov/groundwater/docs/GCD/garzauwcd/garzauwcd_mgmt_plan2014.pdf>
[b] Gateway GCD, 2010 <http://www.twdb.texas.gov/groundwater/docs/GCD/gatewaygcd/gatewaygcd_mgmt_plan2011.pdf>
[c] HPWD, 2015 <http://www.hpwd.org>
[d] Llano Estacado UWCD, 2015. <http://www.llanoestacadouwcd.org/education.html>
[e] Southern Ogallala Conservation & Outreach Program, 2015 <http://www.savingh2o.org/index.html>
[f] Mesa UWCD, 2014 <http://www.twdb.texas.gov/groundwater/docs/GCD/muwcd/muwcd_mgmt_plan2014.pdf>
[g] South Plains UWCD, 2015

The High Plains Underground Water Conservation District No. 1 (UWCD) is the largest GCD in the state of Texas and has a sophisticated conservation program. The High Plains UWCD's mission includes "protecting, preserving, and conserving aquifers within the District's service area." To accomplish this, the district actively promotes both municipal and agricultural conservation. As indicated in Table 5-11, the High Plains UWCD has the following municipal conservation programs:

- *Conservation Connect Magazine:* The first issue of Conservation Connect was published in 2014. The magazine highlights issues relevant to regional water conservation such as waterwise landscaping, rainwater harvesting, water reuse, and current education efforts within the district.

- *Cross Section Newsletter:* This bi-weekly newsletter facilitates communication between the district and its residents. Among other things, the district uses the newsletter to (1) advertise upcoming conservation events in the district's area and (2) run expository and/or feature articles on conservation topics.

- *Public Education:* The High Plains UWCD disseminates municipal water conservation information through public presentations, participation in local conferences and events, and material available on their website under the conservation tab (www.hpwd.org/conservation-urban/).

- *Rainwater Harvesting Workshops:* In 2014, the High Plains UWCD hosted four rainwater harvesting workshops (in Levelland, Plainview, Muleshoe, and Canyon). Participants learned about techniques and installation of small- and large-scale rainwater harvesting systems.

- *Turfgrass Research Funding:* The High Plains UWCD provided funding for a turfgrass research project lead by Drs. Joey Young and Glen Ritchie, both from Texas Tech University. The project aims to determine survival abilities of various turfgrass varieties on the High Plains and the amount of irrigation needed to maintain each variety.

- *Waterwise Conservation Education Program:* This public school initiative raises awareness about indoor water conservation. Students are given a water conservation kit—including a high efficiency showerhead, faucet aerators, a drip/rain gauge, flow rate test bag, toilet leak detector tablets, and an installation DVD—and are educated about indoor water use and the importance of conservation. Students install the fixtures from the kit at home and measure the difference in water use. Statistics are compiled into a statewide database. This program was started in 1995 and is now in its 19th year.

During the 2013-2014 school year, High Plains UWCD estimates that 2,200 students participated in the program.

The South Plains UWCD has a conservation program that includes classroom education, a biannual newsletter, news releases, and public speaking engagements. In 2015, the South Plains UWCD made presentations at the Kids, Kows, and More event (with attendance by approximately 200 children), the Denver City school Jamboree, and the 2015 South Plains Ag Conference (SPUWCD, 2015). In addition, the South Plains UWCD, Llano Estacado UWCD, and Sandy Land UWCD formed the Southern Ogallala Conservation and Outreach Program (SOCOP) in 2007, which serves the education needs of all three districts (SPUWCD, 2015). The program employs an education coordinator, and in 2015, SOCOP purchased a 24-foot trailer to be used as a mobile water conservation education classroom (SPUWCD, 2015).

5.2.1.2.5 Municipal Water Conservation Programs. Many municipalities have water conservation programs. In addition to lowering overall water demand, municipal water conservation can level out the peak demand experienced in the summer. Therefore, conservation can delay the need for new water supply projects and/or reduce the scale of new projects.

Many municipalities in Region O encourage water conservation, and information on their efforts can be found on their city webpages. As the largest municipality on the High Plains, the City of Lubbock has the most developed municipal conservation program in the region. The City is currently engaged in the following water conserving activities:

- *Water rate structure:* The City uses an increasing block rate structure.

- *Reduction of unaccounted for water loss:* The City conducts water loss audits, a water main replacement program, a meter change-out program, and metering of fire hydrants and construction sites.

- *Public education:* The City of Lubbock Water Utilities Conservation and Education Department offers conservation education programs for area students in grades prekindergarten through 12. The program includes engaging, hands-on activities that explore the science of water, as well as water management and stewardship, recycling, use of natural resources, and solid waste issues. The Conservation Education program also provides adult education through various workshops and events, in order to educate citizens on City ordinances and conservation tips and to answer questions about water supply, water conservation, and compliance issues. The department does presentations for church, garden, and neighborhood association groups and has displays at local events (e.g., Home and Garden Show and Parade of Homes).

- *Water conservation ordinances:* City ordinances include a water rate ordinance, a waste of water ordinance, and a water use management plan

Lubbock's current and proposed water conservation efforts are discussed in detail in Chapter 5 of the City's *2013 Strategic Water Supply Plan* (City of Lubbock, 2013).

5.2.1.3 Additional Municipal Water Conservation Strategies

In addition to water savings derived from federal, state and local measures already in place, WUGs may consider enacting additional conservation measures to maximize the volume of water conserved. Municipal conservation strategies can be broadly categorized as administrative, residential indoor, residential outdoor, or commercial. Residential indoor sub-strategies are not discussed further, since their water conservation savings have already been accounted for in the municipal demand projections (Section 5.2.1.2.1).

The potential water conservation strategies listed in this section are not exhaustive, and the water-saving estimates are approximate. Mandatory conservation measures tend to be the most effective (Renwick and Green, 2000). Each municipality should evaluate the anticipated water savings for a given strategy based on its own situation and circumstances. The cost of implementing each strategy will depend on the starting point of each WUG, strategies selected, staff availability, and enforcement requirements.

5.2.1.3.1 Administrative Water Conservation Strategies. Potential administrative water conservation strategies include strategies that must be implemented and carried out by the municipality. Table 5-12 shows water-savings for nine different administrative water conservation strategies. Two of the most well-known water conservation measures, education and water rates, fall within this category.

Education is an important part of a holistic water conservation program. A 2004 study found that 87 percent of Texans are more likely to participate in water-conserving behaviors after receiving information about the benefits of conservation (Tuerff-Davis EnviroMedia, Inc., 2004). However, it is extremely difficult to calculate water-savings for education efforts. In fact, for state reporting, the success of education programs is calculated not in gallons saved, but in units of people reached (i.e., by the number of students attending a presentation, the number of TV ads run, the number of flyers passed out, etc.).

Implementing water rates that promote conservation and/or increasing water rates is considered one of the most effective water conservation strategies. It is well documented that water use (especially outdoor water use) declines with the increasing cost of water and customers become more interested in participating in water conservation programs when the cost of water is high (BBC Research & Consulting, 2012).

Water loss audits (WLAs) and implementation of water loss practices also fall within this category. State and national research indicates that water savings for these strategies average around 2.6 percent (Table 5-12). However, based on the WLA data collected by the TWDB (presented in Section 1.11), regional savings based on implementation of water loss practices could be exponentially higher. Of the Region O entities submitting a 2010 WLA, 20 percent experienced water loss greater than 30 percent.

The reliability of administrative conservation strategies is strategy-dependent. For most of the administrative strategies evaluated, it is difficult to quantify the amount of water savings to be expected from strategy implementation, and the reliability is poor. However, there is sufficient research to substantiate the water-saving potential of the water rate and water loss strategies, and these strategies are considered reliable.

Table 5-12. Administrative Water Conservation: Potential Municipal Strategies

Conservation Strategy	Estimated Water Savings: Percentage	Estimated Water Savings: Volume	Source(s)
10% increase in water rates	2.0% of a municipality's total water usage	Dependent on City's total water use	TWDB, 2004b (p. 23) BBC Research & Consulting, 2012 GDS, 2001 (p. 19)
Water loss audit Implement water loss practices	2.6% of a municipality's total water usage	Dependent on City's total water use	TWDB and TSSWCB, 2012 (p. 24) AWWA, 2007 (p. 6)
Residential leak detection program	3.7% of indoor and outdoor residential water usage	5.9 gpcd	AWWARF, 1999 (p. 129) California Water Plan Update, 2013 (Chapter 3, pp. 10, 13)
Employ a Conservation Coordinator	Difficult to quantify		TWDB, 2004b (p. 83)
Water conservation school education programs	Difficult to quantify		TWDB, 2004b (p. 46)
Conservation and water awareness public information efforts	Difficult to quantify		TWDB, 2004b (p. 93)
Strict enforcement	Difficult to quantify; should accompany most conservation strategies		TWDB, 2004b
Universal metering, with devices having ±5% accuracy	Difficult to quantify; should result in increased revenue and reduced water loss		TWDB, 2004b (pp. 75, 77) BBC Research & Consulting, 2012

gpcd = Gallons per capita per day

5.2.1.3.2 Residential Outdoor Water Conservation Strategies. Roughly 30 percent of municipal water use is for outdoor irrigation (Vickers, 2001). The goal of outdoor water conservation is to promote good horticulture practices and improve irrigation efficiency. Table 5-13 shows potential water-savings for 26 different residential outdoor conservation measures.

Water savings reported for individual conservation measures are often synergistic, making it inaccurate to simply add savings together for different outdoor conservation measures. For example, if a resident replaces his tall fescue lawn with native buffalo grass and, while doing so, limits the amount of turfgrass in his yard by installing flowerbeds of xeric plants, his outdoor water savings will not add up to 112 percent (40%+26%+46%). These calculations give an estimate of the savings that can be achieved through use of single measures, but further evaluation is necessary to select the appropriate number and type of conservation measures that will accomplish the desired savings for a given municipality.

The reliability of residential outdoor conservation strategies is poor, as water savings are based on the behavioral changes and/or monetary investment in conservation appliances or devices by numerous citizens. Strict enforcement of conservation measures by a municipality can improve the reliability of these strategies.

5.2.1.3.3 Commercial Water Conservation Strategies. While residential water use constitutes the majority of municipal water use in Region O, commercial water use cannot be overlooked. Table 5-14 lists several different commercial water conservation strategies that can be implemented. The toilet and washing machine conservation savings have already been accounted for in the municipal demand projections (Section 5.2.1.2.1), but the carwash sub-strategies could provide additional water savings.

In some cities, one or two large commercial facilities are responsible for the majority of the commercial water use. In these instances, it is recommended that the municipality meet with each company individually to discuss water conservation strategies specific to the customer and their facility.

Table 5-13. Residential Outdoor Water Conservation: Potential Municipal Strategies
Page 1 of 3

Conservation Strategy	Estimated Water Savings: % Outdoor Irrigation	Estimated Water Savings: Annual Volume per Household [a] (gallons)	Source(s)
Education and Training			
Identify high-use residential outdoor water users and target programs at these customers	30	36,000	GDS, 2001 (p. 3) Vickers, 2001 (p. 158)
Conduct single-family residential irrigation audits	18	10,680	TWDB, 2004b (p. 52) GDS, 2001 (p. 7) Texas A&M, 2014
Conduct multi-family residential irrigation audits	18	Depends on size of irrigated area	TWDB, 2004b (p. 52) GDS, 2001 (p. 13) Texas A&M, 2014
Customer landscape irrigation and horticulture training and workshops	20		Pacific Institute, 2003 (p. 69)
Mandatory conservation training for irrigation professionals and landscape managers	Unknown		Vickers, 2001 (p. 203)
Demonstration gardens	Unknown		Vickers, 2001 (p. 166)
Require nurseries to tag native/water efficient plants	Unknown		Vickers, 2001 (pp. 166, 176)
Landscaping			
Turfgrass selection	40	1,240 per 100 ft^2 turf	Texas A&M, 2014
Limit percentage of turfgrass in landscape	26	16,000	Pacific Institute, 2003 (p. 73)
Encourage use of turfgrass alternatives			
Xeriscape rebates	46	28,000	Hurd, 2006 (p. 175) Vickers, 2001 (pp. 147, 162-163)
Sustainable landscaping on municipal properties	46	Depends on size of irrigated area	

[a] Assumes average length of irrigation season in Texas of 6 months (GDS, 2001), and that average homeowner who irrigates uses 10,000 gallons per month for outdoor irrigation (Vickers, 2001).

Table 5-13. Residential Outdoor Water Conservation: Potential Municipal Strategies
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Conservation Strategy	Estimated Water Savings: % Outdoor Irrigation	Estimated Water Savings: Annual Volume per Household [a] (gallons)	Source(s)
Landscaping (cont.)			
Medians/narrow strips in xeriscaping, requiring some irrigation	Up to 46% of water used for medians	Depends on size of irrigated area	Hurd, 2006 (p. 175) Vickers, 2001 (pp. 147, 162-163)
Medians/narrow strips in native plants or hardscaping	Up to 100% of water used for medians		Vickers, 2001 (p. 181)
Irrigation Practices			
Time of day restrictions	40	24,000	Vickers, 2001 (p. 200) Texas Tech, 2014 Rowlett, 2001 NOAA, 2014a (Lubbock normals and records)
Day of week water restrictions	33	20,736	Hunter Industries, 2011 (p. 2) Vickers, 2001 (p. 6)
Require flower beds to be irrigated with drip irrigation and on separate zones from turfgrass areas	50	30,000	Pacific Institute, 2003 (p. 71) Vickers, 2001 (p. 200)
Sprinkler system maintenance	23	14,000	Pacific Institute, 2003 (p. 70) Vickers, 2001 (pp. 204, 209)
Customer education on programming automatic sprinkler system controllers	17	10,000	Pacific Institute, 2003 (p. 70) Vickers, 2001 (pp. 200-201) GDS, 2001 (p. 3)
Irrigation controllers that use ET data from weather stations	17	10,000	Pacific Institute, 2003 (p. 70) Vickers, 2001 (pp. 200-201, 204, 209) GDS, 2001 (p. 3)
Rain shutoff devices	8	5,000	Pacific Institute, 2003 (p. 71) Vickers, 2001 (pp. 200-201) GDS, 2001 (p. 3)

[a] Assumes average length of irrigation season in Texas of 6 months (GDS, 2001), and that average homeowner who irrigates uses 10,000 gallons per month for outdoor irrigation (Vickers, 2001).

**Table 5-13. Residential Outdoor Water Conservation: Potential Municipal Strategies
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Conservation Strategy	Estimated Water Savings: % Outdoor Irrigation	Estimated Water Savings: Annual Volume per Household[a] (gallons)	Source(s)
Irrigation Practices (cont.)			
Soil moisture probes	14	8,000	Pacific Institute, 2003 (p. 71) Vickers, 2001 (pp. 200-201) GDS, 2001 (p. 3)
Automatic shutoff nozzles on hoses	8	4,500	Vickers, 2001 (pp. 200-201) GDS, 2001 (p. 3)
Other			
Rain barrel program	5	2,700	TWDB, 2004b (p. 100) Vickers, 2001 (p. 201) NOAA, 2014b (Lubbock precipitation)
Rainwater harvesting system with 4,500-gallon storage capacity	31	18,352	TWDB, 2004b (p. 100) NOAA, 2014b (Lubbock precipitation)
Installation of a graywater system (all graywater used for irrigation)	21	12,636	TWDB, 2004b (p. 103)

[a] Assumes average length of irrigation season in Texas of 6 months (GDS, 2001), and that average homeowner who irrigates uses 10,000 gallons per month for outdoor irrigation (Vickers, 2001).

Table 5-14. Commercial Water Conservation: Potential Municipal Strategies

Conservation Strategy	Estimated Water Savings	Source(s)
Commercial toilet replacement program (3.5 gallons per flush [gpf] to 1.6 gpf)	31.6 gpd per toilet	Vickers, 2001 (pp. 24, 37)
Commercial toilet replacement program (1.6 gpf to 1.28 gpf)	6 gpd per toilet	Vickers, 2001 (pp. 24, 37) TWDB, 2013a (p. 9) U.S. EPA, 2012 (p. 2)
Commercial washing machine rebate	200 to 1,000 gallons per load	TWDB, 2013a (p. 11) U.S. EPA, 2012 AWE, 2014
Commercial carwash:		
Installation of a water reclamation system at a stationary carwash facility	27.5 gallons per vehicle	Vickers, 2001 (p. 253) Brown, 2002 (p. 18)
Installation of a water reclamation system at a conveyor carwash facility	37.8 gallons per vehicle	
Reduced nozzle size, pressure, and timing of wash cycles	26.4 gallons per vehicle	

The commercial conservation strategies evaluated in this section are reliable. The water-savings due to these strategies are dependent on installation of an effective appliance or device, but assuming that the devices promoted are of sufficient effectiveness (Section 5.2.1.4.4), the water savings are automatic.

5.2.1.4 Recommended Municipal Water Conservation Strategies

The LERWPG recommends implementing or continuing municipal water conservation programs as a WMS for 39 municipal WUGs (including the City of Lubbock, which is also a WWP). These WUGs either (1) have per capita use greater than 140 gpd regardless of needs, or (2) specifically mentioned a municipal water conservation WMS in their WUG survey (i.e., Amherst, Anton, and Littlefield). The LERWPG recommends a reduction in per capita water use of 0.5 percent per year (5 percent over 10 years) for these communities, until such time as the WUG achieves a total per capita use of 140 gpd.

5.2.1.4.1 Quantity and Reliability of Water. Table 5-15 provides the anticipated savings from implementing or continuing a recommended municipal water conservation program.

Table 5-15. Estimated Water Savings from Municipal Water Conservation Program

County	Water User Group	Estimated Water Savings or Demand Reduction (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Bailey	Muleshoe	59	64	70	76	83	89
Briscoe	County-other	15	15	14	14	14	14
	Silverton	6	6	2	2	2	2
Castro	Dimmitt	55	58	60	63	65	67
Cochran	County-other	25	27	28	28	29	29
	Morton	24	24	23	23	23	23
Crosby	Lorenzo	12	12	13	14	15	15
Dawson	Lamesa	114	115	116	116	119	121
Deaf Smith	Hereford	198	223	251	286	315	346
Dickens	Spur	9	9	9	8	8	8
Floyd	Floydada	29	30	30	31	32	33
Gaines	Seagraves	20	9	0	0	0	0
	Seminole	117	129	142	158	171	184
Hale	Abernathy	35	37	38	39	40	41
	Petersburg	16	17	17	16	17	17
	Plainview	218	222	221	217	223	225
Hockley	Anton	8	8	8	8	9	9
	Levelland	116	53	0	0	0	0
	Sundown	21	22	22	22	23	24
Lamb	Amherst	5	5	5	6	6	6
	Earth	10	10	9	9	8	8
	Littlefield	48	46	44	42	41	40
	Olton	23	23	23	22	22	22
	Sudan	12	13	14	14	15	15
Lubbock	Idalou	21	21	22	23	23	24
	Lubbock	2,287	2,478	2,674	2,915	3,139	3,382
	Ransom Canyon	17	18	19	20	21	22
	Wolfforth	38	37	29	26	29	32
Lynn	Tahoka	24	20	7	3	4	4
Motley	County-other	5	5	5	5	5	5
	Matador	11	10	10	10	10	10
Parmer	Bovina	19	20	21	23	25	27
	County-other	32	34	36	39	42	45
	Farwell	20	21	23	25	27	29
	Friona	41	45	48	51	55	59
Swisher	Tulia	46	47	47	46	48	50
Terry	Brownfield	90	93	92	69	72	75
Yoakum	Denver City	71	79	86	94	103	112
	Plains	22	24	26	28	31	34

ac-ft/yr = Acre-feet per year

5.2.1.4.2 Financial costs. The TWDB uniform costing model includes municipal water conservation strategy unit costs of $600 per acre-foot of water conserved for urban, $681 per acre-foot for suburban, and $770 per acre-foot for rural applications (TWDB, 2013e). Urban communities are defined as cities designated as metropolitan statistical area cities. Suburban communities are defined as non-metropolitan statistical area cities that are located in a county with a metropolitan statistical area, and rural communities are those that are located in counties that do not include a metropolitan statistical area (U.S. Census Bureau, 2010). The only metropolitan statistical area in Region O is Lubbock (U.S. Census Bureau, 2010), which is therefore classified as urban. Idalou, Ransom Canyon, Shallowater, Slaton, and Wolfforth are classified as suburban communities, while all other Region O communities have been classified as rural. The cost summary is provided in Table 5-16.

5.2.1.4.3 Environmental impacts. Environmental impacts associated with this strategy have been quantified in the impact matrix (Section 5.1.3, Table 5-5, and Appendix 5E) and are expected to be minimal. Implementation of administrative, residential, and commercial conservation strategies will lead to lower indoor and outdoor water usage, resulting in lower municipal water consumption. Lower municipal consumption will reduce pressure on municipal water sources by limiting declines in reservoir and/or aquifer levels, which can extend the effective life of current sources and delay future water supply projects.

Lower indoor water consumption will result in lower gross effluent flows entering wastewater treatment plants and, consequently, reduced treated effluent discharges back into river basins. Depending on the water savings achieved, this may affect streamflow and aquatic habitats and wildlife.

Municipalities (or citizens within a municipality) reliant upon excess irrigation water as a water source may be negatively impacted, as a reduction in the amount of water applied to lawns will reduce the amount of water percolating into the aquifer(s) beneath cities.

Outdoor conservation strategies encouraging the installation of native and xeric plants will improve biodiversity in the area by creating new habitats for wildlife.

Table 5-16. Estimated Capital and Annual Costs for Municipal Water Conservation Program
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WUG County	Entity WUG Name	Capital Cost ($)	Unit Cost ($/ac-ft/yr)						Annual Cost ($)					
			2020	2030	2040	2050	2060	2070	2020	2030	2040	2050	2060	2070
Bailey	Muleshoe	0	770	770	770	770	770	770	45,430	49,280	53,900	58,520	63,910	68,530
Briscoe	County-other	0	770	770	770	770	770	770	11,550	11,550	10,780	10,780	10,780	10,780
	Silverton	0	770	770	770	770	770	770	4,620	4,620	1,540	1,540	1,540	1,540
Castro	Dimmitt	0	770	770	770	770	770	770	42,350	44,660	46,200	48,510	50,050	51,590
Cochran	County-other	0	770	770	770	770	770	770	19,250	20,790	21,560	21,560	22,330	22,330
	Morton	0	770	770	770	770	770	770	18,480	18,480	17,710	17,710	17,710	17,710
Crosby	Lorenzo	0	770	770	770	770	770	770	9,240	9,240	10,010	10,780	11,550	11,550
Dawson	Lamesa	0	770	770	770	770	770	770	87,780	88,550	89,320	89,320	91,630	93,170
Deaf Smith	Hereford	0	770	770	770	770	770	770	152,460	171,710	193,270	220,220	242,550	266,420
Dickens	Spur	0	770	770	770	770	770	770	6,930	6,930	6,930	6,160	6,160	6,160
Floyd	Floydada	0	770	770	770	770	770	770	22,330	23,100	23,100	23,870	24,640	25,410
Gaines	Seagraves	0	770	770	0	0	0	0	15,400	6,930	0	0	0	0
	Seminole	0	770	770	770	770	770	770	90,090	99,330	109,340	121,660	131,670	141,680
Hale	Abernathy	0	770	770	770	770	770	770	26,950	28,490	29,260	30,030	30,800	31,570
	Petersburg	0	770	770	770	770	770	770	12,320	13,090	13,090	12,320	13,090	13,090
	Plainview	0	770	770	770	770	770	770	167,860	170,940	170,170	167,090	171,710	173,250
Hockley	Anton	0	770	770	770	770	770	770	6,160	6,160	6,160	6,160	6,930	6,930
	Levelland	0	770	770	0	0	0	0	89,320	40,810	0	0	0	0
	Sundown	0	770	770	770	770	770	770	16,170	16,940	16,940	16,940	17,710	18,480
Lamb	Amherst	0	770	770	770	770	770	770	3,850	3,850	3,850	4,620	4,620	4,620
	Earth	0	770	770	770	770	770	770	7,700	7,700	6,930	6,930	6,160	6,160
	Littlefield	0	770	770	770	770	770	770	36,960	35,420	33,880	32,340	31,570	30,800

ac-ft/yr = Acre-feet per year

Table 5-16. Estimated Capital and Annual Costs for Municipal Water Conservation Program
Page 2 of 2

WUG County	Entity WUG Name	Capital Cost ($)	Unit Cost ($/ac-ft/yr)						Annual Cost ($)					
			2020	2030	2040	2050	2060	2070	2020	2030	2040	2050	2060	2070
Lamb (cont.)	Olton	0	770	770	770	770	770	770	17,710	17,710	17,710	16,940	16,940	16,940
	Sudan	0	770	770	770	770	770	770	9,240	10,010	10,780	10,780	11,550	11,550
Lubbock	Idalou	0	681	681	681	681	681	681	14,301	14,301	14,982	15,663	15,663	16,344
	Lubbock	0	600	600	600	600	600	600	1,372,200	1,486,800	1,604,400	1,749,000	1,883,400	2,029,200
	Ransom Canyon	0	681	681	681	681	681	681	11,577	12,258	12,939	13,620	14,301	14,982
	Wolfforth	0	681	681	681	681	681	681	25,878	25,197	19,749	17,706	19,749	21,792
Lynn	Tahoka	0	770	770	770	770	770	770	18,480	15,400	5,390	2,310	3,080	3,080
Motley	County-other	0	770	770	770	770	770	770	3,850	3,850	3,850	3,850	3,850	3,850
	Matador	0	770	770	770	770	770	770	8,470	7,700	7,700	7,700	7,700	7,700
Parmer	Bovina	0	770	770	770	770	770	770	14,630	15,400	16,170	17,710	19,250	20,790
	County-other	0	770	770	770	770	770	770	24,640	26,180	27,720	30,030	32,340	34,650
	Farwell	0	770	770	770	770	770	770	15,400	16,170	17,710	19,250	20,790	22,330
	Friona	0	770	770	770	770	770	770	31,570	34,650	36,960	39,270	42,350	45,430
Swisher	Tulia	0	770	770	770	770	770	770	35,420	36,190	36,190	35,420	36,960	38,500
Terry	Brownfield	0	770	770	770	770	770	770	69,300	71,610	70,840	53,130	55,440	57,750
Yoakum	Denver City	0	770	770	770	770	770	770	54,670	60,830	66,220	72,380	79,310	86,240
	Plains	0	770	770	770	770	770	770	16,940	18,480	20,020	21,560	23,870	26,180

ac-ft/yr = Acre-feet per year

5.2.1.4.4 Implementation. When implementing an administrative, residential, or commercial conservation program, municipalities need to consider the following items:

- *Staff time:* Implementation of a conservation strategy/program requires staff time, with some strategies more time-intensive than others. While staff time is not included in the financial costs of the strategies presented, it should factor into a municipality's decision-making process.

- *Enforcement:* Research has found that mandatory conservation measures tend to result in greater water savings than voluntary measures (Renwick and Green, 2000). To ensure citizen participation in mandatory conservation measures, enforcement is necessary, which requires a commitment of both municipal staff time and funds.

- *Water rates and revenue:* In the short term, conservation can negatively impact a municipality's revenue by lowering demand. If unplanned for, this can cause sudden and potentially severe water rate increases. However, in the long term, conservation will lower rates by eliminating or delaying the need for additional water supply projects. Before implementing a conservation program, municipalities should analyze and plan for the short-term impact to revenue.

- *Quality of conservation appliances and devices:* To achieve water savings, the conservation appliances and devices promoted must be capable of completing the task as well as their non-conserving counterparts do. For example, if a low-flush toilet requires two flushes to accomplish what a high-flow toilet can accomplish in one flush, all water savings are lost.

- *Impact to gross effluent flows:* As noted above, lower indoor water consumption will result in lower effluent flows to wastewater treatment plants. If a municipality is planning to implement a water reuse strategy in the future, reductions in water availability due to indoor conservation should be considered.

- *Lifetime of strategies:* The lifetime of various outdoor conservation strategies differs greatly. For example, the projected lifetime of a single-family irrigation audit is 3 years whereas the projected lifetime of a rain barrel is 15 years (GDS Associates, Inc., 2001). Strategies dependent on behavioral changes (e.g., watering less frequently) may require continual awareness and educational efforts to remain effective.

5.2.2 Municipal Water Loss Reduction

Water loss reduction is recommended for all WUGs with losses greater than 20 percent, as reported in the 2010 TWDB Water Loss Audit (discussed in Chapter 1.11), and first tier water needs. The following four WUGs meet both criteria:

- City of Lorenzo
- City of Morton
- City of Shallowater
- City of Sundown

There are numerous ways to reduce system water loss; some of the more commonly used methods include:

- The TWDB Water Conservation Best Management Practices Guide (TWDB, 2004b) recommends that utilities conduct system water audits and engage in "careful and regular metering of water" and "proper maintenance of meters" in order to reduce water loss.

- Utilities can also consider timely repair of leaks and proactive replacement of aging lines.

Each utility should evaluate these and all other water loss reduction strategies to determine which will yield the highest water savings in the most cost-effective manner.

5.2.2.1 *Description of Option*

This water management strategy includes development of a water loss reduction program to replace each water utility's existing main lines. The recommended project would be conducted in two phases (phase 1 to be completed by decade 2020 and phase 2, by decade 2040) with the objective to replace the entire existing main line distribution system for the selected entities. Note that this strategy focuses on reducing losses from the existing distribution system and does not include any new infrastructure required to accommodate growth and expansion.

According to AWWA's 2007 Distribution System Water Loss, the average water loss for water utilities in the South region of the United States is 8.9 percent. Some water losses are still expected to occur from the replaced system due to aging, pipe joints, minor connection leaks, and other factors. For this reason, the water loss reduction program goal is to achieve an ultimate real loss of 10 percent of the utility's existing system input volume.

5.2.2.2 *Quantity and Reliability of Water*

Table 5-17 shows the total water loss reported in 2010 as well as the anticipated savings from implementing water loss reduction techniques. It is assumed that each WUG can reduce their total system water loss to 10 percent. In early years of a main replacement program, however, areas with higher loss rates would be identified and likely replaced first. Water savings, therefore, would likely be greater in the early years of the main replacement program because the larger loss areas of the system would be targeted and replaced first.

Table 5-17. Estimated Water Savings from Water Loss Reduction Program

Municipality	2010 Water Loss (ac-ft/yr)	Estimated Water Savings or Demand Reduction (ac-ft/yr)					
		Phase 1		Phase 2			
		2020	2030	2040	2050	2060	2070
Lorenzo	59	29	31	54	57	61	64
Morton	430	141	141	232	226	231	233
Shallowater	182	68	74	136	150	163	177
Sundown	61	27	28	48	48	50	52

5.2.2.3 Financial Costs

The cost of the line replacement was estimated based on the TWDB's UCM. The total input volume from the 2010 water loss audit was used to determine a minimum pipe diameter to achieve a 5-foot per second velocity, assuming that this total flow runs through the main line. For planning purposes, the costs were estimated conservatively as follows. If the minimum diameter was calculated to be less than 4 inches, a 6-inch-diameter replacement pipe was included. Similarly, if the minimum diameter was calculated to be less than 6 inches, an 8-inch-diameter replacement pipe was included. Utilities with greater pipe diameters were not included in this analysis. Given the locations of the utilities considered, costs for pipe replacement in soil in a rural environment were used, and an additional 20 percent was added to the original unit cost to cover fittings and the remote nature of the installations. Pipe unit costs were used together with a reasonable number of road crossings and engineering costs. The cost summary is provided in Table 5-18.

Table 5-18. Estimated Capital and Annual Costs for Water Loss Reduction Program

Municipality	Cost Component	Estimated Costs ($)					
		Phase 1		Phase 2			
		2020	2030	2040	2050	2060	2070
Lorenzo	Capital cost	2,714,472	—	2,714,472	—	—	—
	Annual cost	208,678	208,678	208,678	208,678	—	—
	Unit cost[a]	7,196	6,732	3,864	3,661	—	—
Morton	Capital cost	5,880,017	—	5,880,017	—	—	—
	Annual cost	452,033	452,033	452,033	452,033	—	—
	Unit cost[a]	3,206	3,206	1,948	2,000	—	—
Shallowater	Capital cost	2,660,008	—	2,660,008	—	—	—
	Annual cost	204,491	204,491	204,491	204,491	—	—
	Unit cost[a]	3,007	2,763	1,504	1,363	—	—
Sundown	Capital cost	1,719,166	—	1,719,166	—	—	—
	Annual cost	132,163	132,163	132,163	132,163	—	—
	Unit cost[a]	4,895	4,720	2,753	2,753	—	—

[a] Unit costs are per acre-foot per year of water — = Zero cost for the program in this decade.

Annual costs were estimated with 5.5 percent interest for 20 years of debt service as specified in the UCM. For the four utilities considered in this analysis, the total annual cost of pipe replacement varies from $132,163 to $452,033, depending largely on the length of main line miles reported. The 2010 water loss audit estimate for the City of Lorenzo, 173 main line miles, appears erroneous for the population of 1,147 served by the water system. Therefore, for planning purposes an estimate of 30 main line miles was used for the cost estimate, based on water systems of similar size in Region O.

5.2.2.4 Environmental Impacts

Environmental impacts associated with this strategy have been quantified in the impact matrix (Section 5.1.3., Table 5-5, Appendix 5E) and are expected to be minimal. The majority of pipeline length will be replaced within established roadway corridors, and the facility improvements identified will be at existing sites. This strategy may actually have a positive impact on the environment by reducing future water demands.

5.2.2.5 Implementation

No significant obstacles to implementation of this strategy have been identified. Pipeline replacement programs are generally more expensive than other water conservation best management practices (BMPs); therefore the most substantial obstacle to implementing this type of strategy may be the large financial burden for these small communities. Technical and financial assistance may be needed to implement a water loss reduction strategy.

5.2.3 Local Groundwater Development

The majority of water use in Region O is from groundwater. However, in areas where extensive groundwater extraction is occurring, new wells may be required to maintain production rates. This WMS would augment an existing water supply by drilling new wells to connect to an existing water system to pump groundwater available for development within the region. Communities that are not located near a WWP's existing pipelines will use smaller projects to meet immediate demand for their residents.

Responses to municipal surveys conducted during this planning cycle indicate that a number of municipalities are either currently in the process or have plans for expansion of local groundwater resources by drilling new wells or acquiring existing wells to meet their identified water needs. A local groundwater development strategy is recommended for 24 municipalities in Region O. A description of each of these projects is provided in the following subsections, followed by a full evaluation of the projects, including a cost analysis for each project.

5.2.3.1 City of Amherst Project

The City of Amherst reports that their well field has declining water levels and plans to pursue local groundwater development. The City has received a community development block grant that they plan to use to acquire land, build a pipeline and/or drill at least one well. For the purposes of this plan, this project will seek to develop 50 acre-feet of supply from the Ogallala Aquifer in the Brazos Basin of Lamb County and will be online in 2020. The exact locations of the additional supply wells are not yet known, but the new wells will likely be located either within the city's existing well field or placed on property acquired by the municipality for future well field development. The primary facilities incorporated into the planning-level cost estimate include:

- Two supply wells (1 active and 1 contingency)
- 2,000 feet of well field piping to the existing distribution system

5.2.3.2 Bailey County-Other Project

The Bailey County-other WUG consists of water users in Bailey County that live in a rural setting either outside of a municipal WUG or within a town with a population of less than 500. Due to decreasing supplies from the Ogallala Aquifer and increasing demands due to population growth, Bailey County-other has a need of more than 100 acre-feet beginning in 2040. Bailey County-other is an aggregated WUG; therefore the number and exact locations of the new wells are difficult to assess, but they will most likely be located near Maple WSC in the southern portion of the county. For the purposes of this plan, this project will seek to develop 150 acre-feet of supply from the Edwards-Trinity (High Plains) Aquifer (limited availability remaining in the Ogallala Aquifer) in the Brazos Basin of Bailey County and will be online by decade 2040. The primary facilities incorporated into the planning-level cost estimate include:

- Two supply wells (1 active and 1 contingency)
- 2,000 feet of well field piping to an existing distribution system

5.2.3.3 City of Bovina Project

The City of Bovina reports that their well field has declining water levels and plans to examine future potential sources of water such as pursuing local groundwater development. For the purposes of this plan, this project will seek to develop 120 acre-feet of supply from the Ogallala Aquifer in the Brazos Basin of Parmer County and will be online by decade 2040. The exact locations of the additional supply wells are not yet known, but they will likely be located either within the city's existing well field or placed on property already owned by the municipality. The primary facilities incorporated into the planning-level cost estimate include:

- Two supply wells (1 active and 1 contingency)
- 2,000 feet of well field piping to the existing distribution system

5.2.3.4 Dawson County-Other Project

The Dawson County-other WUG consists of water users in Dawson County that live in a rural setting either outside of a municipal WUG or within a town with a population of less than 500. The Colorado Basin portion of the Dawson County-other WUG has a water need beginning in 2040 due to decreasing supplies from the Ogallala Aquifer and increasing demands due to population growth. Dawson County-other is an aggregated WUG; therefore, the number and exact locations of the new wells are difficult to assess. For the purposes of this plan, this project will seek to develop 150 acre-feet of supply from the Ogallala Aquifer in the Colorado Basin of Dawson County and will be online by decade 2040. The primary facilities incorporated into the planning-level cost estimate include:

- Two supply wells (1 active and 1 contingency)
- 3,000 feet of well field piping to an existing distribution system

5.2.3.5 Denver City Project

Denver City plans to pursue local groundwater development. For the purposes of this plan, this project will seek to develop 925 acre-feet of supply from the Edwards-Trinity (High Plains) Aquifer (limited availability remaining in the Ogallala Aquifer) in the Colorado Basin of Yoakum County and will be online by 2020. The additional supply wells will be placed on property already owned by the municipality. The primary facilities incorporated into the planning-level cost estimate include:

- Seven supply wells (6 active and 1 contingency)
- 6,500 feet of well field piping to the existing distribution system

5.2.3.6 City of Dimmitt Project

The City of Dimmitt plans to pursue local groundwater development. For the purposes of this plan, this project will seek to develop 300 acre-feet of supply from the Ogallala Aquifer in the Brazos Basin of Castro County and will be online by decade 2040. The exact locations of the additional supply wells are not yet known, but they will likely be located either within the city's existing well field or placed on property already owned by the municipality. The primary facilities incorporated into the planning-level cost estimate include:

- Three supply wells (2 active and 1 contingency)
- 3,500 feet of well field piping to existing distribution system

5.2.3.7 City of Farwell Project

The City of Farwell plans to pursue local groundwater development. For the purposes of this plan, this project will seek to develop 125 acre-feet of supply from the Ogallala Aquifer in the Brazos Basin of Parmer County and will be online by decade 2050. The exact locations of the additional supply wells are not yet known, but they will likely be located either within the city's existing well field or placed on property already owned by the municipality. The primary facilities incorporated into the planning-level cost estimate include:

- Two supply wells (1 active and 1 contingency)
- 2,000 feet of well field piping to the existing distribution system

5.2.3.8 City of Friona Project

The City of Friona plans to pursue local groundwater development. For the purposes of this plan, this project will seek to develop 80 acre-feet of supply from the Ogallala Aquifer in the Brazos Basin of Parmer County and will be online by decade 2050. The exact locations of the additional supply wells are not yet known, but they will likely be located within the city's existing well field. The primary facilities incorporated into the planning-level cost estimate include:

- Two supply wells (1 active and 1 contingency)
- 2,000 feet of well field piping to the existing distribution system

5.2.3.9 Gaines County-Other Project

The Gaines County-other WUG consists of water users in Gaines County who live in a rural setting either outside of a municipal WUG or within a town with a population of less than 500. Due to decreasing supplies from the Ogallala Aquifer and increasing demands due to population growth, the Gaines County-other WUG has a water need beginning in 2020. Gaines County-other is an aggregated WUG, therefore the number and exact locations of the new wells are difficult to assess. For the purposes of this plan, this project will be completed in three phases and will seek to develop 2,000 acre-feet of supply by decade 2060 from the Edwards-Trinity (High Plains) Aquifer (limited availability remaining in the Ogallala Aquifer) in the Colorado Basin of Gaines County. The primary facilities incorporated into the planning-level cost estimate include:

- Phase 1 (online in 2020)
  - Five supply wells (4 active and 1 contingency)
  - 4,500 feet of well field piping to an existing distribution system
- Phase 2 (online in 2040)
  - Seven supply wells (6 active and 1 contingency)
  - 6,500 feet of well field piping to an existing distribution system
- Phase 3 (online in 2060)
  - Five supply wells (4 active and 1 contingency)
  - 4,500 feet of well field piping to an existing distribution system

5.2.3.10 City of Hart Project

The City of Hart plans to pursue local groundwater development. For the purposes of this plan, this project will seek to develop 100 acre-feet of supply from the Ogallala Aquifer in the Brazos Basin of Castro County and will be online in decade 2040 (limited availability in prior decades). The exact locations of the additional supply wells are not yet known, but they will likely be located either within the city's existing well field or placed on property acquired by the municipality for future well field development. The primary facilities incorporated into the planning-level cost estimate include:

- Two supply wells (1 active and 1 contingency)
- 2,000 feet of well field piping to the existing distribution system

5.2.3.11 Hockley County-Other Project

The Hockley County-other WUG consists of water users in Hockley County that live in a rural setting either outside of a municipal WUG or within a town with a population of less than 500. Hockley County-other is an aggregated WUG; therefore, the number and exact locations of the new wells are difficult to assess, but they will likely be located near Smyer or Ropesville in the eastern portion of the county. For the purposes of this plan, this project will seek to develop 150 acre-feet of supply from the Ogallala Aquifer in the Brazos Basin of Hockley County and will be online by 2020. The primary facilities incorporated into the planning-level cost estimate include:

- Two supply wells (1 active and 1 contingency)
- 2,000 feet of well field piping to an existing distribution system

5.2.3.12 City of Idalou Project

The City of Idalou plans to pursue local groundwater development with additional storage capacity. For the purposes of this plan, this project will seek to develop 100 acre-feet of supply from the Ogallala Aquifer in the Brazos Basin of Lubbock County and will be online by decade 2030 (limited availability in prior decade). The exact locations of the additional supply wells are not yet known, but they will likely be located on property the City will acquire in the future for well field development. The primary facilities incorporated into the planning-level cost estimate include:

- Two supply wells (1 active and 1 contingency)
- 7,000 feet of well field piping to the existing distribution system
- A 500,000-gallon elevated storage tank

5.2.3.13 City of Lockney Project

The City of Lockney plans to pursue local groundwater development with additional transmission pipeline. For the purposes of this plan, this project will seek to develop 240 acre-feet of supply from the Ogallala Aquifer in the Brazos Basin of Floyd County and will be online in 2020. The exact locations of the additional supply wells are not yet known, but they will likely be located on property the City will acquire in the future for well field development. The primary facilities incorporated into the planning-level cost estimate include:

- Two supply wells (1 active and 1 contingency)
- 2,000 feet of well field piping to the existing distribution system
- 2 miles of 6-inch-diameter transmission pipeline

5.2.3.14 Lynn County-Other Project

The Lynn County-other WUG consists of water users in Lynn County that live in a rural setting either outside of a municipal WUG or within a town with a population of less than 500. Due to decreasing supplies from the Ogallala Aquifer, the Brazos Basin portion of Lynn County-other has a water need beginning in 2030. Lynn County-other is an aggregated WUG; therefore the number and exact locations of the new wells are difficult to assess, but they will most likely be drilled near Wilson. For the purposes of this plan, this project will seek to develop 100 acre-feet of supply from the Ogallala Aquifer in the Brazos Basin of Lynn County and will be online by decade 2030. The primary facilities incorporated into the planning-level cost estimate include:

- Two supply wells (1 active and 1 contingency)
- 2,000 feet of well field piping to an existing distribution system

5.2.3.15 City of Muleshoe Project

The City of Muleshoe plans to pursue local groundwater development. For the purposes of this plan, this project will be completed in two phases and will seek to develop 500 acre-feet of supply by decade 2060 from the Ogallala Aquifer in the Brazos Basin of Bailey County. The exact locations of the additional supply wells are not yet known, but they will likely be located within the City's existing well field. The primary facilities incorporated into the planning-level cost estimate include:

- Phase 1 (online in 2030)
  - Two supply wells (1 active and 1 contingency)
  - 2,000 feet of well field piping to the existing distribution system
- Phase 2 (online in 2060)
  - Two supply wells (1 active and 1 contingency)
  - 2,000 feet of well field piping to the existing distribution system

5.2.3.16 Parmer County-Other Project

The Parmer County-other WUG consists of water users in Parmer County who live in a rural setting either outside of a municipal WUG or within a town with a population of less than 500. The Brazos Basin portion of Parmer County-other has a water need beginning in 2060 from increasing demand due to population growth. Parmer County-other is an aggregated WUG; therefore, the number and exact locations of the new wells are difficult to assess. For the purposes of this plan, this project will seek to develop 50 acre-feet of supply from the Ogallala Aquifer in the Brazos Basin of Parmer County and will be online by decade 2060. The primary facilities incorporated into the planning-level cost estimate include:

- Two supply wells (1 active and 1 contingency)
- 2,000 feet of well field piping to an existing distribution system

5.2.3.17 City of Plains Project

The City of Plains plans to pursue local groundwater development with additional water treatment. The City of Plains is currently running a pilot program treatment plant to remove arsenic and fluoride. If the pilot program is accepted by the TCEQ, the City of Plains plans to build a full-scale water treatment plant. For the purposes of this plan, this project will seek to develop 500 acre-feet of supply from the Edwards-Trinity (High Plains) Aquifer (limited availability remaining in the Ogallala Aquifer) in the Colorado Basin of Yoakum County and will be online by 2020. The additional supply wells and treatment plant will be placed on property already owned by the municipality. The primary facilities incorporated into the planning-level cost estimate include:

- Five supply wells (4 active and 1 contingency)
- Water treatment plant
- 4,500 feet of well field piping to the existing distribution system

5.2.3.18 City of Seagraves Project

The City of Seagraves has a water need beginning in 2050 due to increasing demand from population growth and plans to pursue local groundwater development. For the purposes of this plan, this project will seek to develop 50 acre-feet of supply from the Edwards-Trinity (High Plains) Aquifer (limited availability remaining in the Ogallala Aquifer) in the Colorado Basin of Gaines County and will be online by decade 2050. The exact locations of the additional supply wells are not yet known, but they will likely be located either within the city's existing well field or placed on property acquired by the municipality for future well field development. The primary facilities incorporated into the planning-level cost estimate include:

- Two supply wells (1 active and 1 contingency)
- 2,000 feet of well field piping to the existing distribution system

5.2.3.19 City of Seminole Project

The City of Seminole has a water need beginning in 2020 due to increasing demand from population growth and plans to pursue a groundwater development project. Because the City considers nearby groundwater too expensive to purchase, the project will be located in Region F (Andrews and/or Winkler counties). For the purposes of this plan, this project will seek to develop 1,000 acre-feet of supply from the Edwards-Trinity (Plateau) Aquifer in the Colorado Basin of southeastern Andrews County (in Region F south of Gaines County) and will be online by 2020. The exact locations of the additional supply wells and transmission pipeline are not yet known, but they will be located on property the City will need to purchase or lease the rights to. The primary facilities incorporated into the planning-level cost estimate include:

- Nine supply wells (7 active and 2 contingency)
- 8,500 feet of well field piping to a new pump station

- Pump station
- 40 miles of main water line to the existing distribution system

5.2.3.20 City of Shallowater Project

The City of Shallowater plans to pursue local groundwater development and a new water treatment system. The current water supply has an issue with elevated uranium, and the City is working with TCEQ to complete a successful pilot study. When the pilot program is accepted by the TCEQ, the City of Shallowater plans to build a full-scale water treatment plant. For the purposes of this plan, this project will seek to develop 400 acre-feet of supply from the Ogallala Aquifer in the Brazos Basin of Lubbock County and will be online by 2030 (limited availability prior to decade 2030). The additional supply wells and treatment plant will be placed on property already owned by the municipality. The primary facilities incorporated into the planning-level cost estimate include:

- Four supply wells (3 active and 1 contingency)
- Water treatment plant
- 9,000 feet of well field piping to the existing distribution system

5.2.3.21 City of Silverton Project

The City of Silverton is currently supplied by Lake Mackenzie and has a water need beginning in 2020. The City has purchased property in Swisher County that contains several existing wells (Ogallala and Dockum aquifers) and plans to pursue a groundwater development project at this location since nearby groundwater in Briscoe County is of poor quality. The exact location of the transmission pipeline is not yet known, and it may be possible for the City of Silverton to use the existing Mackenzie MWA transmission pipeline instead of building an entirely new pipeline; nevertheless, for planning purposes the recommend project includes the cost to construct a new pipeline.

For the purposes of this plan, this project will seek to develop 121 acre-feet of supply from the Dockum Aquifer in the Red River Basin of southeastern Swisher County and will be online by 2020. The additional supply wells will be placed on property already owned by the municipality. The primary facilities incorporated into the planning-level cost estimate include:

- Four supply wells (3 active and 1 contingency)
- 4,000 feet of well field piping to a new pump station
- Pump station
- 19 miles of main water line to the distribution system

5.2.3.22 City of Sundown Project

The City of Sundown plans to pursue local groundwater development. For the purposes of this plan, this project will seek to develop 100 acre-feet of supply from the Ogallala Aquifer in the Colorado Basin of Hockley County and will be online in decade 2070 (limited availability in prior decades). The exact locations of the additional supply wells are not yet known, but they will likely be located either within the City's existing well field or placed on property acquired by the municipality for future well field development. The primary facilities incorporated into the planning-level cost estimate include:

- Two supply wells (1 active and 1 contingency)
- 2,000 feet of well field piping to the existing distribution system

5.2.3.23 City of Tulia Project

The City of Tulia plans to pursue local groundwater development with additional storage capacity and water treatment. A water supply study prepared for the City discusses either developing a new well field or redeveloping an existing well site. The redevelopment project has been selected as a recommended project in this plan; an alternative project developing a new well field for the City of Tulia is presented in Section 5.8.2. For the purposes of this plan, the recommended project will seek to redevelop an existing Dockum Aquifer well site to supply 200 acre-feet from the Ogallala Aquifer in the Red River Basin of Swisher County and be online in 2020. The additional supply wells will be placed on property already owned by the municipality. The primary facilities incorporated into the planning-level cost estimate include:

- Two supply wells (1 active and 1 contingency)
- Disinfection treatment system
- A 250,000-gallon storage tank

5.2.3.24 City of Wolfforth Project

The City of Wolfforth plans to pursue local groundwater development (in Ogallala and Dockum aquifers) with additional storage capacity. For the purposes of this plan, this project will seek to develop 726 acre-feet of supply from the Ogallala Aquifer in the Brazos Basin of Lubbock County and will be online by decade 2030 (limited availability in prior decade). The exact locations of the additional supply wells are not yet known, but they will likely be located on property the City will need to purchase or lease for future well field development. The primary facilities incorporated into the planning-level cost estimate include:

- Four supply wells (3 active and 1 contingency)
- 4,000 feet of well field piping to a new pumping station
- Pump station
- 5.5 miles of main water line to a new elevated storage tank
- A 1,000,000-gallon elevated storage tank

5.2.3.25 Quantity and Reliability of Water

The quantity of water available would depend on the sizes, depths, and locations of the wells. Single well installations are less complicated and generally require less infrastructure, but yield less water for use. Table 5-19 presents the implementation decade and estimated annual water yield for the recommended WUG-specific local groundwater development projects that have been identified. Water quantities provided by the recommended local groundwater development strategies are based on the unallocated water availability that is obtainable during drought-of-record conditions as discussed in Chapter 3. Water losses associated with this strategy are expected to be minimal, 10 percent or less.

Table 5-19. Estimated Water Supply from Local Groundwater Development Projects

County	Municipal WUG	Basin	Estimated WMS Water Supply (ac-ft/yr)					
			2020	2030	2040	2050	2060	2070
Bailey	County-other	Brazos	—	—	150	150	150	150
	Muleshoe	Brazos	—	300	300	300	500	500
Briscoe	Silverton	Red	121	121	121	121	121	121
Castro	Dimmitt	Brazos	—	—	300	300	300	300
	Hart	Brazos	—	—	100	100	100	100
Dawson	County-other	Colorado	—	—	150	150	150	150
Floyd	Lockney	Brazos	240	240	240	240	240	240
Gaines	County-other	Colorado	600	600	1,500	1,500	2,000	1,622 [a]
	Seagraves	Colorado	—	—	—	50	50	50
	Seminole	Colorado	—	1,000	1,000	1,000	1,000	1,000
Hockley	County-other	Brazos	150	150	150	150	150	150
	Sundown	Colorado	—	—	—	—	—	100
Lamb	Amherst	Brazos	50	50	50	50	50	50
Lubbock	Idalou	Brazos	—	100	100	100	100	100
	Shallowater	Brazos	—	400	400	400	400	400
	Wolfforth	Brazos	—	726	726	726	726	726
Lynn	County-other	Brazos	100	100	100	100	100	100
Parmer	Bovina	Brazos	—	—	120	120	120	120
	County-other	Brazos	—	—	—	—	50	50
	Farwell	Brazos	—	—	—	125	125	125
	Friona	Red	—	—	—	80	80	80
Swisher	Tulia	Red	200	200	200	200	200	200
Yoakum	Denver City	Colorado	925	925	925	925	925	925
	Plains	Colorado	500	500	500	500	500	500

[a] Supply amount reduced due to limited groundwater availability for this decade. — = System not yet online.

5.2.3.26 Financial Costs

Costs of this strategy will include planning, design, drilling, and equipping of groundwater wells and construction of a conveyance water line to the nearest system connection. Development of new groundwater resources may occur some distance from the location where it would be used, necessitating the construction of new conveyance and distribution systems. For some WUGS, the cost of this strategy will also include new or improved storage, pump stations, and/or water treatment facilities. Tables 5-20 through 5-43 present estimated capital and annual costs along with water yield for the recommended WUG-specific local groundwater development projects that have been identified.

Table 5-20. Cost Estimate for City of Amherst Groundwater Development Project

Item	Costs (Sept 2013 prices)
Capital costs	
Supply wells (2 @ 300 feet deep, 75 gpm capacity)	$ 326,000
Total cost of facilities	$ 326,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	114,000
Environmental and archaeology studies and mitigation	19,000
Land acquisition and surveying (1 acre)	11,000
Interest during construction (4% with 1% ROI for 1 year)	17,000
Total cost of project	$ 487,000
Annual costs	
Debt service (5.5% for 20 years)	$ 41,000
Intake, pipeline and pump station O&M (1% cost of facilities)	3,000
Pumping energy costs (13,877 kWh @ $.09/kWh)	1,000
Total annual costs	$ 45,000
Quantity of water (ac-ft/yr) [a]	50
Annual cost of water ($ per acre-foot)	$ 900
Annual cost of water ($ per 1,000 gal)	$ 2.76

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

Table 5-21. Cost Estimate for Bailey County-Other Groundwater Development Project

Item	Costs (Sept 2013 prices)
Capital costs	
Supply wells (2 @ 400 feet deep, 150 gpm capacity)	$ 529,000
Total cost of facilities	$ 529,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	185,000
Environmental and archaeology studies and mitigation	19,000
Land acquisition and surveying (1 acre)	11,000
Interest during construction (4% with 1% ROI for 1 year)	27,000
Total cost of project	$ 771,000
Annual costs	
Debt service (5.5% for 20 years)	$ 65,000
Intake, pipeline and pump station O&M (1% cost of facilities)	5,000
Pumping energy costs (42,417 kWh @ $.09/kWh)	4,000
Total annual costs	$ 74,000

Table 5-21. Cost Estimate for Bailey County-Other Groundwater Development Project (continued)

Item	Costs (Sept 2013 prices)
Quantity of water (ac-ft/yr) [a]	150
Annual cost of water ($ per acre-foot)	$ 493
Annual cost of water ($ per 1,000 gal)	$ 1.51

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

Table 5-22. Cost Estimate for City of Bovina Groundwater Development Project

Item	Costs (Sept 2013 prices)
Capital costs	
Supply wells (2 @ 400 feet deep, 150 gpm capacity)	$ 529,000
Total cost of facilities	$ 529,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	185,000
Environmental and archaeology studies and mitigation	21,000
Land acquisition and surveying (1 acre)	13,000
Interest during construction (4% with 1% ROI for 1 year)	27,000
Total cost of project	$ 775,000
Annual costs	
Debt service (5.5% for 20 years)	$ 65,000
Intake, pipeline and pump station O&M (1% cost of facilities)	5,000
Pumping energy costs (47,160 kWh @ $.09/kWh)	4,000
Total annual costs	$ 74,000
Quantity of water (ac-ft/yr) [a]	120
Annual cost of water ($ per acre-foot)	$ 617
Annual cost of water ($ per 1,000 gal)	$ 1.89

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

Table 5-23. Cost Estimate for Dawson County-Other Groundwater Development Project

Item	Costs (Sept 2013 prices)
Capital costs	
Supply wells (2 @ 400 feet deep, 150 gpm capacity)	$ 547,000
Total cost of facilities	$ 547,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	192,000
Environmental and archaeology studies and mitigation	24,000
Land acquisition and surveying (1 acre)	11,000
Interest during construction (4% with 1% ROI for 1 year)	28,000
Total cost of project	$ 802,000
Annual costs	
Debt service (5.5% for 20 years)	$ 67,000
Intake, pipeline and pump station O&M (1% cost of facilities)	5,000
Pumping energy costs (45,724 kWh @ $.09/kWh)	4,000
Total annual costs	$ 76,000
Quantity of water (ac-ft/yr) [a]	150
Annual cost of water ($ per acre-foot)	$ 507
Annual cost of water ($ per 1,000 gal)	$ 1.55

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

Table 5-24. Cost Estimate for Denver City Groundwater Development Project

Item	Costs (Sept 2013 prices)
Capital costs	
Supply wells (7 @ 500 feet deep, 150 gpm capacity)	$ 2,065,000
Total cost of facilities	$ 2,065,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	723,000
Environmental and archaeology studies and mitigation	66,000
Land acquisition and surveying (4 acres)	39,000
Interest during construction (4% with 1% ROI for 1 year)	102,000
Total cost of project	$ 2,995,000
Annual costs	
Debt service (5.5% for 20 years)	$ 251,000
Intake, pipeline and pump station O&M (1% cost of facilities)	21,000
Pumping energy costs (397,398 kWh @ $.09/kWh)	36,000
Total annual costs	$ 308,000

Table 5-24. Cost Estimate for Denver City Groundwater Development Project (continued)

Item	Costs (Sept 2013 prices)
Quantity of water (ac-ft/yr) [a]	925
Annual cost of water ($ per acre-foot)	$ 333
Annual cost of water ($ per 1,000 gal)	$ 1.02

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

Table 5-25. Cost Estimate for City of Dimmitt Groundwater Development Project

Item	Costs (Sept 2013 prices)
Capital costs	
Supply wells (3 @ 500 feet deep, 150 gpm capacity)	$ 889,000
Total cost of facilities	$ 889,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	311,000
Environmental and archaeology studies and mitigation	34,000
Land acquisition and surveying (4 acres)	19,000
Interest during construction (4% with 1% ROI for 1 year)	44,000
Total cost of project	$ 1,297,000
Annual costs	
Debt service (5.5% for 20 years)	$ 109,000
Intake, pipeline and pump station O&M (1% cost of facilities)	9,000
Pumping energy costs (111,703 kWh @ $.09/kWh)	10,000
Total annual costs	$ 128,000
Quantity of water (ac-ft/yr) [a]	300
Annual cost of water ($ per acre-foot)	$ 427
Annual cost of water ($ per 1,000 gal)	$ 1.31

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

Table 5-26. Cost Estimate for City of Farwell Groundwater Development Project

Item	Costs (Sept 2013 prices)
Capital costs	
Supply wells (2 @ 450 feet deep, 150 gpm capacity)	$ 558,000
Total cost of facilities	$ 558,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	195,000
Environmental and archaeology studies and mitigation	21,000
Land acquisition and surveying (4 acres)	13,000
Interest during construction (4% with 1% ROI for 1 year)	38,000
Total cost of project	$ 815,000
Annual costs	
Debt service (5.5% for 20 years)	$ 68,000
Intake, pipeline and pump station O&M (1% cost of facilities)	6,000
Pumping energy costs (57,391 kWh @ $.09/kWh)	5,000
Total annual costs	$ 79,000
Quantity of water (ac-ft/yr) [a]	125
Annual cost of water ($ per acre-foot)	$ 632
Annual cost of water ($ per 1,000 gal)	$ 1.94

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

Table 5-27. Cost Estimate for City of Friona Groundwater Development Project

Item	Costs (Sept 2013 prices)
Capital costs	
Supply wells (2 @ 400 feet deep, 75 gpm capacity)	$ 372,000
Total cost of facilities	$ 372,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	130,000
Environmental and archaeology studies and mitigation	21,000
Land acquisition and surveying (1 acre)	13,000
Interest during construction (4% with 1% ROI for 1 year)	19,000
Total cost of project	$ 555,000
Annual costs	
Debt service (5.5% for 20 years)	$ 46,000
Intake, pipeline and pump station O&M (1% cost of facilities)	4,000
Pumping energy costs (29,610 kWh @ $.09/kWh)	3,000
Total annual costs	$ 53,000

Table 5-27. Cost Estimate for City of Friona Groundwater Development Project (continued)

Item	Costs (Sept 2013 prices)
Quantity of water (ac-ft/yr) [a]	80
Annual cost of water ($ per acre-foot)	$ 663
Annual cost of water ($ per 1,000 gal)	$ 2.03

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

Table 5-28. Cost Estimate for Gaines County-Other Groundwater Development Project

Item	Costs (Sept 2013 Prices) Phase 1	Phase 2	Phase 3
Capital costs			
Supply wells (5 @ 500 feet deep, 150 gpm capacity)	$ 1,468,000		$ 1,468,000
Supply wells (7 @ 500 feet deep, 150 gpm capacity)		$ 2,065,000	
Total cost of facilities	$ 1,468,000	$ 2,065,000	$ 1,468,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	514,000	723,000	514,000
Environmental and archaeology studies and mitigation	46,000	66,000	46,000
Land acquisition and surveying (3 acres)	28,000		28,000
Land acquisition and surveying (4 acres)		39,000	
Interest during construction (4% with 1% ROI for 1 year)	72,000	102,000	72,000
Total cost of project	$ 2,128,000	$ 2,995,000	$ 2,128,000
Annual Costs			
Debt service (5.5% for 20 years)	$ 178,000	$ 251,000	$ 178,000
Intake, pipeline and pump station O&M (1% cost of facilities)	15,000	21,000	15,000
Pumping energy costs (239,713 kWh @ $.09/kWh)	22,000		
Pumping energy costs (386,658 kWh @ $.09/kWh)		35,000	
Pumping energy costs (199,761 kWh @ $.09/kWh)			18,000
Total annual costs	$ 215,000	$ 307,000	$ 211,000
Quantity of water (ac-ft/yr) [a]	600	900	500
Annual cost of water ($ per acre-foot)	$ 358	$ 341	$ 422
Annual cost of water ($ per 1,000 gal)	$ 1.10	$ 1.05	$ 1.29

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

Table 5-29. Cost Estimate for City of Hart Groundwater Development Project

Item	Costs (Sept 2013 prices)
Capital costs	
Supply wells (2 @ 500 feet deep, 150 gpm capacity)	$ 587,000
Total cost of facilities	$ 587,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	205,000
Environmental and archaeology studies and mitigation	21,000
Land acquisition and surveying (1 acre)	13,000
Interest during construction (4% with 1% ROI for 1 year)	29,000
Total cost of project	$ 855,000
Annual costs	
Debt service (5.5% for 20 years)	$ 72,000
Intake, pipeline and pump station O&M (1% cost of facilities)	6,000
Pumping energy costs (40,182 kWh @ $.09/kWh)	4,000
Total annual costs	$ 82,000
Quantity of water (ac-ft/yr) [a]	100
Annual cost of water ($ per acre-foot)	$ 820
Annual cost of water ($ per 1,000 gal)	$ 2.52

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

Table 5-30. Cost Estimate for Hockley County-Other Groundwater Development Project

Item	Costs (Sept 2013 prices)
Capital costs	
Supply wells (2 @ 250 feet deep, 150 gpm capacity)	$ 438,000
Total cost of facilities	$ 438,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	153,000
Environmental and archaeology studies and mitigation	19,000
Land acquisition and surveying (1 acre)	11,000
Interest during construction (4% with 1% ROI for 1 year)	22,000
Total cost of project	$ 643,000
Annual costs	
Debt service (5.5% for 20 years)	$ 54,000
Intake, pipeline and pump station O&M (1% cost of facilities)	4,000
Pumping energy costs (32,497 kWh @ $.09/kWh)	3,000
Total annual costs	$ 61,000

Table 5-30. Cost Estimate for Hockley County-Other Groundwater Development Project (continued)

Item	Costs (Sept 2013 prices)
Quantity of water (ac-ft/yr) [a]	150
Annual cost of water ($ per acre-foot)	$ 407
Annual cost of water ($ per 1,000 gal)	$ 1.25

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

Table 5-31. Cost Estimate for City of Idalou Groundwater Development Project

Item	Costs (Sept 2013 prices)
Capital costs	
Supply wells (2 @ 300 feet deep, 150 gpm capacity)	$ 562,000
Water storage tank (1 @ 0.5 mg)	1,151,000
Total cost of facilities	$ 1,713,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	600,000
Environmental and archaeology studies and mitigation	82,000
Land acquisition and surveying (3 acres)	53,000
Interest during construction (4% with 1% ROI for 1 year)	86,000
Total cost of project	$ 2,534,000
Annual costs	
Debt service (5.5% for 20 years)	$ 212,000
Intake, pipeline and pump station O&M (1% cost of facilities)	17,000
Pumping energy costs (42,776 kWh @ $.09/kWh)	4,000
Total annual costs	$ 233,000
Quantity of water (ac-ft/yr) [a]	100
Annual cost of water ($ per acre-foot)	$ 2,330
Annual cost of water ($ per 1,000 gal)	$ 7.15

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

Table 5-32. Cost Estimate for City of Lockney Groundwater Development Project

Item	Costs (Sept 2013 prices)
Capital costs	
Intake pump station (0.3 mgd)	$ 790,000
Supply wells (2 @ 400 feet deep, 225 gpm capacity)	669,000
Transmission pipelines (6-inch, 2 miles)	282,000
Total cost of facilities	$ 1,741,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	595,000
Environmental and archaeology studies and mitigation	164,000
Land acquisition and surveying (11 acres)	127,000
Interest during construction (4% with 1% ROI for 1 year)	92,000
Total cost of project	$ 2,719,000
Annual costs	
Debt service (5.5% for 20 years)	$ 227,000
Intake, pipeline and pump station O&M (1% cost of facilities)	29,000
Pumping energy costs (152,269 kWh @ $.09/kWh)	14,000
Total annual costs	$ 270,000
Quantity of water (ac-ft/yr) [a]	240
Annual cost of water ($ per acre-foot)	$ 1,125
Annual cost of water ($ per 1,000 gal)	$ 3.45

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

Table 5-33. Cost Estimate for Lynn County-other Groundwater Development Project

Item	Costs (Sept 2013 prices)
Capital costs	
Supply wells (2 @ 200 feet deep, 150 gpm capacity)	$ 405,000
Total cost of facilities	$ 405,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	142,000
Environmental and archaeology studies and mitigation	19,000
Land acquisition and surveying (1 acre)	11,000
Interest during construction (4% with 1% ROI for 1 year)	21,000
Total cost of project	$ 598,000

Table 5-33. Cost Estimate for Lynn County-other Groundwater Development Project (continued)

Item	Costs (Sept 2013 prices)
Annual costs	
Debt service (5.5% for 20 years)	$ 50,000
Intake, pipeline and pump station O&M (1% cost of facilities)	4,000
Pumping energy costs (19,461 kWh @ $.09/kWh)	2,000
Total annual costs	$ 56,000
Quantity of water (ac-ft/yr) [a]	100
Annual cost of water ($ per acre-foot)	$ 560
Annual cost of water ($ per 1,000 gal)	$ 1.72

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

Table 5-34. Cost Estimate for City of Muleshoe Groundwater Development Project

Item	Costs (Sept 2013 Prices)	
	Phase 1	Phase 2
Capital costs		
Supply wells (2 @ 400 feet deep, 300 gpm capacity)	$ 850,000	$ 850,000
Total cost of facilities	$ 850,000	$ 850,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	295,000	295,000
Environmental and archaeology studies and mitigation	19,000	19,000
Land acquisition and surveying (1 acre)	11,000	11,000
Interest during construction (4% with 1% ROI for 1 year)	42,000	42,000
Total cost of project	$ 1,217,000	$ 1,217,000
Annual Costs		
Debt service (5.5% for 20 years)	$ 102,000	$ 102,000
Intake, pipeline and pump station O&M (1% cost of facilities)	8,000	8,000
Pumping energy costs (94,991 kWh @ $.09/kWh)	9,000	
Pumping energy costs (63,327 kWh @ $.09/kWh)		6,000
Total annual costs	$ 119,000	$ 116,000
Quantity of water (ac-ft/yr) [a]	300	200
Annual cost of water ($ per acre-foot)	$ 397	$ 580
Annual cost of water ($ per 1,000 gal)	$ 1.22	$ 1.78

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

Table 5-35. Cost Estimate for Parmer County-other Groundwater Development Project

Item	Costs (Sept 2013 prices)
Capital costs	
Supply wells (2 @ 500 feet deep, 75 gpm capacity)	$ 419,000
Total cost of facilities	$ 419,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	147,000
Environmental and archaeology studies and mitigation	21,000
Land acquisition and surveying (1 acre)	13,000
Interest during construction (4% with 1% ROI for 1 year)	21,000
Total cost of project	$ 621,000
Annual costs	
Debt service (5.5% for 20 years)	$ 52,000
Intake, pipeline and pump station O&M (1% cost of facilities)	4,000
Pumping energy costs (22,915 kWh @ $.09/kWh)	2,000
Total annual costs	$ 58,000
Quantity of water (ac-ft/yr) [a]	50
Annual cost of water ($ per acre-foot)	$ 1,160
Annual cost of water ($ per 1,000 gal)	$ 3.56

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

Table 5-36. Cost Estimate for City of Plains Groundwater Development Project

Item	Costs (Sept 2013 prices)
Capital costs	
Supply wells (5 @ 500 feet deep, 150 gpm capacity)	$ 1,468,000
Water treatment plant (0.7 mgd)	2,000,000
Total cost of facilities	$ 3,468,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	1,214,000
Environmental and archaeology studies and mitigation	46,000
Land acquisition and surveying (3 acres)	28,000
Interest during construction (4% with 1% ROI for 1 year)	137,000
Total cost of project	$ 4,923,000

Table 5-36. Cost Estimate for City of Plains Groundwater Development Project (continued)

Item	Costs (Sept 2013 prices)
Annual costs	
Debt service (5.5% for 20 years)	$ 412,000
Intake, pipeline and pump station O&M (1% cost of facilities)	15,000
Water treatment plant O&M (2.5% cost of facilities)	532,000
Pumping energy costs (199,761 kWh @ $.09/kWh)	18,000
Total annual costs	$ 977,000
Quantity of water (ac-ft/yr) [a]	500
Annual cost of water ($ per acre-foot)	$ 1,954
Annual cost of water ($ per 1,000 gal)	$ 6.00

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

Table 5-37. Cost Estimate for City of Seagraves Groundwater Development Project

Item	Costs (Sept 2013 prices)
Capital costs	
Supply wells (2 @ 500 feet deep, 75 gpm capacity)	$ 419,000
Total cost of facilities	$ 419,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	147,000
Environmental and archaeology studies and mitigation	19,000
Land acquisition and surveying (1 acre)	11,000
Interest during construction (4% with 1% ROI for 1 year)	21,000
Total cost of project	$ 617,000
Annual costs	
Debt service (5.5% for 20 years)	$ 52,000
Intake, pipeline and pump station O&M (1% cost of facilities)	4,000
Pumping energy costs (19,388 kWh @ $.09/kWh)	2,000
Total annual costs	$ 58,000
Quantity of water (ac-ft/yr) [a]	50
Annual cost of water ($ per acre-foot)	$ 1,160
Annual cost of water ($ per 1,000 gal)	$ 3.56

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

Table 5-38. Cost Estimate for City of Seminole Groundwater Development Project

Item	Costs (Sept 2013 prices)
Capital costs	
Intake pump station (1.3 mgd)	$ 2,037,000
Supply wells (9 @ 500 feet deep, 150 gpm capacity)	2,701,000
Transmission pipeline (18-inch, 40 miles)	18,229,000
Total cost of facilities	$ 22,967,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	7,127,000
Environmental and archaeology studies and mitigation	1,180,000
Land acquisition and surveying (106 acres)	372,000
Interest during construction (4% with 1% ROI for 1 year)	1,108,000
Total cost of project	$ 32,754,000
Annual costs	
Debt service (5.5% for 20 years)	$ 2,741,000
Intake, pipeline and pump station O&M (1% cost of facilities)	260,000
Pumping energy costs (1,186,372 kWh @ $.09/kWh)	107,000
Total annual costs	$ 3,108,000
Quantity of water (ac-ft/yr) [a]	1,000
Annual cost of water ($ per acre-foot)	$ 3,107
Annual cost of water ($ per 1,000 gal)	$ 9.54

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

Table 5-39. Cost Estimate for City of Shallowater Groundwater Development Project

Item	Costs (Sept 2013 prices)
Capital costs	
Supply wells (4 @ 200 feet deep, 150 gpm capacity)	$ 902,000
Water treatment plant (0.5 mgd)	1,600,000
Total cost of facilities	$ 2,502,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	876,000
Environmental and archaeology studies and mitigation	62,000
Land acquisition and surveying (2 acres)	21,000
Interest during construction (4% with 1% ROI for 1 year)	122,000
Total cost of project	$ 3,583,000

Table 5-39. Cost Estimate for City of Shallowater Groundwater Development Project (continued)

Item	Costs (Sept 2013 prices)
Annual costs	
Debt service (5.5% for 20 years)	$ 300,000
Intake, pipeline and pump station O&M (1% cost of facilities)	9,000
Water treatment plant O&M (2.5% cost of facilities)	456,000
Pumping energy costs (156,060 kWh @ $.09/kWh)	14,000
Total annual costs	$ 779,000
Quantity of water (ac-ft/yr) [a]	400
Annual cost of water ($ per acre-foot)	$ 1,948
Annual cost of water ($ per 1,000 gal)	$ 5.98

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

Table 5-40. Cost Estimate for City of Silverton Groundwater Development Project

Item	Costs (Sept 2013 prices)
Capital costs	
Intake pump station (0.16 mgd)	$ 727,000
Supply wells (4 @ 700 feet deep, 37.5 gpm capacity)	821,000
Transmission pipelines (6-inch, 19 miles)	2,068,000
Total cost of facilities	$ 3,616,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	1,162,000
Environmental and archaeology studies and mitigation	629,000
Land acquisition and surveying (53 acres)	266,000
Interest during construction (4% with 1% ROI for 1 year)	199,000
Total cost of project	$ 5,872,000
Annual costs	
Debt service (5.5% for 20 years)	$ 491,000
Intake, pipeline and pump station O&M (1% cost of facilities)	47,000
Pumping energy costs (64,505 kWh @ $.09/kWh)	6,000
Total annual costs	$ 544,000
Quantity of water (ac-ft/yr) [a]	121
Annual cost of water ($ per acre-foot)	$ 4,496
Annual cost of water ($ per 1,000 gal)	$ 13.80

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

Table 5-41. Cost Estimate for City of Sundown Groundwater Development Project

Item	Costs (Sept 2013 prices)
Capital costs	
Supply wells (2 @ 300 feet deep, 150 gpm capacity)	$ 471,000
Total cost of facilities	$ 471,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	165,000
Environmental and archaeology studies and mitigation	19,000
Land acquisition and surveying (1 acre)	11,000
Interest during construction (4% with 1% ROI for 1 year)	24,000
Total cost of project	$ 690,000
Annual costs	
Debt service (5.5% for 20 years)	$ 58,000
Intake, pipeline and pump station O&M (1% cost of facilities)	5,000
Pumping energy costs (26,955 kWh @ $.09/kWh)	2,000
Total annual costs	$ 65,000
Quantity of water (ac-ft/yr) [a]	100
Annual cost of water ($ per acre-foot)	$ 650
Annual cost of water ($ per 1,000 gal)	$ 1.99

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

Table 5-42. Cost Estimate for City of Tulia Groundwater Redevelopment Project

Item	Costs (Sept 2013 prices)
Capital costs	
Supply wells (2 @ 300 feet deep, 375 gpm capacity)	$ 839,000
Water storage tank (1 @ 0.25 mg)	275,000
Water treatment plant (0.3 mgd)	27,000
Total cost of facilities	$ 1,141,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	399,000
Environmental and archaeology studies and mitigation	71,000
Land acquisition and surveying (3 acres)	63,000
Interest during construction (4% with 1% ROI for 1 year)	59,000
Total cost of project	$ 1,733,000

Table 5-42. Cost Estimate for City of Tulia Groundwater Redevelopment Project (continued)

Item	Costs (Sept 2013 prices)
Annual costs	
Debt service (5.5% for 20 years)	$ 145,000
Intake, pipeline and pump station O&M (1% cost of facilities)	11,000
Water treatment plant O&M (2.5% cost of facilities)	16,000
Pumping energy costs (54,934 kWh @ $.09/kWh)	5,000
Total annual costs	$ 177,000
Quantity of water (ac-ft/yr) [a]	200
Annual cost of water ($ per acre-foot)	$ 885
Annual cost of water ($ per 1,000 gal)	$ 2.72

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

Table 5-43. Cost Estimate for City of Wolfforth Groundwater Development Project

Item	Costs (Sept 2013 prices)
Capital costs	
Intake pump station (1.0 mgd)	$ 1,665,000
Supply wells (4 @ 200 feet deep, 300 gpm capacity)	1,334,000
Transmission pipelines (8-inch, 5.5 miles)	984,000
Water storage tank (1 @ 1.0 mg)	1,667,000
Total cost of facilities	$ 5,650,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	1,928,000
Environmental and archaeology studies and mitigation	321,000
Land acquisition and surveying (23 acres)	200,000
Interest during construction (4% with 1% ROI for 1 year)	284,000
Total cost of project	$ 8,383,000
Annual costs	
Debt service (5.5% for 20 years)	$ 702,000
Intake, pipeline and pump station O&M (1% cost of facilities)	81,000
Pumping energy costs (514,344 kWh @ $.09/kWh)	46,000
Total annual costs	$ 829,000
Quantity of water (ac-ft/yr) [a]	726
Annual cost of water ($ per acre-foot)	$ 1,142
Annual cost of water ($ per 1,000 gal)	$ 3.50

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

5.2.3.27 *Environmental Impacts*

Environmental impacts associated with this WMS for the 24 recommended projects have been quantified in the impact matrix (Table 5-5, Appendix 5E). Environmental issues are relatively minor for groundwater development strategies and would be associated primarily with the construction of pumping and conveyance facilities. Standard environmental clearances and permits to address protected wildlife habitat, protected plant communities, and/or cultural resources would be required for well locations and conveyance lines. These construction projects would require an environmental assessment, but barring the presence of any endangered species or significant cultural resources, they are not likely to pose any significant environmental impacts.

5.2.3.28 *Implementation*

Implementation issues associated with this strategy include those related to standard water development and construction projects. Although specialized technical expertise will be required, there are no unusual or particularly challenging technical impediments to developing groundwater resources. If a proposed water supply well site is located where the municipality does not possess the right to drill, the required water rights would have to be purchased by the municipality prior to development of the groundwater supply. Technical expertise will be required in the following areas:

- Legal assistance will be required to secure property for groundwater development.
- A professional hydrogeologist and/or engineer will be required to locate and design new municipal supply wells.
- An experienced driller will be required to install new supply wells.
- A professional engineer will be required to design and oversee construction of pumping and conveyance infrastructure.
- Skilled technicians will be required for operation of the well field and conveyance system of municipal water systems.

Funding sources for design and construction would need to be identified. Well sites and conveyance easements and right-of-ways would need to be identified and purchased or leased. Appropriate permitting would be required during the construction phase of the project.

Although not evaluated for all WUGs, groundwater development is a potential option for most communities, irrigated agriculture, and livestock water users. Additional sources of groundwater can help the region meet future demand projections and may be a viable and cost-effective source of new supply for some communities and irrigation and livestock water users. Section 5.10.11 provides BMPs for groundwater development at confined animal feeding operations.

5.2.4 Water Reuse

Texas Water Code §16.053(e)(5)(C) requires the consideration of water reuse as a feasible WMS by regional water planning groups. In the 2012 State Water Plan (TWDB, 2012), reuse accounted for 10 percent of the additional supply that is projected to be developed by 2060 through implementation of the recommended WMSs. In 2010, water reuse accounted for roughly 100,000 acre-feet of supply, and by 2060 this value is anticipated to increase to more than 900,000 ac ft/yr (TWDB, 2012, Chapter 7). Water reuse could potentially provide water for industrial, municipal, power generation, and irrigation WUGs.

To advance public awareness and understanding of water reuse in Texas, the TWDB collaborated with Alan Plummer Associates, Inc. to develop a three-part report that accomplished the following: (1) provided a comprehensive review of the history of reuse in Texas (TWDB and Plummer, 2011a), (2) defined the current knowledge and state of technology related to water reuse (Plummer, 2010), and (3) prioritized key research issues that will aid in advancing water reuse in Texas (TWDB and Plummer, 2011b). This work resulted in a detailed synthesis of both direct and indirect water reuse.

There are a wide range of potential potable and non-potable applications for reclaimed water, including public supply augmentation and a range of urban, industrial, or agricultural uses, along with environmental and recreational uses (Plummer, 2010). Two potable reuse projects are recommended in Region O, for the cities of Farwell and Wolfforth, and are discussed in the following subsections. Other reuse applications are discussed in the BMP section (Section 5.11).

5.2.4.1 City of Farwell Project

The City of Farwell is considering a direct reuse project that would further treat approximately 40 to 60 percent of their treated wastewater and then mix it with available groundwater to meet potable water standards. The City of Farwell strategy consists of constructing a new treatment plant and installing a deep injection well near the existing wastewater treatment plant; the project would be operational in 2020. The primary facilities incorporated into the planning-level cost estimate include:

- Reverse osmosis (RO) water treatment plant and pump station
- One injection well for reject concentrate
- 8,000 feet of main water line to the distribution system
- Two 50,000-gallon tanks (raw and treated water)
- One 150,000-gallon tank (concentrate)

5.2.4.2 City of Wolfforth Project

The City of Wolfforth is considering a direct reuse project to provide approximately 0.5 million gallons per day (mgd) of treated reuse water that can be mixed with available groundwater to meet potable water standards. The City of Wolfforth strategy consists of a new treatment plant and installation of several deep injection wells near their existing wastewater treatment plant. Operations are expected to begin in 2030. The primary facilities incorporated into the planning-level cost estimate include:

- RO water treatment plant and pump station
- Six injection wells for reject concentrate
- 15,000 feet of main water line to the distribution system
- Two 500,000-gallon tanks (raw and treated water)
- One 2,000,000-gallon tank (concentrate)

5.2.4.3 Quantity and Reliability of Water

The strategy is designed to provide the following quantity of potable water supply, with an estimated 70 percent recovery rate (RO efficiency) from the treated wastewater:

- The City of Farwell will have 64 ac-ft/yr potable supply
- The City of Wolfforth will have 560 ac-ft/yr potable supply

Approximately 30 percent of reuse water will be lost to concentrate and disposed of through the deep injection wells. Both water reuse facilities are designed with a peaking factor of 2 to account for peak demand and any potential water losses in addition to those incurred during water treatment. Since the source water is wastewater effluent, the volume is reliable and relatively stable throughout the year.

5.2.4.4 Financial Costs

The total production cost of desalinated water includes the cost of capital or debt service and the O&M costs. O&M costs are a function of chemical, power, equipment replacement, and labor costs. Estimated costs for the two proposed reuse strategies were prepared using the TWDB's UCM. The cost summary for the City of Farwell project is provided in Table 5-44 and the cost summary for the City of Wolfforth project is provided in Table 5-45.

Table 5-44. Cost Estimate for City of Farwell Potable Reuse Project

Item	Costs (Sept 2013 prices)
Capital costs	
Intake pump station (0.1 mgd)	$ 355,000
Water treatment plant (0.2 mgd)	1,190,000
Injection well (2,500 feet deep, 50 gpm capacity)	1,005,000
Water storage tanks (2 @ 0.1 mg, 1 @ 0.25 mg)	661,000
Transmission pipelines (6-inch, 2 miles)	196,000
Total cost of facilities	$ 3,407,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	1,183,000
Environmental and archaeology studies and mitigation	220,000
Land acquisition and surveying (13 acres)	210,000
Interest during construction (4% with 1% ROI for 1 yr)	176,000
Total cost of project	$ 5,196,000
Annual costs	
Debt service (5.5% for 20 years)	$ 435,000
Intake, pipeline and pump station O&M (1% cost of facilities)	25,000
Water treatment plant O&M (2.5% cost of facilities)	221,000

Table 5-44. Cost Estimate for City of Farwell Potable Reuse Project (continued)

Item	Costs (Sept 2013 prices)
Annual costs (cont.)	
Pumping energy costs (7,806 kWh @ $.09/kWh)	1,000
Purchase of water	0
Total annual costs	$ 682,000
Quantity of water (ac-ft/yr)	64
Annual cost of water ($ per acre-foot)	$ 10,656
Annual cost of water ($ per 1,000 gal)	$ 32.70

ROI = Return on investment
O&M = Operation and maintenance

Table 5-45. Cost Estimate for City of Wolfforth Potable Reuse Project

Item	Costs (Sept 2013 prices)
Capital costs	
Intake pump station (1 mgd)	$ 1,169,000
Water treatment plant (1.4 mgd)	5,010,000
Injection wells (6 @ 2,250 feet deep, 50 gpm capacity)	6,032,000
Water storage tanks (2 @ 0.5 mg, 1 @ 2.0 mg)	2,061,000
Transmission pipelines (8-inch, 3 miles)	491,000
Total cost of facilities	$ 14,763,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	5,142,000
Environmental and archaeology studies and mitigation	263,000
Land acquisition and surveying (20 acres)	226,000
Interest during construction (4% with 1% ROI for 2 yrs)	1,428,000
Total cost of project	$ 21,822,000
Annual costs	
Debt service (5.5% for 20 years)	$ 1,826,000
Intake, pipeline and pump station O&M (1% cost of facilities)	103,000
Water treatment plant O&M (2.5% cost of facilities)	930,000
Pumping energy costs (102,188 kWh @ $.09/kWh)	9,000
Purchase of water	0
Total annual costs	$ 2,868,000
Quantity of water (ac-ft/yr)	560
Annual cost of water ($ per acre-foot)	$ 5,121
Annual cost of water ($ per 1,000 gal)	$ 15.71

ROI = Return on investment
O&M = Operation and maintenance

5.2.4.5 Environmental Impacts

Environmental impacts associated with this WMS for the two recommended projects have been quantified in the impact matrix (Table 5-5, Appendix 5E). A major drawback and implementation concern to reuse is related to the perception of water quality issues. A thorough review of federal and state water quality guidelines that govern water reuse, along with a state of the science review of emerging contaminants of concern is included in the second of the three reports by Alan Plummer Associates, Inc. (Plummer, 2010). Water quality requirements for reuse are in place for the protection of public health and the environment, and are a function of the potential degree for public contact.

The conceptual design for both of these projects will use a deep well for injection and disposal of the concentrate. Therefore, minimal environmental impact is expected from these projects based on properly designed and maintained facilities.

5.2.4.6 Implementation

Implementation of water reuse would require evaluation of supply from municipal wastewater treatment facilities, evaluation of downstream water rights, technical engineering design of treatment systems and conveyance, and public education and communication. Reuse applications are more widely accepted and applied throughout both arid and semiarid regions of the U.S., so the technical knowledge to implement reuse projects is readily available. Physical infrastructure is similar to that of potable water; however, an entirely new, separate treatment and conveyance system is required. Similar projects may be potential options for other municipalities in Region O that are currently using land application for their treated wastewater.

Funding for reuse projects is generally less available than for other water projects, with federal and state funding programs generally focusing on potable water or wastewater treatment projects.

5.2.5 Brackish Groundwater Desalination

Desalination of brackish groundwater is an established strategy in the State of Texas for meeting increasing demands and is increasingly cost-effective. To encourage and facilitate the development of brackish groundwater in the state, the TWDB proposed the Brackish Groundwater Initiative in 2004 with a goal to develop models that illustrate the use of innovative, cost-effective technologies and offer practical solutions to implementation. With financial assistance from the Texas Legislature, the TWDB has to date funded 12 brackish groundwater desalination demonstration projects for a total amount of about $2.6 million.

There are 101 permitted water desalination facilities in the state, ranging from small units rated at 2,000 gallons per day (gpd) supplying service stations to large municipal facilities. These permitted facilities lie in 49 counties across Texas.

Of the 101 permitted facilities, 46 are municipal brackish water desalination facilities, producing about 123 mgd (137,760 ac-ft/yr), of which 73 mgd is brackish groundwater desalination and 50 mgd is brackish surface water desalination. The majority (34) of the municipal facilities use brackish groundwater as a source. El Paso Water Utilities' Kay Bailey Hutchison Desalination Facility has the highest design capacity in the state (27.5 mgd, or 30,800 ac-ft/yr). Reverse osmosis (RO) is the predominant desalination technology used in Texas; 44 of 45 desalination facilities use RO technology.

5.2.5.1 Background

In Region O, brackish groundwater is present in two major aquifers (those that supply large quantities of water over large areas of the state), the Ogallala and Seymour, and three minor aquifers (those that supply relatively small quantities of water over large areas or supply larger quantities of water over small areas), the Dockum, Edwards-Trinity (High Plains), and Whitehorse-Artesia. The Dockum aquifer is being considered as a brackish groundwater source for two desalination projects in Region O, for the Abernathy and Seminole municipal WUGs.

The Dockum aquifer is a minor aquifer found in the northwest part of the state and underlies the majority of counties in Region O. It consists of gravel, sandstone, siltstone, mudstone, shale, and conglomerate. Groundwater located in the sandstone and conglomerate units is recoverable, the highest yields coming from the coarsest grain deposits located at the middle and base of the group. Typically, the water-bearing sandstones are locally referred to as the Santa Rosa Aquifer. The water quality in the aquifer is generally poor and the water is very hard. Naturally occurring radioactivity from uranium present within the aquifer has resulted in gross alpha radiation in excess of the state's primary drinking water standard. Radium-226 and radium-228 also occur in amounts above acceptable standards. Groundwater from the aquifer is used for irrigation, municipal water supply, and oil field water flooding operations, particularly in the Southern High Plains. Water level declines and rises have occurred in different areas of the aquifer.

A field demonstration project in Gaines County conducted by researchers from the Texas Tech University (TTU), National Wind Institute (NWI), and Water Resources Center (WRC) to treat brackish groundwater was recently completed for the City of Seminole (Rainwater et al., 2015). The field demonstration project included a 1,800-foot-deep well in the Dockum Aquifer and an RO system that operated between April 2013 and August 2014. The final report on the project provided the following conclusions regarding desalination production wells:

- Although local geologic conditions can be estimated from study of existing well log databases, site-specific drilling and geophysical testing is recommended.
- Wells should target the upper portions of the Dockum Aquifer if possible, as the aquifer appears to increase in salinity with depth.
- Well production rate impacts the selection of potential pretreatment methods.

Information gathered during this demonstration provided region-specific data that was used to plan for a larger scale brackish groundwater desalination strategy for the cities of Abernathy and Seminole.

5.2.5.2 Treatment Processes

Treatment of brackish groundwater for the proposed projects will include several stages: pre-treatment, desalination, post-treatment and blending, and concentrate disposal. Each of these stages is discussed below.

5.2.5.2.1 Pretreatment. Pretreatment prepares the water for the membranes. It is used to remove suspended matter and condition the water by adding anti-scalants and lowering the pH, which improves RO membrane performance and operational life. Typically, pretreatment consists of chemical additions, such as acidification and anti-scalants, and cartridge filtration. Depending on the source water quality, different levels of pretreatment are required.

5.2.5.2.2 Desalination. Osmosis refers to the natural tendency of water to flow through a semipermeable membrane and dilute liquids with higher salinity. This tendency is measured in terms of the osmotic pressure. The RO process uses pressure to overcome the osmotic pressure and to reverse the flow through a membrane; the membrane prevents the flow of the dissolved solids while allowing the flow of purified water (permeate). This also results in a stream of water (concentrate) that retains all of the salt from the feed water but in a smaller volume. Typical RO operating pressures range from 200 to 450 pounds per square inch (psi) for brackish groundwater plants. The higher the salt concentration in the feed water, the higher the pressure required to force water passage through the membranes (and the higher the energy cost).

A recent technology improvement to RO operations is energy recovery. The concentrate stream exits the membrane vessels with a high residual pressure. This energy is wasted if the concentrate is discharged directly to a drain. Energy recovery turbines can recapture a portion of this energy by extracting the hydraulic energy of the concentrate stream to produce a pressure boost in the membrane feed stream. Energy recovery systems reduce the power and cost necessary to operate the high pressure feed pump, and the liquid concentrate is finally discharged at atmospheric pressure.

5.2.5.2.3 Post-Treatment. Post-treatment processes typically include degasification for removal of dissolved gasses, pH adjustment, stabilization, re-mineralization, and disinfection. The permeate derived from the membrane process is typically mixed with some untreated raw water. This process restores some minerals to the water, thus enhancing taste, reducing the potential for treated water to damage metal elements within the distribution system, and increasing the total production capacity of the plant.

Desalinated water is generally blended with another source water to meet demands. That blending may occur at the treatment facility, in a storage tank, or in the distribution system. It is critical to consider the compatibility of finished water sources during planning and design phases to ensure that existing and planned finished waters are compatible. Water stability and corrosivity are two factors that should be considered when planning to blend water from various sources.

5.2.5.2.4 Concentrate Management and Disposal. Concentrate volumes for disposal will depend on the recovery rate of the desalination system. Actual recovery rates range from 80 percent for slightly brackish water (total dissolved solids [TDS] of 1,000 to 3,000 mg/L), to 40 percent for seawater (32,000 mg/L TDS), and have been estimated at 70 percent for the two proposed projects. Deep well injection is the planned disposal option for both projects. The target zone for brine disposal through deep well injection is about 2,000 to 2,500 feet deep, in the Permian aquifers beneath the Dockum Formation.

5.2.5.3 City of Abernathy Project

The City of Abernathy strategy includes installation of brackish wells near the municipal airport and construction of a treatment plant. The primary facilities incorporated into the planning-level cost estimate include:

- 4 supply wells (3 active, 1 contingency)
  - 1,000-foot spacing
  - 50-gallon per minute (gpm) average flow rate, 100-gpm peak
  - Estimated drawdown of 150 feet
  - Estimated TDS 12,500 mg/L
- 1 injection well
- 5,000 feet of well field piping to treatment plant
- RO water treatment plant and pump station
- 30,000 feet of main water line to distribution system
- Two 250,000-gallon tanks (for raw and treated water)
- One 1,000,000-gallon tank (concentrate)

5.2.5.4 City of Seminole Project

The City of Seminole strategy includes installation of brackish wells near the demonstration test well and construction of a treatment plant. The primary facilities incorporated into the planning-level cost estimate include:

- 11 supply wells (9 active, 2 contingency)
  - 1,000-foot spacing
  - 50-gpm average flow rate, 100-gpm peak
  - Estimated drawdown of 150 feet
  - Estimated TDS 7,500 mg/L
- 6 injection wells
- 11,500 feet of well field piping to treatment plant
- RO water treatment plant and pump station
- 20,000 feet of main water line to distribution system
- Two 500,000-gallon tanks (for raw and treated water)
- One 2,000,000-gallon tank (concentrate)

5.2.5.5 Quantity and Reliability of Water

Desalination of brackish groundwater is attractive in that it is a drought-proof source of supply. The strategy is designed to provide the following quantity of potable water supply, with an estimated 70 percent recovery rate (RO efficiency) from the raw brackish water source:

- The City of Abernathy will have 150 ac-ft/yr (0.13 mgd) potable supply from 214 ac-ft/yr (0.19 mgd) pumped from Dockum Aquifer, with 64 ac-ft/yr lost to concentrate generation.
- The City of Seminole will have 500 ac-ft/yr (0.45 mgd) potable supply from 714 ac-ft/yr (0.64 mgd) pumped from Dockum Aquifer, with 214 ac-ft/yr lost to concentrate generation.

Both desalination facilities are designed with a peaking factor of 2 to account for peak demand and any potential water losses in addition to those incurred during water treatment.

5.2.5.6 Financial Costs

The total production cost of desalinated water includes the cost of capital or debt service and the O&M costs. O&M costs are a function of chemical, power, equipment replacement, and labor costs. Estimated costs for the two proposed desalination projects were prepared using the TWDB's UCM. The cost summary for each project is provided in Tables 5-46 and 5-47.

Table 5-46. Cost Estimate for City of Abernathy Groundwater Desalination Project

Item	Costs (Sept 2013 prices)
Capital costs	
Water treatment plant (0.4 mgd)	$ 2,151,000
Supply wells (4 @ 1,400 feet deep, 100 gpm capacity) Injection well (1 @ 2,000 feet deep, 50 gpm capacity)	3,443,000
Water storage tanks (2 @ 0.25 mg, 1 @ 1.0 mg)	1,249,000
Total cost of facilities	$ 6,843,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	2,395,000
Environmental and archaeology studies and mitigation	108,000
Land acquisition and surveying (7 acres)	93,000
Interest during construction (4% with 1% ROI for 2 years)	661,000
Total cost of project	$ 10,100,000
Annual costs	
Debt service (5.5% for 20 years)	$ 845,000
Intake, pipeline and pump station O&M (1% cost of facilities)	40,000
Water treatment plant O&M (2.5% cost of facilities)	490,000
Pumping energy costs (145,562 kWh @ $.09/kWh)	13,000
Purchase of water	0
Total annual costs	$ 1,388,000
Quantity of water (ac-ft/yr)	150
Annual cost of water ($ per acre-foot)	$ 9,253
Annual cost of water ($ per 1,000 gal)	$ 28.39

ROI = Return on investment
O&M = Operation and maintenance

Table 5-47. Cost Estimate for City of Seminole Groundwater Desalination Project

Item	Costs (Sept 2013 prices)
Capital costs	
Intake pump station (0.89 mgd)	$ 1,118,000
Water treatment plant (1.3 mgd)	4,968,000
Supply wells (11 @ 1,800 feet deep, 100 gpm capacity) Injection wells (6 @ 2,500 feet deep, 50 gpm capacity)	12,585,000
Water storage tanks (2 @ 0.5 mg, 1 @ 2.0 mg)	2,061,000
Transmission pipelines (8-inch, 4 miles)	632,000
Total cost of facilities	$ 21,364,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	7,446,000
Environmental and archaeology studies and mitigation	400,000
Land acquisition and surveying (7 acres)	296,000
Interest during construction (4% with 1% ROI for 2 years)	2,066,000
Total cost of project	$ 31,572,000
Annual costs	
Debt service (5.5% for 20 years)	$ 2,642,000
Intake, pipeline and pump station O&M (1% cost of facilities)	168,000
Water treatment plant O&M (2.5% cost of facilities)	1,042,000
Pumping energy costs (651,706 kWh @ $.09/kWh)	59,000
Purchase of water	0
Total annual costs	$ 3,911,000
Quantity of water (ac-ft/yr)	500
Annual cost of water ($ per acre-foot)	$ 7,822
Annual cost of water ($ per 1,000 gal)	$ 24.00

ROI = Return on investment
O&M = Operation and maintenance

5.2.5.7 Environmental Impacts

Environmental impacts associated with this strategy have been quantified in the impact matrix (Appendix 5E) and are summarized in Table 5-5. Brackish groundwater desalination would likely result in site-specific environmental impacts. However, the footprint for groundwater wells is small when compared to other supply sources, and desalination facilities are typically smaller than infrastructure required for other conventional water supply alternatives.

The environmental impacts of infrastructure associated with transmission and distribution of supply water and treated water will depend on the specific project, but in general, pipeline construction requires a relatively small footprint and leaves few permanent surface features, and pipelines can be routed to avoid sensitive areas.

5.2.5.8 Implementation

The primary challenges with implementation of desalination are permitting, funding of this relatively high-cost supply option, high cost of operation due to high energy requirements, and concentrate disposal from membrane systems.

5.2.5.8.1 Permitting. Three project components with significant permitting activities are (1) developing the groundwater well field, (2) constructing the treatment facility, and (3) disposing of the concentrate.

Permitting requirements for developing groundwater wells in Texas depend largely on whether the potential well field is located within the jurisdictional boundary of a groundwater conservation district (GCD). The City of Abernathy project is located in the High Plains UWCD No. 1, and the City of Seminole project is located in the Llano Estacado UWCD; thus well registration and production permits will likely be required for both projects. Permitting for collection and conveyance can include federal and state approval of alignment with regard to protected habitats or cultural resources, federal permits for crossing jurisdictional or navigable waters of the U.S., and right-of-way approvals from affected land owners or other easement-holding utilities.

Permits required for brackish water treatment plants are similar to those for conventional treatment plants; local building codes, construction and erosion control regulations, fuel storage tanks, and site clearance restrictions will apply.

Concentrate is considered by TCEQ to be an industrial waste. Permit requirements depend on the method of concentrate disposal; for these projects, injections wells are planned. Injection wells in Texas are classified into five different categories, depending on the type of waste to be disposed of. An injection well for a full-scale brackish water desalination plant would likely be permitted as a Class I non-hazardous well, which is required for most industrial wastewaters.

The permitting process for such a well typically takes longer than a year and requires extensive information. Operating requirements require continuous monitoring. The technical report that forms part of the permit application involves detailed discussion of the geology, well construction, reservoir mechanics, area of review, wastes and waste management, waste compatibility, and pre-injection units. Various sections of the report must be completed and sealed by a Texas licensed professional geoscientist and a Texas licensed professional engineer.

Membrane filtration applications in Texas are considered "non-conventional, innovative, or alternative" water treatment technologies, for which TCEQ rules require that a licensed professional engineer provide pilot test data or data collected from similar full-scale operations to demonstrate that the proposed treatment technique will produce finished water that meets drinking water standards (NRS, 2008).

5.2.5.8.2 Funding. In terms of funding, desalination treatment facilities lend themselves to modular expansions attractive for matching capital investments to water demands. Because the equipment consists mainly of hardware (as opposed to tanks or basins), it allows the ability to incorporate technology innovations such as new membrane technology or improved energy recovery devices.

In addition, this type of treatment allows siting flexibility. Treatment may be located closer to the final point of use, minimizing treated water transmission costs.

TWDB has a history of partnering with communities to develop major water supply projects. Although funding is limited in total amount, there are a number of state programs that apply to development of alternative sources of water supply. The *Guidance Manual for Brackish Groundwater Desalination in Texas* (NRS, 2008) includes a table comparing state and federal financial programs suitable for brackish water desalination projects.

5.2.5.8.3 Cost of Operation. A significant challenge is the ongoing annual cost of operation, in particular power costs, which may account for 40 to 60 percent of operational costs. During planning and design of facilities, the following options should be considered: incorporation of renewable energy sources, energy recovery in the treatment process, and operation of the facility during off-peak hours when energy charges are lower.

5.2.5.8.4 Concentrate Disposal. The complicated issues surrounding disposal will affect the project timeline and cost. Permitting of a deep injection well is expected to take at least a year.

5.2.5.8.5 Other Implementation Issues. One of the most important planning elements is accurately characterizing the groundwater source to be used; however, data and information on brackish aquifers are sparse. The petroleum industry can be a source of data, as this industry has been drilling in brackish water zones since its inception. A phased approach is recommended; as new information is developed, the scope of additional work can be tailored to address project needs and minimize risk. Phases of the implementation process may include preliminary (desktop) investigations, test drilling and pilot testing, and permitting, prior to full design and construction.

The City of Abernathy is planning to install a test well in the Dockum Aquifer during 2015, and a field demonstration project was recently completed for the City of Seminole (Rainwater et al., 2015). The City of Seminole has also recently entered into a 40-year water supply agreement with BW Primoris. The agreement calls for the construction of an RO treatment facility (or facilities) to be owned and operated by BW Primoris, which will be used to provide the City's water supply. The source water is the City of Seminole's wells and potentially additional wells installed in deeper aquifers such as the Dockum Aquifer. The treated water would be delivered to the city's existing water supply infrastructure (BW Primoris, 2015). Several other municipalities in Region O have reported being approached by BW Primoris and receiving similar offers to treat their water. As of September 2015, the City of Seminole is the only known municipal customer of BW Primoris within Region O.

5.2.6 Infrastructure to Serve Areas Surrounding Lake Alan Henry

Lake Alan Henry was constructed by and is owned by the City of Lubbock and is one of several water sources for the City. The lake is surrounded by communities of both permanent and seasonal residents, including recreational users. The South Garza Water Supply provides water to the Northridge Development and to the City's Sam Wahl recreation area. South Garza

Water Supply infrastructure installed in 2010 consists of a connection to the Lubbock raw water pipeline, a pump station near the Lubbock raw water pump station, a water treatment plant with a 144,000-gpd capacity, approximately 3½ miles of 10- and 6-inch piping, a 100,000-gallon water storage tank, and a booster pump station with two 250-gpm pumps to pump water to customers. Distribution piping is all 6 inches in diameter and includes fire hydrants. The current water demand served by this system is 25 ac-ft/yr.

This strategy will provide a reliable, regional water source to the existing communities around the lake, many of which are served by wells that are low, unreliable producers and provide aesthetically displeasing water quality.

5.2.6.1 Description of Option

Under this strategy, the existing South Garza Water Supply system will be expanded and extended to serve the communities surrounding the lake. Because the condition and design standards of the existing South Garza facilities are unknown, it assumed that new treatment, pumping, and storage facilities must be built. It is further assumed that the existing 6-inch piping can continue to be used and can be extended to serve additional development on the north side of the lake.

The facilities to be constructed include:

- Raw water intake and pump station with 500,000-gpd capacity
- A 0.5-mgd water treatment plant
- A 1-million gallon water storage tank at the water treatment plant
- Extension of the distribution piping from Northridge Development to serve the following areas:
  - Community of Justiceburg
  - Justiceburg Recreational Vehicle (RV) Park
  - Grubs RV Park
  - North Ridge RV Park

- Installation of distribution piping from the treated water ground storage tank at the water treatment plant, across the Brazos River downstream of the dam, to serve the following areas:
  - Rio Brazos Development
  - West Rio Brazos Development/Oak Canyon Estates
  - Rio Brazos RV Park
  - Community of Polar

5.2.6.2 Quantity of Water

Table 5-48 tabulates the expected water demand from the communities to be served by the water system expansion. Although many of the water users will be seasonal, due to the recreational uses in the area, the table is based on a year-round population in order to present the most conservative estimation of yearly demand.

Table 5-48. Population and Demand Projections for South Garza Water Supply System

Name	Projected Maximum Number of Connections	Population for Maximum Connections	Per Capita Water Use (gpcd)	Water Demand (ac-ft/yr)
North Side of Lake				
Justiceburg	50	150	118	20
Justiceburg RV Park	100	300	45	15
Grubs RV Park	100	300	45	15
North Ridge RV Park	120	360	45	18
North Ridge Development	100	300	118	40
Subtotal	470	1,410	—	108
South Side of Lake				
Rio Brazos Development	200	600	118	79
West Rio Brazos/Oak Creek Estates	120	360	118	48
Rio Brazos RV Park	200	600	45	30
Polar Community	10	30	118	4
Subtotal	530	1,590	—	161
Total	1,000	3,000	—	269 [b]
			Average use (mgd)	0.25
			Peak day use [a] (mgd)	0.50

Source: 2010 Llano Estacado regional water plan (LERWPG, 2010)
[a] Peaking factor (PD/AD) = 2.0
[b] Value was rounded to 270 ac-ft/yr for this strategy

gpcd = Gallons per capita per day
ac-ft/yr = Acre-feet per year
mgd = Million gallons per day

Water losses associated with this strategy are expected to be minimal, 10 percent or less.

5.2.6.3 Reliability of Water

Water Use Permit No. 4146, issued to the City of Lubbock, allows for the diversion of 35,000 ac-ft/yr. Based on the WAM Run3 results developed for this regional water plan, the firm yield available from Lake Alan Henry varies from 20,600 ac-ft/yr in 2020, decreasing to 18,720 ac-ft/yr in 2070 (Table 3-8). Currently, the City's infrastructure allows delivery of 8,000 ac-ft/yr to Lubbock. The South Garza Water Supply is developing a water system, using 540 ac-ft/yr of water under contract with the City of Lubbock. This includes contracts that the City of Lubbock has with the Lake Alan Henry Water District (520 ac-ft/yr) and the South Garza Water Supply (20 ac-ft/yr). Both agreements expire on December 31, 2029. The current water demand served by this water system is 25 ac-ft/yr, and the proposed expansion will increase water demands by 270 ac-ft/yr. As this proposed strategy will not exceed the volume of water allowed under the existing contracts with the City of Lubbock, the 270 ac-ft/yr needed to support the Lake Alan Henry communities is available for that use.

5.2.6.4 Financial Costs

Estimated costs were prepared for the 2010 Regional Water Plan using the TWDB's UCM. These costs have been updated to reflect infrastructure that has been built and to project costs from 2008 to 2013 costs. The cost summary is provided in Table 5-49.

The following assumptions were used to develop the cost estimate for this strategy:

- Water can be withdrawn from Lake Alan Henry to meet the total anticipated demand annual demand of 270 ac-ft/yr.
- The cost for raw water from Lake Alan Henry is $590 per acre-foot.
- Land acquisition for pipelines assumes a 20 foot right-of-way; land acquisition for facilities is based on 2 acres for each pump station, 0.5 acre for the water treatment plan, and 2 acres for the water storage tank.
- Cost of land is $1,000 per acre.
- Pipelines are a minimum 6 inches in diameter to provide fire flow.

Table 5-49. Cost Estimate for South Garza Water Supply System Expansion

Item	Estimated Cost ($)
Capital Costs	
Intake and pump station (0.5 mgd)	$ 534,000
Water treatment plant	1,094,000
Transmission pump stations	737,000
Water storage tank (1 mg)	990,000
Transmission pipelines (6-inch, 14 miles)	775,000
Highway and stream crossings	165,000
Total cost of facilities	$ 4,295,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	1,456,000
Environmental studies and permitting (100% of land costs)	51,000
Land and surveying for pipelines (34 acres @ $275 per acre)	37,400
Land for treatment plant, pump stations and storage tank (17.5 acres)	19,000
Interest during construction (4% with 1% ROI for 2 years)	407,000
Total cost of project	$ 7,672,000
Annual costs	
Debt service (5.5% for 20 years)	$ 642,000
Intake, pipeline and pump station O&M	54,000
Water treatment plant O&M	157,290
Cost of raw water (270 ac-ft/yr @ $590 per acre-foot)	159,300
Pumping energy costs (310,285 kWh @ $.09/kWh)	28,000
Total annual cost	$ 1,047,300
Quantity of water (ac-ft/yr)	270
Annual cost of water ($ per acre-foot)	$ 3,879
Annual cost of water ($ per 1,000 gal)	$ 11.90

ROI = Return on investment
O&M = Operation and maintenance

- The costs are for infrastructure to provide water to the communities identified; cost of water distribution systems, meters, fire hydrants, and other appurtenances within these communities are not included.
- Engineering, legal costs, and contingency fees are calculated as 30 percent of the construction cost for pipelines and 35 percent for all other facilities.
- Environmental and archaeological studies and mitigation are calculated at 100 percent of land costs (including easements).

- Interest during construction is calculated at an annual rate of 4 percent, with a 1 percent rate of return on fund balances during construction, for a period of two years.
- Debt service is calculated based on a 5.5 percent annual rate over 20 years.
- Pumping equipment is assumed to be down 5 percent of the time.
- Power costs are assumed to be $0.09 per kilowatt-hour (kWh)

The total project construction cost for this strategy was estimated at $7.672 million. Annual costs were calculated at $1,047,300. For an annual delivery of 270 acre-feet of treated water, the calculated cost per acre-foot is $3,879, or $11.90 per 1,000 gallons.

5.2.6.5 Environmental Impacts and Limitations

Environmental impacts associated with this strategy have been quantified in the impact matrix (Table 5-5, Appendix 5E) and should be minimal. The majority of pipeline length will be constructed within established roadway corridors, and the facility improvements identified will be at existing sites, with some expansion on property to be acquired under this project. The installation of water infrastructure should be planned so that sensitive habitats, cultural resources, and other environmentally sensitive areas are avoided. In particular, the Oak Canyon area, south of the lake, was reported by South Garza Water System to be subject to special mitigation requirements that were a condition of the building of the lake. No further information has been obtained on these requirements.

5.2.6.6 Implementation

No significant obstacles to this strategy have been identified. The following items must be addressed for implementation.

- Implementation of this strategy will require acquisition of additional land for facility expansions and easements for pipeline installation.
- The existing agreement between South Garza Water Supply and the City of Lubbock will need to be renewed on a regular basis (currently a 20-year term).
- TCEQ will need to approve design modifications to the existing system.
- Withdrawals from Lake Alan Henry are subject to the contract with the City of Lubbock.

- Environmental and cultural resource studies will need to be performed to identify any mitigation needed during construction.

5.3 Recommended Water Conservation Strategies for Irrigation WUGs

5.3.1 Background

The USDA Farm Service Agency crop acreage data indicate that 10.2 million acres within Region O were in production in 2014 (USDA FSA, 2015), including 2.7 million irrigated acres (26 percent of the total acres in production) and 7.5 million acres under dryland cultivation. Of the total 10.2 million acres in production in 2014, the crop types included cotton (22 percent), wheat (10 percent), sorghum (9 percent), corn (4 percent), and peanuts (1 percent) (Table 5-50). Based on data from the High Plains UWCD, which includes all or part of 13 counties in Region O, there were 12,971 center pivot systems irrigating approximately 1.74 million acres within the High Plains UWCD in 2012 (Figure 5-1; HPUWCD, 2012).

Many established agencies, organizations, and programs are in place to address public education/irrigator education in the Region O area:

- The Texas A&M AgriLife Extension Service is a unique education agency with a statewide network of professional educators, trained volunteers, and county offices; the extension service strives to be the premier provider of relevant continuing education, with goals of ensuring sustainable agriculture and protecting the natural resources of the state, while supporting economic development.

- The TWDB's Agricultural Water Conservation Grants Program offers grants to state agencies and political subdivisions for technical assistance, demonstration, technology transfer, education, and metering projects that conserve water.

- The High Plains UWCD has an established water conservation program and publishes a magazine, *Conservation Connect,* that is devoted to water conservation and highlights conservation measures in the region. This publication can be used as a reference by other water conservation districts in Region O.

Table 5-50. Acres by Crop Type
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County	Crop [a]	Crop Type	Irrigation Practice [b]	Planted Acres: By Crop Type and Irrigation Practice	Planted Acres: By Crop
Bailey	Corn	Blue	I	137.96	12,955.80
		White	I	246.00	
		Yellow	I	11,911.04	
		Yellow	N	660.80	
	Cotton-upland	—	I	18,991.71	56,841.10
			N	37,849.39	
	Peanuts	Valencia	I	283.93	283.93
	Sorghum	Grain	I	8,284.28	44,162.13
			N	24,444.09	
	Sorghum-dual purpose	—	I	1,767.14	
			N	164.83	
	Sorghum forage	Sudex	I	2,642.39	
			N	6,859.40	
	Wheat	Hard red winter	I	13,494.56	30,648.75
			N	17,154.19	
	Other	—	I	24,682.70	280,393.88
			N	255,711.18	
				Total irrigated	82,441.71
				Total non-irrigated	342,843.88
				County total	425,285.59
Briscoe	Corn	Yellow	I	772.30	772.30
	Cotton-upland	—	I	10,642.18	23,213.60
			N	12,571.42	
	Peanuts	Southwest Spanish	I	186.00	186.00
	Sorghum	Grain	I	5,365.81	21,299.25
			N	9,264.29	
	Sorghum-dual purpose	—	I	112.00	
			N	960.97	
	Sorghum forage	Cane	I	100.78	
			N	4,720.78	
		Sudex	I	105.00	
			N	669.62	

Source: USDA FSA, 2015

— = Not applicable

[a] Primary crops grown within the region (cotton, corn, sorghum, wheat, and peanuts). Crops included in the other category are alfalfa, triticale, rye, sunflowers, barley, soybeans, sesame, millet, oats, canola, and many types of fruits and vegetables.

[b] I = irrigated, N = not irrigated

Table 5-50. Acres by Crop Type
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County	Crop [a]	Crop Type	Irrigation Practice [b]	Planted Acres: By Crop Type and Irrigation Practice	Planted Acres: By Crop
Briscoe (cont.)	Wheat	Hard red winter	I	1,565.40	21,276.05
			N	19,710.65	
	Other	—	I	990.55	295,552.51
			N	294,561.96	
				Total irrigated	19,840.02
				Total non-irrigated	342,459.69
				County total	362,299.71
Castro	Corn	Sweet	I	0.30	113,126.73
		White	I	9,759.10	
		Yellow	I	101,936.41	
			N	1,430.92	
	Cotton-upland	—	I	12,804.19	14,609.26
			N	1,805.07	
	Peanuts	—	—	—	None reported
	Sorghum forage	Cane, sudex, sweet	I	3,518.15	86,326.14
			N	6,307.93	
	Sorghum	Grain, hybrid	I	26,092.38	
		Grain	N	19,621.08	
	Sorghum-dual purpose	—	I	25,783.35	
			N	5,003.25	
	Wheat	Hard red winter, Soft red winter	I	53,056.59	92,138.82
			N	39,082.23	
	Other	—	I	34,386.82	256,321.28
			N	221,934.46	
				Total irrigated	267,337.29
				Total non-irrigated	295,184.94
				County total	562,522.23
Cochran	Corn	Blue	I	115.60	7,668.40
		Yellow	I	6,567.93	
			N	984.87	

Source: USDA FSA, 2015

— = Not applicable

[a] Primary crops grown within the region (cotton, corn, sorghum, wheat, and peanuts). Crops included in the other category are alfalfa, triticale, rye, sunflowers, barley, soybeans, sesame, millet, oats, canola, and many types of fruits and vegetables.

[b] I = irrigated, N = not irrigated

Table 5-50. Acres by Crop Type
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County	Crop [a]	Crop Type	Irrigation Practice [b]	Planted Acres: By Crop Type and Irrigation Practice	Planted Acres: By Crop
Cochran (cont.)	Cotton-upland	—	I	51,406.40	106,619.38
			N	55,212.98	
	Peanuts	Runner	I	1,134.64	11,281.61
		Southwest Spanish	I	3,184.29	
		Valencia	I	5,694.61	
		Virginia	I	1,268.07	
	Sorghum	Grain	I	13,986.58	38,806.69
			N	22,267.14	
	Sorghum forage	Sudex	I	1,114.24	
			N	1,418.79	
		Sweet	N	19.94	
	Wheat	Hard red winter	I	5,266.10	9,271.09
			N	4,004.99	
	Other	—	I	7,997.02	166,228.01
			N	158,230.99	
				Total irrigated	97,735.48
				Total non-irrigated	242,139.70
				County total	339,875.18
Crosby	Corn	White	I	297.25	2,101.55
		Yellow	I	1,804.30	
	Cotton-upland	—	I	94,229.20	204,244.02
			N	110,014.82	
	Peanuts	Southeast Spanish	I	107.98	147.12
		Southwest Spanish	N	39.14	
	Sorghum	Grain	I	9,201.20	18,624.36
			N	6,941.95	
	Sorghum forage	Sudex	I	555.97	
			N	1,925.24	
	Wheat	Hard red winter	I	1,095.92	14,349.46
			N	13,253.54	
	Other	—	I	3,058.79	173,467.52
			N	170,408.73	

Source: USDA FSA, 2015

— = Not applicable

[a] Primary crops grown within the region (cotton, corn, sorghum, wheat, and peanuts). Crops included in the other category are alfalfa, triticale, rye, sunflowers, barley, soybeans, sesame, millet, oats, canola, and many types of fruits and vegetables.

[b] I = irrigated, N = not irrigated

Table 5-50. Acres by Crop Type
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County	Crop [a]	Crop Type	Irrigation Practice [b]	Planted Acres: By Crop Type and Irrigation Practice	Planted Acres: By Crop
Crosby (cont.)				Total irrigated	110,350.61
				Total non-irrigated	302,583.42
				County total	412,934.03
Dawson	Corn	—	—	—	None reported
	Cotton-upland	—	I	52,222.35	249,794.88
			N	197,572.53	
	Peanuts	Runner	I	1,478.45	3,313.12
		Southwest Spanish	I	109.95	
		Valencia	I	154.00	
		Virginia	I	1,570.72	
	Sorghum	Grain	I	7,002.83	26,699.21
			N	15,971.10	
	Sorghum forage	Sudex	I	928.00	
			N	352.14	
		Sweet	I	949.52	
			N	1,495.62	
	Wheat	Hard red spring	I	186.11	47,442.48
			N	41.00	
		Hard red winter	I	24,476.00	
			N	22,739.37	
	Other	—	I	10,913.73	204,017.86
			N	193,104.13	
				Total irrigated	99,991.66
				Total non-irrigated	431,275.89
				County total	531,267.55
Deaf Smith	Corn	Sweet	I	0.25	46,236.71
		White	I	11,072.28	
			N	180.00	
		Yellow	I	34,645.68	
			N	338.50	
	Cotton-upland	—	I	8,244.15	12,936.30
			N	4,692.15	

Source: USDA FSA, 2015

— = Not applicable

[a] Primary crops grown within the region (cotton, corn, sorghum, wheat, and peanuts). Crops included in the other category are alfalfa, triticale, rye, sunflowers, barley, soybeans, sesame, millet, oats, canola, and many types of fruits and vegetables.
[b] I = irrigated, N = not irrigated

Table 5-50. Acres by Crop Type
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County	Crop [a]	Crop Type	Irrigation Practice [b]	Planted Acres: By Crop Type and Irrigation Practice	Planted Acres: By Crop
Deaf Smith (cont.)	Peanuts	—	—	—	None reported
	Sorghum	Grain	I	14,184.04	102,321.36
			N	48,711.37	
		Hybrid	I	3,212.33	
			N	190.00	
	Sorghum-dual purpose	—	I	17,619.50	
			N	5,271.07	
	Sorghum forage	Alum	I	24.80	
			N	852.65	
		Cane	I	354.98	
			N	375.23	
		Sudex	I	3,172.13	
			N	6,793.84	
		Sweet	I	399.20	
			N	1,160.22	
	Wheat	Hard red winter	I	53,489.25	163,781.10
			N	110,171.85	
		Hard white winter	I	120.00	
	Other	—	I	19,516.23	613,929.79
			N	594,413.56	
				Total irrigated	166,054.82
				Total non-irrigated	773,150.44
				County total	939,205.26
Dickens	Corn	—	—	—	None reported
	Cotton-upland	—	I	6,094.34	26,769.77
			N	20,675.43	
	Peanuts	—	—	—	None reported
	Sorghum	Grain	I	91.00	2,917.22
			N	600.44	
	Sorghum forage	Cane	N	263.68	
		Sudex	I	268.60	
			N	1,693.50	

Source: USDA FSA, 2015

— = Not applicable

[a] Primary crops grown within the region (cotton, corn, sorghum, wheat, and peanuts). Crops included in the other category are alfalfa, triticale, rye, sunflowers, barley, soybeans, sesame, millet, oats, canola, and many types of fruits and vegetables.

[b] I = irrigated, N = not irrigated

Table 5-50. Acres by Crop Type
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County	Crop [a]	Crop Type	Irrigation Practice [b]	Planted Acres: By Crop Type and Irrigation Practice	Planted Acres: By Crop
Dickens (cont.)	Wheat	Hard red winter	I	822.40	10,782.51
			N	9,848.11	
		Hard white spring	N	112.00	
	Other	—	I	533.18	268,084.94
			N	267,551.76	
				Total irrigated	7,809.52
				Total non-irrigated	300,744.92
				County total	308,554.44
Floyd	Corn	Ornamental	I	36.28	12,520.51
		Sweet	I	4.00	
		White	I	3,338.31	
		Yellow	I	9,020.06	
			N	121.86	
	Cotton-upland	—	I	71,371.28	144,069.51
			N	72,698.23	
	Peanuts	—	—	—	None reported
	Sorghum	Grain	I	25,965.33	60,422.80
			N	30,892.24	
		Hybrid	I	492.98	
		Hybrid interplanting forage	I	41.92	
	Sorghum forage	Cane	I	233.63	
			N	399.42	
		Sudex	I	490.91	
			N	1,687.39	
		Sweet	I	9.00	
			N	209.98	
	Wheat	Hard red winter	I	8,089.59	34,491.12
			N	26,401.53	
	Other	—	I	9,239.66	301,710.75
			N	292,471.09	

Source: USDA FSA, 2015

— = Not applicable

[a] Primary crops grown within the region (cotton, corn, sorghum, wheat, and peanuts). Crops included in the other category are alfalfa, triticale, rye, sunflowers, barley, soybeans, sesame, millet, oats, canola, and many types of fruits and vegetables.

[b] I = irrigated, N = not irrigated

Table 5-50. Acres by Crop Type
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County	Crop [a]	Crop Type	Irrigation Practice [b]	Planted Acres: By Crop Type and Irrigation Practice	Planted Acres: By Crop
Floyd (cont.)				Total irrigated	128,332.95
				Total non-irrigated	424,881.74
				County total	553,214.69
Gaines	Corn	Yellow	I	6,241.38	6,241.38
	Cotton-upland	—	I	124,647.07	183,674.93
		—	N	59,027.86	
	Peanuts	Runner	I	7,237.20	33,407.65
			N	160.55	
		Southwest Spanish	I	6,120.70	
			N	118.00	
		Valencia	I	2,133.45	
		Virginia	I	17,637.75	
	Sorghum	Grain	I	25,280.17	43,438.94
			N	11,717.40	
	Sorghum-dual purpose	—	I	2.00	
			N	1.86	
	Sorghum forage	Cane	I	240.00	
		Sudex	I	3,141.50	
			N	3,056.01	
	Wheat	Hard red spring	N	18.30	78,218.46
		Hard red winter	I	65,961.45	
			N	12,118.71	
		Hard white winter	I	120.00	
	Other	—	I	34,987.86	315,108.30
			N	280,120.44	
				Total irrigated	293,750.53
				Total non-irrigated	366,339.13
				County total	660,089.66
Garza	Corn	—	—	—	None reported
	Cotton-upland	—	I	10,159.80	30,824.90
			N	20,665.10	
	Peanuts	—	—	—	None reported

Source: USDA FSA, 2015

— = Not applicable

[a] Primary crops grown within the region (cotton, corn, sorghum, wheat, and peanuts). Crops included in the other category are alfalfa, triticale, rye, sunflowers, barley, soybeans, sesame, millet, oats, canola, and many types of fruits and vegetables.

[b] I = irrigated, N = not irrigated

Table 5-50. Acres by Crop Type
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County	Crop [a]	Crop Type	Irrigation Practice [b]	Planted Acres: By Crop Type and Irrigation Practice	Planted Acres: By Crop
Garza (cont.)	Sorghum	Grain	I	130.00	1,844.83
			N	401.31	
	Sorghum forage	Sudex	N	1,313.52	
	Wheat	Hard red winter	I	40.00	2,563.07
			N	2,473.96	
		Hard white winter	N	49.11	
	Other	—	I	481.70	273,260.35
			N	272,778.65	
	Total irrigated				10,811.50
	Total non-irrigated				297,681.65
	County total				308,493.15
Hale	Corn	Sweet	I	1.44	49,139.31
		White	I	12,672.37	
		Yellow	I	36,164.40	
			N	301.10	
	Cotton-upland	—	I	111,629.24	166,773.55
			N	55,144.31	
	Peanuts	—	—	—	None reported
	Sorghum	Grain	I	44,748.11	85,253.57
			N	30,651.72	
		Hybrid interplanting forage	I	24.90	
		Hybrid	I	4,622.45	
		Hybrid standardplant FG	I	29.60	
			N	18.00	
		Hybrid standardplant GR	I	458.60	
		Hybrid standardplant SU	I	255.80	
			N	141.30	
	Sorghum forage	Cane	I	212.90	
			N	60.00	

Source: USDA FSA, 2015

— = Not applicable

[a] Primary crops grown within the region (cotton, corn, sorghum, wheat, and peanuts). Crops included in the other category are alfalfa, triticale, rye, sunflowers, barley, soybeans, sesame, millet, oats, canola, and many types of fruits and vegetables.

[b] I = irrigated, N = not irrigated

Table 5-50. Acres by Crop Type
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County	Crop [a]	Crop Type	Irrigation Practice [b]	Planted Acres: By Crop Type and Irrigation Practice	Planted Acres: By Crop
Hale (cont.)	Sorghum forage (cont.)	Sudex	I	2,031.93	
			N	1,998.26	
	Wheat	Hard red winter	I	32,183.73	54,631.72
			N	22,447.99	
	Other	—	I	18,913.11	221,877.16
			N	202,964.05	
				Total irrigated	263,948.58
				Total non-irrigated	313,726.73
				County total	577,675.31
Hockley	Corn	White	I	516.10	12,889.73
		Yellow	I	11,706.23	
			N	667.40	
	Cotton-upland	—	I	98,926.08	224,932.54
			N	126,006.46	
	Peanuts	Runner	I	132.00	537.95
		Southeast Spanish	I	35.00	
		Southwest Spanish	I	165.95	
		Valencia	I	120.00	
		Virginia	I	85.00	
	Sorghum	Grain	I	13,585.82	38,851.76
			N	22,799.02	
	Sorghum-dual purpose	—	I	140.00	
	Sorghum forage	Cane	I	344.45	
			N	561.67	
		Sudex	I	573.37	
			N	847.43	
	Wheat	Hard red winter	I	3,730.86	9,326.17
			N	5,481.31	
		Soft red winter	I	74.00	
			N	40.00	
	Other	—	I	6,305.99	180,733.58
			N	174,427.59	

Source: USDA FSA, 2015

— = Not applicable

[a] Primary crops grown within the region (cotton, corn, sorghum, wheat, and peanuts). Crops included in the other category are alfalfa, triticale, rye, sunflowers, barley, soybeans, sesame, millet, oats, canola, and many types of fruits and vegetables.

[b] I = irrigated, N = not irrigated

Table 5-50. Acres by Crop Type
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County	Crop [a]	Crop Type	Irrigation Practice [b]	Planted Acres: By Crop Type and Irrigation Practice	Planted Acres: By Crop
Hockley (cont.)				Total irrigated	136,440.85
				Total non-irrigated	330,830.88
				County total	467,271.73
Lamb	Corn	White	I	10,583.70	50,452.37
		Yellow	I	39,725.67	
		Yellow	N	143.00	
	Cotton-upland	—	I	69,524.39	137,985.76
			N	68,461.37	
	Peanuts	Southeast Spanish	I	197.00	263.10
			N	66.10	
	Sorghum	Grain	I	36,981.65	63,725.02
			N	20,359.77	
		Hybrid interplanting forage	I	10.80	
		Hybrid	I	107.50	
		Hybrid standardplant FG	I	551.70	
		Hybrid standardplant GR	I	683.00	
	Sorghum-dual purpose	—	I	57.50	
	Sorghum forage	Cane	I	137.00	
			N	231.67	
		Sudex	I	3,140.17	
			N	1,292.27	
		Sweet	I	36.50	
			N	135.49	
	Wheat	Hard red winter	I	26,335.07	43,197.11
			N	16,862.04	
	Other	—	I	39,491.33	288,240.56
			N	248,749.23	
				Total irrigated	227,562.98
				Total non-irrigated	356,300.94
				County total	583,863.92

Source: USDA FSA, 2015

— = Not applicable

[a] Primary crops grown within the region (cotton, corn, sorghum, wheat, and peanuts). Crops included in the other category are alfalfa, triticale, rye, sunflowers, barley, soybeans, sesame, millet, oats, canola, and many types of fruits and vegetables.

[b] I = irrigated, N = not irrigated

Table 5-50. Acres by Crop Type
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County	Crop [a]	Crop Type	Irrigation Practice [b]	Planted Acres: By Crop Type and Irrigation Practice	Planted Acres: By Crop
Lubbock	Corn	White	I	913.40	4,603.85
			N	55.30	
		Yellow	I	3,635.15	
	Cotton-upland	—	I	120,430.24	229,160.90
			N	108,730.66	
	Peanuts	Southwest Spanish	I	4.00	4.00
	Sorghum	Grain	I	15,485.96	46,650.95
			N	27,426.06	
	Sorghum Forage	Sudex	I	430.71	
			N	3,308.22	
	Wheat	Hard red winter	I	3,197.70	10,315.19
			N	7,111.49	
		Soft red winter	N	6.00	
	Other	—	I	8,849.07	135,498.86
			N	126,649.79	
				Total irrigated	152,946.23
				Total non-irrigated	273,287.52
				County total	426,233.75
Lynn	Corn	Yellow	I	1,538.63	1,670.73
			N	132.10	
	Cotton-upland	—	I	59,203.44	230,805.86
			N	171,602.42	
	Peanuts	Southwest Spanish	I	120.40	120.40
	Sorghum	Grain	I	12,388.87	39,021.98
			N	23,274.31	
	Sorghum forage	Cane	N	37.40	
		Sudex	I	369.58	
			N	2,951.82	
	Wheat	Hard red winter	I	5,914.34	21,080.97
			N	15,166.63	
	Other	—	I	4,352.62	174,748.06
			N	170,395.44	

Source: USDA FSA, 2015

— = Not applicable

[a] Primary crops grown within the region (cotton, corn, sorghum, wheat, and peanuts). Crops included in the other category are alfalfa, triticale, rye, sunflowers, barley, soybeans, sesame, millet, oats, canola, and many types of fruits and vegetables.

[b] I = irrigated, N = not irrigated

Table 5-50. Acres by Crop Type
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County	Crop [a]	Crop Type	Irrigation Practice [b]	Planted Acres: By Crop Type and Irrigation Practice	Planted Acres: By Crop
Lynn (cont.)				Total irrigated	83,887.88
				Total non-irrigated	383,560.12
				County total	467,448.00
Motley	Corn	—	—	—	None reported
	Cotton-upland	—	I	4,333.37	24,074.36
			N	19,740.99	
	Peanuts	Southwest Spanish	I	530.08	530.08
	Sorghum	Grain	I	60.00	3,328.40
	Sorghum forage	Cane	I	23.80	
			N	16.06	
		Sudex	N	3,228.54	
	Wheat	Hard red winter	I	1,397.89	10,895.83
			N	9,497.94	
	Other	—	I	2,566.44	411,655.80
			N	409,089.36	
				Total irrigated	8,911.58
				Total non-irrigated	441,572.89
				County total	450,484.47
Parmer	Corn	White	I	1,792.60	68,187.69
		Yellow	I	65,314.99	
			N	1,080.10	
	Cotton-upland	—	I	8,671.50	11,936.16
			N	3,264.66	
	Peanuts	—	—	—	None reported
	Sorghum	Grain	I	22,869.53	95,417.13
			N	41,290.25	
		Hybrid	I	1,124.43	
	Sorghum-dual purpose	—	I	8,361.42	
			N	1,639.15	
	Sorghum forage	Cane	I	285.38	
			N	1,372.21	

Source: USDA FSA, 2015

— = Not applicable

[a] Primary crops grown within the region (cotton, corn, sorghum, wheat, and peanuts). Crops included in the other category are alfalfa, triticale, rye, sunflowers, barley, soybeans, sesame, millet, oats, canola, and many types of fruits and vegetables.

[b] I = irrigated, N = not irrigated

Table 5-50. Acres by Crop Type
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County	Crop [a]	Crop Type	Irrigation Practice [b]	Planted Acres: By Crop Type and Irrigation Practice	Planted Acres: By Crop
Parmer (cont.)	Sorghum forage (cont.)	Sudex	I	5,476.34	
			N	12,998.42	
	Wheat	Hard red winter	I	44,127.67	154,171.57
			N	109,902.28	
		Hard white winter	N	141.62	
	Other	—	I	32,066.18	222,037.14
			N	189,970.96	
				Total irrigated	190,090.04
				Total non-irrigated	361,659.65
				County total	551,749.69
Swisher	Corn	Sweet	I	12.36	14,371.96
		White	I	1,022.23	
		Yellow	I	13,304.63	
			N	32.74	
	Cotton-upland	—	I	21,655.01	42,624.52
			N	20,969.51	
	Peanuts	—	—	—	None reported
	Sorghum	Grain	I	23,764.84	77,484.31
			N	37,695.80	
		Hybrid standard plant SU	I	471.22	
	Sorghum-dual purpose	—	I	1,097.56	
			N	1,505.43	
	Sorghum forage	Alum	N	223.71	
		Cane	I	1,354.50	
			N	5,272.17	
		Sudex	I	848.16	
			N	4,471.43	
		Sweet	I	298.92	
			N	480.57	
	Wheat	Hard red winter	I	26,093.60	111,209.30
			N	85,115.70	

Source: USDA FSA, 2015

— = Not applicable

[a] Primary crops grown within the region (cotton, corn, sorghum, wheat, and peanuts). Crops included in the other category are alfalfa, triticale, rye, sunflowers, barley, soybeans, sesame, millet, oats, canola, and many types of fruits and vegetables.

[b] I = irrigated, N = not irrigated

Table 5-50. Acres by Crop Type
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County	Crop [a]	Crop Type	Irrigation Practice [b]	Planted Acres: By Crop Type and Irrigation Practice	Planted Acres: By Crop
Swisher (cont.)	Other	—	I	3,011.57	305,270.10
			N	302,258.53	
	Total irrigated				92,934.60
	Total non-irrigated				458,025.59
	County total				550,960.19
Terry	Corn	Sweet	I	1.20	675.19
		Yellow	I	673.99	
	Cotton-ELS	—	I	363.32	163,839.78
	Cotton-upland	—	I	78,380.88	
			N	85,095.58	
	Peanuts	Runner	I	5,590.12	24,060.67
		Southwest Spanish	I	4,229.50	
		Valencia	I	123.00	
			N	34.70	
		Virginia	I	14,083.35	
	Sorghum	Grain	I	13,138.92	46,764.18
			N	30,507.31	
	Sorghum forage	Sudex	I	424.40	
			N	1,225.28	
		Sweet	I	609.60	
			N	858.67	
	Wheat	Hard red spring	I	242.00	50,914.37
			N	330.28	
		Hard red winter	I	31,690.23	
			N	18,213.84	
		Hard white winter	I	398.09	
			N	39.93	
	Other	—	I	18,190.40	175,518.16
			N	157,327.76	
	Total irrigated				168,139.00
	Total non-irrigated				293,633.35
	County total				461,772.35

Source: USDA FSA, 2015

— = Not applicable

[a] Primary crops grown within the region (cotton, corn, sorghum, wheat, and peanuts). Crops included in the other category are alfalfa, triticale, rye, sunflowers, barley, soybeans, sesame, millet, oats, canola, and many types of fruits and vegetables.

[b] I = irrigated, N = not irrigated

Table 5-50. Acres by Crop Type
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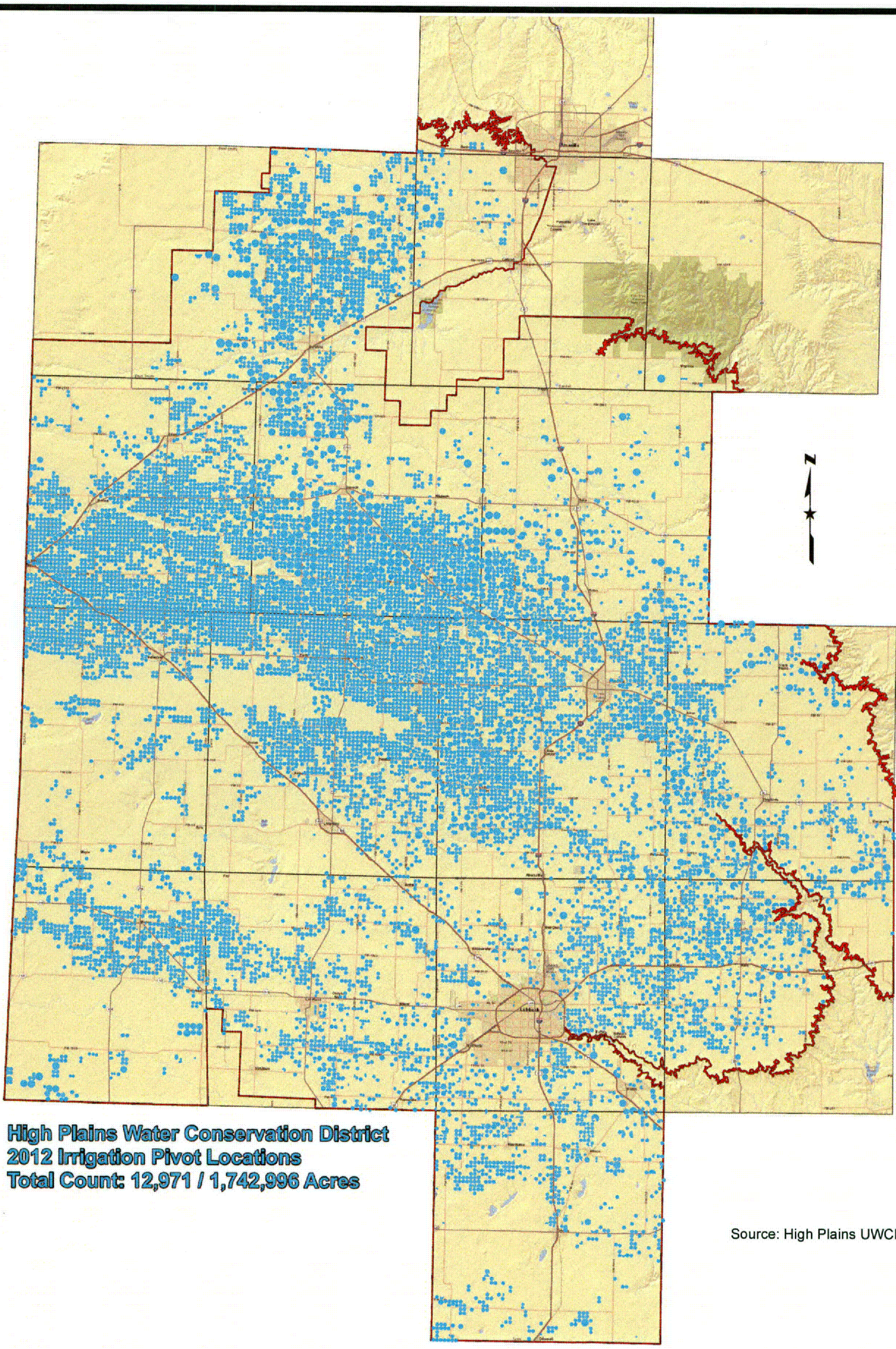
County	Crop [a]	Crop Type	Irrigation Practice [b]	Planted Acres: By Crop Type and Irrigation Practice	Planted Acres: By Crop
Yoakum	Corn	Yellow	I	1,227.00	1,227.00
	Cotton-ELS	—	I	68.00	106,286.49
	Cotton-upland	—	I	58,258.73	
			N	47,959.76	
	Peanuts	Runner	I	1,303.68	18,874.92
		Southwest Spanish	I	4,145.81	
		Valencia	I	420.00	
		Virginia	I	12,897.39	
		Virginia	N	108.04	
	Sorghum	Grain	I	3,924.80	20,135.40
			N	15,526.47	
	Sorghum forage	Sudex	I	96.08	
			N	588.05	
	Wheat	Hard red winter	I	15,802.85	25,219.71
			N	9,416.86	
	Other	—	I	8,501.73	89,982.65
			N	81,480.92	
				Total irrigated	106,646.07
				Total non-irrigated	155,080.10
				County total	261,726.17

Source: USDA FSA, 2015

— = Not applicable

[a] Primary crops grown within the region (cotton, corn, sorghum, wheat, and peanuts). Crops included in the other category are alfalfa, triticale, rye, sunflowers, barley, soybeans, sesame, millet, oats, canola, and many types of fruits and vegetables.

[b] I = irrigated, N = not irrigated



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Daniel B. Stephens & Associates, Inc.
9/30/2015
JN WR11.0030

LLANO ESTACADO REGION
Center Pivots

Figure 5-1

- The South Plains UWCD, Llano Estacado UWCD, and Sandy Land UWCD formed the Southern Ogallala Conservation and Outreach Program (SOCOP) in 2007, which serves the education needs of all three districts (SPUWCD, 2015).

- The South Plains UWCD, Llano Estacado UWCD, and Sandy Land UWCD are supporting the U.S. Geological Survey in developing a regional conceptual model of the hydrogeologic framework, geochemistry, and groundwater flow system of the Ogallala and Edwards-Trinity (High Plains) aquifers in Terry, Gaines, and Yoakum counties (Harris, 2015). The objective of the study, which will be completed in 2016, is to determine the groundwater sources, recharge, discharge, and mixing zones (Harris, 2015).

- The Texas Alliance for Water Conservation (TAWC) project, described in Section 5.3.1.1.1, is an ongoing on-farm demonstration project that was started in 2004, with a mission of conserving water by identifying agricultural production practices and technologies that will reduce the depletion of groundwater while maintaining or improving agricultural production and economic opportunities. This partnership of producers, industries, universities, and government agencies provides not only education but tools for producers to improve efficiencies in water use. This program has been used as a model for the recommendation of ongoing agricultural conservation activities in Region O.

5.3.1.1 Description of Texas Alliance for Water Conservation Activities

The objective of the TAWC is to conserve water in the Texas Southern High Plains while continuing agricultural activities and providing the needed productivity and profitability for producers, communities, and the region. The TAWC project is a partnership of industries, universities, and government agencies, including Texas Tech University, the U.S. Department of Agriculture, and more than 20 area producers. The project uses on-farm demonstrations of cropping and livestock systems to compare the production practices, technologies, and systems that can maintain individual farm profitability while improving water use efficiency, with a goal of extending the life of the Ogallala Aquifer while maintaining the viability of local farms and communities.

The TAWC program is funded by the TWDB, and it began in 2004, with 2005 being the first cropping year under the program. Phase 1 included 9 growing seasons (2005-2013) in the original project area of Hale and Floyd counties. Phase 2 will include 5 growing seasons (2014-2018) in an expanded project area, covering more than 6,000 acres in Floyd, Hale, Lamb, Lubbock, Crosby, Parmer, Swisher, and Deaf Smith counties.

A key strategy of the TAWC project is that producers make all decisions about their agricultural practices. The project sites represent the range of agricultural practices, including monoculture cropping systems, crop rotations, no-till, limited-till and conventional tillage practices, land application of manure, and fully integrated crop and livestock systems. The TAWC measures, monitors, and documents the results of the producer decisions, using instrumentation for water use, soil moisture depletion, crop productivity, and economic return.

The TAWC project objectives include:

- Demonstrating how to reduce total water use
- Demonstrating how to enhance profitability
- Identifying effective crop and irrigation systems
- Impacting producer decision-making by addressing any barriers to adoption of water conservation measures

Annual reports and a project summary are available on the project web site (http://www.depts.ttu.edu/tawc/). The reports include data from 26 producers using sprinkler, furrow, subsurface drip, and dryland farming methods. The *9th Annual Report 2005–2014* was published in September 2014 (TAWC, 2014).

5.3.1.2 TAWC Field Data Collection

The TAWC project sites are intensely monitored for water use, soil moisture depletion, crop productivity, and economic return. Each site is equipped with instruments to measure total water applied from the aquifer, solar radiation, temperature, rainfall, timing and amount of irrigation events, and soil moisture. The data are electronically collected, transmitted, and stored in a single database that is accessible to the project participants (TAWC, 2014).

A number of new irrigation and crop management technologies have been demonstrated on project sites. These technologies include soil moisture sensors, crop stress sensors, and irrigation system management equipment. Specific technologies demonstrated and the year they were initially included in the TAWC project include Smart Field and Smart Crop (2008), Net Irrigate (2008), AquaSpy (2010), Ecolst (2010), John Deere Field Connect (2012), and PivoTrac (2012) (TAWC, 2014). Testing of these technologies under the TAWC project provides information for producers to reference when making decisions regarding their potential implementation (TAWC, 2014).

Two new technologies that the TAWC plans to evaluate in 2015 include precision mobile drip technology (PMDI) and variable rate technology (Kellison, 2015).

- PMDI involves pulling a drip line along the surface and allows producers to adjust the number of emitters they have at various distances down the line (Kellison, 2015). The emitters used with this technology are larger and allow for passage of large sand grains, reducing the amount of clogging (Kellison, 2015).

- Variable rate technology allows producers to control nozzles individually (Kellison, 2015).

5.3.1.3 Water Conservation Potential

The general approach to estimating water savings within the TAWC project has been to quantify crop evapotranspiration (ET) relative to total crop water demand. If the irrigation is less than 100 percent of ET, then the difference is considered to be a potential savings in irrigation based on the assumption that irrigation in excess of 100 percent of ET would not enhance yield.

Corn and cotton are the predominant irrigated crops among the TAWC sites. Irrigation and precipitation were supplied at greater than 100 percent of crop ET needs in 40 percent of cotton and 29 percent of corn fields observed over the period 2006 through 2011. Based on the data collected, the irrigation provided met 70 to 90 percent of crop ET needs for cotton and corn production, resulting in yields that matched yields for crops that received water at or above

100 percent of ET. Producers generally do not have tools to track crop water demands and, as a result, tend to over-irrigate in wet years.

5.3.1.4 Plant Water Use and Water Use Efficiency

The TAWC 9th annual report discusses plant water use and water use efficiency in terms of the results of the 9-year Phase I study, which collected information from 14 center pivot-irrigated fields and two subsurface drip fields. Table 5-51 provides short descriptions of the irrigation methods and their average application efficiencies. Table 5-52 illustrates the potential increase in water that would be available to a crop if the irrigation method were to change. Substantial water savings can be achieved by switching to a more efficient irrigation system, assuming that the choice of crop allows it.

Table 5-51. Irrigation Methods and Efficiencies

Irrigation method	Description	Average Application Efficiency (%)
Mid elevation spray application (MESA)	Nozzles irrigate from higher above the soil surface than either LEPA or LESA.	66.9
Low elevation spray application (LESA)	Uses spray nozzles instead of drag hoses.	75.9
Low energy precision application (LEPA)	Application devices are mounted on the irrigation systems. Can include drag hoses running in alternate furrows.	93.6
Subsurface drip irrigation (SSD)	Irrigation water is applied below the soil surface.	98.0

Source: TAWC, 2014

Table 5-52. Potential Increase in Water Available for Crop Use by Switching to More Efficient Irrigation System

Current System Applying 12 inches	Potential Increase in Available Water (inches) by Switching to			
	MESA	LESA	LEPA	SSD
MESA	0	1.62	4.79	5.58
LESA	—	0	2.80	3.49
LEPA	—	—	0	0.56
SSD	—	—	—	0

Source: TAWC, 2014 — = Less efficient irrigation system (water available for crop use would decrease).

5.3.1.5 *Crop Selection*

Crop selection influences crop water demand; for example, corn requires more water to achieve an economic yield than cotton does. Market conditions impact crop selection, as one crop may be more profitable than another from year to year. Crop water use efficiency (expressed as pounds of grain yield per acre-inch of irrigation applied) was higher for grain sorghum than for corn (TAWC, 2014), although corn water use efficiency was modestly greater than that of grain sorghum when calculated per acre-inch of irrigation plus growing-season rainfall. Where irrigation supply has declined below levels needed for high corn yield, grain sorghum is a profitable alternative crop to corn.

The method of irrigation can also affect crop water use efficiency. For example, efficiency of irrigation was generally greater for cotton and corn when a subsurface rather than surface irrigation method was used (TAWC, 2014). Gains in irrigation efficiency can be achieved by a combination of selecting water-efficient crop varieties, using new irrigation techniques, and following a precise irrigation schedule (TAWC, 2014).

Diversified systems that include both crops and livestock have been shown to lower water use while increasing productivity and at the same time diversifying income sources, reducing soil erosion, and reducing nitrogen fertilizer use. Research at Texas Tech over the past 15 years has shown that an integrated cotton/forage/beef cattle system lowered irrigated water use by about 25 percent compared to a continuous cotton monoculture.

5.3.1.6 *Best Management Practices*

BMPs identified as part of the TAWC project relate to irrigation system management, irrigation scheduling, soil fertility, and crop selection.

With regard to irrigation method, spray modes have been gradually replaced by modes that cause less evaporative losses, resulting in a greater proportion of the pumped water reaching the roots of the crop (TAWC, 2014). Efficiencies increase with the use of mid-elevation spray application (MESA), low elevation spray application (LESA), low elevation precision application (LEPA), and subsurface drip (SSD) progressing from roughly 67 percent for MESA to 98 percent for SSD. Greater yields and profits per acre were achieved for crops irrigated using

LEPA (TAWC, 2014). One site growing cotton yielded 1,001 pounds per acre (lb/ac) using LEPA and 879 lb/ac using LESA, indicating 122 pounds greater yield and $103.70 greater profit per acre. Millet crops yielded 1,950 lb/ac using LEPA and 1,721 lb/ac using LESA, resulting in 230 pounds more yield and $69.00 more profit per acre (TAWC, 2014).

Slowing down the rate of pivot rotation allows deeper water penetration into the plant root zone. At pivot rotation rates of 5 and 4 days per cycle, irrigation reached a depth of only 8 inches. When pivot rotation was slowed to 7 days per cycle, applied water reached a depth of 16 inches, allowing greater delivery of water to the root zone (TAWC, 2014).

When producers monitor ET, it is possible to fine-tune irrigation, resulting in a reduction of water lost through evaporation from the soil or over-irrigation (TAWC, 2014). Section 5.3.1.7 describes a decision-making tool available from TAWC to track soil moisture on individual sites to support more efficient scheduling of irrigation.

Some producers have shifted from the historical pattern of continuous cotton monoculture to more diverse cropping systems that leave more crop residue, thereby conserving soil and water and improving soil structure and fertility (TAWC, 2014).

5.3.1.7 Decision Making Tools

The TAWC program website (http://TAWCsolutions.org) includes several online tools, as described below. In addition, TAWC has provided users with a basic irrigation calculator and a contiguous acre-inch calculator used for water resource allocation.

The *Resource Allocation Analyzer* allows producers to evaluate their crop production alternatives with the objective of maximizing profitability given a specified level of available irrigation water and costs. On the input screen producers provide cost and return information for alternative enterprises, yield expectation, and irrigation availability to create and evaluate numerous scenarios, and can choose up to five crops to analyze.

The *Irrigation Scheduler* allows the user to track and manage crop water balance at each production site. Users can specify and modify various crop parameters (e.g., crop type, planting date, stage of crop development) to match their operation. The tool uses data from the West Texas Mesonet stations to define when to apply water, how much water to apply, and what cut-off times to follow (users outside the West Texas Mesonet region currently must input their own weather data). A future planned improvement to the tool is the use of crop growth factors derived from satellite imagery (TAWC, 2014).

The *Next-Generation Irrigation Scheduling Tool* uses satellite remote sensing to establish crop coefficients that are specific to individual fields. This tool is capable of making irrigation recommendations based on modeling the changes in soil moisture in a field over the growing season. Ideally, actual soil moistures in the field would be measured by in situ monitors; however the installation of those monitors would be costly to producers (TAWC, 2014). The TAWC tool estimates soil moisture based on the Perpendicular Soil Moisture Index (PSMI), which uses Landsat image data. Landsat data are free and are available one day after they are collected. The pixel size of the Landsat images is 100 feet (30 meters). The crop coefficient curves that are developed can then be used for irrigation scheduling, which reduces overwatering (TAWC, 2014). To check field-specific application of the Landsat data, micrometeorological stations are being installed in some of the TAWC fields. Soil moisture sensors are also being installed to a depth of 3 to 4 feet and report data from multiple depths (TAWC, 2014).

The *Fieldprint Calculator* is a tool developed by Field to Market that computes the sustainability levels of a producer's operations and aids in evaluating potential changes that may improve sustainability. This tool is based on seven metrics: land use (acres per pound), irrigation water use (inches per pound), energy use (gallons of diesel per pound), greenhouse gas emissions (pounds of carbon dioxide per pound), soil conservation (tons of soil loss), soil carbon index, and water quality index. The TAWC has initiated discussions with Field to Market to extend the scope of the calculator. Currently the Fieldprint Calculator analyzes each crop year separately with regard to direct and indirect energy use and carbon emissions from production inputs, but does not consider water conservation as a metric in sustainability. The tool may be expanded to include impacts of cropping systems on soil health and soil erosion, and metrics for water conservation (TAWC, 2014).

5.3.1.8 Public Outreach

The TAWC aims to expand the adoption of irrigation conservation methods and has held workshops, conducted interviews, and conducted field walks. Results of the TAWC demonstration project have been shared through educational workshops held in New Mexico and Texas, trade show displays, and demonstrations that include farms shows in Amarillo and Lubbock, cotton ginner meetings in Lubbock, and the Beltwide Cotton Conference in San Antonio. Presentations have also been made at stakeholder meetings, and research presentations have been made at water conferences. A YouTube library is also being developed, with the goal of the program serving as a model that can be applied to other areas.

The TAWC reports that growers are concerned about water conservation, in addition to economics, and the program provides the link between the two. At an April 2014 meeting, the chairman of the producer group reported that he experienced a $100-per-acre increase in profit by upgrading from sprinkler to LEPA irrigation. Soil moisture measurements allowed him to save water earlier in the growing season for use during peak growing times. Participating producers have expressed an increased awareness of water use and conservation practices through their use of irrigation system and soil moisture monitoring technologies demonstrated on the TAWC sites.

5.3.1.9 Obstacles to Adoption

Common obstacles to adoption of conservation measures are discussed in the TAWC report (2014), including over-irrigation (using more water than the crop ET requirements) as a vehicle for fertilizer delivery, and issues associated with renter-operated vs. owner-operated fields (e.g., renters are less willing to invest in infrastructure and new technology, and owners do not want acreage to remain fallow). TAWC staff interviewed producers to better understand challenges to adopting more efficient and effective water management practices and technologies. Some of the common themes that emerged include:

- Production traditions and local cultural norms can be hard to overcome.
- Some producers focus solely on economic-related information that maximizes profitability.

- Costs and complexity of new technologies are a deterrent to adopting more sophisticated practices, and the time necessary for learning new technology is a constraint.
- Producers fear change.

5.3.1.10 Recommendations

The following measures are recommended to maximize the benefits of the ongoing TAWC project in Region O:

- Continue the TAWC program public outreach and education efforts, presenting the findings of the demonstration project and the tools available to producers.
- Involve more Region O producers in the TAWC on-farm demonstrations.
- Consider further expanding the program to cover more of the Region O area. Phase 1 included 9 growing seasons (2005-2013) in 2 counties (Hale and Floyd counties), and Phase 2 will include five growing seasons (2014-2018) in 8 counties (Floyd, Hale, Lamb, Lubbock, Crosby, Parmer, Swisher and Deaf Smith counties). The other 13 counties in Region O could be considered for further program expansion.

5.3.2 Descriptions of Irrigation Water Conservation Strategies

Implementation of water conservation strategies have the potential to reduce demand, leading to decreases in water needs (as long as the water application rates are not increased in an effort to increase yields); however, implementation of these strategies is voluntary. The following subsections describe a number of agricultural water conservation substrategies that could be implemented to meet some portion of the irrigation water needs.

5.3.2.1 Changes in Crop Variety

This substrategy calls for adoption of drought resistant crop types in place of higher water-using varieties that are currently grown. Evaporative demand can be significantly reduced by substituting short season varieties in the place of long season varieties. When compared to their long season varieties, seasonal evaporation was found to be 5 inches less for a short season corn variety and 0.6 inch less for a short season sorghum variety, (Howell et al., 1998). Changing to short season varieties will result in a loss in yield and profitability; one study showed that short season hybrids yield approximately 15 percent less than long season varieties (Howell et al., 1998). Changing to drought resistant crop varieties could also result in conservation savings, although the amount of such savings won't be known until these new varieties have been developed and tested.

5.3.2.2 Changes in Crop Type

This substrategy calls for replacing higher water-using crops with crops that use less water. The main crops grown in Region O include cotton (22 percent), wheat (10 percent), sorghum (9 percent), corn (4 percent), and peanuts (1 percent) (USDA FSA, 2015). Due to the length of its growing season, corn has one of the highest irrigation water requirements of any crop grown in this area, and limited moisture can adversely affect yield (Howell, 1996). Cotton, sorghum, and wheat can better tolerate deficit irrigation practices (Howell, 1996). Water could be conserved by reducing the acreage of irrigated corn.

5.3.2.3 Conversion to Dryland Farming

This substrategy calls for converting irrigated acreage to dryland farming practices. Crops that can be grown using dryland farming practices include cotton, sorghum, and wheat, although eliminating the application of irrigation water will lead to reductions in yield and profitability.

5.3.2.4 Implementation of Irrigation Equipment Efficiency Improvements

Different irrigation methods provide different expected application efficiencies. Substantial water savings can be achieved by switching to a more efficient irrigation system, assuming the crop type allows it (an instance where the crop would not allow a change in irrigation method is irrigated corn, due to the height of the crop canopy). The most marked increase in application efficiency occurs when switching from LESA to LEPA, and switching between these irrigation methods only involves changing the emitters, so is relatively simple. An analysis of 86 loans by the High Plains UWCD that financed the installation of LEPA on 10,320 acres showed an average water savings of 0.61 acre-feet per acre. In addition, field studies conducted under the TAWC project have demonstrated that a higher cotton yield can be achieved under LEPA, as compared to LESA using the same basic irrigation rate.

5.3.2.5 *Irrigation Scheduling*

Monitoring ET allows more precise scheduling of irrigation to minimize over-irrigation and ET losses while still meeting plant water requirements. In general, plant water requirements are determined from a balance of water inputs and outputs from the root zone. The main water inputs to the root zone are effective rainfall, net irrigation (the amount of water required for optimum crop growth), and capillary contributions (water contributed from shallow groundwater). Water is mainly lost from the root zone due to evaporation, crop ET, and deep percolation (water that flows down beyond the root zone).

The TAWC project has experimented with monitoring ET at project sites. Each site is equipped with instruments to measure total water applied from the aquifer, solar radiation, temperature, rainfall, timing and amount of irrigation events, and soil moisture. The data are electronically collected, stored, and transmitted so that they can be compiled into a single database. Such monitoring provides valuable information, but is expensive.

5.3.2.6 *Implementation of Conservation Tillage Methods*

Conservation tillage entails leaving the previous year's crop residue (e.g., corn stalks, wheat stubble) on fields before and after planting the next crop, in order to reduce soil erosion and runoff. This tillage method can reduce evaporation and increase infiltration, water storage, and soil moisture, thereby reducing the amount of water that needs to be applied (Section 5.10.12).

5.3.2.7 *Flow Metering*

On-farm flow metering is recommended to measure the volume of water pumped versus delivered, allowing quantification of water losses. This substrategy calls for installation and use of flow measuring devices on on-farm irrigation infrastructure, if such devices are not present.

5.3.3 *Recommended Irrigation Water Conservation Strategies*

Irrigation accounts for the largest water demands in Region O, with projected water demand for this sector accounting for approximately 95 percent of total water demand in 2020 and 91.5 percent of total water demand by 2070. All but four counties in Region O (Dickens, Garza, Lynn, and Motley) are projected to have irrigation needs in at least one decade during the planning horizon (Table 5-53).

Table 5-53. Irrigation Water Needs by County

County	Irrigation Water Need by Decade (ac-ft/yr)					
	2020	2030	2040	2050	2060	2070
Bailey	82,342	85,313	87,094	90,083	89,878	93,037
Briscoe	3,925	11,415	15,611	15,855	15,644	20,059
Castro	262,924	248,970	275,292	278,928	275,290	286,510
Cochran	66,863	65,589	64,722	63,884	63,051	62,521
Crosby	7,082	6,845	6,300	6,442	6,264	6,064
Dawson	0	0	0	0	0	4,149
Deaf Smith	84,134	91,280	99,284	109,239	116,584	128,438
Dickens	0	0	0	0	0	0
Floyd	26,565	25,099	27,346	27,971	27,922	29,390
Gaines	148,524	193,401	218,191	233,497	242,333	266,837
Garza	0	0	0	0	0	0
Hale	238,491	229,925	222,392	215,937	212,966	205,048
Hockley	47,642	54,097	60,284	57,191	56,414	55,127
Lamb	199,252	204,875	216,428	227,103	230,194	239,866
Lubbock	55,020	57,036	69,663	64,611	61,390	73,945
Lynn	0	0	0	0	0	0
Motley	0	0	0	0	0	0
Parmer	272,720	283,764	297,248	296,409	292,936	298,285
Swisher	97,433	129,665	139,466	144,155	146,895	153,547
Terry	0	9,480	46,855	69,535	83,455	107,467
Yoakum	90,656	99,143	101,954	102,808	103,413	109,358
Total	1,683,573	1,795,897	1,948,130	2,003,648	2,024,629	2,139,648

ac-ft/yr = Acre-feet per year

LERWP recommends phased implementation of agricultural water conservation as a WMS for irrigation WUGs in Region O. For planning purposes, it has been assumed that a subset of the agricultural water conservation substrategies will be implemented across the region in decades 2020, 2040, and 2060.

5.3.3.1 Quantity and Reliability of Water

The water conservation potential is highly influenced by weather and other factors (TAWC, 2014), and in Region O, climatic conditions are harsh and ET rates are high (Kellison, 2015). As water availability declines, two basic strategies can be used alone or in combination to stretch water supplies: apply less water per acre (applying 70 to 80 percent of the crop's ET demand), or apply the available water to fewer acres (TAWC, 2014). Additionally, water conservation can stem from changes in water delivery technology or changes in management (Kellison, 2015).

The amount of irrigation applied as part of the TAWC program averaged 13.6 inches over the nine growing seasons and ranged from 9.2 to 20.9 inches (TAWC, 2014). The TAWC program calculated that for the 2013 growing season, with 5,359 acres enrolled in the program, the estimated sum of the total irrigation potentially conserved across the TAWC project sites totaled 309.6 acre-feet (3,715 acre-inches) (TAWC, 2014). The program found that numerous sites supplied more than 100 percent of the total crop water demand (overwatering). Newer irrigation systems require different management styles compared to the systems they replace, and while the newer systems are more efficient, they can be used to apply more water if they are not well managed (TAWC, 2014). For this and other reasons, it is very difficult to estimate the water savings due to the implementation of agricultural water conservation strategies (Kellison, 2015).

The volume of water that could be conserved through the implementation of agricultural water conservation strategies will depend on many factors, including the number of acres for each crop type and variety and the irrigation equipment and methods being used. Region O does not have specific data for each of these factors, and so a general approach has been taken to estimate the potential water savings that could be achieved through agricultural conservation. In the absence of better estimates of the potential water savings, it has been assumed for planning purposes that the implementation of a subset of the agricultural water conservation substrategies across the region will yield a 5 percent increase in irrigation efficiency for decades 2020, 2040, and 2060, for a total conservation savings of 15 percent. (To avoid grossly overestimating the potential water conservation savings due to the implementation of agricultural water conservation strategies largely by private landowners, conservation savings are estimated to not exceed 15 percent.)

Using this approximation, the potential water savings resulting from implementation of agricultural water conservation strategies are estimated to total 91,945 acre-feet in 2020 and 152,889 acre-feet in 2070, as shown on Table 5-54. The potential demand reduction values shown on Table 5-54 were calculated by multiplying the irrigation supplies in each county for decades 2020, 2040, and 2060 by 5, 10, and 15 percent, respectively. The potential demand reduction values for decades 2030, 2050, and 2070 were set equal to the prior decade.

Table 5-54. Estimated Water Savings from Irrigation Water Conservation

County	Estimated Water Savings or Demand Reduction (ac-ft/yr)					
	Phase 1		Phase 2		Phase 3	
	2020	2030	2040	2050	2060	2070
Bailey	1,846	1,846	2,652	2,652	2,752	2,752
Briscoe	1,667	1,667	1,899	1,899	2,474	2,474
Castro	6,253	6,253	8,350	8,350	8,478	8,478
Cochran	1,768	1,768	2,977	2,977	3,642	3,642
Crosby	5,514	5,514	10,180	10,180	13,995	13,995
Dawson	5,410	5,410	9,610	9,610	12,893	12,893
Deaf Smith	5,464	5,464	8,207	8,207	8,019	8,019
Dickens	480	480	936	936	1,385	1,385
Floyd	6,121	6,121	11,027	11,027	14,833	14,833
Gaines	11,563	11,563	12,306	12,306	9,644	9,644
Garza	584	584	1,033	1,033	1,391	1,391
Hale	6,566	6,566	12,332	12,332	16,533	16,533
Hockley	4,178	4,178	6,086	6,086	8,317	8,317
Lamb	6,305	6,305	8,430	8,430	7,167	7,167
Lubbock	5,711	5,711	8,111	8,111	10,940	10,940
Lynn	4,230	4,230	7,577	7,577	10,173	10,173
Motley	485	485	971	971	1,456	1,456
Parmer	2,854	2,854	2,559	2,559	3,463	3,463
Swisher	4,973	4,973	6,255	6,255	7,922	7,922
Terry	7,201	7,201	8,259	8,259	4,916	4,916
Yoakum	2,771	2,771	3,048	3,048	2,497	2,497
Total	91,945	91,945	132,803	132,803	152,889	152,889

ac-ft/yr = Acre-feet per year

5.3.3.2 Financial Costs

The cost of implementing the agricultural water conservation strategies will depend on many factors, including the number of acres for each crop type and variety and the irrigation equipment and methods being used. Region O does not have specific data for each of these factors, but a range of potential unit costs for implementation of the agricultural water conservation strategies has been calculated.

Capacitance probes are used to monitor soil moisture at depth. These probes measure how deep a rain or irrigation event percolates and are used to assess a crop's water needs (Kellison, 2015). Two probes would be installed to cover the area irrigated by a ¼-mile center pivot (approximately 120 acres) (Kellison, 2015). The probes cost between $1,500 and $3,600 per probe, and a data transfer fee must also be paid (Kellison, 2015). Assuming that the combination of the probe and data transfer fee costs total $3,000 per probe, the unit costs for this technology are approximately $50 per acre ($6,000 / 120 acres).

The cost of switching emitters to change from LESA to bubbler irrigation is between $25 and $30 per drop, and there are 190 to 195 drops per ¼-mile center pivot (Kellison, 2015). The unit cost for changing emitters will be approximately $47.50 per acre (assuming 190 drops at $30 per drop = $5,700 / 120 acres).

Changing from furrow irrigation to a subsurface drip system costs approximately $1,500 per acre (Kellison, 2015).

The TAWC has several tools on their website that are available for use free of charge (Kellison, 2015). These tools include the Water Allocation Tool, Irrigation Scheduling Tool, *Next-Generation Irrigation Scheduling Tool,* and Resource Allocation Analyzer (TAWC, 2014).

The average capital cost of implementation for the agricultural water conservation strategies is assumed to range between $50 and $1,500 per acre-foot of water that is conserved (this is a one-time cost). For planning purposes, a capital cost of $500 per acre-foot of water was selected to estimate potential financial costs of implementing the agricultural water conservation strategies across Region O (Table 5-55). The capital costs have been estimated for implementation in three phases for decades 2020, 2040, and 2060. Annual costs were estimated with 5.5 percent interest for 20 years of debt service as specified in the UCM.

**Table 5-55. Estimated Capital Costs and Annual Costs for Irrigation Water Conservation
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County	Cost Component	Estimated Costs ($)					
		Phase 1		Phase 2		Phase 3	
		2020	2030	2040	2050	2060	2070
Bailey	Capital cost	923,150	—	1,326,000	—	1,376,175	—
	Annual cost	77,249	77,249	110,959	110,959	115,157	115,157
	Unit cost [a]	42	42	42	42	42	42
Briscoe	Capital cost	833,375	—	949,650	—	1,236,975	
	Annual cost	69,736	69,736	79,466	79,466	103,509	103,509
	Unit cost [a]	42	42	42	42	42	42
Castro	Capital cost	3,126,300	—	4,175,200	—	4,239,150	—
	Annual cost	261,607	261,607	349,378	349,378	354,729	354,729
	Unit cost [a]	42	42	42	42	42	42
Cochran	Capital cost	884,150	—	1,488,350	—	1,821,225	—
	Annual cost	73,985	73,985	124,544	124,544	152,399	152,399
	Unit cost [a]	42	42	42	42	42	42
Crosby	Capital cost	2,757,000	—	5,089,750	—	6,997,500	—
	Annual cost	230,704	230,704	425,907	425,907	585,546	585,546
	Unit cost [a]	42	42	42	42	42	42
Dawson	Capital cost	2,705,075	—	4,805,150	—	6,446,475	—
	Annual cost	226,359	226,359	402,092	402,092	539,437	539,437
	Unit cost [a]	42	42	42	42	42	42
Deaf Smith	Capital cost	2,731,900	—	4,103,250	—	4,009,275	—
	Annual cost	228,604	228,604	343,357	343,357	335,493	335,493
	Unit cost [a]	42	42	42	42	42	42
Dickens	Capital cost	240,200	—	467,900	—	692,475	—
	Annual cost	20,100	20,100	39,154	39,154	57,946	57,946
	Unit cost [a]	42	42	42	42	42	42
Floyd	Capital cost	3,060,700	—	5,513,250	—	7,416,375	—
	Annual cost	256,117	256,117	461,345	461,345	620,597	620,597
	Unit cost [a]	42	42	42	42	42	42
Gaines	Capital cost	5,781,375	—	6,153,000	—	4,822,200	—
	Annual cost	483,782	483,782	514,879	514,879	403,518	403,518
	Unit cost [a]	42	42	42	42	42	42
Garza	Capital cost	291,875	—	516,250	—	695,625	—
	Annual cost	24,424	24,424	43,199	43,199	58,209	58,209
	Unit cost [a]	42	42	42	42	42	42

[a] Unit costs are per acre-foot per year of water — = Zero cost for the program in this decade.

**Table 5-55. Estimated Capital Costs and Annual Costs for Irrigation Water Conservation
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County	Cost Component	Estimated Costs ($)					
		Phase 1		Phase 2		Phase 3	
		2020	2030	2040	2050	2060	2070
Hale	Capital cost	3,283,025	—	6,166,050	—	8,266,275	—
	Annual cost	274,721	274,721	515,971	515,971	691,716	691,716
	Unit cost [a]	42	42	42	42	42	42
Hockley	Capital cost	2,089,125	—	3,043,100	—	4,158,300	—
	Annual cost	174,817	174,817	254,645	254,645	347,964	347,964
	Unit cost [a]	42	42	42	42	42	42
Lamb	Capital cost	3,152,600	—	4,215,200	—	3,583,500	—
	Annual cost	263,807	263,807	352,725	352,725	299,865	299,865
	Unit cost [a]	42	42	42	42	42	42
Lubbock	Capital cost	2,855,550	—	4,055,500	—	5,469,900	—
	Annual cost	238,951	238,951	339,362	339,362	457,718	457,718
	Unit cost [a]	42	42	42	42	42	42
Lynn	Capital cost	2,114,800	—	3,788,350	—	5,086,275	—
	Annual cost	176,965	176,965	317,007	317,007	425,616	425,616
	Unit cost [a]	42	42	42	42	42	42
Motley	Capital cost	242,525	—	485,300	—	727,950	—
	Annual cost	20,294	20,294	40,610	40,610	60,914	60,914
	Unit cost [a]	42	42	42	42	42	42
Parmer	Capital cost	1,427,150	—	1,279,600	—	1,731,375	—
	Annual cost	119,423	119,423	107,076	107,076	144,880	144,880
	Unit cost [a]	42	42	42	42	42	42
Swisher	Capital cost	2,486,550	—	3,127,250	—	3,961,050	—
	Annual cost	208,073	208,073	261,686	261,686	331,458	331,458
	Unit cost [a]	42	42	42	42	42	42
Terry	Capital cost	3,600,550	—	4,129,250	—	2,457,825	—
	Annual cost	301,292	301,292	345,533	345,533	205,669	205,669
	Unit cost [a]	42	42	42	42	42	42
Yoakum	Capital cost	1,385,675	—	1,524,050	—	1,248,525	—
	Annual cost	115,952	115,952	127,531	127,531	104,476	104,476
	Unit cost [a]	42	42	42	42	42	42

[a] Unit costs are per acre-foot per year of water — = Zero cost for the program in this decade.

5.3.3.3 *Environmental Impacts*

Environmental impacts associated with this strategy for each of the 21 counties have been quantified in the impact matrix (Appendix 5E) and are summarized in Table 5-5. The environmental impacts of implementing agricultural water conservation strategies will be minimal, since these strategies largely include changing management practices as opposed to widespread land disturbance. Impacts to the environment due to the implementation of agricultural water conservation strategies are expected to be positive, as they will conserve the groundwater resources, potentially reduce erosion, and improve soil quality.

5.3.3.4 *Implementation*

A range of implementation issues are associated with agricultural water conservation strategies:

- The cost of their implementation
- The difficulty in changing irrigation practices that have been followed for years (e.g., using over-irrigation as a delivery for fertilizer)
- The complexity of new technologies and the time it takes to learn a new technology, which can both be a deterrent
- The Federal Crop Insurance program, which can be a disincentive to conserve water
- Issues associated with renter-operated vs. owner-operated fields, with renters being less willing to make investments in infrastructure and new technology and owners not wanting acreage to remain fallow

With irrigation accounting for the largest water demands in the region, conservation has the potential for significant water savings, and implementation of conservation as a strategy will extend the longevity of the aquifers in Region O. The implementation of agricultural water conservation strategies is voluntary, and individual producers would have to implement and pay for such strategies. Without financial and technical assistance, it is unlikely that these conservation strategies will be widely implemented. In their *Assessment of Water Conservation* report to the 82nd Legislature, the TWDB and Texas State Soil and Water Conservation Board (TSSWCB) stated that economic incentives are needed to encourage the early adoption of voluntary agricultural water conservation BMPs, and their report recommended that the Texas

Legislature continue to fund and to expand the State Water Supply Enhancement Program (TWDB and TSSWCB, 2012).

The LERWPG supports the efforts and continued funding of the TAWC program, with possible future expansion. The program's methods of involving producers and providing public education and training are seen as the best way to implement agricultural water conservation strategies going forward.

5.4 Recommended Strategies for the City of Lubbock

5.4.1 Bailey County Well Field Capacity Maintenance

5.4.1.1 Project Description

The Bailey County Well Field (BCWF) consists of 175 active wells with a production capacity that has decreased from 50 mgd in 2010 to 38 mgd in 2012. The City of Lubbock has two goals for the BCWF:

- To maintain a target well field capacity of 50 mgd. Although the capacity of the pipeline from the well field to the City of Lubbock is only 40 mgd, maintaining a well field capacity that is greater than the pipeline capacity gives the City operational flexibility to rotate and repair wells as needed.

- To reserve this well field for peaking in the summer months (June through August, or approximately 120 days).

The *Updated Bailey County Well Field Modeling Report,* completed by DBS&A in September 2012, recommends a production rate of 7,000 ac-ft/yr or less for the BCWF in order for the City to meet its two goals. However, due to drought and the loss of storage in Lake Meredith, Lubbock has been forced to exceed the production rate by as much as two to three times this recommended volume. For the purposes of this strategy, Lubbock assumes a production rate of 10,000 ac-ft/yr, a goal that is considered realistic given past consumption.

This strategy will be completed in phases:

- In the first phase (Initial Capacity Maintenance), the capacity of the well field will be restored to 50 mgd from the 2012 capacity of 38 mgd. The Initial Capacity Maintenance phase includes the installation of 34 new wells that will be drilled to an average depth of 220 feet and are assumed to have an average production rate of 250 gpm. The new wells will be located in areas where the City of Lubbock already owns groundwater rights. This phase has a lifespan of 10 years.

- Subsequent phases (Capacity Maintenance–1, Capacity Maintenance–2, etc.) will maintain the well field's capacity for 10-year increments. The 2012 DBS&A report suggests that 10 new wells will be needed every 10 years to maintain the target capacity of the BCWF, assuming a well field production rate of 10,000 ac-ft/yr. Therefore, each capacity maintenance phase will include the installation of 10 new wells, of the same depth and with the same production rate as the Initial Capacity Maintenance wells. All wells will be located in areas where the City of Lubbock already owns groundwater rights.

Figure 5-2 shows the approximate locations of the new wells and the pipeline for the Initial Capacity Maintenance phase.

For comparison in pricing to other strategies, this strategy is limited to a 20-year project life (i.e., Initial Capacity Maintenance and Capacity Maintenance–1). To execute this strategy, Lubbock will need to build the following infrastructure:

- 34 wells during the Initial Capacity Maintenance phase
- 15.5 miles of 6- to 24-inch collector pipeline for the Initial Capacity Maintenance phase
- 10 wells during the Capacity Maintenance–1 phase
- 3.8 miles of 6- to 24-inch collector pipeline for the Capacity Maintenance–1 phase

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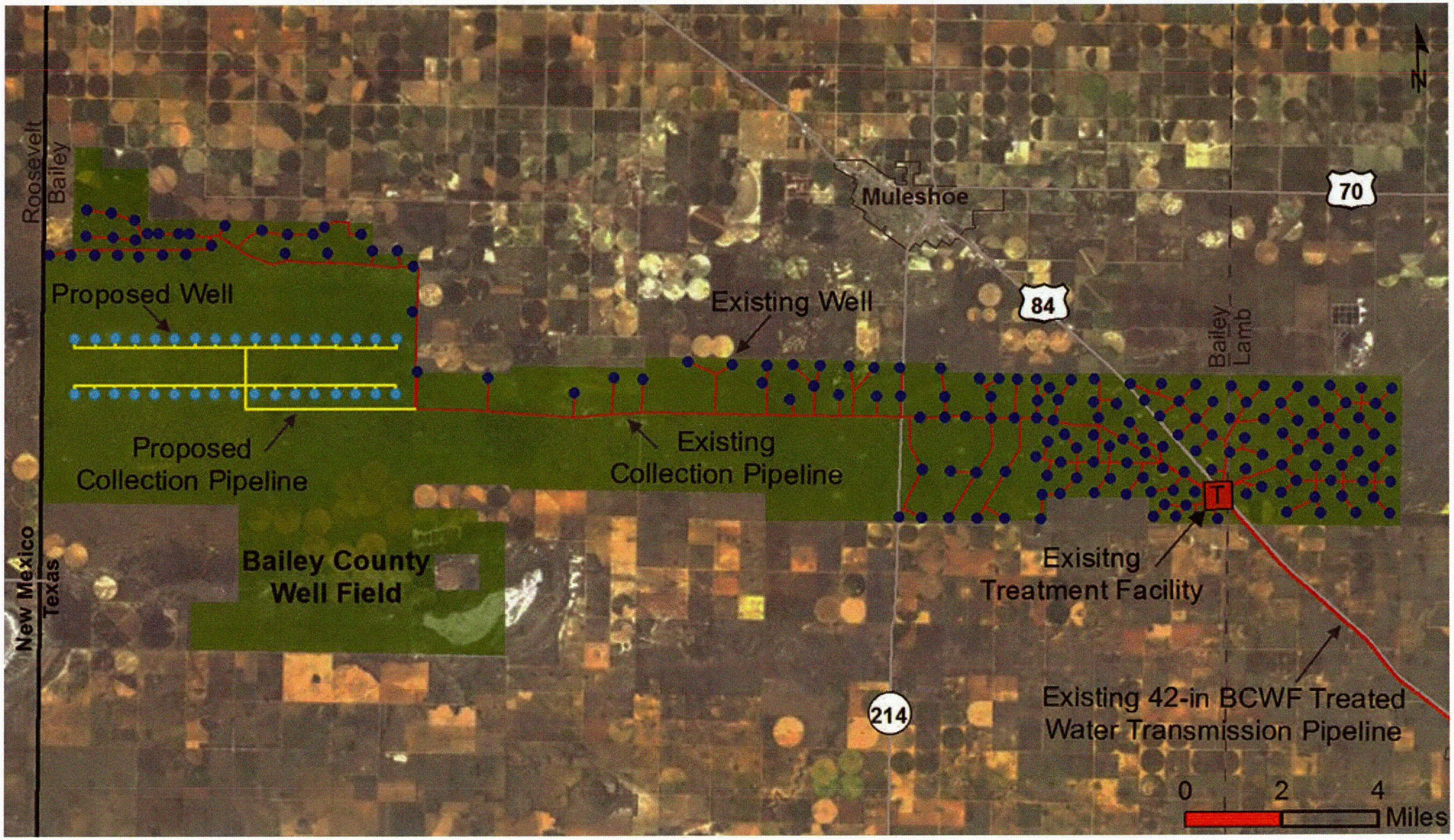

Source: City's Strategic Water Supply Plan (City of Lubbock, 2013)

LLANO ESTACADO REGION

Potential New Well Locations for BCWF Capacity Maintenance Strategy

Daniel B. Stephens & Associates, Inc.
10/27/2015
JN WR11.0030

Figure 5-2

5.4.1.2 Quantity of Water

While the goal of this strategy is to maintain the BCWF's target capacity of 50 mgd and annual production rate of 10,000 ac-ft/yr, the contribution of each phase of this capacity maintenance strategy can be calculated.

In the Initial Capacity Maintenance phase, the 34 new wells will each have an average production rate of 250 gpm, providing a total capacity of 12 mgd, which is 24 percent of the well field's 50-mgd target capacity (12 ÷ 50 = 0.24). Given the assumed production rate from the BCWF of 10,000 ac-ft/yr, the Initial Capacity Maintenance phase of this strategy will provide Lubbock with 2,400 ac-ft/yr.

All subsequent capacity maintenance phases (Capacity Maintenance–1, Capacity Maintenance–2, etc.) include the installation of 10 wells every 10 years. The 10 new wells will each have an average production rate of 250 gpm, providing a total capacity of 3.6 mgd, constituting 7 percent of the well field's 50-mgd target capacity (3.6 ÷ 50 = 0.07). Given the well field's assumed production rate of 10,000 ac-ft/yr, each capacity maintenance phase of this strategy will provide Lubbock with 720 ac-ft/yr.

The quantity of water available for this strategy is limited in decades 2020 through 2040. Table 5-56 provides the estimated annual yield of this strategy during the planning period based on completion of two phases (Initial Capacity Maintenance in 2020 and Capacity Maintenance-1 in 2030). Water losses associated with this strategy are expected to be minimal, 7 percent or less.

Table 5-56. Estimated Water Supply from BCWF Capacity Maintenance

	Estimated WMS Water Supply (ac-ft/yr)					
Phase	2020	2030	2040	2050	2060	2070
Initial CM	997 [a]	997 [a]	2,400	2,400	2,400	2,400
CM-1	—	146 [a]	422 [a]	720	720	720
Total	997	1,143	2,822	3,120	3,120	3,120

[a] Supply amount reduced due to limited groundwater availability for this decade. — = System not yet online.

5.4.1.3 Strategy Cost

A detailed cost estimate summary for the Initial Capacity Maintenance and the first subsequent phase (Capacity Maintenance–1) is presented in Table 5-57. General cost estimating assumptions made for all the recommended City of Lubbock strategies are provided in Appendix 5F. Specific assumptions made in developing the updated costs for the BCWF Capacity Maintenance strategy include:

- Hydraulic calculations from Lubbock *Strategic Water Supply Plan* (City of Lubbock, 2013) were assumed to be correct.
- Delivery pressure was assumed to be 30 pounds per square inch (psi) at the connection to the original well field.

Due to the water availability limitations in decades 2020 through 2040, the annual unit costs for this strategy are greater than those estimated based on the design capacity (Table 5-57). The estimated annual unit costs of this strategy during the planning period based on completion of two phases (Initial Capacity Maintenance in 2020 and Capacity Maintenance–1 in 2030) are:

- Decade 2020: $2,028
- Decade 2030: $2,305
- Decade 2040: $352
- Decades 2050 through 2070: $160

5.4.1.4 Implementation Issues

Lubbock owns the groundwater rights in 83,305 contiguous acres in Bailey and Lamb counties. New wells will be drilled in this area; therefore, no additional water right permits are needed. Other permitting-related requirements include:

- Well drilling permits will be needed from the High Plains UWCD No. 1.
- The design of the new wells and collection pipelines must be approved by the TCEQ.

Owners of groundwater rights are allowed to make improvements to the surface in order to extract and convey their groundwater. Therefore, Lubbock will not need to acquire any property to drill wells or install collection pipelines.

Table 5-57. Bailey County Well Field Capacity Maintenance Cost Estimate Summary

Costs adjusted from HDR costs [a] (March 2012 prices) using an ENR CCI of 9552 for September 2013

Item	Costs (Sept 2013 Prices)		
	Initial CM	Future CM–1	Total
Capital Costs			
Initial CM well field (34 wells, 250 gpm) [b]	$ 9,225,000		$ 9,225,000
Well collection system (15.5 miles 6-, 8-, 12-, 24-inch)	4,521,000		4,521,000
CM–1 well field (10 wells, 250 gpm) [b]		$ 2,714,000	2,714,000
Well collection system (3.8 miles 6-, 8-, 12-, 16-inch)		1,435,000	1,435,000
Capital Cost Subtotal	$13,746,000	$ 4,149,000	$ 17,895,000
Engineering, legal costs and contingencies	4,811,000	1,452,000	6,263,000
Environmental and archaeology studies and mitigation [c]	400,000	98,000	498,000
Land acquisition and surveying (17 acres) [d]	0	0	0
Interest during construction (1 year)	663,000	199,000	863,000
Total Project Cost	$19,620,000	$ 5,898,000	$25,519,000
Annual Costs			
Debt service (5.5%, 20 years)	$ 1,642,000	$ 494,000	$ 2,135,000
Operation and maintenance			
Intake, pipeline, pump station	137,000	41,000	179,000
Pumping energy costs ($0.09 per kWh) [e]	242,587	78,192	320,779
Purchase of water	0	0	0
Total Annual Costs	$ 2,021,587	$ 613,192	$ 2,634,779
Available project yield (ac-ft/yr) [f]	2,400	720	3,120
Annual cost of water ($ per acre-foot) [f]	$ 842.33	$ 852	$ 844
Annual cost of water ($ per 1,000 gallons) [f]	$ 2.59	$ 2.61	$ 2.59

[a] HDR estimate provided in City of Lubbock 2013 *Strategic Water Supply Plan*

CM = Capacity Maintenance

[b] Well costs are based on a typical well 220 feet deep, 50-foot depth to water with 100-foot pumping drawdown, and total dynamic head (TDH) of 172 feet.

[c] Environmental costs are assumed at $26,000 per mile for the pipeline

[d] Land acquisition is not required; the City owns the property on which the proposed improvements will be located.

[e] 2,695,411 kWh for initial 34 wells; 866,800 kWh for 10 future wells

[f] Yield and annual unit cost based on design capacity; implementation of strategy prior to decade 2040 is limited by groundwater availability.

5.4.1.5 Environmental Impacts

Environmental impacts associated with this strategy have been quantified in the impact matrix (Appendix 5E) and are summarized in Table 5-5. A detailed environmental study will be needed to determine the level of environmental impact due to the construction of well field structures and pipelines in Bailey and Lamb counties. To the extent possible, the locations of wells and collector pipelines should be selected to avoid significant environmental impacts.

5.4.2 Canadian River Municipal Water Authority Aquifer Storage and Recovery

5.4.2.1 Project Description

This strategy is based on a 2011 CDM Smith report titled *Canadian River Municipal Water Authority Aquifer Storage and Recovery Facility: Project Delivery Plan.* The purpose of the project is to alleviate pressure on the CRMWA system by making Lubbock's water demands on that system more consistent throughout the year. High summer demand from Lubbock and the other member cities currently puts more pressure on the CRMWA system during the summer and requires infrastructure with a higher capacity to handle the peaks. This project may also delay capacity maintenance projects in the Roberts County Well Field (RCWF) and could remove the need for additional capacity in the transmission pipelines and/or aqueduct.

The project will be implemented after the construction of the second transmission pipeline from the RCWF to the CRMWA aqueduct, at which point Lubbock's CRMWA allocation will be 45,671 ac-ft/yr. Lubbock will build an aquifer storage and recovery (ASR) well field 2 miles east of the North Water Treatment Plant (NWTP) to store water purchased from CRMWA during the winter months. This CRMWA water will be treated at Lubbock's NWTP, transported to the new ASR well field, and injected into the Ogallala Aquifer for storage. The water will be recovered from the Ogallala Aquifer in the summer months when demand is higher. After recovery, the water will be transported back to the NWTP where it will be disinfected and blended with other treated CRMWA water for distribution.

The ASR well field will consist of 45 ASR wells, including 5 contingency wells, drilled at least 1,200 feet apart from each other. A storage tank will be needed at the ASR site, as well as three new pump stations:

- One at the NWTP to transport water from the NWTP to the ground storage facility at the ASR well field
- One at the ASR well field to transport water from the ground storage facility to the ASR injection wells
- Another one at the ASR well field to deliver recovered ASR water to the NWTP

A two-way transmission pipeline will connect the NWTP and the ASR well field. A chlorination-only treatment facility will be needed at the NWTP site to disinfect the ASR water after recovery from the Ogallala Aquifer. Figure 5-3 shows a map of this strategy.

To execute this strategy, Lubbock will need to build the following infrastructure:

- 45 ASR wells, each with a 700-gpm capacity
- 11 miles of collection pipelines, 8 through 48 inches in size
- A 4.0-million gallon ground storage tank
- Three new pump stations (40 mgd each, 14 hp, 500 hp, and 200 hp)
- 3 miles of 48-inch transmission pipeline

5.4.2.2 Quantity of Water

Lubbock estimates that 50 percent of the water purchased from CRMWA during the four winter months will be available for injection into the Ogallala Aquifer. Given the City's anticipated CRMWA allocation of 45,671 ac-ft/yr, Lubbock will have approximately 7,612 ac-ft/yr available for injection in ASR wells (45,671-acre-foot allocation ÷ 12 months = 3,805 acre-feet per month x 4 months = 15,224 acre-feet x 50 percent available for ASR = 7,612 acre-feet). Water loss to nearby irrigation and domestic wells is assumed to be 20 percent. Therefore, the estimated amount of annual recovery is 6,090 ac-ft/yr.

Recovery is planned only during June through September, the highest water demand months. Peak capacity during these months will be 40 mgd, providing a peaking factor of 2.4.

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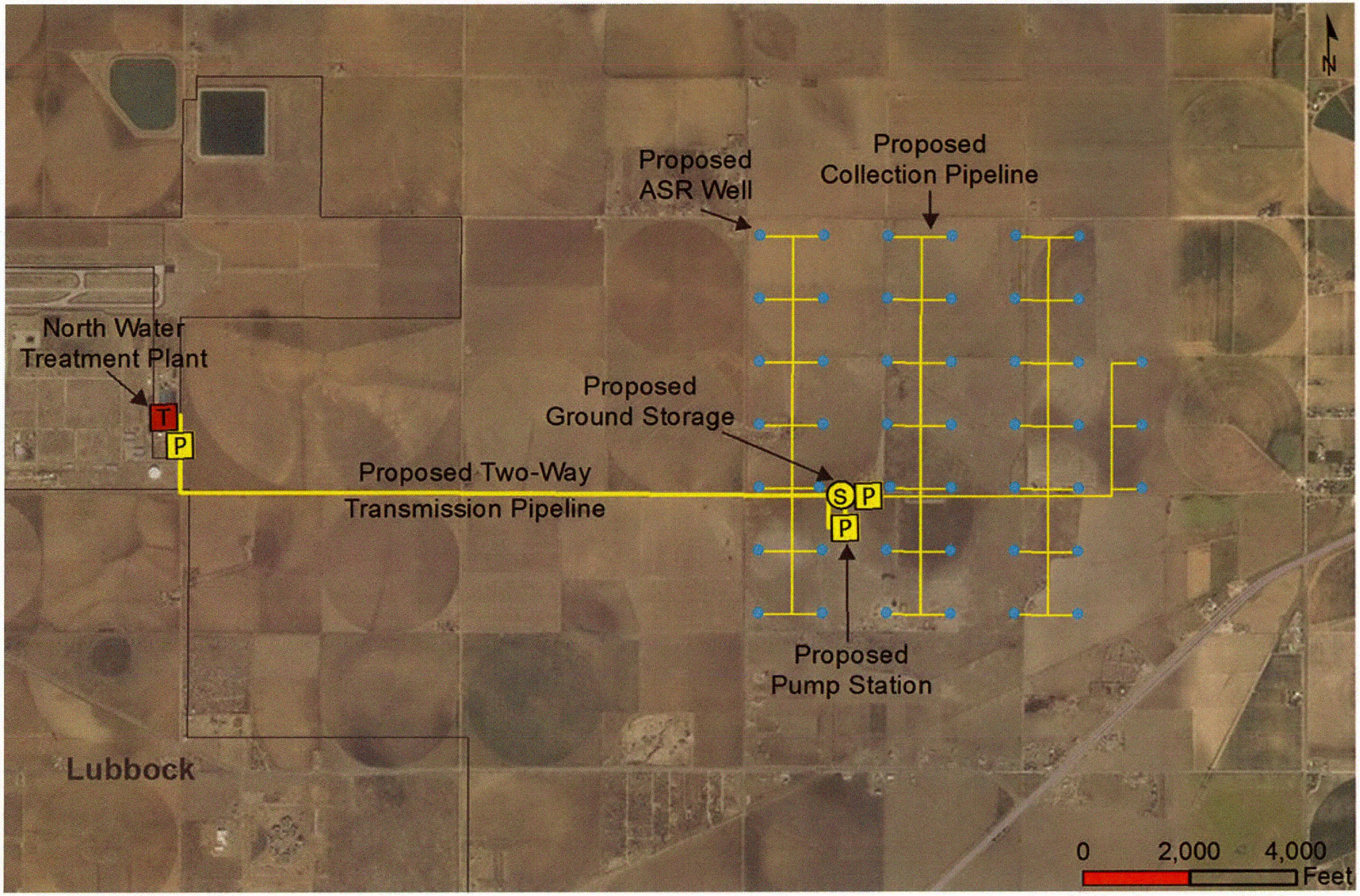

Source: City's Strategic Water Supply Plan (City of Lubbock, 2013)

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CRMWA to Aquifer Storage and Recovery Infrastructure

Figure 5-3

5.4.2.3 Strategy Cost

Table 5-58 summarizes the updated costs for the CRMWA ASR strategy. General cost estimating assumptions made for all the recommended City of Lubbock strategies are provided in Appendix 5F.

Table 5-58. Canadian River Municipal Water Authority Aquifer Storage and Recovery Cost Estimate Summary

Costs adjusted from HDR costs[a] (March 2012 prices) using an ENR CCI of 9552 for September 2013

Item	Costs (Sept 2013 Prices)
Capital Costs	
Pump station at water treatment plant (140 hp)	$ 1,771,000
Pump station and ground storage at ASR well field (500-hp BPS, 4-M-gal storage)	4,308,000
Pump station at ASR well field to ASR wells (200-hp BPS, 2-M-gal storage)	1,493,000
Transmission pipeline (48-inch, 3 miles [SWTP and ASR well field])	4,694,000
ASR well field	
45 ASR wells (220 feet deep, 700 gpm capacity)	20,307,000
11 miles of collector pipelines (8-, 12-, 14-, 16-, 20-, 24-, 36-, 42-, and 48-inch)	3,373,000
Power connection cost	928,000
Water treatment plant (40 mgd, chlorination only)	1,762,000
ASR well field SCADA, valving and pumps	1,031,000
Capital Cost Subtotal	$ 39,667,000
Engineering, legal costs and contingencies	13,480,000
Environmental and archaeology studies and mitigation	3,376,000
Land acquisition and surveying (1,470 acres)[b]	3,714,000
Interest during construction (1 year)	2,108,000
Total Project Cost	$ 62,345,000
Annual Costs	
Debt service (5.5%, 20 years)	$ 5,217,000
Operation and maintenance	
Intake, pipeline, pump station	465,000
Water treatment plant	264,000
Pumping energy costs (6,254,308 kWh at $0.09 per kWh)[c]	747,970
Purchase of water[d]	0
Total Annual Costs	$ 6,693,970

Table 5-58. Canadian River Municipal Water Authority Aquifer Storage and Recovery Cost Estimate Summary (continued)

Costs adjusted from HDR costs[a] (March 2012 prices) using an ENR CCI of 9552 for September 2013

Item	Costs (Sept 2013 Prices)
Available project yield (ac-ft/yr)	6,090
Annual cost of water ($ per acre-foot)	$ 1,099
Annual cost of water ($ per 1,000 gallons)	$ 3.37

[a] HDR estimate provided in City of Lubbock 2013 *Strategic Water Supply Plan*
[b] Land acquisition costs are based on 40-foot ROW and $8,930 per acre for pipeline, and 1.5 mi x 1.5 mi (1,440 acres) at $2,252 per acre for wells. Survey cost is 10% of land value.
[c] Includes pump stations and system losses, and 10% run time on 40 ASR well pumps (5 wells are contingency)
[d] Raw water will be provided at no cost to the ASR project.

5.4.2.4 Implementation Issues

No ASR projects have been implemented within the High Plains UWCD No. 1 boundaries. The District will need to develop and publicize rules for ASR projects.

Permitting-related issues associated with the project include:

- Lubbock will need to acquire groundwater rights in the proposed ASR site.
- Once groundwater rights are acquired, Lubbock will need permits from the High Plains UWCD No. 1 in order to drill wells.
- The design of the new wells and collection pipelines must be approved by the TCEQ.

5.4.2.5 Environmental Impacts

Environmental impacts associated with this strategy have been quantified in the impact matrix (Appendix 5E) and are summarized in Table 5-5. A detailed environmental study will be needed to determine the level of environmental impact due to the construction of ASR well field structures and pipelines in Lubbock County. To the extent possible, the location of the ASR site and transmission pipeline route should be selected to avoid significant environmental impacts.

5.4.3 South Lubbock Well Field

This strategy is based on information from two different reports:

- *Groundwater Treatment Plant Engineering Report*, completed by Parkhill, Smith & Cooper and Black & Veatch in May 2006
- *Groundwater Utilization Study*, completed by DBS&A in March 2007

5.4.3.1 Project Description

In the southern part of the City of Lubbock, groundwater levels in the Ogallala Aquifer are relatively high and saturated thickness is relatively large. The proposed South Lubbock Well Field will draw upon this water during the summer months to help the City meet its peak demands. The well field will consist of 17 new wells (2 of which are contingency wells) drilled to approximately 135 feet on property already owned by the City. The wells are assumed to have an average production rate of 325 gpm (0.47 mgd).

The groundwater under the City has a high salinity (total dissolved solids [TDS] of 470 to >1,600 mg/L) and is potentially "under the influence of surface water," requiring advanced treatment. Therefore, after extraction, the groundwater will be collected and transported by pipeline to a new advanced water treatment plant equipped with microfiltration and RO. For an operational capacity of 7.0 mgd of potable water, 7.2 mgd of raw water is required, with the balance of 0.2 mgd becoming concentrate. A disposal well completed in the Dockum Aquifer will be necessary to dispose of the desalination concentration from the RO. Depth to base of the best Dockum sandstone is about 1,900 feet, and groundwater in the Dockum has an estimated TDS of 25,000 mg/L. The treatment plant and disposal well will be located on the same property as Pump Station #10.

After advanced treatment, which is expected to produce a composite raw water with a TDS concentration below the secondary MCL of 1,000 mg/L, the water will be discharged into the existing ground storage tank at the pump station for blending and distribution into Lubbock's system. Because Pump Station #10 does not have the capacity to handle its existing supply and the proposed new supply, Lubbock will have to redirect water that would have originally come to this pump station to other parts of the City's system. Figure 5-4 shows a map of this strategy.

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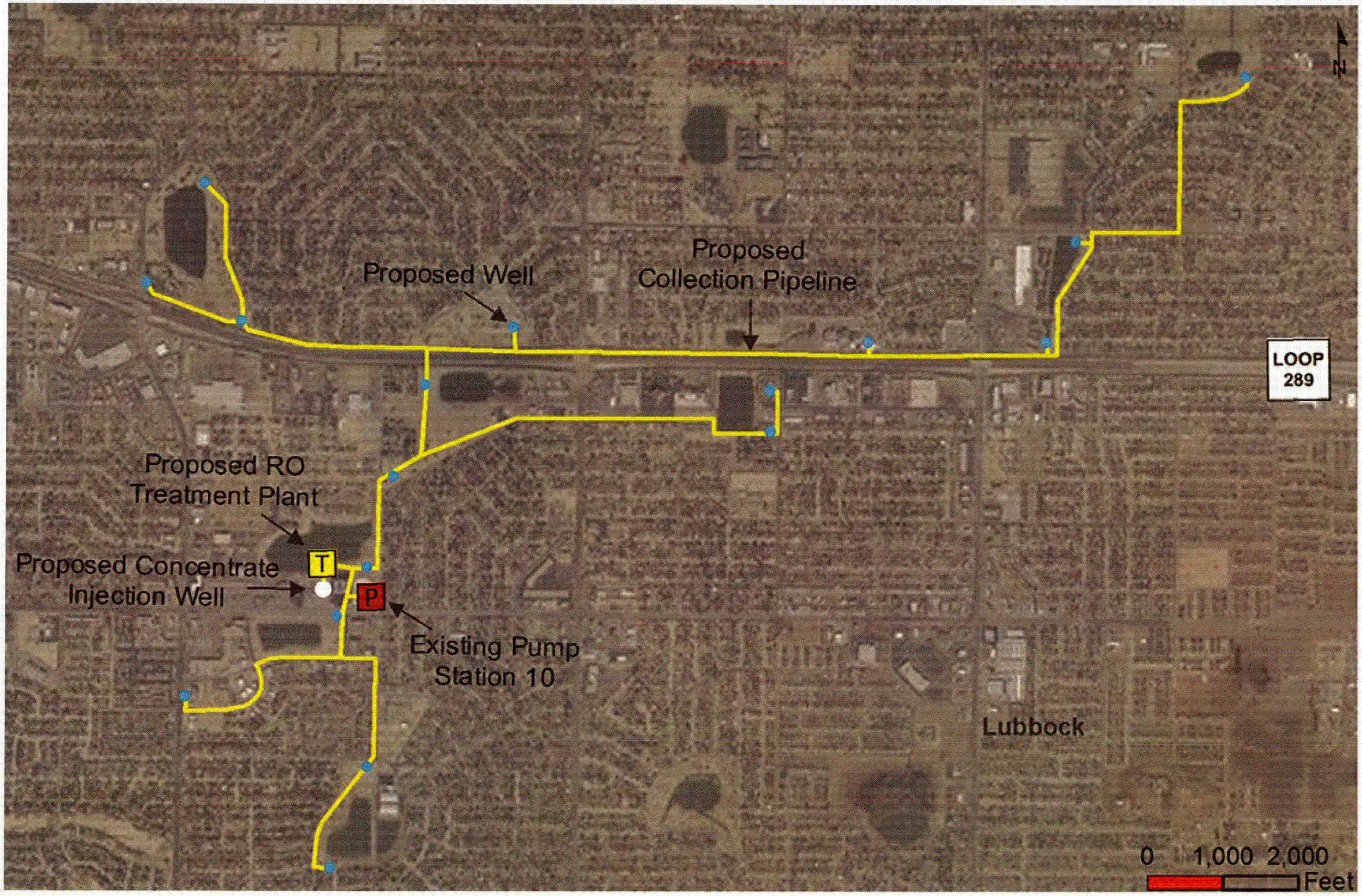

Source: City's Strategic Water Supply Plan (City of Lubbock, 2013)

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South Lubbock Well Field Infrastructure

Figure 5-4

To execute this strategy, Lubbock will need to build the following infrastructure:

- 17 new wells of 325-gpm capacity
- 7 miles of 6- to 18-inch-diameter collector pipeline
- An advanced water treatment plant
- A disposal well completed to 1,900 feet in the Dockum Aquifer

5.4.3.2 Quantity of Water

This strategy is designed to help Lubbock meet its summer (June through September) peak demands. The well field is estimated to produce 7.0 mgd (2,613 acre-feet) during its four months of operation. Water losses associated with this strategy are expected to be minimal, 7 percent or less.

The City has concerns about the sustainability of this well field over time. More studies are needed to determine the longevity of this strategy.

5.4.3.3 Strategy Cost

Table 5-59 summarizes the updated costs for the South Lubbock Well Field strategy. General cost estimating assumptions made for all the recommended City of Lubbock strategies are provided in Appendix 5F.

5.4.3.4 Implementation Issues

Permitting issues associated with the South Lubbock Well Field strategy include:

- Water well permits will be needed from the High Plains UWCD No. 1.
- The design of the new wells and collection pipelines must be approved by the TCEQ.
- Authorization to build and operate a concentrate disposal well will be required from the TCEQ.

Table 5-59. South Lubbock Well Field
Cost Estimate Summary

Costs adjusted from HDR costs[a] (March 2012 prices) using an ENR CCI of 9552 for September 2013

Item	Costs (Sept 2013 Prices)
Capital Costs	
Well field	
17 Ogallala wells (135 feet deep, 325-gpm capacity)[b]	5,042,000
7 miles of collector pipelines (6-, 8-, 10-, 12-, 16-, and 18-inch)	1,585,000
Power connection	175,000
Disposal well (1 Dockum well, 200 feet of pipeline)	778,000
Advanced water treatment plant (7.2 mgd)	30,837,000
Distribution improvements: Interconnect to existing ground storage tank	52,000
Capital Cost Subtotal	$ 38,469,000
Engineering, legal costs and contingencies	13,385,000
Environmental and archaeology studies, permitting and restoration[c]	181,000
Land acquisition and surveying (14 acres)[d]	0
Interest during construction (1 year)	1,821,000
Total Project Cost	$ 53,856,000
Annual Costs	
Debt service (5.5%, 20 years)	$ 4,507,000
Operation and maintenance	
Wells and pipelines	76,000
Water treatment plant	1,979,000
Pumping energy costs (139,313 kWh at $0.09 per kWh)[e]	13,000
Purchase of water	0
Total Annual Costs	$ 6,575,000
Available project yield (ac-ft/yr)	2,613
Annual cost of water ($ per acre-foot)	$ 2,516
Annual cost of water ($ per 1,000 gallons)	$ 7.72

[a] HDR estimate provided in City of Lubbock 2013 *Strategic Water Supply Plan*
[b] An error to the HDR capital cost (an apparent spreadsheet reference error that excluded the well construction cost) was corrected.
[c] Environmental costs are assumed at $26,000 per mile for the pipeline
[d] Land acquisition is not required; the City owns the property on which the proposed improvements will be located. Survey cost is 10% of land value.
[e] Includes system losses and 10% run time on ASR well pumps, with 70% efficiency.

Other implementation issues include:

- The wells, treatment plant, and disposal well will be located on City-owned property; thus, Lubbock will not need to acquire any new property.
- This project is located within a developed part of the city, and pipelines will be located under City streets. Pipeline construction costs will therefore be higher as repairs to surface infrastructure will be required.

5.4.3.5 Environmental Impacts

Environmental impacts associated with this strategy have been quantified in the impact matrix (Appendix 5E) and are summarized in Table 5-5. The environmental impact of this strategy is expected to be small since all new infrastructure will be built within an urban area.

5.4.4 Brackish Well Field at South Water Treatment Plant

5.4.4.1 Project Description

Lubbock will install a new brackish well field on the existing 320-acre South Water Treatment Plant (SWTP) site, consisting of one well drilled in each corner of the SWTP property. This project is intended to be a supplemental source, designed to produce 1.0 mgd. The four wells will be drilled in the Santa Rosa portion of the Dockum Aquifer. No contingency wells are planned since this will not be a main source of water for the City. It is estimated that the Santa Rosa wells will need to be 1,900 feet deep (Bradley and Kalaswad, 2003) and will have an average production rate of 200 gpm (0.29 mgd) (Ewing et al., 2008) and a peak production rate of 300 gpm.

Groundwater in the Santa Rosa Formation is known to have a high salinity, although the exact TDS levels in the Lubbock area are unknown. Using sparse data, the TWDB GAM report (Ewing et al., 2008) estimates a TDS of 25,000 mg/L. Raw groundwater will be collected in pipelines and, with the aid of several pumps, be delivered directly to a new desalination RO plant to treat the brackish groundwater. After treatment, the water will have TDS of roughly 500 mg/L. The treated water will be transported through existing infrastructure to the SWTP for blending and distribution.

The Dockum wells will extract 1.17 mgd, of which 1.0 mgd will become potable water and 0.17 mgd will become concentrate, with a TDS of approximately 170,000 mg/L. The concentrate will be transported by pipeline from the desalination plant to a storage facility located next to two disposal wells on the east side of the SWTP property. A high-pressure pump will be used to deliver water from the storage tank to the two wells, through which the concentrate will be injected into the Permian Formation.

Figure 5-5 shows a map of this strategy.

To execute this strategy, Lubbock will need to build the following infrastructure:

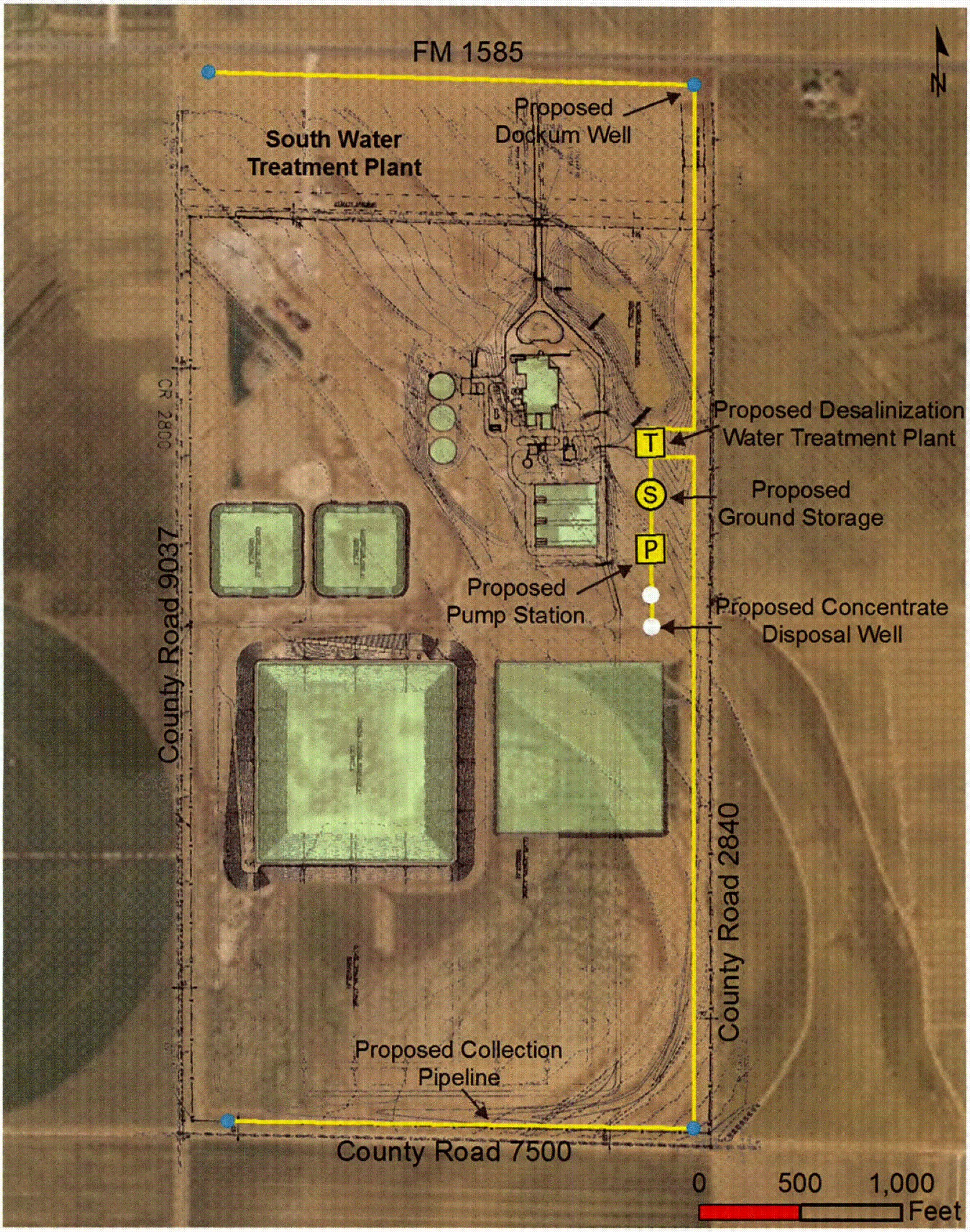
- Four Dockum Aquifer production wells, 200 gpm each
- 10,400 feet of 8-inch-diameter raw water collection pipelines
- Pumps to deliver raw water to desalination treatment plant
- A 1.5-mgd desalination treatment plant
- 8,300 feet of 6-inch-diameter concentrate disposal pipeline
- Ground storage tank for concentrate
- High pressure pump to transport concentrate from storage tank to Permian disposal wells
- Two Permian Formation disposal wells, 120 gpm each

5.4.4.2 Quantity of Water

This strategy is designed to provide 1,120 ac-ft/yr (1.0 mgd) of potable water. To provide this quantity of potable water, 1,310 ac-ft/yr (1.17 mgd) of raw water will need to be pumped from the Dockum Aquifer, with 190 ac-ft/yr lost to concentrate generation (85 percent recovery).

5.4.4.3 Strategy Cost

To develop costs for the Brackish Well Field at SWTP strategy, the following assumptions were made.



Source: City's Strategic Water Supply Plan (City of Lubbock, 2013)

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Brackish Well Field Infrastructure

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Figure 5-5

- The production rate of a high capacity Dockum well is 200 gpm, or 0.29 mgd (Ewing et al., 2008).

- The base of the Dockum Aquifer is 1,900 feet deep (Bradley and Kalaswad, 2003).
- Dockum groundwater has a TDS concentration of 25,000 mg/L (Ewing et al., 2008).
- The Permian disposal well will need to be approximately 5,000 feet deep.

The updated estimated costs, based on these and the general cost estimating assumptions made for all the recommended City of Lubbock strategies (Appendix 5F), are presented in Table 5-60.

5.4.4.4 Implementation Issues

Permitting issues associated with the Brackish Well Field at SWTP strategy include:

- Water well permits will be needed from the High Plains UWCD No. 1.
- The design of the new wells and collection pipelines must be approved by the TCEQ.
- Authorization to build and operate a concentrate disposal well will be required from the TCEQ.

Other implementation issues include:

- The wells, treatment plant, disposal well, and all pipelines will be located on City-owned property; therefore Lubbock will not need to acquire any new property or easements.
- There is a lack of data on the Permian Formation in the City's area, and it is unknown if the Permian can accept the required injection rate (1.75 mgd) for an extended period of time.

5.4.4.5 Environmental Impacts

Environmental impacts associated with this strategy have been quantified in the impact matrix (Appendix 5E) and are summarized in Table 5-5. The SWTP site was purchased as part of the LAH water supply project in 2009. The City completed environmental assessments for the

SWTP site before purchasing the property and submitted an Environmental Assessment for the SWTP site in July 2009. That assessment found no known impacts to wildlife habitats or cultural resources; therefore, environmental impacts are anticipated to be minimal for this project.

Table 5-60. Brackish Well Field at South Water Treatment Plant Cost Estimate Summary

Costs adjusted from HDR costs[a] (March 2012 prices) using an ENR CCI of 9552 for September 2013

Item	Costs (Sept 2013 Prices)
Capital Costs	
Concentrate pump station (21 hp with 0.18 M-gal storage)	$ 958,000
Well field (4 Dockum wells, 300 gpm, 1,900 feet deep)	3,137,000
Raw water piping (10,400 feet of 8 -inch) and concentrate disposal piping (8,300 feet of 6-inch)	532,000
Power connection cost	42,000
Concentrate well (2 Permian wells, 120 gpm, 5,000 feet deep)	3,710,000
Desalination water treatment (1.5 mgd)	16,355,000
Capital Cost Subtotal	$ 24,734,000
Engineering, legal costs and contingencies	8,630,000
Environmental and archaeology studies and mitigation	0
Land acquisition and surveying (13 acres)[b]	0
Interest during construction (1 years)	1,167,740
Total Project Cost	$ 34,531,740
Annual Costs	
Debt service (5.5%, 20 years)	$ 2,890,000
Operation and maintenance[c]	
Wells and pipelines	92,000
Water treatment plant	945,000
Pumping energy costs ($0.09 per kWh)[d]	184,000
Purchase of water	0
Total Annual Costs	$ 4,111,000
Available project yield (ac-ft/yr)	1,120
Annual cost of water ($ per acre-foot)	$ 3,671
Annual cost of water ($ per 1,000 gallons)	$ 11.26

[a] HDR estimate provided in City of Lubbock 2013 *Strategic Water Supply Plan*
[b] Land acquisition is not required; the City owns the property on which the proposed improvements will be located
[c] Operation and maintenance cost from Lubbock SWSP, projected to the current time period.
[d] Based on 95% run time for Dockum wells and 50% run time for disposal wells and 70% pump and motor efficiency.

5.4.5 Lake Alan Henry Phase 2

5.4.5.1 Project Description

Lake Alan Henry (LAH) is located on the South Fork of the Double Mountain Fork of the Brazos River (South Fork) and has a capacity of 94,808 acre-feet. A 2008 yield study by HDR concluded that the firm yield of the lake is 22,210 ac-ft/yr and the 2-year safe yield is 16,080 ac-ft/yr (City of Lubbock, 2013). Firm yield allows for full use of all available reservoir storage during the simulation period, while safe yield reserves one year of supply at the lowest point during the simulation period.

While the John T. Montford dam was completed in 1993, infrastructure projects to deliver raw water to the City were not initiated until 2007. Lubbock split the infrastructure construction into two phases.

LAH Phase 1 was completed in September 2012 and can deliver 8,000 ac-ft/yr to the City, with a peaking capacity of 15 mgd. LAH Phase 1 infrastructure includes:

- Two pump stations: the LAH Pump Station and the Post Pump Station
- A 42-inch, 22-mile raw water transmission pipeline from the LAH Pump Station to the Post Pump Station
- A 48-inch, 29-mile raw water transmission pipeline from the Post Pump Station to the SWTP
- Transmission lines that transport treated water from the SWTP to Pump Stations #8, #10, and #14

Initial construction of the raw water transmission pipeline included enough capacity for both Phase 1 and Phase 2, so no expansion of that pipeline will be needed for this strategy. In fact, Lubbock has additional capacity in this pipeline to accommodate a future project (such as the Post Reservoir, the North Fork Scalping Operation, the South Fork Discharge, or the North Fork Diversion to LAH Pump Station).

LAH Phase 2 will double the amount of water available to Lubbock. Infrastructure to be completed during this phase includes:

- Construction of the Southland Pump Station
- Expansion of the capacity at both the LAH and Post pump stations, from 15 mgd to 30 mgd
- Expansion of the capacity at the SWTP from 15 mgd to 30 mgd

Figure 5-6 shows a map of the proposed infrastructure for this strategy.

5.4.5.2 Quantity of Water

The current LAH Phase 1 infrastructure delivers 8,000 ac-ft/yr from the lake, with a peaking capacity of 15 mgd. Phase 2 infrastructure improvements will enable Lubbock to draw an additional 8,000 ac/ft/yr, for a total of 16,000 ac-ft/yr from the lake, with a peaking capacity of 30 mgd. Phase 2 will allow Lubbock to operate the lake just under its 2-year safe yield of 16,080 ac-ft/yr. Water losses associated with this strategy are expected to be minimal, 7 percent or less.

5.4.5.3 Strategy Cost

Table 5-61 summarizes the updated costs for the LAH Phase 2 strategy. General cost estimating assumptions made for all the recommended City of Lubbock strategies are provided in Appendix 5F.

5.4.5.4 Implementation Issues

Water Use Permit 4146 allows Lubbock to divert up to 35,000 ac-ft/yr from Lake Alan Henry; therefore, no additional permitting will be needed. However, design changes to the SWTP, pump stations, and transmission lines will need to be approved by the TCEQ.

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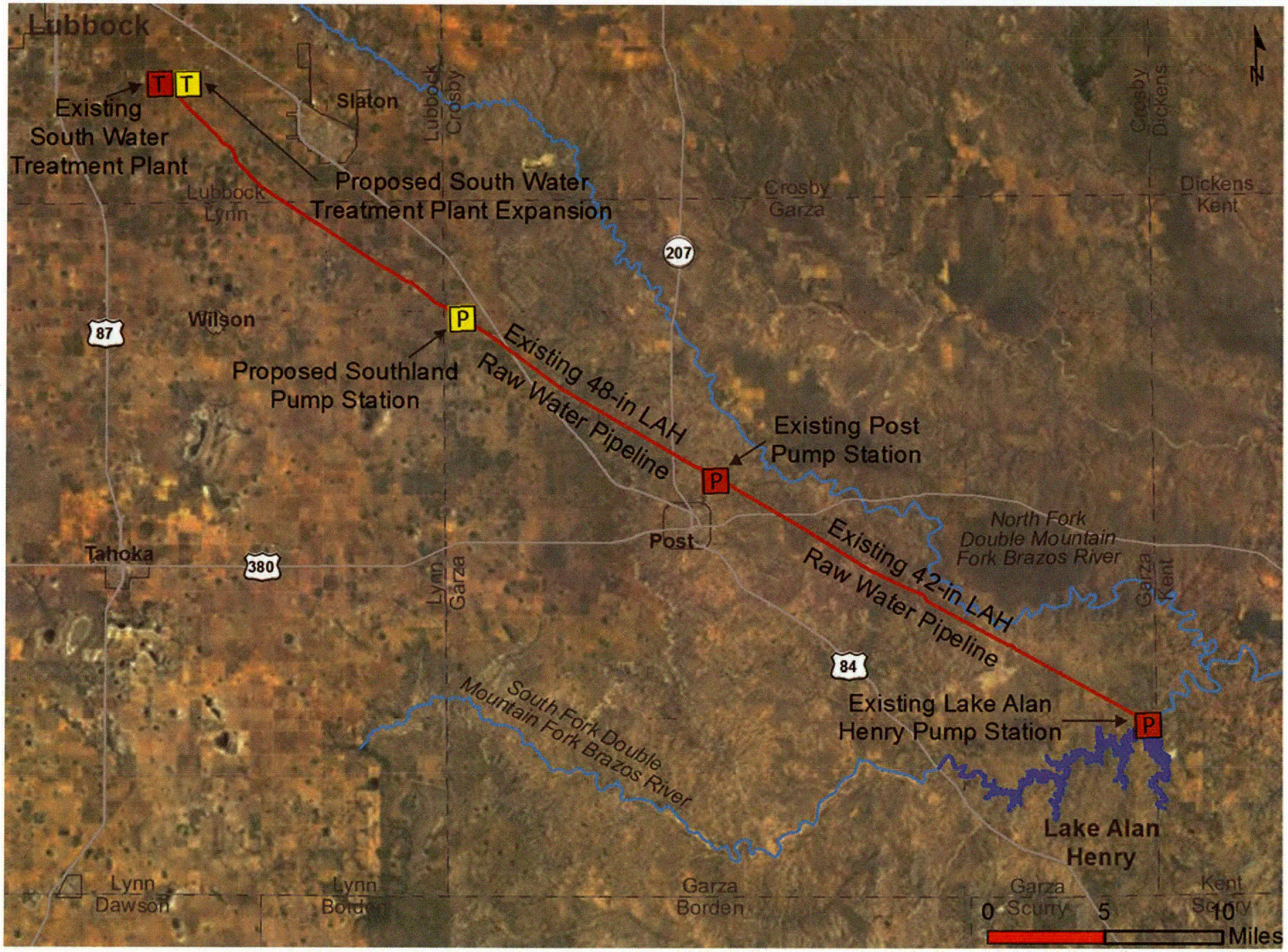

Source: City's Strategic Water Supply Plan (City of Lubbock, 2013)

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Lake Alan Henry Phase 2

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Figure 5-6

Table 5-61. Lake Alan Henry Phase 2 Cost Estimate Summary

Costs adjusted from HDR costs[a] (March 2012 prices) using an ENR CCI of 9552 for September 2013

Item	Costs (Sept 2013 Prices)
Capital Costs[b]	
LAH Pump Station expansion (additional 15 mgd, 2,200 hp)	$ 4,835,000
Post Pump Station expansion (additional 15 mgd, 1,250 hp)	3,433,000
Southland Pump Station construction (30 mgd, 3,600 hp)	7,122,000
Water treatment plant expansion (additional 15 mgd)	24,607,000
Capital Cost Subtotal	$ 39,997,000
Engineering, legal costs and contingencies	13,999,000
Environmental and archaeology studies and mitigation	10,000
Land acquisition and surveying (5 acres)[c]	12,000
Interest during construction (2 years)	3,781,000
Total Project Cost	$ 57,799,000
Annual Costs	
Debt service (5.5%, 20 years)	$ 4,837,000
Operation and maintenance	
Intake, pipeline, pump station[d]	400,000
SWTP expansion[e]	115,000
Pumping energy costs (42,986,983 kWh at $0.09 per kWh)[f]	1,934,000
Total Annual Costs	$ 7,286,000
Available project yield (ac-ft/yr)	8,000
Annual cost of water ($ per acre-foot)	$ 911
Annual cost of water ($ per 1,000 gallons)	$ 2.79

[a] HDR estimate provided in City of Lubbock 2013 *Strategic Water Supply Plan*
[b] The Lubbock SWSP states that facility component sizes were taken from a Freese and Nichols, Inc. Opinion of Probable Construction Cost provided to the City of Lubbock.
[c] Land acquisition is required for the Southland Pump Station only (5 acres); land cost is $2,000 per acre; surveying is 20% of land cost.
[d] 1% of the cost of facilities.
[e] 2.5% of the cost of facilities.
[f] Includes costs to pump the additional 7.1 mgd (8,000 ac-ft/yr) of water through the LAH Pump Station and LAH raw water pipeline; based on an average flow with a peaking factor of 2.

Other implementation issues associated with the LAH Phase 2 strategy are:

- The raw water transmission pipeline from the LAH Pump Station to the SWTP was constructed with enough capacity to accommodate LAH Phases 1 and 2, as well as another future project. Therefore, no changes are needed to this pipeline.
- Lubbock owns the property needed to construct the Southland Pump Station and the expansion to the SWTP.

5.4.5.5 Environmental Impacts

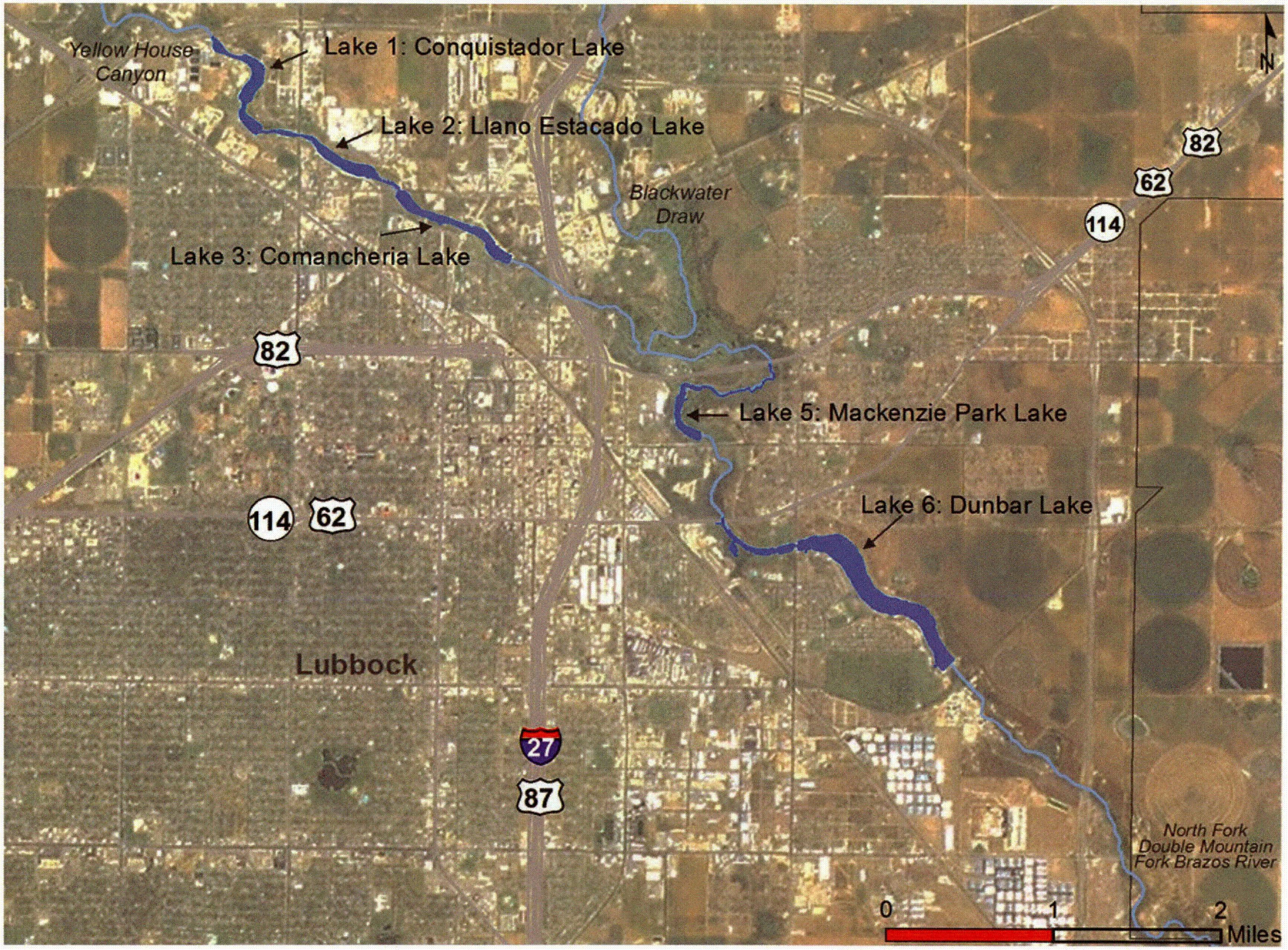
Environmental impacts associated with this strategy have been quantified in the impact matrix (Appendix 5E) and are summarized in Table 5-5. Environmental impacts are anticipated to be low, as the City completed several environmental assessments in order to construct LAH Phase 1 and mitigation for LAH has already been completed. One of those assessments, an overall environmental assessment for Phase 1, was approved by the TWDB, allowing the City to qualify for low-interest TWDB loans. The City also completed environmental assessments for the proposed Southland Pump Station site and the SWTP expansion site, and no sensitive wildlife habitats or cultural sites were identified. Therefore, no additional assessments should be needed at either of these two locations.

The USFWS's listing of the smalleye and sharpnose shiners as federally endangered since the completion of the City's environmental assessments is not anticipated to impact this strategy. While these species are located in Garza County, they have not been found in the lake or upstream of it on the South Fork (Figure 1-15).

5.4.6 Jim Bertram Lake 7

5.4.6.1 Project Description

In 1969, Lubbock began planning the Jim Bertram Lake System (previously known as the Canyon Lake System), located in northeast Lubbock in the Yellow House Canyon along the North Fork River (Figure 5-7). Currently, this lake system consists of eight small dams and five small lakes: Lakes 1, 2, 3, 5, and 6 (Lake 4 was never constructed). Jim Bertram Lake 7, to be located on the North Fork directly upstream of Buffalo Springs Lake, will be part of this lake system (Figure 5-8).



Source: City's Strategic Water Supply Plan (City of Lubbock, 2013)

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LLANO ESTACADO REGION
Jim Bertram Lake System

Figure 5-7

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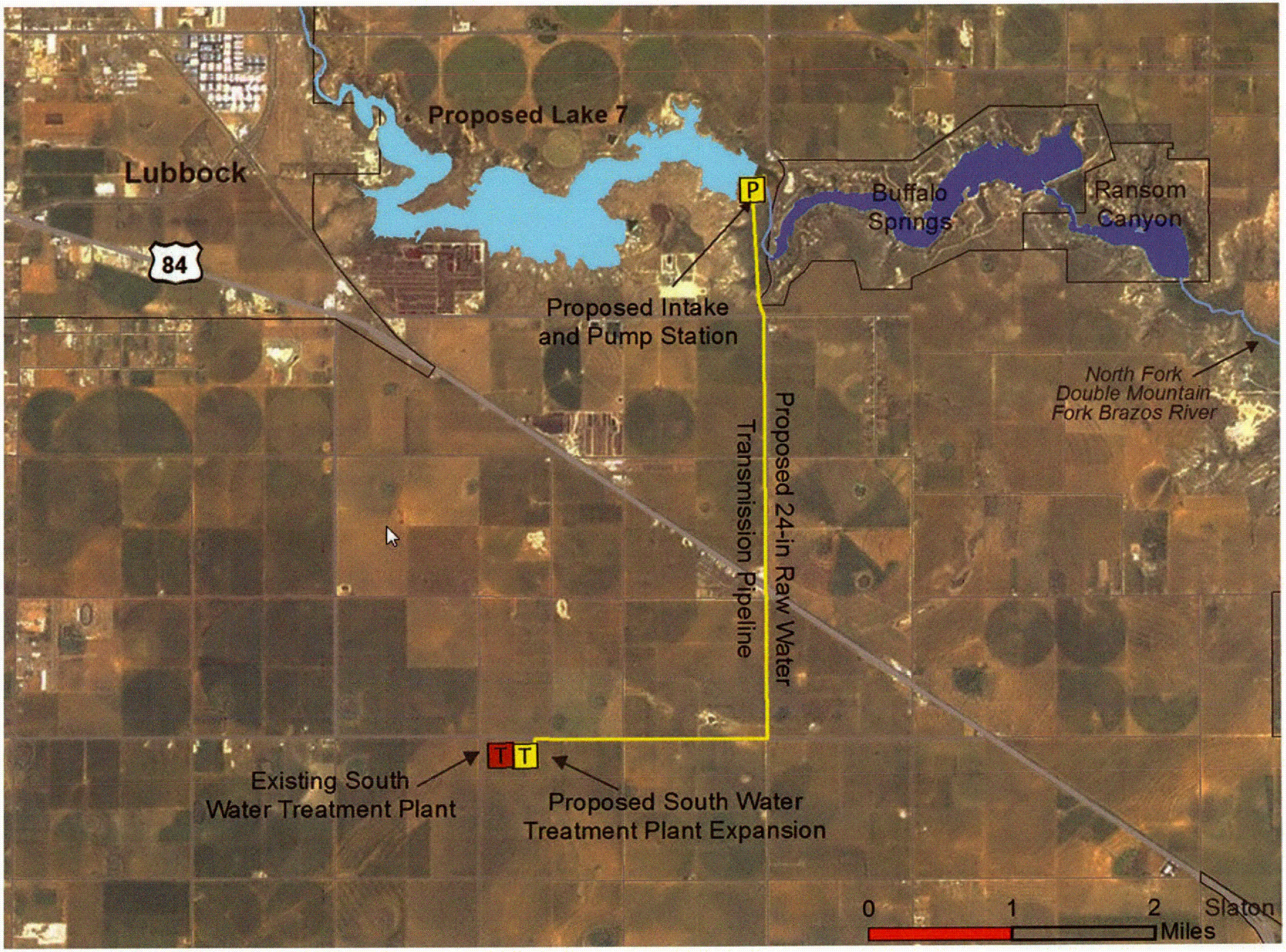

Source: City's Strategic Water Supply Plan (City of Lubbock, 2013)

LLANO ESTACADO REGION

Jim Bertram Lake 7 Infrastructure

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Figure 5-8

The City of Lubbock commissioned HDR to complete a study titled *Feasibility of Constructing the Proposed Lake 7,* which was delivered in September 2011. Much of the information for this strategy comes from this report.

Jim Bertram Lake 7 will have a capacity of 20,000 acre-feet at a conservation pool elevation of 3,100 feet above mean sea level (ft msl). The dam and lake will span 774 acres. The lake will capture water from three different sources: stormwater flows, discharges from Lubbock's South and South Central playa lake drainage systems, and reclaimed water discharged from the City's SWTP. Roughly 65 percent of the lake's annual yield will come from reclaimed water.

An intake structure and pump station will be placed near the dam. Water will travel from the pump station to the SWTP through a new transmission pipeline. Expansion of the SWTP and associated high service pump station will be necessary. Figure 5-8 shows a map of this strategy.

To execute this strategy, Lubbock will need to build the following infrastructure:

- A dam and reservoir (20,000 acre-feet, 774 acres)
- A new intake structure and 665-hp pump station near the Lake 7 dam
- A 5-mile, 24-inch-diameter transmission pipeline
- A 10.1-mgd expansion of the SWTP, including an expansion of the high service pump station at the SWTP

5.4.6.2 Quantity of Water

RPS modeled this surface water strategy, using a modified TCEQ WAM Run 3 for the Brazos River Basin, in order to evaluate the potential firm yield that will be 100 percent reliable during the historical drought of record (the modeling assumptions are detailed in Section 5.1.1). The modeled firm yield for Jim Bertram Lake 7 was 13,800 ac-ft/yr (Appendix 5C).

Lubbock will operate the lake at its one-year safe yield of 11,300 ac-ft/yr (HDR, 2011). This yield consists of inputs from three different sources:

- Reclaimed water (8 mgd) 7,300 ac-ft/yr
- Playa lake developed water 2,200 ac-ft/yr
- Natural inflow 1,800 ac-ft/yr
- Total 11,300 ac-ft/yr

A 2014 report by HDR indicates that neither vertical nor horizontal leakage from the lake will be a significant operational issue. Therefore, it is assumed that no water will be lost to leakage.

Lubbock estimates it will have approximately 8 mgd of reclaimed water available for this project. Increases and decreases in this amount will have a roughly 1:1 impact on the lake's yield. Reclaimed water will be discharged into the North Fork at Outfall 007 at the SEWRP and/or potentially a new outfall constructed further upstream. Minimal carriage losses between the outfall and Jim Bertram Lake 7 are anticipated.

Lubbock completed the South-Central Drainage System in 2003 and the South Drainage System in 2008 in an effort to reduce flooding around playa lakes within the city limits. These systems capture water from the naturally occurring playa lakes and discharge it into the Yellow House Canyon, a tributary of the North Fork, pursuant to the City's Municipal Separate Storm Sewer System (MS4) TPCES Permit No. WQ0004773000. In October 2008, Lubbock completed a *Municipal Precipitation Runoff* study (PSC, 2008) modeling the estimated amount of water to be captured and discharged at each system. The results are provided in Table 5-62.

Table 5-62. Precipitation Runoff Modeling Results

Storm Event	Storm Water Discharges (ac-ft/yr)		
	South-Central	South	Total Discharge
2-Year	1,278	773	2,051
5-Year	2,182	1,279	3,461
10-Year	2,941	1,713	4,654

Using the information above, HDR estimated that 2,200 acre-feet of playa lake developed water will be available to the City on an annual basis (HDR, 2011). The volume of natural flows was modeled by RPS, taking into account TCEQ's Consensus Criteria for Environmental Flow Needs (CCEFN), which sets the instream flow requirements.

5.4.6.3 Strategy Cost

Table 5-63 summarizes the updated costs for the Jim Bertram Lake 7 strategy. General cost estimating assumptions made for all the recommended City of Lubbock strategies are provided in Appendix 5F.

**Table 5-63. Jim Bertram Lake 7
Cost Estimate Summary**

Costs adjusted from HDR costs[a] (March 2012 prices) using an ENR CCI of 9552 for September 2013

Item	Costs (Sept 2013 Prices)
Capital Costs	
Dam and reservoir (20,000 acre-feet, 774 acres, 3,100 ft msl)	$ 26,098,000
Intake and pump station (10.6 mgd, 665 hp)	6,781,000
Transmission pipeline (24-inch, 5 miles)	3,496,000
SWTP expansion (10.1 mgd)	55,027,000
Capital Cost Subtotal	$ 61,941,000
Engineering, legal costs and contingencies	19,085,000
Environmental and archaeology studies and mitigation	1,231,000
Land acquisition and surveying (803 acres)[b]	1,354,000
Interest during construction (2 years)	5,369,000
Total Project Cost	$ 82,066,000
Annual Costs	
Debt service (5.5%, 20 years)	$ 3,481,000
Reservoir debt service (5.5%, 40 years)	2,525,000
Operation and maintenance[c]	
Intake, pipeline, pump station	103,000
Dam and reservoir	391,000
SWTP expansion	1,605,000
Pumping energy costs (4,126,800kWh at $0.09 per kWh)	372,000
Total Annual Costs	$ 8,476,000
Available project yield (ac-ft/yr)	13,800
Annual cost of water ($ per acre-foot)	$ 614
Annual cost of water ($ per 1,000 gallons)	$ 1.88

[a] HDR estimate provided in City of Lubbock 2013 *Strategic Water Supply Plan*

[b] Land acquisition costs are based on $1,254 per acre for the reservoir, and $8,988 per acre for pipelines, the intake and pump station. A 30-foot ROW is assumed for pipelines. Surveying is 10% of land costs.

[c] Operations and maintenance costs are assumed as 1% of facility cost for intake, pipeline and pump station, and 1.5% for dam and reservoir. For water treatment, costs in the Lubbock SWSP, which were based on a sliding scale depending on facility size, are projected to the current time.

5.4.6.4 Implementation Issues

Permitting issues associated with the Jim Bertram Lake 7 strategy include:

- Lubbock's TPDES Permit No. 10353-002 allows the City to discharge up to 14.5 mgd (16,242 ac-ft/yr) at Outfall 007. No additional permitting for the discharge of reclaimed water should be necessary.

- To secure the right to transport, impound, and divert water from Jim Bertram Lake 7, Lubbock submitted Water Rights Application No. 5921 to the TCEQ in 2005. The application was declared administratively complete in April 2006. However, the technical review has not yet been completed. Once the TCEQ issues the permit, this water right will be available to the City of Lubbock.

- To construct the lake, Lubbock will need a Section 404 permit from the United States Army Corps of Engineers (USACE).

- Environmental mitigation plans must be approved by the USACE and other state and federal resource agencies.

Other implementation issues associated with this strategy include:

- Lubbock will need to acquire property to construct the lake, dam, pump station, and mitigation area.
- Lubbock will need easements to construct the raw water transmission pipeline that will transport water from the pump station at the lake to the SWTP.
- The treated water transmission pipeline will be installed within the city limits and within existing right-of-way; therefore Lubbock will not need to acquire any new property or easements for this pipeline.

5.4.6.5 Environmental Impacts

Environmental impacts associated with this strategy have been quantified in the impact matrix (Appendix 5E) and are summarized in Table 5-5. Lubbock submitted an Environmental Information Document (EID) for Jim Bertram Lake 7 to the TCEQ in July 2011. Due to the inundation of 774 acres of ranchland, this strategy will have an environmental impact. Notably, no federal- or state-protected aquatic life (e.g., the sharpnose shiner and smalleye shiner) were found at the project site. The two main environmental concerns identified by the EID are:

- A strong population of Texas horned lizards was found at the reservoir site. This species is listed by the Texas Parks and Wildlife Department as threatened. If the project is constructed, further research will be needed, and it is anticipated that a management and mitigation plan will be necessary.

- There are 17 archaeological sites in or near the reservoir site. Additional research will be needed to determine the exact impact this strategy will have on each of those sites.

The EID acknowledges the need for a mitigation plan to compensate for unavoidable environmental impacts.

5.4.7 North Fork Scalping Operation

5.4.7.1 Project Description

The North Fork Scalping Operation will capture storm flows on the North Fork and transport them to LAH, thereby increasing the firm yield of the lake. Stormwater flows on the North Fork occur in large, sudden pulses after precipitation events, and infrastructure for this project must be sized to handle these surges of water. A 1,000-acre-foot diversion lake will be constructed on the North Fork to capture the pulse flows. A pump station built at the diversion lake will pump water through a new transmission pipeline, which will discharge the water into a stilling basin located on Gobbler Creek. The stilling basin is needed to slow the velocity of the water entering Gobbler Creek and thus reduce erosion. The natural flow of Gobbler Creek will carry the storm flows into LAH.

Water will be transported from LAH to the City of Lubbock through the existing LAH pipeline system, which will require some modifications due to the additional volume of water. The City built the pipeline with additional capacity, anticipating a future water supply project such as the North Fork Scalping Operation, so an expansion of the LAH raw water pipeline will not be necessary. However, expansions to the LAH and Post pump stations will be necessary, as will construction of the Southland Pump Station, to deliver the additional volume of water to the SWTP. The SWTP will also require expansion. Figure 5-9 shows a map of this strategy.

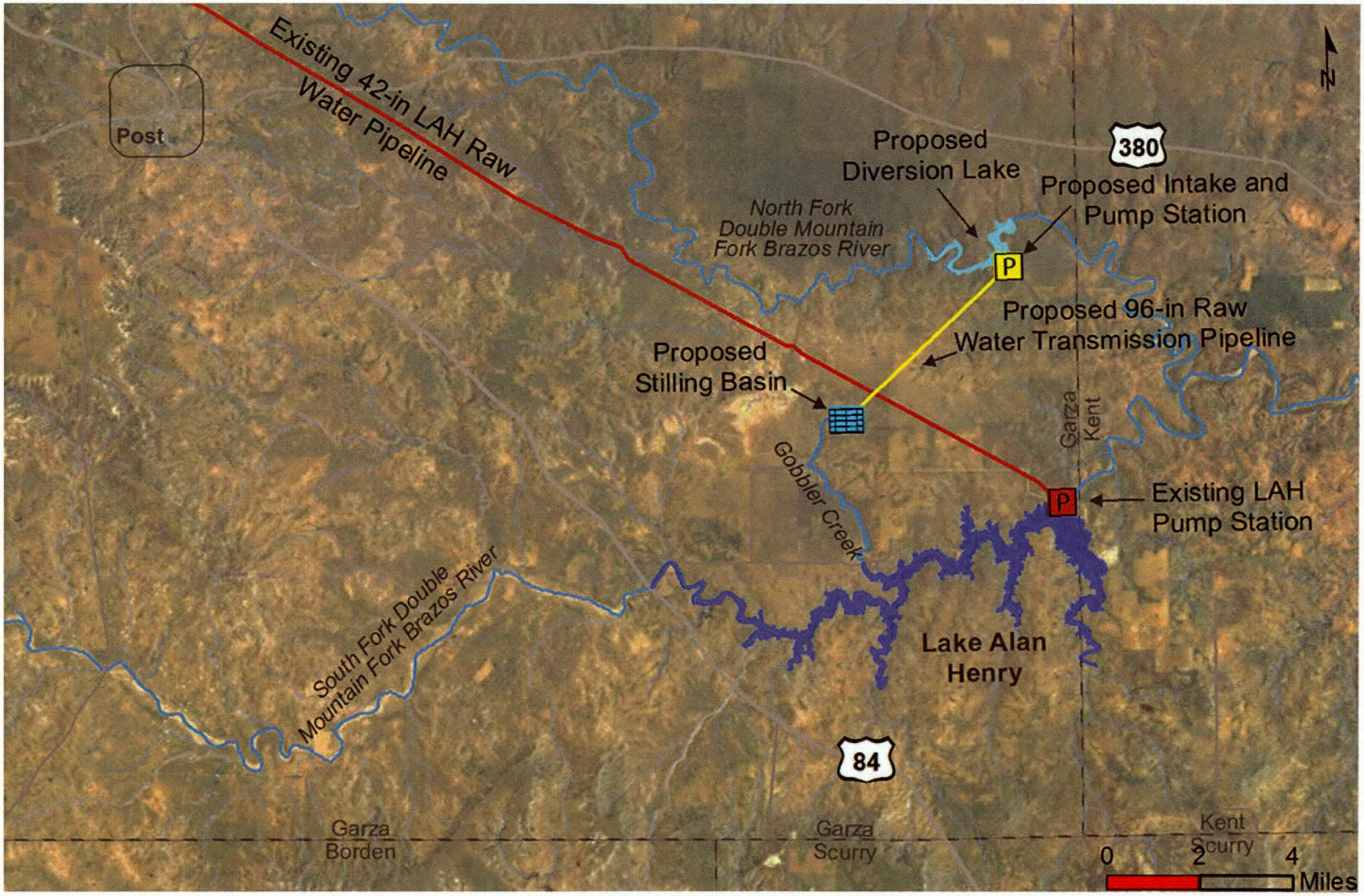
To execute this strategy, Lubbock will need to build the following infrastructure:

- A dam and diversion reservoir (1,000 acre-feet, 650 acres)
- An intake structure and 12,700-hp pump station at the diversion lake
- A 5-mile, 96-inch transmission pipeline to transport water from the diversion lake to Gobbler Creek
- A stilling basin
- 7.8-mgd expansions of the LAH and Post pump stations
- Southland Pump Station
- A 7.8 mgd expansion of the SWTP

This strategy could be implemented in conjunction with the North Fork Diversion to LAH Pump Station strategy, an indirect reuse strategy. Both projects could use the same diversion lake.

5.4.7.2 Quantity of Water

RPS modeled this surface water strategy, using a modified TCEQ WAM Run 3 for the Brazos River Basin, in order to evaluate the potential firm yield that will be 100 percent reliable during the historical drought of record (the modeling assumptions are detailed in Section 5.1.1). The modeled firm yield due to the North Fork Scalping Operation was 10,390 ac-ft/yr in decade 2020, decreasing each decade to 7,890 ac-ft/yr in decade 2070. The modeled safe yield from this strategy was 9,580 ac-ft/yr in decade 2020, decreasing each decade to 8,150 ac-ft/yr in decade 2070 (Appendix 5C). This strategy is dependent on stormwater flows, which are intermittent and unpredictable. Water losses associated with this strategy are expected to be minimal, 7 percent or less.



Source: City's Strategic Water Supply Plan (City of Lubbock, 2013)

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North Fork Scalping Operation Infrastructure

Figure 5-9

5.4.7.3 Strategy Cost

Table 5-64 summarizes the updated costs for the North Fork Scalping Operation strategy. General cost estimating assumptions made for all the recommended City of Lubbock strategies are provided in Appendix 5F.

Table 5-64. North Fork Scalping Operation Cost Estimate Summary

Costs adjusted from HDR costs [a] (March 2012 prices) using an ENR CCI of 9552 for September 2013

Item	Costs (Sept 2013 Prices)
Capital Costs	
Dam and reservoir (conservation pool 1,000 acre-feet, 650 acres	$ 2,661,000
Intake and pump station (162.4 mgd, 12,000 hp)	31,264,000
Transmission pipeline (96-inch, 5 miles)	22,043,000
Stilling basin	779,000
SWTP expansion (7.8 mgd)	15,178,000
LAH system expansion [b]	10,489,000
Capital Cost Subtotal	$ 82,414,000
Engineering, legal costs and contingencies	27,218,000
Environmental and archaeology studies and mitigation	1,121,000
Land acquisition and surveying (684 acres) [c]	1,233,000
Interest during construction (2 years)	7,839,000
Total Project Cost	$ 119,825,000
Annual Costs	
Debt service (5.5%, 20 years)	$ 9,494,000
Reservoir debt service (5.5%, 40 years)	397,000
Operation and maintenance [d]	
Intake, pipeline, pump station	333,000
Dam and reservoir	40,000
SWTP expansion	1,303,000
Pumping energy costs (3,667,577 kWh at $0.09 per kWh)	504,000
LAH pumping energy costs (5,498,510 kWh at $0.09 per kWh) [e]	1,870,000
Total Annual Costs	$ 13,941,000
Available project yield (ac-ft/yr)	10,390 [f]
Annual cost of water ($ per acre-foot)	$ 1,342 [f]
Annual cost of water ($ per 1,000 gallons)	$ 4.12 [f]

[a] HDR estimate provided in City of Lubbock 2013 *Strategic Water Supply Plan*

[b] Includes expansion of the Post and LAH pump stations and construction of Southland pump station.

[c] Land acquisition costs are based on $1,254 per acre for the reservoir and $8,988 per acre for pipelines, the intake and pump station. A 40-foot ROW is assumed for pipelines.

[d] Operation and maintenance cost are assumed as a percentage of facility cost: 1% for intake, pipeline and pump station, 1.5% for dam and reservoir, and 2.5% for the SWTP expansion.

[e] Includes energy costs for both the LAH pump station and pipeline

[f] Values shown are for decade 2020

The quantity of water available for this strategy varies over time and therefore the unit costs also vary for each decade during the planning period. Table 5-65 provides the estimated annual water supply and unit cost of this strategy during each decade of the planning period.

Table 5-65. Estimated Water Supply and Costs from North Fork Scalping Operation

Component	Planning Decade					
	2020	2030	2040	2050	2060	2070
Water supply (ac-ft/yr)	10,390	9,790	9,220	8,660	8,110	7,890
Unit cost ($/ac-ft/yr)	1,342	1,424	482	514	499	513

5.4.7.4 Implementation Issues

Permitting issues associated with the North Fork Scaling Operation include:

- Lubbock will need a new water use permit from the TCEQ to impound, divert, and transport water from the North Fork to LAH. All diversions from the North Fork are subject to instream flow requirements.
- To construct the diversion lake, Lubbock will need a Section 404 permit from the USACE.
- Lubbock may need a new discharge permit in order to discharge the captured water from the North Fork to Gobbler Creek on the South Fork.
- Environmental mitigation plans must be approved by the USACE and other state and federal resource agencies.

Other implementation issues are:

- Lubbock will need to acquire property to construct the dam, diversion lake, pump station, and stilling basin. Lubbock already owns the land need for the Southland Pump Station.
- Lubbock will need easements to construct the raw water transmission pipeline that will transport water from the diversion lake to Gobbler Creek.

- The LAH raw water pipeline was built with extra capacity, anticipating a future water supply project (such as the Post Reservoir, the North Fork Scalping Operation, the South Fork Discharge, or the North Fork Diversion to LAH Pump Station). If the extra capacity is assigned to another proposed project, modifications to the LAH raw water pipeline will be necessary.

5.4.7.5 Environmental Impacts

Environmental impacts associated with this strategy have been quantified in the impact matrix (Appendix 5E) and are summarized in Table 5-5. Due to the conversion of 650 acres of ranchland into a diversion lake in Garza County, this strategy will have an environmental impact. Studies are needed to determine the exact level of environmental impact that would be caused by implementation of this strategy. Concerns include:

- In March 2014, the USFWS listed the smalleye shiner and sharpnose shiner as federally endangered. Both species are located in the project area on the North Fork (see Appendix 1B for a list of other threatened and endangered species in the county).

- Golden alga can be toxic to fish when it occurs in large blooms. Golden alga is located on the North Fork but not on the South Fork. Transporting water from the North Fork into LAH may increase the chances for golden algal growth in LAH, decreasing the lake's water quality and causing fish kills.

- Increased flows to Gobbler Creek may change the stream's size and configuration.

5.5 Region O Supplies from Region A Recommended Strategies

The recommended strategies for CRMWA are fully evaluated in the Region A water plan, but are summarized in the following subsections. These recommended strategies would provide a total of up to 92,400 ac-ft/yr for CRMWA, of which up to 42,343 ac-ft/yr has been allocated to WUGs in Region O (Table 5-66).

Table 5-66. Region O Supplies from Region A Recommended Strategies for Canadian River Municipal Water Authority

WMS/Entity [a]	WMS Water Supply (ac-ft/yr)					
	2020	2030	2040	2050	2060	2070
Conjunctive Use of Roberts County Well Field and Lake Meredith						
Brownfield	137	138	140	144	144	144
Lamesa	153	179	202	226	226	226
Levelland	229	220	219	213	220	225
Lubbock	3,544	3,584	3,811	3,870	3,867	3,864
O'Donnell	14	13	12	12	12	13
Plainview	275	276	285	288	288	288
Slaton	140	131	127	122	121	121
Tahoka	46	44	42	41	42	42
WMS Total	4,538	4,585	4,838	4,916	4,920	4,923
WMS unit cost ($/ac-ft/yr)	451	451	106	106	106	106
Replace Well Capacity CRMWA I						
Brownfield	—	124	182	274	331	403
Lamesa	—	161	262	430	520	633
Levelland	—	199	285	405	505	631
Lubbock	—	3,226	4,955	7,352	8,894	10,819
O'Donnell	—	11	16	23	28	35
Plainview	—	248	370	548	662	806
Slaton	—	118	166	231	279	340
Tahoka	—	39	55	78	96	119
WMS Total	—	4,126	6,291	9,341	11,315	13,786
WMS unit cost ($/ac-ft/yr)	—	177	177	179	179	179
Additional Transmission Pipeline CRMWA II						
Brownfield	—	662	673	692	691	691
Lamesa	—	860	967	1,087	1,086	1,085
Levelland	—	1,059	1,051	1,023	1,055	1,082
Lubbock	—	17,204	18,294	18,574	18,560	18,548
O'Donnell	—	61	60	58	59	60
Plainview	—	1,323	1,367	1,383	1,382	1,381
Slaton	—	631	612	585	583	583
Tahoka	—	210	203	196	200	204
WMS Total	—	22,010	23,227	23,598	23,616	23,634
WMS unit cost ($/ac-ft/yr)	—	676	676	240	240	240
Region O Total	4,538	30,721	34,356	37,855	39,851	42,343

[a] Presenting supplies only for the 8 member cities located in Region O (3 member cities are located in Region A).

ac-ft/yr = Acre-feet per year
— = System not yet online.

5.5.1 Conjunctive Use of Roberts County Well Field and Lake Meredith

5.5.1.1 Background

CRMWA's system is designed to use and deliver water from Lake Meredith and Roberts County groundwater; however, supply is limited due to supply availability and delivery systems. Region A included a conjunctive use water management strategy that aims to use Lake Meredith and Roberts County groundwater in a manner that most efficiently manages and delivers water supply to its customers. The Region A water plan identifies three major components for conjunctively managing these sources:

- Use of supply from Lake Meredith in years when available
- Control of invasive brush within the Lake Meredith watershed
- Aquifer storage and recovery of supplies in excess of demands

Each of these components is summarized individually below.

5.5.1.2 Supply from Lake Meredith

With the ongoing drought, there have been several years in which CRMWA used very little to no water from Lake Meredith, and for planning purposes, the reliable supply is assumed to be zero. However, when there are inflows to the lake and water levels recover, CRMWA plans to use this source for water supply, reducing groundwater pumping. Depending upon the ultimate end user, water from the two sources may need to be blended to meet water quality standards. Since both systems are currently in place, there are no infrastructure improvements associated with this strategy.

5.5.1.3 Brush Control in Lake Meredith Watershed

CRMWA has an active salt cedar control program in the Lake Meredith watershed, with the purpose of increasing flow in the Canadian River, improving water quality, and improving habitat. CRMWA has treated approximately 27,000 acres of salt cedar, which accounts for about 95 percent of the total salt cedar in the Lake Meredith watershed; however, retreatment will likely still be needed. This substrategy recommends that CRMWA continue with its program to control salt cedar in the Lake Meredith watershed with support from the State Water Supply Enhancement Program.

5.5.1.4 CRMWA Aquifer Storage and Recovery

CRMWA currently has 65 mgd of capacity in the existing transmission system from the Roberts County well field. As CRMWA develops additional well field capacity in Roberts County and constructs the new CRMWA II pipeline, the maximum quantity of water that can be transported from the well field will increase by 54 mgd to 119 mgd. The average annual supply from this system (including CRMWA II) is estimated at 117,000 ac-ft/yr, based on system peaking factor of 1.15, for an average delivery of 104 mgd.

During non-peak periods, the capacity of the CRMWA transmission system is underutilized; yet during peak demand months, the ability to meet all of CRMWA's customers' future peak demands may be limited. Excess CRMWA water could be treated and stored by the member cities during non-peak periods for future use during peak times, using aquifer storage and recovery (ASR). This substrategy would use existing well fields and infrastructure. CRMWA is conducting a feasibility study to further evaluate this strategy for all member cities. Supply will be available for the ASR project after CRMWA II is online in 2023.

5.5.2 Expanded Development of Roberts County Well Field with Additional Transmission

Currently, the Roberts County Well Field (RCWF) consists of 45 active wells and a 48-mile, 54-inch transmission pipeline (CRMWA I) with a capacity of 65 mgd, or approximately 69,000 ac-ft/yr. The pipeline passes just south of Borger and intersects the main CRMWA aqueduct 25 miles north of the Amarillo Regulating Reservoir (Figure 5-10). As is typical of well fields in the Ogallala Aquifer, capacity in the RCWF is decreasing over time. The current capacity of the well field is 84 mgd, and it is estimated that groundwater supply in the RCWF will decline by 1 mgd per year (FNI et al., 2010).

The Expanded Development of Roberts County Well Field with Additional Transmission strategy proposes to construct a second transmission pipeline from the RCWF to the main aqueduct to use the full capacity of the main aqueduct and construct enough additional wells to maintain the well field capacity and fill both transmission lines. Region A's consultants (Freese and Nichols, Inc.) estimate that approximately 20 new wells will be needed to implement this strategy. The

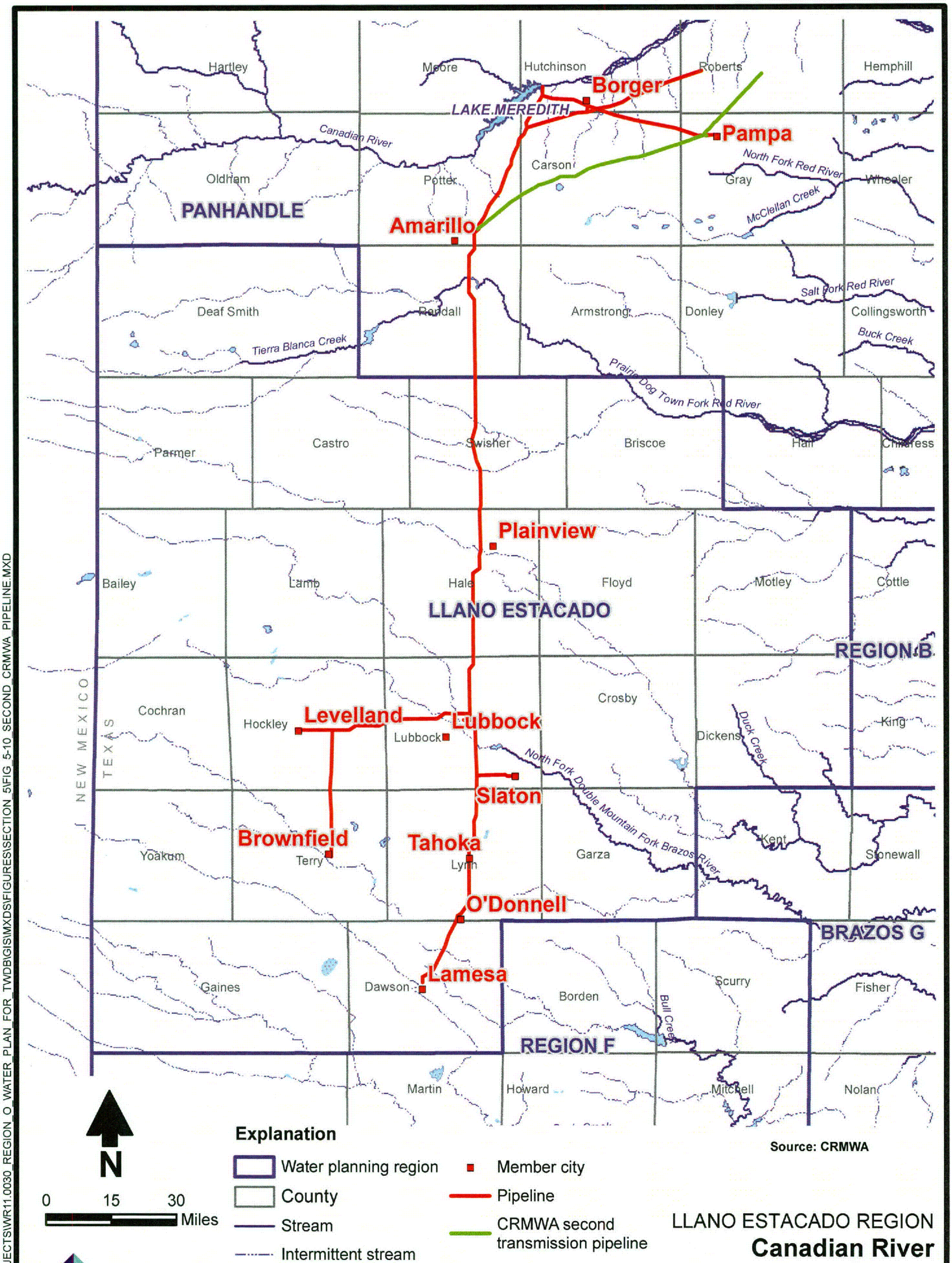

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Figure 5-10

S:\PROJECTS\WR11.0030_REGION_O_WATER_PLAN_FOR_TWDB\GIS\MXDS\FIGURES\SECTION_5\FIG_5-10_SECOND_CRMWA_PIPELINE.MXD proposed second transmission pipeline (CRMWA II) is a 67-mile, 54-inch-diameter pipeline with a capacity of 54 mgd. CRMWA expects to operate this pipeline at approximately 80 percent of capacity, supplying an additional 48,000 ac-ft/yr. CRMWA II will take a more southerly route than CRMWA I, intersecting the main aqueduct at the Amarillo Regulating Reservoir. Two new booster pump stations and a storage tank will also be necessary to transport the additional groundwater from the RCWF to the aqueduct. After construction of CRMWA II, the total system capacity will be 117 mgd, or roughly 131,000 ac-ft/yr.

5.6 Recommended Strategies for the White River MWD

5.6.1 Local groundwater development

White River MWD (WRMWD) manages and operates White River Lake and a well field in Crosby County that provides water to the cities of Crosbyton, Post, Ralls, and Spur. Due to low lake levels, the WRMWD stopped supplying lake water in 2012 and began supplying groundwater. This WMS would augment their current water supply by drilling additional wells to expand the District's existing well field.

5.6.1.1 Description of Option

This project will develop an additional water supply in 2020 from the Ogallala Aquifer in Crosby County. The additional supply wells will be placed on property already owned by the WRMWD. The primary facilities incorporated into the planning-level cost estimate include:

- Five supply wells (4 active and 1 contingency)
- 5,600 feet of well field piping to existing distribution system

5.6.1.2 Quantity and Reliability of Water

This project will develop 600 acre-feet of water supply in the Brazos Basin that is expected to be reliable during drought of record conditions. Water losses associated with this strategy are expected to be minimal, 10 percent or less.

5.6.1.3 Financial Costs

The estimated cost for this project was prepared using the TWDB's UCM and is provided in Table 5-67. The WRMWD requested a debt service term of 30 years for this project.

Table 5-67. Cost Estimate for White River MWD Groundwater Development Project

Item	Costs (Sept 2013 prices)
Capital costs	
Supply wells (5 @ 400 feet deep, 150 gpm capacity)	$ 1,334,000
Pipeline crossing and fittings	251,000
SCADA integration	165,000
Total cost of facilities	$ 1,750,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	600,000
Environmental and archaeology studies and mitigation	51,000
Land acquisition and surveying (3 acres)	27,000
Interest during construction (4% with 1% ROI for 1 year)	85,000
Total cost of project	$ 2,513,000
Annual costs	
Debt service (5.5% for 30 years)	$ 173,000
Intake, pipeline and pump station O&M (1% cost of facilities)	17,000
Pumping energy costs (178,210 kWh @ $.09/kWh)	16,000
Total annual costs	$ 206,000
Quantity of water (ac-ft/yr) [a]	600
Annual cost of water ($ per acre-foot)	$ 343
Annual cost of water ($ per 1,000 gal)	$ 1.05

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

5.6.1.4 Environmental Impacts

Environmental impacts associated with this strategy have been quantified in the impact matrix (Table 5-5, Appendix 5E). Environmental issues are expected to be relatively minor for this groundwater development project.

5.6.1.5 Implementation

The additional supply wells will be drilled within the WRMWD's existing well field. No additional water right permits are needed. Other permitting-related requirements include:

- Well drilling permits will be needed from the High Plains UWCD No. 1.
- The design of the new wells and collection pipelines must be approved by the TCEQ.

5.7 Alternative Strategies for the City of Lubbock

5.7.1 Direct Potable Reuse to South Water Treatment Plant

5.7.1.1 Project Description

Lubbock will designate up to 9 mgd of incoming effluent at the Southeast Water Reclamation Plant (SEWRP) for advanced treatment, which will include advanced oxidation, disinfection, and RO. A new RO water treatment plant will be needed at the SEWRP, along with a disposal well completed in the Dockum Aquifer, through which the concentrate reject water produced by the RO plant will be injected.

After advanced treatment, this reclaimed water will be of higher quality than any of Lubbock's other raw water sources. A storage tank and pump station at the SEWRP, along with a transmission pipeline, will be necessary to pump this highly treated reclaimed water from the RO plant to a location just upstream of the SWTP, where it will be injected into the raw water pipeline leading to the SWTP and blended with other raw water sources. The blended water will then undergo conventional water treatment at the SWTP before entering Lubbock's distribution system. Figure 5-11 shows a map of this strategy.

To execute the strategy, Lubbock will need to build the following infrastructure:

- A 9-mgd advanced water treatment plant at the SEWRP
- A 1,900-foot Dockum Aquifer disposal well for the RO concentrate at the SEWRP
- A 200-foot pipeline from the RO treatment plant to the disposal well

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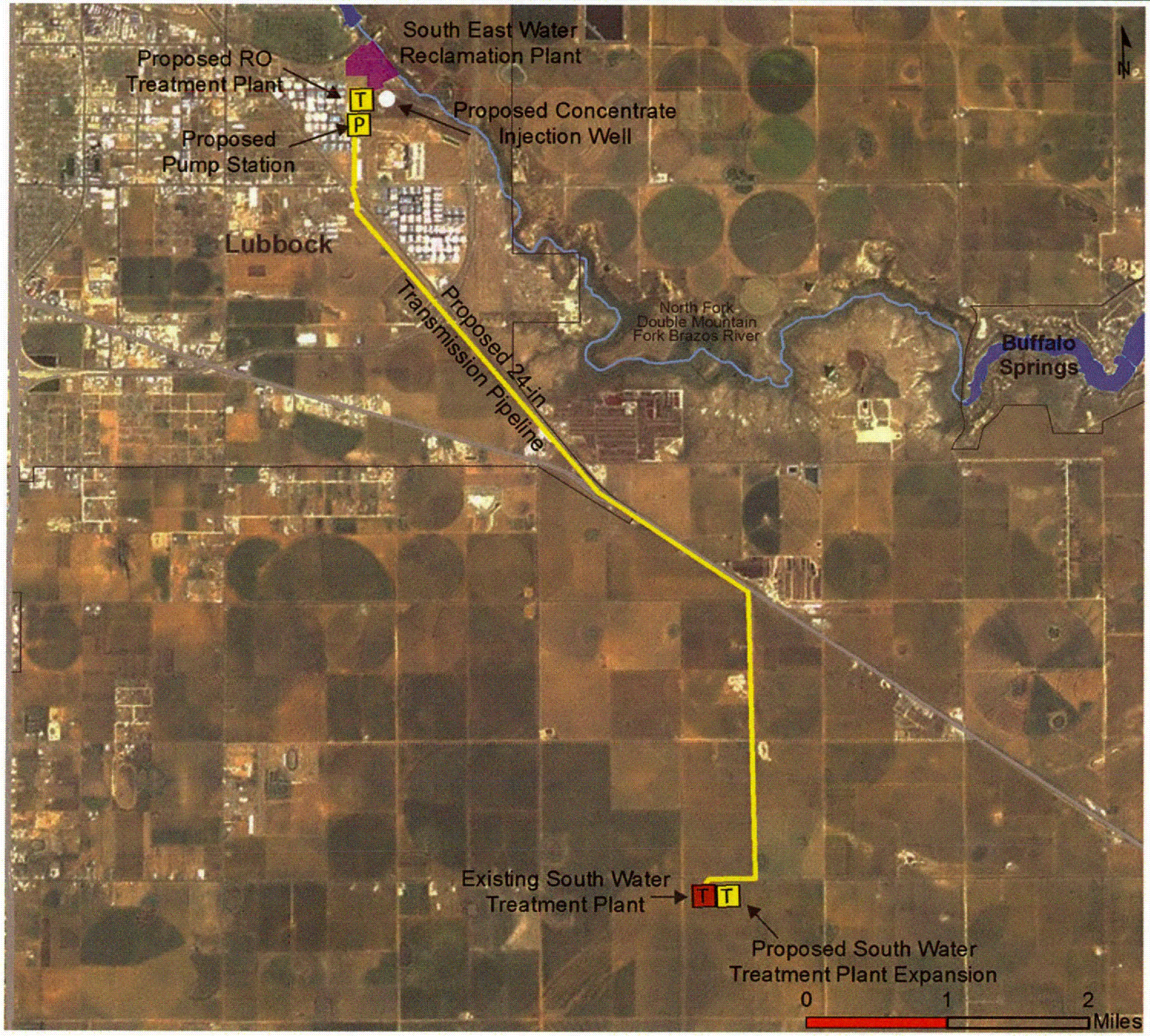

Source: City's Strategic Water Supply Plan (City of Lubbock, 2013)

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Direct Potable Reuse to South Water Treatment Plant

Figure 5-11

- A 0.45-million gallon ground storage tank at the SEWRP to serve the booster station
- A 500-hp pump station to deliver reclaimed water from the SEWRP to the SWTP
- A 7.5-mile, 24-inch pipeline to deliver reclaimed water from the SEWRP to the SWTP
- A 9-mgd expansion of the SWTP to treat the additional volume of raw water

5.7.1.2 Quantity of Water

This strategy is designed to provide a peak of 9 mgd and an average of 10,089 ac-ft/yr of water. Water losses associated with this strategy are expected to be minimal, 7 percent or less.

5.7.1.3 Strategy Cost

Table 5-68 summarizes the updated costs for the Direct Reuse to the SWTP strategy. General cost estimating assumptions made for all the City of Lubbock strategies are provided in Appendix 5F.

Table 5-68. Direct Potable Reuse to the South Water Treatment Plant Cost Estimate Summary

Costs adjusted from HDR costs [a] (March 2012 prices) using an ENR CCI of 9552 for September 2013

Item	Costs (Sept 2013 Prices)
Capital Costs	
Transmission pipeline (24-inch, 7.5 miles [SEWRP to SWTP])	$ 5,456,000
Transmission pump station(s) (9 mgd, 500 hp)	2,845,000
Advanced water treatment at SEWRP (9 mgd)	37,470,000
SWTP expansion (9 mgd)	17,028,000
Dockum Aquifer injection well (1,900 feet deep, 150 gpm capacity)	773,000
Capital Cost Subtotal	$ 63,572,000
Engineering, legal costs and contingencies	21,977,000
Environmental and archaeology studies and mitigation [b]	413,000
Land acquisition and surveying (46 acres) [c]	454,000
Interest during construction (1 year)	3,025,000
Total Project Cost	$ 89,441,000
Annual Costs	
Debt service (5.5%, 20 years)	$ 7,484,000
Operation and maintenance	

Table 5-68. Direct Potable Reuse to the South Water Treatment Plant Cost Estimate Summary (continued)

Costs adjusted from HDR costs [a] (March 2012 prices) using an ENR CCI of 9552 for September 2013

Item	Costs (Sept 2013 Prices)
Annual Costs (cont.)	
Intake, pipeline, pump station	197,000
Advanced water treatment plant	3,920,000
Pumping energy costs (3,115,767 kWh @ $0.09 per kWh)	280,000
Purchase of water	0
Total Annual Costs	$ 11,881,000
Available project yield (ac-ft/yr)	10,089
Annual cost of water ($ per acre-foot)	$ 1,178
Annual cost of water ($ per 1,000 gallons)	$ 3.61

[a] HDR estimate provided in City of Lubbock 2013 *Strategic Water Supply Plan*
[b] Environmental costs are assumed at $26,000 per mile (adjusted from HDR estimate of $25,000) for the pipeline.
[c] No land acquisition is required for the SWTP expansion, booster station, or disposal well. Land acquisition costs are based on a 30-foot right-of-way (ROW) for the 24-inch pipe, 40-foot ROW for the 42-inch pipe, and $8,988 per acre. Surveying is 10% of land cost.

5.7.1.4 Implementation Issues

Due to the drought, the need for direct potable reuse projects in Texas has recently become a priority. However, the TCEQ has not yet developed requirements for direct potable reuse projects. Once created, these requirements will serve as the basis for direct potable reuse permit applications.

In addition to traditional effluent treatment, advanced treatment will be necessary for a direct reuse project. The design of the advanced treatment process to be implemented at Lubbock's SEWRP will take into account the need for multiple barriers, redundancy and backup power sources, an alternative effluent disposal or storage method in case of an acute episode, and a well-developed monitoring and sampling plan.

5.7.1.5 Environmental Impacts

Environmental impacts associated with this strategy have been quantified in the impact matrix (Table 5-5, Appendix 5E). Many of the improvements will be located on property already in use by the City for water reclamation and treatment, and for this reason, few environmental impacts are anticipated. The proposed pipeline will be placed in existing right-of-way, to the extent possible. Environmental costs are included for the pipeline corridor.

5.7.2 Direct Potable Reuse to North Water Treatment Plant

5.7.2.1 Project Description

Lubbock will designate up to 9 mgd of incoming effluent at the SEWRP for advanced treatment, which will include advanced oxidation, disinfection, and RO. A new RO water treatment plant will be needed at the SEWRP, along with a Dockum Aquifer disposal well for the concentrate reject water.

After advanced treatment, this reclaimed water will be of higher quality than any of Lubbock's other raw water sources. A ground storage tank and a pump station at the SEWRP, along with a transmission pipeline, will be necessary to pump this highly treated reclaimed water from the RO plant to a location just upstream of the NWTP, where it will be injected into the raw water pipeline leading to the NWTP and blended with raw CRMWA water. The blended water will then undergo conventional water treatment at the NWTP before entering Lubbock's distribution system. The NWTP has enough existing capacity to treat the additional 9 mgd of raw water, so an expansion will not be necessary. Figure 5-12 shows a map of this strategy.

To execute this strategy, Lubbock will need to build the following infrastructure:

- A 9-mgd advanced water treatment plant at the SEWRP
- A 1,900-foot Dockum Aquifer disposal well for the RO concentrate at the SEWRP
- A 200-foot pipeline from the RO treatment plant to the disposal well
- A 0.45-million gallon ground storage tank at the SEWRP for the RO concentrate
- A 650-hp pump station to deliver reclaimed water from the SEWRP to the NWTP
- A 6-mile, 24-inch pipeline to deliver reclaimed water from the SEWRP to the NWTP

5.7.2.2 Quantity of Water

This strategy is designed to provide a peak of 9 mgd and an average of 10,089 ac-ft/yr of water. Water losses associated with this strategy are expected to be minimal, 7 percent or less.

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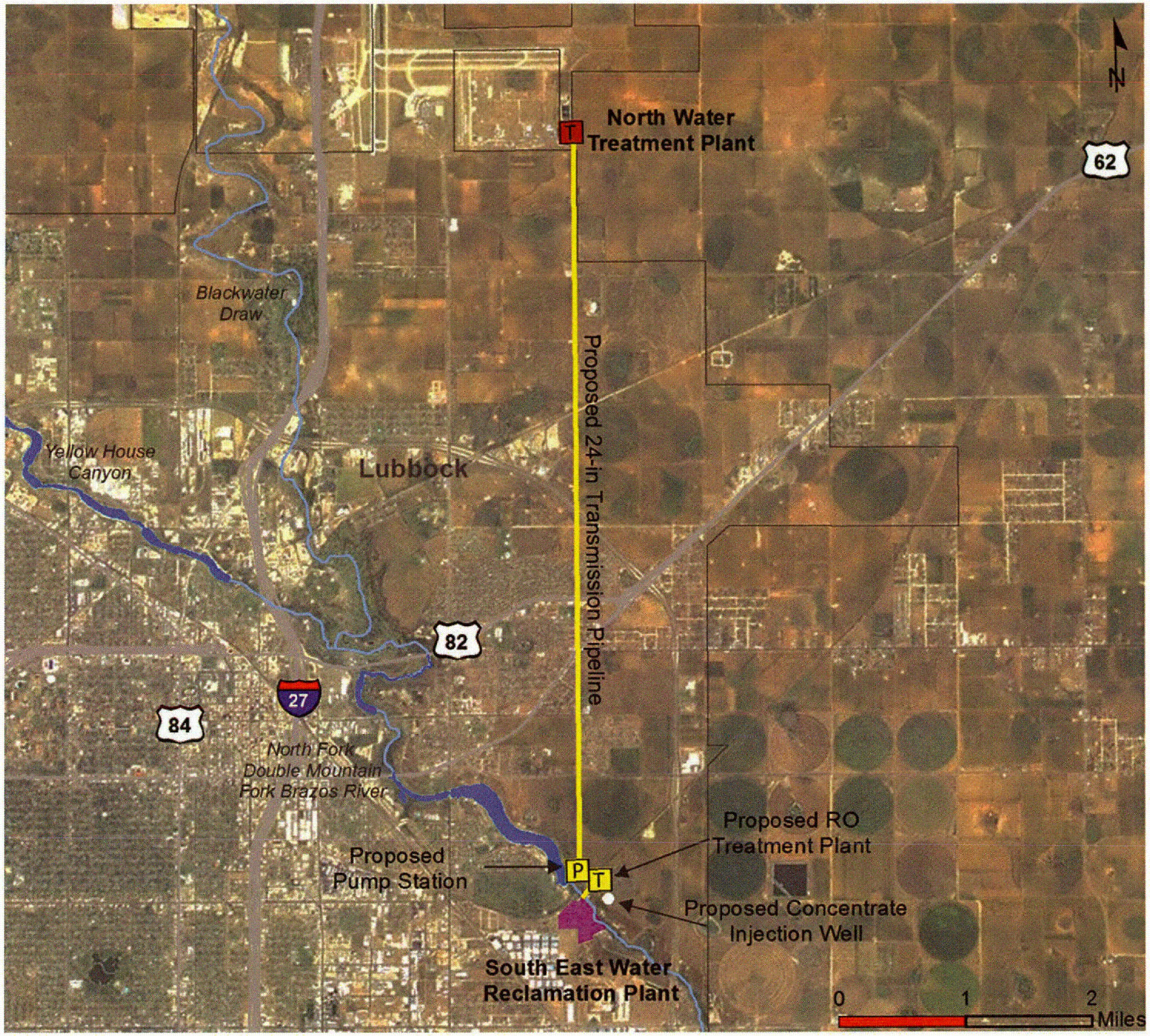

Source: City's Strategic Water Supply Plan (City of Lubbock, 2013)

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Direct Potable Reuse to North Water Treatment Plant

Figure 5-12

5.7.2.3 Strategy Cost

Table 5-69 summarizes the updated costs for the Direct Reuse to the NWTP strategy. General cost estimating assumptions made for all the City of Lubbock strategies are provided in Appendix 5F.

Table 5-69. Direct Potable Reuse to the North Water Treatment Plant Cost Estimate Summary

Costs adjusted from HDR costs [a] (March 2012 prices) using an ENR CCI of 9552 for September 2013

Item	Costs (Sept 2013 Prices)
Capital Costs	
Transmission pipeline (24-inch, 6 miles [SEWRP to NWTP])	$ 5,321,000
Pump station at SEWRP (9 mgd, 650 hp)	4,397,000
Advanced water treatment at SEWRP (9 mgd, RO)	37,470,000
Dockum Aquifer injection well (1,900 feet deep, 150 gpm capacity)	773,000
Capital Cost Subtotal	$ 47,961,000
Engineering, legal costs and contingencies	16,520,000
Environmental and archaeology studies and mitigation [b]	156,000
Land acquisition and surveying (28 acres) [c]	277,000
Interest during construction (2 years)	4,544,000
Total Project Cost	$ 69,458,000
Annual Costs	
Debt service (5.5%, 20 years)	$ 5,812,000
Operation and maintenance [d]	
Intake, pipeline, pump station	171,000
Advanced water treatment plant	2,457,000
Pumping energy costs (3,946,834 kWh @ $0.09 per kWh)	356,000
Purchase of water	0
Total Annual Costs	$ 8,796,000
Available project yield (ac-ft/yr)	10,089
Annual cost of water ($ per acre-foot)	$ 872
Annual cost of water ($ per 1,000 gallons)	$ 2.68

[a] HDR estimate provided in City of Lubbock 2013 *Strategic Water Supply Plan*
[b] Environmental costs are assumed at $26,000 per mile (adjusted from HDR estimate of $25,000) for the pipeline.
[c] Land acquisition costs are based on a 30-foot ROW for pipelines and $8,988 per acre. Surveying is 10% of land cost.
[d] Operation and maintenance cost from Lubbock SWSP, projected to the current time period. For water treatment, costs in the Lubbock SWSP were based on a sliding scale depending on facility size. Other costs are a percentage of capital costs.

5.7.2.4 Implementation Issues

Due to the drought, the need for direct potable reuse projects in Texas has recently become a priority. However, the TCEQ has not yet developed requirements for direct potable reuse projects. Once created, these requirements will serve as the basis for direct potable reuse permit applications.

In addition to traditional effluent treatment, advanced treatment will be necessary for a direct reuse project. The design of the advanced treatment process to be implemented at Lubbock's SEWRP will take into account the need for multiple barriers, redundancy and backup power sources, an alternative effluent disposal or storage method in case of an acute episode, and a well-developed monitoring and sampling plan.

5.7.2.5 Environmental Impacts

Environmental impacts associated with this strategy have been quantified in the impact matrix (Table 5-5, Appendix 5E). Many of the improvements will be located on property already in use by the City for water reclamation and treatment, and for this reason, few environmental impacts are anticipated. The proposed pipeline will be placed in existing right-of-way, to the extent possible. Environmental costs are included for the pipeline corridor.

5.7.3 North Fork Diversion at County Road 7300

5.7.3.1 Project Description

Lubbock has an existing 13-mile, 27-inch pipeline that carries water from the SEWRP to Outfall 001, located at the intersection of the North Fork of the Double Mountain Fork of the Brazos River (North Fork) and Farm-to-Market Road (FM) 400. Under this strategy, the City will discharge up to 9 mgd of treated effluent into the North Fork at Outfall 001, from which point the water will travel 2.7 miles downstream to a new diversion facility at County Road 7300. Once diverted, the water will be pumped to the SWTP through a new transmission pipeline. An expansion of the SWTP will be necessary to treat the additional volume of raw water. Figure 5-13 shows a map of this strategy.

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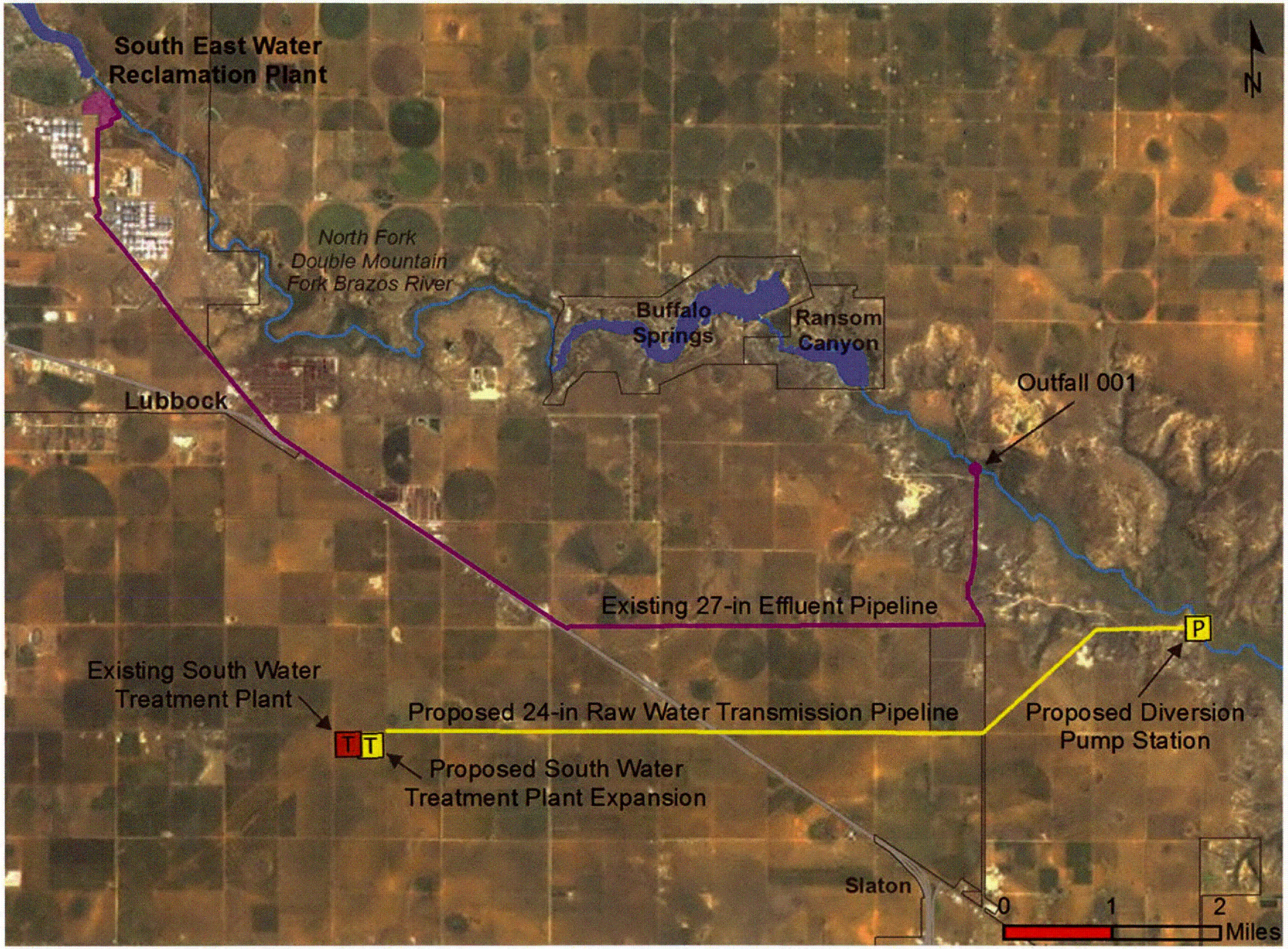

Source: City's Strategic Water Supply Plan (City of Lubbock, 2013)

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North Fork Diversion at County Road 7300

Figure 5-13

To execute this strategy, Lubbock will need to build the following infrastructure:

- An intake structure
- A 1,150-hp pump station to deliver water from the diversion site to the SWTP
- An 8-mile, 24-inch pipeline to transport water from the diversion site to the SWTP
- A 9-mgd expansion of the SWTP and the associated high service pump station

Lubbock already owns the land needed for the new infrastructure at the SEWRP and the SWTP.

5.7.3.2 Quantity of Water

This strategy is designed to provide a peak of 9 mgd and an average of 10,089 ac-ft/yr. Carriage losses in the North Fork are predicted to be insignificant (less than 1 percent).

5.7.3.3 Strategy Cost

General cost estimating assumptions made for all the City of Lubbock strategies are provided in Appendix 5F. The detailed cost estimate summary for the North Fork Diversion to County Road 7300 strategy is presented in Table 5-70.

5.7.3.4 Implementation Issues

Lubbock has the required permits to discharge and capture its return flows in the North Fork at County Road 7300. Under TPDES Permit No. 10353-002, Lubbock can discharge up to 9 mgd (10,089 ac-ft/yr) at Outfall 001; discharges at Outfall 001 began in May 2003. In April 2004, the City filed an application for an amendment to Water Use Permit 3985 to capture these return flows, and the TCEQ issued the permit in December 2012. Water Use Permit 3985 now authorizes the diversion of up to 10,089 ac-ft/yr minus 0.47 percent for carriage losses at the County Road 7300 site.

Lubbock will need to secure permitting for the construction of the diversion facilities needed for this strategy. The City will also need to acquire land for the construction of the diversion facilities for this strategy and for pipeline easements from the diversion site to the SWTP for the new raw water pipeline.

Table 5-70. North Fork Diversion at County Road 7300
Cost Estimate Summary

Costs adjusted from HDR costs[a] (March 2012 prices) using an ENR CCI of 9552 for September 2013

Item	Costs (Sept 2013 Prices)
Capital Costs	
Intake and pump station (9.5 mgd, 1,150 hp)	$ 9,940,000
Transmission pipeline(24-inch, 8 miles [raw water pipeline to SWTP])	4,905,000
SWTP expansion (9 mgd)	17,028,000
Capital Cost Subtotal	$ 31,873,000
Engineering, legal costs and contingencies	10,910,000
Environmental and archaeology studies and mitigation	267,000
Land acquisition and surveying (34 acres)[b]	294,000
Interest during construction (2 years)	3,034,000
Total Project Cost	$ 46,378,000
Annual Costs	
Debt service (5.5%, 20 years)	$ 3,881,000
Operation and maintenance[c]	
Intake, pipeline, pump station	367,000
SWTP	1,462,000
Pumping energy costs (7,049,681 kWh at $0.09 per kWh)	634,000
Total Annual Costs	$ 6,344,000
Available project yield (ac-ft/yr)	10,089
Annual cost of water ($ per acre-foot)	$ 629
Annual cost of water ($ per 1,000 gallons)	$ 1.93

[a] HDR estimate provided in City of Lubbock 2013 *Strategic Water Supply Plan*
[b] Land acquisition costs are based on a 30-foot ROW and $8,988 per acre for pipelines, and $1,254 per acre for the intake and pump station. Surveying is 10% of land cost.
[c] Operation and maintenance cost from Lubbock SWSP, projected to the current time period. For water treatment, costs in the Lubbock SWSP were based on a sliding scale depending on facility size. Other costs are a percentage of capital costs.

5.7.3.5 Environmental Impacts

Environmental impacts associated with this strategy have been quantified in the impact matrix (Table 5-5, Appendix 5E). A detailed environmental study is needed to determine the level of environmental impact of this project. Minimal impacts to bird and mammal species are expected due to the construction of the new transmission pipeline and expansion at the SWTP site (see Appendix 1B for a list of threatened and endangered species by county). However, as a result of the construction of the diversion facility and change in river flow due to the increased discharge of reclaimed water, low to moderate environmental impacts to the smalleye and sharpnose shiners are anticipated.

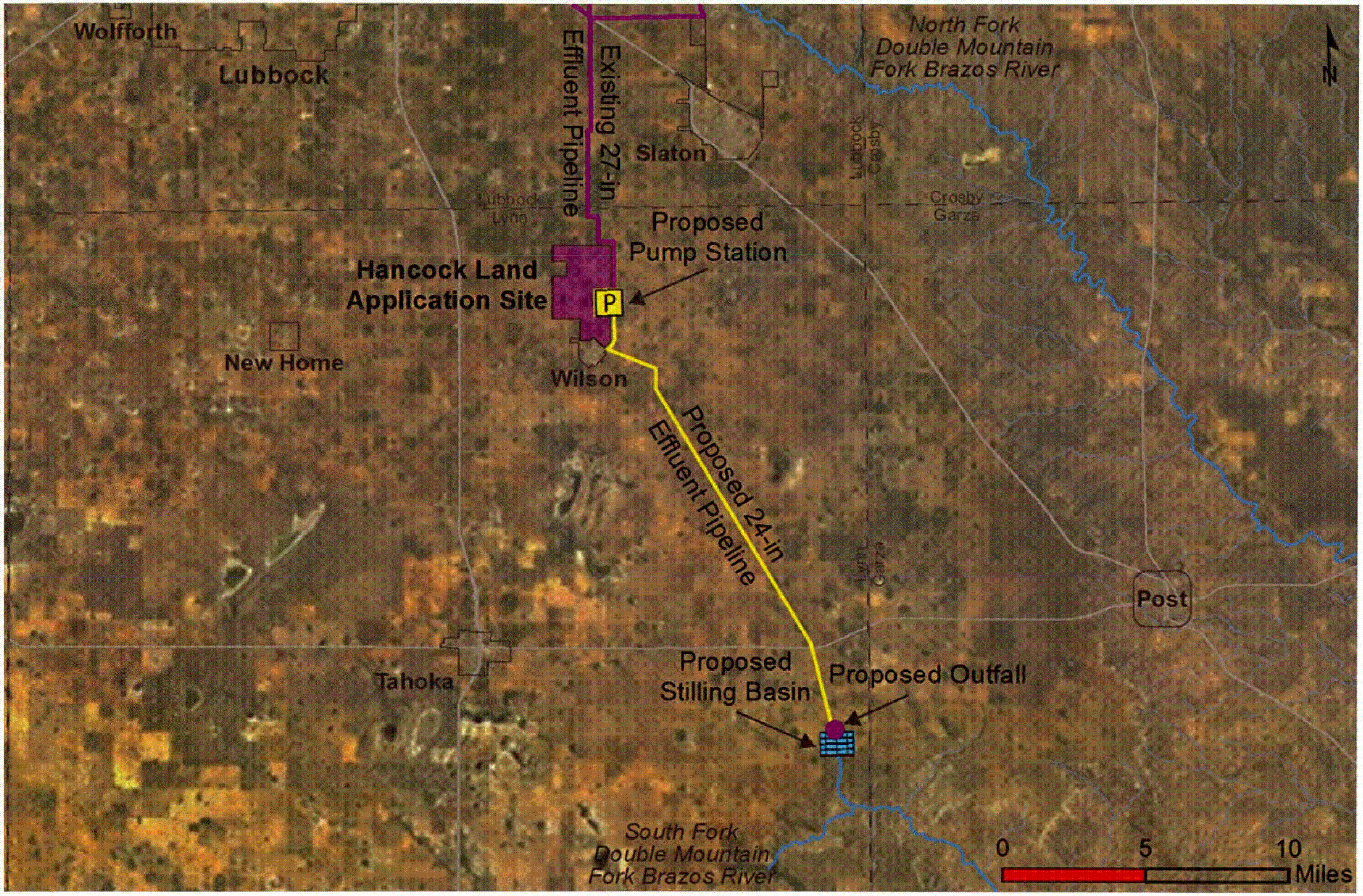
5.7.4 South Fork Discharge

5.7.4.1 Project Description

Lubbock has an existing 18-mile, 27-inch pipeline from the SEWRP to the Hancock Land Application Site (HLAS), located just north of the town of Wilson, Texas. This pipeline will be extended approximately 18 miles to a tributary of the South Fork of the Double Mountain Fork of the Brazos River (South Fork). The City will discharge up to 9 mgd of treated effluent into the tributary, through which the water will travel downstream and be stored in LAH. Water will be transported from LAH to the City of Lubbock through the existing LAH pipeline system, and due to the additional volume of water, some modifications to the existing system will be needed. No expansion of the 36-mgd LAH raw water transmission pipeline is needed (only 27 mgd capacity will be required to transport water from the lake to the SWTP); however, expansion of the Post and LAH pump stations and construction of the Southland Pump Station will be needed to deliver the additional volume of water to the SWTP. Additionally, the SWTP will require a 7.3-mgd expansion. Figure 5-14 shows a map of this strategy.

To execute this strategy, Lubbock will need to build the following infrastructure:

- A 7.3-mgd pump station at the HLAS
- An 18-mile, 24-inch pipeline extension from the HLAS to a South Fork tributary
- A stilling basin at the discharge point into the South Fork
- LAH Pump Station expansion
- Post Pump Station expansion
- Southland Pump Station
- A 7.3 mgd expansion of the SWTP and the associated high service pump station



Source: City's Strategic Water Supply Plan (City of Lubbock, 2013)

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South Fork Discharge

Figure 5-14

5.7.4.2 Quantity of Water

The reclaimed water will travel approximately 36 miles in the South Fork from the discharge point to LAH. Carriage losses are estimated to be 19 percent, or 1.7 mgd. Therefore, this strategy will be able to provide a peak of 7.3 mgd and an average of 8,183 ac-ft/yr.

5.7.4.3 Strategy Cost

Table 5-71 summarizes the updated costs for the South Fork Discharge strategy. General cost estimating assumptions made for all the City of Lubbock strategies are provided in Appendix 5F.

5.7.4.4 Implementation Issues

The City will need to obtain the following permits or permit modifications:

- Lubbock's TPDES Permit No. 10353-002 allows the City to discharge up to 14.5 mgd (16,242 ac-ft/yr) at Outfall 007 and up to 9.0 mgd (10,089 ac-ft/yr) at Outfall 001. If this strategy is implemented, TPDES Permit No. 10353-002 will require an amendment to allow the City to discharge up to 9 mgd (10,089 ac-ft/yr) at a new outfall on the South Fork.

- In order to claim and divert the return flows after they are discharged, Lubbock will need a water rights permit (Texas Water Code Section 11.042).

- Lubbock will need to secure permitting for the construction of the outfall and stilling basin.

Other implementation issues include:

- The City will need to acquire pipeline easements in order to extend the existing HLAS pipeline to the South Fork tributary discharge site.
- Lubbock will need to acquire easements for the construction of the stilling basin.
- The LAH raw water pipeline was built with extra capacity, anticipating a future water supply project (such as the Post Reservoir, the North Fork Scalping Operation, the

South Fork Discharge, or the North Fork Diversion to LAH Pump Station). If the extra capacity is assigned to another proposed project, modifications to the LAH raw water pipeline will be necessary.

Table 5-71. South Fork Discharge Cost Estimate Summary

Costs adjusted from HDR costs [a] (March 2012 prices) using an ENR CCI of 9552 for September 2013

Item	Costs (Sept 2013 Prices)
Capital Costs	
Intake and pump station (7.3 mgd, 350 hp)	$ 2,814,000
Transmission pipeline (24-inch, 18 miles)	12,384,000
Stilling basin	35,000
LAH system expansion [b]	9,726,000
SWTP expansion (7.3 mgd)	14,424,000
Capital Cost Subtotal	$ 39,383,000
Engineering, legal costs and contingencies	13,165,000
Environmental and archaeology studies and mitigation	770,000
Land acquisition and surveying (90 acres) [c]	847,000
Interest during construction (2 years)	3,792,000
Total Project Cost	$ 57,957,000
Annual Costs	
Debt service (5.5%, 20 years)	$ 4,850,000
Operation and maintenance [d]	
Intake, pipeline, pump station	292,000
SWTP	1,238,000
South Fork pumping energy costs (2,091,326 kWh at $0.09 per kWh)	188,000
LAH pumping energy costs (19,406,701 kWh at $0.09 per kWh)	1,747,000
Total Annual Costs	$ 8,315,000
Available project yield (ac-ft/yr)	8,183
Annual cost of water ($ per acre-foot)	$ 1,016
Annual cost of water ($ per 1,000 gallons)	$ 3.12

[a] HDR estimate provided in City of Lubbock 2013 *Strategic Water Supply Plan*

[b] Includes expansion of the LAH and Post pump stations and construction of the Southland pump station.

[c] Land acquisition costs are based on $8,988 per acre for pipelines and $1,254 per acre for the intake and pump station. Assumed ROWs are 30 feet for the 24-inch pipeline and 40 feet for the 42-inch pipeline. Surveying is 10% of land cost.

[d] Operation and maintenance cost from Lubbock SWSP, projected to the current time period. For water treatment, costs in the Lubbock SWSP were based on a sliding scale depending on facility size. Other costs are a percentage of capital costs.

5.7.4.5 Environmental Impacts

Environmental impacts associated with this strategy have been quantified in the impact matrix (Table 5-5, Appendix 5E). A detailed environmental study is needed to determine the level of environmental impact of this project. Some environmental impact to bird and mammal species may occur along the 18-mile pipeline extension from the HLAS to the South Fork tributary in Lynn County (see Appendix 1B for a list of threatened and endangered species by county). Little impact is anticipated at the stilling basin site, and minimal impact is expected in the South Fork segment between the discharge point and LAH. While the smalleye and sharpnose shiner species are located in Garza County, they have not been found on the South Fork upstream of LAH (Figure 1-15). Mitigation for LAH has already been completed.

5.7.5 North Fork Diversion to Lake Alan Henry Pump Station

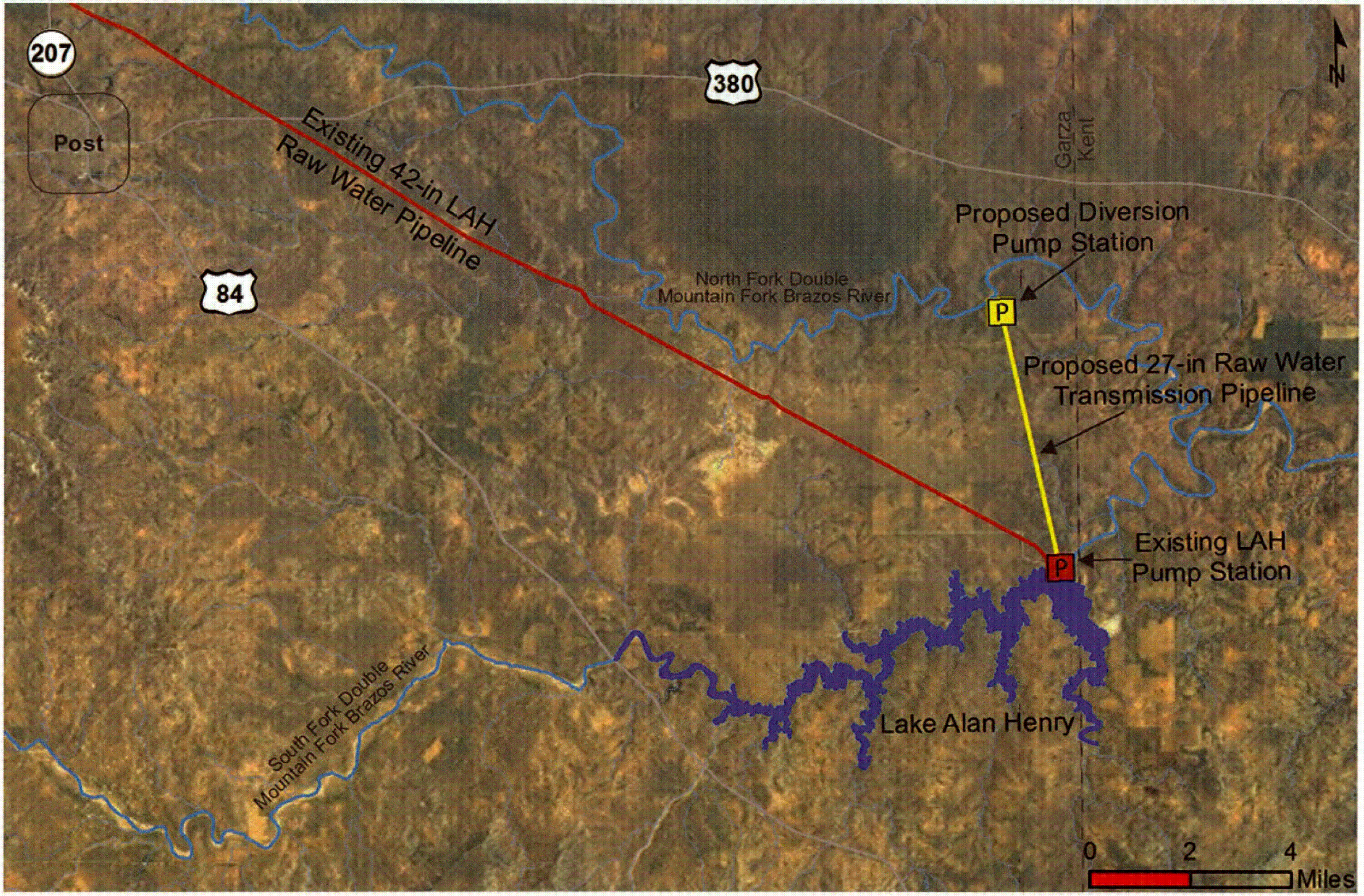
5.7.5.1 Project Description

Lubbock has an existing 13-mile, 27-inch pipeline that carries water from the SEWRP to Outfall 001, located at the intersection of the North Fork and FM 400. Under this strategy, the City will discharge 9 mgd of treated effluent into the North Fork at Outfall 001, from which point the water will travel 67 miles downstream to a new diversion site. Because of the distance, carriage losses are estimated to be high (26 percent).

A coffer dam will be needed at the diversion site to allow the City to divert water during low flows. The diverted water will be pumped to the existing LAH Pump Station through a new pipeline, where it will enter the LAH raw water pipeline. No expansion of the 36-mgd LAH raw water transmission pipeline is necessary (LAH Phases 1 and 2 will require only 27 mgd to transport water from the lake to the SWTP). However, the LAH and Post pump stations will need to be expanded and the Southland Pump Station will need to be constructed to deliver the additional volume of water to the SWTP. In addition, the SWTP will require a 6.7-mgd expansion. Figure 5-15 shows a map of this strategy.

To execute this strategy, Lubbock will need to build the following infrastructure:

- An intake structure, including a small coffer dam
- A 400-hp pump station at the diversion site



Source: City's Strategic Water Supply Plan (City of Lubbock, 2013)

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North Fork Diversion to the Lake Alan Henry Pump Station

Figure 5-15

- A 5-mile, 27-inch pipeline to deliver water from the diversion site to the LAH Pump Station
- A 6.7-mgd expansion of the LAH Pump Station
- A 6.7-mgd expansion of the Post Pump Station
- Southland Pump Station
- A 6.7-mgd expansion of the SWTP and associated high service pump station

5.7.5.2 Quantity of Water

Due to the 67 miles between the discharge point at Outfall 001 and the proposed diversion site, carriage losses are estimated to be 26 percent, or 2.3 mgd. Therefore, this strategy will be able to provide only 6.7 mgd of the 9-mgd discharge, or 7,510 ac-ft/yr.

5.7.5.3 Strategy Cost

Table 5-72 summarizes the updated costs for the North Fork Diversion to LAH Pump Station strategy. General cost estimating assumptions made for all the City of Lubbock strategies are provided in Appendix 5F.

5.7.5.4 Implementation Issues

The City's existing TPDES Permit No. 10353-002 allows Lubbock to discharge up to 9 mgd of treated effluent in the North Fork at Outfall 001. No new discharge permit will be required. The City will need to obtain the following additional permits or permit modifications:

- A new water use permit from the TCEQ giving bed and banks authorization for the transportation and diversion of up to 10,089 ac-ft/yr minus carriage losses.
- Permitting for the diversion facility.

Other implementation issues include:

- Lubbock will need to acquire property at the diversion site to build a pump station.
- The City will need to acquire pipeline easements in order to build a raw water pipeline from the diversion site to the LAH Pump Station.

- The LAH raw water pipeline was built with extra capacity, anticipating a future water supply project (such as the Post Reservoir, the North Fork Scalping Operation, the South Fork Discharge, or the North Fork Diversion to LAH Pump Station). If the extra capacity is assigned to another proposed project, modifications to the LAH raw water pipeline will be necessary.

Table 5-72. North Fork Diversion to Lake Alan Henry Pump Station Cost Estimate Summary

Costs adjusted from HDR costs [a] (March 2012 prices) using an ENR CCI of 9552 for September 2013

Item	Costs (Sept 2013 Prices)
Capital Costs	
Intake and pump station (6.7 mgd, 400 hp)	$ 4,646,000
Transmission pipeline (27-inch, 5 miles)	3,475,000
LAH system expansions [b]	9,355,000
SWTP expansion (6.7 mgd)	13,374,000
Capital Cost Subtotal	$ 30,850,000
Engineering, legal costs and contingencies	10,624,000
Environmental and archaeology studies and mitigation	303,000
Land acquisition and surveying (38 acres) [c]	333,000
Interest during construction (2 years)	2,948,000
Total Project Cost	$ 45,058,000
Annual Costs	
Debt service (5.5%, 20 years)	$ 3,770,000
Operation and maintenance [d]	
Intake, pipeline, pump station	244,000
SWTP	1,146,000
North Fork pumping energy costs (2,445,0517 kWh at $0.09 per kWh)	220,000
LAH pumping energy costs (17,793,668 kWh at $0.09 per kWh) [e]	1,601,000
Total Annual Costs	$ 6,981,000
Available project yield (ac-ft/yr)	7,510
Annual cost of water ($ per acre-foot)	$ 930
Annual cost of water ($ per 1,000 gallons)	$ 2.85

[a] HDR estimate provided in City of Lubbock 2013 *Strategic Water Supply Plan*
[b] Includes expansion of the LAH and Post pump stations and construction of the Southland pump station.
[c] Land acquisition costs are based on $8,988 per acre for pipelines and $1,254 per acre for the intake and pump station. Assumed ROWs are 30 feet for the 24-inch pipeline and 40 feet for the 42-inch pipeline. Surveying is 10% of land cost.
[d] Operation and maintenance cost from Lubbock SWSP, projected to the current time period. For water treatment, costs in the Lubbock SWSP were based on a sliding scale depending on facility size. Other costs are a percentage of capital costs.
[e] Energy costs to pump water through the LAH Pump Station and LAH raw water pipeline are not included.

5.7.5.5 Environmental Impacts

Environmental impacts associated with this strategy have been quantified in the impact matrix (Table 5-5, Appendix 5E). Studies will be needed to determine the exact impacts of implementing this strategy. The main concerns are associated with the construction of the small coffer dam at the diversion site. The conversion of ranch land at the dam site may impact animal habitats, possibly requiring mitigation. More data are needed to determine what impact, if any, this water supply strategy will have on species inhabiting the area, specifically, the sharpnose shiner, smalleye shiner, Texas horned lizard, and black-footed ferret.

5.7.6 Reclaimed Water to Aquifer Storage and Recovery

5.7.6.1 Project Description

Lubbock will build an ASR well field east of the NWTP to store highly treated effluent from the SEWRP. To provide the source water for this well field, Lubbock will designate up to 9 mgd of incoming effluent at the SEWRP for advanced treatment, which will include advanced oxidation, disinfection, and RO. A new RO water treatment plant will be needed at the SEWRP, along with a Dockum Aquifer disposal well for the concentrate reject water produced by the RO plant. After advanced treatment, this reclaimed water will be of higher quality than any of Lubbock's other raw water sources.

The reclaimed water will be transported from the RO plant at the SEWRP to a ground storage tank at the new ASR well field through a new transmission pipeline. Water will be pumped from the ground storage tank to the ASR wells, where it will be injected into the Ogallala Aquifer for storage. The depth to the base of the Ogallala Aquifer is about 200 feet.

The water will be recovered 1.25 miles downgradient; groundwater at the ASR site is thought to move to the southeast. After recovery, the water will be transported through a second newly constructed pipeline to the NWTP for treatment and distribution. A chlorination expansion will be needed at the NWTP site to disinfect the stored water after recovery from the Ogallala Aquifer.

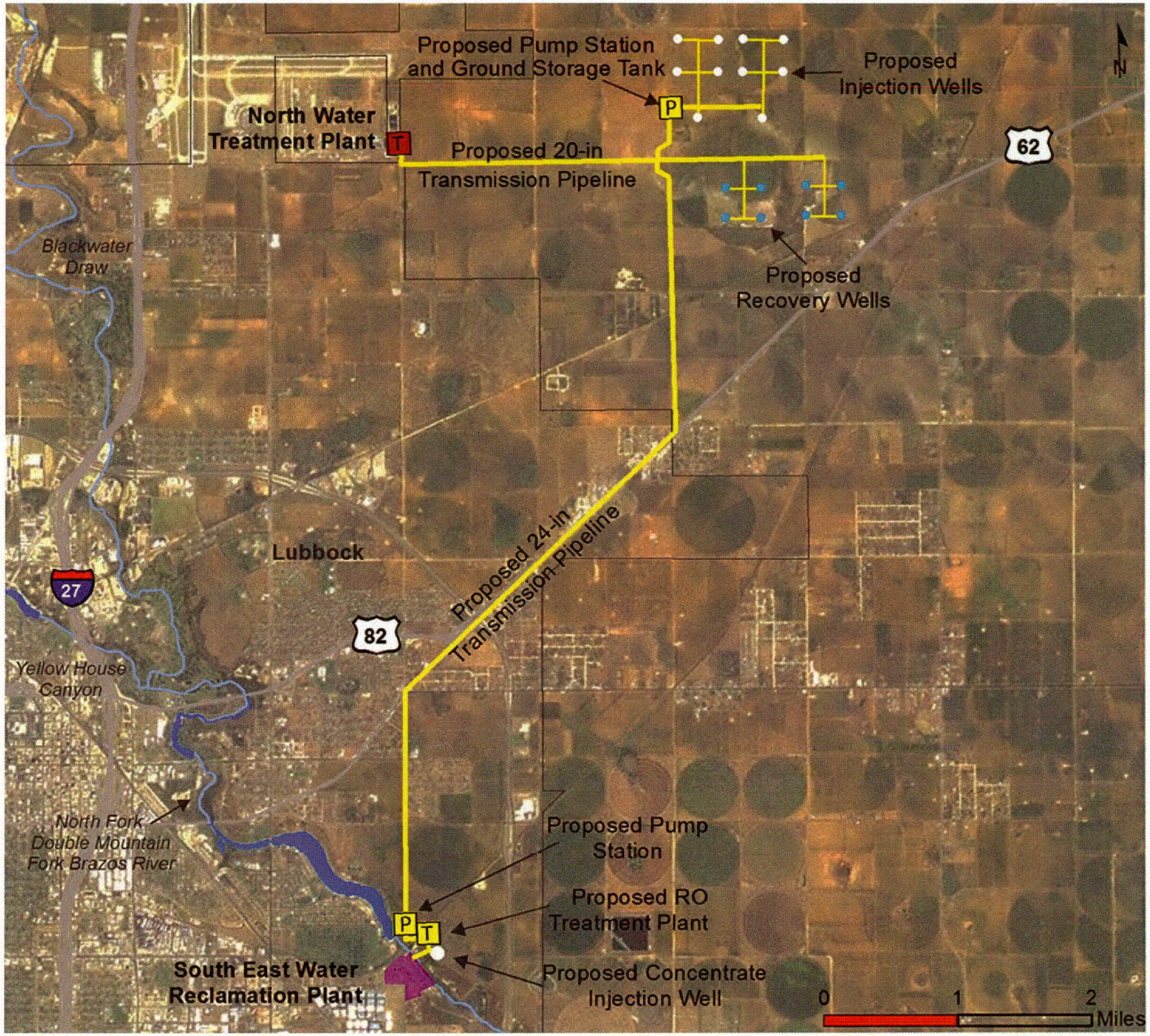
The ASR well field will consist of ten ASR injection wells, including one contingency well, drilled at least 1,200 feet apart from each other. The well field will also have eight ASR recovery wells, including one contingency well, with the same horizontal spacing as the injection wells. Figure 5-16 shows a map of this strategy.

To execute this strategy, Lubbock will need to build the following infrastructure:

- A 9-mgd advanced water treatment plant at the SEWRP
- A 1,900-foot Dockum Aquifer disposal well for the RO concentrate at the SEWRP and a 200-foot pipeline from the plant to the disposal well
- A 550-hp pump station to deliver water from the SEWRP to ground storage at the ASR site
- A 7-mile, 24-inch pipeline to deliver reclaimed water from the SEWRP to the ground storage tank at the ASR site
- A booster pump station to deliver water from the ground storage tank to the ASR wells for injection
- Ten Ogallala ASR injection wells, including one contingency well
- Eight Ogallala ASR recovery wells, including one contingency well
- A 2.5-mile, 20-inch pipeline to deliver the recovered water to the NWTP
- A 7.2-mgd expansion of the NWTP to accommodate additional chlorine disinfection capacity

5.7.6.2 Quantity of Water

Lubbock will have up to 9 mgd of reclaimed water available from the SEWRP for injection into the Ogallala Aquifer at the ASR site. Because of nearby Ogallala irrigation wells, an estimated 20 percent, or 1.8 mgd, loss of water is predicted. Therefore, this strategy will be able to provide 7.2 mgd, or 8,071 ac-ft/yr.



Source: City's Strategic Water Supply Plan (City of Lubbock, 2013)

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Reclaimed Water Aquifer Storage and Recovery Infrastructure

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5.7.6.3 Strategy Cost

Table 5-73 summarizes the updated costs for the Reclaimed Water to ASR strategy. General cost estimating assumptions made for all the City of Lubbock strategies are provided in Appendix 5F.

5.7.6.4 Implementation Issues

No ASR projects have been implemented within the High Plains UWCD No. 1. The District will need to develop and publicize rules for ASR projects. Other permitting issues associated with this strategy include:

- Lubbock will need to acquire groundwater rights in the proposed ASR site.
- Lubbock will need permits from the High Plains UWCD No. 1 in order to drill wells (once groundwater rights are acquired).
- The design of the new wells and collection pipelines must be approved by the TCEQ.
- Depending on the regulatory classification of the ASR return flows, Lubbock may have additional permitting requirements under Texas Water Code Section 11.154.

Other issues associated with this strategy include:

- Lubbock will need to acquire property to build the ASR well field.
- Lubbock needs to acquire easements to construct the pipeline from the SEWRP to the ASR well field and the pipeline from the ASR well field to the NWTP.

5.7.6.5 Environmental Impacts

Environmental impacts associated with this strategy have been quantified in the impact matrix (Table 5-5, Appendix 5E). A detailed environmental study will be needed to determine the level of environmental impact in Lubbock County due to the construction of ASR well field structures, transmission pipelines, and SEWRP expansion (see Appendix 1B for a list of threatened and endangered species by county). To the extent possible, the ASR site and transmission pipeline route should be selected to avoid significant environmental impacts. Minimal impact is expected due to the expansion of the SEWRP since this site is already being used for similar purposes.

Table 5-73. Reclaimed Water to Aquifer Storage and Recovery Cost Estimate Summary

Costs adjusted from HDR costs[a] (March 2012 prices) using an ENR CCI of 9552 for September 2013

Item	Costs (Sept 2013 Prices)
Capital Costs	
Advanced water treatment at SEWRP (9 mgd)	$ 37,470,000
Disposal well (1 Dockum well 1,900 feet deep, 150 gpm capacity; 200 feet of pipeline)	773,000
Pump station (from SEWRP to ASR well field, 9 mgd, 550 hp)	3,951,000
Transmission pipeline	
24-inch, 7 miles (SEWRP to ASR well field)	6,350,000
20-inch, 2.5 miles (ASR to NWTP)	1,095,000
Injection booster station, ground storage tank at ASR well field (0.45 mg, 40 hp)	1,167,000
ASR injection well field	
10 wells (220 feet deep, 700 gpm capacity)	4,512,000
2.5 miles of distribution piping (8, 12, 16, 18 and 24-inch)	625,000
Power connection cost	206,000
ASR recovery well field	
8 wells (220 feet deep, 700 gpm capacity)	3,181,000
2.7 miles of collector piping (8, 12, 16, 18 and 24-inch)	705,000
Power connection cost	165,000
ASR well field SCADA, valving, pumps	258,000
NWTP modifications: additional disinfection (7.2 mgd)	325,000
Capital Cost Subtotal	$ 60,783,000
Engineering, legal costs and contingencies	20,835,000
Environmental and archaeology studies and mitigation	1,604,000
Land acquisition and surveying (676 acres)[b]	1,764,000
Interest during construction (2 years)	5,949,000
Total Project Cost	$ 90,935,000
Annual Costs	
Debt service (5.5%, 20 years)	$ 7,609,000
Operation and maintenance	
Intake, pipeline, pump station	301,000
Water treatment plant	2,525,000
Transmission pumping energy costs (3,674,343 kWh at $0.09 per kWh)	331,000
ASR pumping energy costs (3,824,759 kWh at $0.09 per kWh)	344,000
Total Annual Costs	$ 11,110,000
Available project yield (ac-ft/yr)	8,071
Annual cost of water ($ per acre-foot)	$ 1,377
Annual cost of water ($ per 1,000 gallons)	$ 4.22

[a] HDR estimate provided in City of Lubbock 2013 *Strategic Water Supply Plan*
[b] Land acquisition costs are based on a 30-foot ROW and $8,988 per acre for pipelines (36 acres), and $2,000 per acre for the well fields (640 acres). Surveying is 10% of land cost.

5.7.7 Post Reservoir

5.7.7.1 Project Description

The 2,280-acre Post Reservoir will be located in Garza County, Texas, northeast of the City of Post on the North Fork. An intake structure, new pump station, and transmission pipeline will be built to transport raw water from the reservoir to the existing Post Pump Station. From there, the raw water will be conveyed to the City of Lubbock through the existing LAH infrastructure, and due to the additional volume of water, some modifications to the existing system will be needed. An expansion (from 15 mgd to 23 mgd) of the Post Pump Station will be necessary, as well as the construction of a storage tank at the pump station.

From the Post Pump Station, the water will be transported, along with water from LAH, to the SWTP through the existing LAH raw water pipeline. The City built the pipeline with an additional 9 mgd of capacity above the 27 mgd needed for LAH Phases 1 and 2, anticipating a future water supply project such as the Post Reservoir. Therefore, an expansion of the LAH raw water pipeline will not be necessary. However, construction of the Southland Pump Station will be needed to deliver the additional volume of water to the SWTP, which will also require an expansion. Figure 5-17 shows a map of this strategy.

Post Reservoir will capture natural flows on the North Fork and reclaimed water discharged from the City of Lubbock. Lubbock considers this an indirect reuse project since the majority of the reservoir's yield will be dependent upon the City's reclaimed water discharges.

To execute this strategy, Lubbock will need to build the following infrastructure:

- A dam and reservoir (57,420 acre-feet, 2,280 acres)
- An intake structure and pump station at the reservoir
- A 6-mile, 24-inch transmission pipeline from Post Reservoir to the Post Pump Station
- An 8-mgd expansion of the Post Pump Station
- A 0.75-million gallon ground storage tank at the Post Pump Station

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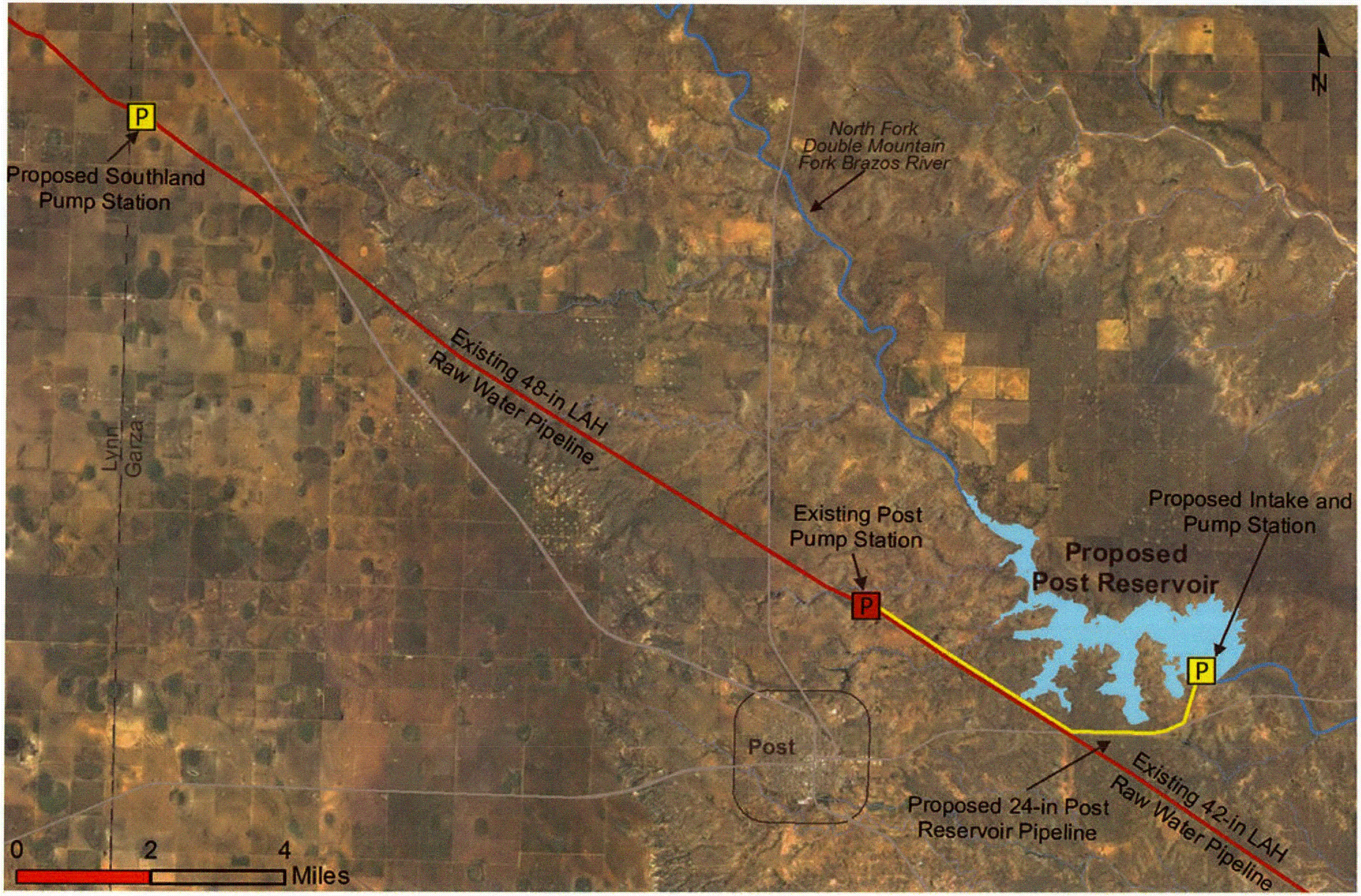

Source: City's Strategic Water Supply Plan (City of Lubbock, 2013)

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Post Reservoir Infrastructure

Figure 5-17

- Southland Pump Station
- An 8-mgd expansion of the SWTP

5.7.7.2 Quantity of Water

RPS modeled the Post Reservoir water strategy using a modified TCEQ WAM Run 3 for the Brazos River Basin, in order to evaluate the potential yield that will be 100 percent reliable during the historical drought of record (the modeling assumptions are detailed in Section 5.1.1). The modeled firm yield for Post Reservoir was 5,060 ac-ft/yr and the modeled safe yield was 4,830 ac-ft/yr, based only on naturalized flows. The modeled firm yield and modeled safe yield were both set to 10,600 ac ft/yr because of the availability of City of Lubbock return flows and stormwater discharges. This yield volume is 100 percent reliable when supplemented with either return flows or stormwater discharge, and the modeled yields (firm and safe) far exceed the existing permit volume (10,600 ac-ft/yr) with both of these additional sources. The existing Post Reservoir permit volume was used as the maximum modeled available yield for the strategy (Appendix 5C).

5.7.7.3 Strategy Cost

Table 5-74 summarizes the updated costs for the Post Reservoir strategy. General cost estimating assumptions made for all the City of Lubbock strategies are provided in Appendix 5F.

5.7.7.4 Implementation Issues

Permitting issues associated with the Post Reservoir strategy include:

- Lubbock's TPDES Permit No. 10353-002 allows the City to discharge up to 14.5 mgd (16,242 ac-ft/yr) at Outfall 007 and up to 9.0 mgd (10,089 ac-ft/yr) at Outfall 001. No additional permitting for the discharge of reclaimed water should be necessary.
- The White River Municipal Water District (WRMWD) holds Certificate of Adjudication No. 12-3711, which has a priority date of January 20, 1970. The Certificate authorizes the impoundment of 57,420 acre-feet of water at the Post Reservoir site and the diversion of 5,600 ac-ft/yr for municipal use, 1,000 ac-ft/yr for industrial use, and 4,000 ac-ft/yr for mining use (10,600 ac-ft/yr total). In order to build the reservoir, Lubbock will need to acquire ownership of the water right and obtain an amendment allowing the full 10,600 ac-ft/yr diversion for municipal use.

Table 5-74. Post Reservoir Cost Estimate Summary

Costs adjusted from HDR costs[a] (March 2012 prices) using an ENR CCI of 9552 for September 2013

Item	Costs (Sept 2013 Prices)
Capital Costs	
Dam and reservoir (57,420 acre-feet, 2,280 acres, 2,471 ft msl)	$ 22,824,000
Intake and pump station (8 mgd, 600 hp)	6,488,000
Transmission pipeline (24-inch, 6 miles)	3,620,000
SWTP expansion (8.0 mgd)	15,449,000
LAH system expansion[b]	8,037,000
Capital Cost Subtotal	$ 56,418,000
Engineering, legal costs and contingencies	19,163,000
Permitting fees	5,000,000
Environmental and archaeology studies and mitigation	3,102,000
Land acquisition and surveying (2,307 acres)[c]	3,412,000
Interest during construction (2 years)	6,097,000
Total Project Cost	$ 93,192,000
Annual Costs	
Debt service (5.5%, 20 years)	$ 4,275,000
Reservoir debt service (5.5%, 40 years)	2,624,000
Operation and maintenance[d]	
Intake, pipeline, pump station	181,000
Dam and reservoir	342,000
SWTP expansion	1,326,000
Post pipeline pumping energy costs (3,667,577 kWh at $0.09 per kWh)	330,000
LAH pipeline pumping energy costs (5,498,510 kWh at $0.09 per kWh)[e]	495,000
Total Annual Costs	$ 9,573,000
Available project yield (ac-ft/yr)	10,600
Annual cost of water ($ per acre-foot)	$ 903
Annual cost of water ($ per 1,000 gallons)	$ 2.77

[a] HDR estimate provided in City of Lubbock 2013 *Strategic Water Supply Plan*
[b] Includes expansion of the Post Pump Station and construction of the Southland Pump Station.
[c] Land acquisition costs are based on $1,254 per acre for the reservoir and $8,988 per acre for pipelines, the intake and pump station. A 30-foot ROW is assumed for pipelines.
[d] Operations and maintenance costs are assumed as 1% of facility cost for intake, pipeline and pump station, and 1.5% for dam and reservoir. For water treatment, costs in the Lubbock SWSP, which were based on a sliding scale depending on facility size, are projected to the current time period.
[e] Includes costs to pump water through the LAH Pump Station and LAH raw water pipeline

- Lubbock will need clarification on the 19,000 acre-feet of sediment reserve identified in the special conditions sections of Certificate of Adjudication No. 12-3711.
- To construct the lake, Lubbock will need a Section 404 permit from the USACE.
- Environmental mitigation plans must be approved by the USACE and other state and federal resource agencies.

Other implementation issues include:

- Lubbock will need to acquire property to construct the dam, lake, pump station, and mitigation area. The City already owns the land needed for the Southland Pump Station.
- Lubbock will need easements to construct the raw water transmission pipeline that will transport water from the pump station at the reservoir to the Post Pump Station.
- The LAH raw water pipeline was built with extra capacity, anticipating a future water supply project (such as the Post Reservoir, the North Fork Scalping Operation, the South Fork Discharge, or the North Fork Diversion to LAH Pump Station). If the extra capacity is assigned to another proposed project, modifications to the LAH raw water pipeline will be necessary.

5.7.7.5 Environmental Impacts

Environmental impacts associated with this strategy have been quantified in the impact matrix (Table 5-5, Appendix 5E). Detailed studies are needed to determine the level of environmental impact of this project. Due to the inundation of 2,250 acres of ranchland in Garza County, this strategy is anticipated to have a high environmental impact. A mitigation plan to compensate for the impacts to animal habitats will likely be necessary. See Appendix 1B for a list of threatened and endangered species by county.

On August 4, 2014, the USFWS listed the sharpnose and smalleye shiners as endangered under the Endangered Species Act. The sharpnose shiner's natural historical range included the Brazos, Wichita, and Colorado Rivers, and the smalleye shiner was native to the Brazos River. Both species are now confined to the river segments of the Brazos River basin upstream of Possum Kingdom Reservoir, including portions of Crosby and Garza Counties (USFWS, 2014). The two primary factors affecting the status of shiners are river fragmentation and alterations of the natural streamflow regime caused by dams, groundwater withdrawal, salt cedar encroachment, and drought (USFWS, 2014). Along with the final listing decision, the USFWS designated approximately 623 miles of the Upper Brazos River Basin as critical habitat in 11 Texas counties (USFWS, 2014), including Crosby and Garza counties within Region O. The determination is that these species require about 171 miles of continuous river segment in order to reproduce and survive. The USFWS's 2014 designation of critical habitat for the smalleye and sharpnose shiners will likely impact this project.

Post Reservoir is proposed to be constructed on the North Fork in Garza County, approximately 40 miles downstream of Buffalo Springs Lake and 390 miles upstream of Possum Kingdom Lake, within the current range of both shiner species. If the reservoir is built, there would still be adequate river miles between Post Reservoir and Possum Kingdom Reservoir for the shiner species reproduction and survival, but many other possible environmental issues could arise. The USFWS's listing proposal recommends that if any new reservoirs are built in the critical habitat area, they be built as far up the river as possible (close to Buffalo Springs Reservoir) or, preferably, as far down the river segment as possible (close to Possum Kingdom Reservoir) (Clayton, 2015). The proposal indicates that while building the reservoir far up the river would still give adequate length of river for the species, there could be other problems associated with the construction (decreased flow in the river, reduced water temperature associated with releases from the dam to maintain minimum flow standards, increased sediment, etc.).

5.8 Alternative Strategies for Municipal WUGs

Any alternative WMSs included in the RWP may be substituted for one of the recommended strategies, should it become infeasible. The following sections present evaluations of alternative WMSs for two municipal WUGs: Hockley County-other (Smyer) and the City of Tulia.

5.8.1 Smyer CRMWA Lease from Levelland

The City of Levelland has an open ended agreement with the City of Smyer to provide up to 1.8 mgd of Levelland's CRMWA allocation, if Levelland does not need it. Smyer would use this water to blend with their current groundwater supply. This additional supply would improve their water quality by reducing arsenic and fluoride concentrations and extend their future water supply.

5.8.1.1 Description of Option

This alternative project for Hockley County-other (Smyer) would build a new pipeline from the City of Smyer to a connection between Lubbock and Levelland along the existing CRMWA supply line. For planning purposes this project is designed based on the 1.8-mgd agreement and would include a new storage tank for the City of Smyer. The primary facilities incorporated into the planning-level cost estimate include:

- 2 miles of main water line from the new pump station to Smyer
- Pump station
- A 1,000,000-gallon elevated storage tank

5.8.1.2 Quantity and Reliability of Water

This project is estimated to provide an annual supply of 30 acre-feet for the City of Smyer. The source of this supply would be provided through a demand reduction by the City of Levelland from their CRWMA water allotment. The water supply would be available to the City of Smyer when the City of Levelland does not need it. The CRMWA source water is from the Ogallala Aquifer in the Canadian Basin of Roberts County (Region A). Water losses associated with this strategy are expected to be minimal, 10 percent or less.

5.8.1.3 Financial Costs

The estimated cost for this project was prepared using the TWDB's UCM and is provided in Table 5-75.

Table 5-75. Cost Estimate for Hockley County-other CRMWA Lease Pipeline Project

Item	Costs (Sept 2013 prices)
Capital costs	
Intake pump station (1.81 mgd)	$ 1,587,000
Water storage tank (1 @ 1 mg)	699,000
Transmission pipelines (6-inch, 2 miles)	418,000
Total cost of facilities	$ 2,704,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	925,000
Environmental and archaeology studies and mitigation	183,000
Land acquisition and surveying (11 acres)	163,000
Interest during construction (4% with 1% ROI for 1 year)	140,000
Total cost of project	$ 4,115,000
Annual costs	
Debt service (5.5% for 20 years)	$ 344,000
Intake, pipeline and pump station O&M (1% cost of facilities)	51,000
Pumping energy costs (393,915 kWh @ $.09/kWh)	35,000
Total annual costs	$ 430,000
Quantity of water (ac-ft/yr) [a]	30
Annual cost of water ($ per acre-foot)	$ 14,333
Annual cost of water ($ per 1,000 gal)	$ 43.98

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

5.8.1.4 *Environmental Impacts*

Environmental impacts associated with this alternative WMS have been quantified in the impact matrix (Table 5-5, Appendix 5E). Environmental issues would be associated primarily with the construction of pumping and conveyance facilities. Standard environmental clearances and permits to address protected wildlife habitat, protected plant communities, and/or cultural resources would be required for conveyance lines. The construction project would require an environmental assessment, but barring the presence of any endangered species or significant cultural resources, this project is not likely to pose any significant environmental impacts.

5.8.1.5 Implementation

Implementation of this strategy would be dependent on the approval of the full CRMWA board to authorize the use of Levelland's allotment to the City of Smyer. When approved, funding sources for the design and construction of this project will need to be identified. Conveyance easements and right-of-ways would need to be identified and purchased or leased.

5.8.2 Tulia Local Groundwater Development

The City of Tulia plans to pursue local groundwater development with additional storage capacity and water treatment. A water supply study prepared for the City discusses either developing a new well field or redeveloping an existing well site. The redevelopment project was selected as a recommended project for this plan (discussed in Section 5.2.3). The alternative project for developing a new well field for the City of Tulia is evaluated below.

5.8.2.1 Description of Option

The alternative project will develop a new City of Tulia well field completed in the Ogallala Aquifer in Swisher County by decade 2020. The exact location of the additional supply wells is not yet known but will be located on property the City will acquire in the future for well field development. The primary facilities incorporated into the planning-level cost estimate include:

- Two supply wells (1 active and 1 contingency)
- 2,000 feet of well field piping to the distribution system
- 4 miles of main water line to the new pump station
- Pump station
- Disinfection treatment system

5.8.2.2 Quantity and Reliability of Water

This project will develop 200 acre-feet of water supply from Red Basin that is expected to be reliable during drought of record conditions. Water losses associated with this strategy are expected to be minimal, 10 percent or less.

5.8.2.3 *Financial Costs*

The estimated cost for this project was prepared using the TWDB's UCM and is provided in Table 5-76.

Table 5-76. Cost Estimate for City of Tulia Groundwater Development Project

Item	Costs (Sept 2013 prices)
Capital costs	
Intake pump station (0.3 mgd)	$ 756,000
Supply wells (2 @ 300 feet deep, 375 gpm capacity)	821,000
Transmission pipelines (6-inch, 4 miles)	414,000
Water treatment plant (0.3 mgd)	27,000
Total cost of facilities	$ 2,018,000
Engineering, legal, contingencies (30% for pipelines, 35% for other)	686,000
Environmental and archaeology studies and mitigation	230,000
Land acquisition and surveying (15 acres)	161,000
Interest during construction (4% with 1% ROI for 1 year)	109,000
Total cost of project	$ 3,204,000
Annual costs	
Debt service (5.5% for 20 years)	$ 268,000
Intake, pipeline and pump station O&M (1% cost of facilities)	31,000
Water treatment plant O&M (2.5% cost of facilities)	16,000
Pumping energy costs (111,164 kWh @ $.09/kWh)	10,000
Total annual costs	$ 325,000
Quantity of water (ac-ft/yr) [a]	200
Annual cost of water ($ per acre-foot)	$ 1,625
Annual cost of water ($ per 1,000 gal)	$ 4.99

[a] Based on peaking factor of 1.5

ROI = Return on investment
O&M = Operation and maintenance

5.8.2.4 *Environmental Impacts*

Environmental impacts associated with this strategy have been quantified in the impact matrix (Table 5-5, Appendix 5E). Environmental issues are expected to be relatively minor for this groundwater development project and would be associated primarily with the construction of pumping and conveyance facilities. Standard environmental clearances and permits to address protected wildlife habitat, protected plant communities, and/or cultural resources would be required for well locations and conveyance lines once the locations are determined. The construction project will require an environmental assessment, but would be placed in a location no endangered species or significant cultural resources are present and therefore is not likely to pose any significant environmental impacts.

5.8.2.5 Implementation

Funding sources for design and construction of this project will need to be identified. Well sites and conveyance easements and right-of-ways would need to be identified and purchased or leased. Permitting-related requirements include:

- Well drilling permits will be needed from the High Plains UWCD No. 1.
- The design of the new wells and collection pipelines must be approved by the TCEQ.

5.9 Strategies Considered But Not Recommended

The possibility of importing water from the greater Mississippi River basin to Region O has been studied for many years. Water importation plans to Region O have previously been considered by the Texas Water Development Board (TWDB, 1968), U.S. Bureau of Reclamation (USBR, 1973), U.S. Army Corps of Engineers (USACE, 1973), and U.S. Department of Commerce (High Plains Associates 1982; USACE, 1982). The plans are generally similar in that surface water would be diverted from the Mississippi or its tributaries to source reservoirs and then transferred through canals and pumping stations over hundreds of miles and thousands of feet in elevation to terminal reservoirs in west Texas, western Oklahoma, and eastern New Mexico.

Water importation was included as a strategy in the 2001 Region O regional water plan, but it was not included in the 2006 or 2011 plans. The LERWPG asked that this strategy be evaluated as a part of the current planning round and that the evaluation be expanded to include any other potential water sources (e.g., the Great Lakes Basin). The LERWPG recognizes that the strategy is currently unfeasible, due to social, economic, and environmental considerations, and water importation is therefore not being recommended as a WMS as part of the current planning cycle. Nevertheless, the group has included the evaluation of the strategy (provided in Appendix 5G) for informational purposes.

5.10 Best Management Practices

5.10.1 Manufacturing Water Conservation

The 2011 TWDB water use survey includes responses from 55 facilities in the manufacturing sector in Region O, 27 of which are in Lubbock County (Table 5-77); the responding facilities are assumed to be the vast majority of the facilities in the region (TWDB, 2013d). Water use reported by all of these facilities combined was 14,231 acre-feet in 2011 (TWDB, 2013d). Listed facilities include gas plants, petroleum companies, and facilities that produce feed and agricultural products, food products, building products, and textiles (TWDB, 2013d). Data from the 2012 Economic Census indicate that in 2012, these facilities contributed more than $5,137 million to the economy, provided between 11,000 and 14,000 jobs, and had an annual payroll of more than $408 million (data were withheld for some counties to avoid disclosing data for individual facilities) (Table 5-78; U.S. Census Bureau, 2012).

Water is used in the manufacturing sector as process water and for cooling, cleaning, drinking, sanitary, and landscape irrigation purposes (LERWPG, 2010), with the volume of water used for each purpose varying by facility. As discussed in Chapter 1, water use by the manufacturing sector has averaged 0.2 percent of total water use in Region O over the period of 2003 to 2012 (an average of 9,077 ac ft/yr). As discussed in Chapter 2, 14 of the 21 counties in Region O have manufacturing activity, and water use in the manufacturing sector is projected to increase over the planning horizon. Water demand for the manufacturing sector in Region O was 9,579 acre-feet in 2010 (Table 1-7) and is projected to increase to 16,575 ac ft/yr by 2020 and to 20,822 ac ft/yr by 2070 (Table 2-14).

5.10.1.1 Description of Option

The TCEQ has developed a form to assist manufacturing facilities in developing water conservation plans. The information that is required to be included in each facility's conservation plan includes (TCEQ, 2013):

Table 5-77. Region O Manufacturing Facilities and Water Use in 2011
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County	Number of Facilities	Basin	Facility	Intake (gallons)
Castro	3	Brazos	Westway Feed Products	1,765,000
		Brazos	Gomax Foods, Inc.	45,000
		Red	Dimmitt Sulfur Products, Ltd.	17,183,436
Crosby	1	Brazos	Lorenzo Textile Mills	165,000
Deaf Smith	4	Red	Caviness Packing Company, Inc.	150,226,000
		Red	Arrowhead Mills, Inc.	2,203,000
		Red	ADM Alliance Nutrition Inc., Hereford Plant	381,000
		Red	21st Century Grain Processing	1,038,000
Gaines	3	Colorado	INEOS USA LLC-Hobbs FRACT Complex	32,903,642
		Colorado	HESS Corporation, Seminole Gas Plant	1,744,833,927
		Colorado	Phillips Petroleum Company, Gaines Station PPL	3,000
Garza	1	Brazos	Jackson Bros Meat Packers	570,000
Hale	6	Brazos	Western Ag Sales Company, Inc.	311,000
		Brazos	Martin Resources, Inc., Plainview Plant	31,368,292
		Brazos	County Services, Inc.	1,688,670
		Brazos	Cargill Meat Solutions Corp (Hale County)	99,959,700
		Brazos	Azteca Milling LP, Plainview Plant	180,692,400
		Brazos	Cargill Meat Solutions Corp (Hale County)	439,049,000
Hockley	4	Brazos	Occidental Permian Ltd, Slaughter Gasoline Plant	128,304,108
		Brazos	Occidental Permian Ltd., Mallet CO2 Removal Plant	42,000,000
		Brazos	Occidental Permian Ltd., Mallet CO2 Removal Plant	13,200,000
		Brazos	Ingram Concrete, LLC, Levelland Plant	1,129,840
Lamb	2	Brazos	Plains Cotton Cooperative Association, American Cotton Growers Div	134,510,588
		Brazos	El Paso Natural Gas Company, Dimmit Station	234,200
Lubbock	27	Brazos	Ingram Concrete, LLC, Lubbock North Plants	4,099,000
		Brazos	Industrial Molding Corporation	4,056,000
		Brazos	Pyco Industries Inc., East 50th Street Facility	5,235,000
		Brazos	Lubbock Gasket & Supply	375,000
		Brazos	PYCO Industries, Inc., Ave A Facility	3,358,000
		Brazos	ITT Goulds Pumps TTO	1,069,237
		Brazos	PYCO Industries, Inc., East 50th Street Facility	16,121,000
		Brazos	PYCO Industries Inc., Ave A Facility	70,985,000
		Brazos	Ingram Concrete, LLC, Lubbock South Plant	1,095,050

Source: TWDB, 2013b

Table 5-77. Region O Manufacturing Facilities and Water Use in 2011
Page 2 of 2

County	Number of Facilities	Basin	Facility	Intake (gallons)
Lubbock (cont.)	27	Brazos	Hanson Pipe & Products, Inc., Lubbock Plant	6,255,300
		Brazos	Praters Foods, Inc.	7,165,400
		Brazos	Consolidated Pipe & Tube Company	117,000
		Brazos	Southern Cotton Oil Company	1,800,000
		Brazos	Cap Rock Winery, Inc.	75,000
		Brazos	Delta Water Labs	75,600
		Brazos	Llano Estacado Winery, Inc.	331,716
		Brazos	Gandy's Dairies Inc., Lubbock Plant	32,574,000
		Brazos	Tri Gas, Inc.	1,415,000
		Brazos	Texas Turbine	789,000
		Brazos	Arctic Glacier Inc., Lubbock Plant	31,466,000
		Brazos	Hanson Pipe & Products, Inc., Lubbock Plant	254,000
		Brazos	Featherlite Building Products, Lubbock Plant	879,000
		Brazos	TYCO Fire Protection Products	6,511,000
		Brazos	Southern Cotton Oil Company	31,045,000
		Brazos	Diamond Plastics Corporation	3,869,000
		Brazos	Land O Lakes Purina Feed, LLC, Lubbock Plant	393,200
		Brazos	Lubbock Avalanche Journal	186,000
Parmer	2	Red	Unifeed Hi Pro, Inc.	901,000
		Red	Cargill Meat Solutions Corporation	477,067,000
Terry	2	Colorado	Brown Field Farmers, LLC	566,471
		Colorado	Ingram Concrete, LLC, Brownfield Plant	1,740,000
			Total (gallons)	4,637,253,913
			Total (acre-feet)	14,231

Source: TWDB, 2013b

Table 5-78. Region O Manufacturing Summary, 2012

County	Number of Facilities	Number of Employees	Annual payroll (million $)	Value of products (million $)
Bailey	7	148	5.2	D
Briscoe	2	0 – 19	D	D
Castro	6	20 – 99	1.8	D
Cochran	1	0 – 19	D	D
Crosby	3	28	1.0	D
Dawson	15	121	5.7	22.0
Deaf Smith	25	1,469	59.8	1,084.2
Dickens	0	0	0	0
Floyd	7	38	1.8	11.4
Gaines	17	158	7.8	31.9
Garza	2	0 – 19	D	D
Hale	23	2,631	90.2	2,414.6
Hockley	15	199	8.5	D
Lamb	6	500 – 999	D	D
Lubbock	240	4,984	216.1	1,572.9
Lynn	3	63	1.9	D
Motley	1	0-19	D	D
Parmer	6	1,000 – 2,499	D	D
Swisher	8	75	3.1	D
Terry	5	22	0.8	D
Yoakum	7	98	4.8	D
Total	399	11,554 – 13,707	408.5	5,137.0

Source: U.S. Census, 2012 D = Data withheld to avoid disclosing data for individual firms

- Background data (water demand, water sources, how water is metered and treated, and major products or services provided by the applicant)

- Existing water use and conservation practices, including the volumes of water used for
  - Production uses (cooling, condensing, and refrigeration, processing, washing, and transport, boiler feed, incorporation into product, etc.)
  - Facility uses (cooling towers, ponds, once through, sanitary and drinking water, and irrigation and dust control)
- Whether water is recirculated in the facility
- An estimate of the volume of water that is consumed by the process and not available for reuse
- Projected water demand
- Specific and quantified water conservation goals

The specific and quantified conservation goals that get established are for the amount of water to be recycled, reused, or not lost or consumed (so available for return flow) (TCEQ, 2013). Facilities are also asked to include information about the metering and leak-detection and repair measures that are used and the equipment or process modifications that are used to improve water use efficiency (TCEQ, 2013).

In the manufacturing sector, water can be conserved through modifying or making substitutions in the facility's process, recycling or reusing cooling water, and/or conserving steam and hot water (e.g., energy conservation and waste heat recovery) (LERWPG, 2010). Other conservation methods include conducting facility-specific water audits and completing retrofits in response to the results, providing rebates for fixture and/or appliance replacements, and retrofitting facility restrooms.

The TWDB has published a BMP guide for industrial water users (TWDB, 2013a) that includes a voluntary list of management practices that facilities may implement to conserve water. The TCEQ water conservation plan form for the manufacturing sector provides a link to this document. Overall TWDB-recommended BMPs include:

- As water use and the potential for conservation varies considerably by facility, the TWDB's initial recommendation is for facilities to conduct an industrial water audit to identify the relationships between all water coming into and being used inside the facility (TWDB, 2013a). Benefits from implementation of a facility water audit may include lower utility costs, process costs, and energy savings (TWDB, 2013a).

- The second BMP that the TWDB recommends is the industrial water waste reduction BMP, which focuses on the most economical changes that can be made to improve water use efficiency (TWDB, 2013a). Implementation of this BMP could increase water use efficiency at facilities by prohibiting wasteful activities (e.g., irrigation practices and scheduling, single-pass cooling, non-recycling decorative fountains, discharge of process water, and use of inefficient water softeners) (TWDB, 2013a).

- The TWDB also recommends that facilities implement the industrial submetering BMP to help in identifying significant opportunities for monitoring ongoing water use within the facility (TWDB, 2013a).

The document goes on to list more detailed specific BMPs, broken into five categories: conservation analysis and planning, educational practices, system operations, cooling systems management, and landscaping (TWDB, 2013a).

The LERWPG recommends that manufacturing facilities develop and implement site-specific water conservation practices, by completing facility-specific water use audits and then identifying and implementing specific BMPs that are appropriate for their facility.

5.10.1.2 Quantity and Reliability of Water

Studies have shown that the estimated water savings for implementing facility water audits have been in the range of 10 percent to 35 percent on average. Efficiency measures that involve changing from high quality or potable water to recycling water have shown savings in the range of 50 percent to as high as 95 percent (Vickers, 2001). The total volume conserved will depend on the facility.

The water quantity generated by the industrial water waste reduction BMP will depend on whether any wasteful activities are identified and what is done to change behaviors and practices to reduce water waste (TWDB, 2013a). The water quantity generated by the industrial submetering BMP will depend on the facility's baseline water use and whether any leaks are found and fixed as a result of the new metering.

As with the municipal water conservation strategies, the reliability of the manufacturing water conservation activities will be BMP-dependent, but they are expected to be reliable with proper implementation. For the facility-specific water audits, the results will depend on implementation of specific BMPs, with their selection being dependent on the facility audit findings. Changes made in practices to mitigate water waste will be reliable, as long as the changes are maintained. The submetering BMP will be reliable as long as the meters are maintained and any leaks that are identified are fixed.

5.10.1.3 Financial Costs

The cost of implementing facility-specific water audits will depend on the size and nature of the facility, as well as whether the work is done by existing staff or by a contractor. The cost of implementing the industrial water waste reduction BMP will depend on the wasteful practices that are identified and what solutions are chosen to address them. For the industrial submetering BMP, there will be capital costs of the meter and its installation, as well as operational expenses for training, reading, maintaining, and calibrating the meters. Meter costs range from $50 to $100 for small flow rates, to several thousand dollars for larger compound meters, and these meters have a typical design life of 10 to 15 years (TWDB, 2013a).

5.10.1.4 Environmental Impacts

As with the municipal water conservation strategies, manufacturing water conservation activities are expected to have minimal environmental impacts. Implementation of many of the manufacturing BMPs may lead to lower indoor and outdoor water usage, resulting in lower municipal water consumption. Reducing water demand will reduce the pressure on the water supplies by limiting declines in reservoir and/or aquifer levels, extending the effective life of the current water sources and delaying the need for future water supply projects.

5.10.1.5 Implementation

Implementation issues that facilities may have when conducting facility-specific audits and implementing manufacturing BMPs will stem from staff and resources available for assessing current water use, implementing any changes based on the findings, and maintaining any changed practices or newly installed equipment.

5.10.2 Graywater Reuse

5.10.2.1 Description of Option

In 2003, the Texas Legislature adopted House Bill 2661, which defines graywater and includes provisions for facilitating its use in a safe manner. In Texas, graywater is defined as wastewater from clothes washers, showers, bathtubs, and sinks not used for the disposal of hazardous or toxic materials (TWDB, 2004b). Graywater cannot include water from clothes washers used for washing diapers, sinks used for food preparation, toilets, or urinals (TWDB, 2004b). House Bill 2661 allows private residences to use up to 400 gallons per day of untreated graywater for landscape irrigation, gardening or composting as long as

- The graywater is used by the occupants of the residence.
- The system overflows into a sewage collection system or on-site wastewater treatment and disposal system.
- The graywater is stored in tanks that are clearly labeled and that have restricted access.
- The system uses purple pipe or purple tape around the pipe.
- Graywater is not allowed to pond or run off across property lines.
- The graywater is distributed by a surface or subsurface system that does not spray into the air (unless the graywater receives additional treatment).

HB 2661 also encourages builders of new homes to install dual piping that provides the capacity to collect graywater from allowable sources (TWDB, 2004b).

The standard components of a graywater system include (Little, 2003):

- Conveyance piping to collect water from a source and deliver it to the graywater system
- Surge tank to hold flows (e.g., plastic trash barrel)
- Filter to remove particles such as lint and hair (e.g., sock, sand filter)
- Storage tank to hold water until ready to use
- Three-way valve to allow graywater to go to sewer or septic system
- Pump to move water to distribution point such as irrigation system

Advantages of reusing graywater include the following:

- Replaces potable water use and therefore lowers water bills and possibly sewer bills for utility customers
- May support plant growth when used for outdoor irrigation (due to the nutrients in graywater)
- Reduces energy and chemical use
- May decrease or delay the need to expand wastewater treatment facilities

5.10.2.2 Quantity and Reliability of Water

Water savings due to the implementation of graywater reuse will vary depending on the scope of each system (TWDB, 2004b). It is estimated that a household's total water use could be reduced by approximately 30 percent by reusing graywater for toilet flushing (Eriksson et al., 2002). In some cases, graywater use may provide more water than was previously used when potable water was the source of supply, in which case only the reduction in potable water use should be calculated as the actual savings (TWDB, 2004b).

5.10.2.3 Financial Costs

Costs to utilities will include the administrative costs associated with oversight of the implementation of graywater projects, including review of plans and inspections (TWDB, 2004b). The TWDB estimates that staff labor cost should range from $50 to $100 per project, with additional marketing and outreach costs of $20 to $50 per project (TWDB, 2004b). Graywater system costs will depend on the size and scope of each project and will be the responsibility of the builder or private party that is implementing the project.

5.10.2.4 Environmental Impacts

Reusing graywater may have some disadvantages (Little, 2003), including:

- May spread disease if system is not properly operated
- May develop odors if stored more than 24 hours
- May adversely impact soil (salt buildup)
- Decreases the amount of wastewater going to the treatment plant, which may affect the overall wastewater system
- Lowers the availability of reclaimed water for other uses

5.10.2.5 Implementation

Implementation of this BMP will entail following rules pertaining to graywater adopted by TCEQ, as well as any local city or county health department rules (TWDB, 2004b). Municipalities can support graywater reuse by providing educational materials and/or rebates for residents who want to install systems and by requiring graywater reuse on new construction. Retrofitting existing homes and buildings for collection and use of graywater is not recommended, due to the high cost of this option (TWDB, 2004b).

5.10.3 Treated Wastewater Reuse for Energy Production and/or Irrigation

5.10.3.1 Description of Option

The LERWPG supports using treated municipal wastewater for energy production and/or irrigation. Many of the WUGs in Region O are already land applying their treated wastewater (using it for irrigation). In addition, the City of Lubbock sells treated wastewater to energy companies for cooling.

Industrial uses of reclaimed water can include both cooling and process water for chemical manufacturing, textile production, and petroleum/coal development/production, all of which use water at a constant rate. Thus industrial applications provide good opportunities for year-round use of reclaimed water (Plummer, 2010). Industrial water quality requirements are relative to the use and tend to be centered on the scaling and corrosion of the infrastructure due to parameters such as dissolved solids, hardness, silica, dissolved oxygen, and nutrients such as ammonia. On top of these physical concerns, introducing reclaimed water that contains organic matter and nutrients to an industrial system has the potential for undesirable biological growth.

Indirect reuse applications for agriculture, similar to urban reuse, are limited by water quality restrictions. In Texas, reclaimed water is allowed for the irrigation of food, irrigation of pastures or sod farms, irrigation of feed crops, and silviculture. Agricultural requirements for reclaimed water are also relative to the potential for human contact. Food crop contamination by microbial pathogens found in reclaimed water is of great concern, so much so that if the reclaimed water isn't treated to remove these pathogens, then an additional step of commercial processing must take place to destroy them. Another important and potentially expensive issue of concern is based on irrigating with water containing a high concentration of salts. A build-up of these salts in the soil could be damaging if the irrigation water is not properly applied.

5.10.3.2 Quantity and Reliability of Water

Water quantities available through reuse are highly variable as they are based on discharge from wastewater treatment plants, water available after consideration of downstream water rights holders, secondary and tertiary treatment technologies, infrastructure including conveyance and storage, and required water quality for various demands. The quantity of reuse water generated through the application of reclaimed water is relative to each individual project and is directly equal to the amount of water designated for the use since there are none of the losses usually associated with water treatment. The quantity and reliability of water for a potential water reuse project will need to be evaluated on a project-specific basis.

5.10.3.3 Financial Costs

There are a wide range of costs associated with the implementation of water reuse projects. These are primarily associated with capital costs of facilities, engineering costs, regulatory costs, and costs associated with operation and maintenance (TWDB, 2004b). Financial incentives that reward the reuse of water can be put in place to help a developer connect to the reclaimed water system or replumb facilities from potable to non-potable water use (TWDB, 2004b). It is estimated that the implementation of the water reuse projects included in the state's 2007 water plan would cost $4 billion (TWDB and Plummer, 2011b). Each potential water reuse project will need to be designed and the cost estimated before proceeding with implementation.

5.10.3.4 Environmental Impacts

A growing field of research is focused on understanding the transfer of emerging contaminants of concern (i.e., pharmaceuticals and ingredients in personal care products) through the use of reclaimed wastewater for irrigation. Research now shows that pharmaceuticals are taken up by plants in their roots and leaves, and therefore they accumulate in the biomass of the plants (Herklotz et al., 2010). One study on cucumbers indicates that transfer through the food-chain pathway is within the same magnitude or even higher than transfer through drinking water, and the concern is greater for plants whose edible parts are leaves, since the study found significantly higher concentrations in leaves than in fruit (Shenker et al., 2011). The potential environmental impacts of a proposed water reuse project will need to be evaluated on a project-specific basis.

5.10.3.5 Implementation

Implementation of water reuse would require evaluation of supply from municipal wastewater treatment facilities, evaluation of downstream water rights, technical engineering design of treatment systems and conveyance, and public education and communication. Reuse applications are more widely accepted and applied throughout both arid and semiarid regions of the U.S., so the technical knowledge to implement reuse projects is readily available. Physical infrastructure is similar to that of potable water; however, an entirely new, separate treatment and conveyance system is required. Funding for reuse projects is generally less available than for other water projects, with federal and state funding programs generally focusing on potable water or wastewater treatment projects. The implementation issues will need to be evaluated for each individual reuse project.

5.10.4 Non-Potable Water Reuse for Hydraulic Fracturing

5.10.4.1 Description of Option

Produced water is the largest byproduct of oil and gas production, with treatment and disposal costs of up to $6.00 per barrel (Yu, 2014). The estimate for the annual volume of produced water in the U.S. is 21 billion barrels (Yu, 2014). Common produced water management options include disposal well injection, surface discharge, commercial/municipal wastewater treatment plant discharge, and reuse (Ma et al., 2014). Over 90 percent of produced water is treated by oil/water separation and deep well injection; reinjection costs range between $0.40 and $2.00 per barrel, with disposal well installation costs of $400,000 to $3,000,000 per well. Produced water treatment and disposal costs total over $40 billion per year (SPE, 2015).

Treatment and reuse of produced water can enhance gas recovery and the economic viability of gas production (Ma et al., 2014). The Research Partnership to Secure Energy for America (RPSEA) and U.S. Department of Energy National Energy Technology Laboratory (DOE/NETL) have begun funding studies of produced water treatment technologies, including distillation, RO, membrane filtration, nanofiltration, chemical treatment, ion exchange, and electrodialysis (Yu, 2014). Produced water quality is variable, often having high concentrations of TDS, organics, and total suspended solids (TSS), in addition to the chemicals added for drilling and hydraulic fracturing (fracking) (Ma et al., 2014). While the majority of floating oil and organic matter can be removed through centrifuge and/or gravity separation processes, the small particle sizes present challenges to treatment and are the source of membrane fouling (Yu, 2014).

In a study that applied forward osmosis (FO) as a treatment method for produced water, results indicated that this treatment method can achieve high rejection of organic and inorganic contaminants with reversible membrane fouling, recovering more than 80 percent of the produced water (Hickenbottom et al., 2013). A treatment unit with a capacity of 30 barrels per day was used to test a low-temperature distillation/humidification dehumidification (HDH) process for treating produced water at a wellhead, with a first pass yield of 20 percent (Balch et al., 2012). The TDS concentration of the produced water was reduced from as high as 25,000 mg/L to less than 200 mg/L, and the total organic carbon concentration was reduced from 470.2 to 17.83 mg/L. The study results indicate that the HDH process is economical for small to intermediate volumes of produced water (Balch et al., 2012).

Drillers that are using fracking techniques to develop shale plays in Texas, including the Barnett Shale, Eagle Ford Shale, and Haynesville Shale, use disposal well injection, mainly due to the costs, but are considering reuse (Ma et al., 2014). Treatment and reuse of produced water is becoming a viable alternative for managing produced water (Ma et al., 2014), and the implementation of this practice is expected to become more widespread as the costs come down. The LERWPG supports using non-potable (produced) water from oil and gas wells for fracking or other uses.

5.10.4.2 Quantity and Reliability of Water

The quantity of treated produced water available for reuse will be limited only by the treatment technology, capacity, and cost. This water supply will be reliable, so long as oil and gas exploration continues.

5.10.4.3 Financial Costs

Cost data for the current treatment technologies was not found, but many sources indicate that costs are the limiting factor to implementation (Ma et al., 2014). Development of cost-effective treatment processes is seen as essential for maintaining domestic production and long-term energy security; however, treatment processes that are portable and cost-effective have not yet been identified (Yu, 2014). Treatment and reuse of produced water is expected to be widely implemented once the costs become comparable to deep well injection costs.

In addition to the treatment costs, companies will likely also need to rent or purchase aboveground storage for storage of the produced water.

5.10.4.4 Environmental Impacts

Treatment and reuse of produced water minimizes potential environmental impacts and reduces demands on local water supplies (Ma et al., 2014), while protecting the environment from drilling waste (Hickenbottom et al., 2013).

5.10.4.5 Implementation

Factors affecting the feasibility of reusing produced water include water quality, water quantity, treatment technologies, economics, disposal options, environmental impacts, and regulations (Ma et al., 2014). Limited water resources and high treatment costs provide an opportunity for reuse of produced water (SPE, 2015), but to date, a treatment process that is economically feasible and scalable to allow for treating large volumes of produced water has not been identified (Yu, 2014). RO treatment is cost prohibitive and thermal treatments (e.g., distillation and evaporation) have low clean water recovery rates (approximately 25 percent), large plant size, and limited flexibility, while HDH processes are not applicable in high humidity environments (Yu, 2014).

5.10.5 Brush Management

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) estimates that brush in Texas uses approximately 10 million acre-feet of water annually compared to 15 million acre-feet annually consumed for all other purposes. Brush control has the potential to provide numerous benefits, including enhanced water yield, improved soil conservation leading to decreased erosion rates, increased biodiversity, protection of water quality, raised water table, and help with managing invasive species (TSSWCB, 2014a).

The Texas Brush Control Program (TBCP) was created in 1985 and replaced in 2011 by the Water Supply Enhancement Program (WSEP). The WSEP was established by the 82nd Texas Legislature to be administered by the Texas State Soil and Water Conservation Board (TSSWCB) "with the purpose of increasing the available surface and ground water through the selective control of brush species that are detrimental to water conservation" (TSSWCB, 2014b). The TSSWCB collaborates with a range of agencies to identify watersheds across the state where it is practical to implement brush control practices. Once potential watersheds are identified, the TSSWCB uses a competitive grant process to review proposed projects, with an emphasis on funding those that balance water conservation needs with the highest projected yield from brush control (TSSCWB, 2014b).

5.10.5.1 Description of Option

In Region O, brush management is most applicable in the watersheds above each of the reservoirs (Lake Mackenzie in Briscoe County, White River Lake in Crosby County, and Lake Alan Henry in Garza County). There is also the potential for a new reservoir, Post Reservoir (Section 5.2.27), to be built on the North Fork located east of Post in Garza County; if constructed, that reservoir would be another potential location for implementation of this BMP.

The CRMWA has been implementing a salt cedar management program since 2004 to improve water quality and to create better habitat for the federally listed Arkansas River shiner. Under this program the CRMWA has treated more than 26,000 acres (or approximately 95 percent of the salt cedar in the watershed) in an effort to increase flow in the Canadian River and its tributaries within the Lake Meredith watershed (CRMWA, 2015). CRMWA has treated an average of approximately 900 acres annually for the last three years using hand spraying methods. They estimate that 750 acres will be treated this year and that approximately 750 to 1,000 acres will be treated annually on an ongoing basis (Satterwhite, 2015). The LERWPG supports their efforts.

The USDA-NRCS and Texas AgriLife Research and Extension began releasing salt cedar beetles in the Big Spring area in 2004 and released the Crete species of salt cedar beetles in the area around Lake Alan Henry in 2008 (Spear, 2015). The beetles did not survive the cold winter temperatures in 2011, and so the USDA-NRCS released beetles from the Tunisian species of salt cedar beetles, originating from Uzbekistan, in 2012 (Spear, 2015). City of Lubbock staff began noticing beetle effects in 2012, and larger populations of beetles began defoliating more trees in 2013 and 2014 (Spear, 2015).

In 2013, the City of Lubbock began investigating the plant density of the salt cedar upstream of Lake Alan Henry (Spear, 2015). The plants located between Highway 84 and the mouth of the lake were dense, large trees, and trees became smaller and less dense further upstream. The City initiated a salt cedar spraying program in 2013, spraying herbicide by helicopter (Spear, 2015), and plans to continue spraying different areas of the watershed each year. The U.S. Geological Survey is working on a watershed model, and once it has been completed, it will help the City determine the best approach to managing invasive plants (Spear, 2015).

The City is also preparing a watershed management plan and is recommending that ranchers remove brush and develop range grassland vegetation in order to decrease erosion and increase runoff into Lake Alan Henry (Laing, 2015). The draft plan is scheduled to be completed in December 2015 (Laing, 2015). A feasibility study for conducting brush control for water supply enhancement is underway for Lake Alan Henry and will estimate the potential water yield to be come from brush control in the reservoir's watershed. The LERWPG recommends that a feasibility study also be conducted for the White River Municipal Water District.

5.10.5.2 Quantity of Water

Site-specific conditions, along with ongoing site maintenance, are instrumental in the success of brush management projects. Pre- and post-monitoring efforts assess that success. For years, land managers have qualitatively observed increases in spring flow and streamflow upon removal of brush species, such as mesquite and juniper (TSSWCB, 2014a). Based on these observations, scientists have sought to quantify the effects of brush removal.

A simple rangeland water balance can be modeled and quantified with the following equation:

$$\text{Water yield} = P - ET - \Delta S$$

where P = precipitation
ET = evapotranspiration,
S = storage

In order to increase the water yield, given that P and S are relatively constant, ET must be reduced. Reducing ET effectively has its limitations, which Hibbert (1983) summarizes as:

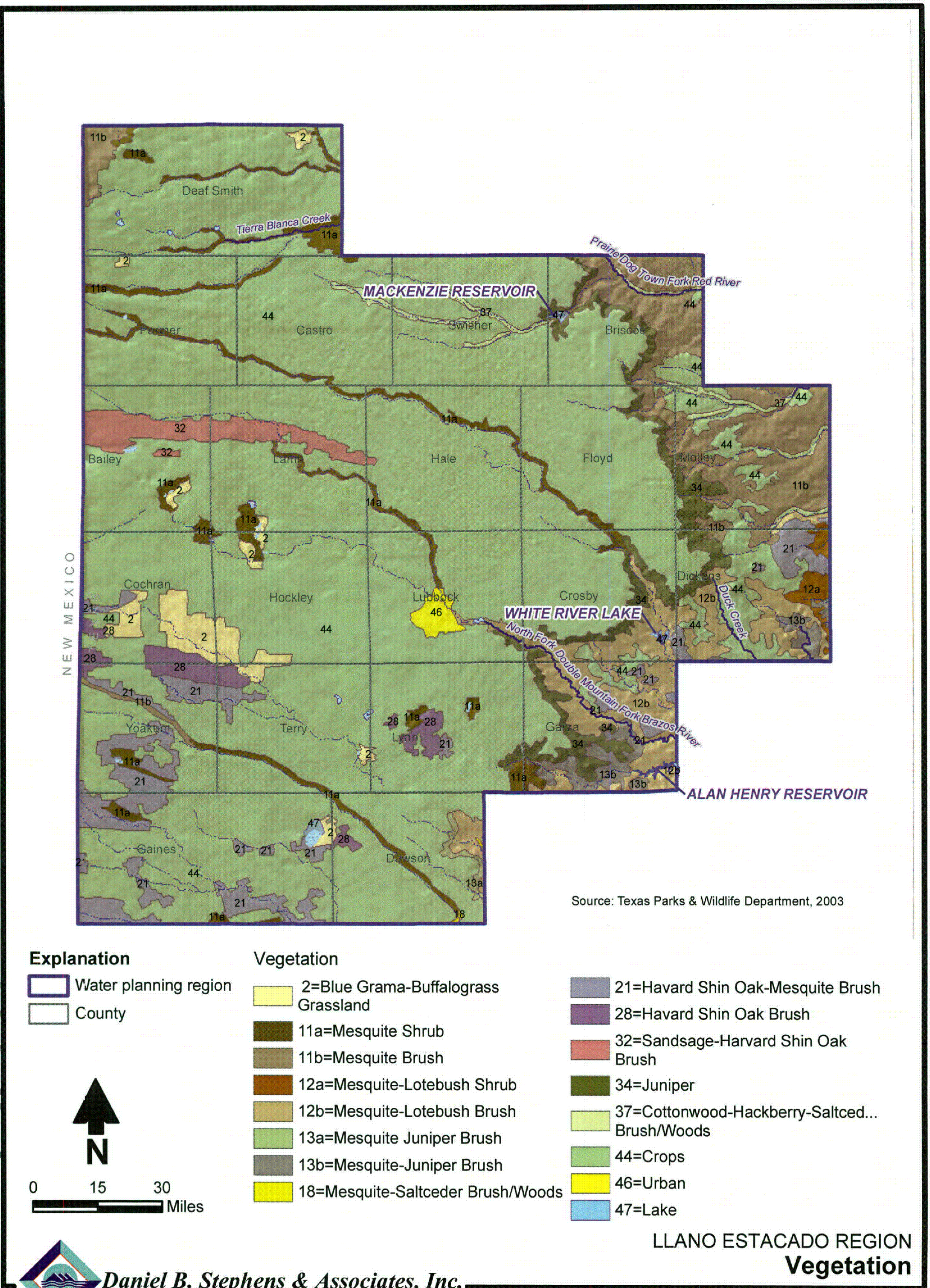
1. Annual precipitation should be greater than 18 inches per year (in/yr), and potential ET more than 15 in/yr.
2. Replacement plants should use less water.
3. Replacement plants should be low in biomass and deciduous or dormant much of the time.

4. High-water-use plants must be thinned sufficiently so that remaining roots don't deplete the water savings.

Through water yield studies in the western U.S. along with data from the Edwards Plateau in Texas, Thurow and Hester (1997) concluded that a significant increase in water yield is possible if brush land is converted to grassland in areas that receive at least 18 in/yr of precipitation. Conversion of vegetation from brush to grass in regions with less than 18 in/yr does not result in an increased yield because the water that is saved from plant transpiration is lost through increased soil evaporation or is consumed through herbaceous growth (TSSWCB, 2014a). The fundamental controlling factors for successfully conserving water due to the implementation of brush control activities include the availability of groundwater and the temporal response and makeup of the vegetative community that replaces the vegetation after removal (Wilcox et al., 2006).

Figure 5-18 shows the vegetation types within Region O, along with the reservoir locations (brush management will have the greatest benefit in the watersheds upstream of the region's reservoirs). Two eligible brush species that have been listed as detrimental to water conservation are mesquite (*Prosopis spp.*) and juniper (*Juniperus spp.*). Tables 5-79a and 5-79b show the acreages for mesquite and juniper vegetation types by county within the region, including total acreages that receive at least 18 in/yr of precipitation.

The recently released Texas Water State Enhancement plan (TSSWCB, 2014a) includes results from a series of field studies that provide valuable insight into the impacts of removing vegetation on rangeland hydrology. Research at the AgriLife Research field station at Sonora showed that water yield increased exponentially as brush cover declined in treated areas; however, significant yields of water were not observed until thinning reduced cover to less than about 15 percent, since the remaining trees expand their root systems after an area is thinned to use any excess water (TSSWCB, 2014a). Rainwater et al. (2008) completed a comprehensive review of water use by brush species, some of which is cited and summarized in the following paragraphs.



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LLANO ESTACADO REGION
Vegetation

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Figure 5-18

Table 5-79a. Region O Mesquite Vegetation Class and Average Annual Precipitation by County
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County	Vegetation Class	Number of Acres [a]								
	Precipitation (in/yr)	*16 – 17*	*17 – 18*	*18 -19*	*19 – 20*	*20 – 21*	*21 – 22*	*22 – 23*	*23 – 24*	*24 – 25*
Bailey	Mesquite shrub		8,612	3,636						
			2,841	2,038						
Briscoe	Mesquite brush						15,787	186,354	6,859	
							8,379	26,916	1,614	
Castro	Mesquite shrub			363	302	6,424				
				1,565	10,051	1,968				
Cochran	Mesquite shrub			2,646						
				2,367						
Crosby	Mesquite shrub						1,423	52		
							6,731	734		
	Mesquite-lotebush brush					5,172	18,979	57,707	1,065	
						3,691	4,146	28,178	2,926	
Dawson	Mesquite juniper brush			1,803	15,080					
				2,731	1,547					
	Mesquite shrub			6,849						
				17,829						
	Mesquite-juniper brush				380					
	Mesquite-saltceder brush/woods			1,718	799					
Deaf Smith	Mesquite brush		21,974	25,680						
			2,836	2,810						
	Mesquite shrub		606	10,653	24,584	2,867				
			34	3,826	46,686	43				

Source: McMahan et al., 1984.

[a] Blank cells indicate no acreage with more than 16 inches of precipitation annually in the county.

— = Total acreage is not shown, because areas receiving less than 18 inches of precipitation per year should not be the target of a brush management program.

Table 5-79a. Region O Mesquite Vegetation Class and Average Annual Precipitation by County
Page 2 of 3

County	Vegetation Class	Number of Acres [a]								
Dickens	Mesquite brush								11,952	
									3,571	
	Mesquite-juniper brush							2,817	16,951	5,564
									15,717	1,062
	Mesquite-lotebush brush							60,639	69,844	6,355
								6,736	7,642	221
									36,528	4,303
									9,375	957
Floyd	Mesquite brush							21,884		
								8,515		
	Mesquite shrub					332	3,775			
						2,042	15,027			
Gaines	Mesquite shrub	9,198	3,463	5,993						
			928	516						
Garza	Mesquite shrub					10,748	286			
						126	648			
	Mesquite-juniper brush					7,134	52,275			
						5,724	20,078			
	Mesquite-lotebush brush					20,962	151,501	22,312		
						2,754	50,893	13,525		
Hale	Mesquite shrub			1,549	9,684	2,175				
				1,815	14,134	8,507				

Source: McMahan et al., 1984.

[a] Blank cells indicate no acreage with more than 16 inches of precipitation annually in the county.

— = Total acreage is not shown, because areas receiving less than 18 inches of precipitation per year should not be the target of a brush management program.

Table 5-79a. Region O Mesquite Vegetation Class and Average Annual Precipitation by County
Page 3 of 3

County	Vegetation Class	Number of Acres [a]								
Hockley	Mesquite shrub			5,108	519					
				1,324	2,038					
Lamb	Mesquite shrub			15,197						
				15,986	3,587					
Lubbock	Mesquite shrub				51	81				
					5,377	3,198				
	Mesquite-lotebush brush				2,878	1,409				
					9,304	2,670				
Lynn	Mesquite shrub				5,860	16,817				
						4,434	15			
Motley	Mesquite brush							15,372	291,281	18,144
								6,425	47,369	2,442
	Mesquite-lotebush brush								5,009	165
									5,107	235
Parmer	Mesquite shrub			3,160	7,862	9				
				13,372	23,521					
Terry	Mesquite shrub			6,258						
				12,699						
Yoakum	Mesquite brush		15,196	12						
			354	332						
	Mesquite shrub		5,532	8,637						
			1,010	3,362						
	Total	—	—	181,834	184,243	109,283	349,944	458,166	532,809	39,448

Source: McMahan et al., 1984.

[a] Blank cells indicate no acreage with more than 16 inches of precipitation annually in the county.

— = Total acreage is not shown, because areas receiving less than 18 inches of precipitation per year should not be the target of a brush management program.

Table 5-79b. Region O Juniper Vegetation Class and Average Annual Precipitation by County

County	Vegetation Class	Number of Acres [a]								
	Precipitation (in/yr)	*16 – 17*	*17 – 18*	*18 -19*	*19 – 20*	*20 – 21*	*21 – 22*	*22 – 23*	*23 – 24*	*24 – 25*
Briscoe	Juniper						19,951	31,821		
							3,314	3,018		
Crosby						5,221	11,713	35,539	16,129	
						2,429	328	4,976	2,444	
Dickens								14,912	22,346	
								400	2,525	
Floyd								24,466		
								4,035		
Garza						6,302	74,636			
						328	2,062			
Lubbock					430	2,669				
					1,047	1,071				
Lynn						3,333	838			
						4,120	309			
Motley								16,940	28,974	
								1,513	4,032	
Swisher							1,653			
							846			
	Total	—	—	—	1,477	25,473	115,650	137,621	76,451	—

Source: McMahan et al., 1984.

[a] Blank cells indicate no acreage with more than 16 inches of precipitation annually in the county.

— = Total acreage is not shown, because areas receiving less than 18 inches of precipitation per year should not be the target of a brush management program.

Published water use by mesquite varies widely depending upon numerous constraining factors, including atmospheric conditions and water availability (Wan and Sosebee, 1991; Rainwater et al., 2008). On the North Concho River, in an area that receives 20 inches of average annual rainfall, the results of a multi-year paired site study on upland mesquite found water savings of 26,400 gallons per acre per year after treating heavy mesquite (TSSWCB, 2014a). The treated site consumed approximately 0.7 inch less water annually than the control site during the study period. This is contrary to the findings published by Wilcox (2002), which conclude that shrub control of mesquite rangelands is unlikely to affect streamflow because (1) evaporative demand is high, (2) soils are typically deep and thus isolate groundwater from surface processes, (3) runoff is generated as Horton overland flow, and (4) runoff is flashy and in much greater volumes that minimize the impacts of interception or storage.

A study completed by Wan and Sosebee (1991) in Lubbock focused on mesquite communities growing in a sandy loam soil. Using seasonal transpiration rates they found that for a mesquite stand of 300 trees per acre the calculated annual water consumption was 85,700 gallons per acre (0.26 acre-feet per acre). Approximately 1,900,000 acres of mesquite shrub cover in areas of the Llano Estacado region (McMahan et al., 1984) receive more than18 inches of precipitation per year (PRISM, 2012) (Table 5-79a). Removal of the full acreage could yield as much as 500,000 acre-feet of water, but full removal is not realistic. However, if 5 percent of the total mesquite acreage were removed, the yield could be as much as 25,000 acre-feet.

Studies have shown that mesquite transpiration rates vary widely, depending on tree density and soil water availability (8 to 44 gallons per day per tree), and rates can increase dramatically when the stand density drops (Rainwater et al., 2008). This is based on the plant's ability to use their lateral roots to take advantage of excess water. In order to benefit from mesquite removal, densities need to be decreased beyond the point where the remaining plants' water use will not increase to levels that offset the decreased density (Rainwater et al., 2008).

Removal of juniper generally results in greater water savings then the removal of other brush species because of its high capacity for rainfall interception, dense canopy and litter, and evergreen characteristics (TSSWCB, 2014a). Owens and Ansley (1997) estimated the daily water use of redberry juniper at 46.8 gallons, but said that this most likely represents an overestimate. Other researchers have reported values in the 20-gallons per day range (Jacks, 1998), which highlights the conflicting reports on the impact of juniper removal on rangeland hydrology (Rainwater et al., 2008). Water yield from juniper removal also varies widely, with some researchers finding no significant increases following removal (Collings and Myrick, 1966) and others publishing results indicating an increase in storage of up to 15 percent (Gifford, 1975).

Research completed at the Sonora Agricultural Experimental Station monitored seven 10-acre moderately grazed plots (three that had all woody vegetation removed) to investigate the rangeland hydrologic cycle (Thurow and Hester, 1997). A plot composed of 36 percent juniper, 24 percent oak, and 40 percent grass resulted in no recharge, whereas a plot composed of 100 percent grass resulted in 3.6 inches of deep drainage (Thurow and Hester, 1997). This difference is equal to an increased yield of 100,500 gallons per acre (0.31 acre-feet per acre). Approximately 360,000 acres of juniper in the Llano Estacado region (McMahan, 1984) receive more than 18 inches of precipitation (PRISM, 2012). If this total acreage were treated, the water yield could be as high as 111,600 acre-feet, and if 5 percent of this acreage were treated, the water yield could be as high as 5,580 acre-feet. The magnitude of the water yield will vary depending on the total number, seasonal distribution, size, duration, and intensity of storms received during any given year (Gifford, 1975).

5.10.5.3 Reliability of Water

The success of a brush management project is highly variable and dependent upon a range of physical conditions. Though water enhancement following brush control has been investigated in several areas of Texas, the economic benefits and overall productivity of a brush control program varies significantly depending on geology, physical characteristics of the water source that may be affected by the water enhancement efforts, quantity of brush, brush species, and potential impacts on threatened or endangered species (Biggs & Matthews et al., 2010). Therefore, the TSSWCB has developed a set of criteria that are used to maximize its ability to fund projects that demonstrate the positive impacts of brush control on streamflow enhancement (Rainwater et al., 2008). Projects are given a ranking in each category, and the higher the score, the greater the expectation is that brush management will enhance runoff potential. The TSSWCB criteria include:

- *Soils:* Low permeability in the water catchment area and leading toward the streambed
- *Slope:* Sufficiently steep to carry runoff to the streambed
- *Area:* Large enough to generate measureable flow contribution
- *Brush cover distribution:* Fraction of the area with treatable brush cover and proximity to stream channel
- *Land use:* Vegetation and land management strategies by a land owner
- *Streamflow observation:* Proximity to a stream gaging station
- *Groundwater conditions:* Depth to groundwater table, groundwater flow direction, and aquifer permeability

These criteria assist the TSSWCB in selecting brush control projects to fund, but there is still a large degree of uncertainty associated with the return on investment.

5.10.5.4 Financial Costs

The costs associated with brush removal are dependent upon the method. Costs published in the state's water supply enhancement plan range from $20 to $225 per acre for treatment (TSSWCB, 2014a). Table 5-80 shows the acreage of salt cedar that CRMWA treated each year between 2004 and 2012 and their associated costs. The cost ranged between $74 and $227 per acre and averaged $131 per acre over the 9-year program (CRMWA, 2015). The acreages treated and costs for the City of Lubbock's salt cedar management program are also shown on Table 5-80 (Spear, 2015). The cost per acre of the Lubbock program has averaged $100 per acre (Spear, 2015).

5.10.5.5 Environmental Impacts

Environmental impacts differ by brush management technique (e.g., chemical, mechanical, biological, and prescribed burning) (TSSWCB, 2014b). Brush management has the potential to improve wildlife habitat and grazing conditions for livestock and to increase spring flows in some areas (Environmental Defense, 2003). The potential environmental impacts will need to be assessed on a project by project basis, as part of the project planning phase.

Table 5-80. CRMWA and City of Lubbock Salt Cedar Management Programs

Year	Acres Treated	Cost ($)	
		Total	Per Acre
CRMWA (2004-2012)			
2004	850	161,944	190.52
2005	3,013	682,771	226.61
2006	2,602	452,353	173.85
2007	2,758	452,885	164.21
2008	5,378	806,617	149.98
2009	6,725	498,850	74.18
2010	2,302	189,759	82.43
2011	300	32,039	106.80
2012	2,600	193,672	74.49
Total	26,528	3,470,890	130.84 [a]
City of Lubbock (2013-2014)			
2013	300	28,308	94.36
2014	400	42,000	105.00
Total	700	70,308	99.68 [a]

[a] Average per-acre cost

5.10.5.6 Implementation

Implementation issues associated with brush removal include:

- The disturbance of the land during the removal process, which has the potential to significantly impact erosion/runoff rates.
- Getting adequate landowner participation.
- The difficulty of accurately quantifying the impacts of brush removal with a high degree of confidence.

5.10.6 Cloud Seeding

5.10.6.1 Description of Option

Precipitation enhancement introduces silver iodide, a seeding agent, into clouds in an attempt to stimulate them to generate more rainfall than they would have produced naturally (McCain, 2014). The silver iodide provides the cloud with additional ice nuclei that grow in size, melt, and fall to the ground as meaningful rainfall. The extra cloud growth results in a longer life for the storm, resulting in more rain falling over a larger area (McCain, 2014).

Accounts of cloud seeding date back to 1891, when the USDA conducted rain-producing experiments using explosive-filled balloons (McCain, 2014). Approximately 10 years later, C.W. Post conducted a weather modification project on the edge of the Caprock Escarpment overlooking the town of Post (McCain, 2014).

Since 1970, the CRMWD in Big Spring has operated a successful weather modification program to increase rainfall runoff into the reservoirs that it manages (McCain, 2014). Seeding is done from May to September in four counties, and it is the longest running project in the United States (McCain, 2014). Other successful precipitation enhancement programs that have been conducted in Texas include the High Plains Experiment (HIPLEX), which operated from 1974 to 1980, and the Southwest Cooperative Program, which ran for nine years in the 1980s (McCain, 2014). Two more recent programs are discussed below.

5.10.6.1.1 High Plains Underground Water Conservation District Cloud Seeding Program. In the early 1990s, the High Plains UWCD was experiencing drought conditions and began evaluating the potential for implementing precipitation enhancement (cloud seeding) as a WMS (McCain, 2014). The goals of the program included increasing natural recharge of, and reducing the region's dependence on, the Ogallala Aquifer. The High Plains UWCD's interest in cloud seeding stemmed from advances that had been made in weather modification technology, along with the implementation of cloud seeding projects in other areas (e.g., by the CRMWD in Big Spring) (McCain, 2014). In 1995, the district authorized North American Weather Consultants to determine the appropriate seeding methodology for the area, and the results of the analysis determined that due to a temperature inversion layer, the seeding agent would need to be applied at either the cloud top or base by a specially equipped aircraft. A series of public meetings followed, and a significant majority of participants supported an investment in this technology (McCain, 2014).

The initial program started in 1997 with the target area consisting of Bailey, Cochran, Hale, Lubbock, Lynn, and Parmer counties, parts of Armstrong, Castro, Crosby, Deaf Smith, Floyd, Hockley, Lamb, Potter, and Randall counties in Texas, and Roosevelt, Curry, and southwestern Quay counties in New Mexico, for a total acreage of 9,818,500 acres (McCain, 2014). The program was initially funded by participants paying a pro-rata share of the fixed and reimbursable program costs, based on the total acreage enrolled in the program, with later cost-sharing from the State of Texas (McCain, 2014).

The South Plains and Sandy Land UWCDs (Terry and Yoakum counties) were added to the program in 1998 (McCain, 2014), and Gaines County and a 15-mile strip of land in Andrews County were added to the project area in 2000. Weather Modification, Inc. operated the program until 2001, when the HPUWCD began directing the program (McCain, 2014). The program included significant monitoring and data evaluation, with monthly reading of rain gauges and comparison of the information to the Doppler radar images provided by the National Weather Service (McCain, 2014). The HPUWCD cloud seeding program was discontinued by board action in October 2002 (McCain, 2014).

5.10.6.1.2 Sandy Land UWCD and the Seeding Operations & Atmospheric Research Program. The Sandy Land UWCD began a cloud seeding program in Yoakum County in 1997 in an effort to increase the amount of annual precipitation and recharge that occurs within the district each year. In the fall of 2001, the district created a regional weather modification program called the Seeding Operations & Atmospheric Research (SOAR) program, which included Yoakum, Terry, and Gaines counties (SLUWCD, 2014). Terry County (South Plains UWCD) participated in the program from 1998 through 2008 (Harris, 2014), discontinuing their participation in 2009 (Harris, 2014). The program continued operating in Yoakum and Gaines counties (Sandy Land and Llano Estacado UWCDs, respectively) through 2013 (Walker, 2014), but as of January 2015, the Sandy Land and Llano Estacado UWCDs are no longer participating in the SOAR program. In earlier years the program included seeding in New Mexico; however, funding was not obtained for this work in the last few years (Walker, 2014). The SOAR program did not seed in Region O in 2014, but instead focused on the areas around Wichita Falls and Haskell, Texas (Walker, 2014).

5.10.6.1.3 Current Status of Cloud Seeding in Region O. Currently, no cloud seeding programs are being implemented within Region O:

- The HPUWCD board of directors determined that precipitation enhancement is not appropriate, cost-effective, or applicable as a goal and that this goal is not applicable to the HPUWCD (HPUWCD, 2010).
- Gateway Groundwater Conservation District (GCD) (includes Motley County) determined that precipitation enhancement is not cost-effective and is not applicable to the operation of the district (GGCD, 2011).
- The South Plains UWCD Board determined that the precipitation enhancement program was not cost-effective and that this goal is not applicable to the South Plains UWCD (SPUWCD, 2013).
- Garza County UWCD determined that precipitation enhancement is not cost-effective and is not applicable to the operation of the district (GCUWCD, 2009).
- The Sandy Land UWCD is no longer participating in any cloud seeding program (Blount, 2015).
- The Llano Estacado UWCD is in the process of updating their management plan and is removing cloud seeding as a strategy (Barnes, 2015).
- Mesa UWCD (Dawson County) has concluded that precipitation enhancement is not effective in enhancing rainfall in Dawson County and therefore not cost-effective (MUWCD, 2014).

5.10.6.2 Quantity and Reliability of Water

The amounts of water produced by cloud seeding are difficult to determine, but estimates range from a 2 to 15 percent increase in annual precipitation or runoff (CDWR, 2013, Chapter 11). The 2013 California Water Plan cites an estimate by California Department of Water Resources staff that the combined California precipitation enhancement projects, on average, generate about 400,000 acre-feet of runoff annually, or about a 4 percent increase in runoff (CDWR, 2013, Chapter 11).

The Sandy Land UWCD groundwater management plan cites initial estimates by outside analysis for an increase of 0.12 inch of rainfall per seeded cloud and discusses benefits of increasing precipitation (SLUWCD, 2014). The district plan indicates that in 2002 and 2003 (two years with below average rainfall), cloud seeding activities resulted in an increase of 0.30 inch in precipitation, leading to recharge of 14,400 acre-feet of water (SLUWCD, 2014).

One benefit of the cloud seeding BMP is that projects can be developed and implemented relatively quickly without multiyear lead times (CDWR, 2013, Chapter 11). Aerial seeding, or using a combination of aerial and ground seeding, yield better results than ground seeding alone (CDWR, 2013, Chapter 11). Precipitation enhancement should not be viewed as a remedy for drought, however, as cloud-seeding opportunities are generally fewer in dry years (CDWR, 2013, Chapter 11).

5.10.6.3 Financial Costs

Costs for cloud seeding would generally be less than $30 per acre-foot of water supply each year, although projects are more expensive when there are fewer seeding opportunities (CDWR, 2013, Chapter 11). In California, $3 to $5 million is spent annually on cloud seeding operations, and the State estimates that over the next 25 years, the annual project cost will total approximately $25 million due to additional planning, equipment, reporting, and operations costs. This equates to nearly $22 per acre-foot of water supplied (CDWR, 2013, Chapter 11).

5.10.6.4 Environmental Impacts and Limitations

The potential for eventual toxic effects of silver caused by the use of silver iodide as a cloud seeding agent has not been shown to be a problem. Silver and silver compounds have a low order of toxicity, and the amounts used for cloud seeding are small. Soil, vegetation, and runoff accumulations have not been large enough to measure above natural background levels (CDWR, 2013, Chapter 11).

5.10.6.5 Implementation

There has been concern that enhancing precipitation in one area could cause a decrease in the amount of precipitation downwind; however, the evidence does not show that seeding clouds causes a decrease in downwind precipitation (CDWR, 2013, Chapter 11).

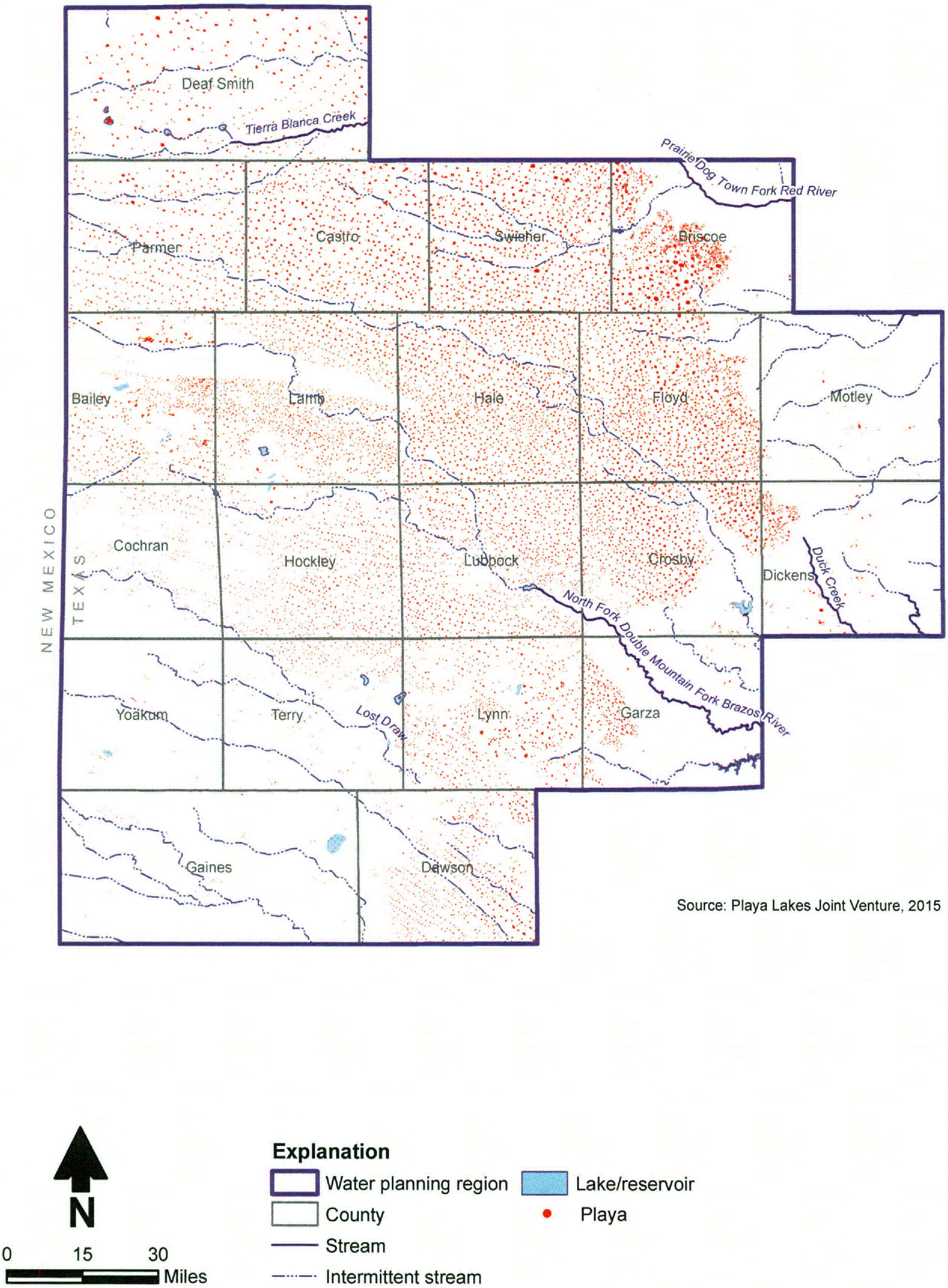
Cloud seeding programs are only effective if there are clouds to seed, and it is difficult to target seeding materials to the right place in the clouds at the right time (CDWR, 2013, Chapter 11).

5.10.7 Playa Best Management Practices

Wetlands represent an invaluable resource in any ecosystem, but especially in the Great Plains region, where they provide critical ecosystem services. Playas, the dominant wetland type throughout the shortgrass prairie ecoregion of the United States, are hydrologically ephemeral, depressional landforms that are typically small and circular in shape (McLachlan et al., 2014). They are formed through a combination of actions, including wind, wave, and dissolution processes (Smith, 2003), occur at densities of one to two per square mile, and range in size from a few acres at a shallow depth to over hundreds of acres in size, with depths of up to 20 feet (Urban et al., 1988).

The Playa Lakes Joint Venture (2015) reports that the playa lakes region includes approximately 60,000 playas, 20,000 to 30,000 of which are located in the high plains of the Llano Estacado subregion, or Southern High Plains. The number and locations of playas within Region O, as reported by the Playa Lakes Joint Venture, are shown on Figure 5-19. A member of the regional water planning group indicated that based on his conversations with Dave Haukos, the Playa Lakes Joint Venture figure may be an overestimate of the number of playa lakes remaining in the Southern High Plains (Steiert, 2015a).

A recent study of the physical loss and modification of Southern Great Plains (Texas, New Mexico, and Oklahoma) playas found that only 0.2 percent of playas had no wetland or watershed modification and that small playas are being lost more rapidly than larger ones (Johnson et al., 2012). The study's conclusions estimate that between 17 percent and 60 percent of the historical playas that were recently still present on the landscape have been lost. The range in results reflects a difference in the severity of the findings, from no more evidence of a depression to watershed cultivation/playa infill (Johnson et al., 2012). Using the Playa Lakes Joint Venture figure of 20,000 to 30,000 playas in the Southern High Plains, a 17 percent reduction would mean that between 16,600 and 24,900 playas remain; a 60 percent reduction would indicate between 8,000 and 12,000 playas remaining in the Southern High Plains. The acknowledgment of the loss of these vital resources to humans and their role in the ecosystem has led to the founding of several organizations along with international management plans focused on protection and management of playas.



Source: Playa Lakes Joint Venture, 2015

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LLANO ESTACADO REGION
Playas

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Figure 5-19

The Southern High Plains region is located in a semiarid environment in the largest nonmountainous land formation in North America, and the presence of playa lakes was a critical factor in the settlement of the Llano Estacado (Johnson and Oliver, 1997). The Southern High Plains does not have any perennial streams, which makes playas the primary element of the surface hydrology and essential to the ecological diversity of the region (Hall et al., 1999). Playas are a unique landform in that each one exists in its own closed watershed (Haukos and Weihs, 2014). They represent the primary drainage system for the Llano Estacado region, and by capturing overland flow, they eliminate the need for an integrated drainage system, while also providing the primary conduit for recharge to the underlying aquifer (Koenig, 1990). Effectively quantifying the recharge to the High Plains Aquifer is a complex task and has important implications for the sustainability of the region (Gurdak and Roe, 2009).

Playa morphology has been well studied by many researchers, resulting in the classification of two main zones. The first is the lake bottom, also known as the playa floor, which is characteristically lined with relatively impermeable hydric soils, typically Randall clay with a thickness of up to 30 feet or more (Hovorka, 1995; Urban et al., 1988). Playa floors can be separated from the underlying Ogallala Aquifer by a pronounced vadose zone of tens to hundreds of feet of unsaturated soil (Gurdak and Roe, 2009). Proceeding upslope from the playa floor, the clay liner gradually becomes thinner until it transitions into the next zone, the annulus, which is characterized by coarse soils, typically a belt of silty sand or silty loam (Hovorka, 1995; Koenig, 1990).

The volume of water that collects in playas depends on several factors, including the frequency and intensity of precipitation, along with the characteristics of the watershed (Gurdak and Roe, 2009). When the volume of water is raised above the clay liner, recharge can occur through the coarse annulus (Urban et al., 1988). Because playas are shallow and occur in low-relief landscapes, small changes in land use practices and/or atmospheric conditions can have a major effect on the volume of water they receive (Weinberg et al., 2015).

Researchers have found that playas contribute 85 to 90 percent of all recharge to the Ogallala Aquifer, yet they cover only 2 to 5 percent of the land area (Playa Lakes Joint Venture, 2015b). This finding indicates that the proportion of recharge from a given area of playa is orders of magnitude greater than the same area upland, and degradation to these recharge basins will result in a corresponding decrease in aquifer recharge (Melcher and Skagen, 2005).

Playa hydrology is defined by periods of wetting and drying, and since playa floors are composed of clay, this sinusoidal activity results in large cracks (macropores) that act as conduits for infiltration (Melcher and Skagen, 2005). Focused dissolution of the underlying caliche layer results in deeper macropores, which provide further pathways for infiltration while removing the water from the influence of the atmosphere, thus ensuring its place in the vadose zone and eventually the Ogallala Aquifer (Melcher and Skagen, 2005; McLachlan et al., 2014). Research has shown that the majority of recharge occurs shortly after the initial inundation, and once the clays swell and the fissures close, infiltration rates diminish rapidly (Gurdak and Roe, 2009; Playa Lakes Joint Venture, 2015b).

Many researchers are working to quantify the amount of water recharged to the Ogallala Aquifer through playa lakes, with a wide range of published results. Gurdak and Roe (2009) completed a literature review and synthesis of research completed on the Southern High Plains, and summarized the findings. Infiltration rates measured with infiltrometers range from 0.36 to 6.4 inches per minute, and rates calculated using a water budget approach range from 47 to 76 inches per year. Recharge estimates range from 0.004 inch per year using a chloride mass balance to 8.6 inches per year using a groundwater model. The range of estimates is relative to each individual site, the method, and any errors associated with each process.

In addition to recharging the aquifer, playas provide numerous other ecosystem services including nutrient cycling, water storage and flood protection, maintenance of landscape habitat, maintenance of characteristic plant communities, maintenance of wetland habitat, and the removal, sequestration, and conversion of elements, compounds, and particulates (Smith, 2003). Playa lakes represent the primary surface water feature in the region for many wildlife species and are productive ecosystems that yield high-quality food (McLachlan et al., 2014). This region lies at the heart of a migratory passage for waterfowl and shorebirds, and therefore represents a critical stopover during long migrations (Moon, 2004). The ecological consequences of the widespread loss of playas are unknown, but are suspected to be extensive, ranging from individual impacts to affecting the entire playa system (Johnson et al., 2012).

Playas occur in the midst of a range of land uses, including agriculture, oil extraction, and feedlots (Melcher and Skagen, 2005), and these activities substantially influence the ecosystem services traditionally associated with a playa (Gurdak and Roe, 2009), and often represent the primary threats to the sustainability of a healthy and functioning playa network. There are many threats to the sustainability of playa processes, the greatest of which is row crop agriculture (LaGrange et al., 2011). Agriculture impacts playas in two principal ways: (1) through the direct conversion of the land to cropland and (2) through filling of the playa by sedimentation (McLachlan et al., 2014; Koenig, 1990).

Many studies have been completed on the sedimentation of playa lakes, with Smith (2003) noting that sedimentation is their single largest immediate threat. Sedimentation can eliminate the ability of playas to hold water and in turn limit their ability to support the region's biodiversity or recharge the aquifer (Melcher and Skagen, 2005). Tsai et al. (2007) monitored water levels in 33 playas while collecting a range of sediment data, and they concluded that the sedimentation of these systems had decreased their storage volumes, shortening their hydroperiod while also increasing losses through evaporation. With more water being lost through evaporation as a result of sedimentation, less water is available for infiltration (Gurdak and Roe, 2009).

Studies have shown that sediment load from cropland is an order of magnitude higher than from rangeland-dominated drainage areas, with estimates in the range of 0.19 to 0.38 inch per year for cropland and 0.026 to 0.033 inch per year for rangeland (Luo et al., 1997). This difference results in playas in cultivated areas having 8.5 times as much sediment run-in compared to playas in rangeland areas. Luo et al. (1997) estimates that at the current rate of sedimentation, all cropland playas could be completely filled within the next 100 years.

5.10.7.1 Description of Option

Given the current ecological health of the Sothern High Plains playas, along with the ecosystem services and avian communities they traditionally support, there is great public interest in their conservation. Playa management and conservation programs have traditionally been focused on avian fauna. In 1986, the North American Waterfowl Management Plan was initiated, the key focus being to reverse the declining waterfowl population and wetland acreage that was prevalent throughout North America in the early 1980s. This plan also recommended the formation of joint ventures to provide a regional focus in areas of high priority. In 1988, the Playa Lakes Joint Venture was formed, and it began operating in a six-state region covering 300,000 square miles in 1989.

The Playa Lakes Joint Venture is currently in the process of developing a Playa Decision Support System, which will help developers, land managers, and conservationists strategically plan where their efforts will have the greatest or least impact on playas. The system will prioritize individual playa basins according to their estimated ecological value and identify clusters of playas that likely have higher ecological value functioning as a group (Playa Lakes Joint Venture, 2015a).

The TWDB is studying the water resource potential of playa lakes in the Texas High Plains and is seeking to measure the volume of water available in playas and the recharge rates into the Ogallala Aquifer (Weinberg et al., 2015). The study has included the reconstruction of the flooding history of 73 playas in 13 counties (9 of which are within Region O) over an 18-year period, resulting in estimates of playa lake volume that are lower than previous estimates (Weinberg et al., 2015). The study is developing screening tools for estimating playa water budgets, to help select playas that are suitable for recharge modification

Playa conservation measures can take many forms and can occur on a range of scales. There are a variety of BMPs that have been studied for their effectiveness, with the most common being grass buffers. Research has shown that grass buffers have the potential to capture soil and contaminants before they reach the wetland (Smith, 2003). The optimal buffer width is relative to slope and inflow rates; buffers of native grasses 10 to 60 meters (approximately 30 to 200 feet) wide are generally adequate for trapping sediments, although sometimes buffers of greater than 200 meters (approximately 650 feet) are necessary (Melcher and Skagen, 2005).

Playa buffer grasses have several physical features that make them favorable for certain situations. In Melcher and Skagen's literature synthesis on the use of grass buffers for playas in agricultural settings (2005), the following characteristics were listed as being favorable for most applications: native status, short to medium height, an ability to germinate in and tolerate the soil and climate conditions, the ability to grow up through accumulating sediments, and local commercial availability. When flows are concentrated due to the watershed morphology, runoff intensity can threaten the buffer's integrity, and the types of grasses used may need to be reconsidered if damage occurs. In these cases, buffers may require stiff grasses that resist high-velocity water and deep runoff common to other regions (Melcher and Skagen, 2005). Adjusting the grass community to fit the hydrology of the playa is a useful approach to protecting playas without requiring farmers to give up further production land to widen the buffers (Melcher and Skagen, 2005).

Other BMPs that also help to limit the amount of sediment or contamination that reaches a playa include conservation tillage, contour tilling, and mulching herbicides into soil after their application, to help diminish soil erosion and contaminant runoff (Melcher and Skagen, 2005). BMPs that help to limit aerial transport of sediment include avoidance of applying nutrient-rich manures or fertilizers when intense rain is predicted and establishment of no-application zones around playas and their buffers (Sharpley et al., 2001). If excessive nutrient runoff is an issue, the accumulation of nutrients in buffer materials may require periodic removal through mowing or haying, short-term grazing, or burning on a rotational basis (Melcher and Skagen, 2005).

Healthy grass buffers are an integral component of playa conservation, especially within agriculturally dominated landscapes (McLachlan et al., 2014). Playas that exist in grasslands contained only 4 to 5 centimeters (1.5 to 2 inches) of sediment, compared to cropland and rangeland playas, which contained 58 and 29 centimeters (23 and 11 inches), respectively (Luo et al., 1997).

5.10.7.2 Quantity and Reliability of Water

Implementation of playa BMPs aids in the conservation of playas by reducing sedimentation, prolonging their lifespan. BMPs will not generate water in a conventional way; however, conservation of playas will maintain and possibly increase the rates of groundwater recharge.

Playa lakes occur at densities of 1 to 2 per square mile and range in size from a few acres to more than hundreds of acres in size (Urban et al., 1988). Assuming that the existing playas have recharge rates of 47 to 76 inches per year (Gurdak and Roe, 2009) (approximately 4 to

6 feet per year), and that buffers are established around 500 acres of playas and this successfully reduces sedimentation into the playas (keeping them from filling in), the volume of recharge that would continue is between 2,000 and 3,000 ac ft/yr. If playa BMPs are implemented around 10,000 acres of playas, the volume of recharge that would continue would be between 40,000 and 60,000 ac ft/yr.

The sustainability of a playa buffer is dependent upon regular maintenance to remove excess sediment buildup and management of the grass community, with the removal of over-mature vegetation and any noxious weeds (Melcher and Skagen, 2005). As long as the buffer areas are maintained, playa BMPs have shown to be effective and will continue to reduce sedimentation.

5.10.7.3 Financial Costs

Willis (2015) presents a cost of $65 per acre to establish playa buffers.

Several avenues are available for private landowners to receive monetary and technical support in their efforts to conserve their playas. The primary mechanism for funding through the federal government is through the Farm Bill which includes the following opportunities:

- Conservation Reserve Program
  - CP23: Wetland Restoration
  - CP23a: Wetland Restoration, Non-floodplain
  - CP33: Habitat Buffers for Upland Birds
  - CP38: State Acres for Wildlife Enhancement
- Wetlands Reserve Program
- Farm and Ranchland Protection Program
- Grassland Reserve Program
- Environmental Quality Incentives Program
- Wildlife Habitat Incentive Program

Two of the main methods are the Conservation Reserve Program and the Wetlands Reserve Program. The Conservation Reserve Program has helped to establish nearly 2 million acres of perennial grasses in the Southern High Plains. It works by providing farmers with a yearly rental fee if they agree to remove environmentally sensitive land from agricultural production, typically for a duration of 10 to 15 years (USDA FSA, 2014). In 2014, approximately 1.8 million acres were enrolled in the CRP in Region O (USDA FSA, 2015). The Wetlands Reserve Program is a voluntary program that offers landowners the opportunity to protect, restore, and enhance their wetlands, and has the goal to achieve the greatest wetland functions and values on every acre enrolled in the program. The landowner has the chance to enroll in a permanent easement where the USDA pays 100 percent of the easement value and 100 percent of the restoration costs, or a 30-year easement with the USDA paying a 75 percent share of the easement value and restoration costs (USDA NRCS, 2014c).

In Texas, a Landowners Incentive Program (LIP) is administered by the Texas Parks and Wildlife Department, with the goal of providing funding to individuals who wish to implement natural resources conservation practices on their lands. This program provides cost sharing and technical support for projects aimed at creating, restoring, protecting, and enhancing habitat for rare or at-risk species. Applications to the LIP are ranked based on several factors, including whether federally listed species will benefit, with special consideration given to habitat enhancement projects that offer long-term protection, long-term monitoring, and greater than required minimum landowner contribution (Smith, 2003).

5.10.7.4 Environmental Impacts and Limitations

Playas are the center of biodiversity on the plains, and they support more than 200 species of birds and other wildlife. Playa lakes are the main source of water for wildlife across the region, and provide rest stops and food for migrating waterfowl and shorebirds and resident animals (Playa Lakes Joint Venture, 2015c). Implementation of playa BMPs will have a positive benefit on the environment due to the protection of habitat. In addition to the benefits to habitat and wildlife, protecting playa lakes also allows them to continue recharging groundwater.

5.10.7.5 Implementation

Implementation issues for this BMP include generating landowner participation, both initially and on an ongoing basis (for conducting the necessary maintenance) after implementation.

5.10.8 Rainwater Harvesting

5.10.8.1 Description of Option

Rainwater harvesting has been used by civilizations for millennia; however, only recently has it become accepted and promoted by municipalities as a strategy to combat water shortages and mitigate drought. The TWDB recognizes rainwater harvesting as an important water conservation measure and promotes its implementation in conjunction with other efficiency measures outside the home (TWDB, 2005). The process of rainwater harvesting involves the capture, diversion, and storage of rainwater for a range of potential purposes. It is typically collected in barrels, cisterns, or large storage tanks, but depending on location can also be captured in collection basins or ponds (Vickers, 2001). In its 2005 rainwater harvesting manual, the TWDB (2005) details numerous benefits that are associated with rainwater harvesting:

- The water is free, the only costs being for the collection and use.
- The end use is located nearby, eliminating costly distribution systems.
- Rainwater use augments the use of groundwater.
- Rainwater is superior for landscape irrigation.
- Rainwater harvesting reduces flow to stormwater infrastructure and associated nonpoint source pollution.
- Rainwater harvesting reduces the demand during peak times while reducing consumers' utility bills.

Hale County rancher Bob Durham recently received assistance from the USDA NRCS Environmental Quality Incentives Program (EQIP) for the design and installation of a rainwater harvesting system on his livestock barns (Terry, 2015). The system, which includes six 5,000-gallon storage tanks (30,000 gallons total storage), a first flush diverter, and system overflow, is used to collect, store, and supply water for his livestock operation (Terry, 2015). The system transports water from storage by gravity flow to a water trough (Terry, 2015). The lifespan of the system will be approximately 20 years (Terry, 2015).

5.10.8.2 Quantity and Reliability of Water

Annual average precipitation rates within Region O range between 15 inches per year in the western portion of the region and 25 inches per year in the eastern portion of the region, so the volume of water that can potentially be captured varies depending on location. More than 70 percent of the households in the region receive annual average rainfall of between 19 and 20 inches per year (PRISM, 2012). In areas with this amount of rainfall, if 1,000 homes with roof areas of 2,000 square feet were to install catchment systems that achieved 100 percent capture of rainfall, approximately 2.4 million gallons of water could potentially be harvested each year. Applying a 75 to 90 percent efficiency factor reduces the volume to between 1.8 and 2.2 million gallons per year. Based on 2010 U.S. Census Bureau data, with 10 percent of the households in Region O harvesting rainwater (and assuming roof area of 2,000 square feet), between approximately 325 and 390 million gallons of water (approximately 1,000 to 1,200 acre-feet) could be harvested annually (Table 5-81).

The USDA NRCS estimates that the rainwater harvesting system recently installed on Bob Durham's two livestock barns in Hale County will each yield approximately 12,000 gallons of water from a 2-inch rain (enough to water 25 head of cattle for a month) and almost 25,000 gallons of water from a 4-inch rain (Terry, 2015). This system requires supplemental water in low rainfall months (e.g., December and January) and yields overflow during the summer months (Terry, 2015).

The reliability of this BMP relates to timing, frequency, and spacing of precipitation events, as well as the quality of the installation and subsequent O&M of each system. First flush diverters should be used for improving water quality before water is captured in a system's storage tanks (Terry, 2015). Extended droughts have the potential to significantly reduce the volume of water available for rainwater harvesting, whereas wet periods can produce more water than could possibly be harvested. Systems that are properly installed and maintained will be reliable.

Table 5-81. Region O Potential Volume of Harvested Rainwater by County

County	Number of Households (2013) [a]	Average Annual Precipitation [b] (in/yr)	Potential Rainwater Supply [c] (gal/yr)	
			75 Percent System Efficiency	90 Percent System Efficiency
Bailey	2,358	19.0	4,188,987	5,026,784
Briscoe	605	23.5	1,329,336	1,595,204
Castro	2,588	20.5	4,960,549	5,952,659
Cochran	1,039	19.0	1,845,784	2,214,940
Crosby	2,164	23.0	4,653,682	5,584,418
Dawson	4,414	19.5	8,047,826	9,657,391
Deaf Smith	6,191	19.5	11,287,741	13,545,289
Dickens	913	24.0	2,048,772	2,458,526
Floyd	2,457	22.5	5,168,914	6,202,697
Gaines	5,437	17.5	8,896,291	10,675,550
Garza	1,588	22.0	3,266,516	3,919,819
Hale	11,624	20.5	22,280,302	26,736,362
Hockley	7,973	19.5	14,536,772	17,444,127
Lamb	4,803	19.5	8,757,070	10,508,484
Lubbock	105,277	20.0	196,867,990	236,241,588
Lynn	2,179	21.0	4,278,467	5,134,160
Motley	433	24.0	971,652	1,165,982
Parmer	3,215	19.5	5,861,749	7,034,099
Swisher	2,604	21.0	5,112,954	6,135,545
Terry	4,067	19.5	7,415,158	8,898,189
Yoakum	2,654	19.0	4,714,831	5,657,797
Total	174,583	—	326,491,341	391,789,609

[a] Source: U.S. Census Bureau, 2013
[b] Source: PRISM, 2013 (one value assigned per county); values are approximate.
[c] Assumes that 10 percent of households, each with a 2,000-square foot roof, implement rainwater harvesting.

in/yr = Inches per year
gal/yr = Gallons per year

5.10.8.3 Financial Costs

The costs associated with a rainwater system vary widely depending on the amount of water being harvested and the end use of the water. Whether the system is for potable or non-potable use, the system components may include a storage container, gutters, roof washer, pump, and filtration unit. The storage basin is the largest expense of the system, and the cost depends on the size and material of the container. The TWDB (2005) manual includes a detailed discussion of estimating costs for each component of the system along with costs for O&M. Potential costs for installing a few different systems (O&M costs are not included) are shown on Table 5-82 and summarized below:

- Approximately $400 to install four rain barrels for a small, non-potable system (400-gallon capacity)
- Approximately $8,000 to install a 5,000-gallon fiberglass tank and the associated system components for a larger, non-potable system
- Approximately $140,000 to install a 50,000-gallon welded steel tank and the associated system components for a larger, potable system

Table 5-82. Rainwater Harvesting System Costs

System Component	Quantity	Unit	Unit Cost ($)	Total Cost ($)
Small scale home harvesting (non-potable use)				
Rain barrels (capacity 50 to 100 gallons)	4	each	100	400
Gutters and rain spouts (vinyl)	50	feet	0.30	15
			Total	415
Larger scale home harvesting (non-potable use)				
Fiberglass tank (capacity 500 to 20,000 gallons)	1	gallons	0.50 – 2.00	7,500 [a]
Gutters and rain spouts (vinyl)	100	feet	0.30	30
Rainwater diverter kit	1	each	50	50
			Total	7,580
Large scale home harvesting (for potable use)				
Welded steel tank (capacity 30,000 to 1 million gallons)	1	gallons	0.80 – 4.00	125,000 [b]
Gutters and rain spouts (galvalum)	200	feet	3.50 – 12.00	2,400
Roof washer (tank with leaf strainer and filter)	1	each	150 – 800	600
Pumps and pressure tanks	—	—	400 – 1,000	800
Treatment and disinfection	—	—	20 – 3,000	2,000 [c]
			Total	130,800

Source: TWDB, 2005
Note: Operation and maintenance costs not included.

[a] Approximate cost for a 5,000 gallon tank (at a unit cost of $1.50/gallon).
[b] Approximate cost for a 50,000 gallon tank (at a unit cost of $2.50/gallon).
[c] Assumes that a reverse osmosis filter will be used, with automatic chlorine dosing.

Rainwater harvesting systems qualify for financial assistance from the USDA NRCS Environmental Quality Incentives Program (EQIP) (Terry, 2015).

5.10.8.4 Environmental Impacts and Limitations

For rainwater catchment systems being installed at sites with existing development, implementation of this BMP will have minimal environmental impacts. In fact, with the widespread implementation of rainwater harvesting, this BMP will have positive environmental impacts due to a reduction in the volume of stormwater runoff from paved surfaces, reducing the mobilization of contaminants such as oil and gasoline.

5.10.8.5 Implementation

For rainwater harvesting, implementation issues include proper system installation and maintenance and lack of control over the timing, frequency, and spacing of precipitation events. Since precipitation in west Texas occurs seasonally, often in high-intensity storms, it is impractical to have enough storage capacity to capture all of the precipitation that falls.

5.10.9 Drought Management

The historical record shows a recurring cycle of drought in Region O. Though it is difficult to predict the timing of droughts, it is certain that droughts will occur during the long-term planning horizon. Given this certainty, advance planning should be undertaken to avoid a crisis management situation during future droughts. A proactive planning approach to drought management is beneficial for all impacted parties.

Drought management is a temporary strategy to manage water demand and conserve available water supplies during times of drought or emergencies. Drought planning should be a foundation for all water systems, particularly those dependent on a surface water source for their supply. Communities that rely on groundwater can also benefit from drought planning, because the demand for groundwater supplies increases when precipitation is low.

Drought contingency planning is considered a critical component of water supply management, but is intended to provide short-term benefits during severe drought conditions and should not replace any long-term water management strategies. Some of the most important actions that can be undertaken to prepare for drought include improving storage capacity (for example the Post Reservoir strategy evaluated in Section 5.7.7) and reducing demand through efficiency and conservation (Sections 5.2.1, 5.2.2, and 5.3.1).

Chapter 7 of this plan contains detailed information on drought, current drought preparations, and recommendations for the region. The remainder of this section provides specific information about the drought management BMPs recommended for WUGs in Region O.

5.10.9.1 Description of Option

The drought management BMPs consist of implementing the drought contingency plans (DCPs) that have been developed within Region O to enable communities within the region to be prepared for droughts or emergency water needs when they occur. The intent of drought management is not to meet long-term growth in demands, but rather to provide a short-term means by which water providers periodically activate their approved DCPs to minimize the adverse impacts of water supply shortages during times of drought or emergency. Drought management measures are typically not used under more hydrologically favorable conditions.

TCEQ requires DCPs for wholesale and retail public water suppliers supplying water to 3,300 connections or more and irrigation districts. Additionally, the TCEQ requires that all public water suppliers supplying water to fewer than 3,300 connections prepare and adopt a DCP that can be made available upon request. A revision of the DCP is due to the TCEQ every five years; the most current DCP revision was required to be submitted to the TCEQ by May 1, 2014. Within Region O, 53 entities have developed DCPs, as discussed in Section 7.1 (along with the TCEQ requirements for DCPs).

For this planning round, 52 of the existing DCPs in Region O were obtained and reviewed. Except for a few, most DCPs were complete, outlining each water system's drought and emergency contingency procedures and identifying the triggering criteria for initiation and termination of drought response stages and associated water use restrictions in effect during times of water shortages. The majority of DCPs in Region O include quantified water use reduction goals for each stage, notification procedures, and enforcement measures, and some also include allowable variances to the plan. These DCPs provide the necessary tools for effective drought management, and communities and WUGs should be ready to implement them when needed.

In each DCP, drought stages and corresponding triggers are identified based on the level of drought along with the mitigation measures or responses for each stage. Recommendations regarding the drought triggers and responses for existing surface water supplies and groundwater sources that entities in Region O rely upon are discussed in Section 7.4 of this plan. These may be useful for entities required to update their plans on a regular basis.

Mitigation measures that may be considered in the region include both short-term supply measures, such as leasing arrangements, and demand reduction measures. Long-term conservation measures help to reduce demand at all times and hence are helpful for reducing demand during all stages of drought. Many water conservation measures can be adopted on a permanent basis, or water managers may choose to implement conservation measures only during drought conditions.

Section 7.5 of this plan provides potential solutions that can act as a guide for municipal WUGs that are the most vulnerable in the event of a loss of water supply. A high-level analysis of options was performed to assess potential emergency water supply options for all County-other WUGs and for municipal WUGs in Region O that had a population of 7,500 or less in 2010 and rely on a sole source of water supply. Consideration of emergency supply options for these entities is particularly important, as many small WUGs may not have existing access to backup supplies through interconnected facilities with adjacent larger systems. The following potential emergency supply options are considered feasible by Region O, but should be investigated in greater detail by individual WUGs before incorporation into their DCP:

- Local groundwater well
- Brackish groundwater
- Emergency interconnect
- Trucked-in water
- Purchase of land with existing wells

The LERWPG recommends both the implementation of DCPs by water suppliers when appropriate to reduce demand during drought and to prolong current water supplies and the development of shortage sharing agreements.

5.10.9.2 Quantity and Reliability of Water

If an entity does not develop supplies that are equal to or greater than their projected water demands even in times of drought, implementation of a drought management strategy (i.e., by activation of the appropriate stage of their approved DCP) will be required to reduce water system demand to meet the available water supply during times of shortage. Because drought management is only active and beneficial under certain periods of time, its reliable yield is essentially zero when considered in an analogous manner to surface water, groundwater, reuse, or conservation.

The primary benefit of a DCP is to identify ahead of time drought mitigation measures and parties responsible for implementing those measures. While a DCP will not result in any direct increase in the water supply, to the extent that the DCP incorporates water conservation measures, which may be set to correspond to various stages of drought, significant water savings could be realized, on the order of 5 to 20 percent.

5.10.9.3 Financial Costs

Model DCPs addressing the requirements of 30 TAC §288(b) were developed as part of this planning cycle for Region O and are discussed in Section 7.7 and included in Appendix 7B. The model DCPs are based largely on templates provided by the TCEQ and were reviewed by TCEQ for inclusion in this RWP. These templates (and additional templates on the TCEQ website) are free but would need to be customized for the entity that chooses to replace or update its DCP.

Costs required to implement the DCP include staff time for monitoring drought conditions and implementing mitigation measures. Costs for mitigation measures would vary depending on the measures specified in the DCP. Many of the demand reduction measures can be implemented at a relatively low cost. Voluntary restrictions will require funding for public education, and mandatory water restrictions will require funding for monitoring and enforcement in order to be effective. Potential costs associated with emergency water purchase or leasing ideally should be addressed during the planning phase, as advance arrangements with water purveyors are likely to be more cost-effective than last-minute deals made under stressful circumstances.

The entities implementing their DCPs can provide detailed information and education as well as financial incentives (such as incentive rates or drought surcharges) to water users. Water providers may also need to address lower revenues resulting from water use restrictions. Tiered pricing or penalties for overuse may help to recoup lost revenue. Some type of revenue generation for drought plan implementation can be incorporated into water billing rates, some portion of which could be used to develop educational materials and forms before a drought happens so that a drought plan can be quickly implemented.

5.10.9.4 Environmental Impacts and Limitations

The impacts resulting from drought management vary depending on the drought mitigation measures chosen by an entity in their specific DCP. To the extent that water conservation measures are part of the drought plan, a positive environmental impact would generally be realized, as voluntary and mandatory conservation measures can help to sustain limited water supply resources during periods of drought. Provisions for a water supply for firefighting always remain even under extreme drought conditions, so adverse effects to a watershed due to fire should not be an issue. Other mitigation measures, such as transfer of agricultural water to urban areas during times of drought, may result in more varied impacts. Allowing some areas of farmland to be fallow during drought seasons should not have a long-term environmental impact.

5.10.9.5 Implementation

Drought management can be undertaken at a regional level through cooperative agreements, or it may be undertaken by individual counties, municipalities, or irrigation water users within the region. Drought management can be effected by entities within the region through the implementation of their DCP. The steps involved in implementing a DCP include:

- Communication with water users in accordance with the notification procedures outlined in the DCP to provide information on trigger levels for each drought stage and the associated mitigation measures that are required.

- Monitoring for drought conditions and/or trigger levels specified in the DCP.
  - U.S. Drought Monitor (drought monitor) is often used to define various stages of drought at a local level. Drought monitor information for Texas can be accessed online at http://droughtmonitor.unl.edu/Home/StateDroughtMonitor.aspx?TX.
  - Systems can monitor current demand relative to their system capacity and/or for the trigger level (such as a supply or demand amount) defined in the DCP.
  - Systems must monitor whether the water system is meeting water use reduction goals specified for each stage and whether a higher drought stage is required.

- Initiation and termination of mitigation measures as identified for each drought stage based on current drought conditions.
  - Enact enforcement measures for water users not complying with the DCP.
  - Allow for variances to the DCP as needed on the local level.

The feasibility of implementing mitigation measures is specific to the measures undertaken. The decision on whether to implement permanent or short-term measures is based on political feasibility, water pricing issues, and the availability of the supply.

5.10.10 Electric-Dry Power Generation

5.10.10.1 Description of Option

For the majority of power generation plants, the need for power plant cooling is the primary water demand. A variety of cooling systems exist, including once-through cooling, recirculated wet cooling, dry cooling, and hybrid (wet/dry) cooling. Cooling water demand through the use of dry and hybrid systems provides significant reduction in water use compared to wet recirculating or once-through cooling.

The water conservation benefits provided by electric-dry power generation plants over less technologically advanced plants are achieved through combined cycle technology, which allows for plants to use less water and less energy to generate power. Combined cycle configurations allow for reuse of heat in the working fluid (water) to operate additional engines on a common shaft. This results in overall thermal efficiencies of around 54 percent, in contrast to efficiencies of 35 to 42 percent in single cycle steam plants.

In addition to the implementation of electric-dry power generation in the future, the LERWPG expects other renewable energy sources (e.g., solar and wind) to help in offsetting the need for steam-generated power in the future. While water conservation is not the primary goal when implementing these technologies, their implementation results in water conservation, since the majority of the water used by power generation plants is for steam generation. Implementation of renewable energy projects has not been included as a strategy in the 2016 regional water plan, but the LERWPG foresees more of these types of projects being implemented in the future, resulting in greater conservation of the water resource.

5.10.10.2 Quantity and Reliability of Water

An electric-dry power generation plant achieves more efficient energy production for the same amount of input water, providing significant savings in water usage. As an example, the Hobbs Generating Station incorporates significant technological advances through the use of fan-cooled radiators that decrease water use by 90 percent when compared to comparable generating stations (Plainview Herald, 2008).

Completely dry cooling systems use mechanical forced air systems to condense steam and have no cooling water requirements. These systems are typically used in arid climates but are less efficient, in large part because arid regions frequently have high ambient temperatures. Dry cooling systems are not suitable for power plants that produce large volumes of steam and thus have large cooling needs, such as coal and nuclear generating plants.

5.10.10.3 Financial Costs

This BMP would involve modification or construction of new dry power generation plants similar to the Hobbs Generating Station. Costs for such plants vary widely based on plant generating capacity, current construction costs, and economic viability from a cost of generation versus sales price of power standpoint.

5.10.10.4 Environmental Impacts and Limitations

The combined cycle technology at the Hobbs Generating Station allows less efficient gas-fired plants in the region to decrease their energy production. This results in an overall annual fuel savings for the amount of power generated, while also helping to reduce greenhouse gas emissions.

5.10.10.5 Implementation

Implementation for this option would involve the siting, design, permitting, and construction for modifications of existing facilities, where feasible, or construction of new generating facilities using combined cycle and/or dry cooling technologies.

5.10.11 Confined Animal Feeding Operations Groundwater Development

5.10.11.1 Description of Option

The livestock water use category includes water used in the production of livestock, for drinking, cleaning, and environmental purposes, as well as water used by wildlife. Cattle feed yards constitute more than 90 percent of livestock water demand in Region O. The water demand for livestock use in the region is projected to increase by 30 percent, from 38,828 ac-ft/yr in 2020 to 50,617 ac-ft/yr in 2070, accounting for 1 percent of the total regional demands in 2020 and 1.6 percent by 2070 (Chapter 2).

This BMP would entail drilling new wells to connect to an existing water system, in order to augment an existing water supply, as discussed in Section 5.2.3. Additional sources of groundwater may be a viable and cost-effective source of new supply for livestock water users, including for confined animal feeding operations (CAFOs). Another option available to livestock producers is to sell the animals when water is scarce. This is a decision that will have to be made by individual producers based on a number of factors.

5.10.11.2 Quantity and Reliability of Water

The quantity of water available would depend on the size, depth, and location of the new well(s). Single well installations are less complicated and require less infrastructure than new well fields, but yield less water for use. Depending on the location of a given well, available water volume and quality could be a concern. The quantity and reliability of the potential new water supply will need to be evaluated on a project-specific basis.

5.10.11.3 Financial Costs

Costs of this strategy include those for planning, design, drilling, and equipping new groundwater well(s), as well as construction of any conveyance water line necessary for connecting the new well(s) to the existing water system. Depending on where the new well(s) are installed and the well depth, screen length, and pumping equipment, well costs may range between $500,000 and $1 million.

5.10.11.4 Environmental Impacts

Environmental issues are relatively minor for this strategy and would be associated primarily with the construction of pumping and conveyance facilities. Standard environmental clearances and permits to address protected wildlife habitat, protected plant communities, and/or cultural resources would be required. The potential for environmental impacts will need to be evaluated on a project-specific basis.

5.10.11.5 Implementation

Implementation of a new local groundwater development project will require well permit(s) from the appropriate groundwater conservation district, and rights-of-way may need to be obtained depending on the location of the new infrastructure. The implementation issues will need to be evaluated on a project-specific basis.

5.10.12 No-Till Farming Techniques

5.10.12.1 Description of Option

The majority of United States farmers prepare their soil for seeding and weed and pest control through tillage, or plowing operations that disturb the soil (USDA ERS, 2010). No-till involves leaving the crop residue undisturbed (USDA ERS, 2010) and is a soil- and moisture-conserving practice (Steiert, 2015b). According to a study conducted by the U.S. Department of Agriculture's Agricultural Resource Management Survey, approximately 35.5 percent of U.S. cropland (88 million acres) planted with eight major crops (barley, corn, cotton, oats, rice, sorghum, soybeans, and wheat) had no tillage operations in 2009, with an increasing trend for no-till operations at a median rate of 1.5 percent per year (USDA ERS, 2010).

With annual cropping, much of a field's organic matter exists as residue left from previous crops, and reducing the intensity of tillage allows soil to retain more organic matter (USDA ERS, 2010). Building soil organic matter helps to increase soil moisture (Steiert, 2015b), and residue also helps to suppress weeds (Steiert, 2015c). There are several forms of reduced tillage, often lumped together as conservation tillage, defined as having at least 30 percent of the soil covered by crop residues, measured just after planting, as opposed to conventional tillage, which leaves less than 15 percent of the soil covered by crop residues after planting (USDA ERS, 2010). Conservation tillage requires low effort and yields high returns (USDA NRCS, 2015a).

An article in the Dryland To-Tiller highlights Roy Carlson's 2,500-acre no-till farming operation near Hereford, Texas, where he farms both irrigated and dryland crops (Steiert, 2014). Mr. Carlson's sons farm an additional 2,500 acres using no-till in the area. Crops include corn, grain sorghum, forages, cotton, wheat, rye, black-eyed peas, sunflowers, radishes, and canola, with the wheat and rye allowing for some grazing during the winter (Steiert, 2014). Roy Carlson has seen an increase in organic matter from 0.9 to 2 percent since he started implementing no-till practices 6 years ago (Steiert, 2014) and increased water-holding capacity of soils, which is vital in west Texas, where irrigation capacities are decreasing. Mr. Carlson says that the increased organic matter and water-holding capacity of the soils has made a large difference to his operation and has been especially beneficial during the recent drought (Steiert, 2014). He cites his attendance at no-till conferences and the opportunity to learn from others' experiences as the reason for adopting no-till practices (Steiert, 2014).

Partnering with the USDA NRCS, Hale County Soil and Water Conservation District (SWCD), and High Plains UWCD, Ronnie and R.N. Hopper recently hosted a crop and residue management field day at their farm in Hale County, with attendance by more than 80 producers, agricultural industry representatives, and agency personnel (USDA NRCS, 2015a). The presentation addressed the long-term benefits of crop and residue management on the land and environment and was scheduled in an effort to help develop a no-till network for support as producers experience challenges with implementing no-till practices (USDA NRCS, 2015a). The need for a long-term commitment to no-till practices was stressed, as were the benefits of their implementation (USDA NRCS, 2015a).

The Hoppers converted to no-till practices 13 years ago, and they employ a diverse cropping system using no-till methods on both irrigated and dryland acres, growing primarily corn and cotton and a variety of rotating crops (USDA NRCS, 2015a), including sunflowers and black-eyed peas (Steiert, 2015b). Almost a third (30 percent) of the Hoppers' operation is on dryland acres (Steiert, 2015b). Ronnie Hopper said that they began seeing the benefits of soil building 2 to 3 years into no-tilling (Steiert, 2015b), and their conversion to no-till practices has turned the formerly depleted soil into fertile soil (USDA NRCS, 2015a). The Hoppers emphasized that the management requirements of no-tilling are far greater than with tillage and that continuous no-till is about working with nature (Steiert, 2015b). They are focusing on soil building and crop rotation and have partnered with Texas Tech University and Cotton, Inc. to quantify the biological benefits of soil building (Steiert, 2015b). The Hoppers see a decline in the number of farmers and a trend toward less tillage on the Southern High Plains, and Ronnie Hopper expects that both trends will continue and economics will lead the region into a dryland situation (Steiert, 2015b).

An article in the *No-Till Farmer* highlights the Snell dryland no-till operations, which include a total of 6,000 acres in southeast Dawson, northern Martin and Borden, and northeastern Castro counties (Steiert, 2015c). The Snells' initial attempts at no-till were not successful, but the family has been successfully implementing the practice since 2012 (Steiert, 2015c). High-residue crops are essential to the practice, and the Snells began growing wheat and grain sorghum and using cover crops such as haygrazer/forage sorghum, millet, and black-eyed peas or cow peas, in order to build soil organic matter (Steiert, 2015c). On the Snell operation, the lowest soil organic content is 1 percent due to the high-residue they maintain (Steiert, 2015c). Mr. Snell said that no-tilling takes more than 1 or 2 years to establish and that the practice is something you have to commit to (Steiert, 2015c). The Snell's sorghum yields have been increasing since they started their no-till operations, and they indicated that they have seen a profitable sorghum yield after harvesting a wheat crop in a dry year using dryland no-till operations (Steiert, 2015c).

5.10.12.2 Quantity and Reliability of Water

When no-till operations are implemented under dryland conditions, their implementation conserves the volume of water that was previously applied to the converted acreage. For acres that are irrigated, implementation of no-till practices will reduce the amount of water that is needed for irrigation, since soil surface cover and organic content increase with implementation of no-till practices, improving water infiltration and soil moisture. The Noble Foundation reports that for every 1 percent of organic-matter content, soil can retain 16,500 gallons of plant-available water per acre, to a depth of 1 foot, which equates to 33,000 gallons of plant-available water per acre for soil with an organic-matter content of 2 percent (Steiert, 2014). This difference can make a large difference in growing a successful crop (Steiert, 2014).

5.10.12.3 Financial Costs

The financial costs of converting to conservation tillage (or no-till) will depend on the practices used during previous years (USDA ERS, 2010). Acres that are converted to dryland farming may be eligible for enrollment in the NRCS Environmental Quality Incentives Program (EQIP), which provides financial and technical assistance to producers that implement residue management conservation practices, such as mulch till, no-till, cover crops, mulching, and crop rotation in an effort to become more drought-resilient (USDA NRCS, 2015b).

5.10.12.4 Environmental Impacts

The environmental benefits of implementing no-till can include a reduction in soil erosion by as much as 30 percent, improvements in soil and water quality, reduced evaporation, conserved energy due to a reduction in the amount of diesel used, water conservation, improved air quality due to the reduction in soil erosion, and improved cover and food for wildlife from the crop residue left on the soil surface (USDA NRCS, 2015a).

5.10.12.5 Implementation

With limited-till and no-till practices, soil surface cover and organic content increase, improving water infiltration and soil moisture and providing ecological and financial benefits (Steiert, 2015b). If a farm adopts no-till practices, it is reasonably likely to continue them over multiple crop seasons (USDA ERS, 2010). Adoption of less intensive tillage practices on a large number of farms could sequester substantial amounts of carbon, and one alternative to cap-and-trade policies could offer incentive payments to farmers for adopting no-till techniques (USDA ERS, 2010).

5.11 Water Conservation Recommendations

Water conservation must be considered for all water users with water needs during the planning horizon. In Region O, water needs occur in all WUG categories. Specific conservation projects or sponsors were not identified for many of the WUG types (e.g., livestock and industrial) during this planning round, making the adoption of recommended conservation water management strategies for those WUG types not feasible. As a result, conservation has not been included as a fully evaluated strategy for all WUG types with needs. In accordance with TAC §357.34(g), this section consolidates the LERWPG's recommendations regarding water conservation and includes recommendations for all WUG types with needs.

5.11.1 Municipal Water Conservation Recommendations

The municipal WUG category is projected to account for approximately 2.6 percent of Region O's water demands in 2020 and approximately 4.1 percent of water demands in 2070 (Chapter 2). The municipal WUG category is projected to account for less than 1 percent of Region O's water needs in 2020 and approximately 2.5 percent of water needs in 2070 (Chapter 4).

The State of Texas Water Conservation Task Force recommends that cities seek to achieve a total per capita demand of 140 gpd. Table 5-6 shows the population, per capita use, and water demand projections by decade for each municipality in Region O, as well as the reduction needed in order to achieve the target use of 140 gpcd. Seminole and Matador will require the largest reductions, each needing a reduction of 50 percent or more. Sundown, Ransom Canyon, and Denver City will each require a reduction of between 40 and 50 percent. Of the 49 municipalities in Region O, only 17 are projected to reach the goal of 140 gpcd during the planning period. The 15 municipalities that are projected to have per capita use below 140 gpcd for all decades in the planning period include Amherst, Anton, Crosbyton, Hale Center, Happy, Hart, Kress, Lockney, Meadow, New Deal, O'Donnell, Post, Ralls, Shallowater, and Slaton. Seagraves and Levelland are both projected to meet the target in 2040.

All county-other WUGs except for Briscoe, Cochran, Motley, and Parmer counties have per capita use values below the target 140 gpd for all decades in the planning period.

The LEWRPG acknowledges the need for conservation, and there are a variety of municipal conservation efforts underway in the region, as discussed in Section 5.2.1. Programs are in place for many municipalities and GCDs. The largest municipality in the High Plains, the City of Lubbock, has the most developed municipal conservation program. The City is currently engaged in multiple water conserving activities, including:

- Adopting increasing block structure water rates
- Using water loss audits, a water main replacement program, a meter change-out program, and metering of fire hydrants and construction sites to reduce non-revenue water
- Implementing public education
- Implementing water conservation and water waste ordinances and a water use management plan

In addition to water savings derived from federal, state, and local measures already in place, WUGs may consider enacting additional conservation measures to maximize the volume of water conserved. Municipal conservation strategies can be broadly categorized as administrative, residential indoor, residential outdoor, or commercial. Residential indoor sub-strategies are not discussed further, since their water conservation savings have already been accounted for in the municipal demand projections (Section 5.2.1.2.1). The LERWPG recommends that municipalities consider implementing the following municipal water conservation strategies:

- *Administrative:* Implement water loss audits and practices and public education programs (including education regarding the importance of leak detection and repair on a residential scale).

- *Residential outdoor:* Identify high-use residential outdoor water users and target programs at these customers (e.g., customer-level water audits, education regarding turfgrass selection, and rebate programs).

- *Commercial:* Encourage appliance upgrades (e.g., toilets, washing machines) and installation of commercial carwash water reclamation systems.

Table 5-2 includes a list of recommended municipal water conservation strategies for individual WUGs with identified initial (first tier) water needs for any decade. The LERWPG has recommended municipal water conservation strategies for WUGs that (1) have per capita use greater than 140 gpd regardless of needs, or (2) specifically mentioned a municipal water conservation strategy in the WUG survey (i.e., Amherst, Anton, and Littlefield). The LERWPG has recommended reductions in per capita water use of 0.5 percent per year (5 percent over 10 years) for these communities.

The unit costs for the municipal water conservation strategies are from the TWDB unified costing model and reflect either $600 per acre-foot of water conserved for urban, $681 per acre-foot for suburban, and $770 for rural communities (TWDB, 2013e). Urban communities are defined as cities designated as metropolitan statistical areas. Suburban communities are defined as non-metropolitan statistical areas that are located in a county with a metropolitan statistical area, and rural communities are those that are located in counties that don't include a metropolitan statistical area (U.S. Census Bureau, 2010). The only metropolitan statistical area in Region O is Lubbock (U.S. Census Bureau, 2010). Thus Lubbock is classified as urban, while Idalou, Ransom Canyon, Shallowater, Slaton, and Wolfforth are classified as suburban communities on Table 5-2, and all other communities are classified as rural.

Before implementing a water conservation program, it is recommended that a thorough, WUG-specific study of strategy options be conducted. For example, in 2013, Alan Plummer Associates, Inc. completed a water conservation evaluation for the City of Lubbock and identified a wide range of feasible municipal conservation strategies (Plummer, 2013). Such evaluations take into consideration WUG-specific conditions and may highlight viable strategies in addition to those recommended for consideration in this plan.

Appendix 5H presents the City of Lubbock's *Water Use Management Plan* as a model water conservation plan pursuant to Texas Water Code §11.1271, although each municipality will need to evaluate the anticipated water savings for a given strategy based on its own size, water source(s), and circumstances. The Lubbock document provides a system description and outlines the City's water conservation plan (Division 2). The water conservation plan addresses metering, records management, control of non-revenue water, water rates, reservoir operations planning, leak detection and repair, water supply contracts, penalties for non-compliance, and the City's irrigation water conservation plan. Chapter 5 of the City of Lubbock's *2013 Strategic Water Supply Plan* goes into more detail on the City's water conservation trends, rate structure, water loss, public education program, existing ordinances, water conservation strategies, and potential water savings (City of Lubbock, 2013).

5.11.2 Agricultural Water Conservation Recommendations

Agricultural irrigation is the largest water demand category in Region O, with projected demand for this sector accounting for approximately 95 percent of total water demand in 2020 and 91.5 percent of total water demand by 2070 (Chapter 2). Irrigation is projected to account for more than 95 percent of Region O's water needs in all decades of the planning period (Chapter 4).

The LERWPG identified the Texas Alliance for Water Conservation (TAWC) project as a model for the ongoing agricultural conservation activities in Region O and recommends that the program be continued and expanded. The TAWC program, described in Section 5.3.1.1.1, is an ongoing on-farm demonstration project that was started in 2004, with a mission of conserving water by identifying agricultural production practices and technologies that will reduce the depletion of groundwater while maintaining or improving agricultural production and economic opportunities. The project is a partnership of producers, industries, universities, and government agencies that provides education and tools for producers to improve efficiencies in water use.

The following measures are recommended to maximize the benefits of the ongoing TAWC project in Region O:

- Continue the TAWC program public outreach and education efforts, presenting the findings of the demonstration project and the tools available to producers.
- Involve more Region O producers in the TAWC on-farm demonstrations.
- Consider further expanding the program to cover more of the Region O area. Phase 1 included 9 growing seasons (2005-2013) in 2 counties (Hale and Floyd), and Phase 2 will include 5 growing seasons (2014-2018) in 8 counties (Floyd, Hale, Lamb, Lubbock, Crosby, Parmer, Swisher and Deaf Smith). The other 13 counties in Region O could be considered for further program expansion.

The LERWPG also recommends the following agricultural conservation activities:

- On-farm flow metering to measure the volume of water pumped versus water delivered, allowing quantification of water losses.
- Use of ground cover and implementation of low-till or no-till methods.
- Voluntary implementation of drip/micro-irrigation systems, irrigation scheduling improvements, and any other methods that are demonstrated to be practical and profitable.

Agricultural water conservation strategies are recommended for all 21 counties in Region O (Table 5-2). An average annual unit cost of $42 per acre-foot of water conserved has been used (capital cost of $500per acre-foot per year financed over 20 years with 5.5 percent interest rate, in accordance with the TWDB costing tool), and the potential water conservation savings have been calculated by decade. As discussed in Section 5.3.1, the LERWPG has assumed that the implementation of a subset of the agricultural conservation substrategies across the region will yield a 5 percent increase in irrigation efficiency for decades 2020, 2040, and 2060, for a total water conservation savings of 15 percent.

5.11.3 Livestock Water Conservation Recommendations

The livestock water use category is for water used in the production of livestock, including for drinking, cleaning, and environmental purposes, as well as by wildlife. Region O's livestock demands are projected to increase by 30 percent during the planning period, from 38,828 ac-ft/yr in 2020 to 50,617 ac-ft/yr in 2070. These volumes account for approximately 1 percent of the total regional demands in 2020, increasing to 1.6 percent of the total regional demands by 2070 (Chapter 2). The livestock WUG category is projected to account for less than 1 percent of Region O's water needs in all decades of the planning period (Chapter 4).

The LERWPG recommends that all livestock operations be diligent in their water use, implementing water conservation practices as economically feasible. Specific conservation projects or sponsors were not identified for the livestock water use category during this planning round; thus it was not feasible to adopt recommended conservation water management strategies for this WUG type. As discussed in Section 5.10.8, rainwater harvesting is one BMP that can be implemented to provide water supply for livestock operations; however, determination of the feasibility of implementing livestock water conservation strategies should be performed at an individual livestock operation level, based on the number and type of livestock, size of buildings/facilities, equipment and technology in use, and cost of water. The most common water conservation strategy in the livestock water use category is to sell the animals when water is not available.

5.11.4 Industrial Water Conservation Recommendations

In Region O, industrial (mining, manufacturing, steam-electric) water demands are projected to account for approximately 1.6 percent of the Region O water demands in 2020 and 2.8 percent in 2070 (Chapter 2); industrial water needs are projected to account for approximately 1.3 percent of the water needs in 2020 and 1.2 percent in 2070 (Chapter 4).

In the TWDB Water Conservation Best Management Practices Guide (TWDB, 2004b, the following conservation BMPs are listed for industrial water users:

- Industrial water audit
- Industrial water waste reduction
- Industrial submetering
- Cooling towers and other cooling systems
- Industrial alternative sources and reuse of process water
- Rinsing/cleaning
- Water treatment
- Boiler and steam systems
- Refrigeration (including chilled water)
- Once-through cooling
- Management and employee programs
- Industrial landscape
- Industrial site specific conservation

The LERWPG recommends that all industrial users consider implementing water conservation BMPs. However, due to industry-specific specific-practices, it is not practical to evaluate conservation strategies for these WUGs on a county-wide basis. In addition, specific conservation projects or sponsors were not identified for the industrial water use category during this planning round; thus it was not feasible to adopt recommended conservation water management strategies for this WUG type. Each mining, manufacturing, and steam-electric WUG will need to evaluate water conservation strategies that are economically viable in their industry.

In addition to industry-specific BMPs, the LERWPG recommends that the following general BMPs be considered for implementation by manufacturing and other industrial facilities within the region:

- Develop and implement site-specific water conservation practices by completing facility-specific water use audits and then identifying and implementing specific BMPs that are appropriate for implementation.
- Implement industrial water waste-reducing activities that focus on the most economical changes that can be made to improve water use efficiency. For example, water use efficiency at facilities can potentially be increased by prohibiting wasteful activities such as wasteful irrigation practices and scheduling, single-pass cooling, non-recycling decorative fountains, discharge of process water, and use of inefficient water softeners.
- Install industrial submeters to help identify significant opportunities for monitoring ongoing water use within facilities.

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Appendix 5A

Required DB17 Reports

Recommended Water User Group (WUG) Water Management Strategies (WMS)

WUG Entity Primary Region: O

WUG Entity Name	WMS Sponsor Region	WMS Name	Source Name	Water Management Strategy Supplies 2020	2030	2040	2050	2060	2070	Unit Cost 2020	Unit Cost 2070
ABERNATHY	O	HALE COUNTY - ABERNATHY GROUNDWATER DESALINATION	O | DOCKUM AQUIFER BRACKISH | HALE COUNTY	150	150	150	150	150	150	$9523	$3620
ABERNATHY	O	HALE COUNTY - ABERNATHY MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	35	37	38	38	40	41	$770	$770
AMHERST	O	LAMB COUNTY - AMHERST LOCAL GROUNDWATER DEVELOPMENT	O | OGALLALA AQUIFER | LAMB COUNTY	50	50	50	50	50	50	$900	$80
AMHERST	O	LAMB COUNTY - AMHERST MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	5	5	5	6	6	6	$770	$770
ANTON	O	HOCKLEY COUNTY - ANTON MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	8	8	8	8	9	9	$770	$770
BOVINA	O	PARMER COUNTY - BOVINA LOCAL GROUNDWATER DEVELOPMENT	O | OGALLALA AQUIFER | PARMER COUNTY	0	0	120	120	120	120	N/A	$75
BOVINA	O	PARMER COUNTY - BOVINA MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	19	20	21	23	25	27	$770	$770
BROWNFIELD	A	CONJUNCTIVE USE - CRMWA	A | MEREDITH LAKE/RESERVOIR	137	138	140	144	144	144	$451	$106
BROWNFIELD	A	EXPAND CAPACITY CRMWA II	A | OGALLALA AQUIFER | ROBERTS COUNTY	0	662	673	692	691	691	N/A	$240
BROWNFIELD	A	REPLACE WELL CAPACITY FOR CRMWA I	A | OGALLALA AQUIFER | ROBERTS COUNTY	0	124	182	274	331	403	N/A	$179
BROWNFIELD	O	TERRY COUNTY - BROWNFIELD MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	90	93	92	69	72	75	$770	$770
COUNTY-OTHER, BAILEY	O	BAILEY COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT	O | EDWARDS-TRINITY-HIGH PLAINS AQUIFER | BAILEY COUNTY	0	0	150	150	150	150	N/A	$60
COUNTY-OTHER, BRISCOE	O	BRISCOE COUNTY-OTHER MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	15	15	14	14	14	14	$770	$770
COUNTY-OTHER, COCHRAN	O	COCHRAN COUNTY-OTHER MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	25	27	28	28	29	29	$770	$770
COUNTY-OTHER, DAWSON	O	DAWSON COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT	O | OGALLALA AQUIFER | DAWSON COUNTY	0	0	150	150	150	150	N/A	$60
COUNTY-OTHER, GAINES	O	GAINES COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT	O | EDWARDS-TRINITY-HIGH PLAINS AQUIFER | GAINES COUNTY	600	600	1,500	1,500	2,000	1,622	$358	$187
COUNTY-OTHER, GARZA	O	GARZA COUNTY - SOUTH GARZA WATER SUPPLY	O | ALAN HENRY LAKE/RESERVOIR	270	270	270	270	270	270	$3879	$1501
COUNTY-OTHER, HOCKLEY	O	HOCKLEY COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT	O | OGALLALA AQUIFER | HOCKLEY COUNTY	150	150	150	150	150	150	$407	$47
COUNTY-OTHER, LYNN	O	LYNN COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT	O | OGALLALA AQUIFER | LYNN COUNTY	100	100	100	100	100	100	$560	$60
COUNTY-OTHER, MOTLEY	O	MOTLEY COUNTY-OTHER MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	5	5	5	5	5	5	$770	$770
COUNTY-OTHER, PARMER	O	PARMER COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT	O | OGALLALA AQUIFER | PARMER COUNTY	0	0	0	0	50	50	N/A	$1160
COUNTY-OTHER, PARMER	O	PARMER COUNTY-OTHER MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	32	34	36	39	42	45	$770	$770

Recommended Water User Group (WUG) Water Management Strategies (WMS)

WUG Entity Name	WMS Sponsor Region	WMS Name	Source Name	Water Management Strategy Supplies 2020	2030	2040	2050	2060	2070	Unit Cost 2020	Unit Cost 2070
DENVER CITY	O	YOAKUM COUNTY - DENVER CITY LOCAL GROUNDWATER DEVELOPMENT	O | EDWARDS-TRINITY-HIGH PLAINS AQUIFER | YOAKUM COUNTY	925	925	925	925	925	925	$333	$62
DENVER CITY	O	YOAKUM COUNTY - DENVER CITY MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	71	79	86	94	103	112	$770	$770
DIMMITT	O	CASTRO COUNTY - DIMMITT LOCAL GROUNDWATER DEVELOPMENT	O | OGALLALA AQUIFER | CASTRO COUNTY	0	0	300	300	300	300	N/A	$63
DIMMITT	O	CASTRO COUNTY - DIMMITT MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	55	58	60	63	65	67	$770	$770
EARTH	O	LAMB COUNTY - EARTH MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	10	10	9	9	8	8	$770	$770
FARWELL	O	PARMER COUNTY - FARWELL LOCAL GROUNDWATER DEVELOPMENT	O | OGALLALA AQUIFER | PARMER COUNTY	0	0	0	125	125	125	N/A	$88
FARWELL	O	PARMER COUNTY - FARWELL MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	20	21	23	25	27	29	$770	$770
FARWELL	O	PARMER COUNTY - FARWELL POTABLE REUSE	O | DIRECT REUSE	64	64	64	64	64	64	$10656	$3859
FLOYDADA	O	FLOYD COUNTY - FLOYDADA MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	29	30	30	31	32	33	$770	$770
FRIONA	O	PARMER COUNTY - FRIONA LOCAL GROUNDWATER DEVELOPMENT	O | OGALLALA AQUIFER | PARMER COUNTY	0	0	0	80	80	80	N/A	$88
FRIONA	O	PARMER COUNTY - FRIONA MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	41	45	48	51	55	59	$770	[illegible]
HART	O	CASTRO COUNTY - HART LOCAL GROUNDWATER DEVELOPMENT	O | OGALLALA AQUIFER | CASTRO COUNTY	0	0	100	100	100	100	N/A	$100
HEREFORD	O	DEAF SMITH COUNTY - HEREFORD MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	198	223	251	286	315	346	$770	$770
IDALOU	O	LUBBOCK COUNTY - IDALOU LOCAL GROUNDWATER DEVELOPMENT	O | OGALLALA AQUIFER | LUBBOCK COUNTY	0	100	100	100	100	100	N/A	$210
IDALOU	O	LUBBOCK COUNTY - IDALOU MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	21	21	22	23	23	24	$681	$681
IRRIGATION, BAILEY	O	BAILEY COUNTY IRRIGATION WATER CONSERVATION	DEMAND REDUCTION	1,846	1,846	2,652	2,652	2,752	2,752	$42	$42
IRRIGATION, BRISCOE	O	BRISCOE COUNTY IRRIGATION WATER CONSERVATION	DEMAND REDUCTION	1,667	1,667	1,899	1,899	2,474	2,474	$42	$42
IRRIGATION, CASTRO	O	CASTRO COUNTY IRRIGATION WATER CONSERVATION	DEMAND REDUCTION	6,253	6,253	8,350	8,350	8,478	8,478	$42	$42
IRRIGATION, COCHRAN	O	COCHRAN COUNTY IRRIGATION WATER CONSERVATION	DEMAND REDUCTION	1,768	1,768	2,977	2,977	3,642	3,642	$42	$42
IRRIGATION, CROSBY	O	CROSBY COUNTY IRRIGATION WATER CONSERVATION	DEMAND REDUCTION	5,514	5,514	10,180	10,180	13,995	13,995	$42	$42
IRRIGATION, DAWSON	O	DAWSON COUNTY IRRIGATION WATER CONSERVATION	DEMAND REDUCTION	5,410	5,410	9,610	9,610	12,893	12,893	$42	$42
IRRIGATION, DEAF SMITH	O	DEAF SMITH COUNTY IRRIGATION WATER CONSERVATION	DEMAND REDUCTION	5,464	5,464	8,207	8,207	8,019	8,019	$42	$42
IRRIGATION, DICKENS	O	DICKENS COUNTY IRRIGATION WATER CONSERVATION	DEMAND REDUCTION	480	480	936	936	1,385	1,385	$42	$42
IRRIGATION, FLOYD	O	FLOYD COUNTY IRRIGATION WATER CONSERVATION	DEMAND REDUCTION	6,121	6,121	11,027	11,027	14,833	14,833	$42	[illegible]
IRRIGATION, GAINES	O	GAINES COUNTY IRRIGATION WATER CONSERVATION	DEMAND REDUCTION	11,563	11,563	12,306	12,306	9,644	9,644	$42	[illegible]
IRRIGATION, GARZA	O	GARZA COUNTY IRRIGATION WATER CONSERVATION	DEMAND REDUCTION	584	584	1,033	1,033	1,391	1,391	$42	$42

Recommended Water User Group (WUG) Water Management Strategies (WMS)

WUG Entity Name	WMS Sponsor Region	WMS Name	Source Name	Water Management Strategy Supplies 2020	2030	2040	2050	2060	2070	Unit Cost 2020	Unit Cost 2070
IRRIGATION, HALE	O	HALE COUNTY IRRIGATION WATER CONSERVATION	DEMAND REDUCTION	6,566	6,566	12,332	12,332	16,533	16,533	$42	$42
IRRIGATION, HOCKLEY	O	HOCKLEY COUNTY IRRIGATION WATER CONSERVATION	DEMAND REDUCTION	4,178	4,178	6,086	6,086	8,317	8,317	$42	$42
IRRIGATION, LAMB	O	LAMB COUNTY IRRIGATION WATER CONSERVATION	DEMAND REDUCTION	6,305	6,305	8,430	8,430	7,167	7,167	$42	$42
IRRIGATION, LUBBOCK	O	LUBBOCK COUNTY IRRIGATION WATER CONSERVATION	DEMAND REDUCTION	5,711	5,711	8,111	8,111	10,940	10,940	$42	$42
IRRIGATION, LYNN	O	LYNN COUNTY IRRIGATION WATER CONSERVATION	DEMAND REDUCTION	4,230	4,230	7,577	7,577	10,173	10,173	$42	$42
IRRIGATION, MOTLEY	O	MOTLEY COUNTY IRRIGATION WATER CONSERVATION	DEMAND REDUCTION	485	485	971	971	1,456	1,456	$42	$42
IRRIGATION, PARMER	O	PARMER COUNTY IRRIGATION WATER CONSERVATION	DEMAND REDUCTION	2,854	2,854	2,559	2,559	3,463	3,463	$42	$42
IRRIGATION, SWISHER	O	SWISHER COUNTY IRRIGATION WATER CONSERVATION	DEMAND REDUCTION	4,973	4,973	6,255	6,255	7,922	7,922	$42	$42
IRRIGATION, TERRY	O	TERRY COUNTY IRRIGATION WATER CONSERVATION	DEMAND REDUCTION	7,201	7,201	8,259	8,259	4,916	4,916	$42	$42
IRRIGATION, YOAKUM	O	YOAKUM COUNTY IRRIGATION WATER CONSERVATION	DEMAND REDUCTION	2,771	2,771	3,048	3,048	2,497	2,497	$42	$42
LAMESA	A	CONJUNCTIVE USE - CRMWA	A | MEREDITH LAKE/RESERVOIR	153	179	202	226	226	226	$451	$106
LAMESA	A	EXPAND CAPACITY CRMWA II	A | OGALLALA AQUIFER | ROBERTS COUNTY	0	860	967	1,087	1,086	1,085	N/A	$240
LAMESA	A	REPLACE WELL CAPACITY FOR CRMWA I	A | OGALLALA AQUIFER | ROBERTS COUNTY	0	161	262	430	520	633	N/A	$179
LAMESA	O	DAWSON COUNTY - LAMESA MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	114	115	116	116	119	121	$770	$770
LEVELLAND	A	CONJUNCTIVE USE - CRMWA	A | MEREDITH LAKE/RESERVOIR	229	220	219	213	220	225	$451	$106
LEVELLAND	A	EXPAND CAPACITY CRMWA II	A | OGALLALA AQUIFER | ROBERTS COUNTY	0	1,059	1,051	1,023	1,055	1,082	N/A	$240
LEVELLAND	A	REPLACE WELL CAPACITY FOR CRMWA I	A | OGALLALA AQUIFER | ROBERTS COUNTY	0	199	285	405	505	631	N/A	$179
LEVELLAND	O	HOCKLEY COUNTY - LEVELLAND MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	116	53	0	0	0	0	$770	N/A
LITTLEFIELD	O	LAMB COUNTY - LITTLEFIELD MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	48	46	44	42	41	40	$770	$770
LOCKNEY	O	FLOYD COUNTY - LOCKNEY LOCAL GROUNDWATER DEVELOPMENT	O | OGALLALA AQUIFER | FLOYD COUNTY	240	240	240	240	240	240	$1125	$179
LORENZO	O	CROSBY COUNTY - LORENZO MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	12	12	13	14	15	15	$770	$770
LORENZO	O	CROSBY COUNTY - LORENZO WATER LOSS REDUCTION	DEMAND REDUCTION	29	31	54	57	61	64	$7196	$0
LUBBOCK	A	CONJUNCTIVE USE - CRMWA	A | MEREDITH LAKE/RESERVOIR	3,544	3,584	3,811	3,870	3,867	3,864	$451	$106
LUBBOCK	A	EXPAND CAPACITY CRMWA II	A | OGALLALA AQUIFER | ROBERTS COUNTY	0	17,204	18,294	18,574	18,560	18,548	N/A	$240
LUBBOCK	A	REPLACE WELL CAPACITY FOR CRMWA I	A | OGALLALA AQUIFER | ROBERTS COUNTY	0	3,226	4,955	7,352	8,894	10,819	N/A	$179
LUBBOCK	O	LUBBOCK COUNTY - LUBBOCK BAILEY COUNTY WELL FIELD CAPACITY MAINTENANCE	O | OGALLALA AQUIFER | LAMB COUNTY	997	1,443	2,822	3,120	3,120	3,120	$2028	$160
LUBBOCK	O	LUBBOCK COUNTY - LUBBOCK BRACKISH WELL FIELD AT THE SOUTH WATER TREATMENT PLANT	O | DOCKUM AQUIFER BRACKISH | LUBBOCK COUNTY	1,120	1,120	1,120	1,120	1,120	1,120	$3671	$1090

Recommended Water User Group (WUG) Water Management Strategies (WMS)

WUG Entity Name	WMS Sponsor Region	WMS Name	Source Name	Water Management Strategy Supplies 2020	2030	2040	2050	2060	2070	Unit Cost 2020	Unit C[illegible]
LUBBOCK	O	LUBBOCK COUNTY - LUBBOCK CRMWA AQUIFER STORAGE AND RECOVERY	O | OGALLALA AQUIFER ASR | LUBBOCK COUNTY	0	6,090	6,090	6,090	6,090	6,090	N/A	$243
LUBBOCK	O	LUBBOCK COUNTY - LUBBOCK JIM BERTRAM LAKE 7	O | LAKE 7 (JIM BERTRAM LAKE/RESERVOIR SYSTEM)	13,800	13,800	13,800	13,800	13,800	13,800	$614	$179
LUBBOCK	O	LUBBOCK COUNTY - LUBBOCK LAKE ALAN HENRY PHASE 2	O | ALAN HENRY LAKE/RESERVOIR	8,000	8,000	8,000	8,000	8,000	8,000	$911	$306
LUBBOCK	O	LUBBOCK COUNTY - LUBBOCK MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	2,287	2,478	2,674	2,915	3,139	3,382	$600	$600
LUBBOCK	O	LUBBOCK COUNTY - LUBBOCK NORTH FORK SCALPING OPERATION	O | ALAN HENRY LAKE/RESERVOIR	10,390	9,790	9,220	8,660	8,110	7,890	$1324	$513
LUBBOCK	O	LUBBOCK COUNTY - LUBBOCK SOUTH LUBBOCK WELL FIELD	O | OGALLALA AQUIFER | LUBBOCK COUNTY	0	2,613	2,613	2,613	2,613	2,613	N/A	$791
MATADOR	O	MOTLEY COUNTY - MATADOR MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	11	10	10	10	10	10	$770	$770
MORTON	O	COCHRAN COUNTY - MORTON MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	24	24	23	23	23	23	$770	$770
MORTON	O	COCHRAN COUNTY - MORTON WATER LOSS REDUCTION	DEMAND REDUCTION	141	141	232	226	231	233	$3206	$0
MULESHOE	O	BAILEY COUNTY - MULESHOE LOCAL GROUNDWATER DEVELOPMENT	O | OGALLALA AQUIFER | BAILEY COUNTY	0	300	300	300	500	500	N/A	$266
MULESHOE	O	BAILEY COUNTY - MULESHOE MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	59	64	70	76	83	89	$770	$770
O'DONNELL	A	CONJUNCTIVE USE - CRMWA	A | MEREDITH LAKE/RESERVOIR	14	13	12	12	12	13	$451	[illegible]
O'DONNELL	A	EXPAND CAPACITY CRMWA II	A | OGALLALA AQUIFER | ROBERTS COUNTY	0	61	60	58	59	60	N/A	$240
O'DONNELL	A	REPLACE WELL CAPACITY FOR CRMWA I	A | OGALLALA AQUIFER | ROBERTS COUNTY	0	11	16	23	28	35	N/A	$179
OLTON	O	LAMB COUNTY - OLTON MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	23	23	23	22	22	22	$770	$770
PETERSBURG	O	HALE COUNTY - PETERSBURG MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	16	17	17	16	17	17	$770	$770
PLAINS	O	YOAKUM COUNTY - PLAINS LOCAL GROUNDWATER DEVELOPMENT	O | EDWARDS-TRINITY-HIGH PLAINS AQUIFER | YOAKUM COUNTY	500	500	500	500	500	500	$1954	$1130
PLAINS	O	YOAKUM COUNTY - PLAINS MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	22	24	26	28	31	34	$770	$770
PLAINVIEW	A	CONJUNCTIVE USE - CRMWA	A | MEREDITH LAKE/RESERVOIR	275	276	285	288	288	288	$451	$106
PLAINVIEW	A	EXPAND CAPACITY CRMWA II	A | OGALLALA AQUIFER | ROBERTS COUNTY	0	1,323	1,367	1,383	1,382	1,381	N/A	$240
PLAINVIEW	A	REPLACE WELL CAPACITY FOR CRMWA I	A | OGALLALA AQUIFER | ROBERTS COUNTY	0	248	370	548	662	806	N/A	$179
PLAINVIEW	O	HALE COUNTY - PLAINVIEW MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	218	222	221	217	223	225	$770	$770
RANSOM CANYON	O	LUBBOCK COUNTY - RANSOM CANYON MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	17	18	19	20	21	22	$681	[illegible]
SEAGRAVES	O	GAINES COUNTY - SEAGRAVES LOCAL GROUNDWATER DEVELOPMENT	O | EDWARDS-TRINITY-HIGH PLAINS AQUIFER | GAINES COUNTY	0	0	0	50	50	50	N/A	$120

Recommended Water User Group (WUG) Water Management Strategies (WMS)

WUG Entity Name	WMS Sponsor Region	WMS Name	Source Name	Water Management Strategy Supplies 2020	2030	2040	2050	2060	2070	Unit Cost 2020	Unit Cost 2070
SEAGRAVES	O	GAINES COUNTY - SEAGRAVES MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	20	9	0	0	0	0	$770	N/A
SEMINOLE	O	GAINES COUNTY - SEMINOLE GROUNDWATER DESALINATION	O | DOCKUM AQUIFER BRACKISH | GAINES COUNTY	500	500	500	500	500	500	$7822	$2538
SEMINOLE	O	GAINES COUNTY - SEMINOLE LOCAL GROUNDWATER DEVELOPMENT	F | EDWARDS-TRINITY-PLATEAU AQUIFER | ANDREWS COUNTY	0	1,000	1,000	1,000	1,000	1,000	N/A	$367
SEMINOLE	O	GAINES COUNTY - SEMINOLE MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	117	129	142	158	171	184	$770	$770
SHALLOWATER	O	LUBBOCK COUNTY - SHALLOWATER LOCAL GROUNDWATER DEVELOPMENT	O | OGALLALA AQUIFER | LUBBOCK COUNTY	0	400	400	400	400	400	N/A	$1198
SHALLOWATER	O	LUBBOCK COUNTY - SHALLOWATER WATER LOSS REDUCTION	DEMAND REDUCTION	68	74	136	150	163	177	$3007	$0
SILVERTON	O	BRISCOE COUNTY - SILVERTON LOCAL GROUNDWATER DEVELOPMENT	O | DOCKUM AQUIFER | SWISHER COUNTY	121	121	121	121	121	121	$4496	$438
SILVERTON	O	BRISCOE COUNTY - SILVERTON MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	6	6	2	2	2	2	$770	$770
SLATON	A	CONJUNCTIVE USE - CRMWA	A | MEREDITH LAKE/RESERVOIR	140	131	127	122	121	121	$451	$106
SLATON	A	EXPAND CAPACITY CRMWA II	A | OGALLALA AQUIFER | ROBERTS COUNTY	0	631	612	585	583	583	N/A	$240
SLATON	A	REPLACE WELL CAPACITY FOR CRMWA I	A | OGALLALA AQUIFER | ROBERTS COUNTY	0	118	166	231	279	340	N/A	$179
SPUR	O	DICKENS COUNTY - SPUR MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	9	9	9	8	8	8	$770	$770
SUDAN	O	LAMB COUNTY - SUDAN MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	12	13	14	14	15	15	$770	$770
SUNDOWN	O	HOCKLEY COUNTY - SUNDOWN LOCAL GROUNDWATER DEVELOPMENT	O | OGALLALA AQUIFER | HOCKLEY COUNTY	0	0	0	0	0	100	N/A	$650
SUNDOWN	O	HOCKLEY COUNTY - SUNDOWN MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	21	22	22	22	23	24	$770	$770
SUNDOWN	O	HOCKLEY COUNTY - SUNDOWN WATER LOSS REDUCTION	DEMAND REDUCTION	27	28	48	48	50	52	$4895	$0
TAHOKA	A	CONJUNCTIVE USE - CRMWA	A | MEREDITH LAKE/RESERVOIR	46	44	42	41	42	42	$451	$106
TAHOKA	A	EXPAND CAPACITY CRMWA II	A | OGALLALA AQUIFER | ROBERTS COUNTY	0	210	203	196	200	204	N/A	$240
TAHOKA	A	REPLACE WELL CAPACITY FOR CRMWA I	A | OGALLALA AQUIFER | ROBERTS COUNTY	0	39	55	78	96	119	N/A	$179
TAHOKA	O	LYNN COUNTY - TAHOKA MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	24	20	7	3	4	4	$770	$770
TULIA	O	SWISHER COUNTY - TULIA LOCAL GROUNDWATER DEVELOPMENT	O | OGALLALA AQUIFER | SWISHER COUNTY	200	200	200	200	200	200	$885	$160
TULIA	O	SWISHER COUNTY - TULIA MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	46	47	47	46	48	50	$770	$770
TE RIVER MWD - SSIGNED WATER VOLUMES	O	CROSBY COUNTY - WHITE RIVER MWD LOCAL GROUNDWATER DEVELOPMENT	O | OGALLALA AQUIFER | CROSBY COUNTY	600	600	600	600	600	600	$343	$55

Recommended Water User Group (WUG) Water Management Strategies (WMS)

				Water Management Strategy Supplies							
WUG Entity Name	**WMS Sponsor Region**	**WMS Name**	**Source Name**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**Unit Cost 2020**	**Unit C**
WOLFFORTH	O	LUBBOCK COUNTY - WOLFFORTH LOCAL GROUNDWATER DEVELOPMENT	O | OGALLALA AQUIFER | LUBBOCK COUNTY	0	726	726	726	726	726	N/A	$175
WOLFFORTH	O	LUBBOCK COUNTY - WOLFFORTH MUNICIPAL WATER CONSERVATION	DEMAND REDUCTION	38	37	29	26	29	32	$681	$681
WOLFFORTH	O	LUBBOCK COUNTY - WOLFFORTH POTABLE REUSE	O | DIRECT REUSE	0	560	560	560	560	560	N/A	$1861
			Region O Total RecommendedWMS Supplies	139,463	177,480	224,876	228,665	251,294	253,643		

Recommended Projects Associated with Water Management Strategies

Project Sponosr Region: O

Sponsor Name	Is Sponsor a WWP?	Project Name	Project Description	Capital Cost	Online Decade
ABERNATHY	N	HALE COUNTY - ABERNATHY GROUNDWATER DESALINATION	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD; NEW WATER RIGHT/PERMIT; NEW WATER TREATMENT PLANT; STORAGE TANK; INJECTION WELL; PUMP STATION	$10,100,000	2020
AMHERST	N	LAMB COUNTY - AMHERST LOCAL GROUNDWATER DEVELOPMENT	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	$487,000	2020
BOVINA	N	PARMER COUNTY - BOVINA LOCAL GROUNDWATER DEVELOPMENT	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	$775,000	2040
COUNTY-OTHER, BAILEY	N	BAILEY COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	$771,000	2040
COUNTY-OTHER, DAWSON	N	DAWSON COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	$802,000	2040
COUNTY-OTHER, GAINES	N	GAINES COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT PHASE 1	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	$2,128,000	2020
COUNTY-OTHER, GAINES	N	GAINES COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT PHASE 2	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	$2,995,000	2040
COUNTY-OTHER, GAINES	N	GAINES COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT PHASE 3	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	$2,128,000	2060
COUNTY-OTHER, GARZA	N	GARZA COUNTY - INFRASTRUCTURE TO SERVE AREAS SURROUNDING LAKE ALAN HENRY	CONVEYANCE/TRANSMISSION PIPELINE; NEW SURFACE WATER INTAKE; NEW WATER TREATMENT PLANT; PUMP STATION; STORAGE TANK	$7,672,000	2020
COUNTY-OTHER, HOCKLEY	N	HOCKLEY COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	$643,000	2020
COUNTY-OTHER, LYNN	N	LYNN COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	$598,000	2020
COUNTY-OTHER, PARMER	N	PARMER COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	$621,000	2060
DENVER CITY	N	YOAKUM COUNTY - DENVER CITY LOCAL GROUNDWATER DEVELOPMENT	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	$2,995,000	2020
DIMMITT	N	CASTRO COUNTY - DIMMITT LOCAL GROUNDWATER DEVELOPMENT	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	$1,297,000	2040
FARWELL	N	PARMER COUNTY - FARWELL DIRECT POTABLE REUSE	CONVEYANCE/TRANSMISSION PIPELINE; INJECTION WELL; NEW WATER TREATMENT PLANT; PUMP STATION; STORAGE TANK	$5,196,000	2020
FARWELL	N	PARMER COUNTY - FARWELL LOCAL GROUNDWATER DEVELOPMENT	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	$815,000	2050
FRIONA	N	PARMER COUNTY - FRIONA LOCAL GROUNDWATER DEVELOPMENT	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	$555,000	2050
HART	N	CASTRO COUNTY - HART LOCAL GROUNDWATER DEVELOPMENT	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	$855,000	2040
IDALOU	N	LUBBOCK COUNTY - IDALOU LOCAL GROUNDWATER DEVELOPMENT	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD; STORAGE TANK	$2,534,000	2030
IRRIGATION, BAILEY	N	BAILEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	ON FARM IRRIGATION CONSERVATION	$923,150	2020
IRRIGATION, BAILEY	N	BAILEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	ON FARM IRRIGATION CONSERVATION	$1,326,000	2040
IRRIGATION, BAILEY	N	BAILEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	ON FARM IRRIGATION CONSERVATION	$1,376,175	2060
IRRIGATION, BRISCOE	N	BRISCOE COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	ON FARM IRRIGATION CONSERVATION	$833,375	2020
IRRIGATION, BRISCOE	N	BRISCOE COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	ON FARM IRRIGATION CONSERVATION	$949,650	2040
IRRIGATION, BRISCOE	N	BRISCOE COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	ON FARM IRRIGATION CONSERVATION	$1,236,975	2060
IRRIGATION, CASTRO	N	CASTRO COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	ON FARM IRRIGATION CONSERVATION	$3,126,300	2020
IRRIGATION, CASTRO	N	CASTRO COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	ON FARM IRRIGATION CONSERVATION	$4,175,200	2040
IRRIGATION, CASTRO	N	CASTRO COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	ON FARM IRRIGATION CONSERVATION	$4,239,150	2060
IRRIGATION, COCHRAN	N	COCHRAN COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	ON FARM IRRIGATION CONSERVATION	$884,150	2020

Recommended Projects Associated with Water Management Strategies

Sponsor Name	Is Sponsor a WWP?	Project Name	Project Description	Capital Cost	Online Decade
IRRIGATION, COCHRAN	N	COCHRAN COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	ON FARM IRRIGATION CONSERVATION	$1,488,350	2040
IRRIGATION, COCHRAN	N	COCHRAN COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	ON FARM IRRIGATION CONSERVATION	$1,821,225	2060
IRRIGATION, CROSBY	N	CROSBY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	ON FARM IRRIGATION CONSERVATION	$2,757,000	2020
IRRIGATION, CROSBY	N	CROSBY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	ON FARM IRRIGATION CONSERVATION	$5,089,750	2040
IRRIGATION, CROSBY	N	CROSBY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	ON FARM IRRIGATION CONSERVATION	$6,997,500	2060
IRRIGATION, DAWSON	N	DAWSON COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	ON FARM IRRIGATION CONSERVATION	$2,705,075	2020
IRRIGATION, DAWSON	N	DAWSON COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	ON FARM IRRIGATION CONSERVATION	$4,805,150	2040
IRRIGATION, DAWSON	N	DAWSON COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	ON FARM IRRIGATION CONSERVATION	$6,446,475	2060
IRRIGATION, DEAF SMITH	N	DEAF SMITH COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	ON FARM IRRIGATION CONSERVATION	$2,731,900	2020
IRRIGATION, DEAF SMITH	N	DEAF SMITH COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	ON FARM IRRIGATION CONSERVATION	$4,103,250	2040
IRRIGATION, DEAF SMITH	N	DEAF SMITH COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	ON FARM IRRIGATION CONSERVATION	$4,009,275	2060
IRRIGATION, DICKENS	N	DICKENS COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	ON FARM IRRIGATION CONSERVATION	$240,200	2020
IRRIGATION, DICKENS	N	DICKENS COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	ON FARM IRRIGATION CONSERVATION	$467,900	2040
IRRIGATION, DICKENS	N	DICKENS COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	ON FARM IRRIGATION CONSERVATION	$692,475	2060
IRRIGATION, FLOYD	N	FLOYD COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	ON FARM IRRIGATION CONSERVATION	$3,060,700	2020
IRRIGATION, FLOYD	N	FLOYD COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	ON FARM IRRIGATION CONSERVATION	$5,513,250	2040
IRRIGATION, FLOYD	N	FLOYD COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	ON FARM IRRIGATION CONSERVATION	$7,416,375	2060
IRRIGATION, GAINES	N	GAINES COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	ON FARM IRRIGATION CONSERVATION	$5,781,375	2020
IRRIGATION, GAINES	N	GAINES COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	ON FARM IRRIGATION CONSERVATION	$6,153,000	2040
IRRIGATION, GAINES	N	GAINES COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	ON FARM IRRIGATION CONSERVATION	$4,822,200	2060
IRRIGATION, GARZA	N	GARZA COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	ON FARM IRRIGATION CONSERVATION	$291,875	2020
IRRIGATION, GARZA	N	GARZA COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	ON FARM IRRIGATION CONSERVATION	$516,250	2040
IRRIGATION, GARZA	N	GARZA COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	ON FARM IRRIGATION CONSERVATION	$695,625	2060
IRRIGATION, HALE	N	HALE COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	ON FARM IRRIGATION CONSERVATION	$3,283,025	2020
IRRIGATION, HALE	N	HALE COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	ON FARM IRRIGATION CONSERVATION	$6,166,050	2040
IRRIGATION, HALE	N	HALE COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	ON FARM IRRIGATION CONSERVATION	$8,266,275	2060
IRRIGATION, HOCKLEY	N	HOCKLEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	ON FARM IRRIGATION CONSERVATION	$2,089,125	2020
IRRIGATION, HOCKLEY	N	HOCKLEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	ON FARM IRRIGATION CONSERVATION	$3,043,100	2040
IRRIGATION, HOCKLEY	N	HOCKLEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	ON FARM IRRIGATION CONSERVATION	$4,158,300	2060
IRRIGATION, LAMB	N	LAMB COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	ON FARM IRRIGATION CONSERVATION	$3,152,600	2020
IRRIGATION, LAMB	N	LAMB COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	ON FARM IRRIGATION CONSERVATION	$4,215,200	2040
IRRIGATION, LAMB	N	LAMB COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	ON FARM IRRIGATION CONSERVATION	$3,583,500	2060
IRRIGATION, LUBBOCK	N	LUBBOCK COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	ON FARM IRRIGATION CONSERVATION	$2,855,550	2020

Recommended Projects Associated with Water Management Strategies

Sponsor Name	Is Sponsor a WWP?	Project Name	Project Description	Capital Cost	Online Decade
IRRIGATION, LUBBOCK	N	LUBBOCK COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	ON FARM IRRIGATION CONSERVATION	$4,055,500	2040
IRRIGATION, LUBBOCK	N	LUBBOCK COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	ON FARM IRRIGATION CONSERVATION	$5,469,900	2060
IRRIGATION, LYNN	N	LYNN COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	ON FARM IRRIGATION CONSERVATION	$2,114,800	2020
IRRIGATION, LYNN	N	LYNN COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	ON FARM IRRIGATION CONSERVATION	$3,788,350	2040
IRRIGATION, LYNN	N	LYNN COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	ON FARM IRRIGATION CONSERVATION	$5,086,275	2060
IRRIGATION, MOTLEY	N	MOTLEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	ON FARM IRRIGATION CONSERVATION	$242,525	2020
IRRIGATION, MOTLEY	N	MOTLEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	ON FARM IRRIGATION CONSERVATION	$485,300	2040
IRRIGATION, MOTLEY	N	MOTLEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	ON FARM IRRIGATION CONSERVATION	$727,950	2060
IRRIGATION, PARMER	N	PARMER COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	ON FARM IRRIGATION CONSERVATION	$1,427,150	2020
IRRIGATION, PARMER	N	PARMER COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	ON FARM IRRIGATION CONSERVATION	$1,279,600	2040
IRRIGATION, PARMER	N	PARMER COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	ON FARM IRRIGATION CONSERVATION	$1,731,375	2060
IRRIGATION, SWISHER	N	SWISHER COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	ON FARM IRRIGATION CONSERVATION	$2,486,550	2020
IRRIGATION, SWISHER	N	SWISHER COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	ON FARM IRRIGATION CONSERVATION	$3,127,250	2040
IRRIGATION, SWISHER	N	SWISHER COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	ON FARM IRRIGATION CONSERVATION	$3,961,050	2060
IRRIGATION, TERRY	N	TERRY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	ON FARM IRRIGATION CONSERVATION	$3,600,550	2020
IRRIGATION, TERRY	N	TERRY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	ON FARM IRRIGATION CONSERVATION	$4,129,250	2040
IRRIGATION, TERRY	N	TERRY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	ON FARM IRRIGATION CONSERVATION	$2,457,825	2060
IRRIGATION, YOAKUM	N	YOAKUM COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	ON FARM IRRIGATION CONSERVATION	$1,385,675	2020
IRRIGATION, YOAKUM	N	YOAKUM COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	ON FARM IRRIGATION CONSERVATION	$1,524,050	2040
IRRIGATION, YOAKUM	N	YOAKUM COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	ON FARM IRRIGATION CONSERVATION	$1,248,525	2060
LOCKNEY	N	FLOYD COUNTY - LOCKNEY LOCAL GROUNDWATER DEVELOPMENT	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD; PUMP STATION	$2,719,000	2020
LORENZO	N	CROSBY COUNTY - LORENZO WATER LOSS REDUCTION PHASE 1	CONVEYANCE/TRANSMISSION PIPELINE; WATER LOSS CONTROL	$2,714,472	2020
LORENZO	N	CROSBY COUNTY - LORENZO WATER LOSS REDUCTION PHASE 2	CONVEYANCE/TRANSMISSION PIPELINE; WATER LOSS CONTROL	$2,714,472	2040
LUBBOCK	Y	LUBBOCK COUNTY - LUBBOCK BAILEY COUNTY WELL FIELD FUTURE CAPACITY MAINTENANCE	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	$5,898,000	2030
LUBBOCK	Y	LUBBOCK COUNTY - LUBBOCK BAILEY COUNTY WELL FIELD INITIAL CAPACITY MAINTENANCE	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	$19,620,000	2020
LUBBOCK	Y	LUBBOCK COUNTY - LUBBOCK BRACKISH WELL FIELD AT THE SOUTH WATER TREATMENT PLANT	CONVEYANCE/TRANSMISSION PIPELINE; INJECTION WELL; MULTIPLE WELLS/WELL FIELD; NEW WATER TREATMENT PLANT; PUMP STATION	$34,531,740	2020
LUBBOCK	Y	LUBBOCK COUNTY - LUBBOCK CRMWA AQUIFER STORAGE AND RECOVERY	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD; NEW WATER TREATMENT PLANT; PUMP STATION; STORAGE TANK; NEW WATER RIGHT/PERMIT	$62,345,000	2030
LUBBOCK	Y	LUBBOCK COUNTY - LUBBOCK JIM BERTRAM LAKE 7	CONVEYANCE/TRANSMISSION PIPELINE; PUMP STATION; RESERVOIR CONSTRUCTION; WATER TREATMENT PLANT EXPANSION; NEW SURFACE WATER INTAKE	$82,066,000	2020
LUBBOCK	Y	LUBBOCK COUNTY - LUBBOCK LAKE ALAN HENRY PHASE 2	PUMP STATION; WATER TREATMENT PLANT EXPANSION	$57,799,000	2020

Recommended Projects Associated with Water Management Strategies

Sponsor Name	Is Sponsor a WWP?	Project Name	Project Description	Capital Cost	Online Decade
LUBBOCK	Y	LUBBOCK COUNTY - LUBBOCK NORTH FORK SCALPING OPERATION	CONVEYANCE/TRANSMISSION PIPELINE; PUMP STATION; RESERVOIR CONSTRUCTION; WATER TREATMENT PLANT EXPANSION; DIVERSION AND CONTROL STRUCTURE; NEW SURFACE WATER INTAKE; NEW WATER RIGHT/PERMIT	$119,825,000	2020
LUBBOCK	Y	LUBBOCK COUNTY - LUBBOCK SOUTH LUBBOCK WELL FIELD	CONVEYANCE/TRANSMISSION PIPELINE; INJECTION WELL; MULTIPLE WELLS/WELL FIELD; NEW WATER TREATMENT PLANT	$53,856,000	2030
MORTON	N	COCHRAN COUNTY - MORTON WATER LOSS REDUCTION PHASE 1	CONVEYANCE/TRANSMISSION PIPELINE; WATER LOSS CONTROL	$5,880,017	2020
MORTON	N	COCHRAN COUNTY - MORTON WATER LOSS REDUCTION PHASE 2	CONVEYANCE/TRANSMISSION PIPELINE; WATER LOSS CONTROL	$5,880,017	2040
MULESHOE	N	BAILEY COUNTY - MULESHOE LOCAL GROUNDWATER DEVELOPMENT PHASE 1	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	$1,217,000	2030
MULESHOE	N	BAILEY COUNTY - MULESHOE LOCAL GROUNDWATER DEVELOPMENT PHASE 2	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	$1,217,000	2060
PLAINS	N	YOAKUM COUNTY - PLAINS LOCAL GROUNDWATER DEVELOPMENT	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD; NEW WATER TREATMENT PLANT	$4,923,000	2020
SEAGRAVES	N	GAINES COUNTY - SEAGRAVES LOCAL GROUNDWATER DEVELOPMENT	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	$617,000	2050
SEMINOLE	N	GAINES COUNTY - SEMINOLE GROUNDWATER DESALINATION	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD; NEW WATER RIGHT/PERMIT; NEW WATER TREATMENT PLANT; PUMP STATION; STORAGE TANK; INJECTION WELL	$31,572,000	2020
SEMINOLE	N	GAINES COUNTY - SEMINOLE LOCAL GROUNDWATER DEVELOPMENT	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD; NEW WATER RIGHT/PERMIT; PUMP STATION	$32,754,000	2030
SHALLOWATER	N	LUBBOCK COUNTY - SHALLOWATER LOCAL GROUNDWATER DEVELOPMENT	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD; NEW WATER TREATMENT PLANT	$3,583,000	2030
SHALLOWATER	N	LUBBOCK COUNTY - SHALLOWATER WATER LOSS REDUCTION PHASE 1	CONVEYANCE/TRANSMISSION PIPELINE; WATER LOSS CONTROL	$2,660,008	2020
SHALLOWATER	N	LUBBOCK COUNTY - SHALLOWATER WATER LOSS REDUCTION PHASE 2	CONVEYANCE/TRANSMISSION PIPELINE; WATER LOSS CONTROL	$2,660,008	2040
SILVERTON	N	BRISCOE COUNTY - SILVERTON LOCAL GROUNDWATER DEVELOPMENT	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD; PUMP STATION	$5,872,000	2020
SUNDOWN	N	HOCKLEY COUNTY - SUNDOWN LOCAL GROUNDWATER DEVELOPMENT	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	$690,000	2070
SUNDOWN	N	HOCKLEY COUNTY - SUNDOWN WATER LOSS REDUCTION PHASE 1	CONVEYANCE/TRANSMISSION PIPELINE; WATER LOSS CONTROL	$1,719,166	2020
SUNDOWN	N	HOCKLEY COUNTY - SUNDOWN WATER LOSS REDUCTION PHASE 2	CONVEYANCE/TRANSMISSION PIPELINE; WATER LOSS CONTROL	$1,719,166	2040
TULIA	N	SWISHER COUNTY - TULIA LOCAL GROUNDWATER DEVELOPMENT	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD; NEW WATER TREATMENT PLANT; STORAGE TANK	$1,733,000	2020
WHITE RIVER MWD	Y	CROSBY COUNTY - WHITE RIVER MWD LOCAL GROUNDWATER DEVELOPMENT	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	$2,513,000	2020
WOLFFORTH	N	LUBBOCK COUNTY - WOLFFORTH LOCAL GROUNDWATER DEVELOPMENT	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD; PUMP STATION; STORAGE TANK	$8,383,000	2030
WOLFFORTH	N	LUBBOCK COUNTY - WOLFFORTH POTABLE REUSE	CONVEYANCE/TRANSMISSION PIPELINE; INJECTION WELL; NEW WATER TREATMENT PLANT; PUMP STATION; STORAGE TANK	$21,822,000	2030

Region O Total Recommended Capital Cost	**$814,288,541**

***Projects with a capital cost of zero are excluded from the report list.**

Water User Group (WUG) Management Supply Factor

REGION O	WUG MANAGEMENT SUPPLY FACTOR					
	2020	2030	2040	2050	2060	2070
ABERNATHY	1.1	1.2	1.2	1.2	1.1	1.1
AMHERST	1.5	1.5	1.4	1.4	1.3	1.3
ANTON	1.6	1.6	1.6	1.6	1.5	1.5
BOVINA	1.1	1.0	1.3	1.2	1.1	1.0
BROWNFIELD	1.1	1.1	1.1	1.1	1.0	1.0
COUNTY-OTHER, BAILEY	1.0	1.0	1.1	1.1	1.0	1.0
COUNTY-OTHER, BRISCOE	1.0	1.1	1.1	1.1	1.1	1.1
COUNTY-OTHER, CASTRO	1.0	1.0	1.0	1.0	1.0	1.0
COUNTY-OTHER, COCHRAN	1.0	1.0	1.0	1.0	1.0	1.0
COUNTY-OTHER, CROSBY	1.5	1.5	1.4	1.4	1.3	1.3
COUNTY-OTHER, DAWSON	1.1	1.0	1.2	1.2	1.1	1.0
COUNTY-OTHER, DEAF SMITH	1.1	1.1	1.1	1.1	1.0	1.0
COUNTY-OTHER, DICKENS	1.9	2.0	2.0	2.0	2.0	2.0
COUNTY-OTHER, FLOYD	1.5	1.4	1.4	1.3	1.2	1.1
COUNTY-OTHER, GAINES	1.2	1.0	1.2	1.0	1.0	1.0
COUNTY-OTHER, GARZA	3.4	3.6	3.6	3.5	3.3	3.2
COUNTY-OTHER, HALE	1.0	1.0	1.0	1.1	1.0	1.0
COUNTY-OTHER, HOCKLEY	1.3	1.3	1.3	1.3	1.2	1.2
COUNTY-OTHER, LAMB	1.0	1.0	1.0	1.0	1.0	1.0
COUNTY-OTHER, LUBBOCK	1.0	1.0	1.0	1.0	1.0	1.0
COUNTY-OTHER, LYNN	1.3	1.3	1.3	1.3	1.2	1.1
COUNTY-OTHER, MOTLEY	1.1	1.1	1.1	1.1	1.1	1.1
COUNTY-OTHER, PARMER	1.0	1.0	1.0	1.0	1.0	1.0
COUNTY-OTHER, SWISHER	1.0	1.0	1.0	1.0	1.0	1.0
COUNTY-OTHER, TERRY	1.1	1.0	1.0	1.1	1.1	1.0
COUNTY-OTHER, YOAKUM	1.0	1.0	1.0	1.0	1.0	1.0
CROSBYTON	1.2	1.2	1.2	1.2	1.1	1.1
DENVER CITY	1.2	1.1	1.1	1.1	1.1	1.0
DIMMITT	1.0	1.0	1.1	1.1	1.1	1.0
EARTH	1.1	1.1	1.1	1.1	1.1	1.1
FARWELL	1.2	1.1	1.1	1.2	1.2	1.1
FLOYDADA	1.4	1.3	1.3	1.2	1.1	1.1
FRIONA	1.0	1.0	1.0	1.1	1.1	1.0
HALE CENTER	1.0	1.0	1.0	1.0	1.0	1.0
HAPPY	1.4	1.4	1.4	1.3	1.2	1.1
HART	1.1	1.0	1.5	1.4	1.4	1.3
HEREFORD	1.1	1.0	1.1	1.1	1.1	1.0
IDALOU	1.0	1.2	1.2	1.2	1.1	1.1
IRRIGATION, BAILEY	0.3	0.3	0.3	0.2	0.2	0.1
IRRIGATION, BRISCOE	0.9	0.7	0.6	0.6	0.6	0.4
IRRIGATION, CASTRO	0.3	0.3	0.3	0.2	0.2	0.1
IRRIGATION, COCHRAN	0.4	0.4	0.3	0.3	0.3	0.3
IRRIGATION, CROSBY	1.0	1.0	1.0	1.0	1.1	1.1
IRRIGATION, DAWSON	1.1	1.1	1.1	1.1	1.2	1.1
IRRIGATION, DEAF SMITH	0.6	0.5	0.5	0.4	0.4	0.3
IRRIGATION, DICKENS	1.1	1.1	1.2	1.2	1.3	1.3
IRRIGATION, FLOYD	0.9	0.9	0.9	0.9	0.9	0.9
IRRIGATION, GAINES	0.6	0.5	0.4	0.3	0.2	0.1
IRRIGATION, GARZA	1.1	1.1	1.1	1.1	1.2	1.2
IRRIGATION, HALE	0.4	0.4	0.4	0.4	0.4	0.4

Water User Group (WUG) Management Supply Factor

REGION O	WUG MANAGEMENT SUPPLY FACTOR					
	2020	2030	2040	2050	2060	2070
IRRIGATION, HOCKLEY	0.7	0.6	0.6	0.6	0.6	0.6
IRRIGATION, LAMB	0.4	0.4	0.3	0.2	0.2	0.1
IRRIGATION, LUBBOCK	0.7	0.7	0.6	0.6	0.6	0.5
IRRIGATION, LYNN	1.1	1.1	1.1	1.1	1.2	1.2
IRRIGATION, MOTLEY	1.1	1.1	1.2	1.2	1.3	1.4
IRRIGATION, PARMER	0.2	0.1	0.1	0.1	0.1	0.1
IRRIGATION, SWISHER	0.5	0.4	0.3	0.3	0.3	0.3
IRRIGATION, TERRY	1.1	1.0	0.7	0.5	0.3	0.1
IRRIGATION, YOAKUM	0.4	0.3	0.3	0.2	0.2	0.1
KRESS	2.3	2.1	1.9	1.8	1.5	1.3
LAMESA	1.0	1.2	1.3	1.5	1.4	1.3
LEVELLAND	1.2	1.4	1.4	1.4	1.3	1.3
LITTLEFIELD	1.1	1.1	1.1	1.1	1.1	1.1
LIVESTOCK, BAILEY	0.6	0.4	0.4	0.3	0.3	0.2
LIVESTOCK, BRISCOE	0.9	0.9	0.9	0.8	0.8	0.8
LIVESTOCK, CASTRO	0.6	0.5	0.4	0.3	0.3	0.3
LIVESTOCK, COCHRAN	0.3	0.3	0.2	0.6	0.6	0.4
LIVESTOCK, CROSBY	0.6	0.6	0.6	0.6	0.5	0.5
LIVESTOCK, DAWSON	1.1	1.1	1.0	1.1	1.1	1.0
LIVESTOCK, DEAF SMITH	0.6	0.7	0.9	0.8	0.7	1.0
LIVESTOCK, DICKENS	0.8	0.8	0.8	0.8	0.7	0.7
LIVESTOCK, FLOYD	1.1	1.0	1.0	1.1	1.0	1.0
LIVESTOCK, GAINES	1.0	1.0	1.0	1.0	1.0	0.5
LIVESTOCK, GARZA	0.2	0.2	0.2	0.2	0.2	0.[illegible]
LIVESTOCK, HALE	0.5	0.6	0.9	0.5	0.5	0.4
LIVESTOCK, HOCKLEY	2.0	2.0	2.0	2.0	2.1	2.1
LIVESTOCK, LAMB	0.7	0.8	0.7	0.5	0.4	0.2
LIVESTOCK, LUBBOCK	1.0	1.0	1.0	1.1	1.0	1.0
LIVESTOCK, LYNN	1.1	1.1	1.1	1.0	1.0	1.0
LIVESTOCK, MOTLEY	0.7	0.7	0.6	0.6	0.6	0.6
LIVESTOCK, PARMER	0.9	0.8	0.8	0.7	0.7	0.7
LIVESTOCK, SWISHER	1.0	1.0	1.0	1.0	1.0	1.0
LIVESTOCK, TERRY	1.2	1.0	1.0	0.5	0.3	0.0
LIVESTOCK, YOAKUM	0.0	0.0	0.0	0.0	0.0	0.0
LOCKNEY	1.8	1.7	1.7	1.7	1.6	1.6
LORENZO	1.3	1.3	1.3	1.2	1.2	1.1
LUBBOCK	1.7	2.0	2.0	1.8	1.7	1.5
MANUFACTURING, BAILEY	0.4	0.4	0.3	0.3	0.2	0.2
MANUFACTURING, CASTRO	1.0	1.0	0.9	0.9	0.9	0.8
MANUFACTURING, CROSBY	2.0	2.0	2.0	2.0	2.0	2.0
MANUFACTURING, DAWSON	1.0	1.0	1.0	1.0	1.0	1.0
MANUFACTURING, DEAF SMITH	0.4	0.3	0.5	0.5	0.2	0.4
MANUFACTURING, GAINES	0.9	0.7	0.6	0.5	0.4	0.2
MANUFACTURING, GARZA	1.0	1.0	1.0	1.0	1.0	1.0
MANUFACTURING, HALE	0.6	0.9	1.0	1.0	1.0	1.0
MANUFACTURING, HOCKLEY	1.0	1.0	1.0	1.0	1.0	1.0
MANUFACTURING, LAMB	0.5	0.7	0.8	0.8	0.8	0.8
MANUFACTURING, LUBBOCK	0.9	1.0	1.0	1.0	1.0	1.0
MANUFACTURING, MOTLEY	1.0	1.0	1.0	1.0	1.0	1.[illegible]
MANUFACTURING, PARMER	0.7	0.7	0.6	0.6	0.6	0.5

Water User Group (WUG) Management Supply Factor

REGION O	WUG MANAGEMENT SUPPLY FACTOR					
	2020	2030	2040	2050	2060	2070
MANUFACTURING, TERRY	1.0	1.0	1.0	0.5	0.5	0.0
MATADOR	1.1	1.1	1.1	1.1	1.1	1.1
MEADOW	1.0	1.0	1.0	1.0	1.0	1.0
MINING, COCHRAN	1.0	1.0	1.0	1.0	1.0	1.0
MINING, CROSBY	0.7	0.6	0.6	0.6	0.6	0.6
MINING, DAWSON	0.8	0.4	0.2	0.0	0.0	0.0
MINING, DICKENS	1.0	1.0	1.0	1.0	1.0	1.0
MINING, FLOYD	1.0	1.0	1.0	1.0	1.0	1.0
MINING, GAINES	0.9	0.7	0.6	0.5	0.5	0.4
MINING, GARZA	1.0	1.0	1.0	1.0	1.0	1.0
MINING, HALE	0.0	0.0	0.0	0.0	0.0	0.0
MINING, HOCKLEY	94.8	61.3	29.4	1.5	0.0	0.0
MINING, LAMB	0.0	0.0	0.0	0.0	0.0	0.0
MINING, LUBBOCK	0.0	0.0	0.0	0.0	0.0	0.0
MINING, LYNN	0.4	0.4	0.4	0.5	0.6	0.7
MINING, MOTLEY	0.4	0.5	0.5	0.5	0.6	0.6
MINING, TERRY	1.0	1.0	1.0	0.0	0.0	0.0
MINING, YOAKUM	0.7	0.2	0.1	0.0	0.0	0.0
MORTON	1.1	1.1	1.3	1.3	1.3	1.3
MULESHOE	1.0	1.0	1.0	1.0	1.0	1.0
NEW DEAL	1.7	1.6	1.5	1.4	1.3	1.2
O'DONNELL	1.7	1.3	1.3	1.3	1.2	1.2
OLTON	1.1	1.1	1.2	1.2	1.2	1.2
PETERSBURG	1.0	1.0	1.0	1.0	1.1	1.0
PLAINS	1.8	1.5	1.3	1.1	1.0	1.0
PLAINVIEW	1.4	1.6	1.7	1.7	1.7	1.6
POST	1.4	1.4	1.4	1.3	1.3	1.3
RALLS	1.1	1.1	1.1	1.1	1.1	1.1
RANSOM CANYON	1.7	1.6	1.6	1.5	1.4	1.3
SEAGRAVES	1.1	1.0	1.0	1.1	1.1	1.0
SEMINOLE	1.0	1.2	1.1	1.0	1.0	1.0
SHALLOWATER	1.1	1.9	1.8	1.7	1.6	1.5
SILVERTON	1.6	1.6	1.6	1.6	1.6	1.6
SLATON	1.0	1.7	1.6	1.5	1.5	1.5
SPUR	1.1	1.1	1.1	1.0	1.0	1.0
STEAM ELECTRIC POWER, HALE	0.4	0.7	1.0	1.0	1.0	1.0
STEAM ELECTRIC POWER, LAMB	0.6	0.8	1.0	1.0	1.0	0.9
STEAM ELECTRIC POWER, LUBBOCK	3.5	3.0	2.5	2.1	1.4	0.9
STEAM ELECTRIC POWER, YOAKUM	0.6	0.5	0.4	0.3	0.2	0.1
SUDAN	1.2	1.2	1.1	1.1	1.1	1.0
SUNDOWN	1.1	1.0	1.0	1.0	1.0	1.2
TAHOKA	1.2	1.5	1.5	1.5	1.4	1.4
TULIA	1.1	1.1	1.1	1.1	1.0	1.0
WOLFFORTH	1.0	2.3	1.9	1.7	1.5	1.3

*WUG supplies and projected demands are entered for each of a WUG's region-county-basin divisions. To calculate the Management Supply Factor for each WUG as a whole, not split by region-county-basin the combined total of existing and future supply is divided by the total projected demand.

Appendix 5B

County Summaries

Bailey County

Location: On the Texas-New Mexico border

Area: 827 square miles

River Basin: Brazos

Major reservoirs: None

Underlying aquifers: Ogallala
Dockum (total dissolved solids greater than 10,000 milligrams per liter)
Edwards-Trinity (High-Plains) (southern part of county)

Groundwater district: High Plains Underground Water Conservation District No. 1.

Ecoregion: High Plains

Projected population: 8,012 in 2020, increasing by 60 percent to 12,790 in 2070

Major population center: Muleshoe

Table 1. Summary of Water Needs

Water User Group	Current Water Sources [a]	Decade Shortage Occurs	2070 Surplus/Need [b] (ac-ft/yr)
Municipal			
County-other	Ogallala Aquifer	2040	–146
Muleshoe	Ogallala Aquifer	2020	–587
Irrigation	Ogallala Aquifer Direct reuse	2020	–93,037
Livestock	Ogallala Aquifer Brazos livestock local supply	2020	–2,451
Manufacturing	Ogallala Aquifer	2020	–324
Mining	NA		
Steam-electric power	NA		

[a] Source located within county unless otherwise noted.
[b] Positive numbers represent a surplus, negative, a need.

ac-ft/yr = Acre-feet per year
NA = Not applicable (no use for this water user group in the county)

Table 2. Unallocated Water Availability

Water Source	River Basin	Projected Water Availability (ac-ft/yr) 2020	2030	2040	2050	2060	2070
Brazos livestock local supply	Brazos	0	0	0	0	0	0
Direct reuse	Brazos	0	0	0	0	0	0
Dockum Aquifer	Brazos	1	1	1	1	1	1
Edwards Trinity (High Plains) Aquifer	Brazos	279	279	279	279	279	279
Ogallala Aquifer	Brazos	0	300	300	300	500	500
County Total		280	580	580	580	780	780

ac-ft/yr = Acre-feet per year

Table 3. Recommended Water Management Strategies

Water User Group	Water Management Strategy	Water Management Strategy Water Supply (ac-ft/yr) 2020	2030	2040	2050	2060	2070
Municipal							
County-other	Local groundwater development	0	0	150	150	150	150
Muleshoe	Municipal water conservation	59	64	70	76	83	89
Muleshoe	Local groundwater development	0	300	300	300	500	500
Irrigation	Irrigation water conservation	1,846	1,846	2,652	2,652	2,752	2,752

ac-ft/yr = Acre-feet per year

Briscoe County

Location: Northeastern part of Region O

Area: 900 square miles

River Basin: Red

Major Reservoirs: Lake Mackenzie

Underlying aquifers: Ogallala (western part of county)
Dockum (western part of county)
Seymour (southeast corner of county)

Groundwater district: None

Ecoregion: High Plains (western portion of county)
Rolling Plains (eastern portion of county)

Projected population: 1,673 in 2020, remaining constant until 2070

Major population center: Silverton

Table 1. Summary of Water Needs

Water User Group	Current Water Sources [a]	Decade Shortage Occurs	2070 Surplus/Need [b] (ac-ft/yr)
Municipal			
County-Other	Other aquifer	2020 [c]	7
Silverton	Ogallala Aquifer Lake Mackenzie	2020	–48
Irrigation	Ogallala Aquifer Dockum Aquifer Seymour Aquifer Other aquifer	2020	–20,059
Livestock	Ogallala Aquifer Dockum Aquifer Other aquifer Red livestock local supply	2020	–75
Manufacturing	NA		
Mining	NA		
Steam-electric power	NA		

[a] Source located within county unless otherwise noted.
[b] Positive numbers represent a surplus, negative, a need.
[c] Need in 2020, surplus in all other decades

ac-ft/yr = Acre-feet per year
NA = Not applicable (no use for this water user group in the county)

Table 2. Unallocated Water Availability

Water Source	River Basin	Projected Water Availability (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Dockum Aquifer	Red	94	94	94	94	94	94
Ogallala Aquifer	Red	754	619	617	934	830	751
Other aquifer	Red	0	0	0	0	0	0
Red livestock local supply	Red	0	0	0	0	0	0
Red Run-of-River	Red	80	80	80	80	80	80
Seymour Aquifer	Red	0	0	0	0	0	0
	County Total	928	793	791	1,108	1,004	925

ac-ft/yr = Acre-feet per year

Table 3. Recommended Water Management Strategies

Water User Group	Water Management Strategy	Water Management Strategy Water Supply (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Municipal							
County-other	Municipal water conservation	15	15	14	14	14	14
Silverton	Municipal water conservation	6	6	2	2	2	2
Silverton	Local groundwater development	121	121	121	121	121	121
Irrigation	Irrigation water conservation	1,667	1,667	1,899	1,899	2,474	2,474

ac-ft/yr = Acre-feet per year

Castro County

Location:	North-central part of Region O
Area:	894 square miles
River Basin:	Red (northern portion of county) Brazos (southern portion of county)
Major reservoirs:	None
Underlying aquifers:	Ogallala Dockum (except for northeastern corner of county has total dissolved solids predominately greater than 10,000 milligrams per liter)
Groundwater district:	High Plains Underground Water Conservation District No. 1 (except for small area along northern county border)
Ecoregion:	High Plains
Projected population:	8,890 in 2020, increasing by 28 percent to 11,407 in 2070
Major population centers:	Dimmitt, Hart

Table 1. Summary of Water Needs

Water User Group	Current Water Sources [a]	Decade Shortage Occurs	2070 Surplus/Need [b] (ac-ft/yr)
Municipal			
County-Other	Ogallala Aquifer	—	24
Dimmitt	Ogallala Aquifer	2020	–329
Hart	Ogallala Aquifer	2040	–25
Irrigation	Ogallala Aquifer Direct reuse	2020	–286,510
Livestock	Ogallala Aquifer Brazos livestock local supply Red livestock local supply	2020	–5,606
Manufacturing	Ogallala Aquifer	2020	–260
Mining	NA		
Steam-electric power	NA		

[a] Source located within county unless otherwise noted.
[b] Positive numbers represent a surplus, negative, a need.

ac-ft/yr = Acre-feet per year
NA = Not applicable (no use for this water user group in the county)

Table 2. Unallocated Water Availability

Water Source	River Basin	Projected Water Availability (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Brazos livestock local supply	Brazos	0	0	0	0	0	0
Direct reuse	Brazos	0	0	0	0	0	0
Dockum Aquifer	Brazos	0	0	0	0	0	0
	Red	1	1	1	1	1	1
Ogallala Aquifer	Brazos	0	0	31,422	45,066	47,533	57,353
	Red	0	0	9,457	10,866	12,650	22,715
Red livestock local supply	Red	0	0	0	0	0	0
	County Total	1	1	40,880	55,933	60,184	80,069

ac-ft/yr = Acre-feet per year

Table 3. Recommended Water Management Strategies

Water User Group	Water Management Strategy	Water Management Strategy Water Supply (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Municipal							
Dimmitt	Municipal water conservation	55	58	60	63	65	67
Dimmitt	Local groundwater development	0	0	300	300	300	300
Hart	Local groundwater development	0	0	100	100	100	100
Irrigation	Irrigation water conservation	6,253	6,253	8,350	8,350	8,478	8,478

ac-ft/yr = Acre-feet per year

Cochran County

Location: On the Texas-New Mexico border

Area: 775 square miles

River Basin: Brazos (northern portion of county)
Colorado (southern portion of county)

Major reservoirs: None

Underlying aquifers: Ogallala
Dockum (total dissolved solids greater than 10,000 milligrams per liter)
Edwards-Trinity (High-Plains)

Groundwater district: High Plains Underground Water Conservation District No. 1

Ecoregion: High Plains

Projected population: 3,491 in 2020, increasing by 9 percent to 3,807 in 2070

Major population center: Morton

Table 1. Summary of Water Needs

Water User Group	Current Water Sources [a]	Decade Shortage Occurs	2070 Surplus/Need [b] (ac-ft/yr)
Municipal			
County-Other	Ogallala Aquifer	2020	–23
Morton	Ogallala Aquifer	2020	–119
Irrigation	Ogallala Aquifer Direct reuse	2020	–62,521
Livestock	Ogallala Aquifer Brazos livestock local supply Colorado livestock local supply	2020	–442
Manufacturing	NA		
Mining	Ogallala Aquifer	2020	–4
Steam-electric power	NA		

[a] Source located within county unless otherwise noted.
[b] Positive numbers represent a surplus, negative, a need.

ac-ft/yr = Acre-feet per year
NA = Not applicable (no use for this water user group in the county)

Table 2. Unallocated Water Availability

Water Source	River Basin	Projected Water Availability (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Brazos livestock local supply	Brazos	0	0	0	0	0	0
Colorado livestock local supply	Colorado	0	0	0	0	0	0
Direct reuse	Brazos	0	0	0	0	0	0
	Colorado	0	0	0	0	0	0
Dockum Aquifer	Brazos	0	0	0	0	0	0
	Colorado	0	0	0	0	0	0
Edwards-Trinity (High Plains) Aquifer	Brazos	137	137	137	137	137	137
	Colorado	127	127	127	127	127	127
Ogallala Aquifer	Brazos	0	0	0	0	0	0
	Colorado	0	0	0	0	0	0
	County Total	264	264	264	264	264	264

ac-ft/yr = Acre-feet per year

Table 3. Recommended Water Management Strategies

Water User Group	Water Management Strategy	Water Management Strategy Water Supply (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Municipal							
County-other	Municipal water conservation	25	27	28	28	29	29
Morton	Municipal water conservation	24	24	23	23	23	23
Morton	Water loss reduction	141	141	232	226	231	233
Irrigation	Irrigation water conservation	1,768	1,768	2,977	2,977	3,642	3,642

ac-ft/yr = Acre-feet per year

Crosby County

Location:	East-central portion of Region O
Area:	900 square miles
River Basin:	Brazos Red (northeast corner of county)
Major reservoirs:	White River Lake (southeast corner of county)
Underlying aquifers:	Ogallala (majority of county except for southeastern portion) Dockum (western edge has total dissolved solids predominantly greater than 10,000 milligrams per liter)
Groundwater district:	High Plains Underground Water Conservation District No. 1 (majority of county except for southern portion)
Ecoregion:	High Plains (northwest portion of county) Rolling Plains (south and east portions of county)
Projected population:	6,526 in 2020, increasing by 34 percent to 8,715 in 2070
Major population centers:	Crosbyton, Lorenzo, Ralls

Table 1. Summary of Water Needs

Water User Group	Current Water Sources [a]	Decade Shortage Occurs	2070 Surplus/Need [b] (ac-ft/yr)
Municipal			
County-Other	Dockum Aquifer Ogallala Aquifer Other aquifer	—	56
Crosbyton	Ogallala Aquifer White River Lake	—	50
Lorenzo	Ogallala Aquifer	2050	–40
Ralls	Ogallala Aquifer White River Lake	—	25
Irrigation	Dockum Aquifer Ogallala Aquifer Other aquifer Direct reuse	2020	–6,064

[a] Source located within county unless otherwise noted.
[b] Positive numbers represent a surplus, negative, a need.

ac-ft/yr = Acre-feet per year
— = Surplus projected for all decades

Table 1. Summary of Water Needs (continued)

Water User Group	Current Water Sources [a]	Decade Shortage Occurs	2070 Surplus/Need [b] (ac-ft/yr)
Livestock	Brazos livestock local supply Dockum Aquifer Ogallala Aquifer Other aquifer Red livestock local supply	2020	–139
Manufacturing	Ogallala Aquifer	—	3
Mining	Ogallala Aquifer	2020	–210
Steam-electric power	NA		

[a] Source located within county unless otherwise noted.
[b] Positive numbers represent a surplus, negative, a need.

ac-ft/yr = Acre-feet per year
— = Surplus projected for all decades
NA = Not applicable (no use for this water user group in the county)

Table 2. Unallocated Water Availability

Water Source	River Basin	Projected Water Availability (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Brazos livestock local supply	Brazos	0	0	0	0	0	0
Brazos Run-of-River	Brazos	10	10	10	10	10	10
Direct reuse	Brazos	0	0	0	0	0	0
Dockum Aquifer	Brazos	1,096	1,096	1,096	1,096	1,096	1,096
	Red	48	48	48	48	48	48
Ogallala Aquifer	Brazos	31,452	34,964	39,034	43,599	47,664	51,214
	Red	0	0	0	0	0	0
Other aquifer	Brazos	250	250	250	250	250	250
Red livestock local supply	Red	0	0	0	0	0	0
County Total		32,856	36,368	40,438	45,003	49,068	52,618

ac-ft/yr = Acre-feet per year

Table 3. Recommended Water Management Strategies

Water User Group	Water Management Strategy	Water Management Strategy Water Supply (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Municipal							
Lorenzo	Municipal water conservation	12	12	13	14	15	15
Lorenzo	Water loss reduction	29	31	54	57	61	64
White River MWD	Local groundwater development	600	600	600	600	600	600
Irrigation	Irrigation water conservation	5,514	5,514	10,180	10,180	13,995	13,995

ac-ft/yr = Acre-feet per year

Dawson County

Location: Southeastern edge of Region O

Area: 900 square miles

River Basin: Colorado
Brazos (northeastern corner of county)

Major reservoirs: None

Underlying aquifers: Ogallala (most of county except for east central portion)
Dockum (total dissolved solids greater than 5,000 milligrams per liter)
Edwards-Trinity (High-Plains) (north and central areas of county)

Groundwater district: Mesa Underground Water Conservation District

Ecoregion: High Plains
Rolling Plains (significant portion along eastern county border)

Projected population: 14,807 in 2020, increasing by 19 percent to 17,575 in 2070

Major population centers: Lamesa, O'Donnell

Table 1. Summary of Water Needs

Water User Group	Current Water Sources [a]	Decade Shortage Occurs	2070 Surplus/Need [b] (ac-ft/yr)
Municipal			
County-Other	Dockum Aquifer Ogallala Aquifer	2040	–149
Lamesa	Ogallala Aquifer (Dawson and Roberts counties) Lake Meredith (Region A)	2020	–1,220
O'Donnell	Ogallala Aquifer (Roberts County) Lake Meredith (Region A)	2030	–12
Irrigation	Ogallala Aquifer Edwards-Trinity (High Plains) Aquifer	2070	–4,149
Livestock	Brazos livestock local supply Colorado livestock local supply Dockum Aquifer Ogallala Aquifer	2020	–2
Manufacturing	Ogallala Aquifer	2070	–7
Mining	Ogallala Aquifer	2020	–255
Steam-electric power	NA		

[a] Source located within county unless otherwise noted.
[b] Positive numbers represent a surplus, negative, a need.

ac-ft/yr = Acre-feet per year
NA = Not applicable (no use for this water user group in the county)

Table 2. Unallocated Water Availability

Water Source	River Basin	Projected Water Availability (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Brazos livestock local supply	Brazos	0	0	0	0	0	0
Colorado livestock local supply	Colorado	0	0	0	0	0	0
Dockum Aquifer	Colorado	16	16	16	16	16	16
Edwards-Trinity (High Plains) Aquifer	Brazos	0	0	0	0	0	0
	Colorado	0	0	0	0	0	0
Ogallala Aquifer	Brazos	4,235	4,235	4,123	3,160	234	0
	Colorado	84,518	78,649	60,903	41,050	7,394	150
County Total		88,769	82,900	65,042	44,226	7,644	166

ac-ft/yr = Acre-feet per year

Table 3. Recommended Water Management Strategies

Water User Group	Water Management Strategy	Water Management Strategy Water Supply (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Municipal							
County-other	Local groundwater development	0	0	150	150	150	150
Lamesa	Municipal water conservation	114	115	116	116	119	121
Irrigation	Irrigation water conservation	5,410	5,410	9,610	9,610	12,893	12,893

ac-ft/yr = Acre-feet per year

Deaf Smith County

Location:	Along the Texas-New Mexico border, the northernmost county in Region O
Area:	1,497 square miles (second largest in Region O)
River Basin:	Red Canadian (northwestern corner of county)
Major reservoirs:	None
Underlying aquifers:	Ogallala Dockum
Groundwater district:	High Plains Underground Water Conservation District No. 1 (except for northwestern portion and southeast corner)
Ecoregion:	High Plains Rolling Plains (small area along northern border)
Projected population:	22,151 in 2020, increasing by 83 percent to 40,531 in 2070
Major population center:	Hereford

Table 1. Summary of Water Needs

Water User Group	Current Water Sources [a]	Decade Shortage Occurs	2070 Surplus/Need [b] (ac-ft/yr)
Municipal			
County-Other	Ogallala Aquifer Dockum Aquifer	—	37
Hereford	Ogallala Aquifer Dockum Aquifer	2030 [c]	–151
Irrigation	Ogallala Aquifer Dockum Aquifer Direct reuse	2020	–128,438
Livestock	Ogallala Aquifer Dockum Aquifer Canadian livestock local supply Red livestock local supply	2020	–798
Manufacturing	Ogallala Aquifer	2020	–2,638
Mining	NA		
Steam-electric power	NA		

[a] Source located within county unless otherwise noted.
[b] Positive numbers represent a surplus, negative, a need.
[c] Needs are projected in 2030 and 2070.

ac-ft/yr = Acre-feet per year
— = Surplus projected for all decades
NA = Not applicable (no use for this water user group in the county)

Table 2. Unallocated Water Availability

Water Source	River Basin	Projected Water Availability (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Canadian livestock local supply	Canadian	0	0	0	0	0	0
Direct reuse	Red	0	0	0	0	0	0
Dockum Aquifer	Canadian	0	0	0	0	0	0
	Red	1,830	1,430	1,130	0	0	0
Ogallala Aquifer	Canadian	73	0	0	0	0	0
	Red	0	0	0	0	0	0
Red livestock local supply	Red	0	0	0	0	0	0
	County Total	1,903	1,430	1,130	0	0	0

ac-ft/yr = Acre-feet per year

Table 3. Recommended Water Management Strategies

Water User Group	Water Management Strategy	Water Management Strategy Water Supply (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Municipal							
Hereford	Municipal water conservation	198	223	251	286	315	346
Irrigation	Irrigation water conservation	5,464	5,464	8,207	8,207	8,019	8,019

ac-ft/yr = Acre-feet per year

Dickens County

Location:	Eastern border of Region O
Area:	902 square miles
River Basin:	Red (northeast portion of county) Brazos (southwest portion of county)
Major reservoirs:	None
Underlying aquifers:	Ogallala (northwestern corner of county) Dockum (slightly larger area of northwestern corner of county)
Groundwater district:	None
Ecoregion:	Rolling Plains High Plains (small northwestern portion of county)
Projected population:	2,164 in 2020, remaining constant to 2070
Major population center:	Spur

Table 1. Summary of Water Needs

Water User Group	Current Water Sources [a]	Decade Shortage Occurs	2070 Surplus/Need [b] (ac-ft/yr)
Municipal			
County-Other	Ogallala Aquifer Other aquifer	—	135
Spur	Ogallala Aquifer (Crosby County) White River Lake (Crosby County)	—	0
Irrigation	Ogallala Aquifer Other aquifer	—	1,173
Livestock	Brazos livestock local supply Ogallala Aquifer Dockum Aquifer Other aquifer Red livestock local supply	2020	–117
Manufacturing	NA		
Mining	Ogallala Aquifer	—	0
Steam-electric power	NA		

[a] Source located within county unless otherwise noted.
[b] Positive numbers represent a surplus, negative, a need.

ac-ft/yr = Acre-feet per year
— = Surplus projected for all decades
NA = Not applicable (no use for this water user group in the county)

Table 2. Unallocated Water Availability

Water Source	River Basin	Projected Water Availability (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Brazos livestock local supply	Brazos	0	0	0	0	0	0
Brazos Run-of-River	Brazos	130	130	130	130	130	130
Dockum Aquifer	Brazos	2,091	2,091	2,091	2,091	2,091	2,091
	Red	1,559	1,559	1,559	1,559	1,559	1,559
Ogallala Aquifer	Brazos	5,052	5,077	5,102	5,102	5,127	5,127
	Red	5,042	5,145	5,031	5,034	4,610	4,505
Other aquifer	Brazos	0	0	0	0	0	0
	Red	0	0	0	0	0	0
Red livestock local supply	Red	0	0	0	0	0	0
County Total		13,874	14,002	13,913	13,916	13,517	13,412

ac-ft/yr = Acre-feet per year

Table 3. Recommended Water Management Strategies

Water User Group	Water Management Strategy	Water Management Strategy Water Supply (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Municipal							
Spur	Municipal water conservation	9	9	9	8	8	8
Irrigation	Irrigation water conservation	480	480	936	936	1,385	1,385

ac-ft/yr = Acre-feet per year

Floyd County

Location: East-central portion of Region O

Area: 992 square miles

River Basin: Red (northeast portion of county)
Brazos (southwest portion of county)

Major reservoirs: None

Underlying aquifers: Ogallala (all of county except northeast corner)
Dockum (most of county, southwest corner has total dissolved solids greater than 5,000 milligrams per liter, absent from northeast corner)
Edwards-Trinity (High-Plains) Aquifer (central portion of county)

Groundwater district: High Plains Underground Water Conservation District No. 1 (all of county except northeastern corner)

Ecoregion: High Plains
Rolling Plains (northeastern portion of county)

Projected population: 6,869 in 2020, increasing by 20 percent to 8,270 in 2070

Major population centers: Floydada, Lockney

Table 1. Summary of Water Needs

Water User Group	Current Water Sources [a]	Decade Shortage Occurs	2070 Surplus/Need [b] (ac-ft/yr)
Municipal			
County-Other	Ogallala Aquifer	—	29
Floydada	Ogallala Aquifer Lake Mackenzie (Briscoe County)	—	7
Lockney	Ogallala Aquifer Lake Mackenzie (Briscoe County)	2020	–67
Irrigation	Ogallala Aquifer Dockum Aquifer Direct reuse Other aquifer	2020	–29,390
Livestock	Dockum Aquifer Ogallala Aquifer Other aquifer Brazos livestock local supply Red livestock local supply	2050	–23

[a] Source located within county unless otherwise noted.
[b] Positive numbers represent a surplus, negative, a need.
ac-ft/yr = Acre-feet per year
— = Surplus projected for all decades

Table 1. Summary of Water Needs (continued)

Water User Group	Current Water Sources [a]	Decade Shortage Occurs	2070 Surplus/Need [b] (ac-ft/yr)
Manufacturing	NA		
Mining	Ogallala Aquifer	—	0
Steam-electric power	NA		

[a] Source located within county unless otherwise noted.
[b] Positive numbers represent a surplus, negative, a need.

ac-ft/yr = Acre-feet per year
— = Surplus projected for all decades
NA = Not applicable (no use for this water user group in the county)

Table 2. Unallocated Water Availability

Water Source	River Basin	Projected Water Availability (ac-ft/yr) 2020	2030	2040	2050	2060	2070
Brazos livestock local supply	Brazos	0	0	0	0	0	0
Direct reuse	Brazos	0	0	0	0	0	0
Dockum Aquifer	Brazos	745	745	745	745	745	745
	Red	0	0	0	0	0	0
Edwards-Trinity (High Plains) Aquifer	Brazos	521	521	518	505	499	491
	Red	695	695	695	695	683	671
Ogallala Aquifer	Brazos	37,856	38,151	39,002	36,517	36,403	36,214
	Red	0	0	0	0	0	0
Other aquifer	Red	0	0	0	0	0	0
Red livestock local supply	Red	0	0	0	0	0	0
Red Run-of-River	Red	10	10	10	10	10	10
County Total		39,827	40,122	40,970	38,472	38,340	38,131

ac-ft/yr = Acre-feet per year

Table 3. Recommended Water Management Strategies

Water User Group	Water Management Strategy	Water Management Strategy Water Supply (ac-ft/yr) 2020	2030	2040	2050	2060	2070
Municipal							
Floydada	Municipal water conservation	29	30	30	31	32	33
Lockney	Local groundwater development	240	240	240	240	240	240
Irrigation	Irrigation water conservation	6,121	6,121	11,027	11,027	14,833	14,833

ac-ft/yr = Acre-feet per year

Gaines County

Location:	On the Texas-New Mexico border, in the southwestern corner of Region O
Area:	1,502 square miles (largest in Region O)
River Basin:	Colorado
Major reservoirs:	None
Underlying aquifers:	Ogallala Dockum (majority of county, northern border and northeastern corner have total dissolved solids greater than 5,000 milligrams per liter) Edwards-Trinity (High Plains) (northern and central portions)
Groundwater district:	Llano Estacado Underground Water Conservation District
Ecoregion:	High Plains
Projected population:	21,316 in 2020, increasing by 120 percent to 46,886 in 2070
Major population centers:	Seagraves, Seminole

Table 1. Summary of Water Needs

Water User Group	Current Water Sources [a]	Decade Shortage Occurs	2070 Surplus/Need [b] (ac-ft/yr)
Municipal			
County-Other	Ogallala Aquifer	2020	–1,613
Seagraves	Ogallala Aquifer	2060	–32
Seminole	Ogallala Aquifer	2020	–1,675
Irrigation	Ogallala Aquifer	2020	–266,837
Livestock	Ogallala Aquifer Colorado livestock local supply	2070	–146
Manufacturing	Ogallala Aquifer	2020	–2,380
Mining	Ogallala Aquifer	2020	–463
Steam-electric power	NA		

[a] Source located within county unless otherwise noted.
[b] Positive numbers represent a surplus, negative, a need.

ac-ft/yr = Acre-feet per year
NA = Not applicable (no use for this water user group in the county)

Table 2. Unallocated Water Availability

Water Source	River Basin	Projected Water Availability (ac-ft/yr) 2020	2030	2040	2050	2060	2070
Colorado livestock local supply	Colorado	0	0	0	0	0	0
Dockum Aquifer	Colorado	0	0	0	0	0	0
Edwards-Trinity (High Plains) Aquifer	Colorado	46,202	30,316	22,997	16,523	12,904	1,672
Ogallala Aquifer	Colorado	0	0	0	0	0	0
County Total		46,202	30,316	22,997	16,523	12,904	1,672

ac-ft/yr = Acre-feet per year

Table 3. Recommended Water Management Strategies

Water User Group	Water Management Strategy	Water Management Strategy Water Supply (ac-ft/yr) 2020	2030	2040	2050	2060	2070
Municipal							
County-other	Local groundwater development	600	600	1,500	1,500	2,000	1,622
Seagraves	Local groundwater development	0	0	0	50	50	50
	Municipal water conservation	20	9	0	0	0	0
Seminole	Groundwater desalination	500	500	500	500	500	500
	Local groundwater development	0	1,000	1,000	1,000	1,000	1,000
	Municipal water conservation	117	129	142	158	171	184
Irrigation	Irrigation water conservation	11,563	11,563	12,306	12,306	9,644	9,644

ac-ft/yr = Acre-feet per year

Garza County

Location:	Southeastern portion of Region O
Area:	893 square miles
River Basin:	Brazos Colorado (small part along southwest border)
Major reservoirs:	Lake Alan Henry (most of the lake, rest is in Kent County in Region G)
Streams:	North Fork of the Double Mountain Fork of the Brazos River (running diagonally, northwest to southeast, across county) South Fork of the Double Mountain Fork of the Brazos River (southern portion of county)
Underlying aquifers:	Ogallala (western portion) Dockum (western half of county has total dissolved solids predominantly greater than 10,000 milligrams per liter) Edwards-Trinity (High Plains) (western portion)
Groundwater district:	Garza County Underground Water Conservation District
Ecoregion:	Rolling Plains High Plains (two small sections along the western county border)
Projected population:	7,077 in 2020, increasing by 26 percent to 8,905 in 2070
Major population center:	Post

Table 1. Summary of Water Needs

Water User Group	Current Water Sources [a]	Decade Shortage Occurs	2070 Surplus/Need [b] (ac-ft/yr)
Municipal			
County-Other	Ogallala Aquifer Dockum Aquifer Lake Alan Henry	—	21
Post	Ogallala Aquifer (Crosby and Roberts counties) White River Lake (Crosby County) Lake Meredith (Region A)	—	306
Irrigation	Ogallala Aquifer Dockum Aquifer Other aquifer	—	120

[a] Source located within county unless otherwise noted.
[b] Positive numbers represent a surplus, negative, a need.
ac-ft/yr = Acre-feet per year
— = Surplus projected for all decades

Table 1. Summary of Water Needs (continued)

Water User Group	Current Water Sources [a]	Decade Shortage Occurs	2070 Surplus/Need [b] (ac-ft/yr)
Livestock	Brazos livestock local supply Dockum Aquifer Edwards-Trinity (High Plains) Aquifer Ogallala Aquifer Other aquifer	2020	–278
Manufacturing	Ogallala Aquifer	—	0
Mining	Ogallala Aquifer	—	0
Steam-electric power	NA		

[a] Source located within county unless otherwise noted.
[b] Positive numbers represent a surplus, negative, a need.

ac-ft/yr = Acre-feet per year
— = Surplus projected for all decades
NA = Not applicable (no use for this water user group in the county)

Table 2. Unallocated Water Availability

Water Source	River Basin	Projected Water Availability (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Brazos livestock local supply	Brazos	0	0	0	0	0	0
Brazos Run-of-River	Brazos	30	30	30	30	30	30
Dockum Aquifer	Brazos	362	362	362	362	362	362
	Colorado	2	2	2	2	2	2
Edwards-Trinity (High Plains) Aquifer	Brazos	14	14	14	14	14	14
	Colorado	0	0	0	0	0	0
Ogallala Aquifer	Brazos	8,129	8,505	9,190	9,073	8,771	9,180
Other aquifer	Brazos	137	137	137	137	137	137
	County Total	8,674	9,050	9,735	9,618	9,316	9,725

ac-ft/yr = Acre-feet per year

Table 3. Recommended Water Management Strategies

Water User Group	Water Management Strategy	Water Management Strategy Water Supply (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Municipal							
County-other	South Garza Water Supply	270	270	270	270	270	270
Irrigation	Irrigation water conservation	584	584	1,033	1,033	1,391	1,391

ac-ft/yr = Acre-feet per year

Hale County

Location:	Central portion of Region O
Area:	1,005 square miles
River Basin:	Brazos Red (small area in northeast corner)
Major reservoirs:	None
Underlying aquifers:	Ogallala Dockum (total dissolved solids predominantly greater than 10,000 milligrams per liter) Edwards-Trinity (High Plains) (south-central portion)
Groundwater district:	High Plains Underground Water Conservation District No. 1
Ecoregion:	High Plains
Projected population:	38,314 in 2020, increasing by 9 percent to 41,814 in 2070
Major population center:	Abernathy, Hale Center, Petersburg, Plainview

Table 1. Summary of Water Needs

Water User Group	Current Water Sources [a]	Decade Shortage Occurs	2070 Surplus/Need [b] (ac-ft/yr)
Municipal			
County-Other	Ogallala Aquifer	—	27
Abernathy	Ogallala Aquifer	2020	–49
Hale Center	Ogallala Aquifer	—	1
Petersburg	Ogallala Aquifer	2020	–2 [c]
Plainview	Ogallala Aquifer (Hale and Roberts counties) Lake Meredith (Region A)	—	205
Irrigation	Ogallala Aquifer Other aquifer Direct reuse Edwards-Trinity (High Plains) Aquifer	2020	–205,048
Livestock	Ogallala Aquifer Brazos livestock local supply Red livestock local supply	2020	–1,805
Manufacturing	Ogallala Aquifer	2020 [d]	90

[a] Source located within county unless otherwise noted.
[b] Positive numbers represent a surplus, negative, a need.
[c] Need projected in 2020, 2030, 2040, and 2070; surplus in 2060; neither a need or surplus in 2050.
[d] Need projected in 2020 and 2030 and a surplus for all remaining decades.

ac-ft/yr = Acre-feet per year
— = Surplus projected for all decades

Table 1. Summary of Water Needs (continued)

Water User Group	Current Water Sources [a]	Decade Shortage Occurs	2070 Surplus/Need [b] (ac-ft/yr)
Mining	Ogallala Aquifer	2020	–662
Steam-electric power	Ogallala Aquifer	2020 [e]	0

[a] Source located within county unless otherwise noted.
[b] Positive numbers represent a surplus, negative, a need
[e] Need projected in 2020 and 2030 and neither a need or surplus for all remaining decades.

ac-ft/yr = Acre-feet per year
— = Surplus projected for all decades

Table 2. Unallocated Water Availability

Water Source	River Basin	Projected Water Availability (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Brazos livestock local supply	Brazos	0	0	0	0	0	0
Direct reuse	Brazos	0	0	0	0	0	0
Dockum Aquifer	Brazos	734	734	734	734	734	734
	Red	4	4	4	4	4	4
Edwards-Trinity (High Plains) Aquifer	Brazos	0	0	0	0	0	0
Ogallala Aquifer	Brazos	0	0	915	842	823	954
	Red	0	0	0	0	0	0
Other aquifer	Brazos	0	0	0	0	0	0
Red livestock local supply	Red	0	0	0	0	0	0
	County Total	738	738	1,653	1,580	1,561	1,692

ac-ft/yr = Acre-feet per year

Table 3. Recommended Water Management Strategies

Water User Group	Water Management Strategy	Water Management Strategy Water Supply (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Municipal							
Abernathy	Groundwater desalination	150	150	150	150	150	150
	Municipal water conservation	35	37	38	39	40	41
Petersburg	Municipal water conservation	16	17	17	16	17	17
Plainview	Municipal water conservation	218	222	221	217	223	225
Irrigation	Irrigation water conservation	6,566	6,566	12,332	12,332	16,533	16,533

ac-ft/yr = Acre-feet per year

Hockley County

Location:	Central portion of Region O
Area:	908 square miles
River Basin:	Brazos Colorado (southwestern portion of county)
Major reservoirs:	None
Underlying aquifers:	Ogallala Dockum (total dissolved solids greater than 10,000 milligrams per liter) Edwards-Trinity (High Plains)
Groundwater district:	High Plains Underground Water Conservation District No. 1 (except for southwest corner of county) South Plains Underground Water Conservation District (small area along south central county border)
Ecoregion:	High Plains
Projected population:	25,130 in 2020, increasing by 19 percent to 29,935 in 2070
Major population center:	Anton, Levelland, Sundown

Table 1. Summary of Water Needs

Water User Group	Current Water Sources [a]	Decade Shortage Occurs	2070 Surplus/Need [b] (ac-ft/yr)
Municipal			
County-Other	Ogallala Aquifer	—	39
Anton	Ogallala Aquifer	—	77
Levelland	Ogallala Aquifer (Hockley and Roberts counties) Lake Meredith (Region A)	2030	–1,029
Sundown	Ogallala Aquifer	2020	–82
Irrigation	Ogallala Aquifer Direct reuse	2020	–55,127
Livestock	Ogallala Aquifer Brazos livestock local supply Colorado livestock local supply	2020	–45
Manufacturing	Ogallala Aquifer	2070	–3
Mining	Ogallala Aquifer	2060	–15
Steam-electric power	NA		

[a] Source located within county unless otherwise noted.
[b] Positive numbers represent a surplus, negative, a need.

ac-ft/yr = Acre-feet per year
— = Surplus projected for all decades
NA = Not applicable (no use for this water user group in the county)

Table 2. Unallocated Water Availability

Water Source	River Basin	Projected Water Availability (ac-ft/yr) 2020	2030	2040	2050	2060	2070
Brazos livestock local supply	Brazos	0	0	0	0	0	0
Colorado livestock local supply	Colorado	0	0	0	0	0	0
Direct reuse	Brazos	0	0	0	0	0	0
	Colorado	0	0	0	0	0	0
Dockum Aquifer	Brazos	571	571	571	571	571	571
	Colorado	0	0	0	0	0	0
Edwards-Trinity (High Plains) Aquifer	Brazos	96	96	96	96	96	96
	Colorado	0	0	0	0	0	0
Ogallala Aquifer	Brazos	4,499	12,554	20,371	14,807	9,582	7,874
	Colorado	0	0	0	0	0	251
	County Total	5,166	13,221	21,038	15,474	10,249	8,792

ac-ft/yr = Acre-feet per year

Table 3. Recommended Water Management Strategies

Water User Group	Water Management Strategy	Water Management Strategy Water Supply (ac-ft/yr) 2020	2030	2040	2050	2060	2070
Municipal							
County-other	Local groundwater development	150	150	150	150	150	150
Anton	Municipal water conservation	8	8	8	8	9	9
Levelland	Municipal water conservation	116	53	0	0	0	0
Sundown	Local groundwater development	0	0	0	0	0	100
	Municipal water conservation	21	22	22	22	23	24
	Water loss reduction	27	28	48	48	50	52
Irrigation	Irrigation water conservation	4,178	4,178	6,086	6,086	8,317	8,317

ac-ft/yr = Acre-feet per year

Table 4. Alternative Water Management Strategies

Water User Group	Water Management Strategy	Water Management Strategy Water Supply (ac-ft/yr) 2020	2030	2040	2050	2060	2070
Municipal							
County-other	Smyer CRMWA lease from Levelland	30	30	30	30	30	30

ac-ft/yr = Acre-feet per year

Lamb County

Location: Central portion of Region O

Area: 1,016 square miles

River Basin: Brazos

Major reservoirs: None

Underlying aquifers: Ogallala

Dockum (total dissolved solids greater than 10,000 milligrams per liter)

Edwards-Trinity (High Plains) (southwestern corner)

Groundwater district: High Plains Underground Water Conservation District No. 1

Ecoregion: High Plains

Projected population: 14,615 in 2020, increasing by 9 percent to 15,795 in 2070

Major population centers: Amherst, Earth, Littlefield, Olton, Sudan

Table 1. Summary of Water Needs

Water User Group	Current Water Sources [a]	Decade Shortage Occurs	2070 Surplus/Need [b] (ac-ft/yr)
Municipal			
County-Other	Ogallala Aquifer	—	4
Amherst	Ogallala Aquifer	2030	–22
Earth	Ogallala Aquifer	—	13
Littlefield	Ogallala Aquifer	—	17
Olton	Ogallala Aquifer	—	62
Sudan	Ogallala Aquifer	2070	–2
Irrigation	Ogallala Aquifer Direct reuse	2020	–239,866
Livestock	Ogallala Aquifer Brazos livestock local supply	2020	–2,639
Manufacturing	Ogallala Aquifer	2020	–146
Mining	Ogallala Aquifer	2020	–333
Steam-electric power	Ogallala Aquifer	2020 [c]	–2,984

[a] Source located within county unless otherwise noted.
[b] Positive numbers represent a surplus, negative, a need.
[c] Need projected in 2020, 2030, 2070, neither a need nor a surplus in 2040, 2050, 2060.

ac-ft/yr = Acre-feet per year
— = Surplus projected for all decades

Table 2. Unallocated Water Availability

Water Source	River Basin	Projected Water Availability (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Brazos livestock local supply	Brazos	0	0	0	0	0	0
Direct reuse	Brazos	0	0	0	0	0	0
Dockum Aquifer	Brazos	0	0	0	0	0	0
Edwards-Trinity (High Plains) Aquifer	Brazos	164	164	164	164	164	164
Ogallala Aquifer	Brazos	1,047	1,493	3,172	5,632	4,024	6,596
County Total		1,211	1,657	3,336	5,796	4,188	6,760

ac-ft/yr = Acre-feet per year

Table 3. Recommended Water Management Strategies

Water User Group	Water Management Strategy	Water Management Strategy Water Supply (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Municipal							
Amherst	Local groundwater development	50	50	50	50	50	50
	Municipal water conservation	5	5	5	6	6	6
Earth	Municipal water conservation	10	10	9	9	8	8
Littlefield	Municipal water conservation	48	46	44	42	41	40
Olton	Municipal water conservation	23	23	23	22	22	22
Sudan	Municipal water conservation	12	13	14	14	15	15
Irrigation	Irrigation water conservation	6,305	6,305	8,430	8,430	7,167	7,167

ac-ft/yr = Acre-feet per year

Lubbock County

Location:	Central portion of Region O
Area:	896 square miles
River Basin:	Brazos
Streams:	Headwaters of the North Fork of the Double Mountain Fork of the Brazos River (North Fork) occur in central Lubbock County at the confluence of the Blackwater Draw and the Yellow House Draw
Major reservoirs:	None
Underlying aquifers:	Ogallala Dockum (total dissolved solids greater than 10,000 milligrams per liter) Edwards-Trinity (High Plains) (majority of county except for the eastern border)
Groundwater district:	High Plains Underground Water Conservation District No. 1
Ecoregion:	High Plains Rolling Plains (area around the North Fork)
Projected population:	309,769 in 2020, increasing by 56 percent to 484,316 in 2070
Major population centers:	Abernathy, Idalou, Lubbock, New Deal, Ransom Canyon, Shallowater, Slaton, Wolfforth City of Lubbock accounts for 47 percent of the Region O population in 2020, increasing to 50 percent in 2070.

Table 1. Summary of Water Needs

Water User Group	Current Water Sources [a]	Decade Shortage Occurs	2070 Surplus/Need [b] (ac-ft/yr)
Municipal			
County-Other	Ogallala Aquifer (Bailey, Lamb, Lubbock, Roberts counties) Lake Alan Henry (Garza County) Lake Meredith (Region A)	—	59
Abernathy	Ogallala Aquifer (Hale County)	2020	–25
Idalou	Ogallala Aquifer	2020	–86
Lubbock	Ogallala Aquifer (Bailey, Lamb, Roberts counties) Lake Alan Henry (Garza County) Lake Meredith (Region A)	2020	–43,148
New Deal	Ogallala Aquifer (Lubbock and Roberts counties) Lake Meredith (Region A)	—	35

[a] Source located within county unless otherwise noted.
[b] Positive numbers represent a surplus, negative, a need.
ac-ft/yr = Acre-feet per year
— = Surplus projected for all decades

Table 1. Summary of Water Needs (cont.)

Water User Group	Current Water Sources [a]	Decade Shortage Occurs	2070 Surplus/Need [b] (ac-ft/yr)
Municipal (cont.)			
Ransom Canyon	Ogallala Aquifer (Bailey, Lamb, Roberts counties) Lake Meredith (Region A) Lake Alan Henry (Garza County)	—	121
Shallowater	Ogallala Aquifer (Bailey and Lubbock counties)	2020	–275
Slaton	Ogallala Aquifer (Roberts County) Lake Meredith (Region A)	2020	–691
Wolfforth	Ogallala Aquifer	2020	–797
Irrigation	Ogallala Aquifer Direct reuse	2020	–73,945
Livestock	Ogallala Aquifer Brazos livestock local supply	—	29
Manufacturing	Ogallala Aquifer	2020	–143
Mining	Ogallala Aquifer	2020	–4,314
Steam-electric power	Direct reuse	2070	–945

[a] Source located within county unless otherwise noted.
[b] Positive numbers represent a surplus, negative, a need.
ac-ft/yr = Acre-feet per year
— = Surplus projected for all decades

Table 2. Unallocated Water Availability

Water Source	River Basin	Projected Water Availability (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Brazos livestock local supply	Brazos	0	0	0	0	0	0
Brazos Run-of-River	Brazos	20	20	20	20	20	20
Direct Reuse	Brazos	4,806	7,214	9,107	10,586	15,200	19,558
Dockum Aquifer	Brazos	15	15	15	15	15	15
Edwards-Trinity (High Plains) Aquifer	Brazos	690	690	690	690	690	690
Ogallala Aquifer	Brazos	0	5,994	20,392	15,188	9,555	22,485
Lake Alan Henry [a]	Brazos	12,575	12,295	11,995	11,675	11,355	10,695
	County Total	18,106	26,228	42,219	38,174	36,835	53,463

[a] Owned by the City of Lubbock, located in Garza County.
ac-ft/yr = Acre-feet per year

Table 3. Recommended Water Management Strategies

Water User Group	Water Management Strategy	Water Management Strategy Water Supply (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Municipal							
Idalou	Local groundwater development	0	100	100	100	100	100
	Municipal water conservation	21	21	22	23	23	24
Ransom Canyon	Municipal water conservation	17	18	19	20	21	22
Shallowater	Municipal water conservation	0	400	400	400	400	400
	Water loss reduction	68	74	136	150	163	177
Wolfforth	Local groundwater development	0	726	726	726	726	726
	Municipal water conservation	38	37	29	26	29	32
	Potable water reuse	0	560	560	560	560	560
Wholesale Water Provider							
Lubbock	Bailey County Well Field capacity maintenance	997	1,143	2,822	3,120	3,120	3,120
	Brackish well field at the South Water Treatment Plant	1,120	1,120	1,120	1,120	1,120	1,120
	CRMWA aquifer storage and recovery	0	6,090	6,090	6,090	6,090	6,090
	Jim Bertram Lake 7	13,800	13,800	13,800	13,800	13,800	13,800
	Lake Alan Henry Phase 2	8,000	8,000	8,000	8,000	8,000	8,000
	Municipal water conservation	2,287	2,478	2,674	2,915	3,139	3,382
	North Fork scalping operation	10,390	9,790	9,220	8,660	8,110	7,890
	South Lubbock well field	0	2,613	2,613	2,613	2,613	2,613
Irrigation	Irrigation water conservation	5,711	5,711	8,111	8,111	10,940	10,940

ac-ft/yr = Acre-feet per year

Table 4. Alternative Water Management Strategies

Water User Group	Water Management Strategy	Water Management Strategy Water Supply (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Wholesale Water Provider							
Lubbock	Direct potable reuse to South Water Treatment Plant	10,089	10,089	10,089	10,089	10,089	10,089
	Direct potable reuse to North Water Treatment Plant	10,089	10,089	10,089	10,089	10,089	10,089
	North Fork diversion at CR 7300	10,089	10,089	10,089	10,089	10,089	10,089
	South Fork discharge	8,183	8,183	8,183	8,183	8,183	8,183
	North Fork diversion to Lake Alan Henry pump station	7,510	7,510	7,510	7,510	7,510	7,510
	Reclaimed water to aquifer storage and recovery	8,071	8,071	8,071	8,071	8,071	8,071
	Post Reservoir	10,600	10,600	10,600	10,600	10,600	10,600

ac-ft/yr = Acre-feet per year

Lynn County

Location:	South-central portion of Region O
Area:	892 square miles
River Basin:	Brazos Colorado (southwestern corner of county)
Major reservoirs:	None
Underlying aquifers:	Ogallala (almost all) Dockum (total dissolved solids greater than 10,000 milligrams per liter) Edwards-Trinity (High Plains)
Groundwater district:	High Plains Underground Water Conservation District No. 1
Ecoregion:	High Plains Rolling Plains (portions along the eastern border of county)
Projected population:	6,279 in 2020, increasing by 13 percent to 7,074 in 2070
Major population centers:	O'Donnell, Tahoka

Table 1. Summary of Water Needs

Water User Group	Current Water Sources [a]	Decade Shortage Occurs	2070 Surplus/Need [b] (ac-ft/yr)
Municipal			
County-Other	Ogallala Aquifer	2030	–69
O'Donnell	Ogallala Aquifer (Roberts County) Lake Meredith (Region A)	2030	–68
Tahoka	Ogallala Aquifer (Roberts and Lynn counties) Lake Meredith (Region A)	2030	–166
Irrigation	Ogallala Aquifer Edwards-Trinity (High Plains) Aquifer Direct reuse	—	72
Livestock	Brazos livestock local supply Colorado livestock local supply Ogallala Aquifer	2020	–6
Manufacturing	NA		
Mining	Ogallala Aquifer	2020	–177
Steam-electric power	NA		

[a] Source located within county unless otherwise noted.
[b] Positive numbers represent a surplus, negative, a need.

ac-ft/yr = Acre-feet per year
— = Surplus projected for all decades
NA = Not applicable (no use for this water user group in the county)

Table 2. Unallocated Water Availability

Water Source	River Basin	Projected Water Availability (ac-ft/yr) 2020	2030	2040	2050	2060	2070
Brazos livestock local supply	Brazos	0	0	0	0	0	0
Brazos Run-of-River	Brazos	30	30	30	30	30	30
Colorado livestock local supply	Colorado	0	0	0	0	0	0
Direct reuse	Brazos	0	0	0	0	0	0
Dockum Aquifer	Brazos	5	5	5	5	5	5
	Colorado	0	0	0	0	0	0
Edwards-Trinity (High Plains) Aquifer	Brazos	0	0	0	0	0	0
	Colorado	9	9	9	9	9	9
Ogallala Aquifer	Brazos	18,573	21,996	23,652	19,812	15,028	15,930
	Colorado	38	358	663	948	1,118	1,253
County Total		18,655	22,398	24,359	20,804	16,190	17,227

ac-ft/yr = Acre-feet per year

Table 3. Recommended Water Management Strategies

Water User Group	Water Management Strategy	Water Management Strategy Water Supply (ac-ft/yr) 2020	2030	2040	2050	2060	2070
Municipal							
County-other	Local groundwater development	100	100	100	100	100	100
Tahoka	Municipal water conservation	24	20	7	3	4	4
Irrigation	Irrigation water conservation	4,230	4,230	7,577	7,577	10,173	10,173

ac-ft/yr = Acre-feet per year

Motley County

Location:	Eastern border of Region O
Area:	990 square miles
River Basin:	Red
Major reservoirs:	None
Underlying aquifers:	Ogallala (southwestern corner) Seymour (north-central) Dockum (southwestern corner)
Groundwater district:	Gateway Groundwater Conservation District
Ecoregion:	Rolling Plains High Plains (southwestern corner of county)
Projected population:	1,212 in 2020, remaining constant to 2070
Major population center:	Matador

Table 1. Summary of Water Needs

Water User Group	Current Water Sources [a]	Decade Shortage Occurs	2070 Surplus/Need [b] (ac-ft/yr)
Municipal			
County-Other	Other aquifer Seymour Aquifer	—	2
Matador	Other aquifer	—	12
Irrigation	Dockum Aquifer Ogallala Aquifer Seymour Aquifer Other aquifer	—	1,583
Livestock	Dockum Aquifer Red livestock local supply Ogallala Aquifer Other aquifer	2020	–209
Manufacturing	Ogallala Aquifer	—	0
Mining	Ogallala Aquifer	2020	–57
Steam-electric power	NA		

[a] Source located within county unless otherwise noted.
[b] Positive numbers represent a surplus, negative, a need.

ac-ft/yr = Acre-feet per year
— = Surplus projected for all decades
NA = Not applicable (no use for this water user group in the county)

Table 2. Unallocated Water Availability

Water Source	River Basin	Projected Water Availability (ac-ft/yr) 2020	2030	2040	2050	2060	2070
Dockum Aquifer	Red	1,900	1,900	1,900	1,900	1,900	1,900
Ogallala Aquifer	Red	9,556	9,556	9,556	9,556	9,196	8,836
Other aquifer	Red	0	0	0	0	0	0
Red livestock local supply	Red	0	0	0	0	0	0
Red Run-of-River	Red	10	10	10	10	10	10
Seymour Aquifer	Red	1,656	1,649	1,649	1,565	1,565	1,537
County Total		13,122	13,115	13,115	13,031	12,671	12,283

ac-ft/yr = Acre-feet per year

Table 3. Recommended Water Management Strategies

Water User Group	Water Management Strategy	Water Management Strategy Water Supply (ac-ft/yr) 2020	2030	2040	2050	2060	2070
Municipal							
County-other	Municipal water conservation	5	5	5	5	5	5
Matador	Municipal water conservation	11	10	10	10	10	10
Irrigation	Irrigation water conservation	485	485	971	971	1,456	1,456

ac-ft/yr = Acre-feet per year

Parmer County

Location:	Northern part of Region O on the Texas-New Mexico border
Area:	881 square miles
River Basin:	Brazos Red (northern portion of county)
Major reservoirs:	None
Underlying aquifers:	Ogallala Dockum (except for northwestern corner has total dissolved solids predominantly greater than 10,000 milligrams per liter)
Groundwater district:	High Plains Underground Water Conservation District No. 1
Ecoregion:	High Plains
Projected population:	11,424 in 2020, increasing by 51 percent to 17,244 in 2070
Major population centers:	Bovina, Farwell, Friona

Table 1. Summary of Water Needs

Water User Group	Current Water Sources [a]	Decade Shortage Occurs	2070 Surplus/Need [b] (ac-ft/yr)
Municipal			
County-Other	Ogallala Aquifer	2020	–92
Bovina	Ogallala Aquifer	2030	–131
Farwell	Ogallala Aquifer	2020	–173
Friona	Ogallala Aquifer	2020	–127
Irrigation	Ogallala Aquifer Direct reuse	2020	–298,285
Livestock	Ogallala Aquifer Brazos livestock local supply Red livestock local supply	2020	–2,149
Manufacturing	Ogallala Aquifer	2020	–1,413
Mining	NA		
Steam-electric power	NA		

[a] Source located within county unless otherwise noted.
[b] Positive numbers represent a surplus, negative, a need.

ac-ft/yr = Acre-feet per year
NA = Not applicable (no use for this water user group in the county)

Table 2. Unallocated Water Availability

Water Source	River Basin	Projected Water Availability (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Brazos livestock local supply	Brazos	0	0	0	0	0	0
Direct reuse	Brazos	0	0	0	0	0	0
	Red	0	0	0	0	0	0
Dockum Aquifer	Brazos	0	0	0	0	0	0
	Red	2	2	2	2	2	2
Ogallala Aquifer	Brazos	0	7,745	20,079	16,003	11,153	13,876
	Red	0	0	0	0	0	0
Red livestock local supply	Red	0	0	0	0	0	0
Red Run-of-River	Red	10	10	10	10	10	10
	County Total	12	7,757	20,091	16,015	11,165	13,888

ac-ft/yr = Acre-feet per year

Table 3. Recommended Water Management Strategies

Water User Group	Water Management Strategy	Water Management Strategy Water Supply (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Municipal							
Bovina	Local groundwater development	0	0	120	120	120	120
	Municipal water conservation	19	20	21	23	25	27
County-other	Local groundwater development	0	0	0	0	50	50
	Municipal water conservation	32	34	36	39	42	45
Farwell	Local groundwater development	0	0	0	125	125	125
	Municipal water conservation	20	21	23	25	27	29
	Potable water reuse	64	64	64	64	64	64
Friona	Local groundwater development	0	0	0	80	80	80
	Municipal water conservation	41	45	48	51	55	59
Irrigation	Irrigation water conservation	2,854	2,854	2,559	2,559	3,463	3,463

ac-ft/yr = Acre-feet per year

Swisher County

Location: North-central portion of Region O

Area: 890 square miles

River Basin: Red
Brazos (southwestern corner of county)

Major reservoirs: None

Underlying aquifers: Ogallala
Dockum (all of county except for southwestern corner has total dissolved solids greater than 5,000 milligrams per liter)

Groundwater district: High Plains Underground Water Conservation District No. 1

Ecoregion: High Plains

Projected population: 8,257 in 2020, increasing by 14 percent to 9,380 in 2070

Major population centers: Happy, Kress, Tulia

Table 1. Summary of Water Needs

Water User Group	Current Water Sources [a]	Decade Shortage Occurs	2070 Surplus/Need [b] (ac-ft/yr)
Municipal			
County-Other	Ogallala Aquifer	—	4
Happy [c]	Ogallala Aquifer Dockum Aquifer (Randall County)	—	7
Kress	Ogallala Aquifer	—	22
Tulia	Ogallala Aquifer Dockum Aquifer Lake Mackenzie (Briscoe County)	2020	–235
Irrigation	Ogallala Aquifer	2020	–153,547
Livestock	Ogallala Aquifer Brazos livestock local supply Red livestock local supply	—	5
Manufacturing	NA		
Mining	NA		
Steam-electric power	NA		

[a] Source located within county unless otherwise noted.
[b] Positive numbers represent a surplus, negative, a need.
[c] The City of Happy is split between Region O and Region A. This table shows projections for the Region O portion. The portion in Region A is projected to have a surplus of 1 ac-ft/yr in the 2070 decade.

ac-ft/yr = Acre-feet per year
— = Surplus projected for all decades
NA = Not applicable (no use for this water user group in the county)

Table 2. Unallocated Water Availability

Water Source	River Basin	Projected Water Availability (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Brazos livestock local supply	Brazos	0	0	0	0	0	0
Dockum Aquifer	Brazos	83	83	83	83	83	83
	Red	121	121	121	121	121	121
Ogallala Aquifer	Brazos	4,666	24,116	18,791	13,551	7,773	3,399
	Red	200	200	200	200	200	200
Red livestock local supply	Red	0	0	0	0	0	0
	County Total	5,070	24,520	19,195	13,955	8,177	3,803

ac-ft/yr = Acre-feet per year

Table 3. Recommended Water Management Strategies

Water User Group	Water Management Strategy	Water Management Strategy Water Supply (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Municipal							
Tulia	Local groundwater development	200	200	200	200	200	200
	Municipal water conservation	46	47	47	46	48	50
Irrigation	Irrigation water conservation	4,973	4,973	6,255	6,255	7,922	7,922

ac-ft/yr = Acre-feet per year

Table 4. Alternative Water Management Strategies

Water User Group	Water Management Strategy	Water Management Strategy Water Supply (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Municipal							
Tulia	Local groundwater development (new location)	200	200	200	200	200	200

ac-ft/yr = Acre-feet per year

Terry County

Location:	Southern portion of Region O
Area:	899 square miles
River Basin:	Colorado Brazos (small northeastern portion of county)
Major reservoirs:	None
Underlying aquifers:	Ogallala Dockum (total dissolved solids predominately greater than 10,000 milligrams per liter) Edwards-Trinity (High Plains)
Groundwater district:	South Plains Underground Water Conservation District
Ecoregion:	High Plains
Projected population:	13,599 in 2020, increasing by 29 percent to 17,535 in 2070
Major population centers:	Brownfield, Meadow

Table 1. Summary of Water Needs

Water User Group	Current Water Sources [a]	Decade Shortage Occurs	2070 Surplus/Need [b] (ac-ft/yr)
Municipal			
County-Other	Ogallala Aquifer Edwards-Trinity (High Plains) Aquifer	—	6
Brownfield	Ogallala Aquifer (Terry and Roberts counties) Lake Meredith (Region A)	2030	–1,304
Meadow	Ogallala Aquifer (Terry and Roberts counties) Lake Meredith (Region A)	—	0
Irrigation	Ogallala Aquifer	2030	–107,467
Livestock	Ogallala Aquifer Brazos livestock local supply Colorado livestock local supply	2050	–379
Manufacturing	Ogallala Aquifer	2050	–2
Mining	Ogallala Aquifer	2050	–206
Steam-electric power	NA		

[a] Source located within county unless otherwise noted.
[b] Positive numbers represent a surplus, negative, a need.

ac-ft/yr = Acre-feet per year
NA = Not applicable (no use for this water user group in the county)

Table 2. Unallocated Water Availability

Water Source	River Basin	Projected Water Availability (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Brazos livestock local supply	Brazos	0	0	0	0	0	0
Colorado livestock local supply	Colorado	0	0	0	0	0	0
Edwards-Trinity (High Plains) Aquifer	Brazos	23	23	23	23	23	23
	Colorado	929	892	892	892	892	892
Ogallala Aquifer	Brazos	5,978	5,970	2,964	0	0	0
	Colorado	44,861	0	0	0	0	0
County Total		51,791	6,885	3,879	915	915	915

ac-ft/yr = Acre-feet per year

Table 3. Recommended Water Management Strategies

Water User Group	Water Management Strategy	Water Management Strategy Water Supply (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Municipal							
Brownfield	Municipal water conservation	90	93	92	69	72	75
Irrigation	Irrigation water conservation	7,201	7,201	8,259	8,259	4,916	4,916

ac-ft/yr = Acre-feet per year

Yoakum County

Location:	Southern portion of Region O on the Texas-New Mexico border
Area:	800 square miles
River Basin:	Colorado
Major reservoirs:	None
Underlying aquifers:	Ogallala
	Dockum (total dissolved solids predominately greater than 10,000 milligrams per liter)
	Edwards-Trinity (High Plains)
Groundwater district:	Sandy Land Underground Water Conservation District
Ecoregion:	High Plains
Projected population:	8,920 in 2020, increasing by 63 percent to 14,511 in 2070
Major population centers:	Denver City, Plains

Table 1. Summary of Water Needs

Water User Group	Current Water Sources [a]	Decade Shortage Occurs	2070 Surplus/Need [b] (ac-ft/yr)
Municipal			
County-Other	Ogallala Aquifer	—	2
Denver City	Ogallala Aquifer	2020	–1,037
Plains	Ogallala Aquifer	2020	–525
Irrigation	Ogallala Aquifer	2020	–109,358
Livestock	Colorado livestock local supply	2020	–322
Manufacturing	NA		
Mining	Ogallala Aquifer	2020	–641
Steam-electric power	Ogallala Aquifer	2020	–7,864

[a] Source located within county unless otherwise noted.
[b] Positive numbers represent a surplus, negative, a need.

ac-ft/yr = Acre-feet per year
NA = Not applicable (no use for this water user group in the county)

Table 2. Unallocated Water Availability

Water Source	River Basin	Projected Water Availability (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Colorado livestock local supply	Colorado	0	0	0	0	0	0
Edwards-Trinity (High Plains) Aquifer	Colorado	1,893	1,757	1,642	1,642	1,524	1,436
Ogallala Aquifer	Colorado	0	0	0	0	0	0
County Total		1,893	1,757	1,642	1,642	1,524	1,436

ac-ft/yr = Acre-feet per year

Table 3. Recommended Water Management Strategies

Water User Group	Water Management Strategy	Water Management Strategy Water Supply (ac-ft/yr)					
		2020	2030	2040	2050	2060	2070
Municipal							
Denver City	Local groundwater development	925	925	925	925	925	925
	Municipal water conservation	71	79	86	94	103	112
Plains	Local groundwater development	500	500	500	500	500	500
	Municipal water conservation	22	24	26	28	31	34
Irrigation	Irrigation water conservation	2,771	2,771	3,048	3,048	2,497	2,497

ac-ft/yr = Acre-feet per year

Appendix 5C

RPS Memorandum

RPS

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MEMORANDUM

TO: Amy Ewing, P.G. and Andrew Donnelly

FROM: Michael Pinckney, P.E. and Tony Smith, P.E.

SUBJECT: Region O Surface Water Sources Water Management Strategies Evaluations

DATE: September 29, 2015

Espey Consultants, Inc. dba RPS (RPS) is contracted with Daniel B. Stephens & Associates, Inc. to evaluate the surface water supply strategies located within the Llano Estacado Regional Water Planning Area (Region O) for the 2016 Regional Water Plan. RPS has evaluated the recommended and alternative surface water supply strategies identified by Region O to quantify the supply made available by each strategy.

To evaluate surface Water Management Strategies (WMSs) within the Region O Planning Area, the Texas Commission on Environmental Quality's (TCEQ) Water Availability Model (WAM) Run 3 for the Brazos River Basin has been utilized as the basis for the quantification of existing and potential future firm water supply. The base Run 3 WAM assumes full utilization of permitted diversion volumes and full consumptive use of diverted water, i.e. no return flows. For consistency amongst various regional plans, the Brazos G WAM utilized by Region G (a modified WAM Run 3) for evaluation of potential water management strategies was utilized by Region O. This WAM includes certain levels of current and future return flows by entities located throughout the basin, the implementation of actual, contracted diversion locations, updated elevation-area-capacity information for reservoirs authorized for greater than 5,000 ac-ft storage capacity, and existing subordination agreements.

RPS was provided two recommended WMSs and one alternative strategy to evaluate the firm supply of each strategy, namely:

- Construction of Jim Bertram Lake 7 (Recommended Strategy);
- Scalp flows from the North Fork of the Double Mountain Fork of the Brazos River to augment yield of Lake Alan Henry (Recommended Strategy);
- Construct Post Reservoir (Alternative Strategy).

RPS evaluated a total of four scenarios to identify the potential yield of the proposed strategies:

- Jim Bertram Lake 7,
- North Fork Scalping Operation,
- Jim Bertram Lake 7 and North Fork Scalping Operation,
- Post Reservoir.

Modeling of the three surface water strategies has been performed consistent with the modeling performed in preparation of the City of Lubbock's Strategic Water Supply Plan dated February 2013. The following assumptions have been employed in the evaluation of the surface water supply strategies:

- Senate Bill 3 environmental flow standards with a priority date of March 1, 2012 are implemented;
- Return flows are incorporated into the modeling in a manner consistent with analyses from previous rounds of planning for Region O;
- The Brazos Sys-Ops permit (priority date October 15, 2004) is modeled in the evaluations of Jim Bertram Lake 7 and North Fork scalping operation strategy evaluations;
- Sedimentation of Lake Alan Henry at rate of 0.61% per year, consistent with modeling of the existing surface water supply modeling;
- Model assumptions adopted in the City of Lubbock's Strategic Water Supply Plan model representations are adopted in the present evaluation.
    - The flow distribution for the Lake Alan Henry control point is revised to utilize the Double Mountain Fork at Justiceberg USGS Gauge control point for determination of flow.
    - All inflows to Lake Alan Henry held in reservoir due to waste of releases from high channel losses.

Evaluation of Jim Bertram Lake 7 Strategy

The Jim Bertram Lake 7 WMS is a proposed 20,000 ac-ft, 774 acre reservoir located on the North fork of the Double Mountain Fork of the Brazos River. The strategy impounds return flows from the City of Lubbock, developed storm water discharges from the City of Lubbock's South and South Central Playa Lake Drainage System and available stream flow. It was assumed in the Lubbock Water Supply Plan that both the return flows from the City and the developed storm water discharges are developed water sources and therefore not subject to environmental flow restrictions. The return flows from the City of Lubbock are modeled as a uniform inflow to a dummy control point for diversion to supplement Lake 7 supplies. The storm water discharges from the playa lake drainage system are modeled as a time series inflow to a dummy control point for diversion to supplement Lake 7 supplies. Unused quantities of return flows and storm water return flows are modeled to enter the river downstream of Lake 7. The strategy is modeled at a priority date of April 14, 2006 with the modeled return flows and storm water discharges protected from senior water rights. The modeled firm yield of the project is approximately 13,800 ac-ft per year, the modeled safe yield is approximately 10,750 ac-ft per year. The strategy, as modeled, has no significant impact on existing downstream water rights. For the purpose of comparison to past evaluations, the safe yield of the lake 7 strategy was modeled to be 11,300 ac-ft per year in the Lubbock Water Supply Plan. Figure 1 portrays the modeled flow frequency of the Double Mountain Fork of the Brazos River (WAM control Point CON244), at the confluence of the North and South Forks of the Double Mountain Fork, which is downstream of all proposed Region O WMSs. As can be seen the modeled monthly regulated flow appears to increase with the implementation of the strategy due to the addition of storm water and wastewater discharges. Figure 2 presents the modeled reservoir storage time series of the proposed Lake 7 reservoir.

Figure 1: Frequency Curve of Modeled Monthly Regulated Flow in the Double Mountain Fork of the Brazos River

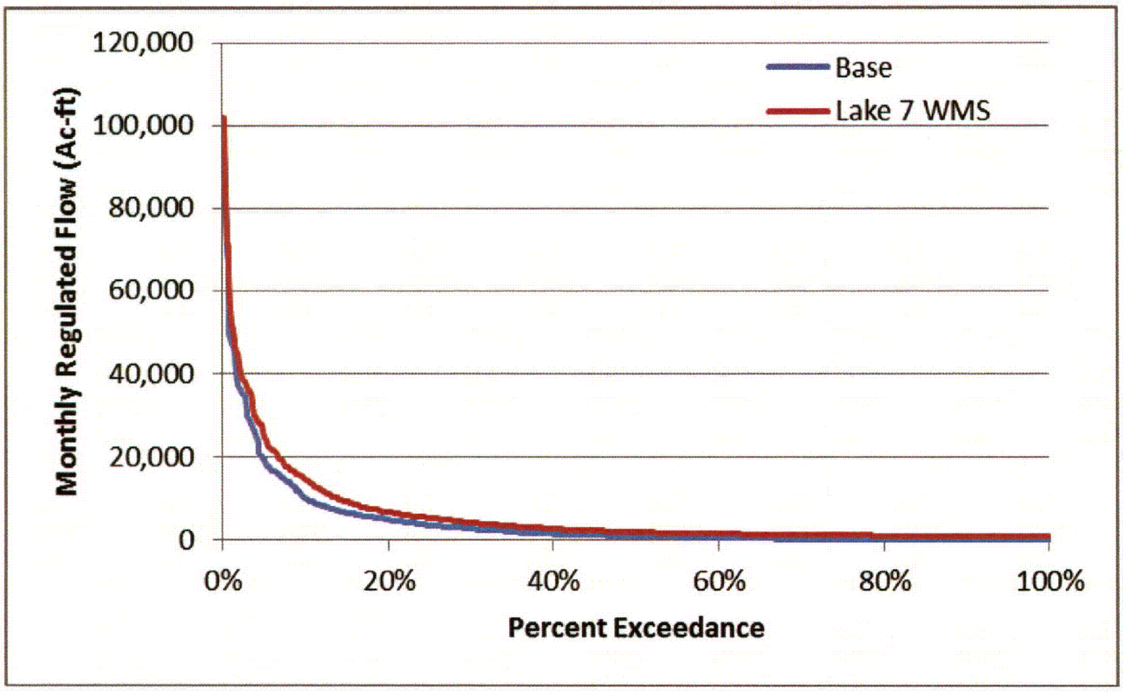
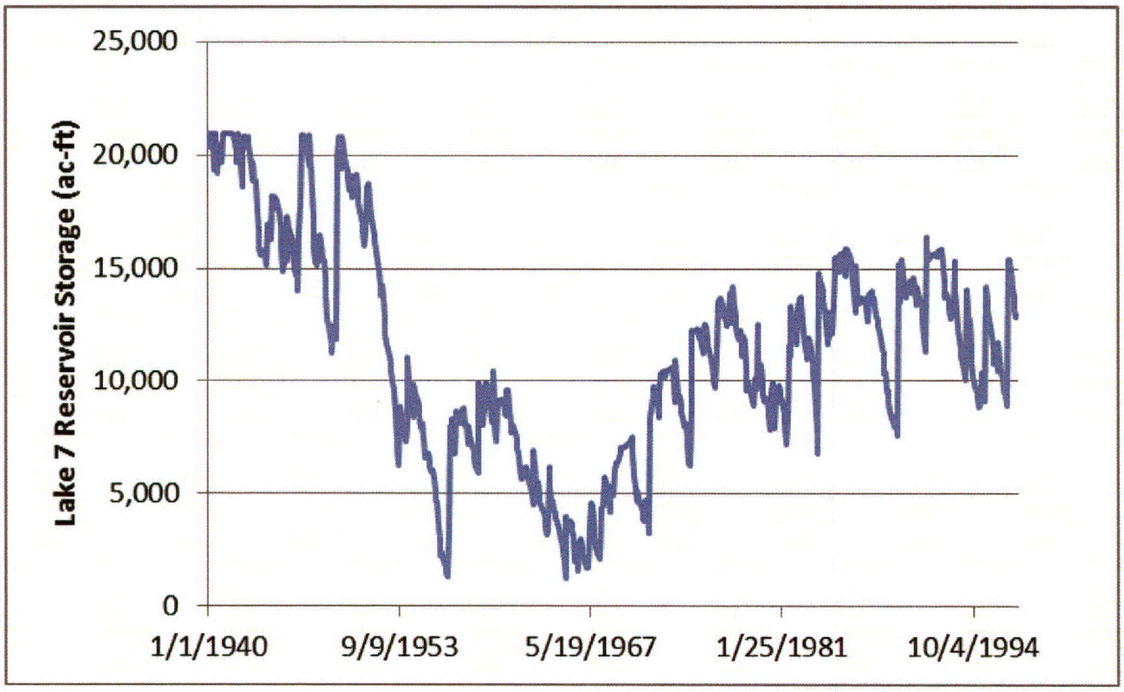


Figure 2: Time Series Plot of modeled Lake 7 Reservoir Storage under Firm Yield Diversion



Evaluation of North Fork Scalping Operation

The North Fork Scalping Operation surface water strategy is a proposed diversion reservoir located on the North fork of the Double Mountain Fork of the Brazos River and pump station to divert flow into Lake Alan Henry (LAH). The strategy impounds developed storm water discharges from the City of Lubbock's South and South Central Playa Lake Drainage System and available stream flow. It was assumed in the Lubbock Water Supply Plan that discharges from the City's playa drainage system is a developed water source and is therefore not subject to environmental flow restrictions. The storm water discharges from the playa lake drainage system are modeled as a time series inflow to a dummy control point for diversion to supplement the North Fork Scalping Operation supplies. Unused quantities of storm water return flows are modeled to enter the river downstream of the diversion reservoir on the North Fork of the Double Mountain Fork of the Brazos River. The strategy is modeled at a 2020 priority date with the storm water discharges protected from senior water rights. Table 1 presents modeled firm yield of LAH, the firm yield of LAH with the North Fork Scalping Operation project implemented, and the change in firm yield as a result of the North Fork Scalping Operation strategy. Table 2 presents modeled safe yield of LAH, the safe yield of LAH with the North Fork Scalping Operation project implemented, and the change in safe yield as a result of the North Fork Scalping Operation strategy.

Table 1: Decadal Firm Yield of the North Fork Scalping Operation Strategy

Decade	Lake Alan Henry Firm Yield (ac-ft/yr)	Lake Alan Henry Firm Yield with North Fork Scalping Strategy (ac-ft/yr)	Increase in Firm Yield from North Fork Scalping Strategy (ac-ft/yr)
2020	20,600	30,990	10,390
2030	20,320	30,110	9,790
2040	20,020	29,200	9,180
2050	19,700	28,360	8,660
2060	19,380	27,490	8,110
2070	18,720	26,610	7,890

Table 2: Decadal Safe Yield of the North Fork Scalping Operation Strategy

Decade	Lake Alan Henry Safe Yield (ac-ft/yr)	Lake Alan Henry Safe Yield with North Fork Scalping Strategy (ac-ft/yr)	Increase in Safe Yield from North Fork Scalping Strategy (ac-ft/yr)
2020	17,470	27,050	9,580
2030	17,170	26,270	9,100
2040	16,850	25,300	8,450
2050	15,980	24,300	8,320
2060	15,050	23,280	8,230
2070	14,100	22,250	8,150

For the purpose of comparison to past evaluations, the Lubbock Water Supply Plan identifies that the North Fork Scalping operation could increase the yield of Lake Alan Henry by 8,725 ac-ft/yr. Figure 3 portrays the modeled flow frequency of the Double Mountain Fork of the Brazos

River (WAM control Point CON244), at the confluence of the North and South Forks of the Double Mountain Fork. As can be seen the modeled monthly regulated flow appears to decrease slightly or remain unchanged with the implementation of the strategy due to the addition of discharges and scalping of only high flows. Figure 4 presents the modeled reservoir storage time series of Lake Alan Henry under the Scalping Operation.

Figure 3: Frequency Curve of Modeled Monthly Regulated Flow in the Double Mountain Fork of the Brazos River

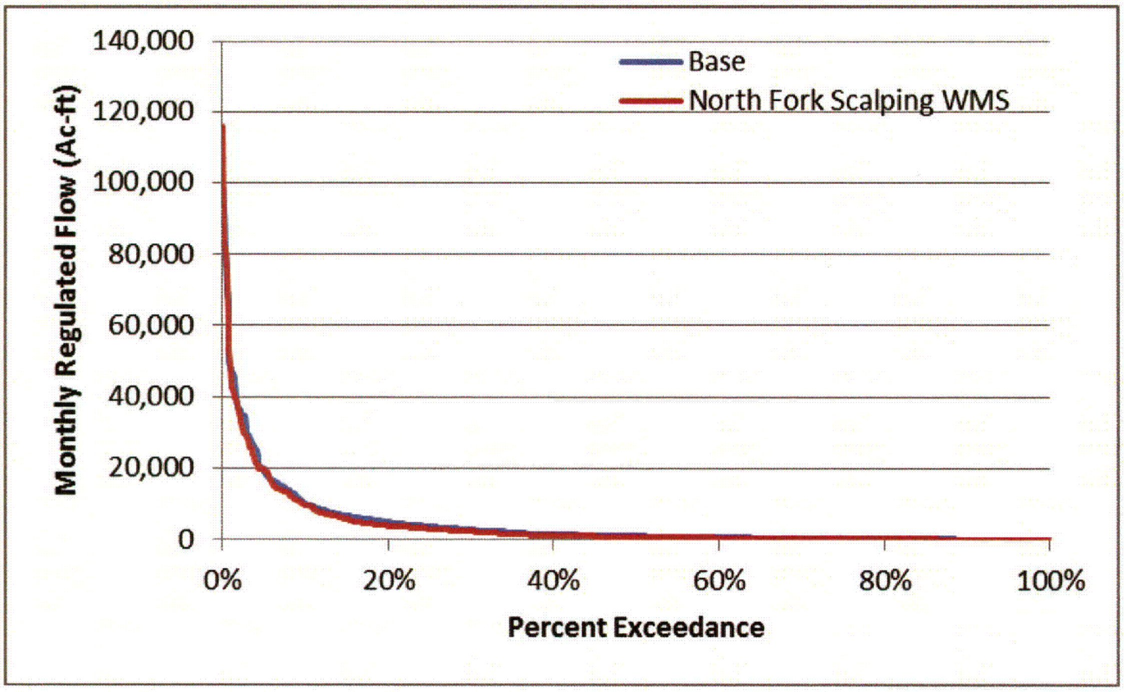
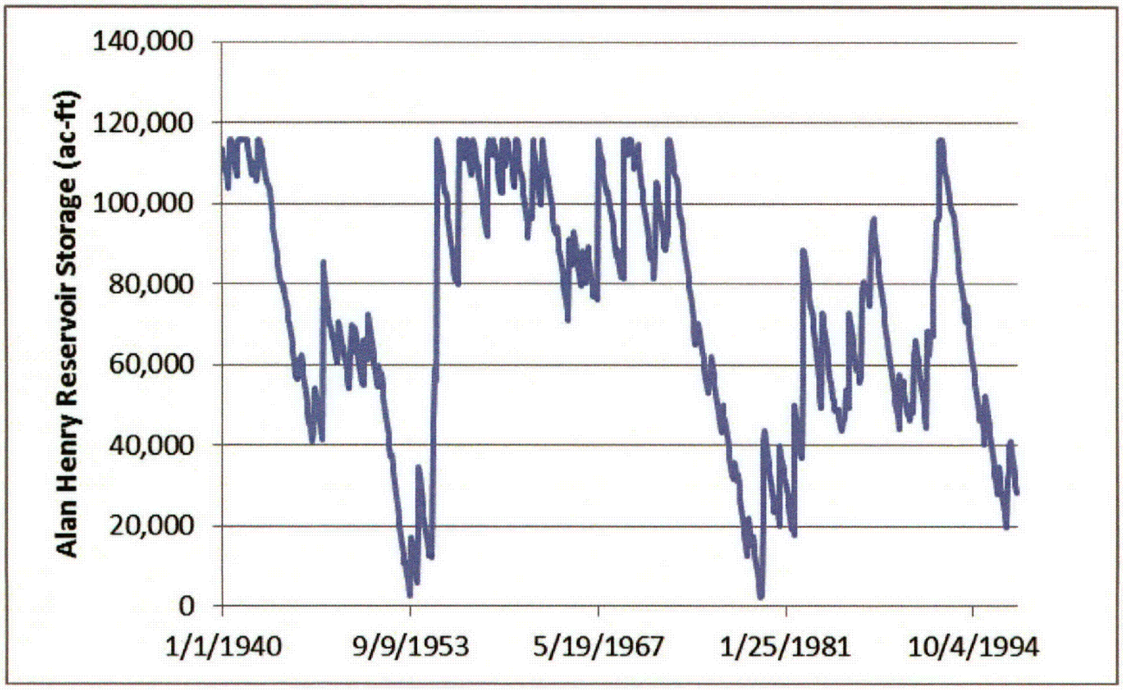


Figure 4: Time Series Plot of modeled Lake Alan Henry Reservoir Storage with Scalping Operation



Cumulative Evaluation of Lake 7 and North Fork Scalping

To evaluate the cumulative effects of the two recommended strategies, Jim Bertram Lake 7 and North Fork Scalping Operation, a WAM scenario modeling the implementation of both strategies was developed. The same assumptions utilized in the individual strategy scenarios are also adopted for the cumulative effects scenario. The return flows from the City of Lubbock are modeled as a uniform inflow to a dummy control point for diversion to supplement Lake 7 supplies. The storm water discharges from the playa lake drainage system are modeled as a time series inflow to a dummy control point for diversion to supplement Lake 7 supplies. Unused quantities of return flows are modeled to enter the river downstream of Lake 7, while unused quantities of storm water discharges are modeled with channel losses to a dummy control point for diversion to supplement the North Fork Scalping Operation supplies. Unused quantities of storm water return flows are modeled to enter the river downstream of the diversion reservoir on the North Fork of the Double Mountain Fork of the Brazos River. The Lake 7 strategy is modeled at a priority date of April 14, 2006 and the North Fork Scalping Strategy is modeled at a 2020 priority date. The modeled firm yield of the Lake 7 strategy is approximately 14,200 ac-ft per year, the firm yield from the North Fork Scalping Operation is presented in Table 3.

Table 3: Decadal Firm Yield of the North Fork Scalping Operation Strategy under Cumulative Effects Scenario

Decade	Lake Alan Henry Firm Yield (ac-ft/yr)	Lake Alan Henry Firm Yield with North Fork Scalping Strategy (ac-ft/yr)	Increase in Firm Yield from North Fork Scalping Strategy (ac-ft/yr)
2020	20,600	42,640	27,250
2030	20,320	41,200	22,040
2040	20,020	39,760	20,880
2050	19,700	38,320	19,740
2060	19,380	36,870	18,620
2070	18,720	35,430	17,490

Evaluation of Post Reservoir

The Post Reservoir surface water strategy is a proposed 57,420 ac-ft, 2,280 acre reservoir located on the North fork of the Double Mountain Fork of the Brazos River northeast of Post, Texas in Garza County. Post Reservoir is authorized by Certificate of Adjudication 12-3711, authorizing diversion and use of up to 10.600 ac-ft per year at a priority date of January 20, 1970. The strategy as described in the Strategic Water Supply Plan for the City of Lubbock can supply a range of firm yield depending upon use of upstream return flows, playa storm water discharges, and instream flow requirements. For presentation herein, RPS modeled four scenarios of the Post Reservoir alternative strategy:

- Post Reservoir as permitted impounding only naturalized flow;
- Post Reservoir as permitted impounding naturalized flow and return flows;
- Post Reservoir as permitted impounding naturalized flow and playa storm water discharges;
- Post Reservoir as permitted impounding naturalized flow, return flows and playa storm water discharges.

As in the previous WMS scenarios described above, it was assumed in the Lubbock Water Supply Plan that both the return flows from the City and the developed storm water discharges are developed water sources and are therefore not subject to environmental flow restrictions. This assumption has been maintained for the analyses herein. The return flows from the City of Lubbock are modeled as a uniform inflow to a dummy control point for diversion to supplement Post Reservoir supplies. The storm water discharges from the playa lake drainage system are modeled as a time series inflow to a dummy control point for diversion to supplement Post Reservoir supplies. Unused quantities of return flows and storm water return flows are modeled to enter the river downstream of Post Reservoir. The WMS is modeled at a priority date of January 20, 1970 with the modeled return flows and storm water discharges protected from senior water rights. The modeled firm yield and safe yield of the project under various scenarios of inflow sources is presented in Table 4. The strategy, as modeled, has no significant impact on existing downstream water rights. For the purpose of comparison, the Lubbock Water Supply Plan assumed the yield of the Post Reservoir strategy to be 8,962 ac-ft per year. Note that unless it is part of the strategy to amend the existing permit for a larger diversion amount, the existing permitted diversion of 10,600 ac-ft/year is the maximum possible modeled available yield from this WMS.

Table 4: Modeled Firm Yield of the Post Reservoir Strategy under Multiple Source Water Scenarios

Decade	Post Reservoir Firm Yield (ac-ft/yr)	Post Safe Yield (ac-ft/yr)	Existing Permit Amount (ac-ft/yr)	Strategy Firm Yield (ac-ft/yr)
Naturalized Flow	5,060	4,830	10,600	5,060
Naturalized Flow + Return Flows	11,970	11,450		10,600
Naturalized Flow + Storm Water Discharges	10,930	10,450		10,600
Naturalized Flow + Return Flows + Storm Water Discharges	17,840	16,400		10,600

Figure 5 portrays the modeled flow frequency of the Double Mountain Fork of the Brazos River (WAM control Point CON244), at the confluence of the North and South Forks of the Double Mountain Fork, which is downstream of all proposed Region O WMSs. As can be seen the modeled monthly regulated flow appears to increase with the implementation of the strategy due to the addition of storm water and wastewater discharges. Figure 6 presents the modeled reservoir storage time series of the proposed Post Reservoir.

Figure 5: Frequency Curve of Modeled Monthly Regulated Flow in the Double Mountain Fork of the Brazos River

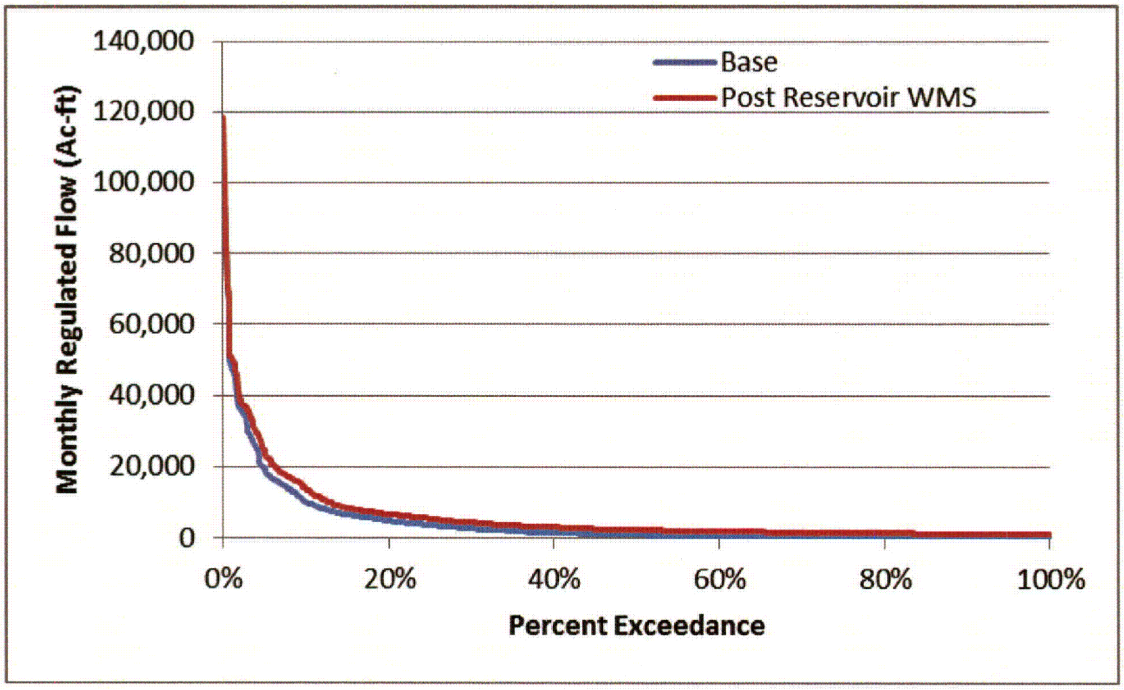
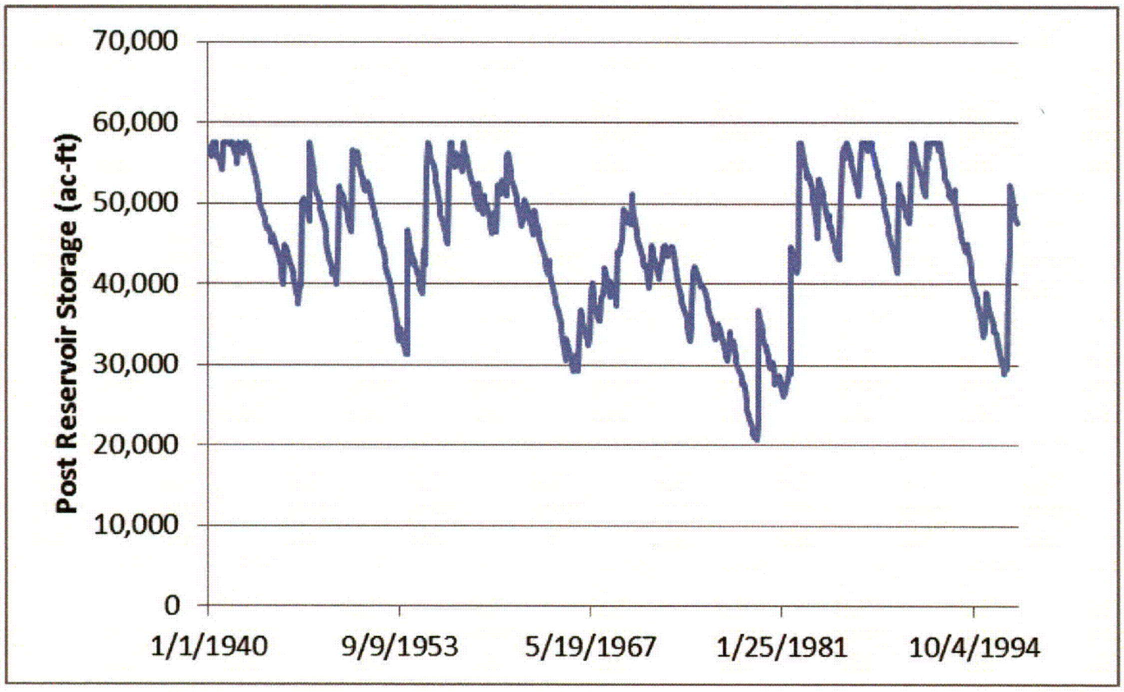


Figure 6: Time Series Plot of modeled Post Reservoir Storage



EVALUATED SURFACE WATER SUPPLY STRATEGIES IN REGION O

To summarize, a total of 3 individual WMSs, two recommended and one alternative, as well as one cumulative effects evaluation of the combination of the two recommended strategies have been evaluated using a modified TCEQ WAM Run3 consistent with the Region G 'Brazos G WAM'. The strategies evaluated are:

- Construction of Jim Bertram Lake 7 (Recommended Strategy),
- Scalp flows from the North Fork of the Double Mountain Fork of the Brazos River to augment yield of Lake Alan Henry (Recommended Strategy),
- Construct Post Reservoir (Alternative Strategy).

The scenarios evaluated by RPS and the modeled yield of the WMSs in each scenario are as follows:

- Jim Bertram Lake 7 – firm yield of 13,800 ac-ft per year;
- North Fork Scalping Operation – firm yield of 10,390 to 7,890 ac-ft per year;
- Jim Bertram Lake 7 and North Fork Scalping Operation – Firm Yield 14,200 ac-ft per year and 27,250 to 17,490 ac-ft per year, respectively;
- Post Reservoir – Firm Yield of 5,060 to 10,600 ac-ft per year depending upon presence of return flows or storm water discharges to supplement permit.

Modeled firm yields are based on a WAM period of record of 1940 - 1997, reflecting naturalized flows based upon the historical hydrologic record of that period. During the 1940 - 1997 period, the critical period upon which firm water supplies are calculated is the drought of record that occurred in the 1950s. Recent reservoir storage volumes within Region O suggest that the region is within, or has recently experienced, a potential new drought of record. If indeed more recent hydrologic conditions in the region have produced a new drought of record, the present official TCEQ WAM models do not currently consider these more recent conditions. Thus, the quantification of firm surface water supplies within the region using the official TCEQ WAM Run 3 may not be adequately conservative in quantifying future firm supplies. For future planning purposes, it is recommended that TCEQ consider the need for (and possibly develop) an expanded hydrological period within future WAM models in the region in order to reflect more recent hydroclimatological conditions in the region's river basins.

Appendix 5D

WMS Water Availability Model Runs

Appendix 5D. WMS Water Availability Model Runs

Appendix 5D is available only in the electronic version of this plan.

Appendix 5E

WMS Evaluation Impact Matrix

Appendix 5E. Impact Matrix by Subcategory and WMS

WUG County	WUG Name	WMS	County of Project Location	Acres Impacted			Threatened and Endangered Species							
				Temporarily Impacted	Permanently Impacted	Acres Impacted Score	Critical Habitat Impact	Proposed for Listing		Threatened Species		Endangered Species		T & E Species Score
								Number of Species	Degree of Impact	Number of Species	Degree of Impact	Number of Species	Degree of Impact	
Recommended WMSs														
BAILEY	COUNTY-OTHER	Local groundwater development	BAILEY	2.0	1.0	1.5	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
BAILEY	IRRIGATION	Irrigation water conservation	BAILEY	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
BAILEY	MULESHOE	Local groundwater development	BAILEY	2.0	1.0	1.5	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
BAILEY	MULESHOE	Municipal water conservation	BAILEY	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
BRISCOE	COUNTY-OTHER	Municipal water conservation	BRISCOE	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	4.0	0.0	1.0
BRISCOE	IRRIGATION	Irrigation water conservation	BRISCOE	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	4.0	0.0	1.0
BRISCOE	SILVERTON	Local groundwater development	BRISCOE	4.0	1.0	2.5	1.0	1.0	0.0	4.0	0.5	4.0	0.5	2.0
BRISCOE	SILVERTON	Municipal water conservation	BRISCOE	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	4.0	0.0	1.0
CASTRO	DIMMITT	Local groundwater development	CASTRO	2.0	1.0	1.5	1.0	1.0	0.0	5.0	0.5	3.0	0.5	2.0
CASTRO	DIMMITT	Municipal water conservation	CASTRO	1.0	1.0	1.0	1.0	1.0	0.0	5.0	0.0	3.0	0.0	1.0
CASTRO	HART	Local groundwater development	CASTRO	2.0	1.0	1.5	1.0	1.0	0.0	5.0	0.5	3.0	0.5	2.0
CASTRO	IRRIGATION	Irrigation water conservation	CASTRO	1.0	1.0	1.0	1.0	1.0	0.0	5.0	0.0	3.0	0.0	1.0
COCHRAN	COUNTY-OTHER	Municipal water conservation	COCHRAN	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
COCHRAN	IRRIGATION	Irrigation water conservation	COCHRAN	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
COCHRAN	MORTON	Local groundwater development	COCHRAN	1.0	2.0	1.5	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
COCHRAN	MORTON	Municipal water conservation	COCHRAN	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
COCHRAN	MORTON	Water loss reduction	COCHRAN	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
CROSBY	IRRIGATION	Irrigation water conservation	CROSBY	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	4.0	0.0	1.0
CROSBY	LORENZO	Municipal water conservation	CROSBY	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	4.0	0.0	1.0
CROSBY	LORENZO	Water loss reduction	CROSBY	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.5	4.0	1.0	2.3
CROSBY	White River MWD	Local groundwater development	CROSBY	2.0	1.0	1.5	5.0	1.0	0.0	4.0	0.5	4.0	1.0	3.3
DAWSON	COUNTY-OTHER	Local groundwater development	DAWSON	2.0	1.0	1.5	1.0	2.0	0.5	4.0	0.5	4.0	0.5	2.3
DAWSON	IRRIGATION	Irrigation water conservation	DAWSON	1.0	1.0	1.0	1.0	2.0	0.0	4.0	0.0	4.0	0.0	1.0
DAWSON	LAMESA	Municipal water conservation	DAWSON	1.0	1.0	1.0	1.0	2.0	0.0	4.0	0.0	4.0	0.0	1.0
DEAF SMITH	HEREFORD	Municipal water conservation	DEAF SMITH	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
DEAF SMITH	IRRIGATION	Irrigation water conservation	DEAF SMITH	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
DICKENS	IRRIGATION	Irrigation water conservation	DICKENS	1.0	1.0	1.0	1.0	2.0	0.0	4.0	0.0	4.0	0.0	1.0
DICKENS	SPUR	Municipal water conservation	DICKENS	1.0	1.0	1.0	1.0	2.0	0.0	4.0	0.0	4.0	0.0	1.0
FLOYD	FLOYDADA	Municipal water conservation	FLOYD	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
FLOYD	IRRIGATION	Irrigation water conservation	FLOYD	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
FLOYD	LOCKNEY	Local groundwater development	FLOYD	2.0	1.0	1.5	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0

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								Number of Species	Degree of Impact	Number of Species	Degree of Impact	Number of Species	Degree of Impact	
GAINES	COUNTY-OTHER	Local groundwater development	GAINES	3.0	1.0	2.0	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
GAINES	IRRIGATION	Irrigation water conservation	GAINES	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
GAINES	SEAGRAVES	Local groundwater development	GAINES	2.0	1.0	1.5	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
GAINES	SEAGRAVES	Municipal water conservation	GAINES	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
GAINES	SEMINOLE	Groundwater desalination	GAINES	3.0	2.0	2.5	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
GAINES	SEMINOLE	Local groundwater development	GAINES	5.0	2.0	3.5	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
GAINES	SEMINOLE	Municipal water conservation	GAINES	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
GARZA	COUNTY-OTHER	South Garza Water Supply	GARZA	4.0	2.0	3.0	5.0	2.0	0.5	4.0	0.5	4.0	1.0	3.5
GARZA	IRRIGATION	Irrigation water conservation	GARZA	1.0	1.0	1.0	1.0	2.0	0.0	4.0	0.0	4.0	0.0	1.0
HALE	ABERNATHY	Municipal water conservation	HALE	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
HALE	IRRIGATION	Irrigation water conservation	HALE	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
HALE	PETERSBURG	Municipal water conservation	HALE	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
HALE	PLAINVIEW	Municipal water conservation	HALE	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
HALE, LUBBOCK	ABERNATHY	Groundwater desalination	HALE	3.0	2.0	2.5	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
HOCKLEY	ANTON	Municipal water conservation	HOCKLEY	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
HOCKLEY	IRRIGATION	Irrigation water conservation	HOCKLEY	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
HOCKLEY	LEVELLAND	Municipal water conservation	HOCKLEY	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
HOCKLEY	SUNDOWN	Local groundwater development	HOCKLEY	2.0	1.0	1.5	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
HOCKLEY	SUNDOWN	Municipal water conservation	HOCKLEY	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
HOCKLEY	SUNDOWN	Water loss reduction	HOCKLEY	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
LAMB	AMHERST	Local groundwater development	LAMB	2.0	1.0	1.5	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
LAMB	AMHERST	Municipal water conservation	LAMB	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
LAMB	EARTH	Municipal water conservation	LAMB	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
LAMB	IRRIGATION	Irrigation water conservation	LAMB	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
LAMB	LITTLEFIELD	Municipal water conservation	LAMB	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
LAMB	OLTON	Municipal water conservation	LAMB	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
LAMB	SUDAN	Municipal water conservation	LAMB	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
LUBBOCK	ABERNATHY	Municipal water conservation	LUBBOCK	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
LUBBOCK	IDALOU	Local groundwater development	LUBBOCK	2.0	2.0	2.0	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
LUBBOCK	IDALOU	Municipal water conservation	LUBBOCK	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
LUBBOCK	IRRIGATION	Irrigation water conservation	LUBBOCK	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0

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				Temporarily Impacted	Permanently Impacted	Acres Impacted Score	Critical Habitat Impact	Proposed for Listing		Threatened Species		Endangered Species		T & E Species Score
								Number of Species	Degree of Impact	Number of Species	Degree of Impact	Number of Species	Degree of Impact	
LUBBOCK	LUBBOCK	Bailey County Well Field capacity maintenance	BAILEY	4.0	1.0	2.5	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
LUBBOCK	LUBBOCK	Brackish well field at the South Water Treatment Plant	LUBBOCK	2.0	2.0	2.0	1.0	1.0	0.0	4.0	0.5	3.0	0.5	1.0
LUBBOCK	LUBBOCK	CRMWA aquifer storage and recovery	LUBBOCK	4.0	2.0	3.0	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
LUBBOCK	LUBBOCK	Jim Bertram Lake 7	LUBBOCK	3.0	5.0	4.0	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
LUBBOCK	LUBBOCK	Lake Alan Henry Phase 2	GARZA, LUBBOCK	1.0	2.0	1.5	1.0	2.0	0.5	4.0	0.5	3.0	0.5	2.3
LUBBOCK	LUBBOCK	Municipal water conservation	LUBBOCK	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
LUBBOCK	LUBBOCK	North Fork scalping operation	GARZA, LUBBOCK	3.0	5.0	4.0	5.0	2.0	0.5	4.0	0.5	4.0	1.0	3.5
LUBBOCK	LUBBOCK	South Lubbock well field	LUBBOCK	4.0	2.0	3.0	1.0	1.0	0.0	4.0	0.5	3.0	0.5	1.0
LUBBOCK	RANSOM CANYON	Municipal water conservation	LUBBOCK	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
LUBBOCK	SHALLOWATER	Local groundwater development	LUBBOCK	2.0	2.0	2.0	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
LUBBOCK	SHALLOWATER	Water loss reduction	LUBBOCK	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
LUBBOCK	WOLFFORTH	Local groundwater development	LUBBOCK	3.0	2.0	2.5	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
LUBBOCK	WOLFFORTH	Municipal water conservation	LUBBOCK	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
LUBBOCK	WOLFFORTH	Potable reuse	LUBBOCK	2.0	2.0	2.0	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
LYNN	COUNTY-OTHER	Local groundwater development	LYNN	2.0	1.0	1.5	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
LYNN	IRRIGATION	Irrigation water conservation	LYNN	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
LYNN	TAHOKA	Municipal water conservation	LYNN	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
MOTLEY	COUNTY-OTHER	Municipal water conservation	MOTLEY	1.0	1.0	1.0	1.0	1.0	0.0	5.0	0.0	3.0	0.0	1.0
MOTLEY	IRRIGATION	Irrigation water conservation	MOTLEY	1.0	1.0	1.0	1.0	1.0	0.0	5.0	0.0	3.0	0.0	1.0
MOTLEY	MATADOR	Municipal water conservation	MOTLEY	1.0	1.0	1.0	1.0	1.0	0.0	5.0	0.0	3.0	0.0	1.0
PARMER	BOVINA	Local groundwater development	PARMER	2.0	1.0	1.5	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
PARMER	BOVINA	Municipal water conservation	PARMER	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
PARMER	COUNTY-OTHER	Local groundwater development	PARMER	2.0	1.0	1.5	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
PARMER	COUNTY-OTHER	Municipal water conservation	PARMER	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
PARMER	FARWELL	Local groundwater development	PARMER	2.0	1.0	1.5	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
PARMER	FARWELL	Municipal water conservation	PARMER	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
PARMER	FARWELL	Potable reuse	PARMER	2.0	2.0	2.0	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
PARMER	FRIONA	Local groundwater development	PARMER	2.0	1.0	1.5	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
PARMER	FRIONA	Municipal water conservation	PARMER	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0

Appendix 5E. Impact Matrix by Subcategory and WMS

WUG County	WUG Name	WMS	County of Project Location	Acres Impacted			Threatened and Endangered Species							
				Temporarily Impacted	Permanently Impacted	Acres Impacted Score	Critical Habitat Impact	Proposed for Listing		Threatened Species		Endangered Species		T & E Species Score
								Number of Species	Degree of Impact	Number of Species	Degree of Impact	Number of Species	Degree of Impact	
PARMER	IRRIGATION	Irrigation water conservation	PARMER	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
SWISHER	IRRIGATION	Irrigation water conservation	SWISHER	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
SWISHER	TULIA	Local groundwater development	SWISHER	3.0	2.0	2.5	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
SWISHER	TULIA	Municipal water conservation	SWISHER	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
TERRY	BROWNFIELD	Municipal water conservation	TERRY	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
TERRY	IRRIGATION	Irrigation water conservation	TERRY	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
YOAKUM	DENVER CITY	Local groundwater development	YOAKUM	2.0	1.0	1.5	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
YOAKUM	DENVER CITY	Municipal water conservation	YOAKUM	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
YOAKUM	IRRIGATION	Irrigation water conservation	YOAKUM	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
YOAKUM	PLAINS	Local groundwater development	YOAKUM	2.0	1.0	1.5	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
YOAKUM	PLAINS	Municipal water conservation	YOAKUM	1.0	1.0	1.0	1.0	1.0	0.0	4.0	0.0	3.0	0.0	1.0
Alternative WMSs														
Hockley	Smyer	Smyer CRMWA Lease from Levelland	Hockley	2.0	2.0	2.0	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
LUBBOCK	LUBBOCK	Direct potable reuse to North Water Treatment Plant	LUBBOCK	3.0	2.0	2.5	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
LUBBOCK	LUBBOCK	Direct potable reuse to South Water Treatment Plant	LUBBOCK	3.0	2.0	2.5	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
LUBBOCK	LUBBOCK	North Fork diversion at CR 7300	LUBBOCK	3.0	2.0	2.5	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
LUBBOCK	LUBBOCK	North Fork diversion to Lake Alan Henry pump station	GARZA, LUBBOCK	3.0	2.0	2.5	5.0	2.0	0.5	4.0	0.5	4.0	1.0	3.5
LUBBOCK	LUBBOCK	Post Reservoir	GARZA, LUBBOCK	3.0	5.0	4.0	5.0	2.0	0.5	4.0	0.5	4.0	1.0	3.5
LUBBOCK	LUBBOCK	Reclaimed water to aquifer storage and recovery	LUBBOCK	4.0	2.0	3.0	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
LUBBOCK	LUBBOCK	South Fork discharge	LUBBOCK, LYNN	4.0	2.0	3.0	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0
SWISHER	TULIA	Local groundwater development	SWISHER	2.0	2.0	2.0	1.0	1.0	0.0	4.0	0.5	3.0	0.5	2.0

Appendix 5E. Impact Matrix by Subcategory and WMS

WUG County	WUG Name	WMS	County of Project Location	Instream Flows: Origin of Diverted Water	Instream Flows: Stream Flow Impacts	Instream Flows: Instream Flows Score	Agricultural Resources: Acres Impacted	Agricultural Resources: Water Supply Impact	Agricultural Resources: Ag. Resources Score	Playa Wetland Impact: Playa Wetland Score	Spring Impact: Spring Score	Cultural Sites Impact: Cultural Sites Score	Total Score
Recommended WMSs													
BAILEY	COUNTY-OTHER	Local groundwater development	BAILEY	1.0	1.0	1.0	2.0	3.0	2.5	2.0	2.0	3.0	14.0
BAILEY	IRRIGATION	Irrigation water conservation	BAILEY	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
BAILEY	MULESHOE	Local groundwater development	BAILEY	1.0	1.0	1.0	2.0	4.0	3.0	2.0	3.0	3.0	15.5
BAILEY	MULESHOE	Municipal water conservation	BAILEY	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
BRISCOE	COUNTY-OTHER	Municipal water conservation	BRISCOE	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
BRISCOE	IRRIGATION	Irrigation water conservation	BRISCOE	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
BRISCOE	SILVERTON	Local groundwater development	BRISCOE	1.0	1.0	1.0	2.0	3.0	2.5	2.0	4.0	3.0	17.0
BRISCOE	SILVERTON	Municipal water conservation	BRISCOE	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
CASTRO	DIMMITT	Local groundwater development	CASTRO	1.0	1.0	1.0	2.0	4.0	3.0	2.0	3.0	3.0	15.5
CASTRO	DIMMITT	Municipal water conservation	CASTRO	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
CASTRO	HART	Local groundwater development	CASTRO	1.0	1.0	1.0	2.0	3.0	2.5	2.0	2.0	3.0	14.0
CASTRO	IRRIGATION	Irrigation water conservation	CASTRO	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
COCHRAN	COUNTY-OTHER	Municipal water conservation	COCHRAN	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
COCHRAN	IRRIGATION	Irrigation water conservation	COCHRAN	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
COCHRAN	MORTON	Local groundwater development	COCHRAN	1.0	1.0	1.0	2.0	3.0	2.5	2.0	2.0	2.0	13.0
COCHRAN	MORTON	Municipal water conservation	COCHRAN	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
COCHRAN	MORTON	Water loss reduction	COCHRAN	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	8.5
CROSBY	IRRIGATION	Irrigation water conservation	CROSBY	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
CROSBY	LORENZO	Municipal water conservation	CROSBY	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
CROSBY	LORENZO	Water loss reduction	CROSBY	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	8.8
CROSBY	White River MWD	Local groundwater development	CROSBY	1.0	1.0	1.0	2.0	5.0	3.5	2.0	5.0	5.0	21.3
DAWSON	COUNTY-OTHER	Local groundwater development	DAWSON	1.0	1.0	1.0	2.0	3.0	2.5	2.0	2.0	3.0	14.3
DAWSON	IRRIGATION	Irrigation water conservation	DAWSON	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
DAWSON	LAMESA	Municipal water conservation	DAWSON	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
DEAF SMITH	HEREFORD	Municipal water conservation	DEAF SMITH	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
DEAF SMITH	IRRIGATION	Irrigation water conservation	DEAF SMITH	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
DICKENS	IRRIGATION	Irrigation water conservation	DICKENS	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
DICKENS	SPUR	Municipal water conservation	DICKENS	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
FLOYD	FLOYDADA	Municipal water conservation	FLOYD	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
FLOYD	IRRIGATION	Irrigation water conservation	FLOYD	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
FLOYD	LOCKNEY	Local groundwater development	FLOYD	1.0	1.0	1.0	2.0	3.0	2.5	2.0	2.0	4.0	15.0

Appendix 5E. Impact Matrix by Subcategory and WMS

WUG County	WUG Name	WMS	County of Project Location	Instream Flows			Agricultural Resources			Playa Wetland Impact	Spring Impact	Cultural Sites Impact	Total Score
				Origin of Diverted Water	Stream Flow Impacts	Instream Flows Score	Acres Impacted	Water Supply Impact	Ag. Resources Score	Playa Wetland Score	Spring Score	Cultural Sites Score	
GAINES	COUNTY-OTHER	Local groundwater development	GAINES	1.0	1.0	1.0	2.0	5.0	3.5	2.0	3.0	3.0	16.5
GAINES	IRRIGATION	Irrigation water conservation	GAINES	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
GAINES	SEAGRAVES	Local groundwater development	GAINES	1.0	1.0	1.0	2.0	3.0	2.5	2.0	2.0	3.0	14.0
GAINES	SEAGRAVES	Municipal water conservation	GAINES	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
GAINES	SEMINOLE	Groundwater desalination	GAINES	1.0	1.0	1.0	2.0	2.0	2.0	2.0	3.0	3.0	15.5
GAINES	SEMINOLE	Local groundwater development	GAINES	1.0	1.0	1.0	4.0	5.0	4.5	2.0	3.0	3.0	19.0
GAINES	SEMINOLE	Municipal water conservation	GAINES	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
GARZA	COUNTY-OTHER	South Garza Water Supply	GARZA	2.0	2.0	2.0	1.0	2.0	1.5	2.0	1.0	5.0	18.0
GARZA	IRRIGATION	Irrigation water conservation	GARZA	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
HALE	ABERNATHY	Municipal water conservation	HALE	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
HALE	IRRIGATION	Irrigation water conservation	HALE	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
HALE	PETERSBURG	Municipal water conservation	HALE	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
HALE	PLAINVIEW	Municipal water conservation	HALE	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
HALE, LUBBOCK	ABERNATHY	Groundwater desalination	HALE	1.0	1.0	1.0	2.0	2.0	2.0	2.0	2.0	5.0	16.5
HOCKLEY	ANTON	Municipal water conservation	HOCKLEY	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
HOCKLEY	IRRIGATION	Irrigation water conservation	HOCKLEY	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
HOCKLEY	LEVELLAND	Municipal water conservation	HOCKLEY	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
HOCKLEY	SUNDOWN	Local groundwater development	HOCKLEY	1.0	1.0	1.0	2.0	3.0	2.5	2.0	2.0	3.0	14.0
HOCKLEY	SUNDOWN	Municipal water conservation	HOCKLEY	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
HOCKLEY	SUNDOWN	Water loss reduction	HOCKLEY	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	8.5
LAMB	AMHERST	Local groundwater development	LAMB	1.0	1.0	1.0	2.0	3.0	2.5	2.0	2.0	4.0	15.0
LAMB	AMHERST	Municipal water conservation	LAMB	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
LAMB	EARTH	Municipal water conservation	LAMB	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
LAMB	IRRIGATION	Irrigation water conservation	LAMB	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
LAMB	LITTLEFIELD	Municipal water conservation	LAMB	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
LAMB	OLTON	Municipal water conservation	LAMB	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
LAMB	SUDAN	Municipal water conservation	LAMB	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
LUBBOCK	ABERNATHY	Municipal water conservation	LUBBOCK	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
LUBBOCK	IDALOU	Local groundwater development	LUBBOCK	1.0	1.0	1.0	2.0	3.0	2.5	2.0	4.0	5.0	18.5
LUBBOCK	IDALOU	Municipal water conservation	LUBBOCK	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
LUBBOCK	IRRIGATION	Irrigation water conservation	LUBBOCK	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0

Appendix 5E. Impact Matrix by Subcategory and WMS

WUG County	WUG Name	WMS	County of Project Location	Instream Flows			Agricultural Resources			Playa Wetland Impact	Spring Impact	Cultural Sites Impact	Total Score
				Origin of Diverted Water	Stream Flow Impacts	Instream Flows Score	Acres Impacted	Water Supply Impact	Ag. Resources Score	Playa Wetland Score	Spring Score	Cultural Sites Score	
LUBBOCK	LUBBOCK	Bailey County Well Field capacity maintenance	BAILEY	1.0	1.0	1.0	3.0	5.0	4.0	2.0	3.0	3.0	17.5
LUBBOCK	LUBBOCK	Brackish well field at the South Water Treatment Plant	LUBBOCK	1.0	1.0	1.0	1.0	2.0	1.5	2.0	5.0	1.0	13.5
LUBBOCK	LUBBOCK	CRMWA aquifer storage and recovery	LUBBOCK	1.0	1.0	1.0	2.0	1.0	1.5	2.0	1.0	5.0	15.5
LUBBOCK	LUBBOCK	Jim Bertram Lake 7	LUBBOCK	3.0	5.0	4.0	5.0	2.0	3.5	3.0	1.0	5.0	22.5
LUBBOCK	LUBBOCK	Lake Alan Henry Phase 2	GARZA, LUBBOCK	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0	5.0	15.8
LUBBOCK	LUBBOCK	Municipal water conservation	LUBBOCK	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
LUBBOCK	LUBBOCK	North Fork scalping operation	GARZA, LUBBOCK	5.0	3.0	4.0	5.0	2.0	3.5	3.0	1.0	5.0	24.0
LUBBOCK	LUBBOCK	South Lubbock well field	LUBBOCK	1.0	1.0	1.0	1.0	5.0	3.0	1.0	5.0	1.0	15.0
LUBBOCK	RANSOM CANYON	Municipal water conservation	LUBBOCK	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
LUBBOCK	SHALLOWATER	Local groundwater development	LUBBOCK	1.0	1.0	1.0	2.0	4.0	3.0	2.0	5.0	5.0	20.0
LUBBOCK	SHALLOWATER	Water loss reduction	LUBBOCK	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	8.5
LUBBOCK	WOLFFORTH	Local groundwater development	LUBBOCK	1.0	1.0	1.0	2.0	5.0	3.5	2.0	5.0	5.0	21.0
LUBBOCK	WOLFFORTH	Municipal water conservation	LUBBOCK	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
LUBBOCK	WOLFFORTH	Potable reuse	LUBBOCK	1.0	2.0	1.5	1.0	2.0	1.5	2.0	1.0	5.0	15.0
LYNN	COUNTY-OTHER	Local groundwater development	LYNN	1.0	1.0	1.0	2.0	3.0	2.5	2.0	2.0	3.0	14.0
LYNN	IRRIGATION	Irrigation water conservation	LYNN	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
LYNN	TAHOKA	Municipal water conservation	LYNN	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
MOTLEY	COUNTY-OTHER	Municipal water conservation	MOTLEY	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
MOTLEY	IRRIGATION	Irrigation water conservation	MOTLEY	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
MOTLEY	MATADOR	Municipal water conservation	MOTLEY	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
PARMER	BOVINA	Local groundwater development	PARMER	1.0	1.0	1.0	2.0	3.0	2.5	2.0	2.0	4.0	15.0
PARMER	BOVINA	Municipal water conservation	PARMER	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
PARMER	COUNTY-OTHER	Local groundwater development	PARMER	1.0	1.0	1.0	2.0	3.0	2.5	2.0	2.0	4.0	15.0
PARMER	COUNTY-OTHER	Municipal water conservation	PARMER	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
PARMER	FARWELL	Local groundwater development	PARMER	1.0	1.0	1.0	2.0	3.0	2.5	2.0	2.0	4.0	15.0
PARMER	FARWELL	Municipal water conservation	PARMER	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
PARMER	FARWELL	Potable reuse	PARMER	1.0	2.0	1.5	1.0	2.0	1.5	2.0	1.0	4.0	14.0
PARMER	FRIONA	Local groundwater development	PARMER	1.0	1.0	1.0	2.0	3.0	2.5	2.0	2.0	4.0	15.0
PARMER	FRIONA	Municipal water conservation	PARMER	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5

Appendix 5E. Impact Matrix by Subcategory and WMS

WUG County	WUG Name	WMS	County of Project Location	Instream Flows			Agricultural Resources			Playa Wetland Impact	Spring Impact	Cultural Sites Impact	Total Score
				Origin of Diverted Water	Stream Flow Impacts	Instream Flows Score	Acres Impacted	Water Supply Impact	Ag. Resources Score	Playa Wetland Score	Spring Score	Cultural Sites Score	
PARMER	IRRIGATION	Irrigation water conservation	PARMER	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
SWISHER	IRRIGATION	Irrigation water conservation	SWISHER	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
SWISHER	TULIA	Local groundwater development	SWISHER	1.0	1.0	1.0	2.0	3.0	2.5	2.0	2.0	4.0	16.0
SWISHER	TULIA	Municipal water conservation	SWISHER	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
TERRY	BROWNFIELD	Municipal water conservation	TERRY	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
TERRY	IRRIGATION	Irrigation water conservation	TERRY	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
YOAKUM	DENVER CITY	Local groundwater development	YOAKUM	1.0	1.0	1.0	2.0	5.0	3.5	2.0	3.0	2.0	15.0
YOAKUM	DENVER CITY	Municipal water conservation	YOAKUM	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
YOAKUM	IRRIGATION	Irrigation water conservation	YOAKUM	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
YOAKUM	PLAINS	Local groundwater development	YOAKUM	1.0	1.0	1.0	2.0	4.0	3.0	2.0	3.0	2.0	14.5
YOAKUM	PLAINS	Municipal water conservation	YOAKUM	1.0	1.0	1.0	1.0	2.0	1.5	1.0	1.0	1.0	7.5
Alternative WMSs													
Hockley	Smyer	Smyer CRMWA Lease from Levelland	Hockley	1.0	1.0	1.0	2.0	2.0	2.0	2.0	1.0	3.0	13.0
LUBBOCK	LUBBOCK	Direct potable reuse to North Water Treatment Plant	LUBBOCK	1.0	1.0	1.0	2.0	2.0	2.0	2.0	1.0	5.0	15.5
LUBBOCK	LUBBOCK	Direct potable reuse to South Water Treatment Plant	LUBBOCK	1.0	1.0	1.0	2.0	2.0	2.0	2.0	1.0	5.0	15.5
LUBBOCK	LUBBOCK	North Fork diversion at CR 7300	LUBBOCK	1.0	1.0	1.0	2.0	2.0	2.0	2.0	1.0	5.0	15.5
LUBBOCK	LUBBOCK	North Fork diversion to Lake Alan Henry pump station	GARZA, LUBBOCK	1.0	1.0	1.0	2.0	2.0	2.0	2.0	1.0	5.0	17.0
LUBBOCK	LUBBOCK	Post Reservoir	GARZA, LUBBOCK	2.0	5.0	3.5	5.0	2.0	3.5	5.0	1.0	5.0	25.5
LUBBOCK	LUBBOCK	Reclaimed water to aquifer storage and recovery	LUBBOCK	1.0	1.0	1.0	2.0	1.0	1.5	2.0	1.0	5.0	15.5
LUBBOCK	LUBBOCK	South Fork discharge	LUBBOCK, LYNN	1.0	1.0	1.0	2.0	2.0	2.0	2.0	1.0	5.0	16.0
SWISHER	TULIA	Local groundwater development	SWISHER	1.0	1.0	1.0	2.0	3.0	2.5	2.0	2.0	4.0	15.5

Appendix 5F

Cost Estimating Assumptions for City of Lubbock Strategies

Appendix 5F. Cost Estimating Methodology and Assumptions for City of Lubbock Water Management Strategies

Costs for each of the Lubbock water management strategies were prepared by HDR Engineering, Inc. (HDR) for the 2013 City of Lubbock *Strategic Water Supply Plan*. For this Regional Water Plan, Daniel B. Stephens & Associates, Inc. (DBS&A) reviewed the original cost spreadsheets to establish the basis of the infrastructure costs (e.g., capacities of infrastructure and hydraulic conditions). Soft costs were updated where appropriate to be consistent with the current version of the TWDB UCM. The electrical usage was updated based on an independent calculation.

The capital cost components were not re-evaluated, but rather were projected to the appropriate time period using the Engineering News Record Construction Cost Index (ENR CCI). No attempt was made to compare the cost tables from the previous cost model used by HDR to the current cost model.

Capital costs items were separated in some of the cost tables. For example, the costs for well drilling and associated collector piping were combined in the HDR tables, but are shown separately in the updated cost tables prepared by DBS&A. This allows calculation of engineering, legal costs, and contingencies based on differing percentages for pipelines versus other infrastructure. The basis of those discreet costs is the HDR spreadsheets.

From the UCM guidance, the following recommended guidelines are used unless additional information is available that affects the particular cost item, in which case the methodology used is listed in the table assumptions:

1. Engineering, legal costs and contingencies are 30 percent of construction costs for pipelines and pump station and 35 percent for all other facilities.

2. Environmental and archaeology studies are to be 100 percent of land costs.

3. Operations and maintenance costs are calculated as a percentage of facility cost as follows:
   - 1 percent for pipelines
   - 2.5 percent for pump stations
   - 1.5 percent for dams

4. Electrical costs are calculated assuming 5 percent down-time for pumps, $0.09 per kilowatt-hour, and a combined efficiency of 70 percent (pump and motor).

5. Interest during construction is based on a rate of 4 percent and 1 percent return on investment.

6. Project financing is at a rate of 5.5 percent for a 20-year period.

7. Land acquisition costs are based on the nominal median, size-adjusted price per acre from the Texas A&M University (TAMU) Real Estate Center (http://recenter.tamu.edu/data/rland/). Land area to be acquired is based on the following requirements.

Facility	Suggested Land Area (acres)
• Pump station	5
• Water treatment plant	0.5 per million-gallons-per-day capacity
• Water storage tanks	2
• Reservoirs	Inundation area (Larger land areas may be required in order to account for flood pool, freeboard, etc.)
• Well fields	0.5 per well minimum (Larger land areas may be required in order to obtain a certain quantity of water rights.)

Finally, to deliver water obtained through the implementation of these strategies, in some cases expansion or modification of the City's distribution system may be required. In 10 of the City's strategies, construction of approximately 4 miles of 42-inch transmission main, to be built by others, is needed to connect Pump Station #14 to the Low Head B bypass line that feeds Pump Station #7. This transmission main is needed for the following strategies:

- South Lubbock Well Field (Section 5.4.3)
- Lake Alan Henry Phase 2 (Section 5.4.5)
- Jim Bertram Lake 7 (Section 5.4.6)
- North Fork Scalping Operation (Section 5.4.7)
- Direct Potable Reuse to South Water Treatment Plant (Section 5.7.1)
- North Fork Diversion at County Road 7300 (Section 5.7.3)
- South Fork Discharge (Section 5.7.4)
- North Fork Diversion to Lake Alan Henry Pump Station (Section 5.7.5)
- Reclaimed Water to Aquifer Storage and Recovery (Section 5.7.6)
- Post Reservoir (Section 5.7.7)

The costs associated with this construction and any other related changes are not included in the cost estimates provided for the City of Lubbock strategies.

Appendix 5G

Water Importation Evaluation

Appendix 5G. Water Importation

The possibility of importing water from the greater Mississippi River basin to Region O has been studied for many years. Water importation plans to Region O have previously been considered by the Texas Water Development Board (TWDB, 1968), U.S. Bureau of Reclamation (USBR, 1973), U.S. Army Corps of Engineers (USACE, 1973), and U.S. Department of Commerce (High Plains Associates 1982; USACE, 1982). The plans are generally similar in that surface water would be diverted from the Mississippi or its tributaries to source reservoirs and then transferred through canals and pumping stations over hundreds of miles and thousands of feet in elevation to terminal reservoirs in west Texas, western Oklahoma, and eastern New Mexico. Another option that has not been previously studied but is considered herein is the importation of water from the Great Lakes basin.

The importation plans are feasible from an engineering standpoint and would supply a large quantity of water to Region O and possibly to TWDB planning regions between Region O and the source rivers, lessening the withdrawal of groundwater from the Ogallala Aquifer. However, the financial, political, legal, energy, and environmental concerns are great and would require extensive further study.

5G.1 Description of Option

Initial plans considered for the diversion of water from the Mississippi basin proposed to obtain surface water directly from the Mississippi River in Louisiana (TWDB, 1968; USBR, 1973; USACE, 1973). However, the USACE later decided against directly diverting from the Mississippi River because tributaries in Arkansas and eastern Texas could meet the water demand with reduced canal lengths and pumping requirements (USACE, 1982). The 1982 USACE plans were selected for consideration in this report as they are more feasible.

The USACE (1982) considered two importation plans that covered the range between the quantity of water needed and the maximum quantity of water available. Plan 1, with a total import of 1.55 million ac-ft/yr after conveyance and evaporation losses, would more than restore the quantity of irrigation in the High Plains Ogallala Aquifer region of west Texas, eastern New Mexico, and Oklahoma that was expected to go out of production between 1977 and 2020 (1.16 million ac-ft/yr). Plan 2 would provide the maximum quantity of water that is expected to be available from the source rivers after maintaining baseflow (USACE, 1982). The quantity of water that could be delivered to Region O under Plan 2 is 8.7 million ac-ft/yr after accounting for conveyance and evaporation losses.

Plan 1 would divert surface water from the Red River in Arkansas and Sulphur River in eastern Texas (TWDB Planning Region D):

- Diversions from the Red River would approach 2,000 cubic feet per second (cfs) and would be stored in the nearby proposed Bodcau Reservoir near Fulton, Arkansas to the east of the Red River. The Bodcau Reservoir has a proposed capacity of 1,100,000 acre-feet.

- Diversions from the Sulphur River would be a little more than 1,000 cfs and would be stored in the proposed Marvin Nichols reservoir (formerly proposed to be called the Naples Reservoir) near De Kalb, Texas. The Marvin Nichols Reservoir has a proposed capacity of 2,100,000 acre-feet.

After accounting for losses, the Bodcau reservoir would supply the water conveyance canal at a rate of about 1,780 cfs (approximately 1.29 million ac-ft/yr), and the Marvin Nichols reservoir would provide a supply to the canal of about 930 cfs (approximately 0.67 million ac-ft/yr) for a total of 2,710 cfs (approximately 1.96 million ac-ft/yr).

The route of the main water conveyance canal would start at the Bodcau reservoir and would extend for 75 miles, crossing the Red River by siphon, to the confluence with the Sulphur River spur supplying water from the Marvin Nichols reservoir. The Sulphur River spur canal would extend 25 miles to connect the Marvin Nichols reservoir to the main canal. The combined channel would be enlarged in De Kalb, Texas and would travel an additional 465 miles across Texas to the proposed terminal reservoir site in Blanco Canyon near Crosbyton, Texas (Figure 5G-1) for a total of 565 miles of concrete-lined canal. This trans-Texas canal would generally follow drainage divides and would be aligned to reduce environmental impacts and conflicts with inhabited and developed areas. The canal would require 21 pumping stations and use 7.5 billion kilowatt-hours (kW-hr) per year to lift the water 2,610 feet in elevation. The project would require construction of crossings for 21 rail lines, 3 interstate highways, 28 U.S. highways, 43 state highways, and 30 pipelines (USACE, 1982).

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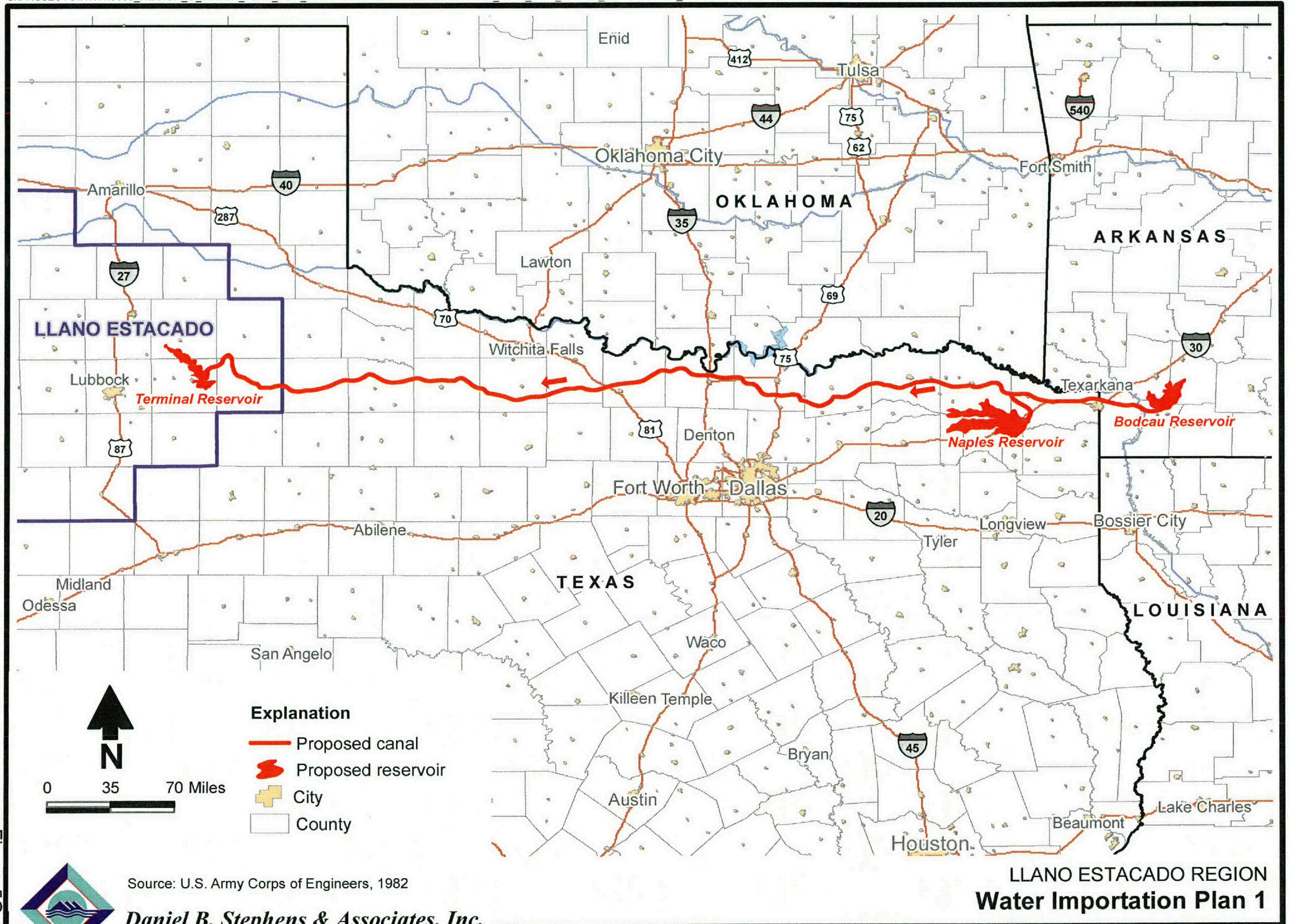

Source: U.S. Army Corps of Engineers, 1982

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JN WR11.0030

LLANO ESTACADO REGION
Water Importation Plan 1

Figure 5G-1

The total land area required for the source and terminal reservoirs is 155,000 acres. An additional 38,000 acres is required for the canal and pump stations for a total of 193,000 acres of land.

Evaporation and seepage losses would reduce the input to the canal by about 10 percent for an inflow of 1.77 million ac-ft/yr at the terminal reservoir. After accounting for additional evaporation losses in the terminal reservoir (about 50,000 ac-ft/yr) and transmission losses (10 percent) between the terminal reservoir and the farm headgates, the delivered quantity of water would be about 1.55 million ac-ft/yr (USACE 1982).

Plan 2 is similar to Plan 1 except for an enlargement of the canals and terminal reservoirs and extension of the canal and reservoir system to the Arkansas, White, and Ouachita Rivers in Arkansas and the Sabine River in Texas (Figure 5G-2). Four additional source reservoirs were proposed (USACE, 1982):

- Des Arc reservoir on the White River near Clarendon, Arkansas (200,000-acre-foot capacity)
- Saline reservoir on the Arkansas River near Pine Bluff, Arkansas (2,800,000-acre-foot capacity)
- Tulip Reservoir on the Ouachita River near Camden, Arkansas (1,500,000-acre-foot capacity)
- Carthage Reservoir on the Sabine River near Tatum, Texas (1,500,000-acre-foot capacity)

The canal, mostly concrete-lined but natural channel in parts, would extend for 845 miles and would require construction of crossings for 58 rail lines, 8 interstate highways, 68 U.S. highways, 128 state highways, and 83 pipelines. The canal would travel under the Arkansas, Ouachita, and Red Rivers by siphon. The canal would require 30 pumping stations and 49 billion kW-hr per year to lift the water a total of 2,725 feet. The total land area required for the source and terminal reservoirs is 441,000 acres. An additional 93,000 acres is required for the canal and pump stations for a total of 534,000 acres.

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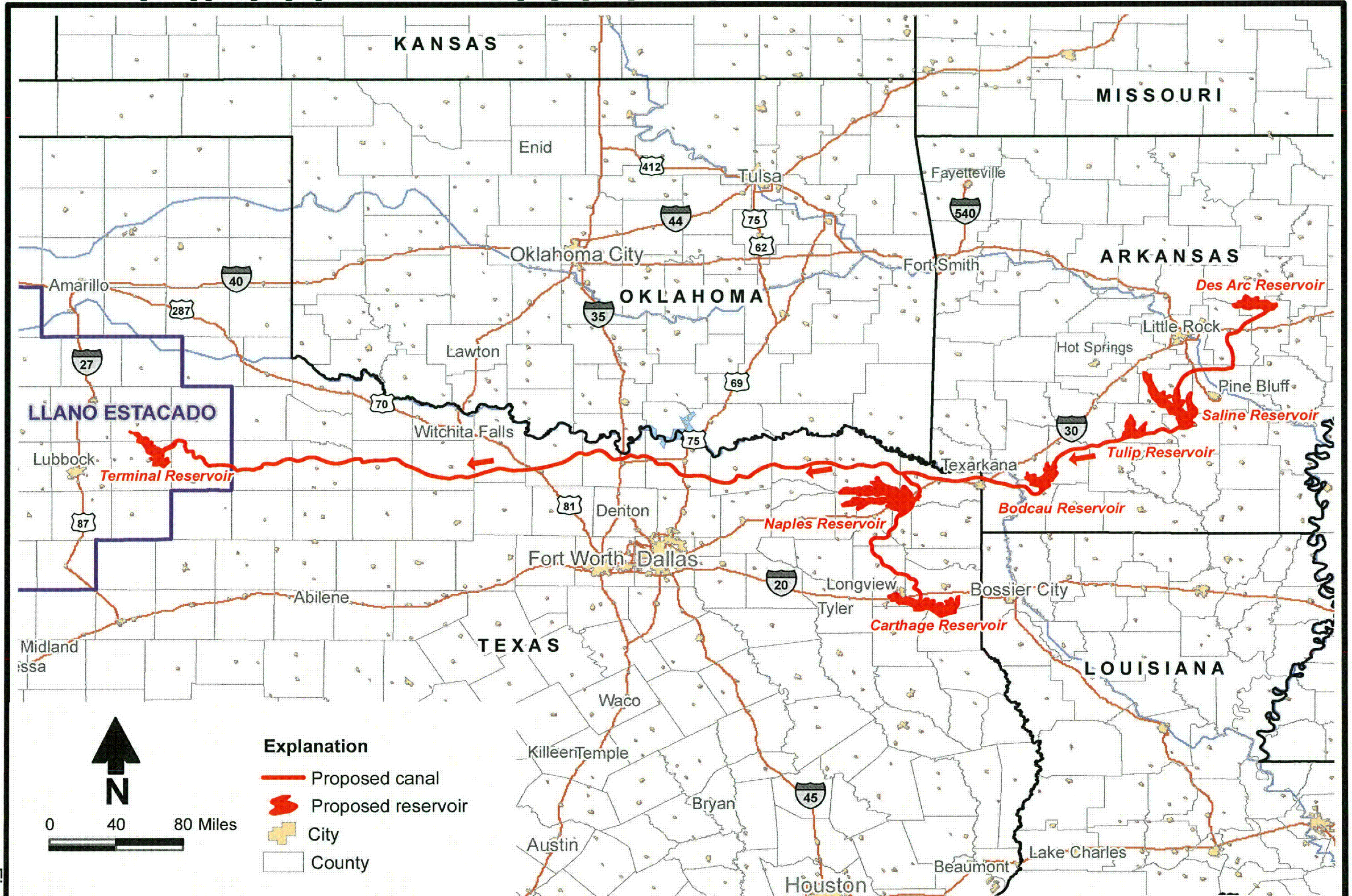


LLANO ESTACADO REGION

Water Importation Plan 2

Daniel B. Stephens & Associates, Inc.

10/27/2015

JN WR11.0030

Figure 5G-2

After accounting for losses, the reservoirs would supply the canal system at a total rate of 10.91 million ac-ft/yr. Transmission losses along the canal would reduce the volume of water delivered to the terminal reservoir to 9.80 million ac-ft/yr. Evaporation in the terminal reservoir (120,000 ac-ft/yr) and transmission losses (10 percent) between the terminal reservoir and the farm headgates would result in about 8.7 million ac-ft/yr delivered to the farm headgates.

An alternative or supplement to the terminal reservoir is the use of artificial recharge through an aquifer storage and recovery (ASR) project. Artificial recharge was considered by the USACE but was determined to be less desirable due to uncertainty in locating appropriate recharge sites and expected requirement of significant legal and institutional changes (USACE, 1982). However, large-scale ASR projects have been implemented in other states since the High Plains study, and this option should be considered in future evaluations.

Beyond the Mississippi River Basin, the Great Lakes basin could also be considered as a source of water for Region O. There are no known studies that detail importation of water from the Great Lakes basin to west Texas, but the transfer from the Great Lakes basin would likely use the Mississippi River basin to transfer water south and then a water transfer system similar to the trans-Texas canal to move the water from the Mississippi River to Region O. The only existing large-scale diversion from the Great Lakes basin is the Chicago diversion, which was initiated in 1848 and is currently limited by the U.S. Supreme Court to 2.32 million ac-ft/yr. Additional large-scale diversions are banned by the 2008 Great Lakes compact between the states of Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin. The compact prohibits the diversion of water from the Great Lakes basin and prohibits any federal agency from studying the diversion of water from the Great Lakes basin unless approved by the governor of each of the Great Lakes states (U.S. Code Title 42 Title 42, Chapter 19B, Subchapter IV, § 1962d-20). Political opposition from the Great Lakes states makes this option unlikely to be implementable.

5G.2 Quantity and Reliability of Water

The states and basins of origin both upstream and downstream of the potential diversion points would be considered to have prior rights to waters in perpetuity against the importing areas

(HPA, 1982). Therefore, only surplus flows above baseflow in the source rivers would be available for importation. The estimates of water ultimately available through importation (1.55 million ac-ft/yr under Plan 1 and 8.7 million ac-ft/yr under Plan 2) are based on the estimated surplus flows above baseflow in the source rivers.

The USACE and U.S. Fish and Wildlife Service (USFWS) had widely different estimates of baseflow for many of the source rivers (USACE, 1982, Appendix D), and the USFWS estimates particularly do not support the Plan 2 estimate. The quantity of 8.7 million ac-ft/yr was based on the USACE (1982, Appendix D) baseflow estimates that were calculated after analyzing flow records, state water compacts, average outflows of upstream dams, and previous studies. In their reconnaissance study for the fish and wildlife instream need, the USFWS made preliminary baseflow estimates that were potentially over-estimated (USACE, 1982, Appendix D). However, the difference between the USFWS and USACE baseflow requirements is greater than the maximum source yield reported by USACE for the White, Red, and Arkansas Rivers, suggesting that there may be no surplus flow available from these rivers. Further, the USFWS baseflow requirements for the Ouachita River in Arkansas indicate that only a negligible quantity of water is available, and the USFWS baseflow requirements for the Sulphur and Sabine Rivers in Texas were lower than the USACE baseflow estimates. If only the USFWS-estimated surplus in the Sulphur and Sabine Rivers are available for diversion (instead of the USACE estimates for the six rivers), the quantity of water that could be imported would be only about 1.4 million ac-ft/yr after accounting for losses. Given the disparity in the USACE and USFWS baseflow estimates, further and updated evaluation of streamflow records and fish and wildlife instream needs is necessary to better understand the quantity of water available from the source rivers.

Furthermore, if a trans-Texas canal is constructed to import water from eastern Texas and Arkansas, additional demand along the canal corridor may reduce the quantity of water delivered to Region O. The canal would cross and obtain water from Region D, which itself has an estimated supply need of 96,142 ac-ft/yr by 2060 (TWDB, 2012). The canal would continue westward through Regions C (Dallas-Fort Worth area), B (north-central Texas), and G (Brazos), which have unmet demands of 1,588,236 ac-ft/yr, 40,397 ac-ft/yr, and 390,732 ac-ft/yr, respectively, for a total supply demand of 2.12 million ac-ft/yr by 2060 (TWDB, 2012). Many of these supply demands can be met within those planning regions, but it is expected that there would be competing demands along the canal corridor.

5G.3 Financial Costs

The cost for the USACE 1982 projects over the anticipated 20-year construction period was estimated to range from $6.5 billion to $26.2 billion in 1977 dollars, depending on the quantity of water to be imported. Using the USACE Civil Works Construction Cost Index System (CWCCIS) composite index between 1977 and 2015 (USACE, 2014), the construction cost in current dollars is estimated to range from $25 billion to $99 billion for Plans 1 and 2, respectively. Further evaluation of current construction costs is needed to refine this estimate.

Construction costs include those for the primary components, which include source reservoirs, canals, pump stations, siphons, land purchase, terminal reservoirs, realignment of roads, rail-lines and highways, and cultural resource and wildlife mitigation. Construction costs do not include those for source diversion structures (e.g., lock and dam structures) and delivery systems from the terminal reservoirs to the farm headgates (HPA, 1982). The U.S. Bureau of Reclamation estimated that the capital costs in 1978 dollars to distribute water from the terminal reservoirs to the farms would be $2,150 per acre ($7,480 in 2015 dollars based on the CWCCIS). The total annual costs including interest, amortization, operation, maintenance, replacement, and energy ranged from $760 million to $3.836 billion per year in 1977 dollars, depending on the quantity of water imported (HPA, 1982); these costs in 2015 dollars would range from $2.9 billion to $14.5 billion per year. The unit cost in 1977 dollars per acre-foot of water ranged from $441 to $490 and in 2015 dollars, after applying the CWCCIS, from $1,672 to $1,855 per acre-foot per year. These annual unit costs do not include the capital construction costs.

5G.4 Environmental Impacts and Limitations

In 1982, the USFWS completed an environmental assessment of each of the alternative interstate, interbasin transfer routes evaluated by UASACE. The environmental assessments found adverse impacts on fish, wildlife, and other natural resources at and near the points of diversion, at and around the source reservoirs, along the conveyance routes, and at and around the terminal storage reservoirs. A primary negative environmental impact would be the large amount of land required for these facilities, much of which would be important habitat. Wetlands and bottomland hardwoods in southwestern Arkansas and wildlife habitat in northeast Texas would be lost or modified along the route (HPA, 1982), although the loss of habitat could be mitigated to some extent by acquiring replacement habitat (HPA, 1982). Each of the seven storage reservoirs would involve environmental, social, and cultural resource impacts equivalent to a large multiple-purpose water resource project. The beneficial gains (lake, fisheries, recreation, etc.) typically associated with large reservoirs would not be dependable due to widely fluctuating water levels as part of the route plan (HPA, 1982).

A preliminary review of USFWS-listed endangered species potentially found along the canal route identified Louisiana black bear, southwestern willow flycatcher, sharpnose shiner, smalleye shiner, least tern, black-capped vireo, and golden-cheeked warbler (USFWS, 2015). Threatened animal species include the red knot, piping plover, and lesser prairie-chicken (USFWS, 2015). Threatened plant species include *Geocarpon minimum* (no common name) (USFWS, 2015).

Many rivers and streams in Arkansas and Texas (mostly Region D) could potentially be impacted by the water importation plan. Alteration of the streamflow could impact aquatic ecosystems and reduce wetland and floodplain forest areas. In addition, transfer of water in the canals may result in continuous mixing of aquatic life forms throughout all the major drainages crossed by the water conveyance system, and such unintentional introductions could have profound effects on local endemic species (USACE, 1982, Appendix D). No assessments were made of the impacts downstream of the points of diversion considered by the USACE for interbasin transfers. However, possible impacts include changes in stream morphology, adverse impact on aquatic species and productivity, impacts to riparian wildlife habitat, reduction in water quality, reduction of minimum flows needed for salinity repulsion in the Mississippi River Delta, and reduction of freshwater flows needed for the coastal fisheries in Louisiana (HPA, 1982).

The importation plan could potentially impact one national forest, one national grassland, three national wildlife refuges, 10 state wildlife areas, four state parks, one state forest, and four wild, scenic, or free-flowing rivers. However, most of these impacts would be indirect. A current review of National Park Service properties along the proposed conveyance route shows no national parks, monuments, or historic sites that would be expected to be impacted by the water conveyance system.

The above information is only an overview of potential environmental impacts. A variety of environmental assessments would need to be performed if the importation plan is considered further.

5G.5 Implementation

Further evaluation of interstate water importation needs to consider technical, financial, legal, and political aspects of the project.

Technical studies that would need to be conducted include an updated survey and mapping of the proposed canal and reservoir areas, estimation of the range of water quantities available, and modernization of the facility designs.

Financial considerations include updating the total estimated construction cost, project cost per unit of transferred water, and cost for the energy requirements. A special interstate public entity may be required to finance, construct, maintain, and operate the water system, similar to the Port Authority of New York and New Jersey. This authority would likely need bonding, taxing authority, and power to purchase and condemn land (USACE, 2015).

Legal review should be conducted to evaluate state and federal regulations that may impact obtaining the water at the source, transporting the water, and using the water. For example, release of canal water to streams may require a National Pollutant Discharge Elimination System (NPDES) permit.

Further evaluation will need to consider the energy demands of the project and the potential need for the construction of power plants. Additional power generation is likely needed, as the power requirements for the plans range from 7.5 billion kW-hr per year to 49 billion kW-hr per year, while the current power generation in the state of Texas is 35 billion kW-hr per year (USEIA, 2014). Plans and costs have not been developed for new power plants.

Imported water from Arkansas and eastern Texas would first require appropriate interstate agreements and Congressional authorization. The importation plans are likely to face political opposition from the source river regions and possibly regions along the canal route:

- In 1983 the U.S. Congress prohibited the U.S. Bureau of Reclamation from studying or constructing recharge projects in the High Plain states that used water from the Great Lakes drainage basin or the State of Arkansas (U.S. Code Title 43, Chapter 12, Subchapter 1, 390g, 390g-8).

- Within the State of Texas, additional demand for supply in planning regions along the canal route may consume a large proportion of the imported water. For example, since 1982 when the USACE developed their estimate of 670,000 ac-ft/yr for importation to Region O from the Marvin Nichols Reservoir, Region C (Dallas-Fort Worth area) has included construction of the Marvin Nichols reservoir in their RWP to supply 490,000 ac-ft/yr to their region. If the Marvin Nichols Reservoir was built, Region C would likely consume a large proportion of the 670,000 ac-ft/yr yield needed for the USACE Region O importation Plan 1.

- Region D, where the reservoir is proposed to be located, opposes construction of the Marvin Nichols reservoir altogether (TWDB, 2012, 2014a).

Implementation of the importation plan would need political support from the source and canal corridor regions.

Water importation is not being recommended as a WMS as part of the current planning cycle; however, the LERWPG has included an evaluation of the strategy for informational purposes. The group recognizes that the strategy is currently unfeasible, due to social, economic, and environmental considerations.

Appendix 5H

City of Lubbock
Water Use Management Plan

ARTICLE 22.08 WATER USE MANAGEMENT PLAN*

Division 1. Generally

Sec. 22.08.001 Introduction

(a) The city is located in Lubbock County in the Texas Panhandle and is the eleventh largest city in the state and the largest city in West Texas. The city's population was estimated by the city planning department to be 242,843 in 2014. According to the Llano Estacado (Region 0) Regional Water Plan, the city's population is expected to increase to almost232,000 by 2025, while the city's planning department estimates the most probable population to be almost 278,000 by 2025. The city is situated in a semi-arid region that requires more water per capita for landscape irrigation than in many other parts of the state. Evidence of landscape irrigation demand is apparent when comparing the average winter water usage of 121 gallons per capita per day (gpcd) to the average summer water usage of 192 gpcd. In response to this, recent city efforts on water conservation have focused on techniques to reduce the amount of water used in landscape irrigation.

(b) This water use management plan - water conservation plan and drought and emergency contingency plan pertains to the use of water by both the city's retail and wholesale water customers, and is intended to meet the requirements of the Texas Commission on Environmental Quality (TCEQ) and the Texas Water Development Board (TWDB).

(Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.002 System description

(a) The city water system currently utilizes three separate water supply sources. During 2014, approximately 60% of the city's annual water usage will be supplied from the Canadian River Municipal Water Authority (CRMWA). Lubbock is a member city of the CRMWA. Water supplied from CRMWA is a blend of surface water and groundwater. The surface water source is Lake Meredith and the ground water source is the CRMWA well field located in Roberts County. The supply capacity of this system to Lubbock is 42 million gallons per day (MGD). This blended supply is treated at the Lubbock North Water Treatment Plant in Lubbock. The treatment plant is a conventional water treatment plant, and treats water for the city and for six other CRMWA southern division member cities: Slaton, Tahoka, O'Donnell, Lamesa, Levelland and Brownfield. CRMWA supplies the raw water to these cities.

(b) The city provides water treatment services only to these cities. These cities reimburse Lubbock for their respective portions of the water treatment cost. CRMWA operates a 250 million gallon capacity raw water reservoir located near the treatment plant. The city owns and operates a 400 million gallon raw water storage reservoir located adjacent to the CRMWA reservoir. This reservoir is used during summertime peak water use periods to supplement the normal supply from CRMWA. Its peak supply capacity is 25 MGD.

(c) During 2014, approximately 20% of the city's annual water usage will be supplied from a well field located in Bailey and Lamb Counties, which is owned and operated by the city of Lubbock. This well field is commonly referred to as the Bailey County Well Field (BCWF), and is made up of 165 production wells. All groundwater from this source is treated at a central location in the well field. Disinfection is the only treatment required for this source. The supply capacity of this system is 40 MGD.

(d) During 2014, approximately 20% of the city's annual water usage will be supplied from Lake Alan Henry located 60 miles southeast of Lubbock in Garza and Kent Counties. The supply capacity of this system to Lubbock is 15 MGD. The water pumped from Lake Alan Henry is treated at the Lubbock South Water Treatment Plant near Lubbock. (e) The city water distribution system contains approximately 1,471 miles of pipeline mains, 12 pump stations, 12 ground storage tanks totaling 64.5 million gallons, 4 conventional elevated storage tanks totaling 4.15 million gallons, and the BCWF pipeline that functions as an unconventional elevated storage system totaling 11.0 million gallons.

(f) The city sells water on a wholesale basis to six separate public water supply systems, the City of Shallowater, Lubbock Reese Redevelopment Authority, Lubbock County Water Control & Improvement District No. 1 (also known as Buffalo Springs Lake community), the Town of Ransom Canyon, the City of Littlefield, and the City of New Deal. The water is supplied to the City of Littlefield only for infrequent emergency use. The water supplied to the City of New Deal is water purchased from the City of Slaton by the City of New Deal and delivered through the City of Lubbock water distribution system, for which Lubbock charges only a delivery fee.

(Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.003 Definitions

For the purposes of this plan, the following definitions shall apply:

Aesthetic water use. Water use for ornamental or decorative purposes such as fountains, reflecting pools, and water gardens.

Annual water supply. The amount of water available to the city within a given year. Normally measured in billions of gallons or acre-feet.

Average winter consumption. The amount of water used by a customer on average during the winter months of December, January, and February.

Conservation. Those practices, techniques, and technologies that reduce the consumption of water, reduce the loss or waste of water, improve 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 use.

Domestic water use. 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, except as provided under the definition of nonessential water use below.

Drought. An extended period of time of below normal precipitation (rainfall, snow, etc.).

Drought of record. Extended period of time of below normal precipitation (rainfall, snow, etc.) that exceeds the length of time and impact on water supplies of previous droughts. The drought of record is used to help determine the estimated yield of reservoirs.

Hand watering. The irrigation and maintenance of landscaped areas, whether publicly or privately owned, including residential and commercial lawns, gardens, golf course greens, tees, fairways, parks, athletic fields, street or alley rights-of-way and medians through the use of manual water devices supplied by a water hose and actively attended to by a person.

Increasing block rate. A water rate structure that has a rate that increases as more water is consumed.

Landscape irrigation or landscape irrigation use. Water used for the irrigation and maintenance of landscaped areas, whether publicly or privately owned, including residential and commercial lawns, gardens, golf course greens, tees, and fairways, parks, athletic fields, street or alley rights-of-way and medians.

Maximum daily supply. The amount of water available to the city during a given day. The amount may be limited due to the water transmission line size, water pump size, the number of operating wells, the amount of raw and treated water storage, the water rights owned by the city and other related factors.

Nonessential water use. Water uses that are neither essential nor required for the protection of public health, safety, and welfare, including without limitation:

(1) Landscape irrigation;

(2) Use of water to wash any motor vehicle, motorbike, boat, trailer, airplane, or other vehicle of any kind;

(3) Use of water to spray or wash down any sidewalks, walkways, driveways, parking lots, tennis courts, or other hard-surfaced areas;

(4) Use of water to spray or wash down buildings or structures for purposes other than immediate fire protection;

(5) Flushing gutters or permitting water to run or accumulate in any gutter or street;

(6) In connection with stage 3 and stage 4 drought response stages, use of water to fill, refill, or add to any indoor or outdoor swimming pools or hot tubs;

(7) Use of water in a fountain or pond for aesthetic or scenic purposes except where necessary to support aquatic and avian life; and

(8) Failure to repair a leak(s) within a reasonable period of time after having been given notice directing the repair of such leak(s).

Per capita water use. A measure of water use for a city or other entity, expressed in gallons per capita per day (gpcd). The measure compares water use to the number of citizens in the area. The measure does not reflect the amount used on average by a citizen.

Water Loss. Measured as the volume of water metered into the water distribution system minus the volume billed for a given time period.

(Ordinance 2010-O0055 adopted 7/22/2010; Ordinance 2012-O0022, sec. 3, adopted 3/29/2012)

Secs. 22.08.004–22.08.030 Reserved

Division 2. Water Conservation Plan

Sec. 22.08.031 Introduction

The city provides retail water service to city residents and also provides water on a wholesale basis to six additional entities. While the city can try to directly influence the water use of its retail water users through the water conservation measures discussed in this plan, as the six wholesale customer's retail utility systems are separate from the city's retail system, the city does not have the ability to implement most of the water conservation measures discussed in this plan for the wholesale customers. The wholesale customers will be able to implement these measures as a part of their respective retail water supply operations. (Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.032 Declaration of policy, purpose, and intent

In order to conserve the available water supply, the city adopts the following regulations concerning water conservation through this article. Water uses regulated or prohibited under this water conservation plan are considered to be discretionary and are deemed to constitute a waste of water which subjects the offender(s) to penalties as defined in section 22.08.046 of this plan. (Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.033 Authorization

The city manager or his/her designee is authorized and directed to implement the applicable provisions of this plan. The city manager or his/her designee will act as the administrator of the plan, oversee the execution and implementation of the plan, and will be responsible for keeping adequate records for program verification. (Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.034 Conservation goals

(a) The city's water conservation goals are to:

(1) Provide an adequate supply of suitable treated water to meet the needs of its retail and wholesale customers; and

(2) Encourage its wholesale customers to adopt and implement water conservation plans that will reduce their per capita water use rates.

(b) The city's wholesale customer water conservation program is predicated on the fact that the implementation of conservation measures must occur largely at the local level. Due to this fact, the city's wholesale program is focused on encouraging and supporting initiatives by its wholesale customers.

(c) TCEQ rules require that water conservation plans contain specific, quantifiable five- and ten-year goals for use in gallons per capita per day. The goals established as part of this plan are not enforceable. The gpcd calculation, as defined by TCEQ, is the total average daily amount of water diverted or pumped for treatment by potable uses divided by the population served.

(d) In order to set a per capita goal for municipal water conservation, baseline per capita water use was determined from the average per capita water use from 2009 to 2013 as determined by the city. In order to determine these values, the city uses total water pumped from all sources divided by the estimated city population as determined by the city's planning department. This resulted in an average value reflecting both wet and dry years. The average per capita use from 2009 to 2013 was 153 gpcd with a high of 178 gpcd in 2011 and a low of 140 gpcd in 2009. This average per capita use rate is less than the target rate of 172 gpcd recommended by the Llano Estacado Regional Water Planning Group, but greater than the target rate of 140 gpcd recommended by the state water conservation task force. The water conservation task force recommends a one percent per year reduction until the target of 140 gpcd is reached; however, in light of the fact that the city has already achieved a significant conservation response, the goals for this plan were developed utilizing a 0.5% per year reduction in per capita water use. This results in a per capita goal for year 2019 of 150 gpcd and a year 2024 goal of 147 gpcd. This reflects a reduction of 0.5% per year from the 155 gpcd in 2013. .

(e) This methodology is similar to that used in the city's previous water conservation plan adopted in 2010. The former and current plans use a 0.5% per year reduction in per capita water use goal. The new goals established under this revised plan are similar to those previously established.

(f) In addition to the per capita water use goal above, the city has set a maximum water loss water goal of 10% for the retail water delivery system for both 2019 and 2024. This would correspond to a loss rate of 15 gpcd in 2019 and 14.6 gpcd in 2024. This goal is a benchmark established by the TCEQ for water loss.

(Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.035 Metering water diverted from the source of supply

The city meters the amount of raw water pumped from the BCWF, Lake Alan Henry, and from the CRMWA supply using meters that are maintained to record flow with an accuracy of plus or minus 5.0%. The amount of water delivered to each wholesale water customer is also metered by the city. (Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.036 Universal metering program

(a) Using meters that meet at least the minimum standards developed by the American Water Works Association and with a metering accuracy range of plus or minus 5.0%, the city individually meters all water usage, except that utilized for fire protection. Combined with the city's computerized billing system, the city's universal metering program has a water delivery accuracy rate of plus or minus 5%, which meets the TCEQ standards for meter accuracy. The city encourages each wholesale water customer to meter all water usage as well.

(b) The city uses a random sampling technique to test meter accuracy and to determine when meters need to be repaired or replaced. The city randomly samples approximately 400 water meters each year. Depending on the results of this sample, additional sampling may be done to target meters of a certain age or meters located within a certain geographical portion of the city. Meters found to have an accuracy of less than plus or minus 5% are either repaired or replaced as needed.

(Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.037 Records management system

The city maintains a records management system which tracks the volume of water pumped, water delivered to retail customers, water sold to wholesale customers, and the volume of water losses. The city's utility billing database allows water sales and uses to be desegregated into the volume used by residential, commercial, public and institutional, and industrial customers. (Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.038 Measures to control unaccounted-for uses of water

The city takes the appropriate steps to monitor and audit its water system for water loss in an effort to conserve water, manages the replacement of old water lines that are prone to leaks and breaks, investigates customer complaints of low pressure and possible leaks, visually inspects suspected leaks, and tracks water delivery to customers to determine illegal connections and abandoned service lines. (Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.039 Program for achieving water conservation goals

(a) The city has established goals, objectives and programs that support a standard for water use. The city's water conservation program is comprised of five main strategies in the following order of priority:

(1) Administrative water conservation efforts;

(2) Water use standards;

(3) Public education and information;

(4) Enforcement; and

(5) Structural changes.

(b) The city will evaluate and implement certain administrative changes to programs, policies, and rules that support water conservation efforts. In 1992, the city moved from a declining block rate to a uniform block rate. In 2007, the city passed a revised water rate ordinance with an inclining block rate structure. Other administrative changes may include the continued review and revision of city codes to determine their affect on the use of water and active enforcement of rules, codes, and regulations affecting water use.

(c) In an effort to manage annual and maximum daily water use, the water conservation program establishes the following water use standards for outdoor landscape irrigation:

(1) Landscape irrigation is allowed to occur only between the hours of 6:00 p.m. to 10:00 a.m. from April 1st through September 30th.

(2) Summer irrigation should provide a maximum of 1.5 inches per zone per week.

(3) Winter irrigation may occur only when temperatures are above 35°F so as not to cause a freezing hazard and should provide a maximum of 1.0 inch per zone per month for dormant grasses (i.e. Bermuda) and 1.0 inch per zone every two weeks for cool season grasses (i.e. Fescue).

(4) Irrigation should occur without water runoff. This may be accomplished by correctly cycling the sprinkler system and allowing time for the water to soak into the landscape between irrigation events.

(d) The city will support programs to educate the public regarding water conservation activities that support its goals. This includes educating the general public on the need for and practices of water conservation through public service announcements, participation in home and garden shows, coordination efforts with the Chamber of Commerce, West Texas Home Builders Association and Lubbock Apartment Association, and supporting water conservation efforts in the local education system.

(e) Structural changes that have been and may be adopted by the city are those programs that result in a physical modification of water use devices or practices, such as landscape design and maintenance, rain and freeze sensors on automatic irrigation systems, plumbing retrofit or rehabilitation programs, controlling water loss, and by reusing treated wastewater and stormwater.

(f) In regards to the city's wholesale water customers, their retail utility systems are separate from the city's retail water system; therefore, the city does not have the ability to implement most of the water conservation items discussed above. The city encourages its wholesale customers to implement these or other appropriate water conservation measures as a part of their respective retail water supply operations.

(Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.040 Water rate structure

The city has adopted a water rate structure which is non-promotional (see section 22.03.085 of this code). (Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.041 Reservoir operations plan

This requirement is not applicable to the city at this time. The city only owns and operates one water supply reservoir, Lake Alan Henry, which is located on the South Fork of the Double Mountain Fork of the Brazos River. (Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.042 Coordination with regional planning groups

The water service area of the city is located within Llano Estacado Regional Planning Area (Region O) and the city has provided a copy of this plan to the Llano Estacado Regional Water Planning Group to ensure consistency with the regional water plan. (Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.043 Leak detection/repair and water loss accounting program

(a) The city routinely monitors the water storage, delivery, and distribution system components for leaks. Waterline leaks are detected by utility personnel while reading meters, maintaining their water and wastewater systems, and while performing other routine surveillance programs. Any reported leaks are repaired in a timely manner. The wholesale water customers are responsible for managing their ongoing leak detections, location, and repair programs.

(b) At a minimum, the city will conduct a water audit using the methodology outlined by the TWDB every five years in accordance with current TWDB rules. Water audits may be conducted on a more frequent basis if the city deems that action to be appropriate.

(Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.044 Water supply contracts

(a) It is a mandatory requirement for the city to require wholesale customers with any new or amended contracts or successor contracts to develop a water conservation plan. Minimum plan requirements for municipal wholesale customers entering or renewing city contracts include:

(1) A completed TCEQ utility profile;

(2) 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;

(3) Metering devices having accuracy within plus or minus 5 percent in order to measure and account for the amount of water diverted from the supply source;

(4) A program for universal metering of both customer and public uses of water, for meter testing and repair, and for periodic meter replacement;

(5) 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.);

(6) A program of continuing public education and information regarding water conservation;

(7) A water rate structure which is not "promotional," meaning a rate structure which is cost-based and which does not encourage the excessive use of water;

(8) A reservoir systems operation plan, if applicable, providing for the coordinated operation of reservoirs owned by the utility within a common watershed or river basin in order to optimize available water supplies;

(9) A means of implementation and enforcement of conservation practices, as evidenced by either:

(A) A copy of the ordinance, resolution, or tariff, indicating official adoption of the water conservation plan by the customer; or

(B) A description of the authority by which the customer will implement and enforce the water conservation plan; and

(10) Documentation of coordination with the regional water planning groups for the service area of the customer in order to ensure consistency with the appropriate regional water plans.

(b) Water conservation plan must include the following additional elements if the customer serves, or plans to serve in the next 10 years, a population of 5,000 or greater:

(1) A 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) 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; and

(3) For wholesale water customers, that they include a requirement that every wholesale water supply contract entered into or renewed after official adoption of the customer's water conservation plan, and including any contract extension, that each successive wholesale customer develop and implement a water conservation plan or water conservation measures using the applicable TCEQ requirements.

(c) Other measures that the customer could adopt to meet the stated conservation goals might include but are not limited to:

(1) Measurement and control of excessive pressure in the distribution system;

(2) Ordinances to promote efficiency and avoid water waste;

(3) Plumbing fixture replacement and retrofit programs;

(4) Other beneficial reuse of water such as grey water and rainwater harvesting systems; and

(5) Other measures as may be applicable.

(d) All customer plans must be reviewed and approved by city council before water sales contracts are signed.

(Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.045 Revisions to the water conservation plan

The city shall review and update, as appropriate, the water conservation plan at least every five (5) years, based on, in part, an assessment of the previous five- and ten-year goals, new or updated information such as the adoption or revision of the regional water plan, or changes in laws or regulations. (Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.046 Penalties for noncompliance with the water conservation plan

Any water customer or other user of the city's water supply that violates this water conservation plan shall be guilty of a misdemeanor and subject to a penalty and fine as set forth in section 1.01.004 of this code for each day of noncompliance. In addition:

(1) Service shall be discontinued to those customers who do not pay their water bills until all required payments are made; and

(2) New water service taps will be provided to new construction and new construction will be approved only if such construction conforms to adopted ordinances.

(Ordinance 2010-O0055 adopted 7/22/2010)

Secs. 22.08.047–22.08.070 Reserved

Division 3. Drought and Emergency Contingency Plan

Sec. 22.08.071 Introduction

(a) A number of situations may limit the city's ability to deliver a sufficient amount of water to meet the demands of all customers. In those instances, the city will take steps to ensure that water is available for essential life and safety needs. This drought and emergency contingency plan (the plan) is designed to address the following situations. Reduction in available water supply up to a repeat of the drought of record;

(b) Water production or distribution limitations (peak water supply);

(c) Supply source contamination; and/or

(d) System outages.

(e) There are four stages to address drought and emergency conditions. Each stage has triggers for initiation, for restrictions on water use to assist in reaching water use reduction goals, and has provisions for rescinding the stage once the conditions that caused the drought or emergency have ceased to exist. The stages are defined as:

(1) Stage 1 - mild water shortage conditions.

(2) Stage 2 - moderate water shortage conditions.

(3) Stage 3 - severe water shortage conditions.

(4) Stage 4 - emergency water shortage conditions.

(Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.072 Declaration of policy, purpose, and intent

(a) 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 city adopts the following regulations and restrictions on the delivery and consumption of water through this article.

(b) Water uses regulated or prohibited under this drought and emergency contingency plan are considered to be nonessential and continuation of such uses during times of water shortage or other emergency water supply conditions are deemed to constitute a waste of water which subjects the offender(s) to penalties as defined in section 22.08.083 of this plan.

(Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.073 Authorization

The city manager 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 city manager, 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. (Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.074 Public involvement

Opportunity for the public and for the wholesale water customers to provide input into the preparation of the plan was provided by the city by means of scheduling and providing public notice of a public meeting to accept input on the plan held on July 8, 2010. The plan was adopted under the open meetings requirement of the TCEQ during the July 22, 2010 city council meeting. (Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.075 Public and wholesale customer education

(a) The city will periodically provide the public and wholesale 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 to the public. The city will periodically provide the public and wholesale 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 to the public by means necessary to educate and provide information to the public, including but not limited to, public service announcements, newspaper notices, utility bill inserts, and educational presentations.

(b) This information will be provided to the wholesale customers by providing them with a copy of this plan.

(Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.076 Coordination with regional water planning groups

The water service area of the city is located within the Llano Estacado Regional Water Planning Area (Region O). The city has provided a copy of this plan to the Llano Estacado Regional

Water Planning Group to ensure consistency with the approved regional water plan. (Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.077 Application

The provisions of this plan shall apply to all persons, customers, and property utilizing water provided by the city, including the city's wholesale water customers. The terms "person" and "customer" as used in the plan includes individuals, corporations, partnerships, associations, and all other legal entities. (Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.078 Triggering criteria for initiation and termination of drought response stages

(a) The city manager, or his/her designee, shall monitor water supply and/or demand conditions on a daily basis and shall determine when conditions warrant initiation or termination of each stage of the plan, that is, when the specified "triggers" are reached. Public notification of the initiation or termination of drought response stages will be made by publication in a newspaper of general circulation, public service announcements, and/or signs posted in public places. Wholesale customer notification of the initiation or termination of drought response stages will be made by email, mail, or telephone.

(b) The triggering criteria below are based on an evaluation of the historical water system capacities and customer use patterns, and consider the impact of drought, emergencies, and high use upon capacities and patterns.

(1) Stage 1 - mild water shortage conditions.

(A) Requirements for initiation. Stage 1 of the plan shall be implemented if any of the following conditions arise:

(i) Daily water use exceeds 80% of the city's maximum daily supply capacity for ten consecutive days;

(ii) Water supply available from all sources is only sufficient to meet projected needs; or

(iii) Water availability is adequate but lake levels, reservoir capacities, or groundwater supplies are low enough that some concern exists for future water supplies if the drought or emergency condition continues.

(B) Requirement for termination. Stage 1 restrictions may be rescinded when all initiation conditions have ceased to exist as determined by the city manager or his/her designee.

(2) Stage 2 - moderate water shortage conditions.

(A) Requirements for initiation. Stage 2 of the plan shall be implemented if any of the following conditions arise:

(i) Daily water use exceeds 90% of the city's maximum daily supply capacity for ten consecutive days;

(ii) Water supply available from all sources are reduced, but are greater than 90% of projected needs; or

(iii) Water availability from lakes and groundwater is below normal and may continue to decline and cause moderate concern for both current and future water supplies or water supplies have been reduced due to failure of a portion of the water supply system.

(B) Requirement for termination. Stage 2 restrictions may be rescinded when all initiation conditions have ceased to exist as determined by the city manager or his/her designee. When stage 2 is terminated, stage 1 automatically becomes effective.

(3) Stage 3 - severe water shortage conditions.

(A) Requirements for initiation. Stage 3 of the plan shall be implemented if any of the following conditions arise:

(i) Daily water use exceeds 100% of the city's maximum daily supply capacity for five consecutive days;

(ii) Water supply available from all sources are reduced to 90% or less of projected needs; or

(iii) Water availability from lakes and groundwater is well below normal, may continue to decline, and additional reductions in current or future water supplies are evident or water supplies have been reduced due to failure of a portion of the water supply system.

(B) Requirement for termination. Stage 3 restrictions may be rescinded when all initiation conditions have ceased to exist as determined by the city manager or his/her designee. When stage 3 is terminated, stage 2 automatically becomes effective.

(4) Stage 4 - emergency water shortage conditions.

(A) Requirements for initiation. Stage 4 of the plan shall be implemented if any of the following conditions arise:

(i) Daily water use exceeds 105% of the city's maximum daily supply capacity for five consecutive days;

(ii) Water supply available from all sources are reduced to less than 70% of projected needs;

(iii) There has been a failure in a major water supply source or system, such as the failure of a dam, storage reservoir, pumping system, transmission pipeline, water treatment facility, major power failure, or natural disaster that causes a severe and prolonged limit on the ability of the water supply system to meet the water supply demands; or

(iv) The source water supply has been contaminated.

(B) Requirement for termination. Stage 4 restrictions may be rescinded when all initiation conditions have ceased to exist as determined by the city manager or his/her designee. When stage 4 is terminated, stage 3 automatically becomes effective.

(Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.079 Drought response stages

The city manager, or his/her designee, shall monitor water supply and/or demand conditions and, in accordance with the triggering criteria set forth in section 22.08.078 above, shall determine that mild, moderate, or severe water shortage conditions exist or that an emergency condition exists and shall implement the following actions. The city shall notify the executive director of the TCEQ within five business days of the implementation of any mandatory provisions of the plan.

(1) Stage 1 - mild water shortage conditions.

(A) Target. Reduce water use to less than 90% of the city's maximum daily supply capacity.

(B) Best management practices for supply management.

(i) The city may reduce or discontinue the flushing of water mains as well as utilize reclaimed water for non-potable purposes where practicable.

(ii) Wholesale customers are required in specific contract provisions to implement these measures as well as any other measures specified in the wholesale supply contract to better manage a limited water supply. Contract provisions requiring wholesale customers to implement mandatory drought restrictions consistent with the city will be added into any new contract or contract revision.

(C) Water use restrictions for reducing demand.

(i) Landscape irrigation is restricted to two days per week. The city manager or his/her designee may, after notice to the citizens of the city, designate irrigation schedules.

(ii) Irrigation shall provide a maximum of 1.5 inches per zone per week.

(iii) Irrigation shall occur without significant water runoff, which can be accomplished by correctly cycling the sprinkler system and allowing time for the water to soak into the landscape between irrigation events.

(iv) All city operations shall adhere to the water use restrictions.

(v) Hand watering for landscape irrigation purposes is allowed on a daily basis regardless of the time of year.

(vi) New plant material may be irrigated on a more frequent basis until the new plant material is established as defined in section 22.03.133(a)(4) related to the operation of irrigation systems.

(vii) The city manager, or his/her designee, 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 (i.e., implement stage 1 of the customer's drought contingency plan).

(2) Stage 2 - moderate water shortage conditions.

(A) Target. Reduce water use to less than 80% of the city's maximum daily supply capacity.

(B) Best management practices for supply management.

(i) The city will reduce or discontinue the flushing of water mains as well as utilize reclaimed water for non-potable purposes where practicable.

(ii) Wholesale customers are required in specific contract provisions to implement these measures as well as any other measures specified in the wholesale supply contract to better manage a limited water supply. Contract provisions requiring wholesale customers to implement mandatory drought restrictions consistent with the city will be added into any new contract or contract revision.

(C) Water use restrictions for reducing demand.

(i) Landscape irrigation is restricted to one day per week. The city manager, or his/her designee, after notice to the citizens of the city, may designate an irrigation watering schedule.

(ii) Irrigation shall provide a maximum of 1.5 inches per zone per week.

(iii) Irrigation shall occur without significant water runoff, which can be accomplished by correctly cycling the sprinkler system and allowing time for the water to soak into the landscape between irrigation events.

(iv) Water customers will refrain from or significantly limit aesthetic and non-essential water use as defined in section 22.08.003. Water shall not be used to wash down hard surfaced areas, including, without limitation, sidewalks, parking lots, gutters, and patios. Water shall not be used for dust control. However, water may be used for construction or to clean surfaces for painting.

(v) All city operations shall adhere to the water use restrictions.

(vi) Hand watering for landscape irrigation purposes is allowed on a daily basis regardless of the time of year.

(vii) New plant material may be irrigated on a more frequent basis until the new plant material is established as defined in section 22.03.133(a)(4) related to the operation of irrigation systems.

(viii) The city manager, or his/her designee, will request wholesale water customers to initiate mandatory measures to reduce nonessential water use (i.e., implement stage 2 of the customer's drought contingency plan).

(3) Stage 3 - severe water shortage conditions.

(A) Target. Reduce water use to less than 70% of the city's maximum daily supply capacity.

(B) Best management practices for supply management.

(i) The city will reduce or discontinue the flushing of water mains as well as utilize reclaimed water for non-potable purposes where practicable.

(ii) Wholesale customers are required in specific contract provisions to implement these measures as well as any other measures specified in the wholesale supply contract to better manage a limited water supply. Contract provisions requiring wholesale customers to implement mandatory drought restrictions consistent with the city will be added into any new contract or contract revision.

(C) Water use restrictions for reducing demand.

(i) Irrigation shall occur without significant water runoff, which can be accomplished by correctly cycling the sprinkler system and allowing time for the water to soak into the landscape between irrigation events.

(ii) Landscape irrigation shall not occur more than one day per month and not for more than 1.5 inches per zone. The city manager, or his/her designee, may designate the irrigation schedule.

(iii) Water customers will refrain from aesthetic and non-essential water use as defined in section 22.08.003. Water shall not be used to wash down hard surfaced areas, including, without limitation, sidewalks, parking lots, gutters, and patios. Water shall not be used for dust control. Pools and hot tubs may not be filled or drained and refilled.

(iv) Use of water from fire hydrants shall be limited to firefighting or other related activities necessary to maintain public health, safety, and welfare. Under the direction of the city manager, use of water from fire hydrants for construction purposes may be allowed by permit.

(v) All city operations shall adhere to the water use restrictions.

(vi) Hand watering for landscape irrigation purposes is allowed on a daily basis regardless of the time of year.

(viii) The city manager, or his/her designee, will contact wholesale water customers to discuss water supply and/or demand conditions and will request that wholesale water customers initiate additional mandatory measures to reduce non-essential water use (i.e., implement stage 3 of the customer's drought contingency plan).

(4) Stage 4 - emergency water shortage conditions.

(A) Target. Reduce water use to less than 50% of the city's maximum daily supply capacity.

(B) Best management practices for supply management.

(i) The city will discontinue the flushing of water mains, discontinue the irrigation of public landscaped areas, and will utilize reclaimed water for non-potable purposes where practicable.

(ii) In addition, in the event of a large-scale system failure or if the source water supply is contaminated, the city may truck in additional fresh water supplies as appropriate.

(iii) Wholesale customers are required in specific contract provisions to implement these measures as well as any other measures specified in the wholesale supply contract to better manage a limited water supply. Contract provisions requiring wholesale customers to implement mandatory drought restrictions consistent with the city will be added into any new contract or contract revision.

(C) Water use restrictions for reducing demand.

(i) All aesthetic and non-essential water use (as defined in section 22.08.003), including landscape irrigation use, is prohibited except where necessary to protect the health, safety, and welfare of the public. No new landscape material may be installed.

(ii) All city operations will adhere to the water use restrictions.

(iii) The city may reduce water system pressure to conserve water.

(iv) All wholesale water customers will be encouraged to implement stage 4 of their drought contingency plans.

(D) In addition, whenever emergency water shortage conditions exist as defined in section 22.08.078 of the plan, the city manager, or his/her designee(s), shall:

(i) Assess the severity of the problem and identify the actions needed and the time required to solve the problem;

(ii) Inform the utility director or other responsible official of each wholesale water customer by telephone, email, or in person and suggest actions, as appropriate to alleviate problems (i.e., notification of the public to reduce water use until service is restored);

(iii) If appropriate, notify city, county, and/or state emergency response officials for assistance;

(iv) Undertake necessary actions, including repairs and/or clean-up as needed; and

(v) Prepare a post-event assessment report on the incident and critique of emergency response procedures and actions.

(Ordinance 2010-O0055 adopted 7/22/2010; Ordinance 2012-O0022, secs. 1–2, adopted 3/29/2012)

Sec. 22.08.080 Coordination with the Canadian River Municipal Water Authority

The city is a wholesale water customer of the Canadian River Municipal Water Authority (CRMWA), and as such must coordinate any drought responses with CRMWA. The city will periodically consult with CRMWA concerning supplies available to the city and at the request of CRMWA enact additional drought conservation measures if so directed by CRMWA. (Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.081 Revisions to the drought and emergency contingency plan

The city shall review and update, as appropriate, the drought and emergency contingency plan at least every five (5) years based, in part, on new or updated information, such as the adoption or revision of the regional water plan. (Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.082 Pro rata water allocation

In the event that the triggering criteria specified in section 22.08.078 of the plan for stage 4 - emergency water shortage conditions have been met, the city manager, or his/her designee, is hereby authorized to initiate allocation of water supplies on a pro rata basis in accordance with Texas Water Code section 11.039. A provision shall be included 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 section 11.039. (Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.083 Enforcement

(a) Any water customer or other user of the city's water supply who violates the drought and emergency contingency plan shall be guilty of a misdemeanor and subject to a penalty and fine as set forth in section 1.01.004 of this code for each day of noncompliance. In addition, in the event: (1) the failure to comply with this article creates an imminent threat to public health, safety, or welfare; or (2) the subject person is convicted of three or more distinct violations (as opposed to consecutive multiple day events of the same violation) within a one-year period, the city, after ten-day's notice and opportunity to cure the violation, may discontinue water service until such time as the user shall be in compliance with this article and, in the case of disconnection due to an imminent health, safety, or welfare threat, pay the required charges and fees for reconnection or, in the case of disconnection due to three or more distinct violations within a one-year period, pay the required charges and fees for reconnections and provide suitable assurance to the city manager that the same action will not be repeated while the subject stage of the drought and emergency contingency plan is in effect.

(b) Any person in apparent control of the property where a violation occurs or originates shall be presumed to be the violator and proof thereof shall constitute a rebuttable presumption that the person in apparent control of such property committed the violation.

(Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.084 Variances

(a) The city water board of appeals, as established in article 2.03, division 11 of this code, may grant, in writing, a temporary variance for existing water uses otherwise prohibited under the drought and emergency contingency 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:

(1) Compliance with this plan cannot be technically accomplished during the duration of this water supply shortage or other condition for which the plan is in effect.

(2) Alternative methods can be implemented which will achieve the same level of reduction in water use.

(b) Persons requesting an exemption from the provisions of this plan shall file a petition for variance with the water board of appeals. All petitions for variances shall be reviewed by the water board of appeals and shall include, in addition to the information provided in article 2.03, division 11 of this code, the following:

(1) Name and address of the petitioner;

(2) Purpose of water use;

(3) Specific provision(s) of this plan from which the petitioner is requesting relief;

(4) Detailed statement with supporting data and information as to how the specific provision(s) of this plan adversely affects the petitioner or what damage or harm will occur to the petitioner or others if petitioner complies with this article;

(5) Description of the relief requested;

(6) Period of time for which the variance is sought;

(7) Alternative measures the petitioner is taking or proposes to take to meet the intent of this plan and the compliance date; and

(8) Other pertinent information.

(c) Variances granted by the water board of appeals shall be subject to the following conditions, unless waived or modified by the water board of appeals.

(1) Variances granted shall include a timetable for compliance.

(2) Variances granted shall expire on the earlier to occur of:

(A) The scheduled expiration;

(B) When the drought and emergency contingency plan is no longer in effect; and

(C) The date upon which the petitioner has failed to meet specified requirements.

(d) No variance shall be retroactive or otherwise justify any violation of this plan occurring prior to the issuance of the variance.

(Ordinance 2010-O0055 adopted 7/22/2010)

Secs. 22.08.085–22.08.100 Reserved

Division 4. Irrigation Water Conservation Plan

Sec. 22.08.101 General

The city owns Water Right No. 3985 in order to land apply sewage effluent from the city's wastewater treatment plant. The permit allows the city to use up to 18,430 acre-feet per year to irrigate 10,000 acres of land. The TCEQ requires a holder of an irrigation right greater than 10,000 acre-feet/year to develop an irrigation water conservation plan. This system is designed for inefficiency in order to ensure that the greatest volume of wastewater possible can be disposed of through this method. Consequently, a water conservation plan is not applicable in this circumstance. (Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.102 Land application site

The city currently has two land application sites. The Lubbock Land Application Site, located east of the city, encompasses 6,000 acres with 2,500 acres irrigated by center pivot systems. The Hancock Land Application Site, located southeast of the city, encompasses 4,000 acres with 2,500 acres irrigated by center pivot systems. Effluent from the Southeast Water Reclamation Plant is used to irrigate crops such as wheat, jose wheat, bermuda, and rye. A 412 million gallon storage reservoir allows the site to store and distribute treated effluent to 31 center pivot sprinkler systems as needed. Irrigation practices are designed to prevent contamination of surface and groundwater in the area. (Ordinance 2010-O0055 adopted 7/22/2010)

Sec. 22.08.103 Goals

The city's current and future goals for this system are to be able to dispose of the total wastewater volume necessary through this system and to not implement any water conserving devices or practices for this system. The city monitors the delivery system for any leaks by visually inspecting the system on a regular basis, and all leaks are repaired in a timely manner. (Ordinance 2010-O0055 adopted 7/22/2010)

Chapter 6

Chapter 6

Impacts of the Regional Water Plan

6. Impacts of the Regional Water Plan

The LERWPG has evaluated the various anticipated impacts that may result from implementation of the 2016 Region O water plan. This chapter addresses the impacts of the plan on the agricultural, natural, and water resources of the State, and on navigation. A summary of the needs that remain unmet by the regional water plan is provided, along with an analysis of the potential socioeconomic impacts of not meeting water needs.

6.1 Impacts on Agricultural Resources in Region

In order to quantitatively evaluate agricultural impacts, an environmental impact matrix was developed and implemented as a part of the water management strategy (WMS) evaluations (Section 5.1.3). The impact to agricultural resources was assessed by considering the number of agricultural acres impacted and the impact of strategy implementation on the water supply. On the impact matrix, the Agricultural Acres Impacted sub-category assesses the amount of agricultural land that will be disturbed due to project implementation, taking into account the differences between temporary and permanent impacts. The Water Supply Impact sub-category assesses the degree to which project implementation will affect the groundwater available for agricultural use. The sub-scores for Agricultural Acres Impacted and Water Supply Impact were averaged together to produce an overall Agricultural Resources score. Table 5-5 shows the impact matrix scores by category, and Appendix 5E includes the complete impact matrix (providing scores for each sub-category).

The Agricultural Resources scores ranged between 1.0 and 4.5 for the recommended projects and 1.5 to 3.5 for the alternative projects. The projects with the lowest scores (smallest agricultural impacts) include the irrigation conservation projects (score of 1.0) and municipal conservation and water loss reduction strategies (score of 1.5). These projects received low agricultural impact scores because they have no impact on agricultural acreage (do not reduce the acreage available for agriculture) and no negative impacts on agricultural water supply. The South Garza Water Supply also received a low agricultural impact score (1.5), indicating minor agricultural impacts.

Agricultural Resources scores for the local groundwater development projects ranged between 2.5 and 4.5, with the differences in the scores occurring because of projects' locations and impacts to the water table. Local groundwater development projects receiving the highest Agricultural Resources scores (highest agricultural impacts) required use of agricultural land for project construction and drilling of numerous high-producing wells. The groundwater development projects with the highest scores include Seminole's local groundwater development project (score of 4.5) and Lubbock's Bailey County Well Field capacity maintenance project (score of 4.0). These scores are highest because they require use of agricultural land for project construction (Seminole's project includes an approximately 40-mile pipeline) and/or drilling of numerous high-producing wells (Lubbock's project includes drilling of 34 new wells in Phase 1). Overall, the Agricultural Resources scores are highest for groundwater projects located in agricultural areas.

With these few exceptions, implementation of the recommended WMSs evaluated in Chapter 5 is not expected to have any significant impacts on agricultural resources. Most of the recommended WMSs for municipal WUGs will be developed using existing water rights, and where water rights need to be obtained, they will be purchased from willing sellers. The agricultural conservation WMSs have the potential to reduce yields, but also to lengthen the time frame for continued irrigation due to the conservation of available supplies.

6.2 Impacts on Other Water Resources of the State

The regional water plan will have a positive impact on other water resources of the State, including other WMSs and groundwater and surface water interrelationships. The implementation of water conservation strategies will help to meet the region's water needs. Implementation of strategies by the wholesale water providers (WWPs) in the region (Canadian River Municipal Water Authority [CRMWA], the City of Lubbock, White River Municipal Water District, and Mackenzie Municipal Water Authority) will continue to benefit the region, particularly as they practice conjunctive management. By using surface water when it is available, these providers conserve the groundwater resources. The water resources are further conserved with the implementation of water reuse projects that use treated wastewater in place of additional potable water, desalination projects that provide new water supplies, and aquifer storage and recovery projects that store excess water, when available, for future withdrawal and use.

6.3 Impacts and Identified Threats to Agricultural and Natural Resources

Agriculture is the main economic activity in the Llano Estacado region and accounts for more than 90 percent of the projected water use in each decade of the planning period. Drought, declining aquifer levels, and brackish groundwater are the main water quantity and quality threats to agriculture in Region O. These threats will be best addressed by implementing the agricultural water conservation substrategies that are evaluated in Section 5.3. Implementation of water reuse, aquifer storage and recovery, and projects that involve conjunctive management of surface and groundwater resources (Sections 5.2.4, 5.4.2, 5.5.1, and 5.7.1 through 5.7.7) will positively impact agricultural resources, through conservation and best management of groundwater resources. Although they are not recommended WMSs, implementation of playa BMPs will also affect agricultural resources, by ensuring that groundwater sources continue to receive recharge, prolonging the life of the aquifers.

While limited, some surface water is present in Region O, in the form of playa wetlands, rivers, and lakes. Many plant and animal species are dependent on these surface water sources for their survival. The main threats facing playas are drought, sedimentation, anthropogenic modifications (e.g., conversion to cropland and playa infilling), water quality changes due to pesticide and fertilizer runoff, livestock operations, and modification of native wetland vegetation. Drought, invasive species (especially salt cedar, zebra mussels, and golden algae), declining spring flow due primarily to aquifer drawdown, and changes in aquatic habitat due to impoundments, diversions, and alterations in streamflow are the major threats facing rivers and lakes in the region. These threats will be addressed through the implementation of:

- Playa BMPs to limit sedimentation and protect playas from agricultural runoff that may have poor quality (Section 5.10.7)
- Brush management strategies, which may increase infiltration and recharge (Section 5.10.5)

- Agricultural conservation practices that conserve the water resource, which may protect the remaining springs and seeps (Section 5.3)

The LERWPG supports the control of invasive aquatic species, for the protection of water supply, water quality, and recreation.

6.4 Impacts on Key Water Quality Parameters in Region

The following subsections describe how implementing recommended and alternative WMSs could affect key parameters of water quality in Texas.

6.4.1 Water Quality Standards

Drinking water quality standards are established in the Texas Administrative Code, Title 30, Chapter 290, Subpart F. Those standards are expressed as primary maximum contaminant levels (MCLs), which are legally enforceable standards, and secondary constituent levels or "secondary standards," which are non-enforceable guidelines based on aesthetic effects that these constituents may cause (taste, color, odor, etc.). In addition to primary MCLs and secondary standards, lead and copper have action levels specified that apply to community water systems.

Surface water quality standards are regulated by the Texas Commission on Environmental Quality (TCEQ). The Texas surface water quality standards are codified in Title 30, Chapter 307 of the Texas Administrative Code and were amended most recently in March 2014. The standards are written by the TCEQ under the authority of the Clean Water Act and the Texas Water Code.

The Texas surface water quality standards establish explicit goals for the quality of streams, rivers, lakes, and bays throughout the state. The standards are developed to maintain the quality of surface waters in Texas so that it supports public health and enjoyment and protects aquatic life, consistent with the sustainable economic development of the state.

Water quality standards identify appropriate uses for the state's surface waters, including aquatic life, recreation, and sources of public water supply. The parameters monitored to evaluate support of those uses include dissolved oxygen, temperature, pH, dissolved minerals, toxic substances, and bacteria. Statewide standards may be revised on a site-specific basis when sufficient information is available.

TCEQ's surface water quality management (SWQM) program coordinates the collection of physical, chemical, and biological samples from more than 1,800 surface water sites statewide. These data may be used by TCEQ to characterize existing conditions or identify emerging problems, evaluate the effectiveness of water quality control programs, or identify trends.

These data may also be used to determine compliance with the Texas surface water quality standards through the *Texas Integrated Report of Surface Water Quality* (Texas Integrated Report) (TCEQ, 2014). Formerly called the "Texas Water Quality Inventory and 303(d) List," the Texas Integrated Report evaluates the quality of surface waters in Texas and provides resource managers with a tool for making informed decisions when directing agency programs. The report is a requirement of the federal Clean Water Act Sections 305(b) and 303(d), and the TCEQ produces a new Texas Integrated Report every two years in even-numbered years, as required by law. The 303(d) list in the report must be approved by the U.S. EPA before it is final. The most recent 303(d) list was completed in 2012. Table 6-1 identifies the water bodies within Region O that do not meet Texas surface water quality standards and lists the constituents of concern for each.

The Texas Clean Rivers Program (CRP) is a unique water quality monitoring, assessment, and public outreach program that is used to manage water quality statewide. The CRP was authorized by Senate Bill 818 in 1991, is funded by state fees, and is implemented through a partnership between the TCEQ and 15 regional water authorities. The Clean Rivers Act requires that planning agencies prepare written reports outlining water quality issues in each basin every five years.

Table 6-1. 2012 303(d)-Listed Segments in Region O

Water Body	Segment Number	Bacteria	Mercury in Edible Tissue	Total Dissolved Solids	Chloride	Sulfate
Red River Basin						
Lower Prairie Dog Town Fork Red River	0207	X				
Brazos River Basin						
White River Lake	1240			X	X	
North Fork Double Mountain Fork Brazos River	1241A	X				
Lake Alan Henry	1241B		X [a]			
Canadian River Basin						
Lake Meredith (Region A)	0102		X [a]	X	X	X

Source: TCEQ, 2013

[a] Listed due to mercury in fish tissue (mercury is not present in lake water). Mercury occurs naturally in the lake sediments that are taken up by small fish and bioaccumulate in the fish tissue up the food chain as larger fish eat smaller ones.

The CRP partner agencies that operate within Region O include the Red River Authority, Brazos River Authority, and Lower Colorado River Authority.

- The Red River Authority monitors 10 subwatersheds, 5 each in the Canadian and Red River Basins. Counties within Region O include areas within 1 of the Canadian and 3 of the Red River subwatersheds that are monitored (Red River Authority, 2014).

- The Brazos River Authority monitors 14 watersheds, 2 of which include areas within Region O: (1) the Caprock, a non-contributing watershed where precipitation is either absorbed by the soils or contained in playa lakes that are not monitored as part of the CRP, and (2) Salt and Double Mountain Forks of the Brazos River (Brazos River Authority, 2012).

- The Lower Colorado River Authority monitors 9 watersheds. A portion of Region O falls within the Upper Colorado River watershed, although Dickens County is the only county within Region O that is considered to have area that contributes flow to the Lower Colorado River (Lower Colorado River Authority et al., 2012).

6.4.2 Impacts of Water Management Strategies on Water Quality

The water quality parameters that are important to the use of water resources in Region O and their associated water quality standards are summarized in Table 6-2. Drinking water quality standards are based on MCLs and secondary standards, established by the Texas Administrative Code (30 TAC, Chapter 290, Subchapter F), as discussed in Section 6.4.1. The lead and copper standards are action levels that apply to selected water systems as specified by the TCEQ.

Table 6-2. Water Quality Parameters and Standards

Parameter	Water Quality Standard (mg/L [a])	Standard Type		
		MCL [b]	Secondary Standard [c]	Action Level [d]
Arsenic	0.01	X		
Chloride	300		X	
Copper	1.3/1.0		X	X
Fluoride	4.0/2.0	X	X	
Iron	0.3		X	
Lead	0.015			X
Manganese	0.05		X	
Mercury	0.002	X		
Nitrate	10	X		
pH	6.5-8.5		X	
Sulfate	300		X	
Total coliform (presence/absence) [e]	[f]	X		
Total dissolved solids (TDS)	1,000		X	

[a] Unless otherwise noted.
[b] Defined by 30 TAC Chapter 290, Subchapter F, Rule §104(b).
[c] Defined by 30 TAC Chapter 290, Subchapter F, Rule §105(b).
[d] Defined by 30 TAC Chapter 290, Subchapter F, Rule §117.
[e] Defined by 30 TAC Chapter 290, Subchapter F, Rule §109.
[f] For systems that collect at least 40 routine distribution samples per month, the MCL is defined as when more than 5 percent of samples collected within a month are coliform positive. For systems that collect fewer than 40 routine distribution samples per month, the MCL is defined as when more than one sample is coliform positive. The acute MCL is defined as when a repeat sample is fecal coliform or E. coli positive.

mg/L = Milligrams per liter
MCL = Maximum contaminant level
TAC = Texas Administrative Code

The water uses in the region include the following:

- Municipal water supply
- Industrial (manufacturing, mining, and steam-electric power)
- Agricultural irrigation
- Livestock
- Recreation
- Aquatic life

The recommended WMSs in this regional water plan include:

1. Municipal conservation (39 WUGs, including Lubbock)
2. Irrigation conservation (all 21 counties in Region O)
3. Local groundwater development (24 municipal projects, plus 1 project for White River MWD and 2 projects [Bailey County well field capacity maintenance and South Lubbock well field] for Lubbock)
4. Potable water reuse (Lubbock, Farwell, and Wolfforth)
5. Brackish groundwater desalination (Lubbock, Abernathy, and Seminole)
6. Municipal water loss reduction (Lorenzo, Morton, Shallowater, and Sundown)
7. Aquifer storage and recovery (Lubbock's CRMWA ASR project)
8. Other surface water projects (South Garza Water Supply and Lubbock's North Fork Scalping Operation and Lake Alan Henry Phase 2 projects)
9. New major reservoir (Lubbock's Jim Bertram Lake 7)

Few water quality impacts are expected to occur as a result of implementation of these recommended WMSs, as summarized in Table 6-3.

Table 6-3. Impacts of Recommended Water Management Strategies on Key Water Quality Parameters

Strategy	Impact/Comments
Municipal conservation	Little or no impact. Uses of water and source of supply will remain the same and will not impact water quality.
Irrigation conservation	Little or no impact. Research and development of drought-tolerant crops and new technology involve the implementation of new water-using or water-using-related technologies. The potential effects on the water quality cannot be evaluated until the techniques are specified.
Local groundwater development	No impact. This strategy is a continuation of existing practices and therefore will have no impact on water quality.
Potable water reuse	Wastewater effluent reused for municipal supply will require advanced treatment, such as reverse osmosis. The waste stream from advanced treatment is proposed to be injected into deep wells. Because of its source, the treated water will be high in total dissolved solids (TDS) and may also have higher concentrations of other water quality parameters (e.g., chloride, sulfate, and nitrate) than the existing sources.
Brackish groundwater desalination	This strategy calls for using source water of lower quality for municipal uses than the supplies currently being used and/or proposed by other water management strategies. The municipal effluent return flows from this water management strategy may be higher in chloride, sulfate, and TDS than return flows from other water sources now being used and/or included in other water management strategies, depending on the level of demineralization of the brackish groundwater.
Municipal water loss reduction	Little or no impact. Uses of water and source of supply will remain the same and will not impact water quality.
Aquifer storage and recovery	The impact of ASR projects on water quality will depend on the water quality of the recharge water and the water quality of the receiving aquifer, and the compatibility of the waters will need to be assessed before a specific project can be implemented. The water quality of the recharge water and receiving aquifer will need to be compatible in order for a project to be feasible; therefore, little or no impact to water quality is expected.
Other surface water projects (including South Garza Water Supply, North Fork Scalping Operation, and Lake Alan Henry Phase 2)	The South Garza Water Supply and Lake Alan Henry Phase 2 projects involve adding infrastructure to increase the project capacities (and withdrawals from Lake Alan Henry). Impacts to water quality could include increasing temperature, decreasing dissolved oxygen concentrations, and increasing nutrient concentrations due to decreased storage in the reservoir. The North Fork Scalping Operation will involve capturing stormwater flows and using them to increase the yield of Lake Alan Henry. Impacts that could occur include encouraging golden algae growth in Lake Alan Henry (it has been found in lakes along the North Fork). Algal blooms release toxins that kill fish, and can reduce concentrations of dissolved oxygen when they decay. Increased flows into Gobbler Creek may change the size and configuration of the channel, although water quality impacts are not anticipated.
New major reservoir (Jim Bertram Lake 7)	Impacts to water quality resulting from impoundment of a new reservoir can include increased water temperature, decreased concentrations of dissolved oxygen and suspended solids, and increased concentrations of nutrients in the reservoir.

6.4.3 Interbasin Transfers

Statutory provisions regarding interbasin transfers are outlined in TWC §11.085. Under those provisions no person may take or divert any state water from a river basin in Texas and transfer such water to any other river basin without first applying for and receiving a water right or an amendment to a permit, certified filing, or certificate of adjudication from the commission authorizing the transfer. The application must include the contract price of the water to be transferred, a statement of each general category of proposed use of the water to be transferred and a detailed description of the proposed uses and users under each category, the cost of diverting, conveying, distributing, and supplying the water to, and treating the water for, the proposed users, and the projected effect on user rates and fees for each class of ratepayers.

The LERWPG regional water plan does not propose any interbasin transfers of surface water, and so the impacts of these statutory provisions have not been considered.

6.5 Impacts of Moving Water from Agricultural and Rural Areas

Implementation of the recommended WMSs evaluated in Chapter 5 is not expected to have any impacts on water supplies that are used for agricultural purposes. Most of the recommended WMSs for municipal WUGs will be developed using existing water rights, and where water rights need to be obtained, they will be purchased from willing sellers. Moving large volumes of water from agricultural and rural areas to other users would have a negative impact on the agricultural communities in the region; however, no large moves of water are planned. Declining water supplies available to irrigated agriculture would result in reduced numbers of irrigated acres and/or application rates, adversely affecting producers and the local and regional economy.

6.6 Long-Term Protection of the State's Water, Agricultural, and Natural Resources

The Region O water plan is consistent with the long-term protection of Texas's water, agricultural, and natural resources, and the planning, analysis, and recommendations described in this plan honor all existing water rights and contracts within the region. Specific resources that are important to the LERWPG include:

- Reservoirs, including Mackenzie Reservoir, White River Lake, Lake Alan Henry, and Lake Meredith (located in Region A, but also important to Region O)

- Surface water features including the Canadian River, Palo Duro Creek, Tierra Blanca Creek, Running Water Draw, Tule Creek, Prairie Dog Fork of the Red River, Blackwater Draw, Yellowhouse Draw, White River, North Fork of the Double Mountain Fork of the Brazos River, Duck Creek, Salt Fork of the Brazos River, South Fork of the Double Mountain Fork of the Brazos River, Red River, Lost Draw, MacKenzie Draw, and Seminole Draw

- The more than 14,000 playa lakes in the region, which are shallow, ephemeral wetlands that hold water after precipitation events and provide sources of recharge and habitat

- Groundwater resources, including the Ogallala Aquifer, Seymour Aquifer, Edwards-Trinity (High Plains) Aquifer, and Dockum Aquifer

- Springs, including Hulsey Springs (supplied by the Santa Rosa Sandstone), Couch Springs (supplied by the Ogallala Aquifer), Buffalo Springs (supplied by the Edwards-Trinity [High-Plains] Aquifer), and Roaring Springs (supplied by the Santa Rosa Sandstone and the Ogallala Aquifer)

- Soil, which is considered as a natural resource and is especially important for agriculture

- Mineral resources, including oil and gas

These resources will be protected through the regional water planning process:

- Reservoirs will be protected through strategies that involve conjunctive management of water resources (Lubbock's potable reuse and ASR projects) and BMPs that include watershed management and drought management.

- Surface water features will be protected through strategies that involve conservation, water reuse, and conjunctive management of water resources and BMPs that include watershed management.

- Playa lakes will be protected through public information and the implementation of playa BMPs (initiatives to enhance recharge and create buffer zones to avoid siltation, leading to improved water quality in the lakes).

- Groundwater resources will be protected through strategies that involve conservation, water reuse, and conjunctive management of water resources and BMPs that include watershed management and drought management.

- Springs will be protected through strategies that involve conservation and BMPs that include watershed management and drought management.

- Soil erosion will be minimized through implementation of watershed management (brush management and playa) BMPs.

- The extent of mineral resources extraction will depend on the market; mining operations will benefit from water supply planning based on available water in the region.

6.7 Impacts on Navigation

The U.S. Army Corps of Engineers regulates any work in or affecting navigable waters of the United States (USACE, 1999), which are defined as waters that are presently being used, have been used in the past, or may be susceptible for use to transport interstate or foreign commerce. The Brazos, Colorado, and Red River basins have sections that are defined as navigable; however, none of these sections are located in Region O (USACE, 1999). As there are no navigable waters in Region O, the regional water plan will have no impacts on navigation.

6.8 Summary of the Identified Water Needs that Remain Unmet

No unmet municipal needs remain after the implementation of the recommended WMSs; however, there are unmet needs for other WUGs (e.g., agriculture, livestock, and industrial). Table 6-4 and Figure 6-1 summarize the unmet needs remaining after implementation of the recommended WMSs. Appendix 6A contains the required Regional Water Planning Application (DB17) report for WUG unmet needs and provides the unmet needs by county and river basin for every WUG.

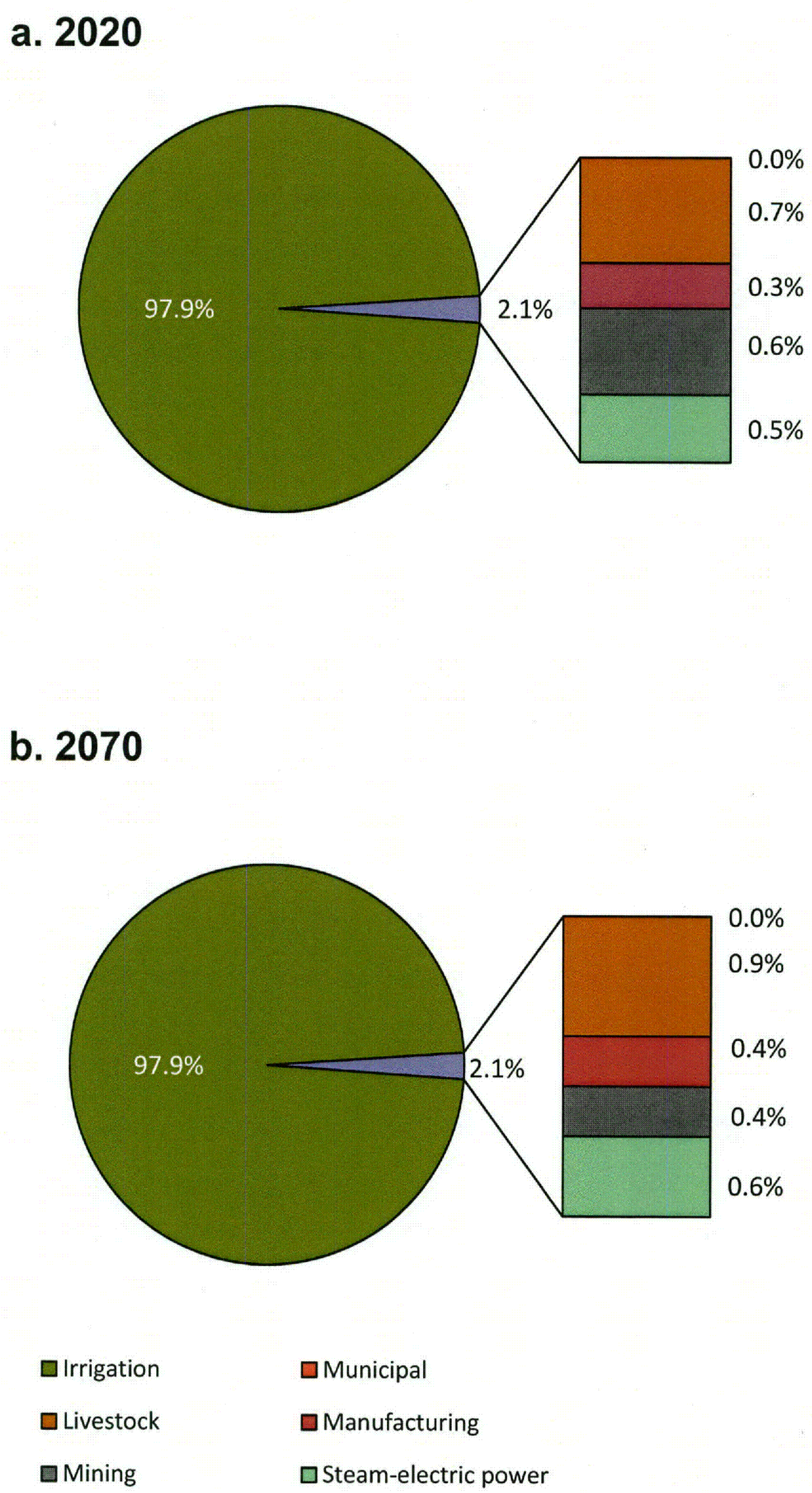
Table 6-4. Unmet Water Needs by WUG Category from 2020 to 2070

WUG Category	Unmet Water Needs by Decade (acre-feet per year)					
	2020	2030	2040	2050	2060	2070
Municipal	0	0	0	0	0	0
Irrigation	1,613,509	1,719,032	1,845,999	1,900,784	1,913,896	2,025,046
Livestock	12,134	14,505	12,889	16,273	18,793	17,631
Industrial						
Manufacturing	5,224	4,968	4,462	4,935	6,769	7,316
Mining	9,921	11,705	11,291	10,314	8,626	7,337
Steam-electric power	7,747	6,617	3,189	4,185	5,474	11,793
Total	1,648,535	1,756,827	1,877,830	1,936,491	1,953,558	2,069,123

6.9 Socioeconomic Impact Analysis

At the formal request of the LERWPG, the TWDB completed a socioeconomic impact analysis for Region O, evaluating the social and economic impacts of not meeting the identified water needs. The analysis was performed using the economic modeling software package IMPLAN (Impact for Planning Analysis), as well as other economic analysis techniques (TWDB, 2015). The results represent a snapshot of the socioeconomic impacts that may occur during a single year of drought of record conditions within each decade of the planning period (TWDB, 2015).

The evaluation focused on estimating income and job losses, and the results provide estimates of financial transfer impacts (e.g., tax losses, water trucking costs, and utility revenue losses), and social impacts (e.g., lost consumer surplus, population and school enrollment losses)



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Daniel B. Stephens & Associates, Inc.

10/28/15

LLANO ESTACADO REGION

Unmet Water Needs by Water User Group Category 2020 and 2070

Figure 6-1

(TWDB, 2015). The TWDB estimates that not meeting the identified water needs in Region O would result in a combined lost income impact of approximately $4 billion in 2020, increasing to $6 billion in 2070 (estimates are in year 2013 dollars). This would coincide with a loss of approximately 34,000 jobs in 2020, increasing to a loss of approximately 61,000 jobs in 2070 (TWDB, 2015). The complete socioeconomic impact analysis report is provided in Appendix 6B.

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Appendix 6A

Water User Group Unmet Needs Summary

Water User Group (WUG) Unmet Needs

REGION O	WUG UNMET NEEDS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
BAILEY COUNTY						
BRAZOS BASIN						
MANUFACTURING	183	206	225	250	274	324
LIVESTOCK	1,049	1,797	1,879	2,045	2,089	2,451
IRRIGATION	80,496	83,467	84,442	87,431	87,126	90,285
BRISCOE COUNTY						
RED BASIN						
LIVESTOCK	29	37	46	55	65	75
IRRIGATION	2,258	9,748	13,712	13,956	13,170	17,585
CASTRO COUNTY						
BRAZOS BASIN						
MANUFACTURING	0	0	35	78	147	221
LIVESTOCK	2,897	3,829	4,855	5,209	5,321	5,606
IRRIGATION	157,497	147,905	167,677	173,903	171,898	176,478
RED BASIN						
MANUFACTURING	85	54	29	31	33	39
IRRIGATION	99,174	94,812	99,265	96,675	94,914	101,554
COCHRAN COUNTY						
BRAZOS BASIN						
MINING	6	9	9	6	5	4
LIVESTOCK	221	229	275	59	83	230
IRRIGATION	61,201	59,718	58,085	56,202	53,606	52,780
COLORADO BASIN						
LIVESTOCK	166	174	183	192	202	212
IRRIGATION	3,894	4,103	3,660	4,705	5,803	6,099
CROSBY COUNTY						
BRAZOS BASIN						
LIVESTOCK	106	112	118	125	131	138
RED BASIN						
MINING	348	352	317	280	243	210
LIVESTOCK	1	1	1	1	1	1
IRRIGATION	2,854	2,657	2,284	2,106	1,788	1,641
DAWSON COUNTY						
BRAZOS BASIN						
LIVESTOCK	2	2	2	2	2	2
IRRIGATION	0	0	0	0	0	227
COLORADO BASIN						
MANUFACTURING	0	0	0	0	0	7
MINING	175	709	828	703	423	255
DEAF SMITH COUNTY						
CANADIAN BASIN						
LIVESTOCK	76	93	98	103	109	115
IRRIGATION	862	801	714	657	603	553
RED BASIN						
MANUFACTURING	2,234	2,600	2,061	2,057	3,295	2,638
LIVESTOCK	4,399	3,973	1,444	2,698	4,181	683
IRRIGATION	77,808	85,015	90,363	100,375	107,962	119,866

Water User Group (WUG) Unmet Needs

REGION O	WUG UNMET NEEDS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
DICKENS COUNTY						
BRAZOS BASIN						
LIVESTOCK	26	31	37	43	49	55
RED BASIN						
LIVESTOCK	44	47	50	54	58	62
FLOYD COUNTY						
RED BASIN						
LIVESTOCK	0	0	0	3	13	23
IRRIGATION	22,648	21,182	20,289	20,914	18,429	19,897
GAINES COUNTY						
COLORADO BASIN						
MANUFACTURING	310	686	1,007	1,295	1,604	2,380
MINING	202	604	777	692	531	463
LIVESTOCK	0	0	0	0	0	146
IRRIGATION	136,961	181,838	205,885	221,191	232,689	257,193
GARZA COUNTY						
BRAZOS BASIN						
LIVESTOCK	231	237	244	252	260	278
HALE COUNTY						
BRAZOS BASIN						
MANUFACTURING	1,227	341	0	0	0	0
MINING	1,154	1,139	1,022	886	766	662
STEAM ELECTRIC POWER	34	24	0	0	0	0
LIVESTOCK	924	1,148	328	1,304	1,454	1,784
IRRIGATION	230,025	221,545	208,378	201,987	194,888	187,050
RED BASIN						
LIVESTOCK	14	20	20	21	21	21
IRRIGATION	1,900	1,814	1,682	1,618	1,545	1,465
HOCKLEY COUNTY						
BRAZOS BASIN						
MANUFACTURING	0	0	0	0	0	3
MINING	0	0	0	0	14	13
IRRIGATION	42,111	48,991	53,317	50,425	47,587	45,991
COLORADO BASIN						
MINING	0	0	0	0	2	2
LIVESTOCK	35	37	39	41	43	45
IRRIGATION	1,353	928	881	680	510	819
LAMB COUNTY						
BRAZOS BASIN						
MANUFACTURING	280	213	105	108	115	146
MINING	570	567	507	445	385	333
STEAM ELECTRIC POWER	6,227	4,267	0	0	0	2,984
LIVESTOCK	889	680	1,070	1,567	1,972	2,639
IRRIGATION	192,947	198,570	207,998	218,673	223,027	232,699
LUBBOCK COUNTY						
BRAZOS BASIN						
MANUFACTURING	232	63	68	72	78	143
MINING	6,261	6,366	5,888	5,302	4,763	4,314
STEAM ELECTRIC POWER	0	0	0	0	0	945

Water User Group (WUG) Unmet Needs

REGION O	WUG UNMET NEEDS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
LUBBOCK COUNTY						
BRAZOS BASIN						
IRRIGATION	49,309	51,325	61,552	56,500	50,450	63,005
LYNN COUNTY						
BRAZOS BASIN						
MINING	634	784	717	511	318	164
LIVESTOCK	0	0	0	0	0	3
COLORADO BASIN						
MINING	49	60	55	39	25	13
LIVESTOCK	1	1	2	2	2	3
MOTLEY COUNTY						
RED BASIN						
MINING	136	109	101	94	75	57
LIVESTOCK	161	170	179	189	199	209
PARMER COUNTY						
BRAZOS BASIN						
LIVESTOCK	582	1,601	1,729	1,862	2,002	2,149
IRRIGATION	220,660	231,601	245,454	244,307	238,307	244,018
RED BASIN						
MANUFACTURING	673	805	932	1,043	1,222	1,413
IRRIGATION	49,206	49,309	49,235	49,543	51,166	50,804
SWISHER COUNTY						
BRAZOS BASIN						
IRRIGATION	11,298	33,509	34,447	34,799	34,286	34,301
RED BASIN						
IRRIGATION	81,162	91,183	98,764	103,101	104,687	111,324
TERRY COUNTY						
BRAZOS BASIN						
MINING	0	0	0	29	21	14
LIVESTOCK	0	0	0	13	16	18
IRRIGATION	0	0	0	375	1,482	5,210
COLORADO BASIN						
MANUFACTURING	0	0	0	1	1	2
MINING	0	0	0	387	272	192
LIVESTOCK	0	0	0	137	219	361
IRRIGATION	0	2,639	39,009	60,901	77,057	97,341
YOAKUM COUNTY						
COLORADO BASIN						
MINING	386	1,006	1,070	940	783	641
STEAM ELECTRIC POWER	1,486	2,326	3,189	4,185	5,474	7,864
LIVESTOCK	281	286	290	296	301	322
IRRIGATION	87,885	96,372	98,906	99,760	100,916	106,861

*WUG supplies and projected demands are entered for each of a WUG's region-county-basin divisions. The unmet needs shown in the WUG Unmet Needs report are calculated by first deducting the WUG split's projected demand from the sum of its total existing water supply volume and all associated recommended water management strategy water volumes. If the WUG split has a greater future supply volume than projected demand in any given decade, this amount is considered a surplus volume. In order to display only unmet needs associated with the WUG split, these surplus volumes are updated to a zero and the unmet needs water volumes are shown as absolute values.

Appendix 6B

Socioeconomic Impact Analysis

Socioeconomic Impacts of Projected Water Shortages

for the Region O Regional Water Planning Area

Prepared in Support of the 2016 Region O Regional Water Plan

Texas Water
Development Board

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Table of Contents

Executive Summary

Evaluating the social and economic impacts of not meeting identified water needs is a required part of the regional water planning process. The Texas Water Development Board (TWDB) estimates those impacts for regional water planning groups, and summarizes the impacts in the state water plan. The analysis presented is for the Region O Regional Water Planning Group.

Based on projected water demands and existing water supplies, the Region O planning group identified water needs (potential shortages) that would occur within its region under a repeat of the drought of record for six water use categories. The TWDB then estimated the socioeconomic impacts of those needs—if they are not met—for each water use category and as an aggregate for the region.

The analysis was performed using an economic modeling software package, IMPLAN (Impact for Planning Analysis), as well as other economic analysis techniques, and represents a snapshot of socioeconomic impacts that may occur during a single year during a drought of record within each of the planning decades. For each water use category, the evaluation focused on estimating income losses and job losses. The income losses represent an approximation of gross domestic product (GDP) that would be foregone if water needs are not met.

The analysis also provides estimates of financial transfer impacts, which include tax losses (state, local, and utility tax collections); water trucking costs; and utility revenue losses. In addition, social impacts were estimated, encompassing lost consumer surplus (a welfare economics measure of consumer wellbeing); as well as population and school enrollment losses.

It is estimated that not meeting the identified water needs in Region O would result in an annually combined lost income impact of approximately $4 billion in 2020, increasing to $6 billion in 2070 (Table ES-1). In 2020, the region would lose approximately 34,000 jobs, and by 2070 job losses would increase to approximately 61,000.

All impact estimates are in year 2013 dollars and were calculated using a variety of data sources and tools including the use of a region-specific IMPLAN model, data from the TWDB annual water use estimates, the U.S. Census Bureau, Texas Agricultural Statistics Service, and Texas Municipal League.

Table ES-1: Region O Socioeconomic Impact Summary

Regional Economic Impacts	2020	2030	2040	2050	2060	2070
Income losses ($ millions)*	$3,990	$4,757	$4,918	$5,205	$5,551	$6,133
Job losses	33,885	38,304	39,164	41,995	51,395	60,971
Financial Transfer Impacts	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Tax losses on production and imports ($ millions)*	$401	$499	$518	$527	$527	$577
Water trucking costs ($ millions)*	-	-	-	$0	$0	$1
Utility revenue losses ($ millions)*	$38	$69	$87	$111	$120	$162
Utility tax revenue losses ($ millions)*	$1	$1	$2	$2	$2	$3
Social Impacts	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Consumer surplus losses ($ millions)*	$2	$11	$23	$50	$90	$152
Population losses	6,221	7,033	7,191	7,710	9,436	11,194
School enrollment losses	1,151	1,301	1,330	1,426	1,746	2,071

***** *Year 2013 dollars, rounded. Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000.*

1 Introduction

Water shortages during a repeat of the drought of record would likely curtail or eliminate certain economic activity in businesses and industries that rely heavily on water. Insufficient water supplies could not only have an immediate and real impact on existing businesses and industry, but they could also adversely and chronically affect economic development in Texas. From a social perspective, water supply reliability is critical as well. Shortages could disrupt activity in homes, schools and government and could adversely affect public health and safety. For these reasons, it is important to evaluate and understand how water supply shortages during drought could impact communities throughout the state.

Administrative rules (31 Texas Administrative Code §357.33 (c)) require that regional water planning groups evaluate the social and economic impacts of not meeting water needs as part of the regional water planning process, and rules direct the TWDB staff to provide technical assistance upon request. Staff of the TWDB's Water Use, Projections, & Planning Division designed and conducted this analysis in support of the Region O Regional Water Planning Group.

This document summarizes the results of the analysis and discusses the methodology used to generate the results. Section 1 summarizes the water needs calculation performed by the TWDB based on the regional water planning group's data. Section 2 describes the methodology for the impact assessment and discusses approaches and assumptions specific to each water use category (i.e., irrigation, livestock, mining, steam-electric, municipal and manufacturing). Section 3 presents the results for each water use category with results summarized for the region as a whole. Appendix A presents details on the socioeconomic impacts by county.

1.1 Identified Regional Water Needs (Potential Shortages)

As part of the regional water planning process, the TWDB adopted water demand projections for each water user group (WUG) with input from the planning groups. WUGs are composed of cities, utilities, combined rural areas (designated as county-other), and the county-wide water use of irrigation, livestock, manufacturing, mining and steam-electric power. The demands are then compared to the existing water supplies of each WUG to determine potential shortages, or needs, by decade. Existing water supplies are legally and physically accessible for immediate use in the event of drought. Projected water demands and existing supplies are compared to identify either a surplus or a need for each WUG.

Table 1-1 summarizes the region's identified water needs in the event of a repeat of drought of the record. Demand management, such as conservation, or the development of new infrastructure to increase supplies are water management strategies that may be recommended by the planning group to meet those needs. This analysis assumes that no strategies are implemented, and that the identified needs correspond to future water shortages. Note that projected water needs generally increase over time, primarily due to anticipated population and economic growth. To provide a general sense of proportion, total projected needs as an overall percentage of total demand by water use category are presented in aggregate in Table 1-1. Projected needs for individual water user groups within the aggregate vary greatly, and may reach 100% for a given WUG and water use category. Detailed water needs by WUG and county appear in Chapter 4 of the 2016 Region O Regional Water Plan.

Table 1-1 Regional Water Needs Summary by Water Use Category

Water Use Category		2020	2030	2040	2050	2060	2070
Irrigation	Water Needs (acre-feet per year)	1,683,573	1,795,897	1,948,130	2,003,648	2,024,629	2,139,648
	% of the category's total water demand	48%	53%	60%	64%	67%	73%
Livestock	Water Needs (acre-feet per year)	12,134	14,505	12,889	16,273	18,793	17,631
	% of the category's total water demand	31%	32%	28%	34%	38%	35%
Manufacturing	Water Needs (acre-feet per year)	5,224	4,968	4,462	4,935	6,769	7,316
	% of the category's total water demand	32%	29%	25%	26%	34%	35%
Mining	Water Needs (acre-feet per year)	9,921	11,705	11,291	10,314	8,626	7,337
	% of the category's total water demand	62%	67%	72%	78%	79%	79%
Municipal	Water Needs (acre-feet per year)	13,233	24,556	30,937	38,977	47,923	56,371
	% of the category's total water demand	14%	24%	29%	34%	39%	42%
Steam-electric power	Water Needs (acre-feet per year)	7,747	6,617	3,189	4,185	5,474	11,793
	% of the category's total water demand	30%	22%	9%	10%	11%	20%
Total water needs (acre-feet per year)		**1,731,832**	**1,858,248**	**2,010,898**	**2,078,332**	**2,112,214**	**2,240,096**

2 Economic Impact Assessment Methodology Summary

This portion of the report provides a summary of the methodology used to estimate the potential economic impacts of future water shortages. The general approach employed in the analysis was to obtain estimates for income and job losses on the smallest geographic level that the available data would support, tie those values to their accompanying historic water use estimate (volume), and thereby determine a maximum impact per acre-foot of shortage for each of the socioeconomic measures. The calculations of economic impacts were based on the overall composition of the economy using many underlying economic "sectors." Sectors in this analysis refer to one or more of the 440 specific production sectors of the economy designated within IMPLAN (Impact for Planning Analysis), the economic impact modeling software used for this assessment. Economic impacts within this report are estimated for approximately 310 of those sectors, with the focus on the more water intense production sectors. The economic impacts for a single water use category consist of an aggregation of impacts to multiple related economic sectors.

2.1 Impact Assessment Measures

A required component of the regional and state water plans is to estimate the potential economic impacts of shortages due to a drought of record. Consistent with previous water plans, several key variables were estimated and are described in Table 2-1.

Table 2-1 Socioeconomic Impact Analysis Measures

Regional Economic Impacts	Description
Income losses - value added	The value of output less the value of intermediate consumption; it is a measure of the contribution to GDP made by an individual producer, industry, sector, or group of sectors within a year. For a shortage, value added is a measure of the income losses to the region, county, or WUG and includes the direct, indirect and induced monetary impacts on the region.
Income losses - electrical power purchase costs	Proxy for income loss in the form of additional costs of power as a result of impacts of water shortages.
Job losses	Number of part-time and full-time jobs lost due to the shortage.
Financial Transfer Impacts	**Description**
Tax losses on production and imports	Sales and excise taxes (not collected due to the shortage), customs duties, property taxes, motor vehicle licenses, severance taxes, other taxes, and special assessments less subsidies.
Water trucking costs	Estimate for shipping potable water.
Utility revenue losses	Foregone utility income due to not selling as much water.
Utility tax revenue losses	Foregone miscellaneous gross receipts tax collections.
Social Impacts	**Description**
Consumer surplus losses	A welfare measure of the lost value to consumers accompanying less water use.
Population losses	Population losses accompanying job losses.
School enrollment losses	School enrollment losses (K-12) accompanying job losses.

2.1.1 Regional Economic Impacts

Two key measures were included within the regional economic impacts classification: income losses and job losses. Income losses presented consist of the sum of value added losses and additional purchase costs of electrical power. Job losses are also presented as a primary economic impact measure.

Income Losses - Value Added Losses

Value added is the value of total output less the value of the intermediate inputs also used in production of the final product. Value added is similar to Gross Domestic Product (GDP), a familiar measure of the productivity of an economy. The loss of value added due to water shortages was estimated by input-output analysis using the IMPLAN software package, and includes the direct, indirect, and induced monetary impacts on the region.

Income Losses - Electric Power Purchase Costs

The electrical power grid and market within the state is a complex interconnected system. The industry response to water shortages, and the resulting impact on the region, are not easily modeled using traditional input/output impact analysis and the IMPLAN model. Adverse impacts on the region will occur, and were represented in this analysis by the additional costs associated with power purchases from other generating plants within the region or state. Consequently, the analysis employed additional power purchase costs as a proxy for the value added impacts for that water use category, and these are included as a portion of the overall income impact for completeness.

For the purpose of this analysis, it was assumed that power companies with insufficient water will be forced to purchase power on the electrical market at a projected higher rate of 5.60 cents per kilowatt hour. This rate is based upon the average day-ahead market purchase price of electricity in Texas from the recent drought period in 2011.

Job Losses

The number of jobs lost due to the economic impact was estimated using IMPLAN output associated with the water use categories noted in Table 1-1. Because of the difficulty in predicting outcomes and a lack of relevant data, job loss estimates were not calculated for the steam-electric power production or for certain municipal water use categories.

2.1.2 Financial Transfer Impacts

Several of the impact measures estimated within the analysis are presented as supplemental information, providing additional detail concerning potential impacts on a sub-portion of the economy or government. Measures included in this category include lost tax collections (on production and imports), trucking costs for imported water, declines in utility revenues, and declines in utility tax revenue collected by the state. Many of these measures are not solely adverse, with some having both positive and negative impacts. For example, cities and residents would suffer if forced to pay large costs for trucking in potable water. Trucking firms, conversely, would benefit from the transaction. Additional detail for each of these measures follows.

Tax Losses on Production and Imports

Reduced production of goods and services accompanying water shortages adversely impacts the collection of taxes by state and local government. The regional IMPLAN model was used to estimate reduced tax collections associated with the reduced output in the economy.

Water Trucking Costs

In instances where water shortages for a municipal water user group were estimated to be 80 percent or more of water demands, it was assumed that water would be trucked in to support basic consumption and sanitation needs. For water shortages of 80 percent or greater, a fixed cost of $20,000 per acre-foot of water was calculated and presented as an economic cost. This water trucking cost was applied for both the residential and non-residential portions of municipal water needs and only impacted a small number of WUGs statewide.

Utility Revenue Losses

Lost utility income was calculated as the price of water service multiplied by the quantity of water not sold during a drought shortage. Such estimates resulted from city-specific pricing data for both water and wastewater. These water rates were applied to the potential water shortage to determine estimates of lost utility revenue as water providers sold less water during the drought due to restricted supplies.

Utility Tax Losses

Foregone utility tax losses included estimates of uncollected miscellaneous gross receipts taxes. Reduced water sales reduce the amount of utility tax that would be collected by the State of Texas for water and wastewater service sales.

2.1.3 Social Impacts

Consumer Surplus Losses of Municipal Water Users

Consumer surplus loss is a measure of impact to the wellbeing of municipal water users when their water use is restricted. Consumer surplus is the difference between how much a consumer is willing and able to pay for the commodity (i.e., water) and how much they actually have to pay. The difference is a benefit to the consumer's wellbeing since they do not have to pay as much for the commodity as they would be willing to pay. However, consumer's access to that water may be limited, and the associated consumer surplus loss is an estimate of the equivalent monetary value of the negative impact to the consumer's wellbeing, for example, associated with a diminished quality of their landscape (i.e., outdoor use). Lost consumer surplus estimates for reduced outdoor and indoor use, as well as residential and commercial/institutional demands, were included in this analysis. Consumer surplus is an attempt to measure effects on wellbeing by monetizing those effects; therefore, these values should not be added to the other monetary impacts estimated in the analysis.

Lost consumer surplus estimates varied widely by location and type. For a 50 percent shortage, the estimated statewide consumer surplus values ranged from $55 to $2,500 per household (residential use), and from $270 to $17,400 per firm (non-residential).

Population and School Enrollment Losses

Population losses due to water shortages, as well as the related loss of school enrollment, were based upon the job loss estimates and upon a recent study of job layoffs and the resulting adjustment of the labor market, including the change in population.[1] The study utilized Bureau of Labor Statistics data regarding layoffs between 1996 and 2013, as well as Internal Revenue Service data regarding migration, to model an estimate of the change in the population as the result of a job layoff event. Layoffs impact both out-migration, as well as in-migration into an area, both of which can negatively affect the population of an area. In addition, the study found that a majority of those who did move following a layoff moved to another labor market rather than an adjacent county. Based on this study, a simplified ratio of job and net population losses was calculated for the state as a whole: for every 100 jobs lost, 18 people were assumed to move out of the area. School enrollment losses were estimated as a proportion of the population lost.

2.2 Analysis Context

The context of the economic impact analysis involves situations where there are physical shortages of surface or groundwater due to drought of record conditions. Anticipated shortages may be nonexistent in earlier decades of the planning horizon, yet population growth or greater industrial, agricultural or other sector demands in later decades may result in greater overall demand, exceeding the existing supplies. Estimated socioeconomic impacts measure what would happen if water user groups experience water shortages for a period of one year. Actual socioeconomic impacts would likely become larger as drought of record conditions persist for periods greater than a single year.

2.2.1 IMPLAN Model and Data

Input-Output analysis using the IMPLAN (Impact for Planning Analysis) software package was the primary means of estimating value added, jobs, and taxes. This analysis employed county and regional level models to determine key impacts. IMPLAN is an economic impact model, originally developed by the U.S. Forestry Service in the 1970's to model economic activity at varying geographic levels. The model is currently maintained by the Minnesota IMPLAN Group (MIG Inc.) which collects and sells county and state specific data and software. The year 2011 version of IMPLAN, employing data for all 254 Texas counties, was used to provide estimates of value added, jobs, and taxes on production for the economic sectors associated with the water user groups examined in the study. IMPLAN uses 440 sector-specific Industry Codes, and those that rely on water as a primary input were assigned to their relevant planning water user categories (manufacturing, mining, irrigation, etc.). Estimates of value added for a water use category were obtained by summing value added estimates across the relevant IMPLAN sectors

[1] Foote, Andrew, Grosz, Michel, Stevens, Ann. "Locate Your Nearest Exit: Mass Layoffs and Local Labor Market Response." University of California, Davis. April 2015. http://paa2015.princeton.edu/uploads/150194

associated with that water use category. Similar calculations were performed for the job and tax losses on production and import impact estimates.

Note that the value added estimates, as well as the job and tax estimates from IMPLAN, include three components:

- *Direct effects* representing the initial change in the industry analyzed;
- *Indirect effects* that are changes in inter-industry transactions as supplying industries respond to reduced demands from the directly affected industries; and,
- *Induced effects* that reflect changes in local spending that result from reduced household income among employees in the directly and indirectly affected industry sectors.

2.2.2 Elasticity of Economic Impacts

The economic impact of a water need is based on the relative size of the water need to the water demand for each water user group (Figure 2-1). Smaller water shortages, for example, less than 5 percent, were anticipated to result in no initial negative economic impact because water users are assumed to have a certain amount of flexibility in dealing with small shortages. As a water shortage deepens, however, such flexibility lessens and results in actual and increasing economic losses, eventually reaching a representative maximum impact estimate per unit volume of water. To account for such ability to adjust, an elasticity adjustment function was used in estimating impacts for several of the measures. Figure 2-1 illustrates the general relationship for the adjustment functions. Negative impacts are assumed to begin accruing when the shortage percentage reaches the lower bound b1 (10 percent in Figure 2-1), with impacts then increasing linearly up to the 100 percent impact level (per unit volume) once the upper bound for adjustment reaches the b2 level shortage (50 percent in Figure 2-1 example).

Initially, the combined total value of the three value added components (direct, indirect, and induced) was calculated and then converted into a per acre-foot economic value based on historical TWDB water use estimates within each particular water use category. As an example, if the total, annual value added for livestock in the region was $2 million and the reported annual volume of water used in that industry was 10,000 acre-feet, the estimated economic value per acre-foot of water shortage would be $200 per acre-foot. Negative economic impacts of shortages were then estimated using this value as the maximum impact estimate ($200 per acre-foot in the example) applied to the anticipated shortage volume in acre-feet and adjusted by the economic impact elasticity function. This adjustment varied with the severity as percentage of water demand of the anticipated shortage. If one employed the sample elasticity function shown in Figure 2-1, a 30% shortage in the water use category would imply an economic impact estimate of 50% of the original $200 per acre-foot impact value (i.e., $100 per acre-foot).

Such adjustments were not required in estimating consumer surplus, nor for the estimates of utility revenue losses or utility tax losses. Estimates of lost consumer surplus relied on city-specific demand curves with the specific lost consumer surplus estimate calculated based on the relative percentage of the city's water shortage. Estimated changes in population as well as changes in school enrollment were indirectly related to the elasticity of job losses.

Assumed values for the bounds b1 and b2 varied with water use category under examination and are presented in Table 2-2.

Figure 2-1 Example Economic Impact Elasticity Function (as applied to a single water user's shortage)

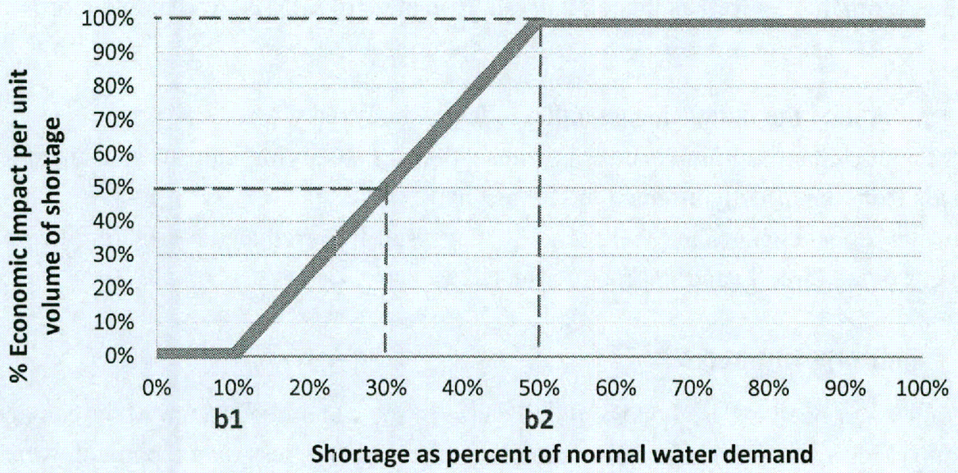

Table 2-2 Economic Impact Elasticity Function Lower and Upper Bounds

Water Use Category	Lower Bound (b1)	Upper Bound (b2)
Irrigation	**5%**	**50%**
Livestock	**5%**	**10%**
Manufacturing	**10%**	**50%**
Mining	**10%**	**50%**
Municipal (non-residential water intensive)	**50%**	**80%**
Steam-electric power	**20%**	**70%**

2.3 Analysis Assumptions and Limitations

Modeling of complex systems requires making assumptions and accepting limitations. This is particularly true when attempting to estimate a wide variety of economic impacts over a large geographic area and into future decades. Some of the key assumptions and limitations of the methodology include:

1. The foundation for estimating socioeconomic impacts of water shortages resulting from a drought are the water needs (potential shortages) that were identified as part of the regional water planning process. These needs have some uncertainty associated with them, but serve as a reasonable basis for evaluating potential economic impacts of a drought of record event.

2. All estimated socioeconomic impacts are snapshot estimates of impacts for years in which water needs were identified (i.e., 2020, 2030, 2040, 2050, 2060, and 2070). The estimates 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. The evaluation assumed that no recommended water management strategies are implemented. In other words, growth occurs, future shocks are imposed on an economy at 10-year intervals, and the resulting impacts are estimated. Note that the estimates presented were not cumulative (i.e., summing up expected impacts from today up to the decade noted), but were simply an estimate of the magnitude of annual socioeconomic impacts should a drought of record occur in each particular decade based on anticipated supplies and demands for that same decade.

3. Input-output models such as IMPLAN rely on a static profile of the structure of the economy as it appears today. This presumes that the relative contributions of all sectors of the economy would remain the same, regardless of changes in technology, supplies of limited resources, and other structural changes to the economy that may occur into the future. This was a significant assumption and simplification considering the 50-year time period examined in this analysis. To presume an alternative future economic makeup, however, would entail positing many other major assumptions that would very likely generate as much or more error.

4. This analysis is not a cost-benefit analysis. That approach to evaluating the economic feasibility of a specific policy or project employs discounting future benefits and costs to their present value dollars using some assumed discount rate. The methodology employed in this effort to estimate the economic impacts of future water shortages did not use any discounting procedures to weigh future costs differently through time.

5. Monetary figures are reported in constant year 2013 dollars.

6. Impacts are annual estimates. The estimated economic model does not reflect the full extent of impacts that might occur as a result of persistent water shortages occurring over an extended duration. The drought of record in most regions of Texas lasted several years.

7. Value added estimates are the primary estimate of the economic impacts within this report. One may be tempted to add consumer surplus impacts to obtain an estimate of total adverse economic impacts to the region, but the consumer surplus measure represents the change to the wellbeing of households (and other water users), not an actual change in the flow of dollars through the economy. The two categories (value added and consumer surplus) are both valid impacts but should not be summed.

8. The value added, jobs, and taxes on production and import impacts include the direct, indirect and induced effects described in Section 2.2.1. Population and school enrollment losses also indirectly include such effects as they are based on the associated losses in employment. The remaining measures (consumer surplus, utility revenue, utility taxes, additional electrical power purchase costs, and potable water trucking costs), however, do not include any induced or indirect effects.

9. The majority of impacts estimated in this analysis may be considered smaller than those that might occur under drought of record conditions. Input-output models such as IMPLAN only capture "backward linkages" on suppliers (including households that supply labor to directly affected industries). While this is a common limitation in these types of economic impact modeling efforts, it is important to note that "forward linkages" on the industries that use the outputs of the directly affected industries can also be very important. A good example is impacts on livestock operators. Livestock producers tend to suffer substantially during droughts, not because there is not enough water for their stock, but because reductions in available pasture and higher prices for purchased hay have significant economic effects on their operations. Food processors could be in a similar situation if they cannot get the grains or other inputs that they need. These effects are not captured in IMPLAN, which is one reason why the impact estimates are likely conservative.

10. The methodology did not capture "spillover" effects between regions – or the secondary impacts that occur outside of the region where the water shortage is projected to occur.

11. The model did not reflect dynamic economic responses to water shortages as they might occur, nor does the model reflect economic impacts associated with a recovery from a drought of record including:
    a. The likely significant economic rebound to the landscaping industry immediately following a drought;
    b. The cost and years to rebuild liquidated livestock herds (a major capital item in that industry);
    c. Direct impacts on recreational sectors (i.e., stranded docks and reduced tourism); or,
    d. Impacts of negative publicity on Texas' ability to attract population and business in the event that it was not able to provide adequate water supplies for the existing economy.

12. Estimates for job losses and the associated population and school enrollment changes may exceed what would actually occur. In practice, firms may be hesitant to lay off employees, even in difficult economic times. Estimates of population and school enrollment changes are based on regional evaluations and therefore do not accurately reflect what might occur on a statewide basis.

13. The results must be interpreted carefully. It is the general and relative magnitudes of impacts as well as the changes of these impacts over time that should be the focus rather than the absolute numbers. Analyses of this type are much better at predicting relative percent differences brought about by a shock to a complex system (i.e., a water shortage) than the precise size of an impact. To illustrate, assuming that the estimated economic impacts of a drought of record on the manufacturing and mining water user categories are $2 and $1 million, respectively, one should be more confident that the economic impacts on manufacturing are twice as large as those on mining and that these impacts will likely be in the millions of dollars. But one should have less confidence that the actual total economic impact experienced would be $3 million.

3 Analysis Results

This section presents a breakdown of the results of the regional analysis for Region O. Projected economic impacts for six water use categories (irrigation, livestock. municipal, manufacturing, mining, and steam-electric power) are also reported by decade.

3.1 Overview of the Regional Economy

Table 3-1 presents the 2011 economic baseline as represented by the IMPLAN model and adjusted to 2013 dollars for Region O. In year 2011, Region O generated about $21 billion in gross state product associated with 280,000 jobs based on the 2011 IMPLAN data. These values represent an approximation of the current regional economy for a reference point.

Table 3-1 Region O Economy

Income ($ millions)*	Jobs	Taxes on production and imports ($ millions)*
$21,180	279,999	$1,867

[1] Year 2013 dollars based on 2011 IMPLAN model value added estimates for the region.

The remainder of Section 3 presents estimates of potential economic impacts for each water use category that could reasonably be expected in the event of water shortages associated with a drought of record and if no recommended water management strategies were implemented.

3.2 Impacts for Irrigation Water Shortages

Seventeen of the 21 counties in the region are projected to experience water shortages in the irrigated agriculture water use category for one or more decades within the planning horizon. Estimated impacts to this water use category appear in Table 3-2. Note that tax collection impacts were not estimated for this water use category. IMPLAN data indicates a negative tax impact (i.e., increased tax collections) for the associated production sectors, primarily due to past subsidies from the federal government. Two factors led to excluding any reported tax impacts: 1) Federal support (subsidies) has lessened greatly since the year 2011 IMPLAN data was collected, and 2) It was not considered realistic to report increasing tax revenue collections for a drought of record.

Table 3-2 Impacts of Water Shortages on Irrigation in Region

Impact Measure	2020	2030	2040	2050	2060	2070
Income losses ($ millions)*	$632	$705	$782	$813	$824	$877
Job losses	10,737	11,874	13,110	13,591	13,761	14,595

**** Year 2013 dollars, rounded. Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000.***

3.3 Impacts for Livestock Water Shortages

Nineteen of the 21 counties in the region are projected to experience water shortages in the livestock water use category for one or more decades within the planning horizon. Estimated impacts to this water use category appear in Table 3-3. Note that tax impacts are not reported for this water use category for similar reasons that apply to the irrigation water use category described above.

Table 3-3 Impacts of Water Shortages on Livestock in Region

Impact Measures	2020	2030	2040	2050	2060	2070
Income losses ($ millions)*	$432	$515	$457	$575	$665	$590
Jobs losses	4,564	5,429	4,816	6,048	6,991	6,195

**** Year 2013 dollars, rounded. Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000***

3.4 Impacts for Municipal Water Shortages

Eighteen of the 21 counties in the region are projected to experience water shortages in the municipal water use category for one or more decades within the planning horizon. Impact estimates were made for the two subtypes of use within municipal use: residential, and non-residential. The latter includes commercial and institutional users. Consumer surplus measures were made for both residential and non-residential demands. In addition, available data for the non-residential, water-intensive portion of municipal demand allowed use of IMPLAN and TWDB Water Use Survey data to estimate income loss, jobs, and taxes. Trucking cost estimates, calculated for shortages exceeding 80 percent, assumed a fixed cost of $20,000 per acre-foot to transport water for municipal use. The estimated impacts to this water use category appear in Table 3-4.

Table 3-4 Impacts of Water Shortages on Municipal Water Users in Region

Impact Measures	2020	2030	2040	2050	2060	2070
Income losses[1] ($ millions)*	$3	$4	$15	$44	$440	$921
Job losses[1]	50	80	298	860	8,634	18,052
Tax losses on production and imports[1] ($ millions)*	$0	$0	$1	$4	$41	$86
Consumer surplus losses ($ millions)*	$2	$11	$23	$50	$90	$152
Trucking costs ($ millions)*	-	-	-	$0	$0	$1
Utility revenue losses ($ millions)*	$38	$69	$87	$111	$120	$162
Utility tax revenue losses ($ millions)*	$1	$1	$2	$2	$2	$3

[1] Estimates apply to the water-intensive portion of non-residential municipal water use.
** Year 2013 dollars, rounded. Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000.*

3.5 Impacts of Manufacturing Water Shortages

Manufacturing water shortages in the region are projected to occur in 11 of the 21 counties in the region for at least one decade of the planning horizon. Estimated impacts to this water use category appear in Table 3-5.

Table 3-5 Impacts of Water Shortages on Manufacturing in Region

Impacts Measures	2020	2030	2040	2050	2060	2070
Income losses ($ millions)*	$393	$429	$634	$944	$1,232	$1,656
Job losses	6,029	5,368	5,927	7,723	10,681	12,697
Tax losses on production and Imports ($ millions)*	$27	$38	$67	$106	$135	$190

** Year 2013 dollars, rounded. Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000.*

3.6 Impacts of Mining Water Shortages

Mining water shortages in the region are projected to occur in 12 of the 21 counties in the region for at least one decade of the planning horizon. Estimated impacts to this water use type appear in Table 3-6.

Table 3-6 Impacts of Water Shortages on Mining in Region

Impact Measures	2020	2030	2040	2050	2060	2070
Income losses ($ millions)*	$2,454	$3,055	$2,948	$2,703	$2,222	$1,849
Job losses	12,506	15,553	15,014	13,773	11,328	9,432
Tax losses on production and Imports ($ millions)*	$342	$426	$411	$376	$309	$257

** Year 2013 dollars, rounded. Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000.*

3.7 Impacts of Steam-Electric Water Shortages

Steam-electric water shortages in the region are projected to occur in 4 of the 21 counties in the region for at least one decade of the planning horizon. Estimated impacts to this water use category appear in Table 3-7.

Note that estimated economic impacts to steam-electric water users:

- Are reflected as an income loss proxy in the form of the estimated additional purchasing costs for power from the electrical grid that could not be generated due to a shortage;
- Do not include estimates of impacts on jobs. Because of the unique conditions of power generators during drought conditions and lack of relevant data, it was assumed that the industry would retain, perhaps relocating or repurposing, their existing staff in order to manage their ongoing operations through a severe drought.
- Does not presume a decline in tax collections. Associated tax collections, in fact, would likely increase under drought conditions since, historically, the demand for electricity increases during times of drought, thereby increasing taxes collected on the additional sales of power.

Table 3-7 Impacts of Water Shortages on Steam-Electric Power in Region

Impact Measures	2020	2030	2040	2050	2060	2070
Income Losses ($ millions)*	$77	$50	$83	$126	$168	$241

** Year 2013 dollars, rounded. Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000.*

3.8 Regional Social Impacts

Projected changes in population, based upon several factors (household size, population, and job loss estimates), as well as the accompanying change in school enrollment, were also estimated and are summarized in Table 3-8.

Table 3-8 Region-wide Social Impacts of Water Shortages in Region

Impact Measures	2020	2030	2040	2050	2060	2070
Consumer surplus losses ($ millions)*	$2	$11	$23	$50	$90	$152
Population losses	6,221	7,033	7,191	7,710	9,436	11,194
School enrollment losses	1,151	1,301	1,330	1,426	1,746	2,071

**** Year 2013 dollars, rounded. Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000.***

Appendix A - County Level Summary of Estimated Economic Impacts for Region O

County level summary of estimated economic impacts of not meeting identified water needs by water use category and decade (in 2013 dollars, rounded). Values presented only for counties with projected economic impacts for at least one decade.

** Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000*

		Income losses (Million $)*						Job losses						Consumer Surplus (Million $)*					
County	Water Use Category	2020	2030	2040	2050	2060	2070	2020	2030	2040	2050	2060	2070	2020	2030	2040	2050	2060	2070
BAILEY	IRRIGATION	$31	$32	$32	$33	$33	$35	526	545	557	576	574	595	-	-	-	-	-	-
BAILEY	LIVESTOCK	$35	$60	$63	$69	$70	$82	350	600	627	683	697	818	-	-	-	-	-	-
BAILEY	MUNICIPAL	-	-	-	-	-	-	-	-	-	-	-	-	$0	$0	$0	$0	$0	$0
BAILEY Total		**$66**	**$92**	**$95**	**$102**	**$103**	**$117**	**876**	**1,145**	**1,184**	**1,258**	**1,272**	**1,413**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
BRISCOE	IRRIGATION	$0	$3	$7	$7	$8	$10	4	52	107	115	116	154	-	-	-	-	-	-
BRISCOE	LIVESTOCK	$1	$1	$2	$2	$2	$3	11	15	19	23	27	31	-	-	-	-	-	-
BRISCOE	MUNICIPAL	-	-	-	-	-	-	-	-	-	-	-	-	$0	$0	$0	$0	$0	$0
BRISCOE Total		**$1**	**$5**	**$9**	**$9**	**$10**	**$13**	**15**	**68**	**126**	**138**	**144**	**185**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
CASTRO	IRRIGATION	$92	$87	$96	$98	$96	$100	1,733	1,641	1,815	1,839	1,815	1,888	-	-	-	-	-	-
CASTRO	LIVESTOCK	$104	$137	$174	$186	$190	$200	1,099	1,453	1,842	1,977	2,019	2,127	-	-	-	-	-	-
CASTRO	MANUFACTURING	-	-	-	-	$3	$8	-	-	-	-	22	66	-	-	-	-	-	-
CASTRO	MUNICIPAL	-	-	-	-	-	-	-	-	-	-	-	-	$0	$0	$0	$0	$0	$0
CASTRO Total		**$196**	**$224**	**$270**	**$284**	**$289**	**$309**	**2,832**	**3,094**	**3,657**	**3,815**	**3,856**	**4,082**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
COCHRAN	IRRIGATION	$31	$31	$30	$30	$30	$29	466	457	451	445	440	436	-	-	-	-	-	-
COCHRAN	LIVESTOCK	$15	$15	$17	$9	$11	$17	163	170	193	106	120	186	-	-	-	-	-	-
COCHRAN	MUNICIPAL	-	-	-	-	-	-	-	-	-	-	-	-	$0	$0	$0	$0	$0	$0
COCHRAN Total		**$46**	**$46**	**$48**	**$39**	**$40**	**$46**	**629**	**627**	**644**	**551**	**559**	**622**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
CROSBY	IRRIGATION	$0	$0	$0	$0	$0	$0	1	1	1	1	1	1	-	-	-	-	-	-
CROSBY	LIVESTOCK	$4	$4	$4	$5	$5	$5	45	48	50	53	55	58	-	-	-	-	-	-
CROSBY	MINING	$51	$53	$49	$44	$38	$33	259	271	249	225	196	169	-	-	-	-	-	-
CROSBY	MUNICIPAL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$0	$0
CROSBY Total		**$55**	**$57**	**$53**	**$49**	**$43**	**$38**	**305**	**320**	**300**	**279**	**252**	**228**	**-**	**-**	**-**	**-**	**$0**	**$0**
DAWSON	IRRIGATION	-	-	-	-	-	$0	-	-	-	-	-	-	-	-	-	-	-	-
DAWSON	MINING	$12	$240	$280	$238	$143	$86	62	1,212	1,416	1,202	723	436	-	-	-	-	-	-
DAWSON	MUNICIPAL	-	-	-	$0	$0	$1	-	-	-	-	1	13	$0	$0	$0	$0	$0	$1
DAWSON Total		**$12**	**$240**	**$280**	**$238**	**$143**	**$87**	**62**	**1,212**	**1,416**	**1,202**	**724**	**449**	**$0**	**$0**	**$0**	**$0**	**$0**	**$1**
DEAF SMITH	IRRIGATION	$25	$30	$34	$37	$40	$44	459	566	634	697	744	820	-	-	-	-	-	-
DEAF SMITH	LIVESTOCK	$162	$147	$56	$101	$155	-	1,715	1,558	591	1,074	1,644	-	-	-	-	-	-	-
DEAF SMITH	MANUFACTURING	$163	$190	$150	$148	$240	$192	2,920	3,398	2,693	2,653	4,306	3,448	-	-	-	-	-	-

		Income losses (Million $)*						Job losses						Consumer Surplus (Million $)*					
County	Water Use Category	2020	2030	2040	2050	2060	2070	2020	2030	2040	2050	2060	2070	2020	2030	2040	2050	2060	2070
DEAF SMITH	MUNICIPAL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$0
DEAF SMITH Total		**$349**	**$367**	**$240**	**$287**	**$435**	**$236**	**5,094**	**5,522**	**3,918**	**4,424**	**6,694**	**4,267**	-	-	-	-	-	**$0**
DICKENS	LIVESTOCK	$3	$3	$3	$4	$4	$4	30	33	37	41	45	49	-	-	-	-	-	-
DICKENS Total		**$3**	**$3**	**$3**	**$4**	**$4**	**$4**	**30**	**33**	**37**	**41**	**45**	**49**	-	-	-	-	-	-
FLOYD	IRRIGATION	$4	$3	$4	$5	$5	$6	57	53	69	76	80	94	-	-	-	-	-	-
FLOYD	MUNICIPAL	-	-	-	-	-	-	-	-	-	-	-	-	$0	$0	$0	$0	$0	$0
FLOYD Total		**$4**	**$3**	**$4**	**$5**	**$5**	**$6**	**57**	**53**	**69**	**76**	**80**	**94**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
GAINES	IRRIGATION	$54	$93	$105	$112	$116	$128	810	1,391	1,569	1,679	1,743	1,919	-	-	-	-	-	-
GAINES	LIVESTOCK	-	-	-	-	-	$5	-	-	-	-	-	60	-	-	-	-	-	-
GAINES	MANUFACTURING	$16	$184	$439	$742	$919	$1,363	87	1,006	2,399	4,052	5,018	7,446	-	-	-	-	-	-
GAINES	MINING	$1	$26	$61	$70	$61	$53	3	140	327	374	325	283	-	-	-	-	-	-
GAINES	MUNICIPAL	-	-	$2	$6	$18	-	-	-	41	122	350	-	$0	$0	$1	$2	$3	$1
GAINES Total		**$71**	**$303**	**$607**	**$930**	**$1,113**	**$1,549**	**900**	**2,537**	**4,337**	**6,226**	**7,436**	**9,709**	**$0**	**$0**	**$1**	**$2**	**$3**	**$1**
GARZA	LIVESTOCK	$8	$9	$9	$9	$9	$10	94	96	99	102	106	113	-	-	-	-	-	-
GARZA Total		**$8**	**$9**	**$9**	**$9**	**$9**	**$10**	**94**	**96**	**99**	**102**	**106**	**113**	-	-	-	-	-	-
HALE	IRRIGATION	$106	$102	$99	$96	$95	$91	1,734	1,672	1,617	1,570	1,548	1,491	-	-	-	-	-	-
HALE	LIVESTOCK	$32	$40	$12	$45	$51	$62	330	410	122	466	518	634	-	-	-	-	-	-
HALE	MANUFACTURING	$147	$2	-	-	-	-	1,910	25	-	-	-	-	-	-	-	-	-	-
HALE	MINING	$390	$385	$346	$300	$259	$224	1,973	1,948	1,748	1,515	1,310	1,132	-	-	-	-	-	-
HALE	MUNICIPAL	-	-	-	-	-	-	-	-	-	-	-	-	$0	$0	$0	$0	$0	$0
HALE	STEAM ELECTRIC POWER	$1	$0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HALE Total		**$677**	**$530**	**$457**	**$441**	**$404**	**$377**	**5,947**	**4,055**	**3,487**	**3,550**	**3,376**	**3,257**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
HOCKLEY	IRRIGATION	$17	$24	$31	$29	$30	$29	261	358	471	441	443	433	-	-	-	-	-	-
HOCKLEY	LIVESTOCK	$1	$1	$1	$1	$2	$2	14	15	16	17	17	18	-	-	-	-	-	-
HOCKLEY	MINING	-	-	-	-	$5	$5	-	-	-	-	27	26	-	-	-	-	-	-
HOCKLEY	MUNICIPAL	-	-	-	-	-	-	-	-	-	-	-	-	$0	$0	$0	$0	$0	$0
HOCKLEY Total		**$19**	**$25**	**$33**	**$31**	**$36**	**$36**	**275**	**373**	**487**	**457**	**488**	**477**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
LAMB	IRRIGATION	$79	$81	$86	$90	$92	$95	1,351	1,389	1,468	1,540	1,561	1,627	-	-	-	-	-	-
LAMB	LIVESTOCK	$30	$23	$36	$53	$67	$90	308	235	370	543	683	914	-	-	-	-	-	-
LAMB	MANUFACTURING	$43	$21	$3	$3	$3	$5	678	337	41	42	45	87	-	-	-	-	-	-
LAMB	MINING	$193	$192	$172	$151	$130	$113	975	970	867	761	658	569	-	-	-	-	-	-
LAMB	MUNICIPAL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$0	$0	$0	$0
LAMB	STEAM ELECTRIC POWER	$58	$2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LAMB Total		**$403**	**$319**	**$297**	**$297**	**$292**	**$303**	**3,312**	**2,932**	**2,746**	**2,886**	**2,947**	**3,196**	-	-	**$0**	**$0**	**$0**	**$0**
LUBBOCK	IRRIGATION	$18	$20	$33	$30	$29	$39	262	304	498	452	433	577	-	-	-	-	-	-
LUBBOCK	MANUFACTURING	$1	-	-	-	-	-	13	-	-	-	-	-	-	-	-	-	-	-
LUBBOCK	MINING	$1,492	$1,517	$1,403	$1,263	$1,135	$1,028	7,637	7,765	7,182	6,467	5,809	5,262	-	-	-	-	-	-
LUBBOCK	MUNICIPAL	-	$2	$7	$29	$408	$901	-	30	145	572	8,010	17,671	$2	$10	$20	$45	$83	$146
LUBBOCK Total		**$1,511**	**$1,539**	**$1,444**	**$1,323**	**$1,572**	**$1,968**	**7,912**	**8,098**	**7,824**	**7,492**	**14,252**	**23,510**	**$2**	**$10**	**$20**	**$45**	**$83**	**$146**

		Income losses (Million $)*						Job losses						Consumer Surplus (Million $)*					
County	Water Use Category	2020	2030	2040	2050	2060	2070	2020	2030	2040	2050	2060	2070	2020	2030	2040	2050	2060	2070
LYNN	MINING	$231	$286	$261	$186	$91	$25	1,168	1,443	1,320	940	462	127	-	-	-	-	-	-
LYNN	MUNICIPAL	-	-	-	$0	$0	$1	-	-	-	-	6	12	-	$0	$0	$0	$0	$0
LYNN Total		**$231**	**$286**	**$261**	**$186**	**$92**	**$26**	**1,168**	**1,443**	**1,320**	**941**	**469**	**139**	**-**	**$0**	**$0**	**$0**	**$0**	**$0**
MOTLEY	LIVESTOCK	$6	$6	$6	$7	$7	$7	64	67	71	75	79	83	-	-	-	-	-	-
MOTLEY	MINING	$20	$16	$14	$13	$9	$5	104	83	76	67	46	28	-	-	-	-	-	-
MOTLEY Total		**$25**	**$22**	**$21**	**$19**	**$16**	**$13**	**167**	**150**	**147**	**142**	**124**	**110**	**-**	**-**	**-**	**-**	**-**	**-**
PARMER	IRRIGATION	$95	$99	$104	$104	$102	$104	1,757	1,828	1,915	1,909	1,887	1,921	-	-	-	-	-	-
PARMER	LIVESTOCK	$21	$57	$62	$66	$71	$77	219	604	652	702	755	810	-	-	-	-	-	-
PARMER	MANUFACTURING	$22	$32	$42	$51	$68	$87	421	601	794	975	1,289	1,648	-	-	-	-	-	-
PARMER	MUNICIPAL	-	-	-	-	-	-	-	-	-	-	-	-	$0	$0	$0	$0	$0	$0
PARMER Total		**$138**	**$188**	**$207**	**$221**	**$242**	**$268**	**2,397**	**3,033**	**3,360**	**3,586**	**3,930**	**4,380**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
SWISHER	IRRIGATION	$40	$54	$58	$60	$61	$64	693	932	1,003	1,037	1,056	1,104	-	-	-	-	-	-
SWISHER	MUNICIPAL	-	-	-	-	-	-	-	-	-	-	-	-	$0	$0	$0	$0	$0	$0
SWISHER Total		**$40**	**$54**	**$58**	**$60**	**$61**	**$64**	**693**	**932**	**1,003**	**1,037**	**1,056**	**1,104**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
TERRY	IRRIGATION	-	$0	$16	$35	$42	$54	-	3	237	507	608	783	-	-	-	-	-	-
TERRY	LIVESTOCK	-	-	-	$5	$8	$13	-	-	-	60	94	152	-	-	-	-	-	-
TERRY	MANUFACTURING	-	-	-	$0	$0	$0	-	-	-	1	1	2	-	-	-	-	-	-
TERRY	MINING	-	-	-	$121	$85	$60	-	-	-	614	432	304	-	-	-	-	-	-
TERRY	MUNICIPAL	-	-	-	-	$4	$9	-	-	-	-	81	183	-	$0	$0	$1	$1	$1
TERRY Total		**-**	**$0**	**$16**	**$161**	**$140**	**$137**	**-**	**3**	**237**	**1,182**	**1,217**	**1,425**	**-**	**$0**	**$0**	**$1**	**$1**	**$1**
YOAKUM	IRRIGATION	$40	$44	$46	$46	$46	$49	623	681	701	707	711	752	-	-	-	-	-	-
YOAKUM	LIVESTOCK	$11	$11	$11	$12	$12	$13	122	124	126	128	131	140	-	-	-	-	-	-
YOAKUM	MINING	$64	$340	$362	$318	$265	$217	325	1,720	1,830	1,607	1,339	1,096	-	-	-	-	-	-
YOAKUM	MUNICIPAL	$3	$3	$6	$8	$9	$9	50	50	111	166	185	174	$0	$1	$1	$2	$2	$2
YOAKUM	STEAM ELECTRIC POWER	$18	$48	$83	$126	$168	$241	-	-	-	-	-	-	-	-	-	-	-	-
YOAKUM Total		**$136**	**$446**	**$507**	**$510**	**$500**	**$528**	**1,120**	**2,576**	**2,768**	**2,608**	**2,366**	**2,161**	**$0**	**$1**	**$1**	**$2**	**$2**	**$2**
Regional Total		**$3,990**	**$4,757**	**$4,918**	**$5,205**	**$5,551**	**$6,133**	**33,885**	**38,304**	**39,164**	**41,995**	**51,395**	**60,971**	**$2**	**$11**	**$23**	**$50**	**$90**	**$152**

Chapter 7

Chapter 7

Drought Response Information, Activities, and Recommendations

7. Drought Response Information, Activities, and Recommendations

Drought is a natural and recurring meteorological phenomenon where there is a deficiency of precipitation over an extended period of time, generally without well-defined beginning or end points. Droughts result in water shortages and may have significant impacts on human activities, depending on their severity. Additionally, our responses in times of drought may exacerbate drought conditions with increased water usage and demand.

There are four categories of drought: meteorological, agricultural, hydrological, and socioeconomic:

- *Meteorological* drought is defined as a period of substantially diminished precipitation that persists long enough to produce a significant hydrologic imbalance. Factors affecting meteorological drought can vary among different regions.

- *Agricultural* drought occurs when there is insufficient precipitation and/or soil moisture to sustain crop or forage production systems; this category of drought typically begins after meteorological drought but before hydrological drought.

- *Hydrological* drought is defined on a river-basin or watershed scale and is measured by decreases in streamflow and lake, reservoir, and groundwater levels. Hydrological droughts lag behind meteorological and agricultural droughts because more time is needed for the basin-wide impacts to manifest.

- *Socioeconomic* drought occurs when a weather-related deficit affects the health, well-being, and quality of life of the population, or when the increased demand of an economic product (such as hydroelectric power) exceeds supply.

Relatively mild, short-duration droughts are common and usually result in relatively mild impacts. Extended severe drought conditions have serious impacts, and these impacts may extend long past the time that normal or above-normal precipitation returns. Due to the potentially devastating effects of drought, it is important that water suppliers and water users consider the possible impacts and develop drought plans to address supply or demand management.

This chapter presents information on current drought preparations and responses in Region O (Section 7.1) and summarizes current drought conditions and the historical drought of record (Section 7.2). Recommendations for region-specific drought and emergency responses are presented in Sections 7.3 through 7.6, and region-specific model drought contingency plans (DCPs) are provided in Section 7.7.

7.1 Descriptions of Current Preparations for Drought in the Region

The Texas Commission on Environmental Quality (TCEQ) requires that all irrigation districts and wholesale and retail public water suppliers supplying water to 3,300 connections or more prepare and submit DCPs. Additionally, the TCEQ requires that all public water suppliers supplying water to less than 3,300 connections prepare and adopt a DCP that can be made available upon request. A revision of the DCP is due to the TCEQ every five years; the most current DCP revision was required to be submitted to the TCEQ by May 1, 2014. The Texas Administrative Code Title 30, Chapter 288, Subchapter B, specifies that a DCP should contain the following:

- Specific, quantified targets for water use reductions
- Drought response stages
- Triggers to begin and end with each stage
- Supply management measures
- Demand management measures
- Descriptions of drought indicators
- Notification procedures
- Enforcement procedures
- Procedures for granting exceptions

- Public input to the plan
- Ongoing public education
- Adoption of plan
- Coordination with regional water planning group

In accordance with this requirement, DCPs have been prepared for cities and communities throughout Region O.

7.1.1 Overall Assessment of Current Drought Preparations

In Region O, 53 DCPs were requested and 52 were obtained and reviewed. Except for a few, most DCPs were complete, outlining each water system's drought and emergency contingency procedures and identifying the triggering criteria for initiation and termination of drought response stages as well as other water use restrictions in effect during time of water shortages. The majority of DCPs in Region O include quantified water use reduction goals for each stage, notification procedures, and enforcement measures, and some also included allowable variances to the plan.

7.1.2 Summary of Current Triggers and Responses

Triggers used for initiating drought responses and the planned responses to drought conditions for DCPs in Region O are presented in Tables 7-1a and 7-1b, respectively. A more detailed summary of drought responses for entities in Region O is contained in Appendix 7A. In general, the drought response plans identify varying stages of drought. Most communities identify at least three drought stages and some identify up to six stages in their DCP. For each drought stage, a trigger to determine when that stage should be activated and a corresponding response are identified, as well as a requirement for termination of the drought stage. Trigger conditions are used to identify the onset of drought and are generally based on either water supply or demand conditions for the water system. Corresponding drought responses typically start with voluntary water use reduction strategies in the earlier stages, building to mandatory water use reductions, restrictions, and prohibitions as the drought stage becomes more severe.

The PDSI is constructed so that the mean will be zero as long as the climate maintains its historical pattern. A PDSI of zero indicates normal conditions while negative numbers indicate drought conditions and positive numbers indicate wet conditions. The PDSI is calculated monthly for climate divisions throughout the United States, including the ten climate divisions within Texas. Region O contains portions of two of those climate divisions: Texas climate divisions 1 (High Plains) and 2 (Low Rolling Plains), shown in Figure 7-1.

The severity of a drought depends primarily on its duration and intensity. Figure 7-2 shows the monthly PDSI values since 1900 for Texas climate divisions 1 and 2. The PDSI monthly index data plotted in this figure were downloaded from the National Climate Data Center website (NCDC, 2014), and the drought ranking and intensity listed for the climate divisions was provided in the 2012 Texas State Water Plan (TWDB, 2012). The drought of record during the 1950s ranks the highest in terms of both duration and intensity for both climate divisions (TWDB, 2012); numerous dry years occurred consecutively during this drought. Other significant droughts occurred in Region O during the 1910s, 1930s, and 1960s. The most recent drought, which appears to have begun in 2011, is one of the most intense droughts on record.

A recently published climate study looked at trends in air temperature and precipitation at 120 long-term weather stations adjacent to 57 Texas reservoirs with data for the time period between 1960 and 2010 (Gelca et al., 2014). Two of the weather stations included in the analysis are located within Region O: Lamesa 1SSE and Lubbock International Airport. The climate study found that annual average temperature, seasonal average temperature, and cold temperature extremes were becoming warmer near many of the reservoirs in Texas. The changes in air temperature are highly correlated with an increase in the water temperature of these reservoirs. Table 7-3 contains the results of the climate study trend analysis for the Lamesa and Lubbock weather stations.

The Spearman rank correlation was used to look for increasing or decreasing trends in temperature and precipitation over time (1960 to 2010). For each secondary climate indicator, the correlation coefficient calculates if that indicator is increasing or decreasing over time. The level of significance in the correlation is indicated by the p value; a p value less than 0.1 indicates a significant trend for that variable.

7.2 Drought(s) of Record

Lowry (1959) found that there had been 11 significant droughts in Texas between the period of 1889 and 1957, with the most severe occurring from 1954 to 1956. The 1953 and 1950 to 1952 droughts were rated separately as the fifth and seventh most severe, although all three of these periods were later combined in the analysis to form the most severe drought (Texas Water Commission, 1965). The drought that occurred from 1950 to 1957 is the current drought of record (Texas Water Resources Institute, 2011).

A drought index is a ranking system derived from the assimilation of data, including rainfall, snowpack, streamflow, and other water supply indicators for a given region, and can be used as an aid in planning and decision making. The Palmer Drought Severity Index (PDSI), created in 1965 by W.C. Palmer to measure the variations in moisture supply, is calculated using precipitation and temperature data and the available water content of the soil. These data are then used to calculate evapotranspiration, soil recharge, runoff, and moisture loss from the surface layer, and moisture conditions are standardized so that comparisons among regions and differing time frames can be made. Based on a score determined through these analyses, the drought status at any given time is described according to the classifications listed in Table 7-2.

Table 7-2. Palmer Drought Severity Index Classifications

PDSI Classification	Description
+ 4.00 or more	Extremely wet
+3.00 to +3.99	Very wet
+2.00 to +2.99	Moderately wet
+1.00 to +1.99	Slightly wet
+0.50 to +0.99	Incipient wet spell
+0.49 to –0.49	Near normal
–0.50 to –0.99	Incipient dry spell
–1.00 to –1.99	Mild drought
–2.00 to –2.99	Moderate drought
–3.00 to –3.99	Severe drought
–4.00 or less	Extreme drought

Table 7-1a. Summary of Drought Contingency Plans
Specific Triggers
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Entity	Mild	Moderate	Severe	Critical	Emergency
Abernathy	TDWD ≥ 80% system capacity for 3 consecutive days.	TDWD ≥ 85% system capacity for 3 consecutive days.	TDWD ≥ 90% system capacity for 3 consecutive days.	TDWD ≥ 95% system capacity for 3 consecutive days.	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).
Amherst	TDWD ≥ 195K gallons for 3 consecutive days or 65K gpd or 11 feet on SCADA; falling treated water reservoir levels below 75% for 3 consecutive days.	TDWD ≥ 210K gallons for 3 consecutive days or 70K gpd or 9 feet on SCADA; falling treated water reservoir levels below 70% for 3 consecutive days.	TDWD ≥ 225K gallons for 3 consecutive days or 75K gpd or 9 feet on SCADA; falling treated water reservoir levels below 65% for 3 consecutive days.	TDWD ≥ 240K gallons for 3 consecutive days or 80K gpd or 8 feet on SCADA; falling treated water reservoir levels below 60% for 3 consecutive days.	TDWD ≥ 240K gallons for 3 consecutive days or 80K gpd or 8 feet on SCADA; falling treated water reservoir levels below 55% for 3 consecutive days,
Anton	None stated.	None stated.	None stated.	None stated.	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).
Bovina	TDWD ≥ 75% pumping capacity for 3 consecutive days.	ADWU ≥ 90% pumping capacity for 3 consecutive days and/or storage capacity below 60% for 48 hours and/or water pressures in distribution system approach 40 psi.	NA	Failure of major component would cause immediate health/safety hazard; TDWD less than system capacity for 3 consecutive days; groundwater wells insufficient to met TDWD; replenishment of water reservoirs has stopped.	Critical conditions persist for an extended period of time.
Brownfield	Available water supply <75% of flow capabilities or when the Water and Wastewater Superintendent determines that a water shortage condition exists.	NA	NA	Available supply <50% of flow capabilities or when 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).	Analysis of water supply availability under drought of record conditions may indicate that there is an immediate risk of water supply shortage; or severe facility capacity limitations exist; or emergency conditions such as supply source contamination exists.
Crosbyton	TDWD ≥ 75% pumping capacity for 3 consecutive days.	TDWD ≥ 90% of average daily water use for 3 consecutive days; net reservoir storage falls below 60% of capacity in 48 hours; water pressure in distribution systems falls below 40 psi for at least 8 hours.	Missing pages	Missing pages	Missing pages
Denver City	TDWD ≥ 65% system capacity for 3 consecutive days; mechanical failures reduce production capacity; contamination of water supply.	TDWD ≥ 75% system capacity for 3 consecutive days; mechanical failures reduce production capacity; contamination of water supply.	TDWD ≥ 80% system capacity for 3 consecutive days; mechanical failures reduce production capacity; contamination of water supply.	TDWD ≥ 90% system capacity for 3 consecutive days; mechanical failures reduce production capacity; contamination of water supply.	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).

TDWD = Total daily water demand
mgd = Million gallons per day
gpd = Gallons per day
SCADA = Supervisory control and data acquisition system
ADWU = Average daily water use
NOAA = National Oceanic and Atmospheric Administration
NA = Not applicable to this DCP
psi = Pounds per square inch
DCP = Drought contingency plan
ft bgs = Feet below ground surface
ft msl = Feet above mean sea level
WRMWD = White River Municipal Water District
CRMWA = Canadian River Municipal Water Authority

Table 7-1a. Summary of Drought Contingency Plans
Specific Triggers
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Entity	Mild	Moderate	Severe	Critical	Emergency
Dimmitt	TDWD ≥ 1.5 mgd for 30 consecutive days or 2.5 mgd on a single day.	TDWD ≥ 1.5 mgd for longer than 30 consecutive days or 2.5 mgd on a single day.	TDWD ≥ 1.5 mgd for 45 consecutive days or 2.5 mgd on a single day.	NA	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); more than 1/4 of water wells are out of service due to natural or man-made disaster.
Earth	TDWD ≥ 70% system capacity for 5 consecutive days.	TDWD ≥ 85% system capacity for 5 consecutive days.	Treated water reservoir levels do not refill to more than 75% of capacity overnight for 2 consecutive days.	Treated water reservoir levels do not refill to more than 50% of capacity overnight for 2 consecutive days.	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); more than 1/4 of water wells are out of service due to natural or man-made disaster.
Farwell	Specific capacity ≤ 75% well's original specific capacity.	Specific capacity ≤ 60% well's original specific capacity.	Specific capacity ≤ 50% well's original specific capacity.	Specific capacity ≤ 45% well's original specific capacity.	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).
Floydada	TDWD ≥ 90% system capacity for 3 consecutive days; weather conditions indicate high use is likely.	TDWD ≥ 100% system capacity for 3 consecutive days; weather conditions indicate mild drought will persist for 5 or more days; mechanical failure requiring more than 24 hours to repair during mild drought conditions.	TDWD ≥ 110% production capacity for a 24-hour period; unable to maintain water storage levels; system demand exceeds high service pump capacity; mechanical failure requiring more than 12 hours to repair during moderate drought conditions.	NA	Water system is contaminated; water system fails from acts of God or man.
Friona	TDWD ≥ 60% system capacity for 3 consecutive days.	TDWD ≥ 70% system capacity for 3 consecutive days.	TDWD ≥ 80% system capacity for 3 consecutive days.	TDWD ≥ 90% system capacity for 3 consecutive days.	TDWD ≥ 95% system capacity for 3 consecutive days; major water line breaks, or pump or system failures occur, which cause unprecedented loss of capability to provide water service; or contamination of the water supply source(s).
Hale Center	TDWD ≥ 80% system capacity for 3 consecutive days; extended period of at least 8 weeks of low rainfall.	TDWD ≥ 90% system capacity for 3 consecutive days; water level in any water storage tank cannot be replenished for 3 consecutive days.	TDWD ≥ 95% system capacity for 3 consecutive days; water consumption of 100% of maximum available; water storage levels in the system drop in one 24-hour period.	NA	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).
Hart	TDWD ≥ 70% system capacity for 5 consecutive days.	TDWD ≥ 85% system capacity for 5 consecutive days.	Treated water reservoir levels do not refill to more than 75% of capacity overnight.	Treated water reservoir levels do not refill to more than 50% of capacity overnight.	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); significant portion of system is out of service due to natural or man-made disaster.

TDWD = Total daily water demand
mgd = Million gallons per day
gpd = Gallons per day
SCADA = Supervisory control and data acquisition system
ADWU = Average daily water use
NOAA = National Oceanic and Atmospheric Administration
NA = Not applicable to this DCP
psi = Pounds per square inch
DCP = Drought contingency plan
ft bgs = Feet below ground surface
ft msl = Feet above mean sea level
WRMWD = White River Municipal Water District
CRMWA = Canadian River Municipal Water Authority

Table 7-1a. Summary of Drought Contingency Plans
Specific Triggers
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Entity	Mild	Moderate	Severe	Critical	Emergency
Hereford	TDWD ≥ 6 mgd for 7 consecutive days or 9 mgd on a single day.	TDWD ≥ 7 mgd for 5 consecutive days or 9 mgd for 2 consecutive days.	TDWD ≥ 7 mgd for 7 consecutive days.	TDWD ≥ 7 mgd for 7 consecutive days and treated water reservoir levels do not refill to more than 75% of capacity overnight.	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).
Idalou	Annually, beginning on May 15 through September 1 between 11 AM and 7PM and/or TDWD ≥ 0.65 mgd for 7 consecutive days or 0.9 mgd on a single day.	TDWD ≥ 0.8 mgd for 7 consecutive days or 1.0 mgd on a single day and/or City well is ≥ 75% of original specific capacity.	City well is ≥ 60% of original specific capacity.	City well is ≥ 50% of original specific capacity.	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).
Kress	ADWU approaches 0.5 mgd or 75% of well field pumping capacity for 3 consecutive days.	ADWU reaches 0.5 mgd or 100% of well field pumping capacity for 3 consecutive days, and/or raw water storage falls below 60% capacity for 48 hours, and/or water pressures approach 40 psi.	NA	Failure of a major component of the system that would cause immediate health or safety hazard, and/or water demand exceeding capacity for 3 consecutive days, and/or groundwater wells insufficient to supply TDWD, and/or all raw water pumped from reservoirs has stopped.	NA
Lamesa	Available water supply <80% of flow capabilities or director of utilities determines a mild shortage condition exists.	Available water supply <75% of flow capabilities or director of utilities determines a moderate shortage condition exists.	Analysis of water supply availability indicates there may be an immediate risk of a shortage; severe facility capacity limitations; emergency conditions such as supply source contamination.	Available water supply <60% of flow capabilities or director of utilities determines a critical shortage condition exists.	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).
Levelland	TDWD ≥ 4.5 mgd for 7 consecutive days or 5 mgd on a single day.	TDWD ≥ 4.8 mgd for 5 consecutive days or 5.3 mgd on a single day.	TDWD ≥ 5 mgd for 3 consecutive days or 5.5 mgd on a single day.	TDWD ≥ 5.3 mgd for 3 consecutive days or 5.7 mgd on a single day.	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).
Littlefield	TDWD ≥ 75% of average daily water use for 3 consecutive days.	TDWD ≥ 90% of average daily water use for 3 consecutive days; net reservoir storage falls below 60% of capacity in 48 hours; water pressure in distribution systems falls below 40 psi for at least 8 hours.	Water demand exceeds firm system capacity for one day.	The imminent or actual failure of a major water supply component of the system which would affect the safety, health or welfare of the citizens of Littlefield; natural or man-made contamination of the water supply source(s).	The imminent or actual failure of a major water supply component of the system which would affect the safety, health or welfare of the public; natural or man-made contamination of the water supply source(s).
Lockney	TDWD > 80% City's production capacity for 7 consecutive days.	TDWD > 85% City's production capacity for 7 consecutive days.	TDWD > 90% City's production capacity for 7 consecutive days.	NA	TDWD > 95% City's production capacity for 7 consecutive days.
Lorenzo	TDWD ≥ 512,640 gallons or 50% of safe operating capacity for 3 days.	TDWD ≥ 410,112 gallons or 60% of safe operating capacity for 3 days.	TDWD ≥ 307,584 gallons or 70% of safe operating capacity for 2 days.	TDWD ≥ 256,320 gallons or 75% of safe operating capacity for 2 days.	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).

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Specific Triggers
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Entity	Mild	Moderate	Severe	Critical	Emergency
Lubbock	TDWD ≥ 80% system capacity for 10 consecutive days; water supply available is only sufficient to meet projected needs; concern for future water supply based on low lake levels, reservoir capacity, groundwater supplies.	TDWD ≥ 90% system capacity for 10 consecutive days; water supply reduced; concern for future water supply based on low lake levels, reservoir capacity, groundwater supplies; supplies reduced due to failure of portion of water supply system.	TDWD > 100% system capacity for 5 consecutive days; water supply reduced to 90% or less of supply needs; water supply from lakes, reservoirs, and groundwater well below normal; supplies reduced due to failure of portion of water supply system.	NA	TDWD > 105% system capacity for 5 consecutive days; water supply reduced to 70% or less of supply needs; failure in water supply source or system that causes severe or prolonged limit on ability of supply to meet demand.
Mackenzie Municipal Water Authority	Lake storage capacity between 70% and 80%.	Lake storage capacity between 50% and 69%.	Lake storage capacity between 30% and 49%.	NA	Lake storage capacity between 20% an 29%; termination of supply will be initiated when lake storage is 15% or less of capacity; 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).
Matador Water District	TDWD ≥ 1.175 mgd for 5 consecutive days or 1.3 mgd on a single day.	TDWD ≥ 1.2 mgd for 5 consecutive days or 1.4 mgd on a single day.	TDWD ≥ 1.35 mgd for 5 consecutive days or 1.5 mgd on a single day.	NA	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).
Meadow	Reduction in long-term source of supply; notification from City of Brownfield (supply source) of initiation of stage 1 of DCP; static water level of City's well ≤ 80 feet; when the area is in an abnormally dry or moderate drought as reported by NOAA.	Reduction in long-term source of supply; notification from City of Brownfield (supply source) of initiation of stage 2 of DCP; static water level of City's well ≤ 75 feet; when the area is in severe drought as reported by NOAA.	Reduction in long-term source of supply; when the area is in extreme drought as reported by NOAA.	Reduction in long-term source of supply; when the area is in exceptional drought as reported by NOAA.	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).
Morton	TDWD ≥ 250,000 gallons for 5 consecutive days or 300,000 gallons on a single day.	TDWD ≥ 350,000 gallons for 5 consecutive days or 400,000 gallons on a single day.	Treated water reservoir levels do not refill to more than 50% of capacity for 2 consecutive days.	Static water level in the City's wells ≤ 175 ft bgs.	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); significant portion of system is out of service due to natural or man-made disaster.
Muleshoe	TDWD ≥ 2 mgd for 10 consecutive days or 2.5 mgd on a single day; water levels in 3 or more water supply wells falls below 130 ft msl.	TDWD ≥ 2 mgd for 15 consecutive days or 2.5 mgd on a single day; water levels in 3 or more water supply wells falls below 135 ft msl.	TDWD ≥ 2 mgd for 20 consecutive days or 2.5 mgd on a single day; water levels in 4 or more water supply wells falls below 140 ft msl.	TDWD ≥ 2 mgd for 20 consecutive days; water levels in 4 or more water supply wells falls below 140 ft msl.	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).
New Deal	Specific capacity ≤ 90% well's original specific capacity for 3 consecutive days.	Well production ≤ 80% well's original production for 3 consecutive days.	Well production ≤ 70% well's original production for 3 consecutive days.	Well production ≤ 60% well's original production for 3 consecutive days.	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).

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Table 7-1a. Summary of Drought Contingency Plans
Specific Triggers
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Entity	Mild	Moderate	Severe	Critical	Emergency
O'Donnell	Available water supply <80% of flow capabilities or director of utilities determines a mild shortage condition exists.	Available water supply <75% of flow capabilities or director of utilities determines a moderate water condition exists.	Analysis of water supply availability indicates there may be an immediate risk of a shortage.	Available water supply <50% of flow capabilities or director of utilities determines a critical water condition exists.	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).
Olton	TDWD ≥ 70% system capacity for 5 consecutive days.	TDWD ≥ 85% system capacity for 3 consecutive days.	Treated water reservoir levels do not refill to more than 75% of capacity for 2 consecutive days.	Treated water reservoir levels do not refill to more than 50% of capacity for 2 consecutive days.	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); significant portion of system is out of service due to natural or man-made disaster.
Petersburg	TDWD ≥ 750,000 gallons for 3 consecutive days or 900,000 gallons on a single day.	NA	TDWD ≥ 750,000 gallons for 3 consecutive days or 1 million gallons on a single day.	NA	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).
Plains	Total daily water supply capacity = 140% of peak daily water demand of record.	Total daily water supply capacity = 125% of peak daily water demand of record.	Total daily water supply capacity = 110% of peak daily water demand of record.	Total daily water supply capacity = 100% of peak daily water demand of record.	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); when determined appropriate to protect health and safety.
Plainview	TDWD ≥ 90% system capacity for 3 consecutive days; weather conditions indicate high use may continue.	TDWD ≥ 100% system capacity for 3 consecutive days; weather conditions indicate mild drought; mechanical failure requiring more than 24 hours to repair.	TDWD ≥ 110% system capacity for 24 hour period; TDWD will not allow storage levels to be maintained; system demand exceeds available high service pump capacity; mechanical failure requiring more than 12 hours to repair.	NA	CRMWA system fails and surface water cannot be delivered to the City; contamination of water system; water system fails due to natural or man-made disaster.
Post	WRMWD initiates mild conditions of DCP; TDWD ≥ 80% system capacity for 3 consecutive days; weather conditions indicate high use may continue.	WRMWD initiates moderate conditions of DCP; TDWD ≥ 90% system capacity for 3 consecutive days; mechanical failure requiring more than 24 hours to repair.	WRMWD initiates severe conditions of DCP; TDWD > 100% system capacity for 3 consecutive days; TDWD will not allow storage levels to be maintained; mechanical failure requiring more than 12 hours to repair.	NA	WRMWD initiates emergency conditions of DCP; Mechanical failure resulting in a loss of at least 25% of the city's water production capacity; contamination of water system.
Ralls	Adopted the WRMWD DCP.				
Ransom Canyon	TDWD approaches 800,000 gallon system capacity; or TDWD ≥ 600,000 gallons for 3 consecutive days; or supply levels are low enough to disrupt some activities; or supply levels are low enough that possibility of degradation of supply situation.	TDWD sometimes reaches 800,000 gallon system capacity; or TDWD ≥ 675,000 gallons for 3 consecutive days; or water levels low enough that could cause future problem; or groundwater or storage levels low enough to disrupt some activity; or imminent or actual failure of major water system component.	TDWD > 800,000 gallon system capacity; or TDWD ≥ 750,000 gallons for 3 consecutive days; or water levels low enough to threaten fire protection; lake levels so low that firefighting pumping equipment will not function; or imminent or actual failure of major water system component.	NA	Major water line fails, or pump or system failures occur, which cause loss of capability to provide water service; or natural or man-made contamination of the water supply source(s).

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Ropesville	TDWD ≥ 50,000 gallons for 3 consecutive days or 150,000 gallons on a single day.	When water supply levels are getting low, TDWD ≥ 50,000 gallons for 3 consecutive days or 150,000 gallons on a single day.	When water sources are low, TDWD ≥100,000 gallons for 3 consecutive days or 150,000 gallons on a single day.	TDWD ≥ 125,000 gallons for 3 consecutive days or 300,000 gallons on a single day.	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).
Seagraves	Not stated.	Not stated.	Not stated.	NA	Not stated.
Seminole	TDWD ≥ 4.5 mgd for 30 consecutive days or 6 mgd on a single day.	Stage 1 conditions continue for 7 consecutive days.	Stage 1 conditions continue for 14 consecutive days.	Stage 1 conditions continue for 30 consecutive days.	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).
Silverton	Mackenzie Municipal Water Authority (MMWA) initiates Stage 1 of its DCP; TDWD ≥ 80% system capacity for 7 consecutive days.	MMWA initiates Stage 2 of its DCP; TDWD ≥ 85% system capacity for 7 consecutive days.	MMWA initiates Stage 3 of its DCP; TDWD ≥ 90% system capacity for 7 consecutive days.	NA	MMWA initiates Stage 4 of its DCP; TDWD ≥ 95% system capacity for 7 consecutive days; Mechanical failure of the transmission or distribution system resulting in a loss of at least 25% of the City's production capacity.
Slaton	TDWD ≥ 1.7 mgd for 7 consecutive days or 1.9 mgd on a single day; Canadian River Municipal Water Authority (CRMWA) initiates Stage 1 of its DCP.	TDWD ≥ 1.8 mgd for 5 consecutive days or 2 mgd on a single day; CRMWA initiates Stage 2 of its DCP.	TDWD ≥ 1.9 mgd for 3 consecutive days or 2.1 mgd on a single day; CRMWA initiates Stage 3 of its DCP.	TDWD ≥ 2.0 mgd for 3 consecutive days or 2.2 mgd on a single day; CRMWA continuing Stage 3 of its DCP.	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).
Smyer	TDWD ≥ 95,000 gallons per day for 3 consecutive days.	TDWD ≥ 80,000 gallons per day for 5 consecutive days but does not exceed 95,000 gallons per day for 5 consecutive days.	NA	NA	Regardless of the level of demand on the municipal water system, the restrictions may be imposed at any time the system is adversely affected by equipment malfunction or failure, loss of power or other occurrence that may impair the operation of the system.
Spur	Adopted the WRMWD DCP.				
Sudan	TDWD ≥ 1.75 mgd for 5 consecutive days or 350,000 on a single day; falling treated water reservoir levels below 75% or 11 feet on SCADA for 5 consecutive days.	TDWD ≥ 2 mgd for 5 consecutive days or 400,000 on a single day; falling treated water reservoir levels below 70% or 10 feet on SCADA for 5 consecutive days; well #2, well #5 or a combination of the 3 other wells fail and are down for repairs.	TDWD ≥ 2.25 mgd for 5 consecutive days or 450,000 on a single day; falling treated water reservoir levels below 65% or 9.5 feet on SCADA for 5 consecutive days; well #2, well #5 or a combination of the 3 other wells fail and are down for repairs.	TDWD ≥ 2.5 mgd for 5 consecutive days or 500,000 on a single day; falling treated water reservoir levels below 60% or 9 feet on SCADA for 5 consecutive days; well #2, well #5 or a combination of the 3 other wells fail and are down for repairs.	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).
Sundown	TDWD ≥ 766,800 gallons per day for 3 consecutive days; state or area is declared to be in a drought; equipment failure causes decrease in pumping capacity.	TDWD ≥ 920,160 gallons per day (60% of capacity) for 3 consecutive days; equipment failure causes decrease in pumping capacity.	TDWD ≥ 1,073,520 gallons per day (70% of capacity) for 3 consecutive days.	TDWD ≥ 1,150,200 gallons per day (75% of capacity) for 3 consecutive days.	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).

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Entity	Mild	Moderate	Severe	Critical	Emergency
Tahoka	TDWD ≥ 80% system capacity for 10 consecutive days; water supply available only sufficient to meet projected needs; lake levels, reservoir capacities, or groundwater supplies are low for some concern exists for future water supplies if drought or emergency conditions continue.	TDWD ≥ 90% system capacity for 10 consecutive days; water supply available reduced, but greater than 90% of projected needs; water availability from lakes or groundwater below normal.	TDWD ≥ 100% system capacity for 5 consecutive days; water supply available reduced to 90% or less of projected needs; water availability from lakes or groundwater well below normal.	NA	TDWD ≥ 105% system capacity for 5 consecutive days; water supply available reduced to 70% or less of projected needs; there has been a failure in a major water supply source or system or natural disaster that causes a severe and prolonged limit on the ability of the water supply system to meet water supply demands.
Tulia	Mackenzie Municipal Water Authority (MMWA) initiates Stage 1 of its DCP; TDWD ≥ 80% system capacity for 7 consecutive days.	MMWA initiates Stage 2 of its DCP; TDWD ≥ 85% system capacity for 7 consecutive days.	MMWA initiates Stage 3 of its DCP; TDWD ≥ 90% system capacity for 7 consecutive days.	NA	MMWA initiates Stage 4 of its DCP; TDWD ≥ 95% system capacity for 7 consecutive days; Mechanical failure of the transmission or distribution system resulting in a loss of at least 25% of the City's production capacity.
White River Municipal Water District	WRMWD delivers surface water and TDWD of all customers ≥ 90% system capacity for 3 consecutive days; WRMWD not able to supply all water demand from surface water, has to use groundwater supply to supplement and TDWD of all customers ≥ 90% system capacity for 3 consecutive days; weather conditions indicate high use may continue.	WRMWD delivers surface water and TDWD of all customers ≥ 100% system capacity for 3 consecutive days; WRMWD not able to supply all water demand from surface water, has to use groundwater supply to supplement and TDWD of all customers ≥ 100% system capacity for 3 consecutive days; weather conditions mild drought for 5 days or more; mechanical failure requiring more than 24 hours to repair.	WRMWD delivers surface water and TDWD of all customers ≥ 110% system capacity; WRMWD not able to supply all water demand from surface water, has to use groundwater supply to supplement and TDWD of all customers ≥ 110% system capacity; TDWD will not allow storage levels to be maintained; system demand exceeds high service pump capacity; mechanical failure requiring more than 12 hours to repair.	NA	WRMWD water system fails and water cannot be delivered; natural or man-made contamination of the water supply source(s); significant portion of system is out of service due to natural or man-made disaster.
Wilson	TDWD > 75% City's production capacity for 3 consecutive days.	TDWD > 90% City's production capacity for 3 consecutive days; net reservoir storage falls below 60% of capacity in 48 hours; water pressure in distribution systems falls below 40 psi for at least 8 hours.	The imminent or actual failure of a major water supply component of the system which would affect the safety, health or welfare of the public; natural or man-made contamination of the water supply source(s).	NA	NA
Wolfforth	Daily production reaches 90% system storage capacity for 15 consecutive days; when Director of Public Works determines a water shortage condition exists.	Daily production reaches 100% system storage capacity for 10 consecutive days; when Director of Public Works determines a water shortage condition exists based on 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).	Daily production reaches 120% system storage capacity for 10 consecutive days; when Director of Public Works determines a water shortage condition exists based on 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).	NA	Daily production reaches 130% system storage capacity for 10 consecutive days; when Director of Public Works determines a water shortage condition exists based on analysis of water production under drought of record conditions may indicate immediate risk of shortage; severe facility capacity limitations exist; emergency conditions, such as contamination of the water supply source(s).

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Table 7-1b. Summary of Drought Contingency Plans
Specific Responses
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Entity	Mild	Moderate	Severe	Critical	Emergency	Water Allocation
Abernathy	Voluntary water use restrictions for irrigation/landscape; 10% voluntary reduction in TDWD.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses; 20% reduction in TDWD.	Moderate condition measures with additional landscape and other watering restrictions; 30% reduction in TDWD.	Moderate and Severe condition measures with additional prohibitions for some uses; 40% reduction in TDWD.	Moderate, Severe and Critical condition measures with additional prohibitions for some uses; 50% reduction in TDWD.	Water will be allocated based on residential household size, multi-family residential size, and commercial user needs.
Amherst	Voluntary water use restrictions for irrigation/landscape; 20% reduction in TDWD for 3 consecutive days.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses; 30% reduction in TDWD for 3 consecutive days.	Moderate condition measures with additional landscape and other watering restrictions; 40% reduction in TDWD for 3 consecutive days.	Moderate and Severe condition measures with prohibition of outdoor water use; 50% reduction in TDWD.	Moderate, Severe and Critical condition measures with prohibition of washing vehicles; 60% reduction in TDWD.	NA
Anton	Voluntary water use restrictions for irrigation/landscape; reduce flushing of water mains; 3% voluntary reduction in TDWD.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses; 7% reduction in TDWD.	Moderate condition measures with additional landscape and other watering restrictions; 12% reduction in TDWD.	Moderate and Severe condition measures with additional prohibitions for some uses; 18% reduction in TDWD.	Missing page	NA
Bovina	Voluntary water use restrictions as described in plan.	Mandatory water use restrictions as described in plan.	NA	Mandatory water use restrictions as described in plan.	Water service will be terminated to selected users in the following order: Industrial, Commercial, Residential, Public Health and Safety Facilities.	NA
Brownfield	Voluntary water use restrictions for irrigation/landscape; practice water conservation and minimize or discontinue non-essential water use; City operations adhere to critical restrictions; 10% voluntary reduction in TDWD.	NA	NA	Mandatory restrictions for irrigation and landscape/outdoor watering and prohibition of non-essential uses described in plan; 50% reduction in TDWD.	Mild and Critical condition measures with additional prohibitions for some uses described in plan; 75% reduction in TDWD.	NA
Crosbyton	Missing pages	Missing pages	Missing pages	Missing pages	Missing pages	Water will be allocated based on single or multifamily residential household size, and limited for commercial and industrial users.
Denver City	Voluntary water use restrictions for irrigation/landscape.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses.	Moderate condition measures with additional landscape and other watering restrictions.	Moderate and Severe condition measures with additional prohibitions for some uses.	Moderate, Severe and Critical condition measures with additional prohibitions for some uses.	NA
Dimmitt	Voluntary water use restrictions for residents and wholesale water customers.	Voluntary water use restrictions for residents; request wholesale and/or large volume water customers initiate mandatory measures to reduce non-essential water use.	Mandatory water use restrictions for residents; request wholesale water customers initiate additional mandatory measures to reduce non-essential water use and initiate pro rata water delivery/diversion curtailment.	NA	Mayor or City Manager will assess the severity of the problem and identify possible actions to take; inform customers, including wholesale customers, and suggest an appropriate action to help alleviate the problem; notify city, county, and/or state emergency response officials and request assistance.	NA

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Table 7-1b. Summary of Drought Contingency Plans
Specific Responses
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Entity	Mild	Moderate	Severe	Critical	Emergency	Water Allocation
Earth	Voluntary water use restrictions for irrigation/landscape.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses.	Moderate condition measures with additional landscape and other watering restrictions.	Moderate and Severe condition measures with additional prohibitions for some uses.	Moderate, Severe and Critical condition measures with additional prohibitions for some uses.	NA
Farwell	Voluntary water use restrictions for irrigation/landscape.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses.	Moderate condition measures with additional landscape and other watering restrictions.	Moderate and Severe condition measures with additional prohibitions for some uses.	Moderate, Severe and Critical condition measures with additional prohibitions for some uses.	Water will be allocated based on residential household size, multi-family residential size, and commercial user needs.
Floydada	Voluntary water use restrictions for residents and commercial and industrial users; system oversight and system adjustments as conditions change.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses; water conservation measures for commercial and industrial users.	Mandatory water use restrictions for non-essential and outdoor uses, control commercial uses not included in the non-essential uses.	NA	Prohibition of non-essential uses; daily water-need estimate to be filed by commercial and industrial users for water-essential uses.	NA
Friona	Voluntary water use restrictions for irrigation/landscape.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses.	Moderate condition measures with additional landscape and other watering restrictions.	Moderate and Severe condition measures with additional prohibitions for some uses.	Moderate, Severe and Critical condition measures with additional prohibitions for some uses.	NA
Hale Center	Voluntary water use restrictions for irrigation/landscape.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses.	Moderate condition measures with additional landscape and other watering restrictions.	NA	Moderate and Severe condition measures with additional prohibitions for some uses.	NA
Hart	Voluntary water use restrictions for irrigation/landscape.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses.	Moderate condition measures with additional landscape and other watering restrictions.	Moderate and Severe condition measures with additional prohibitions for some uses.	Moderate, Severe and Critical condition measures with additional prohibitions for some uses.	Water will be allocated based on residential household size, multi-family residential size, and commercial user needs.
Hereford	Voluntary water use restrictions for irrigation/landscape; curtail flushing of mains to 50% of normal; 10% voluntary reduction in TDWD and 10% reduction of the City's water use.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses; discontinue flushing of water mains; 20% reduction in TDWD.	Moderate condition measures with additional landscape and other watering restrictions; 30% reduction in TDWD.	Moderate and Severe condition measures with additional prohibitions for some uses; 40% reduction in TDWD.	Moderate, Severe and Critical condition measures with additional prohibitions for landscape and some other uses; 50% reduction in TDWD.	NA
Idalou	Voluntary water use restrictions for irrigation/landscape.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses.	Moderate condition measures with additional landscape and other watering restrictions.	Moderate and Severe condition measures with additional prohibitions for some uses.	Moderate, Severe and Critical condition measures with additional prohibitions for some uses.	Water will be allocated based on residential household size, multi-family residential size, and commercial user needs.
Kress	Voluntary water use restrictions.	Missing pages	NA	Missing pages	NA	Water may be rationed or terminated by user type in the following order: Industrial, Commercial, and Residential.
Lamesa	Voluntary water use restrictions for irrigation/landscape.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses; 25% reduction in TDWD.	Moderate condition measures with additional landscape and other watering restrictions.	Moderate and Severe condition measures with additional prohibitions for some uses.	Moderate, Severe and Critical condition measures with additional prohibitions for some uses.	Water will be allocated based on residential household size, multi-family residential size, and commercial user needs.

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Levelland	Voluntary water use restrictions for irrigation/landscape.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses.	Moderate condition measures with additional landscape and other watering restrictions.	Moderate and Severe condition measures with additional prohibitions for some uses.	Moderate, Severe and Critical condition measures with additional prohibitions for some uses.	NA
Littlefield	Voluntary water use restrictions for irrigation/landscape.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses.	Moderate condition measures with additional landscape and other watering restrictions.	Moderate and Severe condition measures with additional prohibitions for some uses.	Moderate, Severe and Critical condition measures with additional prohibitions for some uses.	Water will be allocated based on residential household size, multi-family residential size, and commercial user needs.
Lockney	Voluntary water use restrictions for residents and wholesale water customers.	Voluntary water use restrictions for residents; request wholesale and/or large volume water customers initiate mandatory measures to reduce non-essential water use.	Mandatory water use restrictions for residents; request wholesale water customers initiate additional mandatory measures to reduce non-essential water use and initiate pro rata water delivery/diversion curtailment.	NA	Mayor or City Manager will assess the severity of the problem and identify possible actions to take; inform customers, including wholesale customers, and suggest an appropriate action to help alleviate the problem; notify city, county, and/or state emergency response officials and request assistance.	NA
Lorenzo	Voluntary water use restrictions for irrigation/landscape; 20% voluntary reduction in TDWD.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses; 30% reduction in TDWD.	Moderate condition measures with additional landscape and other watering restrictions; 40% reduction in TDWD.	Moderate and Severe condition measures with additional prohibitions for some uses; 50% reduction in TDWD.	Moderate, Severe and Critical condition measures with additional prohibitions for some uses; 60% reduction in TDWD.	Water will be allocated based on residential household size, multi-family residential size, and commercial user needs.
Lubbock	Mandatory irrigation water use restrictions for residents and wholesale water customers.	Stage 1 restrictions remain in effect as well as additional mandatory irrigation and some outdoor non-essential water use restrictions. Wholesale water customers will be requested to initiate mandatory measures to reduce non-essential water use.	Stage 1 and 2 restrictions remain in effect as well as additional mandatory irrigation and some non-essential water use restrictions. Water use from fire hydrants will be limited to fighting fires and other uses necessary to maintain public health, safety, and welfare.	NA	Stage 1 through 3 restrictions remain in effect as well as prohibition of all irrigation and non-essential water use except where necessary. Mayor or City Manager will assess the severity of the problem and identify possible actions to take; inform customers, including wholesale customers, and suggest an appropriate action to help alleviate the problem; notify city, county, and/or state emergency response officials and request assistance.	NA
Mackenzie Municipal Water Authority	Voluntary water use restrictions for residents and wholesale water customers.	Voluntary water use restrictions for residents; request wholesale and/or large volume water customers initiate mandatory measures to reduce non-essential water use.	Mandatory water use restrictions for residents; request wholesale water customers initiate additional mandatory measures to reduce non-essential water use and initiate pro rata water delivery/diversion curtailment.	NA	Mayor or City Manager will assess the severity of the problem and identify possible actions to take; inform customers, including wholesale customers, and suggest an appropriate action to help alleviate the problem; notify city, county, and/or state emergency response officials and request assistance.	NA
Matador Water District	Voluntary water use restrictions for residents and wholesale water customers.	Voluntary water use restrictions for residents; request wholesale and/or large volume water customers initiate mandatory measures to reduce non-essential water use.	Mandatory water use restrictions for residents; request wholesale water customers initiate additional mandatory measures to reduce non-essential water use and initiate pro rata water delivery/diversion curtailment.	NA	Mayor or City Manager will assess the severity of the problem and identify possible actions to take; inform customers, including wholesale customers, and suggest an appropriate action to help alleviate the problem; notify city, county, and/or state emergency response officials and request assistance.	NA

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Meadow	Voluntary water use restrictions for irrigation/landscape and discontinue non-essential uses; reduce flushing of water mains; increase cost of water; 10% voluntary reduction in TDWD.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses; reduce flushing of water mains; 20% reduction in TDWD.	Moderate condition measures with additional landscape and other watering restrictions; reduce flushing of water mains; 30% reduction in TDWD.	Moderate and Severe condition measures with additional prohibitions for some uses; discontinue flushing of water mains; increase cost of water; 50% reduction in TDWD.	Same as critical condition measures.	NA
Morton	Voluntary water use restrictions for irrigation/landscape.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses.	Moderate condition measures with additional landscape and other watering restrictions.	Moderate and Severe condition measures with additional prohibitions for some uses.	Moderate, Severe and Critical condition measures with additional prohibitions for some uses.	Water will be allocated based on residential household size, multi-family residential size, and commercial user needs.
Muleshoe	Voluntary water use restrictions for irrigation/landscape.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses.	Moderate condition measures with additional landscape and other watering restrictions.	Moderate and Severe condition measures with additional prohibitions for some uses.	Moderate, Severe and Critical condition measures with additional prohibitions for some uses.	Water will be allocated based on residential household size, multi-family residential size, and commercial user needs.
New Deal	Voluntary water use restrictions for irrigation/landscape.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses.	Moderate condition measures with additional landscape and other watering restrictions.	Moderate and Severe condition measures with additional prohibitions for some uses.	Moderate, Severe and Critical condition measures with additional prohibitions for some uses.	NA
O'Donnell	Not stated.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses.	Not stated.	Not stated.	Not stated.	Not stated.
Olton	Voluntary water use restrictions for irrigation/landscape.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses.	Moderate condition measures with additional landscape and other watering restrictions.	Moderate and Severe condition measures with additional prohibitions for some uses.	Moderate, Severe and Critical condition measures with additional prohibitions for some uses.	NA
Petersburg	Voluntary water use restrictions for irrigation/landscape; 10% voluntary reduction in TDWD.	NA	Mandatory restrictions for irrigation/landscape watering and some non-essential uses; 50% reduction in TDWD.	NA	Mild and Critical condition measures with additional prohibitions for some uses; 75% reduction in TDWD.	NA
Plains	Voluntary water use restrictions for irrigation/landscape.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses.	Moderate condition measures with additional landscape and other watering restrictions.	Moderate and Severe condition measures with additional prohibitions for some uses.	Moderate, Severe and Critical condition measures with additional prohibitions for some uses.	NA
Plainview	Voluntary water use restrictions for residents and commercial and industrial users; system oversight and system adjustments as conditions change; maintain daily water demand at or below 90% of capacity.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses; water conservation measures for commercial and industrial users; maintain daily water demand at or below 90% of capacity.	Prohibition of non-essential uses; written permission from city manager for commercial and industrial users for water-essential uses; system priority for water service; maintain daily water demand at or below 90% of capacity.	NA	Same as severe condition measures.	NA

TDWD = Total daily water demand
NA = Not applicable to this DCP
WRMWD = White River Municipal Water District

Table 7-1b. Summary of Drought Contingency Plans
Specific Responses
Page 5 of 6

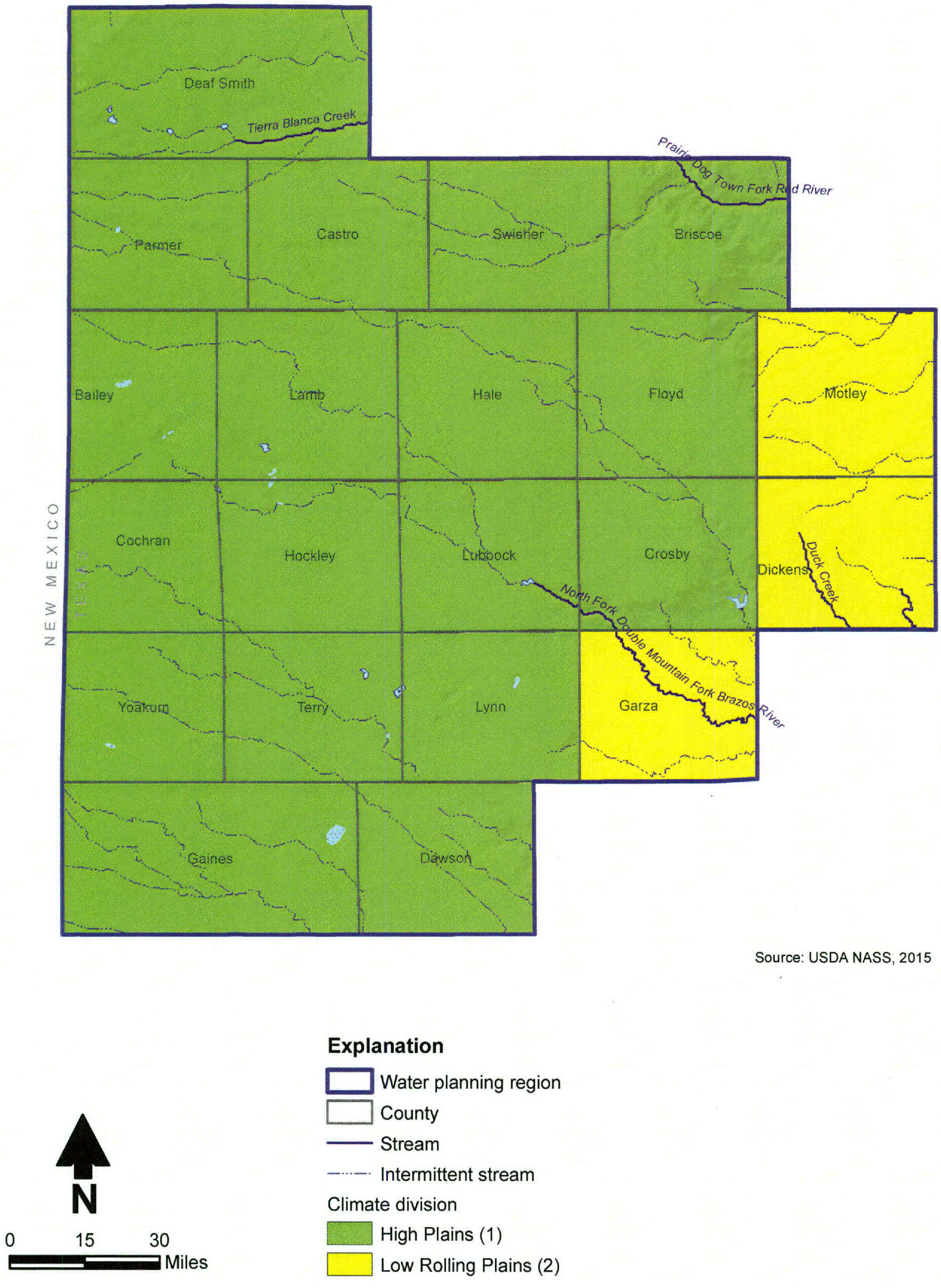
Entity	Mild	Moderate	Severe	Critical	Emergency	Water Allocation
Post	Voluntary water use restrictions for irrigation/landscape and other non-essential uses; 5% voluntary reduction in TDWD.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses; 10% reduction in TDWD.	Moderate condition measures with additional prohibitions for some non-essential uses; water conservation measures for commercial and industrial users; system priority for water service; 15% reduction in TDWD.	NA	Assess severity of problem and identify necessary actions; inform city council and news media; notify county and/or state emergency response officials for assistance; undertake necessary actions; post-event assessment report.	NA
Ralls	Adopted the WRMWD DCP.					
Ransom Canyon	Voluntary water use restrictions for irrigation/landscape and some non-essential uses.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses; prohibition for some non-essential uses.	Moderate condition measures with additional landscape and other watering restrictions.	NA	Water uses not required for domestic use, sanitation, fire protection, or to protect public health, welfare, and safety are prohibited.	NA
Ropesville	Voluntary water use restrictions for irrigation/landscape.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses.	Moderate condition measures with additional landscape and other watering restrictions.	Moderate and Severe condition measures with additional prohibitions for some uses.	Moderate, Severe and Critical condition measures with additional prohibitions for some uses.	Water will be allocated based on residential household size, multi-family residential size, and commercial user needs.
Seagraves	Voluntary water use restrictions for irrigation/landscape; 10% reduction in TDWD.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses; 25% reduction in TDWD.	Moderate condition measures with additional landscape and other water use restrictions; 40% reduction in TDWD.	NA	Moderate and Severe condition measures with additional prohibitions for some uses.	NA
Seminole	Voluntary water use restrictions for irrigation/landscape.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses.	Moderate condition measures with additional landscape and other watering restrictions.	Moderate and Severe condition measures with additional prohibitions for some uses.	Moderate, Severe and Critical condition measures with additional prohibitions for some uses.	Water will be allocated based on residential household size, multi-family residential size, and commercial user needs.
Silverton	Voluntary water use restrictions for irrigation/landscape and other non-essential uses.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses.	Moderate condition measures with additional prohibitions for some non-essential uses; water conservation measures for commercial and industrial users; system priority for water service.	NA	Same as severe condition measures.	NA
Slaton	Voluntary water use restrictions for irrigation/landscape; reduce flushing of mains; 3% voluntary reduction in TDWD.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses; reduce flushing of mains; 7% reduction in TDWD.	Moderate condition measures with additional landscape and other watering restrictions; reduce flushing of mains; 12% reduction in TDWD.	Moderate and Severe condition measures with additional prohibitions for some uses; reduce flushing of mains; 18% reduction in TDWD.	Moderate, Severe and Critical condition measures with additional prohibitions for some uses; discontinue flushing of mains; 30% reduction in TDWD.	NA
Smyer	Mandatory prohibition for irrigation/landscape watering and some non-essential uses; discontinue bulk water sales.	Mandatory prohibition for irrigation/landscape watering and some non-essential uses; discontinue bulk water sales.	NA	NA	Restrictions may be imposed at any time the system is adversely affected by equipment malfunction or failure, loss of power or other occurrence that may impair the operation of the system.	NA

TDWD = Total daily water demand
NA = Not applicable to this DCP
WRMWD = White River Municipal Water District

Table 7-1b. Summary of Drought Contingency Plans
Specific Responses
Page 6 of 6

Entity	Mild	Moderate	Severe	Critical	Emergency	Water Allocation
Spur	Adopted the WRMWD DCP.					
Sudan	Voluntary water use restrictions for irrigation/landscape.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses.	Moderate condition measures with additional landscape and other watering restrictions.	Moderate and Severe condition measures with additional prohibitions for some uses.	Moderate, Severe and Critical condition measures with additional prohibitions for some uses.	NA
Sundown	Voluntary water use restrictions for irrigation/landscape.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses.	Moderate condition measures with additional landscape and other watering restrictions.	Moderate and Severe condition measures with additional prohibitions for some uses.	Moderate, Severe and Critical condition measures with additional prohibitions for some uses.	NA
Tahoka	Voluntary water use restrictions for irrigation/landscape.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses.	Moderate condition measures with additional landscape and other watering restrictions.	NA	Moderate and Severe condition measures with additional prohibitions for some uses.	NA
Tulia	Voluntary water use restrictions for residents and wholesale water customers.	Voluntary water use restrictions for residents; request wholesale and/or large volume water customers initiate mandatory measures to reduce non-essential water use.	Mandatory water use restrictions for residents; request wholesale water customers initiate additional mandatory measures to reduce non-essential water use and initiate pro rata water delivery/diversion curtailment.	NA	Mayor or City Manager will assess the severity of the problem and identify possible actions to take; inform customers, including wholesale customers, and suggest an appropriate action to help alleviate the problem; notify city, county, and/or state emergency response officials and request assistance.	NA
White River Municipal Water District	Voluntary water use restrictions for residents and wholesale water customers.	Voluntary water use restrictions for residents; request wholesale and/or large volume water customers initiate mandatory measures to reduce non-essential water use.	Mandatory water use restrictions for residents; request wholesale water customers initiate additional mandatory measures to reduce non-essential water use and initiate pro rata water delivery/diversion curtailment.	NA	Mayor or City Manager will assess the severity of the problem and identify possible actions to take; inform customers, including wholesale customers, and suggest an appropriate action to help alleviate the problem; notify city, county, and/or state emergency response officials and request assistance.	NA
Wilson	Voluntary water use restrictions for residents and major water customers; mandatory restrictions for irrigation/landscape.	Mild condition measures with additional prohibitions for landscape/irrigation and some other non-essential uses.	Mild and Moderate condition measures with additional prohibitions for some commercial uses not essential for health and human safety.	NA	Major condition measures with additional prohibitions for some commercial uses not essential for health and human safety.	NA
Wolfforth	Voluntary water use restrictions for irrigation/landscape.	Mandatory restrictions for irrigation/landscape watering and some non-essential uses.	Moderate actions with additional landscape and other watering restrictions.	NA	Moderate and Severe actions with additional prohibitions for some uses.	NA

TDWD = Total daily water demand
WRMWD = White River Municipal Water District
NA = Not applicable to this DCP



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LLANO ESTACADO REGION
Climate Divisions

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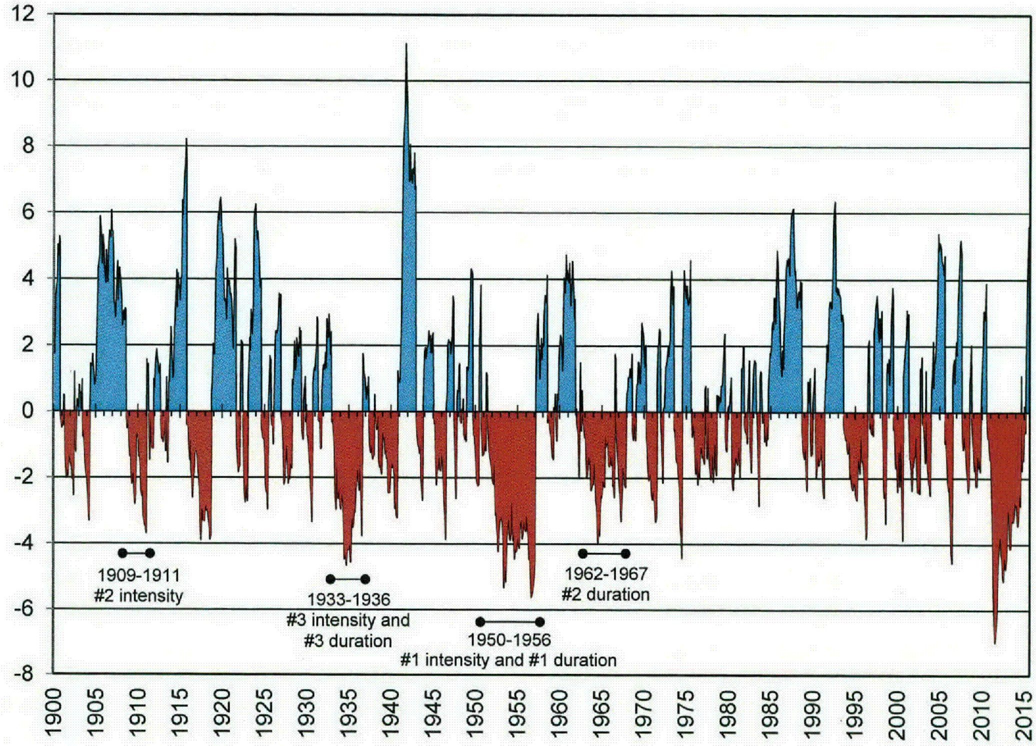
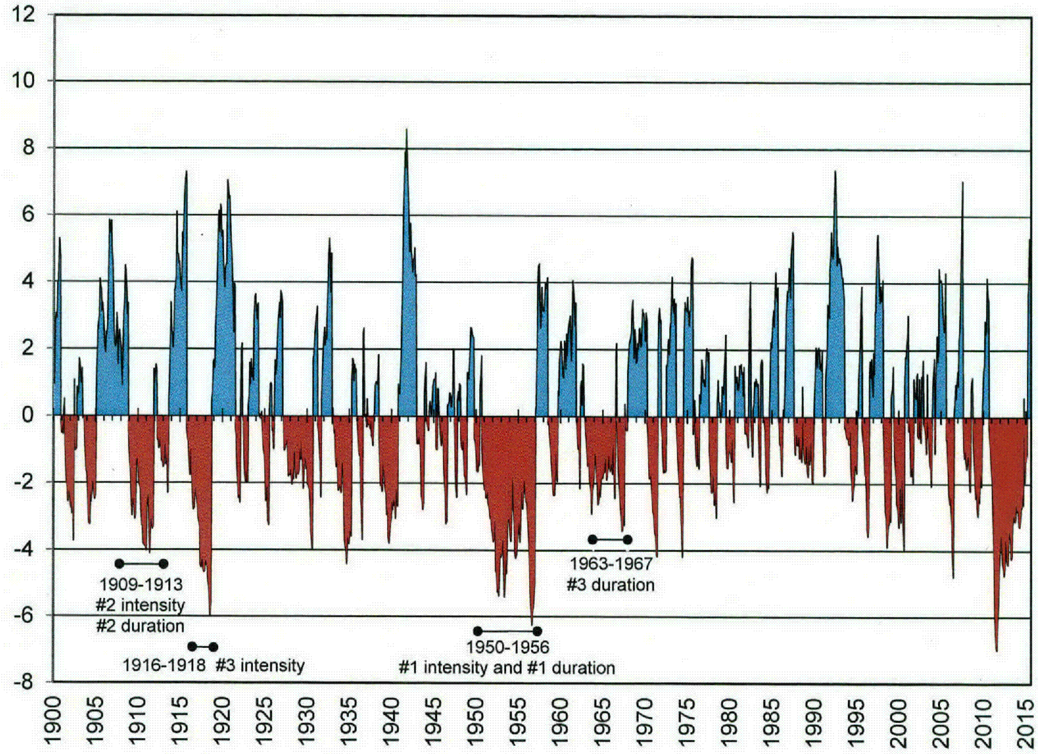
Figure 7-1

Texas Climate Division 1



Texas Climate Division 2



Positive PDSI
Negative PDSI

Sources: NCDC, 2014
TWDB, 2012

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11/3/15

LLANO ESTACADO REGION
Palmer Drought Severity Index
Texas Climate Divisions 1 and 2

Figure 7-2

Table 7-3. Results of Spearman Trend Analysis for Lamesa 1 SSE and Lubbock International Airport Weather Stations 1960 to 2010
Page 1 of 2

Secondary Climate Indicator	Lamesa 1SSE		Lubbock International Airport	
	Correlation Coefficient [a]	p Value [b]	Correlation Coefficient [a]	p Value [b]
Temperature variables				
Annual mean temperature	–0.09	0.67	0.54	**0**
Spring seasonal mean temperature	–0.24	0.1	0.21	0.14
Summer seasonal mean temperature	–0.32	**0.03**	0.34	**0.01**
Autumn seasonal mean temperature	–0.26	**0.09**	0.1	0.5
Winter seasonal mean temperature	–0.07	0.66	0.42	**0**
Days per year with maximum temperature above 90°F	–0.05	0.82	0.31	**0.04**
Days per year with maximum temperature above 32°F	0.08	0.73	–0.48	**0**
Average temperature of warmest consecutive 1 day of the year	–0.14	0.53	0.29	**0.06**
Average temperature of warmest consecutive 3 days of the year	–0.04	0.85	0.23	0.14
Average temperature of warmest consecutive 5 days of the year	0.01	0.97	0.28	**0.07**
Average temperature of warmest consecutive 10 days of the year	0.03	0.89	0.21	0.17
Average temperature of coldest consecutive 1 day of the year	0.14	0.54	0.55	**0**
Average temperature of coldest consecutive 3 days of the year	0.15	0.5	0.53	**0**
Average temperature of coldest consecutive 5 days of the year	0.1	0.64	0.51	**0**
Average temperature of coldest consecutive 10 days of the year	0.05	0.83	0.54	**0**
Duration of summer (begin)	0.19	0.24	–0.05	0.77
Duration of summer (end)	–0.12	0.46	0.16	0.3
Duration of growing season (begin)	–0.13	0.42	–0.1	0.48
Duration of growing season (end)	0.24	0.1	–0.05	0.72
Precipitation variables				
Annual total precipitation	–0.21	0.33	0.01	0.94
Spring seasonal total precipitation	0.12	0.42	0.16	0.29
Summer seasonal total precipitation	0.04	0.8	–0.24	0.1

Source: Gelca, 2014

[a] A positive correlation coefficient indicates an increasing trend over time; negative, a decreasing trend over time.

[b] A p value less than 0.1 (shown in bold) indicates a significant trend.

Table 7-3. Results of Spearman Trend Analysis for Lamesa 1 SSE and Lubbock International Airport Weather Stations 1960 to 2010 Page 2 of 2

Secondary Climate Indicator	Lamesa 1SSE		Lubbock International Airport	
	Correlation Coefficient [a]	p Value [b]	Correlation Coefficient [a]	p Value [b]
Precipitation variables (cont.)				
Autumn seasonal total precipitation	–0.02	0.88	0.04	0.8
Winter seasonal total precipitation	0.14	0.36	0.16	0.28
Dry days per year	0.16	0.47	–0.08	0.61
Days per year with more than 1 inch	–0.05	0.81	–0.04	0.78
Days per year with more than 2 inches	–0.31	0.14	–0.19	0.21
Annual precipitation intensity	–0.32	0.13	–0.17	0.27
Number of 5 day periods with more than 3 inches	0.01	0.92	–0.04	0.77
Day of the year when 25% of annual precipitation has accumulated	–0.04	0.86	0.02	0.9
Day of the year when 50% of annual precipitation has accumulated	–0.12	0.59	–0.24	0.12

Source: Gelca, 2014

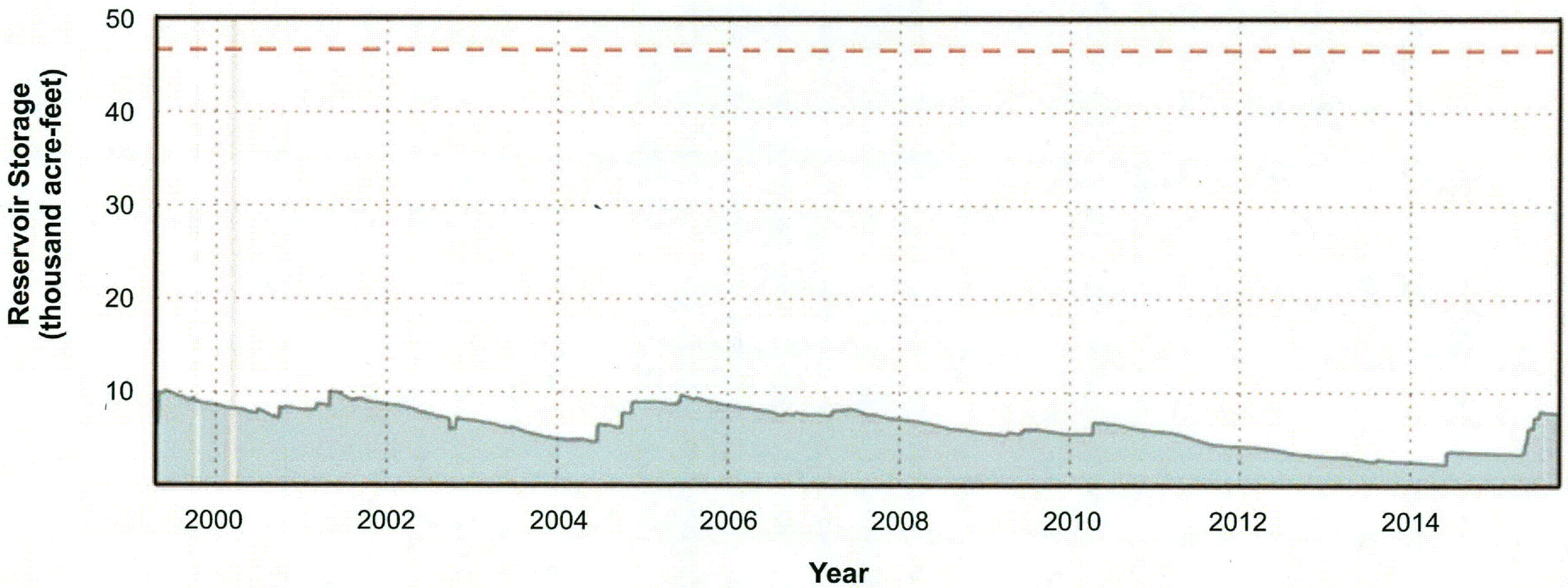
[a] A positive correlation coefficient indicates an increasing trend over time; negative, a decreasing trend over time.

[b] A p value less than 0.1 (shown in bold) indicates a significant trend.

For the Lubbock weather station all of the temperature trends are positive (warming temperatures over time), except for days of the year below freezing, where the negative trend also signifies warming. A majority of the increasing temperature trends (11 of the 19) for the Lubbock weather station were found to be significant. An opposite trend of decreasing temperatures over time is seen at the Lamesa weather station, but only two were found to be significant trends. No significant trends in precipitation were noted at either of the weather stations analyzed in Region O. This trend analysis could be completed for additional active weather stations in the region with available data from 1960 to present (including the recent drought years since 2010) to provide supplemental findings and potentially more conclusive results on climate trends within Region O.

The surface water reservoirs that are relied on by entities within Region O include Lake Mackenzie, White River Lake, and Lake Alan Henry, as well as Lake Meredith, which is located in Region A. The available storage data for each of these reservoirs are shown in Figures 7-3 through 7-6. All of these reservoirs were built after the 1950s drought of record. During the current water planning cycle, both Lake Meredith and White River Lake have had periods where they were offline, and Lake Mackenzie has been supplying water at a severely reduced rate. The region is thought to have experienced a new drought of record, based on the severity of the conditions, reflected in recent reservoir storage volumes within Region O.

In addition, the City of Lubbock recently updated a 2008 yield analysis of Lake Alan Henry, using hydrologic records that extend through December 2014 (the 2008 yield analysis included hydrology from 1940 through 2006, and the Brazos River Basin Water Availability Model [WAM] includes hydrologic records for 1940 through 1997). Yield simulations were performed using the Lake Alan Henry RiverWare model to calculate the firm, 1-year, 18-month, and 2-year safe yields, and the results were compared for the 1950s, 1990s, and recent drought (HDR, 2015). Although the recent drought was four years shorter than the 1990s drought and 8 years shorter than the 1950s drought, it appears to have been more severe, indicating that the watershed has experienced a new drought of record (HDR, 2015).



Explanation

- Dead pool
- Conservation pool
- Flood pool
- Missing data

Source: TWDB, 2015

LLANO ESTACADO REGION

Lake Mackenzie Storage

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Figure 7-3

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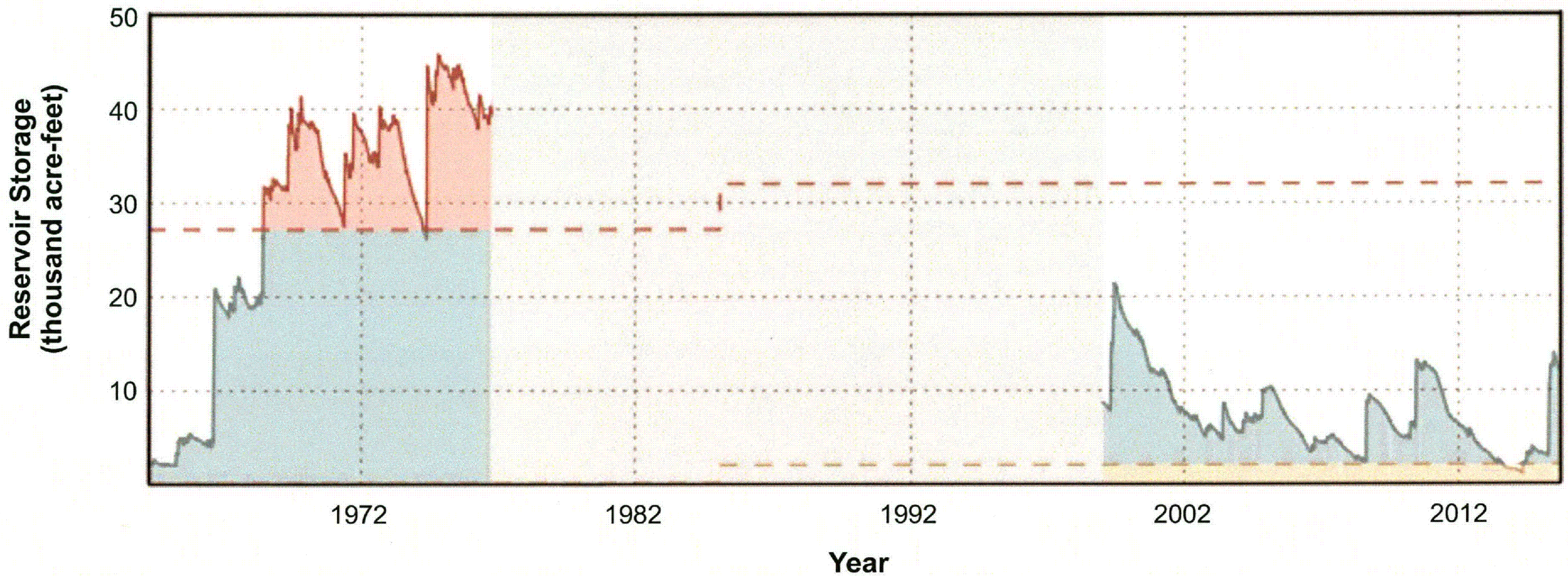

Explanation

- Dead pool
- Conservation pool
- Flood pool
- Missing data

Source: TWDB, 2015

LLANO ESTACADO REGION

White River Lake Storage

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JN WR11.0030

Figure 7-4

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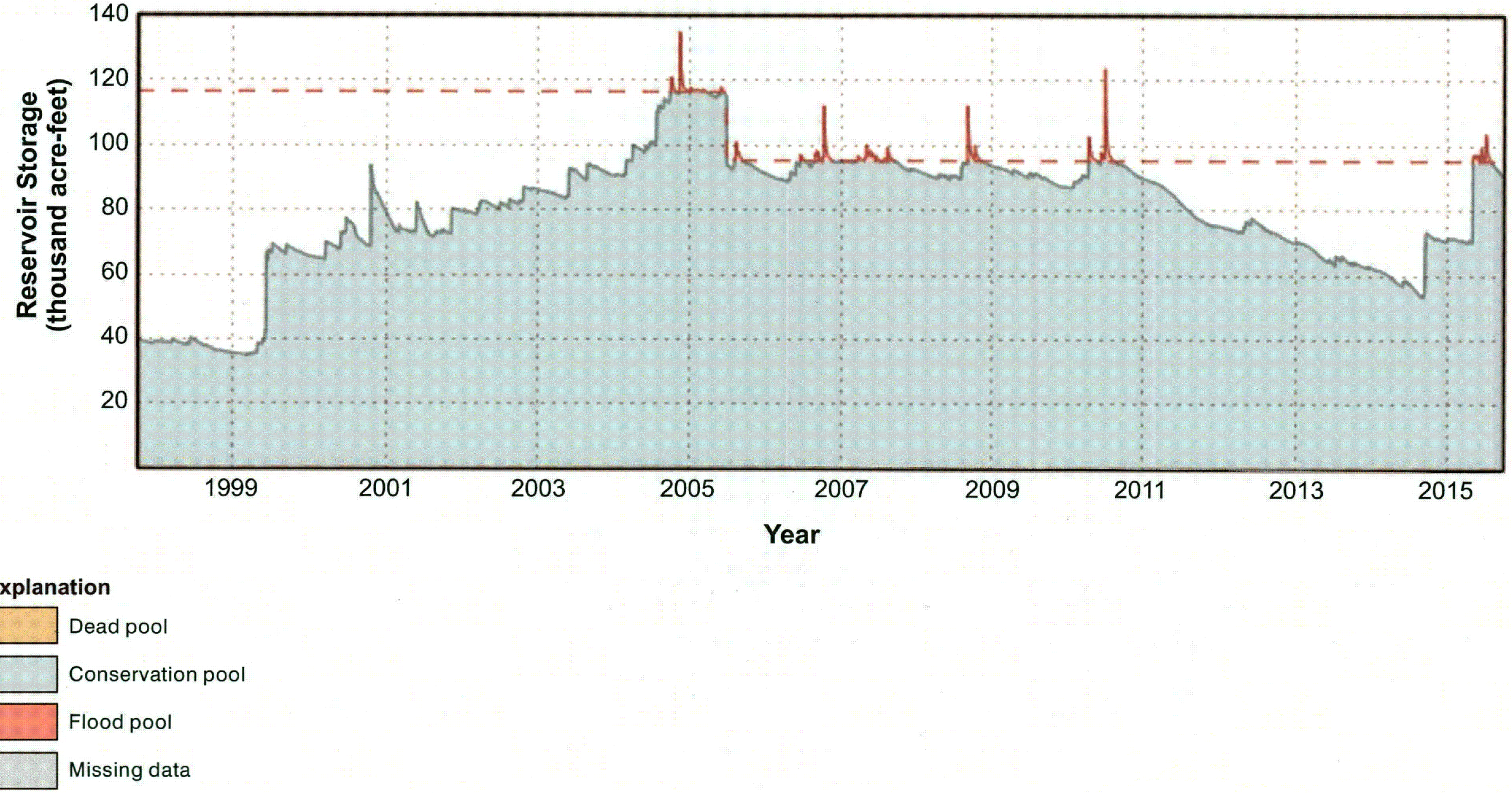

Source: TWDB, 2015

Figure 7-5

LLANO ESTACADO REGION

Lake Alan Henry Storage

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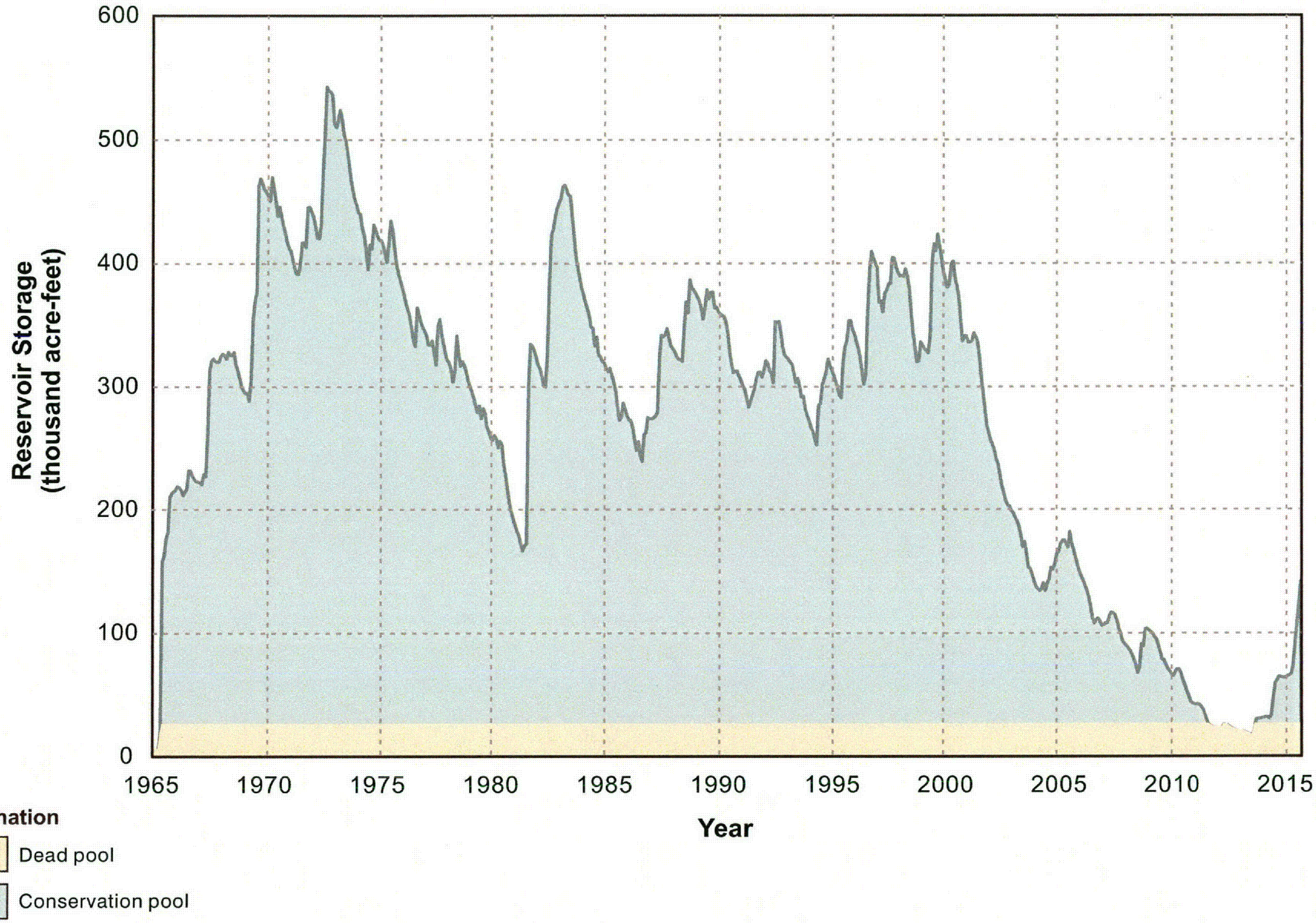
10-1-15

JN WR11.0030

S:\PROJECTS\WR11.0030 REGION O WATER PLAN FOR TWDB\VR-DRAWINGS\FIG7-6 LAKE MEREDITH STORAGE.CDR



Source: CRMWA, 2015

LLANO ESTACADO REGION
Lake Meredith Storage

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10-1-15
JN WR11.0030

Figure 7-6

7.3 Existing and Potential Emergency Interconnects

The LERWPG tasked the technical consultant with compiling information summarizing the existing infrastructure connections between systems within the region. Information on existing connections was available primarily from planning committee members and the municipal surveys conducted during this planning cycle, as well as followup discussions with entities to obtain additional information as needed. The information gathered on existing emergency connections included the user(s) of the interconnections, the supplier(s), the source of water supply, a general description of the infrastructure, and if available, the estimated volume of supply. A general summary of the existing connections within Region O is provided in Table 7-4. There are four existing emergency connections that have agreements and infrastructure in place. In addition, there are a number of non-emergency connections that supply water to various entities within Region O.

The LERWPG tasked the RWPG subcommittee with summarizing information on existing major water infrastructure facilities that could possibly be used for future emergency interconnects. The information gathered on potential emergency connections included the potential user(s) of the interconnections, the potential supplier(s), and the source of water supply. All of the available connection information (existing and potential, emergency and non-emergency) was compiled and provided to the TWDB Executive Administrator confidentially and separately from the regional water plan document, in accordance with 31 TAC §357.42(d). A total of 35 potential emergency connections were identified based on nearby infrastructure between potential suppliers and users, but the feasibility of an agreement between potential entities was not determined. The LERWPG emphasizes that the governing bodies of each involved party would need to provide consent to any potential emergency connections to their water systems before any connection can be made.

The existing DCPs for the municipalities in Region O were obtained and reviewed for any reference to emergency connections between water systems or wholesale water provider systems. The Friona and Petersburg DCPs mention the possibility of emergency interconnection with another water system, and the Earth, Friona, and Morton DCPs mention potential emergency connections with privately owned irrigation wells. A summary of the relevant text from these DCPs follows.

Table 7-4. Existing Water Supply Connections

Entity Providing Supply	Entity Receiving Supply	Source
Emergency connections		
Lubbock	Littlefield	Ogallala Aquifer
Seth Ward WSC	Plainview	Ogallala Aquifer
Spur (resale of White River MWD water)	City of Dickens	White River Lake Ogallala Aquifer
Tulia	Mackenzie MWD (supply for Silverton)	Dockum Aquifer Ogallala Aquifer
Non-emergency connections		
Littlefield	Sunnydale WSC	Ogallala Aquifer
Lubbock	Buffalo Springs Ransom Canyon Shallowater South Garza Water Supply	Ogallala Aquifer Lake Alan Henry CRMWA (Region A Ogallala Aquifer and Lake Meredith)
Canadian River Municipal Water Authority	Brownfield, O'Donnell Lamesa, Plainview Levelland, Slaton Lubbock, Tahoka	Ogallala Aquifer (Region A) Lake Meredith
Mackenzie MWA	Floydada Lockney Silverton Tulia	Lake Mackenzie
White River MWD	Crosby County-other (around lake and near pipelines) Crosbyton Post Ralls Spur	White River Lake Ogallala Aquifer

MWD = municipal water district WSC = water supply corporation

- *Friona:* In the event of source contamination or failure, at the discretion of the City Manager or his/her designee, alternative water supplies shall be provided to affected citizens. Alternative supplies may include, but are not limited to, bottled water, alternate groundwater well(s), or hook-up to another public or private water supplier.
- *Petersburg:* The City will implement use of alternate supply sources from surrounding communities.
- *Earth:* During Stage 3 and 4 (Severe and Critical) drought conditions, private irrigation wells will be connected to city supply.
- *Morton:* If necessary, temporary piping will be installed to connect privately owned irrigation wells to the city system.

7.4 Recommendations Regarding Triggers and Actions to be Taken in Drought

Recommendations regarding the drought triggers and responses for existing surface water supplies and groundwater sources that entities in Region O rely upon are discussed in Sections 7.4.1 and 7.4.2, respectively. Municipalities listed in Table 7-1 that are missing specifications for a drought stage can use the recommended region-specific actions and triggers presented in the following sections.

7.4.1 Drought Trigger Conditions for Surface Water Supply

The LERWPG believes that the DCPs developed by the operators of the surface water supplies are the best management tool for these water sources. The drought trigger conditions for surface water supply are typically associated with the reservoir level but can also be related to system production capacity, especially when a water supplier has a portfolio of several different sources of supply. The LERWPG recommends that the drought triggers and associated actions developed by the operators of the reservoirs in the planning region be the Region O triggers for those associated sources.

The three reservoir supplies located within Region O are Lake Mackenzie, White River Lake, and Lake Alan Henry. The major drought triggers and responses for these reservoirs as of May 2015 are summarized in Table 7-5, along with the source manager and associated water users. The LERWPG recognizes any modification of these drought triggers that are adopted by the regional operator or source manager.

Lake Alan Henry is owned and operated by the City of Lubbock and is subject to the City of Lubbock DCP. The City of Lubbock DCP was developed based on blended use of their various sources of supply; therefore, drought triggers and actions are not specified individually for Lake Alan Henry but are the currently applicable drought triggers and actions in the DCP. The City has a contract with South Garza Water Supply, which supplies water to several communities near the reservoir, and the triggers and responses listed in Table 7-5 also apply to these customers. In addition, the contract prorates the volume of water that South Garza Water Supply may use, depending on the lake level.

Table 7-5. Summary of Reservoir Drought Triggers and Responses

Drought Stage	Trigger	Action
Lake Mackenzie	*Source manager: Mackenzie Municipal Water Authority* *Water users: Floydada, Lockney, Silverton, and Tulia*	
1 Mild	Lake storage 70 to 80%	Voluntary 5 to 10% reduction Implement Stage 1 of customer's DCP
2 Moderate	Lake storage 50 to 69%	10 to 15%reduction Implement Stage 2 of customer's DCP
3 Severe	Lake storage 30 to 49%	15 to 20% reduction Implement Stage 3 of customer's DCP
4 Critical Emergency	Lake storage 20 to 29% Termination at 15% or less Major line break or system failure Contamination of water supply source	Actions as appropriate
White River Lake	*Source manager: White River Municipal Water District* *Water users: Crosby County-other, Crosbyton, Post, Ralls, and Spur*	
A Mild	Reach 90% of production capacity for 3 days	Voluntary measures to limit water use to less than 100% of production capacity
B Moderate	Reach 100% of production capacity for 3 days	Mandatory measures to limit water use to less than 100% of production capacity
C Severe	Reach 110% of production capacity for 3 days	Mandatory measures to limit water use to less than 90% of production capacity
D Emergency	Water system failure or contamination	Mandatory measures to limit water use to less than 90% of production capacity
Lake Alan Henry	*Source manager: City of Lubbock* *Water users: City of Lubbock and South Garza Water Supply*	
1 Mild	Exceed 80% of daily supply capacity for 10 consecutive days Lake level is low and of concern to future water supplies due to drought or emergency	Mandatory measures to limit water use to less than 90% of daily supply capacity
2 Moderate	Exceed 90% of daily supply capacity for 10 consecutive days Lake water availability is below normal and may continue to decline	Mandatory measures to limit water use to less than 80% of daily supply capacity
3 Severe	Exceed 100% of daily supply capacity for 5 consecutive days Lake water availability is well below normal and continues to decline	Mandatory measures to limit water use to less than 70% of daily supply capacity
4 Emergency	Exceed 105% of daily supply capacity for 5 consecutive days Water system failure or contamination	Mandatory measures to limit water use to less than 50% of daily supply capacity

7.4.2 Drought Trigger Conditions for Groundwater Supply

In Region O, groundwater sources are relied upon by more water providers than the reservoir sources. Groundwater production is generally local to points of use, and aquifer properties vary spatially. Thus, many providers using these sources have developed their DCPs in the context of their individual supply portfolios, as summarized in Section 7.1. The LERWPG acknowledges that the DCPs for groundwater suppliers are the best drought management tool for groundwater resources and recommends that the DCPs developed by the operators of these supplies serve as the RWPG drought triggers and associated actions for groundwater. The RWPG also recognizes that these drought triggers and associated actions are subject to change as providers periodically reassess their needs and encourages both wholesale providers and other entities to examine their DCPs regularly and update as them needed.

Other water users, such as agricultural or industrial users, do not have DCPs. To convey drought conditions to all users of groundwater resources within the planning area, LERWPG proposes that entities who do not have an existing DCP use the U.S. Drought Monitor (drought monitor). Drought monitor information for Texas can be accessed online at http://droughtmonitor.unl.edu/Home/StateDroughtMonitor.aspx?TX. The groundwater aquifers, source managers, actions, and water users associated with each source in Region O are summarized in Table 7-6.

The drought monitor is easily accessible, regularly updated, and does not require entities to directly monitor specific sources to benefit from the information. Its simplicity also facilitates its use in communicating drought conditions to customers and other water users. The LERWPG recommends that water providers regularly review the drought monitor both as a tool for tracking drought conditions and for use in drought planning efforts leading up to drought measure implementation. Table 7-7 shows the recommended drought stages with the categories of the drought monitor and corresponding PDSI values.

Table 7-6. Groundwater Sources and Associated Water Users and Managers
Page 1 of 2

Aquifer	Water User [a]	Manager [b]
Dockum	• Deaf Smith County-other • Garza County-other • Happy • Hereford • Irrigation (Briscoe, Dawson, Deaf Smith, and Garza counties) • Livestock (Deaf Smith County) • Tulia	• Garza County UWCD • Gateway GCD • High Plains UWCD No. 1 • Llano Estacado UWCD • Mesa UWCD • South Plains UWCD
Ogallala	• Abernathy • Amherst • Anton • Bovina • Brownfield • County-other (Bailey, Castro, Cochran, Crosby, Dawson, Deaf Smith, Dickens, Floyd, Gaines, Garza, Hale, Hockley, Lamb, Lubbock, Lynn, Motley, Parmer, Swisher, Terry, and Yoakum counties) • Crosbyton • Denver City • Dimmitt • Earth • Farwell • Floydada • Friona • Hale Center • Happy • Hart • Hereford • Idalou • Irrigation (Bailey, Briscoe, Castro, Cochran, Crosby, Dawson, Deaf Smith, Dickens, Floyd, Gaines, Garza, Hale, Hockley, Lamb, Lubbock, Lynn, Motley, Parmer, Swisher, Terry, and Yoakum counties) • Kress • Lamesa • Levelland • Littefield • Livestock (Bailey, Briscoe, Castro, Cochran, Deaf Smith, Floyd, Gaines, Hale, Hockley, Lamb, Lubbock, Parmer, Swisher, and Terry counties) • Lockney • Lorenzo • Lubbock	• Garza County UWCD • Gateway GCD • High Plains UWCD No. 1 • Llano Estacado UWCD • Mesa UWCD • Sandy Land UWCD • South Plains UWCD • White River MWD

[a] Recommended actions for water users are to follow the applicable drought contingency plan (DCP); if a DCP has not been developed by water users or manager, it is recommended that water users or managers follow the drought monitor recommendations.
[b] UWCDs manage groundwater use only in the aquifers within their jurisdictional boundaries. Several counties and areas within counties in Region O do not have a UWCD or source manager for aquifers.

Table 7-6. Groundwater Sources and Associated Water Users and Managers
Page 2 of 2

Aquifer	Water User [a]	Manager [b]
Ogallala (cont.)	• Manufacturing (Bailey, Castro, Crosby, Dawson, Deaf Smith, Gaines, Garza, Hale, Hockley, Lamb, Lubbock, Motley, Parmer, and Terry counties) • Meadow • Mining (Cochran, Crosby, Dawson, Dickens, Floyd, Gaines, Garza, Hale, Hockley, Lamb, Lubbock, Lynn, Motley, Terry, and Yoakum counties) • Morton • Muleshoe • New Deal • O'Donnell • Olton • Petersburg • Plains • Plainview • Post • Ralls • Ransom Canyon • Seagraves • Seminole • Shallowater • Slaton • Spur • Stream-electric (Hale, Lamb, and Yoakum counties) • Sudan • Sundown • Tahoka • Tulia • Wolfforth	
Edwards-Trinity	• Lynn County-other • Irrigation (Lynn County)	• Garza County UWCD • High Plains UWCD No. 1 • Llano Estacado UWCD • South Plains UWCD
Other	• Briscoe County-other • Crosby County-other • Dickens County-other • Irrigation (Briscoe, Crosby, Dickens, Floyd, Garza, Hale, and Motley counties) • Matador	• Garza County UWCD • Gateway GCD • High Plains UWCD No. 1
Seymour	• Irrigation (Briscoe and Motley counties)	• Gateway GCD

[a] Recommended actions for water users are to follow the applicable drought contingency plan (DCP); if a DCP has not been developed by water users or manager, it is recommended that water users or managers follow the drought monitor recommendations.
[b] UWCDs manage groundwater use only in the aquifers within their jurisdictional boundaries. Several counties and areas within counties in Region O do not have a UWCD or source manager for aquifers.

Table 7-7. Drought Stage and U.S. Drought Monitor Classification Scheme

Category	Description	Possible Impacts	PDSI	Recommended Drought Stage
D0	Abnormally dry	Going into drought: • Short-term dryness slowing planting • Growth of crops or pastures Coming out of drought: • Some lingering water deficits • Pastures or crops not fully recovered	–1.0 to –1.9	Mild
D1	Moderate drought	• Some damage to crops, pastures • Streams, reservoirs, or wells low • Some water shortages developing or imminent • Voluntary water-use restrictions requested	–2.0 to –2.9	Moderate
D2	Severe drought	• Crop or pasture losses likely • Water shortages common • Water restrictions imposed	–3.0 to – 3.9	Severe
D3	Extreme drought	• Major crop/pasture losses • Widespread water shortages or restrictions	–4.0 to –4.9	Critical
D4	Exceptional drought	• Exceptional and widespread crop/pasture losses • Shortages of water in reservoirs, streams, and wells creating water emergencies	–5.0 or less	Emergency

Source: National Drought Mitigation Center, 2015   PDSI = Palmer Drought Severity Index

The RWPG recommends the following actions based on each of the drought classifications listed above:

- *Abnormally Dry:* Entities should begin to review their DCPs and status of current supplies and current demands to determine if implementation of a DCP stage is necessary. Mild drought stage recommended.

- *Moderate Drought:* Entities should review their DCP and status of current supplies and current demands to determine if implementation of a DCP stage is necessary. Moderate drought stage recommended.

- *Severe Drought:* Entities should review their DCP and status of current supplies and current demands to determine if implementing a DCP stage or changing to a more stringent stage is necessary. At this point, if the review indicates that current supplies may not be sufficient to meet reduced demands, the entity should begin considering alternative supplies. Severe drought stage recommended.

- *Extreme Drought:* Entities should review their DCP and status of current supplies and current demands to determine if implementing a DCP stage or changing to a more stringent stage is necessary. At this point, if the review indicates that current supplies may not be sufficient to meet reduced demands, the entity should consider alternative supplies. Critical drought stage recommended.

- *Exceptional Drought:* Entities should review their DCP and status of current supplies and current demands to determine if implementing a DCP stage or changing to a more stringent stage is necessary. At this point, if the review indicates that current supplies are not sufficient to meet reduced demands, the entity should implement alternative supplies. Emergency drought stage recommended.

7.5 Emergency Responses to Local Drought Conditions or Loss of Municipal Supply

Entities may experience localized drought conditions or infrastructure failure, temporary water quality impairment, or other unforeseen conditions that result in loss of existing water supplies. This section provides potential solutions that can act as a guide for municipal water user groups (WUGs) that are the most vulnerable in the event of a loss of water supply. A high-level analysis of options was performed to assess potential emergency water supply options for WUGs in Region O that have an estimated Year 2010 population of 7,500 or less and rely on a sole source of water supply, as well as all County-other WUGs (Table 7-8). Consideration of emergency supply options for these entities is particularly important, as many small WUGs may not have existing access to backup supplies through interconnect facilities with adjacent larger systems.

Table 7-8. Potential Emergency Supplies, Screening Level Analysis
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												Implementation Requirements			
County	Water User Group Name	2020 Population	2020 Demand (ac-ft/yr)	Local Groundwater Well	Brackish Groundwater Limited Treatment	Brackish Groundwater Desalination	Emergency Interconnect	Other Named Local Supply	Trucked-In Water	Purchase Land With Existing Wells	Other	Type of Infrastructure Required	Entity Providing Supply	Other Local Entities Required to Participate/Coordinate	Emergency Agreements/ Arrangements Already in Place?
	Earth	1,099	192	•			•		•			Well, pipeline, transportation			
Lamb (cont.)	Littlefield	6,406	953	•			•		•			Well, pipeline, transportation	Lubbock		Yes
	Olton	2,261	469	•					•			Well, transportation			
	Sudan	1,042	250	•			•		•			Well, pipeline, transportation			
Lubbock	Abernathy	774	184	•			•		•			Well, pipeline, transportation			
	County-other	35,783	4,647	•			•		•			Well, pipeline, transportation			
	Idalou	2,341	419	•			•		•			Well, pipeline, transportation			
	Wolfforth	4,577	765	•			•		•			Well, pipeline, transportation			
Lynn	County-other	2,684	311	•			•		•			Well, pipeline, transportation			
Motley	County-other	603	109	•			•		•			Well, pipeline, transportation			
	Matador	609	213	•					•			Well, transportation			
Parmer	Bovina	2,079	373	•					•			Well, transportation			
	County-other	3,241	631	•			•		•			Well, pipeline, transportation			
	Farwell	1,517	396	•					•			Well, transportation			
	Friona	4,587	829	•					•			Well, transportation			
Swisher	County-other	1,634	214	•			•		•			Well, pipeline, transportation			
	Happy	649	99	•					•			Well, transportation			
	Kress	752	79	•			•		•			Well, pipeline, transportation			
Terry	County-other	2,580	320	•			•		•			Well, pipeline, transportation			
Yoakum	County-other	2,171	267	•			•		•			Well, pipeline, transportation			
	Denver City	5,072	1,423	•			•		•			Well, pipeline, transportation			
	Plains	1,677	432	•			•		•			Well, pipeline, transportation			

Note: This screening level analysis provides a high-level analysis of potential emergency water supply options for all County-other WUGs, and WUGs that have an estimated Year 2010 population of 7,500 or less and rely on a sole source of water supply.

ac-ft/yr = Acre-feet per year

Table 7-8. Potential Emergency Supplies, Screening Level Analysis
Page 1 of 2

County	Water User Group Name	2020 Population	2020 Demand (ac-ft/yr)	Local Groundwater Well	Brackish Groundwater Limited Treatment	Brackish Groundwater Desalination	Emergency Interconnect	Other Named Local Supply	Trucked-In Water	Purchase Land With Existing Wells	Other	Implementation Requirements: Type of Infrastructure Required	Implementation Requirements: Entity Providing Supply	Implementation Requirements: Other Local Entities Required to Participate/Coordinate	Implementation Requirements: Emergency Agreements/ Arrangements Already in Place?
Bailey	County-other	2,243	277	•			•		•			Well, pipeline, transportation			
	Muleshoe	5,769	1,174	•			•		•			Well, pipeline, transportation			
Briscoe	County-other	932	297	•			•		•			Well, pipeline, transportation			
	Silverton	741	126				•		•	•		Well, pipeline, transportation	Tulia	Mackenzie Municipal Water Authority	Yes
Castro	County-other	2,816	411	•			•		•			Well, pipeline, transportation			
	Dimmitt	4,845	1,096	•					•			Well, transportation			
	Hart	1,229	180	•					•			Well, transportation			
Cochran	County-other	1,341	500	•			•		•			Well, pipeline, transportation			
	Morton	2,150	473	•					•			Well, transportation			
Crosby	County-other	1,309	155	•			•		•			Well, pipeline, transportation			
	Lorenzo	1,258	231	•			•		•			Well, pipeline, transportation			
Dawson	County-other	4,777	588	•			•		•			Well, pipeline, transportation			
Deaf Smith	County-other	4,575	541	•			•		•			Well, pipeline, transportation			
Dickens	County-other	1,135	153	•			•		•			Well, pipeline, transportation	Spur	Dickens, Valley WSC	Yes
Floyd	County-other	1,664	200	•			•		•			Well, pipeline, transportation			
Gaines	County-other	11,678	1,403	•			•		•			Well, pipeline, transportation			
	Seagraves	2,536	419	•			•		•			Well, pipeline, transportation			
	Seminole	7,102	2,348	•	•	•	•		•			Well, pipeline, transportation, desalination facility			
Garza	County-other	1,065	135	•			•		•			Well, pipeline, transportation			
Hale	Abernathy	2,227	528	•			•		•			Well, pipeline, transportation			
	County-other	8,994	1,171	•			•		•			Well, pipeline, transportation			
	Hale Center	2,380	298	•			•		•			Well, pipeline, transportation			
	Petersburg	1,270	326	•					•			Well, transportation			
Hockley	Anton	1,235	161	•			•		•			Well, pipeline, transportation			
	County-other	7,525	922	•			•		•			Well, pipeline, transportation			
	Sundown	1,531	416	•			•		•			Well, pipeline, transportation			
Lamb	Amherst	796	102	•			•		•			Well, pipeline, transportation			
	County-other	3,011	435	•			•		•			Well, pipeline, transportation			

Note: This screening level analysis provides a high-level analysis of potential emergency water supply options for all County-other WUGs, and WUGs that have an estimated Year 2010 population of 7,500 or less and rely on a sole source of water supply.

ac-ft/yr = Acre-feet per year

The results of this high-level analysis of available options are shown in Table 7-8 and serve as a general indicator of the potential options that might be considered in the event of a local emergency; these options should be investigated in greater detail by the subject WUGs before implementation. The emergency response options considered feasible by Region O include:

- Local groundwater well:
  - Drilling one or more wells may be an option for obtaining an emergency water supply.
  - Required infrastructure would include a new well and additional conveyance facilities.
  - Additional rules may apply when the WUG is located within an Underground Water Conservation District (UWCD).
- Brackish groundwater (limited treatment and desalination):
  - At lower TDS concentrations, brackish groundwater may require only limited treatment or operational measures such as blending with lower-TDS supplies; at greater concentrations, brackish groundwater may require desalination treatment.
  - Required infrastructure may include a new well and additional conveyance facilities and a desalination or treatment facility.
  - Additional rules may apply when the WUG is located within a UWCD.
- Emergency interconnect:
  - An emergency interconnect is an alternative for WUGs located near another water provider; these WUGs should investigate further the potential for obtaining potable water through emergency interconnects with neighboring water systems.
  - Required infrastructure would include piping and valving necessary to connect the systems; additional pressurization and/or conveyance facilities may also be needed.
  - This option would require an agreement with one or more neighboring utilities.
  - Construction would require authorization from TCEQ.

- Trucked-in water:
  - Trucked-in water is considered to be an emergency response option for every WUG.
  - No or little infrastructure would be needed for this option, but it would require agreements with a treated water provider and a water transporter.
  - Potable water trucking companies are required to be licensed by the TCEQ, and there are no licensed potable water trucking companies in Region O.

- Purchase of land with existing wells:
  - Appropriation of land with existing operational wells may be an option for obtaining an emergency water supply.
  - Required infrastructure would include additional conveyance facilities.
  - Additional rules may apply when the WUG is located within an UWCD.

Additional emergency response options recommended by TWDB for consideration included release from an upstream reservoir and curtailment of upstream/downstream water rights. These options are not applicable to Region O and therefore were not included in Table 7-8.

7.6 Other Drought-Related Considerations and RWPG Recommendations

In 1999, the 76th Texas Legislature established the Drought Preparedness Council under HB-2660. The chief of the Texas Division of Emergency Management is the state drought manager and serves as the chair of the Council. The Council consists of representatives from the following member agencies:

- Texas Division of Emergency Management
- Texas Water Development Board
- Texas Commission on Environmental Quality
- Parks and Wildlife Department

- Department of Agriculture
- Texas AgriLife Extension Service
- State Soil and Water Conservation Board
- Texas Department of Housing and Community Affairs
- Texas Forest Service
- Texas Department of Transportation
- Texas Department of Economic Development
- Representative of groundwater management interests (appointed by the governor)

Pursuant to HB-2660, the responsibilities of the Council are to enact the provisions listed in the Water Code, Title 2 (Water Administration), Subtitle C (Water Development), Chapter 16 (Provisions Generally Applicable to Water Development), under Sections 16.055 (Drought Response Plan) and Section 16.0551 (State Drought Preparedness Plan). The Council's responsibilities are as follows:

- Assess and report to the public drought monitoring and water supply conditions.
- Advise the governor on significant drought conditions.
- Recommend specific provisions for a defined state response to drought-related disasters for inclusion in the state emergency management plan and the state water plan.
- Advise the regional water planning groups on drought-related issues in the regional water plans.
- Ensure effective coordination among state, local, and federal agencies in drought-response planning.
- Report to the legislature regarding significant drought conditions in the state (no later than January 15 of each odd-numbered year).
- Develop and implement a comprehensive state drought preparedness plan for mitigating the effects of drought in the state, and periodically update the plan.

In 2005, the Council released the State Drought Preparedness Plan. For analysis and reporting purposes, the Council used National Oceanic and Atmospheric Administration (NOAA) data to divide the state into 10 climate regions and assesses drought-severity within these regions. The Council uses a 5-tiered system to determine the overall level of concern:

- Level 1 - Advisory
- Level 2 - Watch
- Level 3 - Warning
- Level 4 - Emergency
- Level 5 - Disaster

The Council publishes a monthly Drought Situation Report with the results of analyses for climatological, agricultural, and water availability categories of drought. The reports are available on the Drought Preparedness website (https://www.txdps.state.tx.us/dem/CouncilsCommittees/droughtCouncil/stateDroughtPrepCouncil.htm). If drought severity increases in any of the climate regions and the Council determines that additional action is needed, the 2005 Drought Preparedness Plan lists the following potential Council actions:

- Convene Drought Preparedness Council meetings on a more frequent basis.
- Provide supplemental and special reports regarding significant drought effects.
- Initiate drought awareness and conservation campaigns.
- Review each assessment value to make meaningful appraisals and projections of need.
- Communicate drought concerns to the RWPGs, state leaders, and federal representatives.
- Coordinate initial interagency recommendations and initiate necessary actions.
- Recommend legislative actions and agency responsibilities to respond to specific drought-related effects.
- Coordinate media releases to coincide with specific actions each agency is taking to respond to the impacts of drought.

- Issue special reports and disseminate appropriate guidance to affected climate regions.
- Support a gubernatorial declaration/proclamation for a drought emergency in a particular county(s) or climate region.

In a letter dated November 10, 2014, the Drought Preparedness Council made recommendations to the regional water planning groups for addressing drought preparedness as a part of the regional water plans. Their recommendations included:

- Following the outline template for Chapter 7, making an effort to fully address the assessment of current drought preparations and planned responses to local drought conditions or loss of municipal supply.

- Evaluating the drought preparedness impacts of unanticipated population growth or industrial growth within the region over the planning horizon.

The LERWPG followed the outline template for Chapter 7, including summarizing the current drought preparations and planned responses to local drought conditions or loss of municipal supply for the municipal WUGs in Region O. The LERWPG recommends that water providers in the region review the Drought Preparedness Council Situation Reports as part of their routine drought monitoring procedures, as well as implementing and regularly updating their existing DCPs.

In response to the second recommendation, the LERWPG has evaluated the drought preparedness impacts of unanticipated population and/or industrial growth by (1) planning for drought of record conditions over the full planning horizon, which are considered to provide the worst-case water supply scenario, (2) reserving the drought management strategies for use as emergency tools and not recommending them as ongoing water supply strategies, and (3) recommending specific actions and triggers for drought response where WUG DCPs did not include this information. In addition, the plan has been developed using demand projections that the LERWPG feels are too high, which should provide a factor of safety in evaluating potential future conditions.

Surface water is limited in this region, and the majority of the water supplies come from groundwater (an average of 98.6 percent over the period of 2003-2012), but drought can still have significant impacts, leading to greater groundwater withdrawals due to a lack of precipitation. The LERWPG supports the ongoing efforts of the Texas Drought Preparedness Council and recommends that water providers in the region review their Drought Situation Reports as part of their routine drought monitoring procedures.

7.6.1 Drought Management Recommendations

Drought management is a temporary strategy or best management practice to manage water demand and conserve available water supplies during times of drought or emergencies. Drought contingency planning is considered a critical component of water supply management to provide short-term benefits during severe drought conditions, but drought management alone is not recommended to replace any long-term water management strategies. Some of the most important actions that can be undertaken to prepare for drought include improving storage capacity (for example the Jim Bertram Lake 7 strategy evaluated in Section 5.4.6) and reducing demand through efficiency and conservation (Sections 5.2.1 and 5.3 evaluate municipal and agriculture conservation measures, respectively).

Drought management is a best management practice (Section 5.9.10) and consists of implementing the DCPs that have been developed within Region O to enable communities within the region to be prepared for droughts or emergency water needs when they occur. Within Region O, 53 entities have developed DCPs, as discussed in Section 7.1. In each DCP, drought stages and corresponding triggers are identified based on the level of drought along with the mitigation measures or responses for each stage. These DCPs provide the necessary tools for effective drought management, and communities and WUGs should be ready to implement them when needed.

Recommendations regarding the drought triggers and associated actions for water users without an existing DCP, as well as the associated water resources in Region O that the water users rely on, are presented in Section 7.4 of this plan. These recommendations may be useful for entities required to update their plans on a regular basis or for other WUGs that may want to develop a DCP.

The intent of drought management is not to meet long-term growth in demands, but rather to provide a short-term means by which water providers periodically activate their approved DCPs to minimize the adverse impacts of water supply shortages during times of drought or emergency. Drought management measures are typically not used under more hydrologically favorable conditions. The LERWPG recommends:

- The implementation of DCPs by water suppliers when appropriate to reduce demand during drought and to prolong current supplies
- The development of shortage sharing agreements
- The implementation of conservation measures for all users to conserve its water resources for the future

7.7 Development of Region-Specific Model Drought Contingency Plans

Model DCPs addressing the requirements of 30 TAC §288(b) were developed for Region O and are included in Appendix 7B. Two model DCPs were developed: one for a small (i.e., population less than 15,000) retail public water supplier with a sole source of local groundwater and the other for a midsize (i.e., population between 15,000 and 250,000) retail public water supplier with groundwater and surface water sources. The model DCPs were based largely on templates provided by the TCEQ on their website. The model DCPs developed for Region O have been reviewed by TCEQ staff and were updated to address their comments.

Both model DCPs identify five drought stages: mild, moderate, severe, critical, and emergency. The model DCPs also include an optional water allocation drought stage. The recommended responses range from notification of drought conditions and voluntary reductions in the mild stage to increasingly restrictive mandatory restrictions during moderate through emergency stages. Each entity will select the trigger conditions for the different stages and the appropriate responses for their system. It should be noted that DCPs are to be updated and submitted to the TCEQ by May 1, 2014, and every 5 years thereafter.

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Appendix 7A

Region O
Drought Contingency
Plan Descriptions

Appendix 7A.Region O Drought Contingency Plan Descriptions

Many of the communities have drought contingency plans that have the same or very similar drought response measures. For Amherst, Anton, Denver City, Earth, Friona, Hereford, Idalou, Levelland, New Deal, Olton, Plains, Slaton, Sudan, and Sundown, the plans have five water shortage conditions: Stage 1 (mild), Stage 2 (moderate), Stage 3 (severe), Stage 4 (critical), and Stage 5 (emergency). For each stage, the drought responses are as follows:

- *Stage 1:* Voluntary water use restrictions for irrigation/landscape are requested, water customers are encouraged to practice water conservation and to minimize or discontinue water use for non-essential purposes, and the City will adhere to water use restrictions.

- *Stage 2:* Mandatory restrictions are enacted for irrigation/landscape watering of golf courses, greens, parks and other public landscaped areas and for some non-essential uses (including vehicle washing, filling, refilling, or adding water to pools, water used for fountains or other aesthetic features), some non-essential uses are prohibited (including washing of certain hard-surfaced areas, washing of buildings or other structures, flushing gutters, failure to repair controllable leak, use of water for dust control, and use of water from hydrants for construction or other purposes not related to firefighting [except with special permit]), and no water should be served to restaurant patrons unless requested.

- *Stage 3:* Stage 2 restrictions remain in effect as well as additional restrictions on watering of landscaped areas, watering of golf courses and public landscaped areas is prohibited unless source of water is other than the City, and no special permits are granted for use of water from hydrants for construction purposes.

- *Stage 4:* Stage 2 and Stage 3 restrictions remain in effect as well as additional restrictions on watering of landscaped areas, prohibition of vehicle washing not occurring on a commercial car wash or service station, prohibition of filling, refilling, or adding water to pools, prohibition of operation of ornamental fountains or ponds except to support aquatic life or where recirculation systems are in operation, and no new or expanded applications for water service lines, pipeline extensions, water mains, or water service facilities will be allowed.

- *Stage 5:* Stage 2, Stage 3, and Stage 4 restrictions remain in effect as well as prohibition of irrigation of landscaped areas or use of water to wash any vehicle.

Goals for reduction in daily water use or demand vary from city to city and are summarized in Table 7-1 of this water plan. Some cities have additional water use restrictions in addition to the restrictions above; these are also summarized in Table 7-1.

The Cities of Abernathy, Crosbyton, Farwell, Hart, Idalou, Lamesa, Littlefield, Lorenzo, Morton, Muleshoe, Ropesville, and Seminole have the five stages of drought response measures described above, but also include an additional drought response measure, Stage 6 (Water Allocation):

- *Stage 6:* Water will be allocated based on residential household size (persons per household), multi-family residential size, and commercial user needs.

The drought response measures in the plans for the Cities of Hale, Seagraves, Tahoka, and Wolfforth are similar to the five stages of drought response measures described above but are set out in only four stages: Stage 1 (mild), Stage 2 (moderate), Stage 3 (severe), and Stage 4 (emergency). For these plans, drought response measures for Stage 5 described above have been incorporated into Stage 4.

The plans for the Cities of Dimmitt, Lockney, Mackenzie, Matador, Silverton, Tahoka, and Tulia have four water shortage conditions: Stage 1 (mild), Stage 2 (moderate), Stage 3 (severe), and Stage 4 (emergency). For each stage, responses are as follows:

- *Stage 1:* Voluntary water use restrictions for residents and wholesale water customers. The mayor or designee will keep the public informed on drought and water supply status through news media outlets. Wholesale or large-volume water customers will be contacted to discuss water supply and /or demand conditions, and they will be requested to initiate voluntary measures to reduce water use.

- *Stage 2:* Voluntary water use restrictions for residents. Wholesale and/or large-volume water customers will be requested to initiate mandatory measures to reduce non-essential water use and possible curtailment of water service. The mayor or designee will keep the public informed on drought and water supply status through news media outlets.

- *Stage 3:* Mandatory water use restrictions for residents. Wholesale water customers will be requested to initiate additional mandatory measures to reduce non-essential water use and initiate pro rata water delivery/diversion curtailment. The mayor or designee will keep the public informed on drought and water supply status through news media outlets.

- *Stage 4:* The Mayor or City Manager will assess the severity of the problem and identify possible actions to take. They will inform customers, including wholesale customers, and suggest an appropriate action to help alleviate the problem, and notify city, county, and/or state emergency response officials and request assistance.

Drought contingency plans for some communities were sufficiently different from other plans that they are not included in the summaries above. These plans are described below.

Bovina and Kress

The Cities of Bovina and Kress have similar drought contingency plans that outline each City's drought and emergency contingency procedures and identify the triggering criteria for initiation and termination of drought response stages and other water use restrictions in effect during times of water shortages. These plans have three trigger stages: mild, moderate, and critical water shortage conditions. For each stage, responses are as follows:

- *Mild:* Voluntary water use restrictions as defined in the plan
- *Moderate:* Mandatory water use restrictions as defined in the plan
- *Critical:* Mandatory water use restrictions with penalties as defined in the plan

- If critical conditions persist for an extended period of time, the City may ration water use or terminate service to selected users in the following sequence:
  - Industrial users
  - Commercial users
  - Residential users
  - Public health and safety facilities (Bovina only)

Brownfield and Petersburg

The Cities of Brownfield and Petersburg have similar drought contingency plans that contain regulations and restrictions on water use. These plans outline the city's drought and emergency contingency procedures and identify the triggering criteria for initiation and termination of drought response stages and other water use restrictions in effect during times of water shortages. The plans have three trigger stages: Stage 1 (mild), Stage 2 (critical), and Stage 3 (emergency) water shortage conditions. For each stage, responses are as follows:

- *Stage 1:* Voluntary water use restrictions for watering of landscaped areas, reduced or discontinued irrigation of public landscaped areas, reduced or discontinued flushing of water mains, use of reclaimed water for non-potable purposes with a goal of 10 percent reduction in daily water demand. The City of Brownfield will adhere to Stage 2 water use restrictions in their water system operations and requests that their customers practice water conservation and minimize or discontinue water use for non-essential purposes.

- *Stage 2:* Mandatory restrictions for certain non-essential water uses (including irrigation of landscaped areas and parks, vehicle washing, washing of certain hard-surfaced areas, washing of buildings or other structures, flushing gutters, filling, refilling, or adding water to pools, using water for fountains or other aesthetic features, failing to repair a controllable leak, and using water from hydrants for construction or other purposes not related to firefighting), reduced or discontinued irrigation of public landscaped areas, reduced or discontinued flushing of water mains, use of reclaimed water for non-potable purposes with a goal of 50 percent reduction in daily water demand.

- *Stage 3:* All Stage 1 and Stage 2 restrictions in place as well as prohibitions for irrigation of landscaped areas, filling, refilling or adding water to pools, and operating ornamental fountains or ponds, and suspension of new water service connections, lines, extensions, meters, mains, or water service facilities, with a goal of a 75 percent reduction in daily water demand.

Floydada and Plainview

The Cities of Floydada and Plainview have similar drought contingency plans that contain regulations and restrictions on water use. These plans outline the Cities' drought and emergency contingency procedures and identify the triggering criteria for initiation and termination of drought response stages and other water use restrictions in effect during times of water shortages. The plans have four trigger stages: mild, moderate, severe, and emergency water shortage conditions. For each stage, responses are as follows:

- *Step 1 (Mild):* Voluntary water use restrictions will be implemented for residents, and commercial and industrial water customers will be advised of the necessity for strict water conservation. The public will be advised of the drought condition and an information center will be set up. Water system oversight will be implemented and adjustments made as needed.

- *Step 2 (Moderate):* Mandatory outdoor water use restrictions for residents will be implemented; commercial and industrial water customers will be visited to ensure that water conservation practices have been implemented. The City Manager or designee will monitor water system function and will establish hours for outside water use. The information center will keep the public advised of curtailment status.

- *Step 3 (Severe or Emergency):* Mandatory water use restrictions for non-essential and outdoor uses will be implemented; commercial uses not included in the non-essential uses will be controlled to the extent dictated by the City Manager. Businesses requiring water for the basic function of the business will be required to get written permission from the City Manager.

Lubbock

The City of Lubbock has a drought contingency plan that contains regulations and restrictions on water use. This plan outlines the City's drought and emergency contingency procedures and identifies the triggering criteria for initiation and termination of drought response stages and other water use restrictions in effect during times of water shortages. The plan has four water shortage conditions: Stage 1 (mild), Stage 2 (moderate), Stage 3 (severe), and Stage 4 (emergency). For each stage, responses are as follows:

- *Stage 1:* Mandatory irrigation water use restrictions. The City will reduce/discontinue water main flushing and will use reclaimed water for non-potable purposes where practicable. Wholesale customers must follow specific contract provisions to implement these measures as well any other measures specified in the contract. Wholesale water customers will be contacted to discuss water supply and/or demand conditions, and they will be requested to initiate voluntary measures to reduce water use.

- *Stage 2:* Mandatory irrigation and some outdoor non-essential water use restrictions. The City will reduce/discontinue water main flushing and will use reclaimed water for non-potable purposes where practicable. Wholesale customers must follow specific contract provisions to implement these measures as well any other measures specified in the contract. Wholesale water customers will be requested to initiate mandatory measures to reduce non-essential water use.

- *Stage 3:* Mandatory irrigation and some non-essential water use restrictions. The City will discontinue water main flushing and will use reclaimed water for non-potable purposes where practicable. Water use from fire hydrants will be limited to fighting fires and other uses necessary to maintain public health, safety, and welfare. Wholesale customers must follow specific contract provisions to implement these measures as well any other measures specified in the contract. Wholesale water customers will be requested to initiate mandatory measures to reduce non-essential water use.

- *Stage 4:* Mandatory irrigation non-essential water use restrictions. The City will reduce/discontinue water main flushing and will use reclaimed water for non-potable purposes where practicable. The City will discontinue irrigation of public landscaped areas. Wholesale customers must follow specific contract provisions to implement these measures as well any other measures specified in the contract. Wholesale water customers will be requested to initiate mandatory measures to reduce non-essential water use. In the event of a large-scale system failure, water may be trucked in. The City Manager will assess the severity of the shortage, identify appropriate actions and implement necessary actions, and contact responsible and appropriate officials as necessary.

Happy

Happy is still preparing their DCP, and it was not obtained before the deadline for inclusion in the regional water plan.

Appendix 7B

Model Drought Contingency Plans

DRAFT

Region O Model
Drought Contingency Plan
For a Small (population less than 15,000)
Retail Public Water Supplier
Sole Source Local Groundwater

Disclaimer: The following form is a model drought contingency plan for a retail public water supplier with a sole water source from groundwater that was developed by the Region O regional water planning group as a part of the 2016 regional water planning process. This model is supplied for your convenience as a template and includes more than the state requires. Not all items may apply to your utility's situation, but this template may be modified as needed to address your specific issues. At a minimum the red text portions of this model plan should be thoroughly reviewed and updated with appropriate information for your utility. Your utility will be responsible for making sure that your completed drought contingency plan is approved by the Texas Commission on Environmental Quality (TCEQ).

____

(Name of Utility)

____

(Address, City, Zip Code)

____

(CCN#)

____

(PWS #s)

____

(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 and/or resolution (cite or attach ordinance/or resolution).

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 that 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 as developed under their continuing public education program along with information regarding this drought contingency plan. The drought information will include 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 Llano Estacado Regional Water Planning Group (Region O), and (name of water supplier) has provided a copy of this Plan to the Llano Estacado Regional Water Planning Group.

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 water 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:

Aesthetic water use: water use for ornamental or decorative purposes such as fountains, reflecting pools, and water gardens.

Commercial and institutional water use: water use that 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.

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 supply is conserved and made available for future or alternative uses.

Customer: any person, company, or organization using water supplied by (name of water supplier).

Domestic water use: 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.

Even-numbered address: street addresses, box numbers, or rural postal route numbers ending in 0, 2, 4, 6, or 8 and locations without addresses.

Firm system capacity: the system delivery capacity with the largest single water well or production unit out of service.

Industrial water use: the use of water in processes designed to convert materials of lower value into forms having greater usability and value.

Landscape irrigation use: 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.

Non-essential water use: 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 as 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 of 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.

Total system peak capacity: the maximum system delivery capacity with all water wells and production units in service.

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 daily 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 state and local regulation, pertaining to the water supplied by city wells and the water system capacity, and analysis of the vulnerability of the water source under drought of record conditions.

Drought Response Triggers

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:

- *Weather conditions, time of year and system pressures indicate that a mild drought condition exists.*
- *The daily water use exceeds 75 percent of the total system peak capacity for 10 consecutive days.*
- *The static water level in the (name of water supplier) well(s) is more than xxx feet below the measuring point.*
- *The total daily water demand equals or exceeds xxx million gallons for 10 consecutive days.*

The public water supplier may devise other triggering criteria that are tailored to its system.

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 5 consecutive days.

Stage 2 Triggers — MODERATE Water Shortage Conditions

Requirements for initiation
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:

- *The daily water use exceeds 85 percent of the total system peak capacity for 10 consecutive days.*
- *The static water level in the (name of water supplier) well(s) is more than xxx feet below the measuring point.*
- *The total daily water demand equals or exceeds xxx million gallons for 10 consecutive days.*

The public water supplier may devise other triggering criteria that are tailored to its system.

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 5 consecutive days. Upon termination of Stage 2, Stage 1 restrictions will apply.

Stage 3 Triggers — SEVERE Water Shortage Conditions

Requirements for initiation
Customers shall be required to comply with the requirements and restrictions on certain non-essential water uses for Stage 3 of this Plan when:

- *The daily water use exceeds 95 percent of the total system peak capacity for 5 consecutive days.*
- *The static water level in the (name of water supplier) well(s) is more than xxx feet below the measuring point.*
- *The total daily water demand equals or exceeds xxx million gallons for 5 consecutive days.*

The public water supplier may devise other triggering criteria that are tailored to its system.

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 3 consecutive days. Upon termination of Stage 3, Stage 2 restrictions will apply.

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:

- *Water demand exceeds the firm system capacity for 5consecutive days. As a result, supply cannot keep up with demand, and primary wells or storage facilities do not recover sufficiently to allow for continued pumping into the system.*

The public water supplier may devise other triggering criteria that are tailored to its system.

<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 3 consecutive days. Upon termination of Stage 4, Stage 3 restrictions will apply.

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:

- Major water line breaks or pump or system failures that cause unprecedented loss of capability to provide water service; ***or***

- 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 3 consecutive days. Upon termination of Stage 5, Stage 4 restrictions will apply.

Stage 6 Triggers — WATER ALLOCATION

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).

Requirements for initiation
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 6 of this Plan when:

- *Water demand exceeds the firm system capacity for more than 10 consecutive days despite the restrictions in place under Stage 5. As a result, supply cannot keep up with demand, and primary wells or storage facilities do not recover sufficiently to allow for continued pumping into the system.*

Requirements for termination
The water allocation plan prescribed in Section IX may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of 3 consecutive days. Upon termination of Stage 6, Stage 5 restrictions will apply.

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 allocation condition exists and shall implement the following notification procedures:

Drought Response Notification

Notification of the Public:
The (designated official) or his/ her designee shall notify the public by means of:

- *publication in a newspaper of general circulation;*
- *direct mail to each customer;*
- *public service announcements;*
- *signs posted in public places; and/or*
- *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:

- *Mayor / Chairman and members of the City Council / Utility Board*
- *Fire Chief(s)*
- *City and/or County Emergency Management Coordinator(s)*
- *County Judge and Commissioner(s)*
- *State Disaster District / Department of Public Safety*
- *TCEQ (required when mandatory restrictions are imposed or when going to a less restrictive stage)*
- *Major water users*

- *Critical water users (e.g., hospitals)*
- *Parks / street superintendents and public facilities managers*

Note: The plan should specify direct notice only as appropriate to respective drought stages.

Drought Responses

Stage 1 Response — MILD Water Shortage Conditions

Target: Achieve a voluntary 10 percent reduction in daily water demand.

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:

- *Reduction of flushing of water mains (if more than required monthly frequency).*
- *Reduction of watering in public landscaped areas (e.g., parks).*
- *Reduction of water usage during fire training exercises.*
- *Activation and use of an alternative supply source(s).*

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 water customers with an even-numbered address and Saturdays and Wednesdays for water customers with an odd-numbered address, and to irrigate landscapes only between the hours of 12:00 midnight and 10:00 a.m. and between 8:00 p.m. and 12:00 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 25 percent reduction in daily water demand.

Best Management Practices for Supply Management:
Describe additional measures, if any, to be implemented directly by (name of water supplier) to manage limited water supplies and/or reduce water demand. Examples include:

- *Temporary discontinuation of flushing of water mains except for monthly flushing.*
- *Temporary discontinuation of watering in public landscaped areas (e.g., parks).*
- *Use of an alternative supply source(s).*
- *Use of reclaimed water for non-potable purposes.*

Mandatory 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 or Thursdays for customers with an even-numbered address and Saturdays or Wednesdays for water customers with an odd-numbered address, and irrigation of landscaped areas is further limited to the hours from 12:00 midnight until 10:00 a.m. and from 8:00 p.m. to 12:00 midnight on designated watering days. However, irrigation of landscaped areas is permitted at any time if it is by means of a hand-held hose, a faucet-filled bucket or watering can of 5 gallons or less, or a drip irrigation system.

(b) Use of water to wash any motor vehicle, motorbike, boat, trailer, airplane or other vehicle is prohibited except between the hours of 12:00 midnight and 10:00 a.m. and between 8:00 p.m. and 12:00 midnight on designated watering days. 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 rinses. 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 8:00 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 firefighting-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 of 12:00 midnight and 10:00 a.m. and between 8:00 p.m. and 12:00 midnight. 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 (with the exception of non-potable water);
4. Flushing of 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

Target: Achieve a 50 percent reduction in daily water demand.

Best Management Practices for Supply Management:
Describe additional measures, if any, to be implemented directly by (name of water supplier) to manage limited water supplies and/or reduce water demand. Examples include:

- *Reduce flushing of water mains to when required only.*
- *Cease watering in public landscaped areas (e.g., city parks).*
- *Cease use of water for fire training.*

Mandatory Water Use Restrictions for Demand Reduction:
All requirements of Stage 2 shall remain in effect during Stage 3 with the following additional restrictions:

(a) Irrigation of landscaped areas shall be limited to one designated watering day per two week period (based on address number) between the hours of 12:00 midnight 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, 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 prohibited.

(d) The filling, refilling, or adding of water to swimming pools, wading pools, and Jacuzzi-type pools is prohibited.

Stage 4 Response — CRITICAL Water Shortage Conditions

Target: Achieve a 75 percent reduction in daily water demand.

Best Management Practices for Supply Management:
Describe additional measures, if any, to be implemented directly by (name of water supplier) to manage limited water supplies and/or reduce water demand. Examples include:

- *Minimize unnecessary water uses in and around the system.*
- *Monitor progress of actions.*
- *Prohibit outside water use.*

Mandatory Water Use Restrictions for Reducing Demand:
All requirements of Stage 2 and 3 shall remain in effect during Stage 4 with the following additional restrictions:

(a) Irrigation of landscaped areas shall be limited to the hours between 6:00 a.m. and 10:00 a.m. and between 8:00 p.m. and 12:00 midnight on one designated watering day per month (based on address number) 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 10:00 p.m.

(c) 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

Target: Achieve a 90 percent reduction in daily water demand.

Best Management Practices for Supply Management:
Describe additional measures, if any, to be implemented directly by (name of water supplier) to manage limited water supplies and/or reduce water demand. Examples include:

- *Eliminate all unnecessary water uses in and around the system.*
- *Limit water use by fire department to firefighting only.*

Mandatory Water Use Restrictions for Reducing Demand:
All requirements of Stage 2, 3, and 4 shall remain in effect during Stage 5 with the following additional restrictions:

(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

Note: 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 subparagraph for WATER ALLOCATION are not enforceable.

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" include 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 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 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 2 days.

In prescribing the method for claiming more than 2 persons per household, the (designated official) shall adopt methods to ensure 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 $25.00.

Residential water customers shall pay the following surcharges:

- $10.00 for the first 1,000 gallons over allocation.
- $25.00 for the second 1,000 gallons over allocation.
- $50.00 for the third 1,000 gallons over allocation.
- $75.00 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 that 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 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 2 days.

In prescribing the method for claiming more than 2 dwelling units, the (designated official) shall adopt methods to ensure 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 $25.00.

Customers billed from a master meter under this provision shall pay the following monthly surcharges:

- $10.00 for the first 1,000 gallons over allocation.
- $25.00 for the second 1,000 gallons over allocation.
- $50.00 for the third 1,000 gallons over allocation.
- $75.00 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 non-residential commercial customer other than an industrial customer who uses water for processing purposes. A non-residential customer whose monthly usage is less than 5,000 gallons shall be allocated 5,000 gallons. For non-residential customers with higher monthly usage, the allocation shall be approximately 75 percent of the customer's usage for the corresponding month's billing period during 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. 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 non-residential customer agrees to transfer part of its allocation to another non-residential 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).

Non-residential commercial customers shall pay the following surcharges:

- $10.00 for the first 1,000 gallons over allocation.
- $25.00 for the second 1,000 gallons over allocation.
- $75.00 for the third 1,000 gallons over allocation.

- $100.00 for each additional 1,000 gallons over allocation.

The surcharges shall be cumulative.

Industrial Customers

A monthly water allocation shall be established by the (designated official), or his/her designee, for each industrial customer that uses water for processing purposes. The industrial customer's allocation shall be approximately 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 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 12 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 12 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 if (1) the designated period does not accurately reflect the customer's normal water use because the customer had shut down 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 shut down 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) 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:

- $20.00 for the first 1,000 gallons over allocation.
- $50.00 for the second 1,000 gallons over allocation.
- $150.00 for the third 1,000 gallons over allocation.
- $200.00 for each additional 1,000 gallons over allocation.

The surcharges shall be cumulative.

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 $50.00 and not more than $500.00. 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 reconnection charge, hereby established at $50.00, 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; however, 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; however, 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 City 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, and the offense charged, and shall direct him/her to appear in the municipal court or local equivalent on the date shown on the citation, which 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 municipal court or local equivalent to enter a plea of guilty or not guilty for the violation of this Plan. If the alleged violator fails to appear in municipal court or local equivalent, 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 municipal court or local equivalent 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 that 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.

Region O Model
Drought Contingency Plan
For a Midsize (population between 15,000 and 250,000)
Retail Public Water Supplier
Groundwater and Surface Water Sources

Disclaimer: The following form is a model drought contingency plan for a retail public water supplier with both groundwater and surface water sources that was developed by the Region O regional water planning group as a part of the 2016 regional water planning process. This model is supplied for your convenience as a template and includes more than the state requires. Not all items may apply to your utility's situation, but this template may be modified as needed to address your specific issues. At a minimum the red text portions of this model plan should be thoroughly reviewed and updated with appropriate information for your utility. Your utility will be responsible for making sure that your completed drought contingency plan is approved by the Texas Commission on Environmental Quality (TCEQ).

____
(Name of Utility)

____
(Address, City, Zip Code)

____
(CCN#)

____
(PWS #s)

____
(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 and/or resolution (cite or attach ordinance/or resolution).

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 that 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 as developed under their continuing public education program along with information regarding this drought contingency plan. The drought information will include 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 Llano Estacado Regional Water Planning Group (Region O), and (name of water supplier) has provided a copy of this Plan to the Llano Estacado Regional Water Planning Group.

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 water 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.

Commercial and institutional water use: water use that 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.

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 supply is conserved and made available for future or alternative uses.

Customer: any person, company, or organization using water supplied by (name of water supplier).

Domestic water use: 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.

Even-numbered address: street addresses, box numbers, or rural postal route numbers ending in 0, 2, 4, 6, or 8 and locations without addresses.

Firm system capacity: the system delivery capacity with the largest single water well or production unit out of service.

Industrial water use: the use of water in processes designed to convert materials of lower value into forms having greater usability and value.

Landscape irrigation use: 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.

Non-essential water use: 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 as 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 of 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.

Total system peak capacity: the maximum system delivery capacity with all water wells and production units in service.

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 daily 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 state and local regulation, pertaining to the water supplied by city wells, surface water reservoir levels, and the entire water system capacity, and analysis of the vulnerability of the available water sources under drought of record conditions.

Drought Response Triggers

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:

- *Weather conditions, time of year and system pressures indicate that a mild drought condition exists.*
- *Surface water reservoir storage capacity is between 70 and 80 percent.*
- *Surface water source is not able to supply entire demand and it is necessary to use groundwater supply.*
- *The daily water use exceeds 75 percent of the total system peak capacity for 10 consecutive days.*
- *The static water level in the (name of water supplier) well(s) is more than xxx feet below the measuring point.*
- *The total daily water demand equals or exceeds xxx million gallons for 10 consecutive days.*
- *Notification is received, pursuant to requirements specified in the (name of water supplier) wholesale water purchase contract with (name of wholesale water supplier), requesting initiation of Stage 1 of the Drought Contingency Plan.*
- *Treated water reservoir levels continue falling without refilling above xxx 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 that are tailored to its system.

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 5 consecutive days.

Stage 2 Triggers — MODERATE Water Shortage Conditions

Requirements for initiation
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:

- *The daily water use exceeds 85 percent of the total system peak capacity for 10 consecutive days.*
- *Surface water reservoir storage capacity is between 50 and 69 percent.*
- *Surface water source is not able to supply entire demand and it is necessary to use groundwater supply.*
- *The static water level in the (name of water supplier) well(s) is more than xxx feet below the measuring point.*
- *The total daily water demand equals or exceeds xxx million gallons for 10 consecutive days.*
- *Notification is received, pursuant to requirements specified in the (name of water supplier) wholesale water purchase contract with (name of wholesale water supplier), requesting initiation of Stage 2 of the Drought Contingency Plan.*
- *Treated water reservoir levels continue falling without refilling above xxx 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 that are tailored to its system.

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 5 consecutive days. Upon termination of Stage 2, Stage 1 restrictions will apply.

Stage 3 Triggers — SEVERE Water Shortage Conditions

Requirements for initiation
Customers shall be required to comply with the requirements and restrictions on certain non-essential water uses for Stage 3 of this Plan when:

- *The daily water use exceeds 95 percent of the total system peak capacity for 5 consecutive days.*
- *Surface water reservoir storage capacity is between 30 and 49 percent.*

- *Surface water source is not able to supply entire demand and it is necessary to use groundwater supply.*
- *The static water level in the (name of water supplier) well(s) is more than xxx feet below the measuring point.*
- *The total daily water demand equals or exceeds xxx million gallons for 5 consecutive days.*
- *Notification is received, pursuant to requirements specified in the (name of water supplier) wholesale water purchase contract with (name of wholesale water supplier), requesting initiation of Stage 3 of the Drought Contingency Plan.*
- *Treated water reservoir levels continue falling without refilling above xxx 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 that are tailored to its system.

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 3 consecutive days. Upon termination of Stage 3, Stage 2 restrictions will apply.

Stage 4 Triggers — CRITICAL Water Shortage Conditions

Requirements for initiation
Customers shall be required to comply with the requirements and restrictions on certain non-essential water uses for Stage 4 of this Plan when:

- *Surface water reservoir storage capacity is between 20 and 29 percent. Termination of surface water reservoir water supply source will be initiated when the reservoir capacity drops below 15 percent.*
- *Water demand exceeds the firm system capacity for 5 consecutive days. As a result, supply cannot keep up with demand and primary wells or storage facilities do not recover sufficiently to allow for continued pumping into the system.*

The public water supplier may devise other triggering criteria that are tailored to its system.

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 3 consecutive days. Upon termination of Stage 4, Stage 3 restrictions will apply.

Stage 5 Triggers — EMERGENCY Water Shortage Conditions

Requirements for initiation
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:

- Major water line breaks or pump or system failures that cause unprecedented loss of capability to provide water service; ***or***

- Natural or man-made contamination of the water supply source(s).

Requirements for termination
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 3 consecutive days. Upon termination of Stage 5, Stage 4 restrictions will apply.

Stage 6 Triggers — WATER ALLOCATION

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).

Requirements for initiation
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 6 of this Plan when:

- *Water demand exceeds the firm system capacity for more than 10 consecutive days despite the restrictions in place under Stage 5. As a result, supply cannot keep up with demand, and primary wells or storage facilities do not recover sufficiently to allow for continued pumping into the system.*

Requirements for termination
The water allocation plan prescribed in Section IX may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of 3 consecutive days. Upon termination of Stage 6, Stage 5 restrictions will apply.

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 allocation condition exists and shall implement the following notification procedures:

Drought Response Notification

Notification of the Public
The (designated official) or his/ her designee shall notify the public by means of:

- *publication in a newspaper of general circulation;*
- *direct mail to each customer;*
- *public service announcements;*
- *signs posted in public places; and/or*
- *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:

- *Mayor / Chairman and members of the City Council / Utility Board*
- *Fire Chief(s)*
- *City and/or County Emergency Management Coordinator(s)*
- *County Judge and Commissioner(s)*
- *State Disaster District / Department of Public Safety*
- *TCEQ (required when mandatory restrictions are imposed or when going to a less restrictive stage)*
- *Major water users*
- *Critical water users (e.g., hospitals)*
- *Parks / street superintendents and public facilities managers*

Note: The plan should specify direct notice only as appropriate to respective drought stages.

Drought Responses

Stage 1 Response — MILD Water Shortage Conditions

Target: Achieve a voluntary 10 percent reduction in daily water demand.

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:

- *Reduction of flushing of water mains (if more than required monthly frequency).*
- *Reduction of watering in public landscaped areas (e.g., parks).*
- *Reduction of water usage during fire training exercises.*
- *Activation and use of an alternative supply source(s).*

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 water customers with an even-numbered address and Saturdays and Wednesdays for water customers with an odd-numbered address, and to irrigate landscapes only between the hours of 12:00 midnight and 10:00 a.m. and between 8:00 p.m. and 12:00 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 25 percent reduction in daily water demand.

Best Management Practices for Supply Management:

Describe additional measures, if any, to be implemented directly by (name of water supplier) to manage limited water supplies and/or reduce water demand. Examples include:

- *Temporary discontinuation of flushing of water mains except for monthly flushing.*
- *Temporary discontinuation of watering in public landscaped areas (e.g., parks).*
- *Use of an alternative supply source(s).*
- *Use of reclaimed water for non-potable purposes.*

Mandatory 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 or Thursdays for customers with an even-numbered address and Saturdays or Wednesdays for water customers with an odd-numbered address, and irrigation of landscaped areas is further limited to the hours from 12:00 midnight until 10:00 a.m. and from 8:00 p.m. to 12:00 midnight on designated watering days. However, irrigation of landscaped areas is permitted at any time if it is by means of a hand-held hose, a faucet filled bucket or watering can of 5 gallons or less, or a drip irrigation system.

(b) Use of water to wash any motor vehicle, motorbike, boat, trailer, airplane, or other vehicle is prohibited except between the hours of 12:00 midnight and 10:00 a.m. and between 8:00 p.m. and 12:00 midnight on designated watering days. 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 rinses. 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 8:00 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 firefighting-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 of 12:00 midnight and 10:00 a.m. and between 8:00 p.m. and 12:00 midnight. 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 (with the exception of non-potable water);
4. Flushing of 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

Target: Achieve a 50 percent reduction in daily water demand.

Best Management Practices for Supply Management:
Describe additional measures, if any, to be implemented directly by (name of water supplier) to manage limited water supplies and/or reduce water demand. Examples include:

- *Reduce flushing of water mains to when required only.*
- *Cease watering in public landscaped areas (e.g., city parks).*
- *Cease use of water for fire training.*

Mandatory Water Use Restrictions for Demand Reduction:
All requirements of Stage 2 shall remain in effect during Stage 3 with the following additional restrictions:

(a) Irrigation of landscaped areas shall be limited to one designated watering day per two week period (based on address number) between the hours of 12:00 midnight 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, 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 prohibited.

(d) The filling, refilling, or adding of water to swimming pools, wading pools, and Jacuzzi-type pools is prohibited.

Stage 4 Response — CRITICAL Water Shortage Conditions

Target: Achieve a 75 percent reduction in daily water demand.

Best Management Practices for Supply Management:
Describe additional measures, if any, to be implemented directly by (name of water supplier) to manage limited water supplies and/or reduce water demand. Examples include:

- *Minimize unnecessary water uses in and around the system.*
- *Monitor progress of actions.*
- *Prohibit outside water use.*

Mandatory Water Use Restrictions for Reducing Demand:
All requirements of Stage 2 and 3 shall remain in effect during Stage 4 with the following additional restrictions:

(a) Irrigation of landscaped areas shall be limited to the hours between 6:00 a.m. and 10:00 a.m. and between 8:00 p.m. and 12:00 midnight on one designated watering day per month (based on address number) 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 10:00 p.m.

(c) 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

Target: Achieve a 90 percent reduction in daily water demand.

Best Management Practices for Supply Management:
Describe additional measures, if any, to be implemented directly by (name of water supplier) to manage limited water supplies and/or reduce water demand. Examples include:

- *Eliminate all unnecessary water uses in and around the system.*
- *Limit water use by fire department to firefighting only.*

Mandatory Water Use Restrictions for Reducing Demand: All requirements of Stage 2, 3, and 4 shall remain in effect during Stage 5 with the following additional restrictions:

(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

Note: 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 subparagraph for WATER ALLOCATION are not enforceable.

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" include 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 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 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 2 days.

In prescribing the method for claiming more than 2 persons per household, the (designated official) shall adopt methods to ensure 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 $25.00.

Residential water customers shall pay the following surcharges:

- $10.00 for the first 1,000 gallons over allocation.
- $25.00 for the second 1,000 gallons over allocation.
- $50.00 for the third 1,000 gallons over allocation.
- $75.00 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 that 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 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 2 days.

In prescribing the method for claiming more than 2 dwelling units, the (designated official) shall adopt methods to ensure 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 $25.00. Customers billed from a master meter under this provision shall pay the following monthly surcharges:

- $10.00 for the first 1,000 gallons over allocation.
- $25.00 for the second 1,000 gallons over allocation.
- $50.00 for the third 1,000 gallons over allocation.
- $75.00 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 non-residential commercial customer other than an industrial customer who uses water for processing purposes. A non-residential customer whose monthly usage is less than 5,000 gallons shall be allocated 5,000 gallons. For non-residential customers with higher monthly usage, the allocation shall be approximately 75 percent of the customer's usage for the corresponding month's billing period during 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. 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 non-residential 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 1,000 gallons through 25,000 gallons per month:
  - $10.00 for the first 1,000 gallons over allocation.
  - $25.00 for the second 1,000 gallons over allocation.
  - $75.00 for the third 1,000 gallons over allocation.
  - $100.00 for each additional 1,000 gallons over allocation.

- Customers whose allocation is 25,000 gallons per month or more:
  - 1.50 times the block rate for each 1,000 gallons in excess of the allocation up through 5 percent above allocation.
  - 2.00 times the block rate for each 1,000 gallons from 5 percent through 10 percent above allocation.
  - 2.50 times the block rate for each 1,000 gallons from 10 percent through 15 percent above allocation.
  - 3.00 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 that uses water for processing purposes. The industrial customer's allocation shall be approximately 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 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 12 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 12 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 if (1) the designated period does not accurately reflect the customer's normal water use because the customer had shut down 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 shut down 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) 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 1,000 gallons through 25,000 gallons per month:
  - $20.00 for the first 1,000 gallons over allocation.
  - $50.00 for the second 1,000 gallons over allocation.
  - $150.00 or the third 1,000 gallons over allocation.
  - $200.00 for each additional 1,000 gallons over allocation.

- Customers whose allocation is 25,000 gallons per month or more:
  - 1.50 times the block rate for each 1,000 gallons in excess of the allocation up through 5 percent above allocation.

- 2.00 times the block rate for each 1,000 gallons from 5 percent through 10 percent above allocation.
- 2.50 times the block rate for each 1,000 gallons from 10 percent through 15 percent above allocation.
- 3.00 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 $50.00 and not more than $500.00. 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 reconnection charge, hereby established at $50.00, 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; however, 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; however, 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 City 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, and the offense charged, and shall direct him/her to appear in the municipal court or local equivalent on the date shown on the citation, which 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 municipal court or local equivalent to enter a plea of guilty or not guilty for the violation of this Plan. If the alleged violator fails to appear in municipal court or local equivalent, 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 municipal court or local equivalent 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 that 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.

Chapter 8

Chapter 8

Unique Stream Segments and Reservoir Sites and Other Recommendations

8. Unique Stream Segments and Reservoir Sites and Other Recommendations

8.1 Unique Stream Segments

The Llano Estacado Regional Water Planning Group (LERWPG) does not recommend any stream segments within the planning area for designation as stream segments of unique ecological value. In their comments on the Region O Initially Prepared Plan, the Texas Parks and Wildlife Department (TPWD) indicated that they have identified several stream segments in the region that meet at least one of the criteria for classification as ecologically unique. The LERWPG will work with the TPWD, should it decide to pursue nomination of an ecologically significant stream in the future.

8.2 Unique Reservoir Sites

There are two unique reservoir sites that have been designated by the Legislature in Region O: the Post Reservoir and Jim Bertram Lake 7. The LERWPG supports the existing legislative designations and does not recommend any additional reservoir sites for unique designation.

8.2.1 Post Reservoir

With the passage of HB 3096 in 2001, the 77th Texas Legislature designated the site of the proposed Post Reservoir as a unique reservoir site. The 80th Legislature placed a "sunset provision" on reservoir sites that were designated by the 2007 State water plan as unique (McKinnon, 2015), but because the Post Reservoir designation was made in 2001 by stand-alone legislation, it stands (Castleberry, 2015). The LERWPG continues to support the legislative designation and has included Post Reservoir as an alternative strategy for the City of Lubbock.

On August 4, 2014, the U.S. Fish and Wildlife Service listed the sharpnose and smalleye shiners as endangered under the Endangered Species Act. The sharpnose shiner's natural historical range included the Brazos, Wichita, and Colorado Rivers, and the smalleye shiner was native to the Brazos River. Both species are now confined to the river segments of the Brazos River basin upstream of Possum Kingdom Reservoir, including portions of Crosby and Garza Counties (USFWS, 2014). Along with the final listing decision, the U.S. Fish and Wildlife Service designated approximately 623 miles of the Upper Brazos River Basin as critical habitat; this area includes 11 Texas counties (USFWS, 2014), 2 of which, Crosby and Garza, are within Region O. The USFWS's 2014 designation of critical habitat for the smalleye and sharpnose shiners will likely impact this project. The shiner listing and potential impacts on the Post Reservoir project are discussed in more detail in Section 5.7.7.

8.2.2 Jim Bertram Lake 7

With the passage of SB 675 in 2007, the 80th Texas Legislature designated the site of the proposed Jim Bertram Lake 7 as a unique reservoir site. The 80th Legislature placed a sunset provision on reservoir sites that were designated by the 2007 State water plan as unique (McKinnon, 2015), and the Jim Bertram Lake 7 unique reservoir designation was tied to the 2007 group legislation (Castleberry, 2015). Because the City of Lubbock has a pending application with the Texas Commission on Environmental Quality (TCEQ) for securing the permit to build the reservoir (Application 5921, filed in 2005) and they have expended significant funds, the unique reservoir site designation stands for Lake 7 (Castleberry, 2015). The LERWPG continues to support this legislative designation and has included Jim Bertram Lake 7 as a recommended water management strategy for the City of Lubbock.

The proposed Jim Bertram Lake 7 is part of the Jim Bertram Lake System (previously known as the Canyon Lake System), located in northeast Lubbock in Yellow House Canyon along the North Fork river. Currently, this lake system consists of 8 small dams and 5 small lakes: Lakes 1, 2, 3, 5 and 6 (Lake 4 was never constructed). Jim Bertram Lake 7 will be located directly upstream of Buffalo Springs Lake, with a proposed capacity of 20,000 acre-feet.

The City of Lubbock submitted an Environmental Information Document (EID) for the Jim Bertram Lake 7 to the TCEQ in July 2011. Due to the inundation of 774 acres of ranch land, this strategy will have an environmental impact. Notably, no federal or state protected aquatic species were found at the project site, although a strong population of Texas horned lizards (a Texas threatened species) and 17 archaeological sites were found. The EID acknowledges the need for a mitigation plan to compensate for unavoidable impacts.

8.3 Other Legislative Recommendations

The LERWPG has a number of other recommendations for the TWDB's consideration, as discussed in the following subsections.

8.3.1 Funding for Project Implementation

Since the completion of the 2001 Llano Estacado Regional Water Plan, it has been clear that some level of state financial assistance will be required, both within Region O and statewide, in order for the regional water plans to be implemented within the necessary time frame. The LERWPG strongly supports the funding that has been provided for project implementation by the Texas Legislature in past years and would like to thank the State Legislature for creating the State Water Implementation Fund for Texas (SWIFT) loan program. Development of the SWIFT program is a step in the right direction, and the LERWPG acknowledges that progress toward funding the necessary projects has been made; however, the LERWPG recommends that programs be developed that offer direct grants and/or cost-sharing arrangements in addition to the SWIFT loan program. The LERWPG recommends ongoing dedication of funding for projects in the regional and state water plans so that future generations of Texans will have reliable, affordable, and sufficient water supplies.

The LERWPG supports the implementation of high priority projects and would like to see additional funding in support of completion of the following:

- Implementation of water management strategies and water conservation incentives for water user groups in the plan, including loans for public water supply, brush management, water conservation, and research/development of drought tolerant species and more efficient technologies.

- Increased public education regarding water supply issues, including water conservation.

- Continued funding and support of collection, processing, and analysis of the water data needed to continually update and improve the understanding of regional surface and groundwater resources.

- Continued funding and support of the ongoing development and improvements to the TWDB's groundwater availability models for the major and minor aquifers of Texas. The LERWPG fully appreciates and recognizes the importance of the systematic review, integration of new data and effects of changed conditions, and re-calibration and re-verification of these models, and feel it is imperative that funding for this effort be sustained.

The State population voted to approve the SWIFT funding, but it is not clear whether voters will push the legislature to continue funding for regional water planning. At the very least, however, the LERWPG feels that continued funding for planning and implementation of water management strategies is important.

8.3.2 Planning Process Improvements

With the completion of the fourth round of Texas regional water planning, the LERWPG believes that the point of diminishing returns has been reached, with the last few plans serving only as updates to the previous plans. The LERWPG feels that the fourth cycle of planning went more smoothly with increased involvement from the Groundwater Management Areas (GMAs), but proposes that the planning process be expanded to allow for more involvement from the regional water planning groups and the use of higher quality local data, where available. In particular, the LERWPG feels that some of the per capita water use and population projection data provided by the TWDB are over-estimates and that the planning process would be improved if the planning group were able to make revisions to these data. The LERWPG would like to have the ability to override the TWDB's prescribed approach in such case where doing so may be justified. Local groundwater conservation districts were much more involved in helping review and vet the water demand projections during the current planning cycle, and the

LERWPG sees this as an improvement, but the planning group feels that there is room for even more involvement of local planning groups.

The current planning process requires the regional water planning groups to focus on closing gaps between projected water demands and supplies in each decade, but the groups are not involved with the development of the projections. With the State updating the groundwater availability models for the High Plains and Dockum aquifers, the LERWPG looks forward to having improved supply data for use in the next planning round. However, because it is important to obtain the best data available for planning, the LERWPG would also like to have the flexibility to use projections that have been developed and are in use locally, where more refined data are available. The four planning cycles that have been completed have prepared the LERWPG to participate in the discussion of realistic forecast scenarios, and the planning group would welcome participation in these tasks. Therefore, the LERWPG requests the opportunity to continue giving input on the existing and projected future conditions.

The LERWPG recommends that the planning process be reviewed by a representative stakeholder group made up of planning group members from across the state, leading to revisions to better capture region-specific characteristics as part of the planning process. Possible revisions could include more alternative scenario analyses, with respect to both supply and demand. Changed conditions resulting from the potential impact of climate change and policy changes such as those made through the Farm Bill may have dramatic effects on the Llano Estacado Planning Region, and so the LERWPG feels that the planning process would be improved if these were considered more fundamentally.

8.3.3 Rule of Capture and the Common Law Doctrine of Groundwater Ownership

The LERWPG supports the Rule of Capture, as modified by the rules and regulations of existing underground water conservation districts, and the Common Law Doctrine of Groundwater Ownership. The planning group also supports the State's policy that groundwater conservation districts are the preferred method of managing groundwater and support the creation and operation of groundwater conservation districts that are organized and function under Chapter 36 of the Texas Water Code. Accordingly, we urge the Texas Legislature not to empower the regional water planning groups with any water management or regulatory authority.

8.3.4 Importance of Agriculture to the Region and State

The LERWPG acknowledges that agriculture uses the lion's share of water in Region O, but wants to emphasize that water in support of agricultural production is a worthwhile use of the resource. The region's agricultural production is of great economic benefit and those benefits are statewide. The Texas economy does not run solely off the benefits of the oil and gas industry.

The LERWPG feels that the planning process misleads the public about what agriculture is doing to the area and its water resources, and it is important to the LERWPG that agricultural and non-agricultural water users not be pitted against each other as a result. The LERWPG believes that the Region A and Region O regional water plans have the opportunity to educate the rest of the state about the importance of agriculture to the economy of the state of Texas. With continued migration of people into the large cities, it is important to remind people where their food comes from.

The towns and other sectors of water use and development exist because of agriculture, and the water needs in this region are distinctly different in this region than in other parts of the state. The small towns in this region have existed because of water, but they are shrinking, and many businesses have closed. Nevertheless, the population of the Llano Estacado region is not increasing, and the LERWPG believes there will be water in this region for generations to come, particularly for agriculture, livestock, and municipal use.

The agricultural sector recognizes that water is for sale, and absent government intervention, water will move to its highest and best use. In this region, that use has always been for agriculture, and agricultural producers in the region will make necessary adaptations (e.g., growing other crops or adopting different farm management plans), as dictated by economics. Region O has water needs and is working to address them, and the region needs funding and support. The LERWPG has been planning since before the inception of the State's planning program, and the group wants a common sense approach to planning that takes into account the importance of agriculture to this region and the state.

8.3.5 Issue of Planning for the Agricultural Sector

The LERWPG is concerned that the regional water planning process seems to be geared more toward industry and municipalities and does not help solve the problems faced by the agricultural industry. The agricultural projections don't reflect actual conditions, showing large water needs in the agricultural sector that skew the region's water needs, given that producers will change their practices as mandated by economics. Water supply projects cannot be developed and implemented in the agricultural sector as they can in other sectors, and thus the planning process does not satisfy agricultural water needs. The LERWPG would like there to be a better way to adapt the process to allow greater participation for agricultural interests, in order to realistically address the water supply problems.

8.3.6 Playa Best Management Practices

The LERWPG supports and encourages the development and voluntary use of best management practices (BMPs) to improve recharge and to protect playa basins from siltation, including creation and preservation of native grass buffers on land surrounding playas to maintain their water holding capacity. The Texas Water Development Board's BMP guide (TWDB, 2004) should be updated with the addition of new BMPs to provide a valuable resource for those implementing these practices in the region and statewide.

8.3.7 Control of Invasive Species

The LERWPG supports implementation of brush management and control of invasive aquatic vegetation as water conservation practices, and particularly supports and encourages the efforts by the Canadian River Municipal Water Authority and City of Lubbock to control salt cedar as a means to increase water flow to the reservoirs for water supply and environmental purposes. Further, we encourage similar controls to be applied to other watersheds regionally, including those of Lake Mackenzie and White River Lake. The LERWPG also supports the control of invasive aquatic species, such as zebra mussels, quagga mussels, golden algae, milfoil and hydrilla, giant salvinia, and water hyacinth, which have the potential to negatively impact the state's lakes and reservoirs and existing infrastructure.

8.3.8 Protection of Springs and Seeps

The LERWPG supports the voluntary protection of springs and seeps as they exist within the region, and encourages landowners to use BMPs to protect and maintain these important water resources.

8.3.9 Voluntary Water Transfers

The LERWPG supports voluntary water transfers between willing buyers and sellers, but stresses that the governing bodies of each involved party would have to agree before any potential connections and/or transfers could be made.

References

Castleberry, B. 2015. Personal communication between Brad Castleberry, Partner at Lloyd Gosselink Rochelle & Townsend, P.C., and Amy Ewing, Daniel B. Stephens & Associates, Inc. (DBS&A). September 9, 2015.

McKinnon, T. 2015. Personal communication between Temple McKinnon, Texas Water Development Board Regional Water Planning Team Manager, and Amy Ewing, Daniel B. Stephens & Associates, Inc. (DBS&A). September 9, 2015.

Texas Water Development Board (TWDB). 2004. *Water conservation best management practices guide.* Water Conservation Implementation Task Force. Report 362. November 2004. Available at <https://www.twdb.texas.gov/publications/reports/numbered_reports/doc/R362_BMPGuide.pdf>.

U.S. Fish and Wildlife Service (USFWS). 2014. Sharpnose shiner and smalleye shiner protected under the Endangered Species Act. News release, Public Affairs Office, Albuquerque, NM. August 4, 2014. Available at <http://www.fws.gov/southwest/es/arlingtontexas/pdf/FINAL%20NR%20Brazos%20fL%20and%20fCH.pdf>.

Chapter 9

Chapter 9

Reporting of Financing Mechanisms for Water Management Strategies

9. Reporting of Financing Mechanisms for Water Management Strategies

This section assesses how local governments, regional authorities, and other political subdivisions plan to finance the implementation of water management strategies based on a survey that was developed by the TWDB and administered by the LERWPG.

9.1 Introduction

The TWDB requires that regional water plans include an assessment and qualitative report on how individual local governments, regional authorities, and other political subdivisions in their regional water planning area (RWPA) propose to finance recommended water management strategies (WMSs) (31 TAC §357.44). To meet this requirement, each regional water planning group (RWPG) was required to examine the funding needed to implement the WMSs and projects identified and recommended in its 2016 regional water plan.

9.2 Objectives of the Infrastructure Financing Analysis

The objectives of the infrastructure financing analysis are:

- To determine the financing options proposed by political subdivisions to meet future water infrastructure needs (including the identification of any State funding sources considered)

- To determine what role(s) the RWPGs propose that the State take in financing the recommended water supply projects

9.3 Methods and Procedures

In accordance with the Amended General Guidelines (TWDB, 2012), the LERPWG administered the Infrastructure Financing (IFR) Survey to assess how local governments, regional authorities, and other political subdivisions plan to finance the implementation of WMSs. The TWDB developed the survey instrument and methodology and asked each RWPG to solicit and review the survey responses of the entities in its region and report the findings to TWDB. The approach was similar to the one followed in conducting the infrastructure financing survey during the 2011 regional water planning cycle.

9.4 Sample Survey and Survey Information

The IFR survey includes the following questions:

- Amount of funding requested for the "planning, design, acquisition, and permitting" and the "construction" project phases
- Year funding is needed for each phase
- The percentage of state participation in owning excess capacity

A sample survey is attached in Appendix 9A. The survey was released to the LERWPG in mid-October 2015. Information for the surveys was compiled through phone interviews and e-mail communication.

9.5 Survey Responses

The 2016 Region O Water Plan includes 101 recommended WMSs (Chapter 5). The 39 recommended municipal water conservation WMSs were not included in the IFR survey because these strategies do not have any associated projects with capital costs. The remaining 62 recommended WMSs are associated with 112 recommended projects. Each of these WMSs has between 1 and 3 infrastructure-related projects:

- 34 WMSs have 1 associated project, comprising 34 of the 112 projects.
- 6 WMSs have associated projects split into 2 phases, comprising 12 of the 112 projects.
- 22 WMSs have associated projects split into 3 phases, comprising 66 of the 112 projects.

The 62 recommended WMSs and their associated infrastructure-related projects were evaluated for 51 WUGs. However, no project sponsors were identified for 3 of the irrigation water conservation WMSs in Briscoe, Dawson, and Garza counties, nor for 3 of the County-other local groundwater development WMSs (Dawson, Gaines, or Parmer County-other WUGs). Therefore, IFR survey responses were sought from 45 WUGs that were identified as likely sponsors for the 56 recommended WMSs and their associated projects. Responses were received from 43 of the 45 WUGs (96 percent) for 48 of the 56 recommended WMSs (86 percent). The complete Region O 2016 IFR data collection spreadsheet is provided in Appendix 9B.

The responding entities included 4 (Amherst, Lorenzo, Seminole, and White River Municipal Water District) that do not anticipate applying for any TWDB funding for their projects and 3 (Farwell, Lubbock, and Shallowater) that plan to apply for funding for some of their projects, but not all. Thus, the IFR results indicate that funding may be sought for 42 of the 48 recommended WMSs with identified project sponsors responding to the IFR survey. The surveyed WUGs indicated that they may request loans to cover 80 percent or more of the total project costs. Nearly all of the responses indicate that WUGs anticipate requesting funding for one or more project phases by 2020.

The total projected capital costs of all recommended Region O WMSs is $814,288,541, including the costs for all project phases. The IFR survey results indicate that Region O project sponsors may seek $400,708,125 in low-interest loans from the TWDB.

References

Texas Water Development Board (TWDB). 2012. Exhibit C: First amended general guidelines for regional water plan development. October 2012. Available at <http://www.twdb.texas.gov/waterplanning/rwp/planningdocu/2016/doc/current_docs/contract_docs/2012_exhC_1st_amended_gen_guidelines.pdf>.

Appendix 9A

Sample IFR Survey

Infrastructure Financing Survey Report

Entity Name: ABERNATHY

Primary Planning Region: O

Contact Information:

Name:

Phone Number:

Email:

Comments:

As part of the state water planning process, regional water planning groups recommend water supply projects for each of their respective regions. The Texas Water Development Board (TWDB) has several funding programs for water projects that support the planning, design, and construction of water supply projects with several financing options including low-interest loans and deferral of principal and interest. Texas Water Code (TAC 16.053 (q)) requires the regional water planning groups to examine the financing needed to implement the water management strategies and projects recommended in their regional plan.

This Infrastructure Financing Survey is a tool to gather information regarding how you, as a project sponsor, anticipate financing the water supply projects recommended to meet your needs in the 2016 regional water plan, including whether you, as a sponsor, intend to use financial assistance programs offered by the State of Texas and administered by the TWDB.

More information on these financial assistance programs can be found at the TWDB website at:
http://www.twdb.texas.gov/financial/index.asp

Your cooperation and responses to these questions are crucial to assisting the state in providing ongoing funding opportunities to ensure that our communities and our citizens have adequate water supplies. Note that a response to this survey is required for any entity seeking SWIFT funding for state water plan projects.

Please enter only the share of total project costs that you wish to receive through a TWDB program in the "Share of Costs" fields and do not enter a specific portion of a project cost more than once.

Projects you are designated as sponsoring in the Regional Water Plan

For each of the project(s) listed below **for which you are designated as sponsor**, please enter only the funding amounts you anticipate requesting from TWDB categories in the '**Amount**' field; enter the earliest '**Year Needed**' date that you anticipate requiring these amounts; and, enter in the '**State Ownership**' field the percent share of the overall project capacity that you anticipate the state taking initial ownership of. Note that the total amount entered into the separate funding categories may not exceed the **Project Total Capital Cost**. **Only enter the amount of funding that you expect to request from state funding programs.**

Data descriptions:

1) Planning, Design, Permitting, and Acquisition Funding: Enter portion of total costs into the 'Planning and Acquisition' category for which you anticipate applying for a low interest loan from TWDB for development efforts leading up to construction. This option includes providing funding for all pre-construction stages of the project.

2) Construction Funding: Enter portion of total costs into the 'Construction' category for which you anticipate applying for state funding to construct your project using a low interest loan from TWDB.

3) Percent State Participation in Excess Capacity of the Project: Enter the percent share of the total project capacity that will not be needed within the first 10 years of the project life. For some larger projects that qualify, the state may acquire a temporary ownership interest in some percentage portion of the project which allows entities to optimally size a regional project with excess capacity that won't be needed until the future. The entity buys back the state's portion of the facility over time. Principal and interest are deferred on the state-owned portion of project.

Water Management Strategy-Project Name:	HALE COUNTY - ABERNATHY GROUNDWATER DESALINATION	**Project Total Capital Cost:**	$ 10,100,000
1) Planning, Design, Permitting & Acquisition Funding	Amount: $	Year Needed:	
2) Construction Funding	Amount: $	Year Needed:	
Total Anticipated State Funding Assistance:	$ *sum above*		
3) Percent State Participation in Owning Excess Capacity		State Ownership:	%

Appendix 9B

IFR Data Collection Spreadsheet

Appendix 9B. IFR Survey Project Data

SponsorEntityName	ProjectName	IFRElementName	IFRElementValue	YearOfNeed	IFRProjectDataId	EntityRwpId	WMSProjectId	IFRProjectElementsId
ABERNATHY	HALE COUNTY - ABERNATHY GROUNDWATER DESALINATION	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$3,257,000.00	2016		154	2568	1
ABERNATHY	HALE COUNTY - ABERNATHY GROUNDWATER DESALINATION	CONSTRUCTION FUNDING	$6,843,000.00	2016		154	2568	2
ABERNATHY	HALE COUNTY - ABERNATHY GROUNDWATER DESALINATION	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		154	2568	3
AMHERST	LAMB COUNTY - AMHERST LOCAL GROUNDWATER DEVELOPMENT	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$0.00	n/a		173	2573	1
AMHERST	LAMB COUNTY - AMHERST LOCAL GROUNDWATER DEVELOPMENT	CONSTRUCTION FUNDING	$0.00	n/a		173	2573	2
AMHERST	LAMB COUNTY - AMHERST LOCAL GROUNDWATER DEVELOPMENT	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		173	2573	3
BOVINA	PARMER COUNTY - BOVINA LOCAL GROUNDWATER DEVELOPMENT	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$246,000.00	2020		258	2331	1
BOVINA	PARMER COUNTY - BOVINA LOCAL GROUNDWATER DEVELOPMENT	CONSTRUCTION FUNDING	$529,000.00	2025		258	2331	2
BOVINA	PARMER COUNTY - BOVINA LOCAL GROUNDWATER DEVELOPMENT	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		258	2331	3
COUNTY-OTHER, BAILEY	BAILEY COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$50,000.00	2016		375	2552	1
COUNTY-OTHER, BAILEY	BAILEY COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT	CONSTRUCTION FUNDING	$150,000.00	2016		375	2552	2
COUNTY-OTHER, BAILEY	BAILEY COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		375	2552	3
COUNTY-OTHER, DAWSON	DAWSON COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		424	2562	1
COUNTY-OTHER, DAWSON	DAWSON COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT	CONSTRUCTION FUNDING	.	.		424	2562	2
COUNTY-OTHER, DAWSON	DAWSON COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	.	.		424	2562	3
COUNTY-OTHER, GAINES	GAINES COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		449	2564	1
COUNTY-OTHER, GAINES	GAINES COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT PHASE 1	CONSTRUCTION FUNDING	.	.		449	2564	2
COUNTY-OTHER, GAINES	GAINES COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	.	.		449	2564	3
COUNTY-OTHER, GAINES	GAINES COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		449	2649	1
COUNTY-OTHER, GAINES	GAINES COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT PHASE 2	CONSTRUCTION FUNDING	.	.		449	2649	2
COUNTY-OTHER, GAINES	GAINES COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	.	.		449	2649	3
COUNTY-OTHER, GAINES	GAINES COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT PHASE 3	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		449	2650	1
COUNTY-OTHER, GAINES	GAINES COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT PHASE 3	CONSTRUCTION FUNDING	.	.		449	2650	2
COUNTY-OTHER, GAINES	GAINES COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT PHASE 3	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	.	.		449	2650	3
COUNTY-OTHER, GARZA	GARZA COUNTY - INFRASTRUCTURE TO SERVE AREAS SURROUNDING LAKE ALAN HENRY	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$3,377,000.00	2016		451	2143	1
COUNTY-OTHER, GARZA	GARZA COUNTY - INFRASTRUCTURE TO SERVE AREAS SURROUNDING LAKE ALAN HENRY	CONSTRUCTION FUNDING	$4,295,000.00	2016		451	2143	2
COUNTY-OTHER, GARZA	GARZA COUNTY - INFRASTRUCTURE TO SERVE AREAS SURROUNDING LAKE ALAN HENRY	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		451	2143	3
COUNTY-OTHER, HOCKLEY	HOCKLEY COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$30,000.00	2017		476	2300	1
COUNTY-OTHER, HOCKLEY	HOCKLEY COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT	CONSTRUCTION FUNDING	$20,000.00	2018		476	2300	2
COUNTY-OTHER, HOCKLEY	HOCKLEY COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		476	2300	3
COUNTY-OTHER, LYNN	LYNN COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$193,000.00	2017		519	2581	1
COUNTY-OTHER, LYNN	LYNN COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT	CONSTRUCTION FUNDING	$405,000.00	2017		519	2581	2
COUNTY-OTHER, LYNN	LYNN COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		519	2581	3
COUNTY-OTHER, PARMER	PARMER COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		551	2583	1
COUNTY-OTHER, PARMER	PARMER COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT	CONSTRUCTION FUNDING	.	.		551	2583	2
COUNTY-OTHER, PARMER	PARMER COUNTY-OTHER LOCAL GROUNDWATER DEVELOPMENT	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	.	.		551	2583	3
DENVER CITY	YOAKUM COUNTY - DENVER CITY LOCAL GROUNDWATER DEVELOPMENT	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$250,000.00	2020		657	2295	1
DENVER CITY	YOAKUM COUNTY - DENVER CITY LOCAL GROUNDWATER DEVELOPMENT	CONSTRUCTION FUNDING	$2,000,000.00	2022		657	2295	2
DENVER CITY	YOAKUM COUNTY - DENVER CITY LOCAL GROUNDWATER DEVELOPMENT	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		657	2295	3
DIMMITT	CASTRO COUNTY - DIMMITT LOCAL GROUNDWATER DEVELOPMENT	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$408,000.00	2017		664	2296	1
DIMMITT	CASTRO COUNTY - DIMMITT LOCAL GROUNDWATER DEVELOPMENT	CONSTRUCTION FUNDING	$889,000.00	2018		664	2296	2
DIMMITT	CASTRO COUNTY - DIMMITT LOCAL GROUNDWATER DEVELOPMENT	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		664	2296	3
FARWELL	PARMER COUNTY - FARWELL DIRECT POTABLE REUSE	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$150,000.00	2016		714	2219	1
FARWELL	PARMER COUNTY - FARWELL DIRECT POTABLE REUSE	CONSTRUCTION FUNDING	$1,200,000.00	2017		714	2219	2
FARWELL	PARMER COUNTY - FARWELL DIRECT POTABLE REUSE	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		714	2219	3
FARWELL	PARMER COUNTY - FARWELL LOCAL GROUNDWATER DEVELOPMENT	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		714	2584	1
FARWELL	PARMER COUNTY - FARWELL LOCAL GROUNDWATER DEVELOPMENT	CONSTRUCTION FUNDING	.	.		714	2584	2
FARWELL	PARMER COUNTY - FARWELL LOCAL GROUNDWATER DEVELOPMENT	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	.	.		714	2584	3
FRIONA	PARMER COUNTY - FRIONA LOCAL GROUNDWATER DEVELOPMENT	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		742	2297	1
FRIONA	PARMER COUNTY - FRIONA LOCAL GROUNDWATER DEVELOPMENT	CONSTRUCTION FUNDING	.	.		742	2297	2
FRIONA	PARMER COUNTY - FRIONA LOCAL GROUNDWATER DEVELOPMENT	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	.	.		742	2297	3

Appendix 9B. IFR Survey Project Data

SponsorEntityName	ProjectName	IFRElementName	IFRElementValue	YearOfNeed	IFRProjectDataId	EntityRwpId	WMSProjectId	IFRProjectElementsId
HART	CASTRO COUNTY - HART LOCAL GROUNDWATER DEVELOPMENT	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$241,200.00	2018		822	2555	1
HART	CASTRO COUNTY - HART LOCAL GROUNDWATER DEVELOPMENT	CONSTRUCTION FUNDING	$528,300.00	2018		822	2555	2
HART	CASTRO COUNTY - HART LOCAL GROUNDWATER DEVELOPMENT	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		822	2555	3
IDALOU	LUBBOCK COUNTY - IDALOU LOCAL GROUNDWATER DEVELOPMENT	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$656,800.00	2016		872	2298	1
IDALOU	LUBBOCK COUNTY - IDALOU LOCAL GROUNDWATER DEVELOPMENT	CONSTRUCTION FUNDING	$1,370,400.00	2018		872	2298	2
IDALOU	LUBBOCK COUNTY - IDALOU LOCAL GROUNDWATER DEVELOPMENT	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		872	2298	3
IRRIGATION, BAILEY	BAILEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		887	2272	1
IRRIGATION, BAILEY	BAILEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	CONSTRUCTION FUNDING	$923,150.00	2016		887	2272	2
IRRIGATION, BAILEY	BAILEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		887	2272	3
IRRIGATION, BAILEY	BAILEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		887	2221	1
IRRIGATION, BAILEY	BAILEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	CONSTRUCTION FUNDING	$1,326,000.00	2016		887	2221	2
IRRIGATION, BAILEY	BAILEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		887	2221	3
IRRIGATION, BAILEY	BAILEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		887	2554	1
IRRIGATION, BAILEY	BAILEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	CONSTRUCTION FUNDING	$1,376,175.00	2016		887	2554	2
IRRIGATION, BAILEY	BAILEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	$0.00	n/a		887	2554	3
IRRIGATION, BRISCOE	BRISCOE COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		901	2273	1
IRRIGATION, BRISCOE	BRISCOE COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	CONSTRUCTION FUNDING	.	.		901	2273	2
IRRIGATION, BRISCOE	BRISCOE COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	.	.		901	2273	3
IRRIGATION, BRISCOE	BRISCOE COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		901	2553	1
IRRIGATION, BRISCOE	BRISCOE COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	CONSTRUCTION FUNDING	.	.		901	2553	2
IRRIGATION, BRISCOE	BRISCOE COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	.	.		901	2553	3
IRRIGATION, BRISCOE	BRISCOE COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		901	2223	1
IRRIGATION, BRISCOE	BRISCOE COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	CONSTRUCTION FUNDING	.	.		901	2223	2
IRRIGATION, BRISCOE	BRISCOE COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	.	.		901	2223	3
IRRIGATION, CASTRO	CASTRO COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		912	2274	1
IRRIGATION, CASTRO	CASTRO COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	CONSTRUCTION FUNDING	$3,126,300.00	2016		912	2274	2
IRRIGATION, CASTRO	CASTRO COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		912	2274	3
IRRIGATION, CASTRO	CASTRO COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		912	2556	1
IRRIGATION, CASTRO	CASTRO COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	CONSTRUCTION FUNDING	$4,175,200.00	2016		912	2556	2
IRRIGATION, CASTRO	CASTRO COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		912	2556	3
IRRIGATION, CASTRO	CASTRO COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		912	2559	1
IRRIGATION, CASTRO	CASTRO COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	CONSTRUCTION FUNDING	$4,239,150.00	2016		912	2559	2
IRRIGATION, CASTRO	CASTRO COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		912	2559	3
IRRIGATION, COCHRAN	COCHRAN COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		917	2275	1
IRRIGATION, COCHRAN	COCHRAN COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	CONSTRUCTION FUNDING	$884,150.00	2016		917	2275	2
IRRIGATION, COCHRAN	COCHRAN COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		917	2275	3
IRRIGATION, COCHRAN	COCHRAN COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		917	2224	1
IRRIGATION, COCHRAN	COCHRAN COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	CONSTRUCTION FUNDING	$1,488,350.00	2016		917	2224	2
IRRIGATION, COCHRAN	COCHRAN COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		917	2224	3
IRRIGATION, COCHRAN	COCHRAN COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		917	2563	1
IRRIGATION, COCHRAN	COCHRAN COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	CONSTRUCTION FUNDING	$1,821,225.00	2016		917	2563	2
IRRIGATION, COCHRAN	COCHRAN COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		917	2563	3
IRRIGATION, CROSBY	CROSBY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		930	2276	1
IRRIGATION, CROSBY	CROSBY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	CONSTRUCTION FUNDING	$2,757,000.00	2016		930	2276	2
IRRIGATION, CROSBY	CROSBY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		930	2276	3
IRRIGATION, CROSBY	CROSBY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		930	2225	1
IRRIGATION, CROSBY	CROSBY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	CONSTRUCTION FUNDING	$5,089,750.00	2016		930	2225	2
IRRIGATION, CROSBY	CROSBY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		930	2225	3
IRRIGATION, CROSBY	CROSBY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		930	2226	1
IRRIGATION, CROSBY	CROSBY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	CONSTRUCTION FUNDING	$6,997,500.00	2016		930	2226	2
IRRIGATION, CROSBY	CROSBY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		930	2226	3

Appendix 9B. IFR Survey Project Data

SponsorEntityName	ProjectName	IFRElementName	IFRElementValue	YearOfNeed	IFRProjectDataId	EntityRwpId	WMSProjectId	IFRProjectElementsId
IRRIGATION, DAWSON	DAWSON COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		934	2277	1
IRRIGATION, DAWSON	DAWSON COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	CONSTRUCTION FUNDING	.	.		934	2277	2
IRRIGATION, DAWSON	DAWSON COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	.	.		934	2277	3
IRRIGATION, DAWSON	DAWSON COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		934	2227	1
IRRIGATION, DAWSON	DAWSON COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	CONSTRUCTION FUNDING	.	.		934	2227	2
IRRIGATION, DAWSON	DAWSON COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	.	.		934	2227	3
IRRIGATION, DAWSON	DAWSON COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		934	2228	1
IRRIGATION, DAWSON	DAWSON COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	CONSTRUCTION FUNDING	.	.		934	2228	2
IRRIGATION, DAWSON	DAWSON COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	.	.		934	2228	3
IRRIGATION, DEAF SMITH	DEAF SMITH COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		935	2278	1
IRRIGATION, DEAF SMITH	DEAF SMITH COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	CONSTRUCTION FUNDING	$2,731,900.00	2016		935	2278	2
IRRIGATION, DEAF SMITH	DEAF SMITH COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		935	2278	3
IRRIGATION, DEAF SMITH	DEAF SMITH COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		935	2569	1
IRRIGATION, DEAF SMITH	DEAF SMITH COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	CONSTRUCTION FUNDING	$4,103,250.00	2016		935	2569	2
IRRIGATION, DEAF SMITH	DEAF SMITH COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		935	2569	3
IRRIGATION, DEAF SMITH	DEAF SMITH COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		935	2231	1
IRRIGATION, DEAF SMITH	DEAF SMITH COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	CONSTRUCTION FUNDING	$4,009,275.00	2016		935	2231	2
IRRIGATION, DEAF SMITH	DEAF SMITH COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		935	2231	3
IRRIGATION, DICKENS	DICKENS COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		939	2279	1
IRRIGATION, DICKENS	DICKENS COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	CONSTRUCTION FUNDING	$240,200.00	2016		939	2279	2
IRRIGATION, DICKENS	DICKENS COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		939	2279	3
IRRIGATION, DICKENS	DICKENS COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		939	2570	1
IRRIGATION, DICKENS	DICKENS COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	CONSTRUCTION FUNDING	$467,900.00	2016		939	2570	2
IRRIGATION, DICKENS	DICKENS COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		939	2570	3
IRRIGATION, DICKENS	DICKENS COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		939	2232	1
IRRIGATION, DICKENS	DICKENS COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	CONSTRUCTION FUNDING	$692,475.00	2016		939	2232	2
IRRIGATION, DICKENS	DICKENS COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		939	2232	3
IRRIGATION, FLOYD	FLOYD COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		953	2281	1
IRRIGATION, FLOYD	FLOYD COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	CONSTRUCTION FUNDING	$3,060,700.00	2016		953	2281	2
IRRIGATION, FLOYD	FLOYD COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		953	2281	3
IRRIGATION, FLOYD	FLOYD COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		953	2572	1
IRRIGATION, FLOYD	FLOYD COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	CONSTRUCTION FUNDING	$5,513,250.00	2016		953	2572	2
IRRIGATION, FLOYD	FLOYD COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		953	2572	3
IRRIGATION, FLOYD	FLOYD COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		953	2574	1
IRRIGATION, FLOYD	FLOYD COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	CONSTRUCTION FUNDING	$7,416,375.00	2016		953	2574	2
IRRIGATION, FLOYD	FLOYD COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		953	2574	3
IRRIGATION, GAINES	GAINES COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		958	2282	1
IRRIGATION, GAINES	GAINES COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	CONSTRUCTION FUNDING	$5,781,375.00	2016		958	2282	2
IRRIGATION, GAINES	GAINES COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		958	2282	3
IRRIGATION, GAINES	GAINES COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		958	2575	1
IRRIGATION, GAINES	GAINES COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	CONSTRUCTION FUNDING	$6,153,000.00	2016		958	2575	2
IRRIGATION, GAINES	GAINES COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		958	2575	3
IRRIGATION, GAINES	GAINES COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		958	2576	1
IRRIGATION, GAINES	GAINES COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	CONSTRUCTION FUNDING	$4,822,200.00	2016		958	2576	2
IRRIGATION, GAINES	GAINES COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		958	2576	3
IRRIGATION, GARZA	GARZA COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		960	2283	1
IRRIGATION, GARZA	GARZA COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	CONSTRUCTION FUNDING	.	.		960	2283	2
IRRIGATION, GARZA	GARZA COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	.	.		960	2283	3
IRRIGATION, GARZA	GARZA COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		960	2250	1
IRRIGATION, GARZA	GARZA COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	CONSTRUCTION FUNDING	.	.		960	2250	2
IRRIGATION, GARZA	GARZA COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	.	.		960	2250	3
IRRIGATION, GARZA	GARZA COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		960	2235	1
IRRIGATION, GARZA	GARZA COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	CONSTRUCTION FUNDING	.	.		960	2235	2
IRRIGATION, GARZA	GARZA COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	.	.		960	2235	3

Appendix 9B. IFR Survey Project Data

SponsorEntityName	ProjectName	IFRElementName	IFRElementValue	YearOfNeed	IFRProjectDataId	EntityRwpId	WMSProjectId	IFRProjectElementsId
IRRIGATION, HALE	HALE COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		969	2284	1
IRRIGATION, HALE	HALE COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	CONSTRUCTION FUNDING	$3,283,025.00	2016		969	2284	2
IRRIGATION, HALE	HALE COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		969	2284	3
IRRIGATION, HALE	HALE COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		969	2236	1
IRRIGATION, HALE	HALE COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	CONSTRUCTION FUNDING	$6,166,050.00	2016		969	2236	2
IRRIGATION, HALE	HALE COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		969	2236	3
IRRIGATION, HALE	HALE COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		969	2237	1
IRRIGATION, HALE	HALE COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	CONSTRUCTION FUNDING	$8,266,275.00	2016		969	2237	2
IRRIGATION, HALE	HALE COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		969	2237	3
IRRIGATION, HOCKLEY	HOCKLEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		984	2285	1
IRRIGATION, HOCKLEY	HOCKLEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	CONSTRUCTION FUNDING	$2,089,125.00	2016		984	2285	2
IRRIGATION, HOCKLEY	HOCKLEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		984	2285	3
IRRIGATION, HOCKLEY	HOCKLEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		984	2239	1
IRRIGATION, HOCKLEY	HOCKLEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	CONSTRUCTION FUNDING	$3,043,100.00	2016		984	2239	2
IRRIGATION, HOCKLEY	HOCKLEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		984	2239	3
IRRIGATION, HOCKLEY	HOCKLEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		984	2582	1
IRRIGATION, HOCKLEY	HOCKLEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	CONSTRUCTION FUNDING	$4,158,300.00	2016		984	2582	2
IRRIGATION, HOCKLEY	HOCKLEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		984	2582	3
IRRIGATION, LAMB	LAMB COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		1012	2286	1
IRRIGATION, LAMB	LAMB COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	CONSTRUCTION FUNDING	$3,152,600.00	2016		1012	2286	2
IRRIGATION, LAMB	LAMB COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1012	2286	3
IRRIGATION, LAMB	LAMB COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		1012	2240	1
IRRIGATION, LAMB	LAMB COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	CONSTRUCTION FUNDING	$4,215,200.00	2016		1012	2240	2
IRRIGATION, LAMB	LAMB COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1012	2240	3
IRRIGATION, LAMB	LAMB COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		1012	2242	1
IRRIGATION, LAMB	LAMB COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	CONSTRUCTION FUNDING	$3,583,500.00	2016		1012	2242	2
IRRIGATION, LAMB	LAMB COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1012	2242	3
IRRIGATION, LUBBOCK	LUBBOCK COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		1023	2287	1
IRRIGATION, LUBBOCK	LUBBOCK COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	CONSTRUCTION FUNDING	$2,855,550.00	2016		1023	2287	2
IRRIGATION, LUBBOCK	LUBBOCK COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1023	2287	3
IRRIGATION, LUBBOCK	LUBBOCK COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		1023	2249	1
IRRIGATION, LUBBOCK	LUBBOCK COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	CONSTRUCTION FUNDING	$4,055,500.00	2016		1023	2249	2
IRRIGATION, LUBBOCK	LUBBOCK COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1023	2249	3
IRRIGATION, LUBBOCK	LUBBOCK COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		1023	2243	1
IRRIGATION, LUBBOCK	LUBBOCK COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	CONSTRUCTION FUNDING	$5,469,900.00	2016		1023	2243	2
IRRIGATION, LUBBOCK	LUBBOCK COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1023	2243	3
IRRIGATION, LYNN	LYNN COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		1024	2288	1
IRRIGATION, LYNN	LYNN COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	CONSTRUCTION FUNDING	$2,114,800.00	2016		1024	2288	2
IRRIGATION, LYNN	LYNN COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1024	2288	3
IRRIGATION, LYNN	LYNN COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		1024	2244	1
IRRIGATION, LYNN	LYNN COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	CONSTRUCTION FUNDING	$3,788,350.00	2016		1024	2244	2
IRRIGATION, LYNN	LYNN COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1024	2244	3
IRRIGATION, LYNN	LYNN COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		1024	2245	1
IRRIGATION, LYNN	LYNN COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	CONSTRUCTION FUNDING	$5,086,275.00	2016		1024	2245	2
IRRIGATION, LYNN	LYNN COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1024	2245	3
IRRIGATION, MOTLEY	MOTLEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$5,000.00	2020		1042	2289	1
IRRIGATION, MOTLEY	MOTLEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	CONSTRUCTION FUNDING	$237,525.00	2025		1042	2289	2
IRRIGATION, MOTLEY	MOTLEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1042	2289	3
IRRIGATION, MOTLEY	MOTLEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$7,300.00	2020		1042	2246	1
IRRIGATION, MOTLEY	MOTLEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	CONSTRUCTION FUNDING	$478,000.00	2025		1042	2246	2
IRRIGATION, MOTLEY	MOTLEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1042	2246	3
IRRIGATION, MOTLEY	MOTLEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$10,000.00	2060		1042	2247	1
IRRIGATION, MOTLEY	MOTLEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	CONSTRUCTION FUNDING	$717,950.00	2065		1042	2247	2
IRRIGATION, MOTLEY	MOTLEY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1042	2247	3

Appendix 9B. IFR Survey Project Data

SponsorEntityName	ProjectName	IFRElementName	IFRElementValue	YearOfNeed	IFRProjectDataId	EntityRwpId	WMSProjectId	IFRProjectElementsId
IRRIGATION, PARMER	PARMER COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		1052	2290	1
IRRIGATION, PARMER	PARMER COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	CONSTRUCTION FUNDING	$1,427,150.00	2016		1052	2290	2
IRRIGATION, PARMER	PARMER COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1052	2290	3
IRRIGATION, PARMER	PARMER COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		1052	2251	1
IRRIGATION, PARMER	PARMER COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	CONSTRUCTION FUNDING	$1,279,600.00	2016		1052	2251	2
IRRIGATION, PARMER	PARMER COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1052	2251	3
IRRIGATION, PARMER	PARMER COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		1052	2254	1
IRRIGATION, PARMER	PARMER COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	CONSTRUCTION FUNDING	$1,731,375.00	2016		1052	2254	2
IRRIGATION, PARMER	PARMER COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1052	2254	3
IRRIGATION, SWISHER	SWISHER COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		1084	2291	1
IRRIGATION, SWISHER	SWISHER COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	CONSTRUCTION FUNDING	$2,486,550.00	2016		1084	2291	2
IRRIGATION, SWISHER	SWISHER COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1084	2291	3
IRRIGATION, SWISHER	SWISHER COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		1084	2252	1
IRRIGATION, SWISHER	SWISHER COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	CONSTRUCTION FUNDING	$3,127,250.00	2016		1084	2252	2
IRRIGATION, SWISHER	SWISHER COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1084	2252	3
IRRIGATION, SWISHER	SWISHER COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		1084	2253	1
IRRIGATION, SWISHER	SWISHER COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	CONSTRUCTION FUNDING	$3,961,050.00	2016		1084	2253	2
IRRIGATION, SWISHER	SWISHER COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1084	2253	3
IRRIGATION, TERRY	TERRY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		1088	2292	1
IRRIGATION, TERRY	TERRY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	CONSTRUCTION FUNDING	$3,600,550.00	2016		1088	2292	2
IRRIGATION, TERRY	TERRY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1088	2292	3
IRRIGATION, TERRY	TERRY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		1088	2653	1
IRRIGATION, TERRY	TERRY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	CONSTRUCTION FUNDING	$4,129,250.00	2016		1088	2653	2
IRRIGATION, TERRY	TERRY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1088	2653	3
IRRIGATION, TERRY	TERRY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		1088	2654	1
IRRIGATION, TERRY	TERRY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	CONSTRUCTION FUNDING	$2,457,825.00	2016		1088	2654	2
IRRIGATION, TERRY	TERRY COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1088	2654	3
IRRIGATION, YOAKUM	YOAKUM COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		1115	2293	1
IRRIGATION, YOAKUM	YOAKUM COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	CONSTRUCTION FUNDING	$1,385,675.00	2016		1115	2293	2
IRRIGATION, YOAKUM	YOAKUM COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1115	2293	3
IRRIGATION, YOAKUM	YOAKUM COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		1115	2655	1
IRRIGATION, YOAKUM	YOAKUM COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	CONSTRUCTION FUNDING	$1,524,050.00	2016		1115	2655	2
IRRIGATION, YOAKUM	YOAKUM COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1115	2655	3
IRRIGATION, YOAKUM	YOAKUM COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		1115	2656	1
IRRIGATION, YOAKUM	YOAKUM COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	CONSTRUCTION FUNDING	$1,248,525.00	2016		1115	2656	2
IRRIGATION, YOAKUM	YOAKUM COUNTY IRRIGATION - AGRICULTURAL WATER CONSERVATION PHASE 3	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1115	2656	3
LOCKNEY	FLOYD COUNTY - LOCKNEY LOCAL GROUNDWATER DEVELOPMENT	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$782,400.00	2018-9		1478	2299	1
LOCKNEY	FLOYD COUNTY - LOCKNEY LOCAL GROUNDWATER DEVELOPMENT	CONSTRUCTION FUNDING	$1,392,800.00	2018-9		1478	2299	2
LOCKNEY	FLOYD COUNTY - LOCKNEY LOCAL GROUNDWATER DEVELOPMENT	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1478	2299	3
LORENZO	CROSBY COUNTY - LORENZO WATER LOSS REDUCTION PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$0.00	n/a		1487	2560	1
LORENZO	CROSBY COUNTY - LORENZO WATER LOSS REDUCTION PHASE 1	CONSTRUCTION FUNDING	$0.00	n/a		1487	2560	2
LORENZO	CROSBY COUNTY - LORENZO WATER LOSS REDUCTION PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1487	2560	3
LORENZO	CROSBY COUNTY - LORENZO WATER LOSS REDUCTION PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$0.00	n/a		1487	2645	1
LORENZO	CROSBY COUNTY - LORENZO WATER LOSS REDUCTION PHASE 2	CONSTRUCTION FUNDING	$0.00	n/a		1487	2645	2
LORENZO	CROSBY COUNTY - LORENZO WATER LOSS REDUCTION PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1487	2645	3
LUBBOCK	LUBBOCK COUNTY - LUBBOCK BAILEY COUNTY WELL FIELD FUTURE CAPACITY MAINTENANCE	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$0.00	n/a		88	2652	1
LUBBOCK	LUBBOCK COUNTY - LUBBOCK BAILEY COUNTY WELL FIELD FUTURE CAPACITY MAINTENANCE	CONSTRUCTION FUNDING	$13,746,000.00	2016		88	2652	2
LUBBOCK	LUBBOCK COUNTY - LUBBOCK BAILEY COUNTY WELL FIELD FUTURE CAPACITY MAINTENANCE	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		88	2652	3
LUBBOCK	LUBBOCK COUNTY - LUBBOCK BAILEY COUNTY WELL FIELD INITIAL CAPACITY MAINTENANCE	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		88	2163	1
LUBBOCK	LUBBOCK COUNTY - LUBBOCK BAILEY COUNTY WELL FIELD INITIAL CAPACITY MAINTENANCE	CONSTRUCTION FUNDING	.	.		88	2163	2
LUBBOCK	LUBBOCK COUNTY - LUBBOCK BAILEY COUNTY WELL FIELD INITIAL CAPACITY MAINTENANCE	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	.	.		88	2163	3
LUBBOCK	LUBBOCK COUNTY - LUBBOCK BRACKISH WELL FIELD AT THE SOUTH WATER TREATMENT PLANT	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		88	2169	1
LUBBOCK	LUBBOCK COUNTY - LUBBOCK BRACKISH WELL FIELD AT THE SOUTH WATER TREATMENT PLANT	CONSTRUCTION FUNDING	.	.		88	2169	2
LUBBOCK	LUBBOCK COUNTY - LUBBOCK BRACKISH WELL FIELD AT THE SOUTH WATER TREATMENT PLANT	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	.	.		88	2169	3

Appendix 9B. IFR Survey Project Data

SponsorEntityName	ProjectName	IFRElementName	IFRElementValue	YearOfNeed	IFRProjectDataId	EntityRwpId	WMSProjectId	IFRProjectElementsId
LUBBOCK	LUBBOCK COUNTY - LUBBOCK CRMWA AQUIFER STORAGE AND RECOVERY	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		88	2165	1
LUBBOCK	LUBBOCK COUNTY - LUBBOCK CRMWA AQUIFER STORAGE AND RECOVERY	CONSTRUCTION FUNDING	.	.		88	2165	2
LUBBOCK	LUBBOCK COUNTY - LUBBOCK CRMWA AQUIFER STORAGE AND RECOVERY	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	.	.		88	2165	3
LUBBOCK	LUBBOCK COUNTY - LUBBOCK JIM BERTRAM LAKE 7	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$20,125,000.00	2023		88	2171	1
LUBBOCK	LUBBOCK COUNTY - LUBBOCK JIM BERTRAM LAKE 7	CONSTRUCTION FUNDING	$61,941,000.00	2033		88	2171	2
LUBBOCK	LUBBOCK COUNTY - LUBBOCK JIM BERTRAM LAKE 7	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		88	2171	3
LUBBOCK	LUBBOCK COUNTY - LUBBOCK LAKE ALAN HENRY PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$10,000,000.00	2017		88	2170	1
LUBBOCK	LUBBOCK COUNTY - LUBBOCK LAKE ALAN HENRY PHASE 2	CONSTRUCTION FUNDING	$39,997,000.00	2018		88	2170	2
LUBBOCK	LUBBOCK COUNTY - LUBBOCK LAKE ALAN HENRY PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		88	2170	3
LUBBOCK	LUBBOCK COUNTY - LUBBOCK NORTH FORK SCALPING OPERATION	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		88	2173	1
LUBBOCK	LUBBOCK COUNTY - LUBBOCK NORTH FORK SCALPING OPERATION	CONSTRUCTION FUNDING	.	.		88	2173	2
LUBBOCK	LUBBOCK COUNTY - LUBBOCK NORTH FORK SCALPING OPERATION	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	.	.		88	2173	3
LUBBOCK	LUBBOCK COUNTY - LUBBOCK SOUTH LUBBOCK WELL FIELD	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		88	2168	1
LUBBOCK	LUBBOCK COUNTY - LUBBOCK SOUTH LUBBOCK WELL FIELD	CONSTRUCTION FUNDING	.	.		88	2168	2
LUBBOCK	LUBBOCK COUNTY - LUBBOCK SOUTH LUBBOCK WELL FIELD	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	.	.		88	2168	3
MORTON	COCHRAN COUNTY - MORTON WATER LOSS REDUCTION PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$1,500,000.00	2020		1966	2558	1
MORTON	COCHRAN COUNTY - MORTON WATER LOSS REDUCTION PHASE 1	CONSTRUCTION FUNDING	$4,000,000.00	2022		1966	2558	2
MORTON	COCHRAN COUNTY - MORTON WATER LOSS REDUCTION PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1966	2558	3
MORTON	COCHRAN COUNTY - MORTON WATER LOSS REDUCTION PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$1,500,000.00	.		1966	2644	1
MORTON	COCHRAN COUNTY - MORTON WATER LOSS REDUCTION PHASE 2	CONSTRUCTION FUNDING	$4,000,000.00	.		1966	2644	2
MORTON	COCHRAN COUNTY - MORTON WATER LOSS REDUCTION PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1966	2644	3
MULESHOE	BAILEY COUNTY - MULESHOE LOCAL GROUNDWATER DEVELOPMENT PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$293,600.00	2030		1972	2301	1
MULESHOE	BAILEY COUNTY - MULESHOE LOCAL GROUNDWATER DEVELOPMENT PHASE 1	CONSTRUCTION FUNDING	$680,000.00	2030		1972	2301	2
MULESHOE	BAILEY COUNTY - MULESHOE LOCAL GROUNDWATER DEVELOPMENT PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1972	2301	3
MULESHOE	BAILEY COUNTY - MULESHOE LOCAL GROUNDWATER DEVELOPMENT PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$293,600.00	.		1972	2648	1
MULESHOE	BAILEY COUNTY - MULESHOE LOCAL GROUNDWATER DEVELOPMENT PHASE 2	CONSTRUCTION FUNDING	$680,000.00	.		1972	2648	2
MULESHOE	BAILEY COUNTY - MULESHOE LOCAL GROUNDWATER DEVELOPMENT PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		1972	2648	3
PLAINS	YOAKUM COUNTY - PLAINS LOCAL GROUNDWATER DEVELOPMENT	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$1,455,000.00	2020		2074	2302	1
PLAINS	YOAKUM COUNTY - PLAINS LOCAL GROUNDWATER DEVELOPMENT	CONSTRUCTION FUNDING	$1,000,000.00	2022		2074	2302	2
PLAINS	YOAKUM COUNTY - PLAINS LOCAL GROUNDWATER DEVELOPMENT	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		2074	2302	3
SEAGRAVES	GAINES COUNTY - SEAGRAVES LOCAL GROUNDWATER DEVELOPMENT	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$175,000.00	2016		2195	2565	1
SEAGRAVES	GAINES COUNTY - SEAGRAVES LOCAL GROUNDWATER DEVELOPMENT	CONSTRUCTION FUNDING	$150,000.00	2016		2195	2565	2
SEAGRAVES	GAINES COUNTY - SEAGRAVES LOCAL GROUNDWATER DEVELOPMENT	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		2195	2565	3
SEMINOLE	GAINES COUNTY - SEMINOLE GROUNDWATER DESALINATION	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$0.00	n/a		2199	2567	1
SEMINOLE	GAINES COUNTY - SEMINOLE GROUNDWATER DESALINATION	CONSTRUCTION FUNDING	$0.00	n/a		2199	2567	2
SEMINOLE	GAINES COUNTY - SEMINOLE GROUNDWATER DESALINATION	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		2199	2567	3
SEMINOLE	GAINES COUNTY - SEMINOLE LOCAL GROUNDWATER DEVELOPMENT	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$0.00	n/a		2199	2566	1
SEMINOLE	GAINES COUNTY - SEMINOLE LOCAL GROUNDWATER DEVELOPMENT	CONSTRUCTION FUNDING	$0.00	n/a		2199	2566	2
SEMINOLE	GAINES COUNTY - SEMINOLE LOCAL GROUNDWATER DEVELOPMENT	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		2199	2566	3
SHALLOWATER	LUBBOCK COUNTY - SHALLOWATER LOCAL GROUNDWATER DEVELOPMENT	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$160,000.00	2015		2204	2329	1
SHALLOWATER	LUBBOCK COUNTY - SHALLOWATER LOCAL GROUNDWATER DEVELOPMENT	CONSTRUCTION FUNDING	$1,600,000.00	2016		2204	2329	2
SHALLOWATER	LUBBOCK COUNTY - SHALLOWATER LOCAL GROUNDWATER DEVELOPMENT	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		2204	2329	3
SHALLOWATER	LUBBOCK COUNTY - SHALLOWATER WATER LOSS REDUCTION PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$0.00	n/a		2204	2248	1
SHALLOWATER	LUBBOCK COUNTY - SHALLOWATER WATER LOSS REDUCTION PHASE 1	CONSTRUCTION FUNDING	$0.00	n/a		2204	2248	2
SHALLOWATER	LUBBOCK COUNTY - SHALLOWATER WATER LOSS REDUCTION PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		2204	2248	3
SHALLOWATER	LUBBOCK COUNTY - SHALLOWATER WATER LOSS REDUCTION PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$0.00	n/a		2204	2647	1
SHALLOWATER	LUBBOCK COUNTY - SHALLOWATER WATER LOSS REDUCTION PHASE 2	CONSTRUCTION FUNDING	$0.00	n/a		2204	2647	2
SHALLOWATER	LUBBOCK COUNTY - SHALLOWATER WATER LOSS REDUCTION PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		2204	2647	3
SILVERTON	BRISCOE COUNTY - SILVERTON LOCAL GROUNDWATER DEVELOPMENT	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$2,256,000.00	2018		2215	2330	1
SILVERTON	BRISCOE COUNTY - SILVERTON LOCAL GROUNDWATER DEVELOPMENT	CONSTRUCTION FUNDING	$3,616,000.00	2019		2215	2330	2
SILVERTON	BRISCOE COUNTY - SILVERTON LOCAL GROUNDWATER DEVELOPMENT	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		2215	2330	3
SUNDOWN	HOCKLEY COUNTY - SUNDOWN LOCAL GROUNDWATER DEVELOPMENT	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		2342	2332	1
SUNDOWN	HOCKLEY COUNTY - SUNDOWN LOCAL GROUNDWATER DEVELOPMENT	CONSTRUCTION FUNDING	.	.		2342	2332	2
SUNDOWN	HOCKLEY COUNTY - SUNDOWN LOCAL GROUNDWATER DEVELOPMENT	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	.	.		2342	2332	3

Appendix 9B. IFR Survey Project Data

SponsorEntityName	ProjectName	IFRElementName	IFRElementValue	YearOfNeed	IFRProjectDataId	EntityRwpId	WMSProjectId	IFRProjectElementsId
SUNDOWN	HOCKLEY COUNTY - SUNDOWN WATER LOSS REDUCTION PHASE 1	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		2342	2571	1
SUNDOWN	HOCKLEY COUNTY - SUNDOWN WATER LOSS REDUCTION PHASE 1	CONSTRUCTION FUNDING	.	.		2342	2571	2
SUNDOWN	HOCKLEY COUNTY - SUNDOWN WATER LOSS REDUCTION PHASE 1	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	.	.		2342	2571	3
SUNDOWN	HOCKLEY COUNTY - SUNDOWN WATER LOSS REDUCTION PHASE 2	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	.	.		2342	2646	1
SUNDOWN	HOCKLEY COUNTY - SUNDOWN WATER LOSS REDUCTION PHASE 2	CONSTRUCTION FUNDING	.	.		2342	2646	2
SUNDOWN	HOCKLEY COUNTY - SUNDOWN WATER LOSS REDUCTION PHASE 2	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	.	.		2342	2646	3
TULIA	SWISHER COUNTY - TULIA LOCAL GROUNDWATER DEVELOPMENT	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$592,000.00	2020		2392	2333	1
TULIA	SWISHER COUNTY - TULIA LOCAL GROUNDWATER DEVELOPMENT	CONSTRUCTION FUNDING	$1,141,000.00	2021		2392	2333	2
TULIA	SWISHER COUNTY - TULIA LOCAL GROUNDWATER DEVELOPMENT	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		2392	2333	3
WHITE RIVER MWD	CROSBY COUNTY - WHITE RIVER MWD LOCAL GROUNDWATER DEVELOPMENT	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$0.00	n/a		150	2561	1
WHITE RIVER MWD	CROSBY COUNTY - WHITE RIVER MWD LOCAL GROUNDWATER DEVELOPMENT	CONSTRUCTION FUNDING	$0.00	n/a		150	2561	2
WHITE RIVER MWD	CROSBY COUNTY - WHITE RIVER MWD LOCAL GROUNDWATER DEVELOPMENT	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		150	2561	3
WOLFFORTH	LUBBOCK COUNTY - WOLFFORTH LOCAL GROUNDWATER DEVELOPMENT	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$2,733,000.00	2017		2470	2334	1
WOLFFORTH	LUBBOCK COUNTY - WOLFFORTH LOCAL GROUNDWATER DEVELOPMENT	CONSTRUCTION FUNDING	$5,650,000.00	2018		2470	2334	2
WOLFFORTH	LUBBOCK COUNTY - WOLFFORTH LOCAL GROUNDWATER DEVELOPMENT	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		2470	2334	3
WOLFFORTH	LUBBOCK COUNTY - WOLFFORTH POTABLE REUSE	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	$7,059,000.00	2025		2470	2220	1
WOLFFORTH	LUBBOCK COUNTY - WOLFFORTH POTABLE REUSE	CONSTRUCTION FUNDING	$14,763,000.00	2028		2470	2220	2
WOLFFORTH	LUBBOCK COUNTY - WOLFFORTH POTABLE REUSE	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	0%	n/a		2470	2220	3

Chapter 10

Chapter 10

Adoption of Plan and Public Participation

10. Adoption of Plan and Public Participation

The Llano Estacado (Region O) regional water planning group (RWPG) has allowed for public participation in the regional water planning adoption process in accordance with administrative rules, the Contract, statute, and RWPG bylaws. The purpose of this chapter is to document the public participation activities that have been conducted, including the final plan adoption process, which included a public hearing, comment period, and comment response, leading to final adoption of the 2016 regional water plan.

10.1 Llano Estacado Regional Water Planning Group

The Llano Estacado RPWG is composed of 22 voting members representing 11 specific water user groups (Table) 10-1. Members of the Llano Estacado RWPG's Executive Committee include Chairman H.P. (Bo) Brown, Jr., Vice-Chairman Aubrey A. Spear, and Secretary-Treasurer Doug Hutcheson. There are also 5 non-voting members, including the Texas Water Development Board project manager, the regional water planning group's technical consultant, and representatives from the Texas Parks and Wildlife Department, Texas Department of Agriculture, and Texas Commission on Environmental Quality, as required by TWDB regional water planning rules. The High Plains Underground Water Conservation District No. 1 acted as the Llano Estacado RWPG's political subdivision for the fourth round of regional water planning that has culminated in this 2016 regional water plan.

The Llano Estacado RWPG's web site (www.llanoplan.org) is the primary method of distributing information to the public. This web site includes the Llano Estacado RWPG's mission statement, a list of the counties that are included in the region, a map of the region, agendas and meeting minutes for all meetings held from 2002 through 2015, a list of the RWPG members and their contact information, a list of the RWPG subcommittees, an online comment form, planning documents, and other items.

Table 10-1. Llano Estacado Regional Water Planning Group Members
Page 1 of 2

Member	Term Ends	Water User Group [a] / Organization [b]	City [c]
Voting members			
Dr. Melanie Barnes	2019	Public	Lubbock
H.P. Brown, Jr.	2017	Agriculture/cattle	Lubbock
Jack Campsey	2017	GMA # 6	Quanah
Jason Coleman, P.E.	2017	Water districts	Ropesville
Delmon Ellison, Jr.	2019	Agriculture	Seagraves
Harvey Everheart	2017	Water districts	Lamesa
Bill Harbin	2019	Electrical generation	Floydada
Ronnie Hopper	2017	GMA # 2	Petersburg
Doug Hutcheson	2019	Water utilities	Wolfforth
Mark Kirkpatrick	2017	Agriculture	Post
Michael McClendon	2017	River authorities	Waco
Don McElroy	2017	Small business	Muleshoe
Charles (Charlie) Morris	2017	County governments	Spur
Dr. Ken Rainwater	2017	Public	Lubbock
Kent Satterwhite	2017	Water districts	Sanford
Tom Simons	2019	Municipalities (medium) 10,000-30,000	Hereford
Aubrey A. Spear, P.E.	2019	Municipalities (large) 30,000 or more	Lubbock
Jim Steiert	2017	Environment	Hereford
John Taylor	2019	Municipalities (small) less than 10,000	Friona
Jimmy Wedel	2019	Agriculture	Lubbock
Former voting members			
Delaine Baucum	—	Agriculture *(Deceased)*	Seminole
Judge Alan Bayer	—	County government	Brownfield
Bruce Blalack	—	Municipalities (large) 30,000 or more	Lubbock
Jim Conkwright [d]	—	Water districts	Lubbock
Judge Mike DeLoach	—	County government	Littlefield
Tom Fulton	—	Water districts	Spur
Richard Gillespie, P.E.	—	Oil and gas *(Deceased)*	Seminole
Bob Josserand	—	Municipalities (medium) 10,000-30,000	Hereford
Richard Leonard	—	Agriculture	Lamesa
Gene Montgomery	—	Oil and gas	Houston

[a] Voting members
[b] Non-voting members (agency representatives / consultant)
[c] Cites are in Texas unless otherwise noted.
[d] Former vice-chairman

GMA = Groundwater Management Area
— = Not applicable

Table 10-1. Llano Estacado Regional Water Planning Group Members
Page 2 of 2

Member	Term Ends	Water User Group [a] / Organization [b]	City [c]
Non-voting members			
Sarah Backhouse	—	Texas Water Development Board	Austin
John Clayton	—	Texas Parks and Wildlife Department	Waco
Amy Ewing, P.G.	—	DBS&A (technical consultant)	Albuquerque, NM
Jason Lindeman	—	Texas Commission on Environmental Quality	Lubbock
Matt Williams	—	Texas Department of Agriculture	Lubbock
Former non-voting members			
Steve Jones	—	Texas Department of Agriculture	Lubbock
Jay Keith	—	Texas Commission on Environmental Quality	Lubbock
Angela Kennedy	—	Texas Water Development Board	Austin
Malcolm Laing	—	Texas Commission on Environmental Quality	Lubbock
Doug Shaw	—	Texas Water Development Board	Austin

[a] Voting members
[b] Non-voting members (agency representatives / consultant)
[c] Cites are in Texas unless otherwise noted.

GMA = Groundwater Management Area
— = Not applicable
DBS&A = Daniel B. Stephens & Associates, Inc.

10.2 Water Supply and Water Conservation Data Gathering

Daniel B. Stephens & Associates, Inc. (DBS&A) prepared surveys to collect information from wholesale water providers (WWPs) and water user groups (WUGs) regarding historical water use and to confirm the projected water demands and recommended strategies. The information obtained through the surveys was used to validate the water supply data and to confirm which strategies to recommend for each WWP and WUG.

WUG surveys were conducted by DBS&A and Parkhill, Smith and Cooper. DBS&A did extensive followup during the planning period, to clarify and update the survey responses, and Parkhill, Smith and Cooper worked to obtain drought contingency plans from each of the WUGs. The most recent information came from the City of Lubbock, which provided updates to their drought contingency plan and water conservation ordinance in January 2015.

10.3 Llano Estacado Regional Water Planning Group Meetings

The Llano Estacado RWPG conducted all business in meetings posted and held in accordance with the Texas Open Meetings Act, Texas Government Code Chapter 551, including the Open Meetings Act, Section 551.041 (Notice of Meeting Requirements), Section 551.043 (Time and Accessibility of Notice Requirements), and Section 551.053 (Notice Requirements of a Political Subdivision Extending into Four or More Counties). Meeting notices were filed at least 72 hours before the scheduled time of the meeting with the Office of the Texas Secretary of State and the Lubbock County Clerk's Office, and were posted at the administrative office of the High Plains Underground Water Conservation District No. 1 (2930 Avenue Q, Lubbock, TX 79411-2499). Notice of upcoming meetings was also provided to all voting and non-voting members, interested parties, each county clerk in the planning area, regional water planning group chairs, and legislators within the LERWPG. The meeting agendas and notices were posted on the Llano Estacado RWPG's web site at www.llanoplan.org.

The Llano Estacado RWPG conducted meetings on the dates listed in Table 10-2. Each meeting included a standing agenda item for public comment. Minutes of the meetings held during the fourth cycles of planning can be found on the RWPG's website (www.llanoplan.org).

Table 10-2. Llano Estacado Regional Water Planning Group Meetings

Date	Meeting Type
March 11, 2011	Regular meeting
June 16, 2011	Regular meeting
November 17, 2011	Regular meeting
April 26, 2012	Regular meeting
August 23, 2012	Regular meeting
November 8, 2012	Regular meeting
March 21, 2013	Regular meeting
May 16, 2013	Regular meeting
June 27, 2013	Regular meeting
July 31, 2013	Regular meeting
October 17, 2013	Regular meeting
January 16, 2014	Regular meeting
April 23, 2014	Regular meeting
June 19, 2014	Regular meeting
September 18, 2014	Regular meeting
November 21, 2014	Regular meeting
January 27, 1015	Regular meeting
March 26, 2015	Regular meeting
April 15, 2015	Regular meeting
June 18, 2015	Public hearing on Initially Prepared Plan
September 10, 2015	Regular meeting
October 8, 2015	Regular meeting
November 12, 2015	Regular meeting

10.4 Coordination with Other Regions

Planning regions that are adjacent to Region O include Region A (Panhandle) to the north, Regions B and G (Brazos) to the east, and Region F to the south. Four of the Region O voting members also serve as liaisons to the adjacent planning regions, and each Region O meeting includes a standing agenda item for receiving reports from the liaisons. During the fourth planning cycles these liaisons were Kent Satterwhite (Region A), Jack Campsey (Region B), Harvey Everheart (Region F), and Michael McClendon (Region G).

The shared borders, WUGs, WWPs, supplies, and water management strategies in each of these regions are described in Sections 10.4.1 through 10.4.4.

10.4.1 Region A

Region A borders five counties of Region O: Deaf Smith, Swisher, Briscoe, and part of Castro and Motley. DBS&A coordinated with Freese and Nichols, Inc., Region A's technical consultant, to identify shared WUGs and WWPs between the two regions. There is one shared WUG between Region O and Region A, the Town of Happy, and Region O has taken the lead on planning for this WUG. There is also one shared WWP between Region O and Region A, the Canadian River Municipal Water Authority (CRMWA). Previous planning cycles have assigned CRMWA as a WWP in Region A, and Region A has continued as the primary point of contact during the current planning cycle.

DBS&A and Freese and Nichols, Inc. also collaborated on the supplies that are shared between Region A and Region O. One supply located in Region O (groundwater from the Ogallala Aquifer in Deaf Smith County) is currently being used in Region A by the City of Amarillo and the City of Vega, and one supply located in Region A (groundwater from the Dockum Aquifer in Randall County) is currently being used in Region O by the Town of Happy. Water supplies from CRMWA, including surface water from Lake Meredith (when available) and groundwater from the Ogallala Aquifer in Roberts County, are used in both Region A and Region O.

The CRMWA water management strategies have been evaluated as a part of the Region A plan, and the Region O supplies from the Region A recommended CRMWA strategies have been included in the Region O plan (Section 5.5). These strategies include expanded development of the Roberts County well field with additional transmission, and conjunctive use of groundwater with Lake Meredith (including brush control in the Lake Meredith watershed and aquifer storage and recovery projects for the member cities).

10.4.2 Region B

Region B borders two counties of Region O: Motley and Dickens. DBS&A coordinated with Freese and Nichols, Inc., Region B's technical consultant, to identify shared WUGs, WWPs, and supplies between the two regions and found that there are no shared WUGs or WWPs and no Region B supplies are being used in Region O. However, one Region O supply is used in Region B (groundwater from the Other Aquifer in Dickens County supplies the King County-other WUG), and DBS&A collaborated with Freese and Nichols, Inc. on the data for this shared supply.

10.4.3 Region F

Region F borders four counties of Region O: Gaines, Dawson, Garza, and part of Lynn. DBS&A coordinated with Freese and Nichols, Inc., Region F's technical consultant, to identify shared WUGs and WWPs and found that the two regions share no WUGs, but share one WWP. This WWP, the Great Plains Water System, has groundwater rights in Gaines County in Region O and Andrews County in Region F, and it provides water to customers in Ector County in Region F and Gaines County in Region O. Previous planning cycles have assigned the Great Plains Water System as a WWP in Region F, and Region F has continued as the primary point of contact during the current planning cycle.

DBS&A and Freese and Nichols, Inc. also collaborated on the supplies that are shared between Region O and Region F. No Region F water supplies are currently being used in Region O, but Region O groundwater from the Ogallala Aquifer in Gaines County and Dawson County is currently being used in Region F. Groundwater from Gaines County supplies the Great Plains Water System and is sold to the Odessa Power generation facility in Ector County, as well as to mining interests in Gaines County. Groundwater from Dawson County supplies the Borden County-other WUG in Region F.

While no Region F water supplies are currently being used in Region O, one of the Region O recommended local groundwater development strategies would use supplies from Region F. Seminole (Gaines County) is considering drilling new supply wells that would most likely be completed in the Edwards-Trinity (Plateau) Aquifer in the southern portion of Andrews County. DBS&A coordinated with Freese and Nichols, Inc. on this strategy.

10.4.4 Region G

Region G borders two counties of Region O: Garza and Dickens. DBS&A coordinated with HDR, Region G's technical consultant, to determine any shared entities or resources. There are no shared WUGs or WWPs between Region O and Region G, and none of the supplies from one region are being used in the other.

10.5 TWDB Comments on the Initially Prepared Plan and LERWPG Responses

In a letter dated July 21, 2015, the TWDB provided comments on the Region O Initially Prepared Plan. The TWDB comments and the LERWPG's responses regarding how each comment has been addressed in the final regional water plan are included in Appendix 10A.

10.6 Public Comments on the Initially Prepared Plan and LERWPG Responses

In a letter dated August 7, 2015, the Texas Parks and Wildlife Department (TPWD) provided comments on the Region O Initially Prepared Plan. The TPWD comments and the LERWPG's responses regarding how each comment has been addressed in the final regional water plan are included in Appendix 10B.

Written comments were received from Dr. Judy Reeves and Mr. J. Collier Adams, Jr., in letters dated June 18 and August 6, 2015, respectively. Comments were also received from Mr. Kelly Young at the public hearing that was held on June 18, 2015. The LERWPG's responses regarding how the written public and public hearing comments have been addressed in the final regional water plan are included in Appendix 10C.

10.7 Final Plan Adoption

The final 2016 regional water plan was adopted at the LERWPG meeting that was held on November 12, 2015.

Appendix 10A

Responses to Texas Water Development Board Comments

Responses to TWDB Comments on the Initially Prepared 2016 Llano Estacado (Region O) Regional Water Plan

Level 1 Comments (Comments and questions must be satisfactorily addressed in order to meet statutory, agency rule, and/or contract requirements.)

1. *Page ES-12, Table ES-1: The table presents a strategy supply for Post Reservoir of 8,962 AFY. Surface water modeling documentation provided to TWDB subsequent to plan submittal indicates the modeled firm yield of Post Reservoir to be 5,750 AFY. Please verify the yield of the Post Reservoir strategy, include the subsequent surface water methodology for all surface water sources, and clarify that the water management strategy evaluations were based upon the most current WAM Run 3 in the final, adopted regional water plan. [31 Texas Administrative Code (TAC)§357.32(c)]*

RPS modeled the Post Reservoir water strategy using a modified TCEQ WAM Run 3 for the Brazos River Basin, in order to evaluate the potential yield that will be 100 percent reliable during the historical drought of record. The modeled firm yield for Post Reservoir was 5,060 acre-feet per year (ac-ft/yr) and the modeled safe yield was 4,830 ac-ft/yr, based only on naturalized flows. The modeled firm yield and modeled safe yield were both set to 10,600 ac-ft/yr, because of the availability of City of Lubbock return flows and stormwater discharges. This yield volume is 100 percent reliable when supplemented with either return flows or stormwater discharge, and the modeled yields (firm and safe) far exceed the existing permit volume (10,600 ac-ft/yr) with both of these additional sources. The existing Post Reservoir permit volume was used as the maximum modeled available yield for the strategy (Section 5.7.7).

The modified TCEQ WAM Run 3 for the Brazos River Basin has a period of record of 1940 to 1997, reflecting naturalized flows based on the historical hydrologic record of that period and the 1950s drought as the drought of record. The modeling of the surface water strategies was performed consistently with the Region G Brazos G WAM, as well as with the modeling performed for the City of Lubbock's Strategic Water Supply Plan (City of Lubbock, 2013) and the Yield Analyses of North and South Fork Water Supply Projects (HDR, 2013). The following assumptions have been made in the evaluation of the surface water supply strategies:

- Senate Bill 3 environmental flow standards with a priority date of March 1, 2012 have been implemented.
- Return flows are incorporated into the modeling in a manner consistent with analyses from previous rounds of planning for Region O.
- The Brazos Sys-Ops permit (priority date October 15, 2004) was modeled in the evaluations of Jim Bertram Lake 7 and the North Fork scalping operation.
- A sedimentation rate of 0.61 percent per year was used for Lake Alan Henry, consistent with modeling of the existing surface water supply.
- Model assumptions adopted in previous City of Lubbock model representations (City of Lubbock, 2013; HDR, 2013) are adopted in the present evaluation, including:

- The flow distribution for the Lake Alan Henry control point is revised to use the Double Mountain Fork at Justiceburg U.S. Geological Survey gage control point for determination of flow.

- All inflows to Lake Alan Henry are held in the reservoir, in accordance with the subordination agreement that the City of Lubbock has with the Brazos River Authority.

The modeled naturalized flow in the WAM was not modified, and City of Lubbock return flows were added as modeled inflows separate from the naturalized flow of the WAM, so there is not any double counting in the strategy volumes.

Some of the Brazos River Basin modeling assumptions were addressed as part of the Region O hydrovariance letter dated October 17, 2013. The full list of assumptions was discussed with the TWDB during October 2015, and the TWDB indicated that no changes to the surface water modeling would be required. The water management strategy evaluations have been clarified for Post Reservoir (Section 5.7.7), Jim Bertram Lake 7 (Section 5.4.6), and the North Fork Scalping Operation (Section 5.4.7) in the final plan, to make both the surface water modeling assumptions and results clear.

2. *Chapter 3: Please clarify how the run-of-river availabilities were calculated for municipal water users to ensure that all monthly demands are fully met for the entire simulation of the unmodified WAM Run 3 in the final, adopted regional water plan. [Contract Exhibit 'C', Section 3.4]*

None of the municipal water users in Region O rely on run-of river availabilities. Section 3.1.2 of the text of the final, adopted regional water plan has been edited to make clear that the volumes of water identified as available are 100 percent reliable and available during drought of record conditions within the model simulation period (the source supplies reported are the supply volumes that were historically available during drought of record conditions of the period of record modeled in the WAM).

3. *Chapter 3: The plan is not clear as to whether the calculated firm yields and diversions are based upon water available during the drought of record. Please clarify in the final, adopted regional water plan. [Contract Exhibit 'C', Section 3.4.1.2]*

Section 3.1.2 of the text of the final, adopted regional water plan has been edited to make clear that the calculated firm yields and diversions are based on water available during the drought of record.

4. *Pages 4-6, Table 4-3: The plan does not include projected needs associated with each wholesale water provider (WWP), by category of use and county and river basin splits. Please include this WWP need information in the final, adopted regional water plan. [31 TAC §357.33(b)(d)]*

Table 4-3 has been revised to show more detailed WWP projected first tier needs (by category of use, county, and river basin), and a new table (Table 4-5) showing the WWP second tier needs was added in Chapter 4 of the final, adopted regional water plan.

5. *Sections 5.2.1 and 5.2.2: The plan does not appear to present volumes of water for the recommended municipal and irrigation conservation strategy components with capital costs. Please*

specify the volume of water associated with each component of these strategies that have a capital cost in the final, adopted regional water plan. [Contract Exhibit 'D', Section 5.4]

In Section 5.2.1, Table 5-15 shows the estimated water savings due to the recommended municipal water conservation WMSs, and Table 5-16 shows the estimated capital, annual, and unit costs (no capital costs are associated with the recommended municipal water conservation WMSs). In Section 5.2.2, Table 5-17 shows the estimated water savings due to the recommended municipal water loss reduction WMSs, and Table 5-18 shows the estimated capital, annual, and unit costs. In Section 5.3.3, Table 5-54 shows the estimated water savings due to the recommended irrigation water conservation WMSs, and Table 5-55 shows the estimated capital, annual, and unit costs.

6. *Pages 5-57, Table 5-11: Please confirm that the residential indoor component of the municipal conservation strategies savings volumes recommended on page 5-254 do not include federally mandated conservation measures that are shown in Table 5-11 and that are already included in the water demand projections in the final, adopted regional water plan. [31 TAC §357.31(d)]*

Section 5.2.1.4 of the final, adopted regional water plan discusses the recommended municipal water conservation strategies and recommends municipal conservation for water user groups (WUGs) that have a per capita use greater than 140 gpd, regardless of needs, or that specifically mentioned a municipal water conservation WMS in their WUG survey. The LERWPG recommends annual reductions in per capita use of 0.5 percent per year (5 percent over 10 years), and the plan discusses a range of municipal water conservation strategies that could be implemented to achieve this goal (Section 5.2.1.3). That section has been revised so that residential indoor substrategies are not included, since they have already been accounted for in the municipal demand projections.

7. *Table ES-1 and Chapter 5: The plan appears to present unit costs inconsistently. For example, in Tables ES-1 and 5-3, the unit costs appear to be calculated by dividing the total capital cost by the annual yield. In the costing summary tables (Tables 5-30 through 5-40, 5-42 through 5-44, 5-46), unit costs appear to be calculated (correctly) by dividing the annual cost by the annual yield. Please present unit costs consistently throughout the final, adopted regional water plan. [Contract Exhibit 'C', Section 5.1.2]*

The unit costs calculations have been revised, and have been presented correctly and consistently in the final, adopted regional water plan, with the unit costs being calculated by dividing the annual cost by the annual yield.

8. *Pages 5-93, Section 5.2.2.2.7 and page 5-256 Section 5.4.2: The plan appears to include recommended agricultural conservation strategies for maintenance of equipment and wells. Water management strategy components included in regional water plans must be limited to the infrastructure required to develop and convey increased water supplies from sources and to treat the water for end user requirements. Maintenance or replacement of existing equipment or wells shall not be included as a recommended strategy with capital costs. Please remove these costs from the final, adopted regional water plan. [Contract Exhibit 'C', Section 5.1.2]*

The agricultural water conservation strategies (Section 5.3) have been revised in the final, adopted regional water plan so that the recommended strategies with a capital cost do not include the cost of equipment and well maintenance.

9. *Pages 5-105, 5-108, 5-141, and 5-156: It is not clear in the plan whether the Unified Costing Model was utilized for cost estimates or if other project-specific methodologies were utilized. In the absence of more accurate and detailed, project-specific cost estimates, Regional Water Planning Groups (RWPGs) are to utilize the costing model for cost estimates. Please clarify the costing methodology utilized for any water management strategy cost estimates that were not produced using the Unified Costing Model in the final, adopted regional water plan. [Contract Exhibit 'C', Section 5.1.2]*

With the exception of the City of Lubbock water management strategies, where more detailed, project-specific cost estimates were available, the Unified Costing Model has been used to develop the cost estimates that are presented in the final, adopted regional water plan. The text has been revised to clarify the methods for the costs that are presented.

10. *Tables ES-1 and 5-3, pp. 5-271, 5-222, and 5-228: The plan is not clear whether the evaluations of water management strategies for Alan Henry Phase 2, Jim Bertram Lake 7, and Post are based on an unmodified Texas Commission on Environmental Quality (TCEQ) WAM Run 3. Additionally, surface water modeling documentation provided subsequent to plan submittal indicates the modeled firm yield Lake Alan Henry includes a modified priority date. Please include the subsequent surface water methodology for all surface water sources, and clarify that the water management strategy evaluations were based upon the most current WAM Run 3 in the final, adopted regional water plan. If not, please re-evaluate these strategies using an unmodified TCEQ WAM Run 3 for the final, adopted regional water plan. [Contract Exhibit 'C', Section 3.4.2]*

The surface water modeling evaluations of Lubbock's Jim Bertram Lake 7, North Fork Scalping Operation, and Post Reservoir projects were based on a modified TCEQ WAM Run 3 for the Brazos River Basin, with a period of record of 1940 to 1997, reflecting naturalized flows based upon the historical hydrologic record of that period and the 1950s drought as the drought of record. The modeling of the surface water strategies was performed consistent with the Region G Brazos G WAM, as well as with the modeling performed for the City of Lubbock's Strategic Water Supply Plan (City of Lubbock, 2013) and the Yield Analyses of North and South Fork Water Supply Projects (HDR, 2013). The modeling assumptions are detailed in the response to Comment 1. Some of the Brazos River Basin modeling assumptions were addressed in the Region O hydrovariance letter dated October 17, 2013. The full list of assumptions was discussed with the TWDB during October 2015, and the TWDB indicated that no changes to the surface water modeling would be required. In the final plan the water management strategy evaluations have been clarified for Post Reservoir (Section 5.7.7), Jim Bertram Lake 7 (Section 5.4.6), and the North Fork Scalping Operation (Section 5.4.7) to make both the surface water modeling assumptions and results clear.

The Lake Alan Henry Phase 2 project evaluation did not include surface water modeling, since it is an infrastructure improvements strategy that will enable the City of Lubbock to draw an additional 8,000 ac-ft/yr from Lake Alan Henry (existing surface water availability determined in Chapter 3). Project components will include building a new pump station, expanding two other pump stations, and expanding the capacity at Lubbock's South Water Treatment Plant.

11. *Section 5.2.29, page 5-239; Section 5.2.30, page 5-241: For the CRMWA Conjunctive Use of Roberts County Well Field and Lake Meredith and the Expanded Development of Roberts County Well Field (with transmission line) recommended strategies included in the Region O plan, it appears that the strategy evaluations are the CRMWA strategies included in the Region A plan. Please verify that the strategy supply volume and cost data for Region O water user groups (WUGs) entered into the regional water planning database (DB17) is representative of the volume and cost associated only*

with WUGs within Region O and is not duplicative of recommendations included in another regional water plan. [Contract Exhibit 'D', Section 1.0]

The CRMWA Conjunctive Use of Roberts County Well Field and Lake Meredith, and the Expanded Development of Roberts County Well Field (with transmission line) strategies are recommended in the Region A regional water plan. Section 5.5 summarizes these strategies, including unit costs and the strategy supply volumes for the member cities within Region O, and references the Region A plan for their full evaluation. The strategy supply volume and cost data for Region O WUGs entered into DB17 is representative of the volume and cost associated only with Region O WUGs (and is not duplicative of recommendations included in the Region A regional water plan).

12. *Please provide a statement regarding any water availability requirements promulgated by a county commissioners court pursuant to Texas Water Code §35.109, which in Region O applies to the Briscoe/Swisher/Hale County Priority Groundwater Management Area. [31 TAC §357.22(a)(6)]*

In accordance with 31 TAC §357.22(a)(6), the LERWPG contacted the High Plains Underground Water Conservation District (which includes Hale and Swisher counties) and Briscoe, Swisher, and Hale counties and verified that no water availability requirements that are applicable to the Briscoe/Swisher/Hale County Priority Groundwater Management Area have been promulgated in the three counties by a county commissioners court pursuant to Texas Water Code §35.109. Statements to this fact have been added to Sections 1.9 and 3.1 in the final plan.

13. *Please include a summary of the municipal demand savings due to plumbing fixture requirements (as previously provided by TWDB) in the final, adopted regional water plan. [31 TAC §357.31(d)]*

A new table (Table 5-9) has been added to Section 5.2.1.2.1 of the final, adopted regional water plan to summarize the projected savings due to changes in the plumbing code and installation of water-efficient appliances (savings in acre-feet per decade for each WUG), as calculated by the TWDB.

14. *The plan appears to include recommended water management strategies that have not been fully evaluated due to the lack of a quantitative assessment in accordance with 31 TAC §357.34(d). The following recommended water management strategies do not appear to be fully evaluated:*

a) *Local Groundwater Development: Please include a full evaluation in Section 5.2.4. In tables 5-3 and ES-1, please include an estimate of the capital cost, unit cost, and volume of water for the local groundwater development strategies that state "not estimated' for the costs and please include a quantified volume for the annual yield instead of text regarding modeled available groundwater (MAG) availability. [31 TAC §357.34(d)(3)]*

b) *Water Reuse for Farwell and Wolfforth: Please include a full evaluation of these projects in Section 5.2.5. The City of Farwell is only briefly mentioned and the City of Wolfforth project is not discussed at all. In tables 5-3 and ES-1, please include an estimate of the capital cost, unit cost, and volume of water for the City of Wolfforth water reuse strategy and please include a capital cost and unit cost for the City of Farwell direct potable reuse strategy. [31 TAC §357.34(d)(3)]*

c) *Brush Management for the City of Lubbock: Please include a full evaluation in Section 5.2.6. In tables 5-3 and ES-1, please include an estimate of the capital cost and yield under drought of record* *conditions for the City of Lubbock brush control strategy (these may be designated as zero). Please also do not include annual cost as a capital cost. A footnote may be added to the table to note the annual cost. [31 TAC §357.34(d)(3)]*

d) Brush Management for the CRMWA: The CRMWA brush management strategy is mentioned in Section 5.2.6, however Section 5.2.6 does not appear to include a full evaluation the strategy. Please include a full evaluation of the strategy, with allocation of cost and yield under drought of record conditions associated with WUGs in Region 0 included in tables 5-3 and ES-1. [31 TAC §357.34(d)(3)]

If the region is not able to fully evaluate these strategies they may not be included as recommended water management strategies in the final, adopted regional water plan. [31 TAC §357.35(g)(1)]

The recommended water management strategy evaluations have been expanded in the final, adopted regional water plan to meet the quantitative assessment criteria. Strategies that were included on the Region O Task 4D scope of work that could not be fully evaluated are considered to be no longer potentially feasible, as approved by the Llano Estacado regional water planning group at their September 10, 2015 meeting, although some of these have been included as best management practices (BMPs) in the final, adopted regional water plan (please also see the response to Comment 21).

Specifically, the Local Groundwater Development (Sections 5.2.3, 5.4.1, 5.4.3, and 5.6), Water Reuse for Farwell and Water Reuse for Wolfforth (Section 5.2.4) strategies have been fully evaluated in the final, adopted regional water plan. The Brush Management strategy is considered to be no longer potentially feasible; however, brush management has been included as a BMP in the final, adopted regional water plan (Section 5.10.5). CRMWA's brush management strategy is included as part of their conjunctive use strategy, which is a recommended Region A strategy (summarized in Section 5.5).

15. The technical evaluations of the water management strategies do not appear to estimate water losses from the associated strategies. Please include an estimate of water losses in the final, adopted regional water plan, for example as an estimated percent loss. [31 TAC §357.34(d)(3)(A); Contract Exhibit 'C', Section 5.1.1]

Water loss estimates for the recommended and alternative water management strategies have been included in the final, adopted regional water plan.

16. The plan, in some instances, does not appear to include a quantitative reporting of environmental factors. For example, page 5-186 provides a qualitative description of "low to moderate" impacts, but the plan does not appear to include quantification of the impacts. Please include quantitative reporting in the final, adopted regional water plan. [31 TAC §357.34(d)(3)(b)]

In order to quantitatively evaluate environmental impacts, an impact matrix was developed and has been included in the final, adopted regional water plan (Section 5.1.3).

17. Section 6.1: The plan offers a broad overview stating that implementation of water management strategies evaluated is "not expected to have any significant impact" on agricultural resources, but does not appear to include quantification of the non-zero impact. Please include quantitative reporting of impacts to agricultural resources in the final, adopted regional water plan. [31 TAC §357.34(d)(3)(c)]

In order to quantitatively evaluate agricultural impacts, an impact matrix has been developed and implemented as part of the strategy evaluations in the final, adopted regional water plan. A discussion of the impacts to agricultural resources has been added to Section 6.1.

18. Page 5-143 presents an evaluation of a drought management strategy and states "...this section provides specific information about the drought management strategy recommended for WUGs in Region O," however drought management is not included as a volumetrically quantified recommended strategy in Tables ES-1 and 5-3. Please clarify whether drought management is a recommended water management strategy. If drought management is a recommended strategy for the region, please include full documentation, including supply volumes, in the final, adopted regional water plan. [31 TAC §357.34(j)(1)]

In the final, adopted regional water plan, drought management has not been recommended as a water management strategy for any of the water user groups in Region O. Drought management is discussed as one of the BMPs (Section 5.10.9), but its implementation has been reserved as a temporary emergency response and not an ongoing water management strategy.

19. The plan does not appear to recommend conservation as a recommended strategy for WUGs with needs other than municipal and irrigation WUGs. Please document the reason for not recommending conservation for other types of WUGs with needs in the final, adopted regional water plan. [31 TAC §357.34(f)(2)(B)]

The water conservation recommendations subsection (Section 5.11) in the final, adopted regional water plan has been expanded to include recommendations for all WUG types (i.e., municipal, irrigation, livestock, and industrial) with needs. Specific conservation projects or sponsors were not identified for the livestock or industrial water use categories during this planning round; thus it was not feasible to adopt recommended conservation water management strategies for these WUG types. The text has been updated to include this explanation for not having fully evaluated conservation for these WUG types.

20. The plan does not indicate if there are any unmet needs remaining after water management strategies have been recommended. Please include a summary of unmet needs, if any, in the final, adopted regional water plan. If no unmet needs exist, please include a statement to that effect. [31 TAC §357.35(d)]

No unmet municipal or County-other needs remain after the implementation of the recommended water management strategies; however, there are unmet needs for other WUGs (e.g., agriculture, livestock, and industrial). A new table (Table 6-4) summarizing those unmet needs has been added to the final, adopted regional water plan.

21. The plan identifies certain water management strategies as potentially feasible for some WUGs but did not appear to fully evaluate these strategies. For example: local groundwater development, water reuse, brush management, playa best management practices (BMP), rainwater harvesting, manufacturing conservation, drought management, brackish groundwater desalination (excluding the strategy for the City of Lubbock), and electric-dry power generation. Please fully evaluate or provide justification for not evaluating these potentially feasible strategies in the final, adopted regional water plan. [31 TAC §357.35(g)(1)]

The recommended water management strategy evaluations have been expanded in the final, adopted regional water plan to meet the quantitative assessment criteria. Specifically, the local groundwater development, water reuse (projects for Farwell and Wolfforth), and brackish groundwater desalination (projects for Lubbock, Abernathy, and Seminole) strategies have been fully evaluated in the final, adopted regional water plan.

Strategies that were included on the Region O Task 4D scope of work that could not be fully evaluated are considered to be no longer potentially feasible, as approved by the Llano Estacado regional water planning group at their September 10, 2015 meeting. Those strategies, along with the reasons for designating them as no longer potentially feasible, are:

- Evaluating whether there are any groundwater sources that could be brought in to augment the water supply available for irrigation, because no specific project, sponsor, or water source has been identified.

- Evaluating the Blaus Wasser (now BW Primoris) groundwater importation plans for municipal use, because BW Primoris has not sought involvement in the planning process (the current BW Primoris-Seminole water supply arrangement is mentioned in the final plan, but no other customers have been identified to date).

- Implementation of trench recharge to enhance aquifer recharge from precipitation events, because no specific project or sponsor has been identified.

- CRMWA channel water supply enhancement project, because this is an operations and maintenance activity, not a water management strategy.

- Acquisition of available supplies, because this information is either covered by other strategies that are included in the final plan or is confidential.

The following strategies, as presented in the approved Region O Task 4D scope of work, were designated as no longer potentially feasible because no specific project or sponsor has been identified (or for a different stated reason), but have been included as general BMPs (Section 5.10) in the final, adopted plan:

- Graywater reuse

- Treated wastewater reuse for energy production and/or irrigation

- Non-potable water reuse for fracking

- Playa best management practices

- Rainwater harvesting

- Brush management (CRMWA's brush management strategy is included as a part of their conjunctive use strategy)

- Precipitation enhancement

- Drought management (proposed as an emergency tool and not an ongoing water management strategy)
- Electric-dry power generation
- Confined animal feeding operations groundwater development
- No-till farming techniques

These BMPs are not water management strategies that could ultimately be recommended, but they document research conducted as part of the current planning round and general information compiled is provided as it may be useful to the region.

Manufacturing conservation was not included in the approved Region O Task 4D scope of work, but has been addressed as a BMP and as part of the water conservation recommendations section (5.11) of the final, adopted regional water plan.

22. *Some strategy evaluations appear to be incomplete based upon the contract scope of work. Examples include:*

a) *The Water Reuse sub-strategy (non-potable water reuse for fracking), Water Importation sub-strategies b and c (related to groundwater sources);*

b) *Infrastructure Development sub-strategy b.i (pipeline to Smyer and CRMWA water quality improvements);*

c) *Watershed Management sub-strategy b (trench recharge);*

d) *Acquisition of Available Supplies; and*

e) *Confined Animal Feeding Operations sub tasks.*

Please include these strategy evaluations or explain why these subtasks were not completed in the final, adopted regional water plan. [Contract Scope of Work, Task 4D, Subtasks 3, 4, 5, 6, 7, 10, and 13]

Please see the response to Comment 21.

23. *Section 6.4.2, pages 6-7 and Table 6-3, pages 6-9, 6-10: Text in this section and Table 6-3 states that recommended water management strategies include manufacturing conservation, watershed management, drought management, water transfers, and electric-dry power generation. However, these water management strategies are not included in the recommended water management strategy tables 5-3 and ES-1. Please clarify the list of recommended water management strategies in the final, adopted regional water plan. [31 TAC §357.40 9(b)(5)]*

The list of recommended water management strategies has been clarified in the final, adopted regional water plan (the text of Chapter 6 and Table 6-3 have been revised to match the recommended strategies listed in the Executive Summary and Chapter 5).

24. *Section 7.3, pages 7-27: The plan does not summarize the existing emergency interconnects within the regional water planning area. The plan should at a minimum state the number of potential*

emergency connections within the planning area, including if there are none, and indicate the entities that are connected. Please include this summary information in the final, adopted regional water plan. [31 TAC §357.42(d)]

After the official comment letter was received the TWDB clarified that this comment was meant to refer only to *potential* emergency interconnects. A count of potential emergency interconnections in Region O has been added to Section 7.3 of the final plan (the LERWPG subcommittee identified 35 potential emergency interconnections, although many were thought to be infeasible).

25. *Chapter 7: The plan does not provide a general description of local Drought Contingency Plans that involve emergency interconnections. Please indicate whether any local drought contingency plans involve making emergency connections between water systems or WWP systems and, if so, please also provide a general description in the final, adopted regional water plan. [31 TAC §357.42(e)]*

A discussion of the Region O WUG drought contingency plans (DCPs) that involve making emergency interconnections between water systems or wholesale water providers has been added to Section 7.3 of the final, adopted regional water plan. Two of the DCPs mention an emergency interconnection with another water system (Friona and Petersburg), and three of the DCPs mention emergency connections with privately owned irrigation wells (Earth, Friona, and Morton).

26. *Pages 7-42, Section 7.6.1: The plan states that the recommended drought management strategy consists of implementing the drought contingency plans that have been developed, however drought management is not included in the tables of quantified recommended water management strategies (Table ES-1 or Table 5-3). Please clarify whether drought management is a recommended strategy in the plan in the associated summary tables and, if it is recommended, please include the strategy, including volumes of water provided by the strategy, in Section 7.6.1, with associated WUGs/WWPs and associated triggers in the final, adopted regional water plan. [31 TAC §357.42(f)(1)]*

Drought management has not been recommended as a water management strategy for any of the water user groups in Region O, and the text of the final, adopted regional water plan has been revised to make this clear.

27. *Section 7.6: Please indicate how the planning group considered relevant recommendations from the Drought Preparedness Council (a letter was provided to planning groups with relevant recommendations in November 2014) in the final, adopted regional water plan. [31 TAC §357.42(h)]*

Section 7.6 of the final, adopted regional water plan has been revised to clarify how the planning group considered the recommendations from the Drought Preparedness Council, which included:

- Following the outline template for Chapter 7, making an effort to fully address the assessment of current drought preparations and planned responses, and planned responses to local drought conditions or loss of municipal supply.

- Evaluating the drought preparedness impacts of unanticipated population growth or industrial growth within the region over the planning horizon.

The LERWPG followed the outline template for Chapter 7, including summarizing the current drought preparations and planned responses to local drought conditions or loss of municipal supply, for the municipal water user groups in Region O. As discussed in Chapter 7 of the plan, the LERWPG recommends review of the Drought Preparedness Council Situation Reports by water providers in the region, as part of their routine drought monitoring procedures, as well as implementation and regular updates to the existing drought contingency plans.

DBS&A contacted Mr. Mario Chapa with the Texas Department of Public Safety (who was listed in the recommendations letter as the contact for questions) for clarification of what the Drought Preparedness Council was looking for in response to their second recommendation, and he forwarded the question to the council members. No responses have been received to date. In response to this recommendation, the LERWPG has evaluated the drought preparedness impacts of unanticipated population and/or industrial growth by not recommending a drought management strategy, but instead reserving these actions as emergency management tools. In addition, the plan has been developed for drought of record conditions, using demand projections that the LERWPG feels are too high, which should yield a factor of safety in evaluating potential future conditions.

28. *Section 11.2.5, pages 11-7: The plan does not include a summary of how identified water needs for WWPs differ from the 2011 regional water plan. Please include in the final, adopted regional water plan. [31 TAC §357.45(b)(3)]*

A summary of how the identified water needs for WWPs in the 2016 plan compare to those in the 2011 regional water plan has been added to Section 11.2.5 of the final, adopted regional water plan.

Level 2 Comments (Comments and suggestions for consideration that may improve the readability and overall understanding of the regional water plan.)

1. *Pages ES-16 and 11-4 state that present reservoir storage volumes within Region O suggest that the region is within, or has recently experienced, a new drought of record. Please consider including a discussion of the technical basis on which this conclusion of a potential new drought of record is based within Section 7-2 'Drought(s) of Record' in the final, adopted regional water plan.*

The conclusion that the region may be experiencing a new drought of record is based on (1) recent reservoir storage volumes within Region O and (2) an evaluation done by the City of Lubbock for the Lake Alan Henry watershed. A discussion of the technical basis for this conclusion has been added to Section 7.2 in the final, adopted regional water plan.

2. *Pages 3-7, Table 3-2: The table heading refers to modeled available groundwater (MAG) but the table summarizes adopted desired future conditions. Please consider revising the table title in the final, adopted regional water plan.*

The table title has been updated in the final, adopted regional water plan.

3. *Pages 3-27: The first sentence of the second paragraph reads "In some areas the MAG volumes increased since the last planning round." Please consider revising this statement to reference "groundwater availability" rather than "MAG volumes", as MAGs were not developed for Region O during the last planning cycle.*

The text in the final, adopted regional water plan has been updated to reflect that groundwater availability has increased in some areas since the last planning round.

4. *Table 5-48, pages 5-250 and 5-251: The total cost of the project ($6.5M), the annual cost ($593,000), and the cost per acre-foot ($2,196) in the text on page 5-251 do not match the information presented in Table 5-48 ($7.6M, $1.047M, and $3,879, respectively). Please reconcile in the final, adopted regional water plan.*

The South Garza Water System project costs in the text (Section 5.2.6) have been updated to be consistent with the values shown in the table (Table 5-49) for this strategy in the final, adopted regional water plan.

5. *Section 7.4: Suggest considering specific alternative actions and triggers for the entity's whose drought contingency plans have 'NA' or 'missing pages' for critical and emergency stages in Tables 7-1A and 7-2B in the final, adopted regional water plan. [Contract Exhibit 'C', Section 7.4]*

The final plan recommends the region-specific actions and triggers discussed in Section 7.4 for these entities.

6. *Section 7.6.1, pages 7-43, 3rd paragraph: The RWPG's "other recommended drought management measures" are included in paragraph form. Please consider providing the RWPG's "other recommended drought management measures" in a list format in the final, adopted regional water plan.*

The text of this section has been revised into a list format in the final, adopted regional water plan.

7. *Chapter 9: The plan states that the infrastructure finance survey (IFR survey) will be administered by TWDB. Please consider revising this statement to reflect that TWDB has developed the survey, however the RWPG is responsible for administering the survey.*

The text has been revised in the final, adopted regional water plan to make clear that the RWPG has administered the TWDB-created survey.

Appendix 10B

Responses to Texas Parks and Wildlife Department Comments

Responses to TPWD Comments on the Initially Prepared 2016 Llano Estacado (Region O) Regional Water Plan

Texas Parks and Wildlife Department (summarized) comments and responses

1. *TPWD requests that the reference to the "State Fishery" on page 1-61 be changed to "TPWD".*

The reference has been changed.

2. *It appears that the Region O IPP includes more of a narrative rather than quantitative reporting of the impacts of the proposed water supply strategies. Potential reductions in streamflow for surface water strategies are identified, but the connection between instream flows and downstream habitat and biota is lacking. Potential impacts to spring flows and spring ecosystems should be identified where continued groundwater depletion and additional groundwater development are identified as water management strategies.*

A new impact matrix was developed and is being used to quantitatively assess the impacts of the recommended strategies. The matrix evaluates impacts to habitat, threatened and endangered species, and springs. TPWD had the opportunity to review and comment on a draft of the matrix, and it has been revised to address their additional comments.

3. *TPWD notes that the plan does not recommend nomination of any stream segments as ecologically unique. TPWD 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. These segments include portions of the Prairie Dog Town Fork Red River, the North Prong Little Red River, and the South Prong Little Red River.*

The Llano Estacado regional water planning group is not recommending any stream segments within the planning area for designation as stream segments of unique ecological value, but will work with the TPWD in the future, should it decide to make any nominations.

4. *Concerns remain regarding the proposed Post Reservoir and other surface water strategies and their potential impacts to recently listed endangered Smalleye and Sharpnose Shiners, downstream instream uses including aquatic and riparian habitats, water quality, and wildlife habitat.*

Potential water management strategies must meet numerous feasibility requirements before being implemented, one of which is an acceptable level of environmental impact according to federal, state, and local standards. As part of the regional water planning process, Region O has considered the environmental impacts of all recommended and alternate water management strategies. Environmental impact has been evaluated in terms of effect on habitat, threatened and endangered species, agriculture, streams, springs, wetlands, and cultural sites.

Before construction can begin on any surface water project, a permit from the U.S. Army Corps of Engineers, or other authorization from another federal agency, will be required. We expect that the permit issuance action would trigger Section 7 consultation under the Endangered Species Act (as required for all federal actions that may affect any listed species). As part of the Section 7 consultation, the extent of the effects to the listed species will be evaluated, with the purpose of ultimately determining if the proposed action would jeopardize the continued existence of the species or adversely modify its critical habitat. We expect that the project sponsor would work with the U.S. Army Corps of Engineers or other federal agency to identify how to minimize any effects to the fish species.

5. *There is a potential for the proposed Jim Bertram Lake 7 to negatively impact a population of state-threatened Texas horned lizards currently found at the proposed reservoir site.*

As discussed above, potential water management strategies must meet numerous feasibility requirements before being implemented, one of which is an acceptable level of environmental impact according to federal, state, and local standards. As part of the regional water planning process, Region O has considered the environmental impacts of the Jim Bertram Lake 7, one of the City of Lubbock's recommended water management strategies. Environmental impact has been evaluated in terms of effect on habitat, threatened and endangered species, agriculture, streams, springs, wetlands, and cultural sites.

In addition, the City of Lubbock has initiated an in-depth environmental impact evaluation for this strategy. The City submitted an Environmental Information Document (EID) for the Jim Bertram Lake 7 to the Texas Commission on Environmental Quality (TCEQ) in July 2011. The EID acknowledges the need for a mitigation plan for the Texas horned lizards to compensate for the project's impacts. It is anticipated that additional on-site environmental surveys, as well as continued coordination with experts, will be necessary to develop a mitigation plan. Once developed, the mitigation plan will need to be approved by the appropriate federal, state, and/or local authorities before implementation of the strategy can progress.

Appendix 10C

Responses to Public Comments

Responses to Written Public Comments on the Initially Prepared 2016 Llano Estacado (Region O) Regional Water Plan

Dr. Judy Reeves' (summarized) comments and responses.

1. *There is a discontinuity between the Desired Future Conditions (DFCs) in the Llano Estacado Regional Water Management Plan and the management plans of three of the groundwater conservation districts within the Region O planning area:*

    a. *High Plains Underground Water Conservation District has approved an "Allowable Production Rate" of 1.5 acre-feet/contiguous acre/year. If this amount of water is withdrawn from the Ogallala aquifer, it would equate to reducing the saturated thickness up to 10 feet per year (assuming a specific yield of 0.15).*

    b. *Mesa Groundwater Conservation District has approved an "Allowable Production Rate" of 4 acre-feet/contiguous acre/year. If this amount of water is withdrawn, yearly drawdown could be as high as 26.6 feet per year (assuming a specific yield of 0.15).*

    c. *Llano Estacado Groundwater Conservation District's Rule 7.1 states that production cannot exceed 16.3 acre-feet/contiguous acre/year. If the maximum amount of water is withdrawn, yearly drawdown could be as high as 107 feet per year (assuming a specific yield of 0.15).*

    It is unlikely that there is one single place within the Region O that can sustain these Allowable Production Rates and achieve the DFCs mandated by state law ...

    I ask this planning group to explain how the Allowable Production Rates are consistent with the approved DFCs in the Region O water plan.

The Allowable Production Rates as referenced in the High Plains, Mesa, and Llano Estacado District rules are maximum allowable extraction rates only. Water levels in the aquifer, and the resulting changes in saturated thickness, are not the result of Allowable Production Rates, but rather are the result of actual extraction rates. Actual extraction rates are, and will continue to be, a function of many factors such as climatic conditions, crop type, irrigation methods, economic factors, and aquifer production capacity.

The DFCs will be achieved through multiple measures and requirements in accordance with the District Management Plans and the associated District Rules intended to implement those plans. The District Rules include many requirements in addition to the Allowable Production Rates. Some of these other requirements include production reports and water level measurements that can be used to evaluate water-level decline rates and changes in aquifer saturated thickness. For example, although the Allowable Production Rate in the Llano Estacado UWCD is 16.3 acre-feet per contiguous acre per year as correctly identified by Dr. Reeves, recent data demonstrate that the actual drawdown that has occurred in the Ogallala aquifer is nowhere near the 107 feet per year noted by Dr. Reeves in her comment. Rather, the water level change from 2013 to 2014 shows local declines up to about 8 feet and local rises up to about 5 feet, and although an average decline across the entire county is not listed, it would likely be on the order of approximately 1 or 2 feet. Similarly, for the Mesa UWCD, the actual drawdown that has occurred is much less than the 26.6 feet per year noted by Dr. Reeves in her comment. Rather, the average water level decline in 2014 was 0.41 foot (and the average water level decline between 1997 and 2014 was 0.91 foot per year).

In addition, the DFCs have been adopted on a UWCD-wide basis. Although not entirely clear, Dr. Reeves appears to imply that a given DFC is to be met at every location within an aquifer (we infer this through the "It is unlikely that there is one single place ..." portion of the comment), whereas the current DFCs were adopted based on an average across the entire UWCD. In the High Plains UWCD for example, where the DFC goal is to have 50 percent of the 2010 saturated thickness remaining in 50 years, some portions of the District may have less than 50 percent saturated thickness remaining and other portions, more than 50 percent, such that the District-wide average remaining saturated thickness is 50 percent of the 2010 value or more.

Finally, it should be noted that the Districts can update their Management Plans, and if needed their rules, at any time, but must do so at least every 5 years by statute. If the DFCs are not being achieved based on data collected by the Districts, adjustments will need to be made.

2. *If the Allowable Production Rates are not consistent with the goals of the regional water plan, then, according to the Texas Water Code 36.1072(g), the Region O Planning Group should file a petition with the Texas Water Development Board stating that a conflict exists that requires resolution, and that the rules adopted by the districts are not designed to achieve the DFCs.*

See response to Dr. Reeves' comment 1 above. In our opinion, the Allowable Production Rates, in conjunction with other District requirements, are consistent with the goals and requirements of the regional water plan and are therefore consistent with the goals and requirements of the State water plan.

J. Collier Adams, Jr.'s (summarized) comments and responses.

1. *My comments pertain to the administrative state plans and planning process of private property groundwater.. . . The State-sponsored bureaucratic management of privately owned groundwater is fundamentally unlawful because it stubbornly continues to ignore the myriad of ancient pre-existing legal relationships and thereby constitutes an illegitimate transfer of many trillions of dollars of private wealth out of the private economy and into the administrative state law sector.*

In response to the drought of the 1950s and in recognition of the need to plan for the future, the Texas Legislature created the Texas Water Development Board in 1957 to develop water supplies and prepare plans to meet the state's future water needs. In 1997, the 75th Texas Legislature passed Senate Bill 1 to establish rules for Texas state water planning, and the current water planning process is based on these rules. Regional water planning groups are required to prepare and adopt regional water plans that meet the requirements of the Water Planning Rules (31 TAC), and the Llano Estacado regional water planning group is responsible for coordinating the planning process for the 21-county area in west Texas that makes up Region O.

The current planning process does not lead to or support the illegitimate transfer of private property. Recommended water management strategies in the 2016 Region O Plan include local groundwater development for a number of municipal water user groups. In some cases, the additional water supply wells are proposed to be placed on property owned by the municipality. If a proposed water supply well site is located where the municipality does not possess the right to drill, the required water rights would have to be purchased by the municipality prior to development of the groundwater supply.

Responses to Public Hearing Comments on the Initially Prepared 2016 Llano Estacado (Region O) Regional Water Plan

Dr. Judy Reeves' comments

Dr. Judy Reeves provided public comment at the Region O public hearing that was held on June 18, 2015. In a letter also dated June 18, 2015, Dr. Reeves provided written comment documenting the same concerns. Dr. Reeves' comments are summarized and responded to in the response to written public comments document.

Mr. Kelly Young's (summarized) comments and responses

1. In your planning, do you include costs of purchasing groundwater rights from private landowners? Because the groundwater is 99 percent owned by individual landowners, it seems like it would be hard to project costs without having an estimated range of what those rights will cost to buy from individual landowners.

The cost of purchasing groundwater rights has not been included in any of the Region O water management strategies. In the case of the City of Lubbock's strategies, the City already possesses the water rights that will be needed for project implementation. In addition, most of the water user groups planning to implement a local groundwater development strategy already own the water rights that will be needed. Each strategy evaluation states whether groundwater rights would need to be obtained prior to implementation; for strategies where water rights will need to be obtained, the cost to obtain water rights has not been included, because it may vary significantly by location. In the event that groundwater rights need to be obtained, the water user groups will be responsible for identifying and purchasing the necessary water rights. The Llano Estacado regional water planning group supports voluntary water transfers between willing buyers and sellers, but the details of specific transactions will need to be worked out on an individual basis.

Chapter 11

Chapter 11

Implementation and Comparison to the Previous Regional Water Plan

11. Implementation and Comparison to the Previous Regional Water Plan

Section 11.1 of this 2016 Region O Water Plan reports on the level of implementation of the recommended water management strategies (WMSs) provided in the 2011 Region O regional water plan. Section 11.2 compares the data presented in the previous water plan to the information gathered for the current planning effort.

11.1 Implementation of the 2011 Region O Water Plan

The 2011 Implementation Survey was developed by the TWDB to standardize reporting on the level of implementation of the WMSs recommended in the 2011 Region O regional water plan. The survey consists of 14 questions regarding project description, level of implementation, project cost and funding, and volume of water supplied. This information was compiled for each of the recommended WMSs included in the 2011 plan through phone and e-mail surveys conducted over several months.

The 2011 Region O regional water plan recommended 78 WMSs representing 60 different water user groups (WUGs). Information was collected for 98 percent of the WUGs (59 of 60). The City of Anton could not be reached to obtain information regarding its 2 recommended WMSs (groundwater development and municipal conservation).

Of the 76 WMSs with implementation information provided, the majority (71 percent, 54 of 76 WMSs) have been implemented at some level. Conservation strategies (municipal and irrigation) comprise 78 percent (42 of 54) of these partially or fully implemented strategies.

Most of the recommended strategies (77 percent, 60 of 78 WMSs) in the 2011 Region O regional plan are included in the 2016 Region O regional water plan. The strategies not included in the 2016 plan were either deemed unnecessary due to revised supply and/or demand projections, or are no longer considered as a potential strategy for the WUG.

Table 11-1 summarizes the 2011 Implementation Survey results by WMS type. The full 2011 Implementation Survey is provided as Appendix 11A.

11.2 Comparison to the 2011 Region O Water Plan

The following subsections provide a comparison of the data presented in the 2011 regional water plan to the updated data obtained during the 2016 Region O planning effort. Section 11.2.1 compares the water demand projections, and Section 11.2.2 discusses any differences in the modeling assumptions for development of the groundwater and surface water availability data, which are compared in Section 11.2.3. Existing water supplies for water users are compared in Section 11.2.4, and changes in water needs for water users are presented in Section 11.2.5. Differences between the 2016 regional water plan's recommended and alternative WMSs and those included in the 2011 regional water plan are summarized in Section 11.2.6. The differences between the WMSs presented in both the 2011 and 2016 plans for the City of Lubbock are discussed in Section 11.2.7.

11.2.1 Water Demand Projections

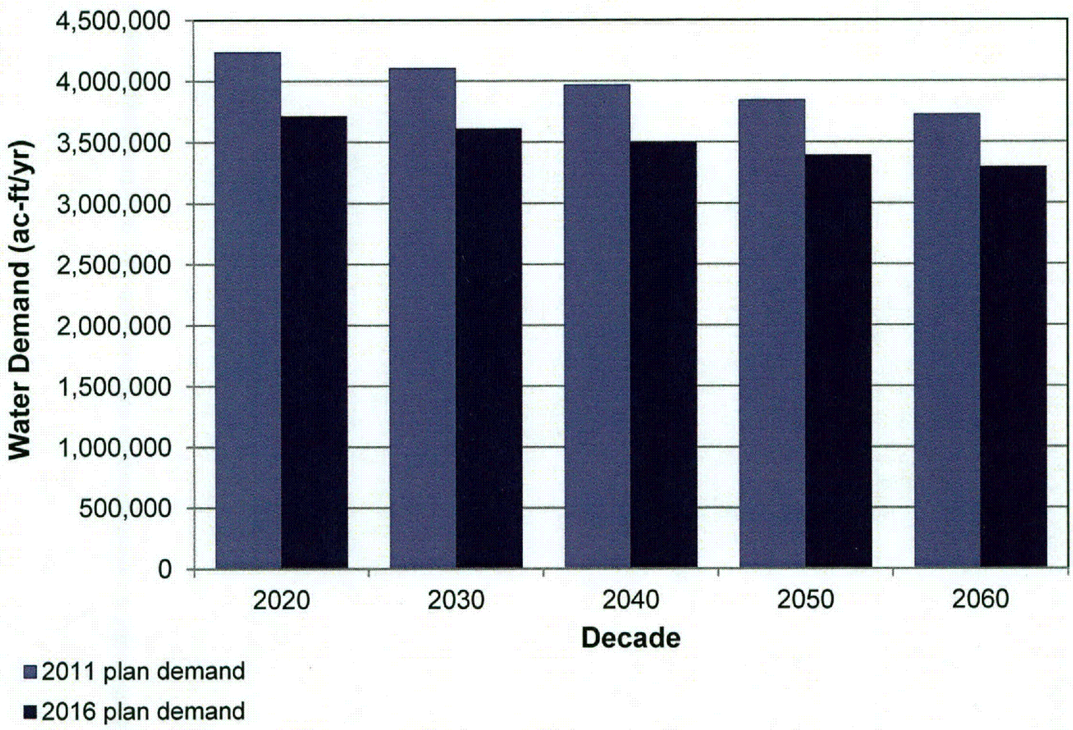
Figure 11-1a shows the projected water demands for Region O from the 2011 regional water plan compared to the projections in the 2016 regional water plan for 2020 through 2060. Projected demand has decreased by approximately 12 percent from the values shown in the 2011 regional water plan. The reduction is due primarily to decreased irrigation demands, which are approximately 13 percent lower for each planning decade compared to the 2011 irrigation projections (Figure 11-1b). The 2016 irrigation demand projections are based on the average of TWDB's 2005 through 2009 irrigation water use estimates. Table 11-2 shows the change in demands from the 2011 plan to the 2016 plan by water user group (WUG) category.

Table 11-1. Summary of 2011 Implementation Survey Results

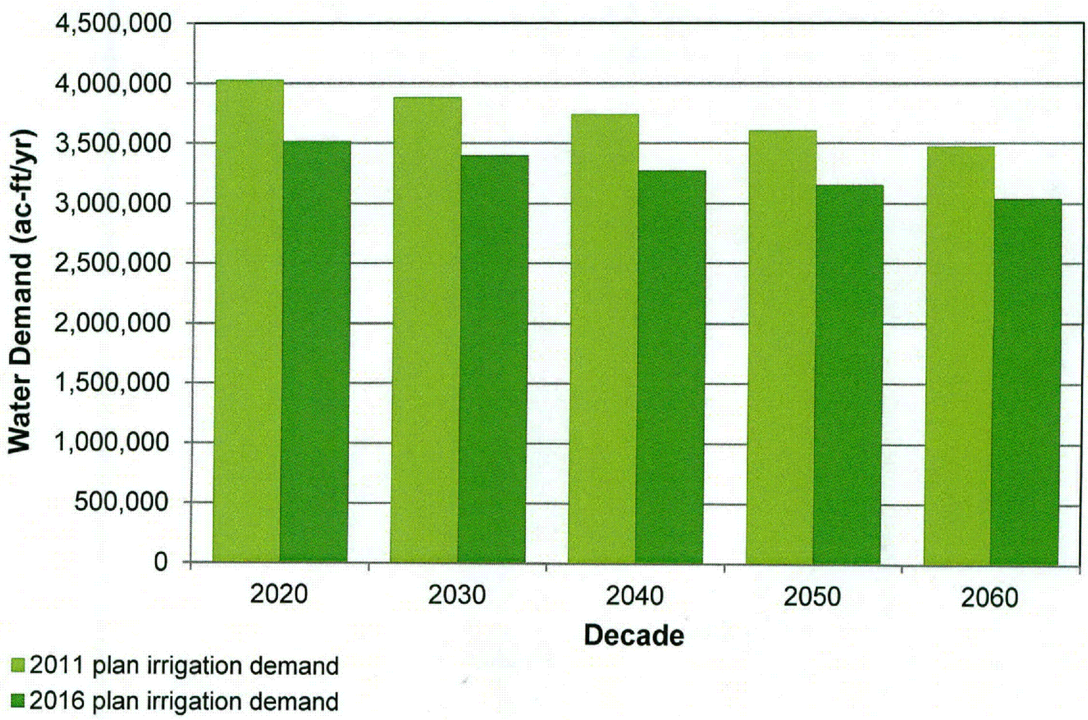
WMS Type	Total	No Response [a]	Implemented	Implementation Initiated	Not Implemented	In 2016 Plan	Not in 2016 Plan
Local groundwater development	25	1	2	7	15	14	11
Groundwater desalination	1			1	1	1	
Irrigation conservation	21		21			21	
Municipal conservation	25	1	21		3	19	6
New major reservoir	2			1	1	2	
Other surface water	3		1		2	3	
Potable water reuse	1				1		1
Total	78	2	45	9	23	60	18
Percentage	—	3%	58%	12%	29%	77%	23%

[a] A minimum of 5 attempts were made to contact WUGs before considering them unresponsive

a. Total Water Demand



b. Irrigation Water Demand



LLANO ESTACADO REGION

Comparison of 2011 and 2016 Water Demand Projections

Daniel B. Stephens & Associates, Inc.

11/2/15

Figure 11-1

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Table 11-2. Change in Water Demand from 2011 Plan to 2016 Plan

	Change in Water Demand by Decade (acre-feet per year)				
Water User Group	2020	2030	2040	2050	2060
Irrigation	–506,452	–486,651	–468,857	–451,783	–435,391
Livestock	–18,912	–16,407	–19,012	–21,828	–24,893
Manufacturing	–94	–114	–132	–148	–181
Mining	5,731	11,014	12,877	12,508	10,728
Municipal	–8,720	–4,041	2,167	10,051	18,457
Steam-electric	160	188	221	261	311
Total	–528,287	–496,011	–472,736	–450,939	–430,969

Projected demand in the livestock and manufacturing categories are also lower for each decade in the 2016 plan, while mining and stream-electric power categories show an increase for each decade. The 2016 livestock demands were adopted by the LERWPG with the support of stakeholders and representatives of the industry and reflect a reduction in demand that is more in line with the rate of growth that the region is experiencing, but the livestock projections still may be overly optimistic given the current outlook for this water use sector. The mining water demand was revised in November 2012 based on a report by the Bureau of Economic Geology, which estimated increased activity (and therefore water use) in the oil, gas, and mining industry (all included in the mining category). The 2016 projections for the municipal category are lower than the 2011 projections for decades 2020 and 2030, but higher for decades 2040 through 2060. The total reduction in regional demand between the 2011 and 2016 plans decreases over time, from 528,287 in 2020 to 430,969 in 2070.

11.2.2 Drought of Record and Model Assumptions

The drought that occurred from 1950 to 1957 is the current drought of record (Texas Water Resources Institute, 2011) for the planning region. This drought of record was used for the water supply modeling in both the 2011 and 2016 regional water plans. However, present reservoir storage volumes within Region O suggest that the region is within or has recently experienced a new drought of record, and firm surface water supplies within the region were reduced for planning purposes. For instance, White River Lake was unavailable for use for almost 2 years during the current water planning cycle and is therefore projected to have no water availability for the current planning effort. In addition, zero local livestock surface water availability was estimated for each decade in the 2016 plan.

The modeled available groundwater amounts for the 2016 plan are based on the adopted Desired Future Conditions (DFCs) for the groundwater resources within the groundwater management areas (GMA) 2 and 6, which were established in 2010. The adopted DFCs in Region O are established limits based on one of the following types of conditions: volume of groundwater in storage over time, saturated thickness of the aquifer over time, or amount of decline in water level in the aquifer over time.

11.2.3 Water Availability

Figures 11-2a and 11-2b show the difference in groundwater and surface water availabilities between the 2011 and 2016 plans, and Table 11-3 provides the change in water availability from the 2011 plan to the 2016 plan by source type.

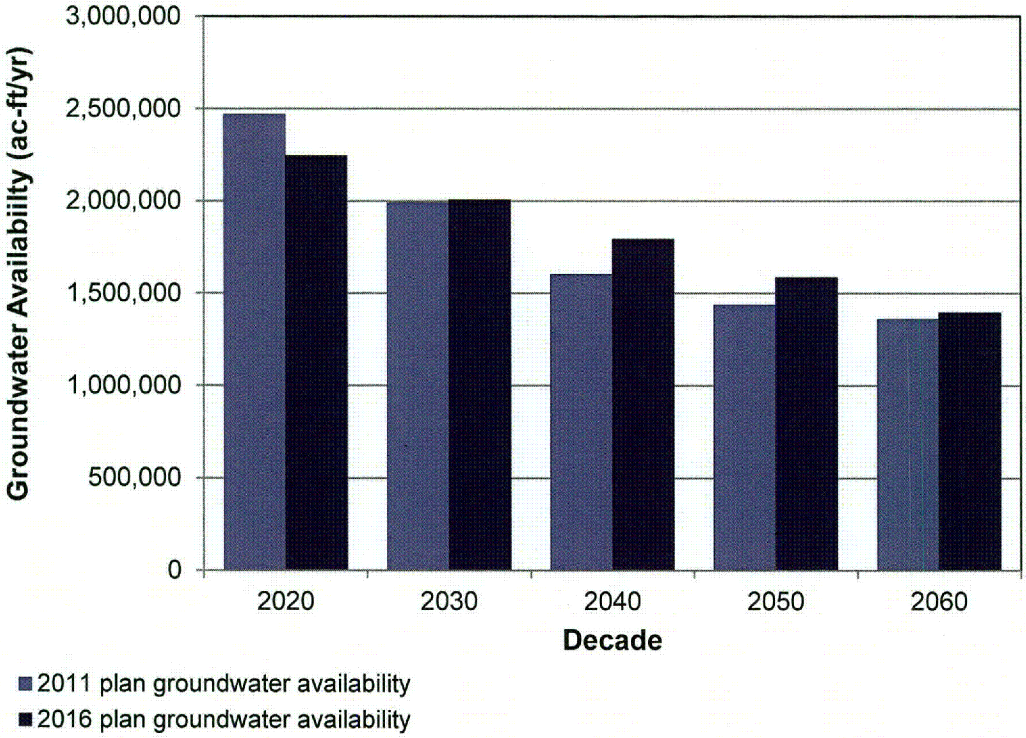
Table 11-3. Change in Water Availability from 2011 Plan to 2016 Plan

Source	Change in Water Availability by Decade (acre-feet per year)				
	2020	2030	2040	2050	2060
Groundwater	–222,671	15,556	191,752	147,028	33,179
Reuse	11,839	13,496	14,474	14,837	14,731
Surface water	–10,245	–10,408	–10,608	–10,853	–11,116
Total	–221,077	18,644	195,618	151,012	36,794

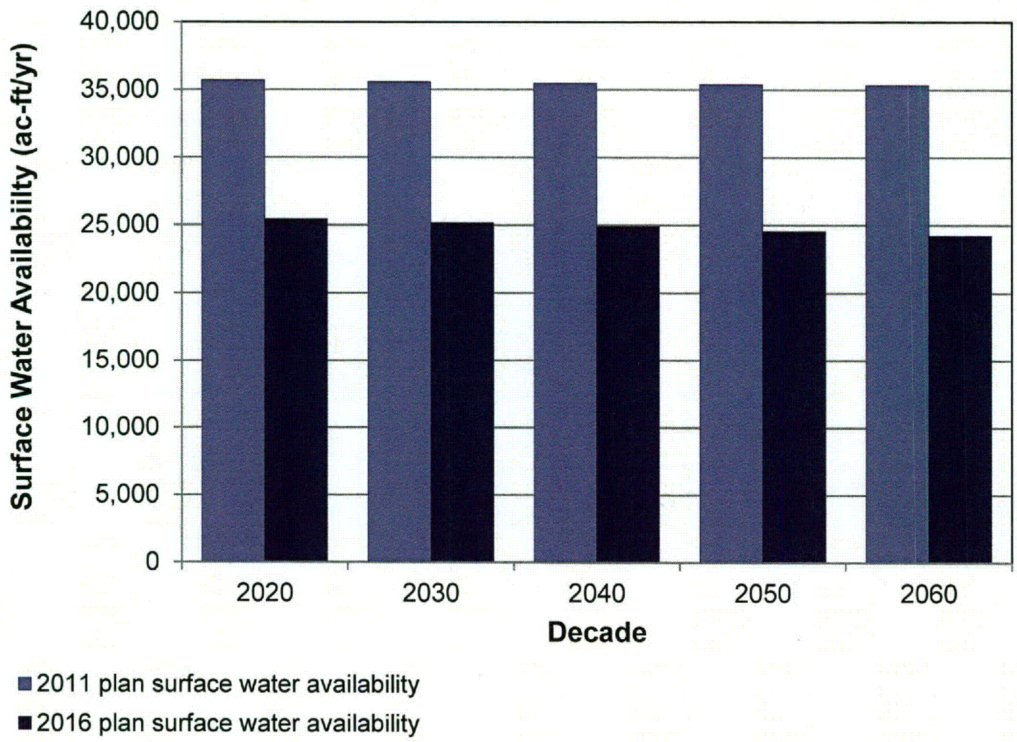
Groundwater availability projected in the 2016 plan is much less in decade 2020 but moderately to greatly increased in decades 2030 through 2060. As noted in Section 11.2.2, the 2016 groundwater availability is based on adopted DFCs.

Reuse water availability projected in the 2016 plan has increased from approximately 12,000 to 15,000 acre-feet per year (ac-ft/yr). The increase is based on the City of Lubbock 2013 Strategic Water Supply Plan (City of Lubbock, 2013).

a. Groundwater Availability



b. Surface Water Availability



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Comparison of 2011 and 2016 Water Availability Projections

Figure 11-2

Surface water availability projected in the 2016 plan is more than 10,000 acre-feet lower in every decade than in the 2011 plan. The decrease is due primarily to the lack of any surface water availability for livestock local supplies determined during the current planning effort.

Total water availability projected in the 2016 plan for Region O is much less in decade 2020. Total water availability increases slightly in decades 2030 and 2060 while large increases are estimated for decades 2040 and 2060.

11.2.4 Existing Water Supplies for Water Users

Table 11-4 shows the change in water supply from the 2011 plan to the 2016 plan by WUG category. The reduction in the amount of available groundwater in decade 2020 for the region (Table 11-3) is reflected in the substantial decrease in allocated water supplies for that decade. For most WUG categories, the water supplies in the 2016 plan have been reduced below the water supplies from the 2011 plan, some to a significant degree. The only exceptions are the mining and steam-electric categories. Mining supplies have increased slightly in decades 2030 through 2060 due to an increase in supply for Gaines County and the addition of Floyd County, which did not have a mining demand or supply in the 2011 plan. Steam-electric supplies have increased in decades 2020 through 2050 due to increased reuse water availability.

Table 11-4. Change in Water Supply by Water User Group from the 2011 Plan to 2016 Plan

Water User Group	Change in Water Supply by Decade (acre-feet per year)				
	2020	2030	2040	2050	2060
Irrigation	–467,579	–215,364	–107,879	–120,675	–173,650
Livestock	–29,075	–26,978	–21,634	–22,662	–25,468
Manufacturing	–5,248	–5,064	–4,543	–5,024	–6,869
Mining	–2,493	400	2,070	2,210	2,105
Municipal	–21,963	–24,012	–19,291	–12,523	–10,582
Steam-electric	3,555	3,945	6,470	4,373	–1,617
Total	–522,803	–267,073	–144,807	–154,301	–216,081

11.2.5 Water User Needs

Table 11-5 shows the change in water needs from the 2011 plan to the 2016 plan by WUG category. Irrigation water needs decreased during all decades due to a decrease in the irrigation water demand (Table 11-2). Compared to the 2011 plan, livestock, manufacturing, mining, and steam-electric power have increased water needs during all decades. In the 2011 plan, three of these four categories (manufacturing, mining, and steam-electric power) had no shortages. Municipal water needs decrease in 2020, but increase from 2030 to 2060. The projected regional water needs in the 2016 plan are less for all decades compared to the 2011 plan (decreased by 3 percent in 2020, decreased by 13 percent in 2060), due mainly to the decrease in the projected irrigation water demand in the 2016 plan.

Table 11-5. Change in Water User Group Needs from 2011 Plan to 2016 Plan

Water User Group	Change in Water Needs by Decade (acre-feet per year)				
	2020	2030	2040	2050	2060
Irrigation	–51,826	–288,672	–383,589	–358,165	–293,375
Livestock	11,371	11,314	3,383	1,565	1,219
Manufacturing	5,224	4,968	4,462	4,935	6,769
Mining	9,921	11,705	11,291	10,314	8,626
Municipal	–1,014	4,440	7,166	10,488	17,465
Steam-electric	7,747	6,617	3,189	4,185	5,474
Total	–18,577	–249,628	–354,098	–326,678	–253,822

There are four wholesale water providers (WWPs) in Region O:

- Canadian River Municipal Water Authority (CRMWA)
- City of Lubbock
- Mackenzie Municipal Water Authority (MMWA)
- White River Municipal Water District (WRMWD)

Table 11-6 compares the water needs or surplus for each WWP between the 2011 and 2016 regional water plans. In the 2011 plan, only the total CRMWA needs (for Regions A and O combined) are presented. The 2011 plan reported that the Region O member city supplies accounted for between 50 and 55 percent of the total CRMWA supplies over the 2011 plan's planning period. The 2011 needs for the Region O member cities were calculated by multiplying the proportion of Region O supplies by the total CRMWA needs for each decade. In the 2011 plan, CRMWA had a projected surplus from 2020 to 2060, but in the 2016 plan, CRMWA has a shortage in every decade. This is due in large part to Lake Meredith water levels rendering the lake unusable for a portion of the current planning period, as well as to growing member city shortages, especially for the City of Lubbock. In both the 2011 and 2016 plans, the City of Lubbock has a projected shortage in every decade; however, in the 2016 plan, the projected shortage is significantly increased in the later decades. Mackenzie MWA shows an order of magnitude decrease in the projected shortages from the 2011 to the 2016 plan. In 2011, White River MWD had a projected shortage in every decade, but in the 2016 plan, White River MWD is projected to meets its water demand for every decade in the planning period.

Table 11-6. Comparison of Wholesale Water Provider Water Needs from 2011 and 2016 Plans

WWP	Plan	Water Need or Surplus (acre-feet per year) [a]				
		2020	2030	2040	2050	2060
CRMWA	2011 [b]	3,102	2,966	2,925	3,083	3,281
	2016	–10,734	–20,502	–25,416	–32,431	–39,893
Lubbock	2011 [c]	–11,359	–14,327	–16,632	–20,208	–21,516
	2016	–10,387	–18,177	–22,735	–29,397	–36,242
Mackenzie MWA	2011 [c]	–2,133	–2,128	–2,098	–2,030	–1,936
	2016	–262	–284	–276	–271	–322
White River MWD	2011 [c]	–603	–686	–833	–1,050	–1,489
	2016	0	0	0	0	0

[a] Positive values indicate a surplus; negative values indicate a need.
[b] Calculated based on data from LERWPG, 2010 (used the proportion of Region O to total CRMWA supplies to calculate the proportion of Region O needs from total CRMWA needs.)
[c] LERWPG, 2010 (Table 4-23 on page 4-101)

11.2.6 Recommended and Alternative Water Management Strategies

Table 11-7 compares the recommended WMSs from the 2011 plan to those recommended in the 2016 plan.

Table 11-7. Comparison of Recommended Water Management Strategies

2011 Recommended WMSs	2016 Recommended WMSs
• Municipal water conservation • Irrigation water conservation • Local groundwater development • Lake Alan Henry Water District • Lake Alan Henry pipeline to Lubbock • Lubbock Jim Bertram Lake System expansion - Lake 7 • Lubbock North Fork diversion (operated in conjunction with Lake 7 and Post Reservoir) • Post Reservoir - delivered to Lake Alan Henry pipeline • Lubbock brackish groundwater desalination • White River MWD - reclaimed water • White River MWD - local groundwater • CRMWA - Region O - local groundwater	• Municipal conservation • Irrigation conservation (projects for all 21 Region O counties) • Local groundwater development • Potable water reuse (Farwell and Wolfforth) • Brackish groundwater desalination (Abernathy and Seminole) • Municipal water loss reduction (Lorenzo, Morton, Shallowater, and Sundown) • Aquifer storage and recovery (Lubbock) • Other surface water projects (South Garza Water Supply's Infrastructure to Serve Areas Around Lake Alan Henry; Lubbock's North Fork Scalping Operation and Lake Alan Henry Phase 2) • New major reservoir (Jim Bertram Lake 7)

Changes in the lists of recommended strategies between the two plans include:

- The 2011 plan recommended municipal conservation for 25 WUGs. In 2016, municipal conservation projects were recommended for 39 municipal WUGs, including Lubbock (Section 5.2.1).

- The 2011 plan recommended 25 local groundwater development projects, and the 2016 plan recommends 27 local groundwater development projects (24 municipal projects, plus 1 White River MWD project and 2 Lubbock projects [Bailey County Well Field capacity maintenance and South Lubbock Well Field]; Sections 5.2.3, 5.4.1, 5.4.3, and 5.6). The list of WUGs with recommended local groundwater development projects has changed, and the scopes of the projects that were included in the 2011 plan have been updated.

- The 2011 plan recommended 1 potable water reuse strategy (White River MWD). The 2016 plan recommends 3 potable water reuse strategies, for Farwell and Wolfforth (Section 5.2.4) and the City of Lubbock (Jim Bertram Lake 7; Section 5.4.6). The White River MWD water reuse project was considered not potentially feasible during the current planning round.

- The 2011 plan included a brackish groundwater desalination project for the City of Lubbock. The 2016 plan recommends 3 brackish groundwater desalination projects, for Abernathy and Seminole (Section 5.2.5) and the City of Lubbock (Brackish well field at South Water Treatment Plant; Section 5.4.4).

- The 2016 plan recommends municipal water loss reduction for 4 WUGs (Lorenzo, Morton, Shallowater, and Sundown; Section 5.2.2); this is a new strategy.

- The City of Lubbock's strategies have been refined and added to since the 2011 plan was adopted (Sections 5.4, 5.7, and 11.2.7).

- The 2011 plan did not include any alternative projects. In 2016, seven of the City of Lubbock's projects are presented as alternative strategies (Section 5.7), because they would use the same reuse water as one of the City's recommended projects (Jim Bertram Lake 7). An alternative water lease/pipeline strategy has also been added for the Hockley County-other WUG (Section 5.8).

- The 2016 plan re-evaluated water importation as a potential strategy, although it was not recommended. This strategy had been evaluated as a part of the 2001 Region O plan, but was not evaluated in the 2006 or 2011 plans.

- The Region O 2016 plan discusses the CRMWA strategies (Section 5.5), but does not include full evaluations for these strategies. The CRMWA strategies are recommended in the Region A 2016 plan.

Other than the changes to the City of Lubbock projects (Section 11.2.7), the only new strategy identified by the planning group during this planning round that has not been considered during previous planning periods was municipal water loss reduction.

11.2.7 City of Lubbock Recommended Water Management Strategies

The 2011 plan lists the following strategies as the recommended WMSs for the City of Lubbock:

- Municipal water conservation
- Lubbock North Fork diversion operation
- Lubbock brackish groundwater desalination
- Lake Alan Henry supply to Lubbock
- Jim Bertram Lake System expansion - Lake 7
- Post Reservoir

Since 2011, the City of Lubbock has added to and refined its WMSs. In February 2013, the City completed its Strategic Water Supply Plan, which identifies 16 water supply strategies (6 reuse water, 6 groundwater, and 4 surface water), in addition to municipal conservation. The assumptions and updated costs associated with these strategies are presented in Sections 5.2.1, 5.4, and 5.7. Lubbock also will receive water supply from several CRMWA strategies (conjunctive use of Roberts County Well Field [RCWF] and Lake Meredith, and expanded development of RCWF with additional transmission), which are evaluated in the Region A water plan. The 2016 Region O recommended WMSs for the City of Lubbock are as follows:

- Municipal water conservation (Section 5.2.1)
- Bailey County Well Field Capacity Maintenance (Section 5.4.1)
- Canadian River Municipal Water Authority Aquifer Storage and Recovery (Section 5.4.2)
- South Lubbock Well Field (Section 5.4.3)

- Brackish Well Field at South Water Treatment Plant (Section 5.4.4)
- Lake Alan Henry Phase 2 (Section 5.4.5)
- Jim Bertram Lake 7 (Section 5.4.6)
- North Fork Scalping Operation (Section 5.4.7)

The 2016 Region O alternative WMSs for the City of Lubbock are as follows:

- Direct Potable Reuse to South Water Treatment Plant (Section 5.7.1)
- Direct Potable Reuse to North Water Treatment Plant (Section 5.7.2)
- North Fork Diversion at County Road 7300 (Section 5.7.3)
- South Fork Discharge (Section 5.7.4)
- North Fork Diversion to Lake Alan Henry Pump Station (Section 5.7.5)
- Reclaimed Water to Aquifer Storage and Recovery (Section 5.7.6)
- Post Reservoir (Section 5.7.7)

For each City of Lubbock WMS presented in the 2011 and 2016 plans, Table 11-8 shows the projected quantity of available water, total capital costs for the strategy, and unit cost of water per acre-foot. The differences between the 6 water supply strategies (5 infrastructure projects and municipal conservation) presented in both the 2011 and 2016 plans are discussed in the following subsections.

11.2.7.1 Municipal Conservation

In the 2011 plan, municipal water conservation was a recommended strategy for all cities that had a shortage during any given decade in the planning period and a per capita use higher than 172 gallons per person per day (gpcd), the year 2000 region-wide average per capita water use. The plan estimated Lubbock's per capita use in 2010 as 205 gpcd and projected it falling to 195 gpcd in 2060. Water savings for plumbing fixture and clothes washer retrofits were applied first, and if additional municipal water savings were needed (as is the case for the City of Lubbock), then savings from irrigation conservation were applied.

Table 11-8. Comparison of City of Lubbock WMSs from 2011 and 2016 Plans

Strategy Type	Strategy	Quantity Available (ac-ft/yr)	Capital Cost [a] ($)	First Decade Online Unit Cost ($/ac-ft/yr)
Strategies Presented in the 2011 Region O Water Plan				
Conservation	Municipal Water Conservation	4,132-7,662	0	656
Reuse	Lubbock North Fork Diversion Operation	3,675	153,040,000	6,340
Groundwater	Lubbock Brackish Groundwater Desalination	3,360	13,167,000	720
Surface water	Lake Alan Henry Supply to Lubbock	21,880	294,329,000	1,310
	Jim Bertram Lake System Expansion - Lake 7	17,650	68,288,400	451
	Post Reservoir	25,720	110,307,000	695
Strategies Presented in the 2016 Region O Water Plan				
Conservation	Municipal Water Conservation [b]	2,287-3,382	0	600
Reuse	Direct Potable Reuse to the SWTP [c]	10,089	89,441,000	1,178
	Direct Potable Reuse to the NWTP [c]	10,089	69,458,000	872
	North Fork Diversion at CR 7300 [c]	10,089	46,378,000	629
	South Fork Discharge [c]	8,183	57,957,000	1,016
	North Fork Diversion to LAH Pump Station [c]	7,510	45,058,000	930
	Reclaimed Water to ASR [c]	8,071	90,935,000	1,377
Groundwater	Bailey County Well Field Capacity Maintenance [b]	997-3,120	25,518,000	2,028
	CRMWA ASR [b]	6,090	62,345,000	1,099
	South Lubbock Well Field [b]	2,613	53,856,000	2,516
	Brackish Well Field at SWTP [b]	1,120	34,531,740	3,671
Surface water	Lake Alan Henry Phase 2 [b]	8,000	57,799,000	911
	Jim Bertram Lake 7 [b]	13,800	82,066,000	614
	Post Reservoir [c]	10,600	93,192,000	903
	North Fork Scalping Operation [b]	7,890-10,390	119,825,000	1,342

[a] Sum of all capital costs
[b] Recommended project
[c] Alternative project

ac-ft/yr = acre feet per year

In the 2016 plan, the LERWPG has recommended municipal water conservation strategies for WUGs that (1) have a per capita use above 140 gpd, (the State of Texas Water Conservation Task Force's recommendation) regardless of needs, or (2) have a per capita use below 140 gpd and specifically mentioned a municipal water conservation strategy in their WUG survey. The

LERWPG recommends an annual reduction of no more than 0.5 percent in total per capita use, based upon a five-year rolling average, until such time as the entity achieves a total per capita use of 140 gpcd or less. Lubbock has a projected shortage beginning in 2020 that lasts throughout the planning period and a projected per capita use of 160 gpcd in 2020 falling to 151 gpcd in 2070. Section 5.2.1 lists a variety of municipal water conservation strategies with their estimated potential water savings. The City of Lubbock may choose to implement any combination of conservation strategies that will account for the needed water savings.

Table 11-9 shows the quantity of water savings due to implementation of municipal water conservation strategies as presented in the 2011 and 2016 plans for the City of Lubbock. The water savings in the 2016 plan is between 30 and 50 percent of the amount projected in the 2011 plan.

Table 11-9. Comparison of City of Lubbock Municipal Water Conservation in 2011 and 2016 Plans

Region O Water Plan	Water Savings from Conservation by Decade (acre-feet per year)				
	2020	2030	2040	2050	2060
2011	7,662	7,112	6,441	6,256	6,405
2016	2,287	2,478	2,674	2,915	3,139

11.2.7.2 North Fork Diversion

The 2011 Lubbock North Fork Diversion Operation strategy includes diversion of both stormwater flows and reclaimed water from the North Fork to the South Fork through Gobbler Creek, which naturally flows into Lake Alan Henry. It was estimated that this strategy could increase the yield of Lake Alan Henry by 26,169 ac-ft/yr by capturing 8,725 ac-ft/yr of stormwater flows and 17,444 ac-ft/yr of reclaimed water flows.

In the 2016 plan, the diversion of stormwater flows (North Fork Scalping Operation) is considered a separate strategy from the diversion of reclaimed water (North Fork Diversion to Lake Alan Henry Pump Station). The 2016 North Fork Scalping Operation is similar to the 2011 Lubbock North Fork Diversion Operation in that it is estimated to divert 8,725 ac-ft/yr of stormwater flows to Lake Alan Henry through Gobbler Creek. RPS modeled the North Fork

Scalping Operation strategy, using a modified TCEQ WAM Run 3 for the Brazos River Basin, in order to evaluate the potential firm yield that will be 100 percent reliable during the historical drought of record (the modeling assumptions are detailed in Section 5.1.1). The modeled increase in firm yield was 10,390 to 7,890 ac-ft/yr, and the modeled increase in safe yield from this strategy was 9,580 to 8,150 ac ft/yr, depending on the availability of stormwater flows (Appendix 5C).

The 2016 North Fork Diversion to Lake Alan Henry Pump Station strategy differs from the 2011 strategy in that the captured reclaimed water will be pumped directly to the Lake Alan Henry Pump Station, rather than through Gobbler Creek. Furthermore, the estimated amount of reclaimed water available from the City of Lubbock for discharge into the North Fork has been significantly decreased; instead of the 2011 estimate of 17,444 ac-ft/yr of available reclaimed water flows, the North Fork Diversion to Lake Alan Henry Pump Station strategy estimates that only 7,510 ac-ft/yr will be available for capture.

11.2.7.3 Brackish Groundwater Desalination

In the 2011 plan, this strategy includes four wells producing water from the Edwards-Trinity (High Plains) and Dockum Aquifers at an estimated total rate of 1,040 gallons per minute (gpm) combined. The well field site is to be in either Lubbock County or Bailey County on property already owned by the City of Lubbock.

In the 2016 plan, this strategy includes four wells producing water from the Dockum Aquifer (Santa Rosa Formation) at an estimated total rate of 800 gpm combined. The well field is located at the South Water Treatment Plant site.

11.2.7.4 Lake Alan Henry Phase 2

The City of Lubbock was in the process of designing the Lake Alan Henry project during the development of the 2011 plan, and the project was presented in its entirety. In the 2011 plan, the Lake Alan Henry Supply to Lubbock strategy included the construction of a 49-mile pipeline, two pump stations, and a 24-million gallon per day (mgd) water treatment plant. The firm yield of Lake Alan Henry was estimated to be 22,500 ac-ft/yr. The 2011 Plan estimated the City of Lubbock's contractual obligations of raw water from the lake to local water users to be

620 ac-ft/yr, leaving an estimated 21,880 ac-ft/yr available for annual delivery to the City of Lubbock.

The City of Lubbock subsequently chose to complete the Lake Alan Henry project in two phases:

- Lake Alan Henry Phase 1 was completed in September 2012 and can deliver 8,000 ac-ft/yr to the City with a peaking capacity of 15 mgd. Lake Alan Henry Phase 1 infrastructure includes 51 miles of pipeline, two pump stations, and a 15-mgd water treatment plant.

- Lake Alan Henry Phase 2 is the recommended strategy presented in the 2016 plan. It is designed to double the amount of water available to the City from 8,000 to 16,000 ac-ft/yr, based on HDR's 2008 2-year safe yield estimate of 16,080 ac-ft/yr. Infrastructure to be built in Phase 2 includes an additional pump station in Southland, a 15-mgd expansion of the capacity at both the LAH and Post pump stations, and a 15-mgd expansion of the South Water Treatment Plant. Initial construction of the raw water transmission pipeline included enough capacity for both Phase 1 and Phase 2, so no expansion of the pipeline is needed.

11.2.7.5 Jim Bertram Lake 7

Both the 2011 and 2016 plans propose the construction of a reservoir upstream of Buffalo Springs Lake in Lubbock County to capture the City's reclaimed water, playa lake developed water, and natural flows on the North Fork.

The 2011 plan estimated that the storage capacity of the lake would be 20,700 acre-feet with a firm yield of 17,650 ac-ft/yr. Details on the amount of the firm yield attributable to reclaimed water, playa lake developed water, and natural flows were not provided.

The City of Lubbock commissioned HDR to complete a study titled *Feasibility of Constructing the Proposed Lake 7,* which was delivered in September 2011. For the 2016 plan, the strategy was updated based on information from the HDR report. The 2016 plan proposes construction of a 774-acre reservoir capable of impounding 20,000 acre-feet. RPS modeled the Jim Bertram Lake 7 strategy, using a modified TCEQ WAM Run 3 for the Brazos River Basin, in order to evaluate the potential firm yield that will be 100 percent reliable during the historical drought of record (the modeling assumptions are detailed in Section 5.1.1). The modeled firm yield for Jim Bertram Lake 7 was 13,800 ac-ft/yr (Appendix 5C). Lubbock will operate the lake at its one-year safe yield of 11,300 ac-ft/yr (HDR, 2011).

11.2.7.6 Post Reservoir

The 2011 and 2016 plans both propose construction of a 2,280-acre reservoir in Garza County capable of impounding 57,420 acre-feet. The 2011 plan estimated that the yield of the reservoir would be 25,720 ac-ft/yr if 22.9 mgd of reclaimed water from the City of Lubbock is available for discharge into the North Fork and if Jim Bertram Lake 7 is not constructed. RPS modeled the Post Reservoir strategy, using a modified TCEQ WAM Run 3 for the Brazos River Basin, in order to evaluate the potential firm yield that will be 100 percent reliable during the historical drought of record (the modeling assumptions are detailed in Section 5.1.1). Many variables affect the firm and safe yield of Post Reservoir, including treatment of upstream return flows, sediment storage reserves, instream flow requirements, and playa lake stormwater flows. Due to the uncertainty surrounding some of these variables, the WAM predicts a range of possible yields for the reservoir. The modeled firm yield for Post Reservoir was 5,060 to 10,600 ac-ft/yr and the modeled safe yield was 4,830 to 10,600 ac-ft/yr, depending on the presence of return flows or stormwater discharges to supplement the total volume (Appendix 5C).

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Appendix 11A

Summary of WMSs Implementation

Sponsor Region	wmsSponsorEntityId	Sponsor	Recommended Water Management Strategy	DBProjectId	CapitalCost	SS2010	SS2020	SS2030	SS2040	SS2050	SS2060	Y denotes strategies with supply volumes included in other strategies	Project Description	Infrastructure Type*
O	163	ABERNATHY	Local groundwater development	62	$699,732	428	428	385	510	459	439	N	4 new wells, drilled as needed (2015, 2015, 2025, and 2042), supplying 736 ac-ft in 2060	Wells
O	163	ABERNATHY	Municipal water conservation	61	$0	50	48	43	32	28	27	N	low flow plumbing fixtures, more efficienct water-using appliances, outdoor conservation, maintenance to reduce leaks, modification of personal behavior	No Infrastructure
O	182	AMHERST	Municipal water conservation	61	$0	7	5	2	0	0	0	N	low flow plumbing fixtures, more efficienct water-using appliances, outdoor conservation, maintenance to reduce leaks, modification of personal behavior	No Infrastructure
O	192	ANTON	Local groundwater development	62	$1,145,246	569	569	512	461	415	373	N	3 new wells, drilled as needed (2006, 2006, 2015), supplying 73 ac-ft in 2060	Wells
O	192	ANTON	Municipal water conservation	61	$0	14	11	6	2	0	0	N	low flow plumbing fixtures, more efficienct water-using appliances, outdoor conservation, maintenance to reduce leaks, modification of personal behavior	No Infrastructure
O	298	BROWNFIELD	Municipal water conservation	61	$0	211	448	687	802	793	788	N	low flow plumbing fixtures, more efficienct water-using appliances, outdoor conservation, maintenance to reduce leaks, modification of personal behavior	No Infrastructure
O	20	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	CRMWA Region O local groundwater development	926	$56,574,000	0	0	15,500	14,130	12,717	11,445	N	development of a well field near the existing CRMWA aqueduct to augment the annual water allocations of Region-O CRMWA member cities	Wells
O	496	COUNTY-OTHER, GARZA	Lake Alan Henry Supply for Lake Alan Henry Water Supply Corporation	63	$7,334,502	270	270	270	270	270	270	N	pump raw water from Lake Alan Henry to treat and deliver to several developments on the north side of the lake - includes construction of a raw water intake, raw water pipeline, water treamtment plant, treated ground storage tank and treated water pipelines	Other
O	708	DENVER CITY	Local groundwater development	62	$786,894	0	0	1,283	1,154	1,039	935	N	4 new wells, drilled as needed (2021, 2023, 2025, and 2027), supplying 935 ac-ft in 2060	Wells

Summary of WMSs Implementation

Sponsor Region	wmsSponsorEntityId	Sponsor	Recommended Water Management Strategy	DBProjectId	CapitalCost	SS2010	SS2020	SS2030	SS2040	SS2050	SS2060	Y denotes strategies with supply volumes included in other strategies	Project Description	Infrastructure Type*
O	708	DENVER CITY	Municipal water conservation	61	$0	77	169	179	171	160	155	N	low flow plumbing fixtures, more efficienct water-using appliances, outdoor conservation, maintenance to reduce leaks, modification of personal behavior	No Infrastructure
O	716	DIMMITT	Local groundwater development	62	$786,894	0	446	810	729	1,070	963	N	3 new wells, drilled as needed (2019, 2021, and 2042), supplying 963 ac-ft in 2060	Wells
O	716	DIMMITT	Municipal water conservation	61	$0	75	110	97	81	75	74	N	low flow plumbing fixtures, more efficienct water-using appliances, outdoor conservation, maintenance to reduce leaks, modification of personal behavior	No Infrastructure
O	727	EARTH	Local groundwater development	62	$786,325	0	0	0	393	354	318	N	2 new wells, drilled as needed (2031 and 2034), supplying 318 ac-ft in 2060	Wells
O	727	EARTH	Municipal water conservation	61	$0	20	28	25	21	20	17	N	low flow plumbing fixtures, more efficienct water-using appliances, outdoor conservation, maintenance to reduce leaks, modification of personal behavior	No Infrastructure
O	775	FARWELL	Local groundwater development	62	$163,152	0	0	0	0	147	132	N	1 new well, drilled in 2020, supplying 107 ac-ft/yr in 2060	Wells
O	775	FARWELL	Municipal water conservation	61	$0	33	64	94	101	97	91	N	low flow plumbing fixtures, more efficienct water-using appliances, outdoor conservation, maintenance to reduce leaks, modification of personal behavior	No Infrastructure
O	818	FRIONA	Local groundwater development	62	$524,596	0	0	419	753	678	610	N	2 new wells, both drilled in 2023, supplying 610 ac-ft in 2060	Wells
O	818	FRIONA	Municipal water conservation	61	$0	46	34	20	5	0	0	N	low flow plumbing fixtures, more efficienct water-using appliances, outdoor conservation, maintenance to reduce leaks, modification of personal behavior	No Infrastructure
O	918	HART	Local groundwater development	62	$509,256	0	0	0	0	198	178	N	1 new well, drilled in 2043, supplying 178 ac-ft/yr in 2060	Wells
O	934	HEREFORD	Municipal water conservation	61	$0	302	572	649	610	596	598	N	low flow plumbing fixtures, more efficienct water-using appliances, outdoor conservation, maintenance to reduce leaks, modification of personal behavior	No Infrastructure
O	972	IDALOU	Local groundwater development	62	$770,132	0	0	0	410	369	332	N	1 new well, drilled in 2031, supplying 332 ac-ft/yr in 2060	Wells

Summary of WMSs Implementation

Sponsor Region	wmsSponsorEntityId	Sponsor	Recommended Water Management Strategy	DBProjectId	CapitalCost	SS2010	SS2020	SS2030	SS2040	SS2050	SS2060	Y denotes strategies with supply volumes included in other strategies	Project Description	Infrastructure Type*
O	987	IRRIGATION, BAILEY	Irrigation water conservation	631	$13,444,000	18,636	16,772	15,095	13,585	12,227	11,004	N	Water Conservation Task Force list of BMPs - (1) specifically focusing on low elevation spray application systems, (2) low-energy precision application systems (LEPA), (3) surge irrigation, (4) furrow diking, chiseling and deep ripping, (5) soil moisture monitoring, (6) drip irrigation, (7) irrigation scheduling, and (8) crop residue management and conservation tillage	Other
O	1001	IRRIGATION, BRISCOE	Irrigation water conservation	631	$4,730,000	6,555	5,900	5,310	4,779	4,301	3,871	N	Water Conservation Task Force list of BMPs - (1) specifically focusing on low elevation spray application systems, (2) low-energy precision application systems (LEPA), (3) surge irrigation, (4) furrow diking, chiseling and deep ripping, (5) soil moisture monitoring, (6) drip irrigation, (7) irrigation scheduling, and (8) crop residue management and conservation tillage	Other
O	1012	IRRIGATION, CASTRO	Irrigation water conservation	631	$30,490,000	42,268	38,041	34,237	30,813	27,732	24,959	N	Water Conservation Task Force list of BMPs - (1) specifically focusing on low elevation spray application systems, (2) low-energy precision application systems (LEPA), (3) surge irrigation, (4) furrow diking, chiseling and deep ripping, (5) soil moisture monitoring, (6) drip irrigation, (7) irrigation scheduling, and (8) crop residue management and conservation tillage	Other
O	1017	IRRIGATION, COCHRAN	Irrigation water conservation	631	$14,580,000	20,215	18,193	16,374	14,737	13,263	11,937	N	Water Conservation Task Force list of BMPs - (1) specifically focusing on low elevation spray application systems, (2) low-energy precision application systems (LEPA), (3) surge irrigation, (4) furrow diking, chiseling and deep ripping, (5) soil moisture monitoring, (6) drip irrigation, (7) irrigation scheduling, and (8) crop residue management and conservation tillage	Other
O	1030	IRRIGATION, CROSBY	Irrigation water conservation	631	$19,030,000	26,380	23,742	21,368	19,231	17,308	15,577	N	Water Conservation Task Force list of BMPs - (1) specifically focusing on low elevation spray application systems, (2) low-energy precision application systems (LEPA), (3) surge irrigation, (4) furrow diking, chiseling and deep ripping, (5) soil moisture monitoring, (6) drip irrigation, (7) irrigation scheduling, and (8) crop residue management and conservation tillage	Other

Summary of WMSs Implementation

Sponsor Region	wmsSponsorEntityId	Sponsor	Recommended Water Management Strategy	DBProjectId	CapitalCost	SS2010	SS2020	SS2030	SS2040	SS2050	SS2060	Y denotes strategies with supply volumes included in other strategies	Project Description	Infrastructure Type*
O	1034	IRRIGATION, DAWSON	Irrigation water conservation	631	$4,380,000	6,080	5,472	4,925	4,432	3,989	3,590	N	Water Conservation Task Force list of BMPs - (1) specifically focusing on low elevation spray application systems, (2) low-energy precision application systems (LEPA), (3) surge irrigation, (4) furrow diking, chiseling and deep ripping, (5) soil moisture monitoring, (6) drip irrigation, (7) irrigation scheduling, and (8) crop residue management and conservation tillage	Other
O	1035	IRRIGATION, DEAF SMITH	Irrigation water conservation	631	$30,470,000	42,246	38,022	34,219	30,797	27,718	24,946	N	Water Conservation Task Force list of BMPs - (1) specifically focusing on low elevation spray application systems, (2) low-energy precision application systems (LEPA), (3) surge irrigation, (4) furrow diking, chiseling and deep ripping, (5) soil moisture monitoring, (6) drip irrigation, (7) irrigation scheduling, and (8) crop residue management and conservation tillage	Other
O	1039	IRRIGATION, DICKENS	Irrigation water conservation	631	$1,300,000	1,803	1,622	1,460	1,314	1,183	1,064	N	Water Conservation Task Force list of BMPs - (1) specifically focusing on low elevation spray application systems, (2) low-energy precision application systems (LEPA), (3) surge irrigation, (4) furrow diking, chiseling and deep ripping, (5) soil moisture monitoring, (6) drip irrigation, (7) irrigation scheduling, and (8) crop residue management and conservation tillage	Other
O	1053	IRRIGATION, FLOYD	Irrigation water conservation	631	$32,220,000	44,665	40,198	36,178	32,561	29,305	26,374	N	Water Conservation Task Force list of BMPs - (1) specifically focusing on low elevation spray application systems, (2) low-energy precision application systems (LEPA), (3) surge irrigation, (4) furrow diking, chiseling and deep ripping, (5) soil moisture monitoring, (6) drip irrigation, (7) irrigation scheduling, and (8) crop residue management and conservation tillage	Other

Summary of WMSs Implementation

Sponsor Region	wmsSponsorEntityId	Sponsor	Recommended Water Management Strategy	DBProjectId	CapitalCost	SS2010	SS2020	SS2030	SS2040	SS2050	SS2060	Y denotes strategies with supply volumes included in other strategies	Project Description	Infrastructure Type*
O	1058	IRRIGATION, GAINES	Irrigation water conservation	631	$7,580,000	10,515	9,463	8,517	7,665	6,898	6,209	N	Water Conservation Task Force list of BMPs - (1) specifically focusing on low elevation spray application systems, (2) low-energy precision application systems (LEPA), (3) surge irrigation, (4) furrow diking, chiseling and deep ripping, (5) soil moisture monitoring, (6) drip irrigation, (7) irrigation scheduling, and (8) crop residue management and conservation tillage	Other
O	1060	IRRIGATION, GARZA	Irrigation water conservation	631	$3,190,000	4,428	3,985	3,587	3,228	2,905	2,615	N	Water Conservation Task Force list of BMPs - (1) specifically focusing on low elevation spray application systems, (2) low-energy precision application systems (LEPA), (3) surge irrigation, (4) furrow diking, chiseling and deep ripping, (5) soil moisture monitoring, (6) drip irrigation, (7) irrigation scheduling, and (8) crop residue management and conservation tillage	Other
O	1069	IRRIGATION, HALE	Irrigation water conservation	631	$30,570,000	42,381	38,143	34,329	30,896	27,806	25,026	N	Water Conservation Task Force list of BMPs - (1) specifically focusing on low elevation spray application systems, (2) low-energy precision application systems (LEPA), (3) surge irrigation, (4) furrow diking, chiseling and deep ripping, (5) soil moisture monitoring, (6) drip irrigation, (7) irrigation scheduling, and (8) crop residue management and conservation tillage	Other
O	1084	IRRIGATION, HOCKLEY	Irrigation water conservation	631	$20,230,000	28,053	25,247	22,723	20,450	18,405	16,565	N	Water Conservation Task Force list of BMPs - (1) specifically focusing on low elevation spray application systems, (2) low-energy precision application systems (LEPA), (3) surge irrigation, (4) furrow diking, chiseling and deep ripping, (5) soil moisture monitoring, (6) drip irrigation, (7) irrigation scheduling, and (8) crop residue management and conservation tillage	Other
O	1112	IRRIGATION, LAMB	Irrigation water conservation	631	$20,520,000	28,457	25,611	23,050	20,745	18,670	16,803	N	Water Conservation Task Force list of BMPs - (1) specifically focusing on low elevation spray application systems, (2) low-energy precision application systems (LEPA), (3) surge irrigation, (4) furrow diking, chiseling and deep ripping, (5) soil moisture monitoring, (6) drip irrigation, (7) irrigation scheduling, and (8) crop residue management and conservation tillage	Other

Summary of WMSs Implementation

Sponsor Region	wmsSponsorEntityId	Sponsor	Recommended Water Management Strategy	DBProjectId	CapitalCost	SS2010	SS2020	SS2030	SS2040	SS2050	SS2060	Y denotes strategies with supply volumes included in other strategies	Project Description	Infrastructure Type*
O	1123	IRRIGATION, LUBBOCK	Irrigation water conservation	631	$35,280,000	48,909	44,018	39,616	35,655	32,089	28,880	N	Water Conservation Task Force list of BMPs - (1) specifically focusing on low elevation spray application systems, (2) low-energy precision application systems (LEPA), (3) surge irrigation, (4) furrow diking, chiseling and deep ripping, (5) soil moisture monitoring, (6) drip irrigation, (7) irrigation scheduling, and (8) crop residue management and conservation tillage	Other
O	1124	IRRIGATION, LYNN	Irrigation water conservation	631	$8,410,000	11,660	10,494	9,445	8,500	7,650	6,885	N	Water Conservation Task Force list of BMPs - (1) specifically focusing on low elevation spray application systems, (2) low-energy precision application systems (LEPA), (3) surge irrigation, (4) furrow diking, chiseling and deep ripping, (5) soil moisture monitoring, (6) drip irrigation, (7) irrigation scheduling, and (8) crop residue management and conservation tillage	Other
O	1142	IRRIGATION, MOTLEY	Irrigation water conservation	631	$640,000	886	798	718	646	582	523	N	Water Conservation Task Force list of BMPs - (1) specifically focusing on low elevation spray application systems, (2) low-energy precision application systems (LEPA), (3) surge irrigation, (4) furrow diking, chiseling and deep ripping, (5) soil moisture monitoring, (6) drip irrigation, (7) irrigation scheduling, and (8) crop residue management and conservation tillage	Other
O	1152	IRRIGATION, PARMER	Irrigation water conservation	631	$13,790,000	19,120	17,208	15,487	13,938	12,545	11,290	N	Water Conservation Task Force list of BMPs - (1) specifically focusing on low elevation spray application systems, (2) low-energy precision application systems (LEPA), (3) surge irrigation, (4) furrow diking, chiseling and deep ripping, (5) soil moisture monitoring, (6) drip irrigation, (7) irrigation scheduling, and (8) crop residue management and conservation tillage	Other

Summary of WMSs Implementation

Sponsor Region	wmsSponsorEntityId	Sponsor	Recommended Water Management Strategy	DBProjectId	CapitalCost	SS2010	SS2020	SS2030	SS2040	SS2050	SS2060	Y denotes strategies with supply volumes included in other strategies	Project Description	Infrastructure Type*
O	1184	IRRIGATION, SWISHER	Irrigation water conservation	631	$37,880,000	52,517	47,266	42,539	38,285	34,457	31,011	N	Water Conservation Task Force list of BMPs - (1) specifically focusing on low elevation spray application systems, (2) low-energy precision application systems (LEPA), (3) surge irrigation, (4) furrow diking, chiseling and deep ripping, (5) soil moisture monitoring, (6) drip irrigation, (7) irrigation scheduling, and (8) crop residue management and conservation tillage	Other
O	1188	IRRIGATION, TERRY	Irrigation water conservation	631	$9,580,000	13,285	11,956	10,760	9,684	8,716	7,844	N	Water Conservation Task Force list of BMPs - (1) specifically focusing on low elevation spray application systems, (2) low-energy precision application systems (LEPA), (3) surge irrigation, (4) furrow diking, chiseling and deep ripping, (5) soil moisture monitoring, (6) drip irrigation, (7) irrigation scheduling, and (8) crop residue management and conservation tillage	Other
O	1215	IRRIGATION, YOAKUM	Irrigation water conservation	631	$7,510,000	10,407	9,366	8,429	7,587	6,828	6,145	N	Water Conservation Task Force list of BMPs - (1) specifically focusing on low elevation spray application systems, (2) low-energy precision application systems (LEPA), (3) surge irrigation, (4) furrow diking, chiseling and deep ripping, (5) soil moisture monitoring, (6) drip irrigation, (7) irrigation scheduling, and (8) crop residue management and conservation tillage	Other
O	1303	LAMESA	Municipal water conservation	61	$0	212	400	501	471	448	431	N	low flow plumbing fixtures, more efficienct water-using appliances, outdoor conservation, maintenance to reduce leaks, modification of personal behavior	No Infrastructure
O	1330	LITTLEFIELD	Municipal water conservation	61	$0	118	196	181	161	151	149	N	low flow plumbing fixtures, more efficienct water-using appliances, outdoor conservation, maintenance to reduce leaks, modification of personal behavior	No Infrastructure
O	1589	LOCKNEY	Local groundwater development	62	$388,302	0	0	410	369	332	299	N	1 new well, drilled in 2021, supplying 299 ac-ft/yr in 2060	Wells
O	1598	LORENZO	Local groundwater development	62	$349,250	0	0	206	185	167	150	N	1 new well, drilled in 2021, supplying 150 ac-ft/yr in 2060	Wells

Summary of WMSs Implementation

Sponsor Region	wmsSponsorEntityId	Sponsor	Recommended Water Management Strategy	DBProjectId	CapitalCost	SS2010	SS2020	SS2030	SS2040	SS2050	SS2060	Y denotes strategies with supply volumes included in other strategies	Project Description	Infrastructure Type*
O	90	LUBBOCK	Lake Alan Henry Pipeline for the City of Lubbock	64	$294,329,000	21,880	21,880	21,880	21,880	21,880	21,880	N	construction of a pipeline from Lake Alan Henry to the City of Lubbock, plus construction of pump stations and a new 24-MGD surface water treatement plant located near the southeast corner of Lubbock	Pipeline
O	90	LUBBOCK	Lubbock brackish groundwater desalination	632	$13,167,000	0	3,360	3,360	3,360	3,360	3,360	N	development of wells in the Trinity and Dockum Group of aquifers in Bailey and Lubbock counties where the City of Lubbock already owns land - developed in sets of 4 wells which will be brought on line as needed	Wells
O	90	LUBBOCK	Lubbock Jim Bertram Lake 7	633	$68,288,400	0	17,650	17,650	17,650	17,650	17,650	N	construction of an impoundment (20,700 AF storage capacity) directly upstream of Buffalo Springs Lake to use Lubbock's "developed water resources" (storm water and treated wastewater discharged in the Yellowhouse Canyon and groundwater from the LLAS) - includes construction of a pipeline, pump station, and expansion of the Lake Alan Henry treatment plant	Impoundment
O	90	LUBBOCK	Lubbock North Fork diversion operation (A)	634	$153,040,000	0	3,675	3,675	3,675	3,675	3,675	N	diversion of storm water flows (interruptible source) and reclaimed wastewater from the North Fork to Lake Alan Henry (via Gobbler Creek) to supplement its firm annual yield - includes construction of a diversion dam with a 1,000 AF capacity	Impoundment
O	90	LUBBOCK	Municipal water conservation	61	$0	4,132	7,662	7,112	6,441	6,256	6,405	N	low flow plumbing fixtures, more efficienct water-using appliances, outdoor conservation, maintenance to reduce leaks, modification of personal behavior	No Infrastructure
O	90	LUBBOCK	Post Reservoir - Delivered to Lake Alan Henry Pipeline	89	$110,307,000	0	0	25,720	25,720	25,720	25,720	N	construction of an impoundment (56,000 AF storage capacity)on the North Fork in Garza County - currently, TCEQ Certificate of Adjudication is held by White River Municipal Water District	Impoundment
O	1808	MATADOR	Municipal water conservation	61	$0	20	37	49	57	63	62	N	low flow plumbing fixtures, more efficienct water-using appliances, outdoor conservation, maintenance to reduce leaks, modification of personal behavior	No Infrastructure
O	2085	MORTON	Local groundwater development	62	$1,185,162	0	855	770	693	623	561	N	2 new wells, both drilled in 2015, supplying 561 ac-ft in 2060	Wells

Summary of WMSs Implementation

Sponsor Region	wmsSponsorEntityId	Sponsor	Recommended Water Management Strategy	DBProjectId	CapitalCost	SS2010	SS2020	SS2030	SS2040	SS2050	SS2060	Y denotes strategies with supply volumes included in other strategies	Project Description	Infrastructure Type*
O	2085	MORTON	Municipal water conservation	61	$0	41	56	48	38	34	32	N	low flow plumbing fixtures, more efficienct water-using appliances, outdoor conservation, maintenance to reduce leaks, modification of personal behavior	No Infrastructure
O	2093	MULESHOE	Municipal water conservation	61	$0	79	81	67	51	44	44	N	low flow plumbing fixtures, more efficienct water-using appliances, outdoor conservation, maintenance to reduce leaks, modification of personal behavior	No Infrastructure
O	2112	NEW DEAL	Local groundwater development	62	$547,803	0	153	153	153	153	153	N	1 new well, drilled in 2011, supplying 127 ac-ft/yr in 2060	Wells
O	2156	OLTON	Municipal water conservation	61	$0	27	17	12	3	0	0	N	low flow plumbing fixtures, more efficienct water-using appliances, outdoor conservation, maintenance to reduce leaks, modification of personal behavior	No Infrastructure
O	2194	PETERSBURG	Local groundwater development	62	$334,846	0	0	0	0	410	369	N	1 new well, drilled in 2041, supplying 369 ac-ft/yr in 2060	Wells
O	2194	PETERSBURG	Municipal water conservation	61	$0	21	24	20	16	14	14	N	low flow plumbing fixtures, more efficienct water-using appliances, outdoor conservation, maintenance to reduce leaks, modification of personal behavior	No Infrastructure
O	2206	PLAINS	Local groundwater development	62	$1,186,082	0	618	556	501	600	539	N	3 new wells, drilled as needed (2012, 2016, and 2045) supplying 539 ac-ft in 2060	Wells
O	2206	PLAINS	Municipal water conservation	61	$0	33	68	106	107	102	98	N	low flow plumbing fixtures, more efficienct water-using appliances, outdoor conservation, maintenance to reduce leaks, modification of personal behavior	No Infrastructure

Sponsor Region	wmsSponsorEntityId	Sponsor	Recommended Water Management Strategy	DBProjectId	CapitalCost	SS2010	SS2020	SS2030	SS2040	SS2050	SS2060	Y denotes strategies with supply volumes included in other strategies	Project Description	Infrastructure Type*
O	2251	RANSOM CANYON	Municipal water conservation	61	$0	35	90	162	248	325	342	N	low flow plumbing fixtures, more efficient water-using appliances, outdoor conservation, maintenance to reduce leaks, modification of personal behavior	No Infrastructure
O	2295	ROPESVILLE	Local groundwater development	62	$349,252	0	0	91	89	85	81	N	1 new well, drilled in 2021, supplying 141 ac-ft/yr in 2060	Wells
O	2344	SEMINOLE	Municipal water conservation	61	$0	178	384	588	778	938	1,035	N	low flow plumbing fixtures, more efficient water-using appliances, outdoor conservation, maintenance to reduce leaks, modification of personal behavior	No Infrastructure
O	2349	SHALLOWATER	Local groundwater development	62	$479,941	389	389	350	315	283	255	N	1 new well, drilled in 2006, supplying 255 ac-ft/yr in 2060	Wells
O	2361	SILVERTON	Local groundwater development	62	$6,171,850	128	128	123	115	111	108	N	1 new well, drilled in 2012, supplying 128 ac-ft/yr in 2060	Wells
O	2368	SMYER	Local groundwater development	62	$249,976	0	0	0	0	0	193	N	1 new well, drilled in 2051, supplying 193 ac-ft/yr in 2060	Wells
O	2394	SPUR	Municipal water conservation	61	$0	21	42	54	50	48	48	N	low flow plumbing fixtures, more efficient water-using appliances, outdoor conservation, maintenance to reduce leaks, modification of personal behavior	No Infrastructure
O	2492	SUDAN	Municipal water conservation	61	0	15	12	8	4	3	3	N	low flow plumbing fixtures, more efficient water-using appliances, outdoor conservation, maintenance to reduce leaks, modification of personal behavior	No Infrastructure
O	2496	SUNDOWN	Local groundwater development	62	948479	0	412	569	512	461	415	N	3 new wells, drilled as needed (2016, 2018, and 2023) supplying 415 ac-ft in 2060	Wells
O	2496	SUNDOWN	Municipal water conservation	61	0	24	25	19	14	11	11	N	low flow plumbing fixtures, more efficient water-using appliances, outdoor conservation, maintenance to reduce leaks, modification of personal behavior	No Infrastructure
O	2550	TULIA	Local groundwater development	62	1406624	778	778	700	630	567	510	N	2 new wells, both drilled in 2006, supplying 510 ac-ft in 2060	Wells

Summary of WMSs Implementation

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O	2550	TULIA	Municipal water conservation	61	0	18	0	0	0	0	0	N	low flow plumbing fixtures, more efficienct water-using appliances, outdoor conservation, maintenance to reduce leaks, modification of personal behavior	No Infrastructure
O	159	WHITE RIVER MWD	Local groundwater development	62	1063625	7742	7742	7742	7742	7742	7742	N	drilling of up to 8 wells within Crosby or Dickens counties on property owned or leased by the district or of one of its memeber cities, and the connection of the 8 wells to WRMWD's existing wholesale supply system	Wells
O	159	WHITE RIVER MWD	Reclaimed water - White River Municipal Water District	70	38089684	0	2240	2240	2240	2240	2240	N	construction of an RO plant at the City of Lubbock's wastewater treatment plant (WWTP) to treat purchased secondary effluent from the City of Lubbock's WWTP - treated effluent piped 41-miles to a proposed constructed wetlands which would flow into White River Lake	Other
O	2628	WILSON	Local groundwater development	62	349252	0	193	174	157	141	127	N	1 new well, drilled in 2011, supplying 127 ac-ft/yr in 2060	Wells
O	2639	WOLFFORTH	Local groundwater development	62	255698	0	0	0	0	437	393	N	1 new well, drilled in 2047, supplying 393 ac-ft/yr in 2060	Wells

Summary of WMSs Implementation

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O	163	ABERNATHY	Local groundwater development	Feasibility Study Ongoing		unknown	0	60,000	2015	No		
O	163	ABERNATHY	Municipal water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	182	AMHERST	Municipal water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	192	ANTON	Local groundwater development							No		
O	192	ANTON	Municipal water conservation							No		
O	298	BROWNFIELD	Municipal water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	20	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	CRMWA Region O local groundwater development	Not Implemented	Other					No		
O	496	COUNTY-OTHER, GARZA	Lake Alan Henry Supply for Lake Alan Henry Water Supply Corporation	Not Implemented		269	unknown	unknown		No		
O	708	DENVER CITY	Local groundwater development	Currently Operating			3,000,000	3,000,000	2012	No		

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O	708	DENVER CITY	Municipal water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	716	DIMMITT	Local groundwater development	Not Implemented	Too soon					No		
O	716	DIMMITT	Municipal water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	727	EARTH	Local groundwater development	Not Implemented	Too soon					No		
O	727	EARTH	Municipal water conservation	Not Implemented						No		
O	775	FARWELL	Local groundwater development	Under Construction		unknown	unknown	unknown		No		
O	775	FARWELL	Municipal water conservation	Not Implemented	Other					No		
O	818	FRIONA	Local groundwater development	Not Implemented	Too soon					No		
O	818	FRIONA	Municipal water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	918	HART	Local groundwater development	Not Implemented	Too soon					No		
O	934	HEREFORD	Municipal water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	972	IDALOU	Local groundwater development	Sponsor Has Taken Official Action to Initiate Project		unknown	unknown	unknown	2011	No		

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O	987	IRRIGATION, BAILEY	Irrigation water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	1001	IRRIGATION, BRISCOE	Irrigation water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	1012	IRRIGATION, CASTRO	Irrigation water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	1017	IRRIGATION, COCHRAN	Irrigation water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	1030	IRRIGATION, CROSBY	Irrigation water conservation	Currently Operating		unknown	unknown	unknown	2011	No		

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O	1034	IRRIGATION, DAWSON	Irrigation water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	1035	IRRIGATION, DEAF SMITH	Irrigation water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	1039	IRRIGATION, DICKENS	Irrigation water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	1053	IRRIGATION, FLOYD	Irrigation water conservation	Currently Operating		unknown	unknown	unknown	2011	No		

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O	1058	IRRIGATION, GAINES	Irrigation water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	1060	IRRIGATION, GARZA	Irrigation water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	1069	IRRIGATION, HALE	Irrigation water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	1084	IRRIGATION, HOCKLEY	Irrigation water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	1112	IRRIGATION, LAMB	Irrigation water conservation	Currently Operating		unknown	unknown	unknown	2011	No		

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O	1123	IRRIGATION, LUBBOCK	Irrigation water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	1124	IRRIGATION, LYNN	Irrigation water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	1142	IRRIGATION, MOTLEY	Irrigation water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	1152	IRRIGATION, PARMER	Irrigation water conservation	Currently Operating		unknown	unknown	unknown	2011	No		

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O	1184	IRRIGATION, SWISHER	Irrigation water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	1188	IRRIGATION, TERRY	Irrigation water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	1215	IRRIGATION, YOAKUM	Irrigation water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	1303	LAMESA	Municipal water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	1330	LITTLEFIELD	Municipal water conservation	Not Implemented	Other					No		
O	1589	LOCKNEY	Local groundwater development	Under Construction				1,400,000	2015	No		
O	1598	LORENZO	Local groundwater development	Not Implemented	Too soon					No		

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O	90	LUBBOCK	Lake Alan Henry Pipeline for the City of Lubbock	Currently Operating		8000	250,000,000	250,000,000	2012	Yes	16,000	315,000,000
O	90	LUBBOCK	Lubbock brackish groundwater desalination	Feasibility Study Ongoing	Too soon	1120	0	33,500,000		No		
O	90	LUBBOCK	Lubbock Jim Bertram Lake 7	Permit Application Submitted/Pending	Permit contraints	11300	400,000	88,400,000		No		
O	90	LUBBOCK	Lubbock North Fork diversion operation (A)	Not Implemented	Too soon	7510	0	52,747,000		No		
O	90	LUBBOCK	Municipal water conservation	Currently Operating					2011	No		
O	90	LUBBOCK	Post Reservoir - Delivered to Lake Alan Henry Pipeline	Not Implemented	Too soon	8962	0	99,000,000		No		
O	1808	MATADOR	Municipal water conservation							No		
O	2085	MORTON	Local groundwater development	Under Construction	Permit contraints		35,000	50,000		No		

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O	2085	MORTON	Municipal water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	2093	MULESHOE	Municipal water conservation							No		
O	2112	NEW DEAL	Local groundwater development	Not Implemented						No		
O	2156	OLTON	Municipal water conservation	Currently Operating		unknown	0	0	2013	No		
O	2194	PETERSBURG	Local groundwater development	Not Implemented	Too soon					No		
O	2194	PETERSBURG	Municipal water conservation	Currently Operating		unknown	24,000	24,000	2014	No		
O	2206	PLAINS	Local groundwater development	Sponsor Has Taken Official Action to Initiate Project	Financing	unknown	unknown	unknown	2016	No		
O	2206	PLAINS	Municipal water conservation	Currently Operating			unknown	unknown	2012	No		

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Sponsor Region	wmsSponsorEntityId	Sponsor	Recommended Water Management Strategy	At what level of Implementation is the project?*	If not implemented, why?*	Initial Volume of Water Provided (acft/yr)	Funds Expended to Date ($)	Project Cost ($) (should include development and construction costs)	Year the Project is Online?*	Is this a phased project?*	(Phased) Ultimate Volume (acft/yr)	(Phased) Ultimate Project Cost ($)
O	2251	RANSOM CANYON	Municipal water conservation	Currently Operating			unknown	unknown	2011	No		
O	2295	ROPESVILLE	Local groundwater development	Not Implemented						No		
O	2344	SEMINOLE	Municipal water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	2349	SHALLOWATER	Local groundwater development	Not Implemented						No		
O	2361	SILVERTON	Local groundwater development	Not Implemented	Financing	unknown	unknown	7,500,000		No		
O	2368	SMYER	Local groundwater development	Under Construction	Other		unknown	48,000		No		
O	2394	SPUR	Municipal water conservation	Currently Operating			unknown	unknown	2011	No		
O	2492	SUDAN	Municipal water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	2496	SUNDOWN	Local groundwater development	Not Implemented	Too soon					No		
O	2496	SUNDOWN	Municipal water conservation	Currently Operating		unknown	unknown	unknown		No		
O	2550	TULIA	Local groundwater development	Not Implemented						No		

Summary of WMSs Implementation

Sponsor Region	wmsSponsorEntityId	Sponsor	Recommended Water Management Strategy	At what level of Implementation is the project?*	If not implemented, why?*	Initial Volume of Water Provided (acft/yr)	Funds Expended to Date ($)	Project Cost ($) (should include development and construction costs)	Year the Project is Online?*	Is this a phased project?*	(Phased) Ultimate Volume (acft/yr)	(Phased) Ultimate Project Cost ($)
O	2550	TULIA	Municipal water conservation	Currently Operating		unknown	unknown	unknown	2011	No		
O	159	WHITE RIVER MWD	Local groundwater development	Currently Operating					2014	No		
O	159	WHITE RIVER MWD	Reclaimed water - White River Municipal Water District	Not Implemented	Other					No		
O	2628	WILSON	Local groundwater development	Not Implemented						No		
O	2639	WOLFFORTH	Local groundwater development	Not Implemented	Too soon					No		

Summary of WMSs Implementation

Sponsor Region	wmsSponsorEntityId	Sponsor	Recommended Water Management Strategy	Year project reaches maximum capacity?*	What is the project funding source(s)?*	Included in the 2016 Plan?*	Comments
O	163	ABERNATHY	Local groundwater development		Other	Yes	Column N - currently drilling a test well in the Santa Rosa to assess project feasibility; Column T - $60,000 is just for the test well; Column Y - unknown; Column Z - 50/50 grant with High Plains Water District; Column AA - included as a groundwater desalination project since they are planning to drill to the Dockum and will need treatment
O	163	ABERNATHY	Municipal water conservation		Unknown	Yes	Column N - DCP implemented, although have not had to enforce it, distributed rain gauges and irrigation instruction; Column R - not feasible to estimate water savings for municipal conservation. Column S and T - not feasible to estimate cost of project implementation for municipal conservation.
O	182	AMHERST	Municipal water conservation		Unknown	No	Column N - Currently in Stage 3 - mandatory - only watering on certain days - daily monitoring of water use - awareness bill inserts. Tiered water rates - adjusted every year - raised rates a lot between 2014 and 2015. (higher rates than Sudan). Rates have been very effective in reducing water waste; Column R - not feasible to estimate water savings for municipal conservation; Column S and T - not feasible to estimate cost of project implementation for municipal conservation.
O	192	ANTON	Local groundwater development		Unknown	No	Column N - AA - despite multiple attempts, unable to get in touch with the City of Anton
O	192	ANTON	Municipal water conservation		Unknown	No	Column N - AA - despite multiple attempts, unable to get in touch with the City of Anton
O	298	BROWNFIELD	Municipal water conservation		Unknown	Yes	Column N - Newspaper ads/inserts, local civic club educational presentations, TWDB conservation pamplets, tiered water rates, rate increase within the past year, water sprinkler ordinance (went into effect late 2014 or early 2015) - the purpose of the ordinance is to stop water waste - ordinance requires rain and freeze sensors, sets minimum temperature for irrigating, prohibits overwatering and runoff, requires certain sprinkler heads; Column R - not feasible to estimate water savings for municipal conservation. Column S and T - not feasible to estimate cost of project implementation for municipal conservation.
O	20	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	CRMWA Region O local groundwater development		Unknown	Yes	Column AA - groundwater development strategy for CRMWA is in 2016 Plan, but the strategy details have changed
O	496	COUNTY-OTHER, GARZA	Lake Alan Henry Supply for Lake Alan Henry Water Supply Corporation		Unknown	Yes	Column N and O - infrastructure includes raw water intake and pump station with 500,000-gcd capacity, a 0.5 mgd water treatment plan, a 1 mgd water storage tank and extension of the existing distribution pipeline to serve more communities; Column P - existing infrastructure was built in 2010, but further expansion is proposed; Column Q - unknown
O	708	DENVER CITY	Local groundwater development		Unknown	Yes	Column N - starting in 2011, the City of Denver City laid about 5 miles of pipeline to connect the existing system to 4 new water wells that were drilled at that time. Those four wells were approved for use in April, 2012. Four additional wells were drilled from late 2011 through 2012 with two approved for use in July of 2013 and two in October of 2013. Approximately ½ mile of additional pipeline was installed to tie in those wells. All of the wells pump from the Ogallala Aquifer, with the first four pumping at a rate of 150 GPM and the next four at 350-400 GPM. The total project cost for the engineering, the pipelines, the wells, two storage tanks and the electrical work was about $3 million. Column Y and Z - unknown

Summary of WMSs Implementation

Sponsor Region	wmsSponsorEntityId	Sponsor	Recommended Water Management Strategy	Year project reaches maximum capacity?*	What is the project funding source(s)?*	Included in the 2016 Plan?*	Comments
O	708	DENVER CITY	Municipal water conservation		Unknown	Yes	Column N - tiered water rates (3 yrs ago) - increased rates (2 yrs ago) - hard to say if its been successful. Hard to know exactly how much water has been saved. Stayed in voluntary restrictions - nothing mandatory - awareness of water use reduction; Column R - not feasible to estimate water savings for municipal conservation. Column S and T - not feasible to estimate cost of project implementation for municipal conservation.
O	716	DIMMITT	Local groundwater development		Unknown	Yes	
O	716	DIMMITT	Municipal water conservation		Unknown	Yes	Column N - Electronic reads on water meters and SCADA to show usage for wells - use SCADA to control booster stations accordingly. They have school water conservation program and they give out conservation kits to students. Column R - not feasible to estimate water savings for municipal conservation. Column S and T - not feasible to estimate cost of project implementation for municipal conservation.
O	727	EARTH	Local groundwater development		Unknown	No	
O	727	EARTH	Municipal water conservation		Unknown	No	Column Q - unknown
O	775	FARWELL	Local groundwater development		Unknown	No	Column N - spoke with the City's engineer and received the following information: The city is in the process of converting an agricultural well to a municipal well (the project has been started - not sure of the completion date). The city's other wells operate at 200-250 gpm - this one could potentially could go up to 350 gpm. This well is located 25-30 feet from the city's existing system - pipine is already in place to connect it to the municipal system.
O	775	FARWELL	Municipal water conservation		Unknown	Yes	Column N - spoke with the City's engineer and received the following information: low residential use in Farwell. One of the bigger water users was the school. The town gave/sold (he's not sure) a low-producing well to the school to irrigate the school field so the school is not using potable water.
O	818	FRIONA	Local groundwater development		Unknown	Yes	
O	818	FRIONA	Municipal water conservation		Unknown	Yes	Column N - drought ordinance and tiered water rates (rate structure in place prior to 2011). Column R - not feasible to estimate water savings for municipal conservation. Column S and T - not feasible to estimate cost of project implementation for municipal conservation.
O	918	HART	Local groundwater development		Unknown	No	
O	934	HEREFORD	Municipal water conservation		Unknown	Yes	Column N - public awareness about the importance of conservation- achieved through bill inserts and presentations at civic clubs. They have a DCP, but it has never been implemented. They implemented tiered water rates 5-6 years ago. Column R - not feasible to estimate water savings for municipal conservation. Column S and T - not feasible to estimate cost of project implementation for municipal conservation.
O	972	IDALOU	Local groundwater development		Unknown	Yes	

Summary of WMSs Implementation

Sponsor Region	wmsSponsorEntityId	Sponsor	Recommended Water Management Strategy	Year project reaches maximum capacity?*	What is the project funding source(s)?*	Included in the 2016 Plan?*	Comments
O	987	IRRIGATION, BAILEY	Irrigation water conservation		Self (cash)	Yes	Column R and S - a volume of water saved is difficult to quanitify for irrigation water conservation. This strategy involves numerous private landowners, not a single entity. Per the water conservation distrct for the county (High Plains UWCD), it is not feasible to quantify the prevalence of conservation practices in place. Furthermore, irrigation conservation practices typically improve the application efficiency (crop yield) rather than reduce the amount of water pumped.
O	1001	IRRIGATION, BRISCOE	Irrigation water conservation		Self (cash)	Yes	Not feasible to estimate water savings or cost of project implementation for irrigation conservation.
O	1012	IRRIGATION, CASTRO	Irrigation water conservation		Self (cash)	Yes	Column R and S - a volume of water saved is difficult to quanitify for irrigation water conservation. This strategy involves numerous private landowners, not a single entity. Per the water conservation distrct for the county (High Plains UWCD), it is not feasible to quantify the prevalence of conservation practices in place. Furthermore, irrigation conservation practices typically improve the application efficiency (crop yield) rather than reduce the amount of water pumped.
O	1017	IRRIGATION, COCHRAN	Irrigation water conservation		Self (cash)	Yes	Column R and S - a volume of water saved is difficult to quanitify for irrigation water conservation. This strategy involves numerous private landowners, not a single entity. Per the water conservation distrct for the county (High Plains UWCD), it is not feasible to quantify the prevalence of conservation practices in place. Furthermore, irrigation conservation practices typically improve the application efficiency (crop yield) rather than reduce the amount of water pumped.
O	1030	IRRIGATION, CROSBY	Irrigation water conservation		Self (cash)	Yes	Column R and S - a volume of water saved is difficult to quanitify for irrigation water conservation. This strategy involves numerous private landowners, not a single entity. Per the water conservation distrct for the county (High Plains UWCD), it is not feasible to quantify the prevalence of conservation practices in place. Furthermore, irrigation conservation practices typically improve the application efficiency (crop yield) rather than reduce the amount of water pumped.

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O	1034	IRRIGATION, DAWSON	Irrigation water conservation		Self (cash)	Yes	Column N - spoke with district manager - $1,000 per flow meter - 177 meters in Dawson County - some meters are 10-15 years old - meters only report what has been used, not saved. Water Used per Year 2005 = 17.33 inches 2006 = 20.92 inches 2007 = 11.17 inches 2005-09 average = 18.5 2008 = 21.56 inches 2009 = 21.62 inches 2010 = 13.03 inches 2011 = 24.99 inches 2012 = 17.63 inches 2010-14 average = 17.6 2013 = 18.93 inches 2014 = 13.43 inches
O	1035	IRRIGATION, DEAF SMITH	Irrigation water conservation		Self (cash)	Yes	Column R and S - a volume of water saved is difficult to quanitify for irrigation water conservation. This strategy involves numerous private landowners, not a single entity. Per the water conservation distrct for the county (High Plains UWCD), it is not feasible to quantify the prevalence of conservation practices in place. Furthermore, irrigation conservation practices typically improve the application efficiency (crop yield) rather than reduce the amount of water pumped.
O	1039	IRRIGATION, DICKENS	Irrigation water conservation		Self (cash)	Yes	Not feasible to estimate water savings or cost of project implementation for irrigation conservation.
O	1053	IRRIGATION, FLOYD	Irrigation water conservation		Self (cash)	Yes	Column R and S - a volume of water saved is difficult to quanitify for irrigation water conservation. This strategy involves numerous private landowners, not a single entity. Per the water conservation distrct for the county (High Plains UWCD), it is not feasible to quantify the prevalence of conservation practices in place. Furthermore, irrigation conservation practices typically improve the application efficiency (crop yield) rather than reduce the amount of water pumped.

Summary of WMSs Implementation

Sponsor Region	wmsSponsorEntityId	Sponsor	Recommended Water Management Strategy	Year project reaches maximum capacity?*	What is the project funding source(s)?*	Included in the 2016 Plan?*	Comments
O	1058	IRRIGATION, GAINES	Irrigation water conservation		Self (cash)	Yes	Column N - spoke with district manager - They do not have a specific number for cost or water savings. Since 2011, Gaines county has not gone over their DFC (-1.45 ft/yr averaged over 5 years). Averaged -1.20 per year since 2011. Main way that they are conserving: Irrigating less land (although planting winter crop instead which may possibly cancel out some of the water savings). No way to determine cost.
O	1060	IRRIGATION, GARZA	Irrigation water conservation		Self (cash)	Yes	Column N - spoke with district manager - no idea as to the amount of water saved or the cost of implementing conservation measures. Water levels are measured annually in January, but there is considerable variation in the levels (depending mainly on precipitation). The DFCs for the county - cannot fall more than 40 feet in 50 years (an average of roughly 8/10 inches every year). This is measured every 5 years (Mr. Wheeler did not say what the last measurement was).
O	1069	IRRIGATION, HALE	Irrigation water conservation		Self (cash)	Yes	Column R and S - a volume of water saved is difficult to quanitify for irrigation water conservation. This strategy involves numerous private landowners, not a single entity. Per the water conservation distrct for the county (High Plains UWCD), it is not feasible to quantify the prevalence of conservation practices in place. Furthermore, irrigation conservation practices typically improve the application efficiency (crop yield) rather than reduce the amount of water pumped.
O	1084	IRRIGATION, HOCKLEY	Irrigation water conservation		Self (cash)	Yes	Column R and S - a volume of water saved is difficult to quanitify for irrigation water conservation. This strategy involves numerous private landowners, not a single entity. Per the water conservation distrct for the county (High Plains UWCD), it is not feasible to quantify the prevalence of conservation practices in place. Furthermore, irrigation conservation practices typically improve the application efficiency (crop yield) rather than reduce the amount of water pumped.
O	1112	IRRIGATION, LAMB	Irrigation water conservation		Self (cash)	Yes	Column R and S - a volume of water saved is difficult to quanitify for irrigation water conservation. This strategy involves numerous private landowners, not a single entity. Per the water conservation distrct for the county (High Plains UWCD), it is not feasible to quantify the prevalence of conservation practices in place. Furthermore, irrigation conservation practices typically improve the application efficiency (crop yield) rather than reduce the amount of water pumped.

Summary of WMSs Implementation

Sponsor Region	wmsSponsorEntityId	Sponsor	Recommended Water Management Strategy	Year project reaches maximum capacity?*	What is the project funding source(s)?*	Included in the 2016 Plan?*	Comments
O	1123	IRRIGATION, LUBBOCK	Irrigation water conservation		Self (cash)	Yes	Column R and S - a volume of water saved is difficult to quanitify for irrigation water conservation. This strategy involves numerous private landowners, not a single entity. Per the water conservation distrct for the county (High Plains UWCD), it is not feasible to quantify the prevalence of conservation practices in place. Furthermore, irrigation conservation practices typically improve the application efficiency (crop yield) rather than reduce the amount of water pumped.
O	1124	IRRIGATION, LYNN	Irrigation water conservation		Self (cash)	Yes	Column R and S - a volume of water saved is difficult to quanitify for irrigation water conservation. This strategy involves numerous private landowners, not a single entity. Per the water conservation distrct for the county (High Plains UWCD), it is not feasible to quantify the prevalence of conservation practices in place. Furthermore, irrigation conservation practices typically improve the application efficiency (crop yield) rather than reduce the amount of water pumped.
O	1142	IRRIGATION, MOTLEY	Irrigation water conservation		Self (cash)	Yes	Column N - main forms of irrigation conservation in Motley County: 1. Convert existing side roll sprinklers to circular pivot system 2. Replace furrow /row water practices with circular pivot systems; Note that irrigation is limited in Motley County. There are a few hundred acres on the western county line that produce water from the Ogallala. There are small areas near the south county line producing from the Dockum aquifer. Approximately 3000 acres in the Northwest Corner of the county produce water from Seymour Aquifer Pod # 3. Column R - per Gateway WCD, the amount of water provided/saved: 1. Unable to quantify. Application efficiency savings are probably offset by increased acreage irrigated with the more efficient systems. 2. Some savings are probably realized from the change from row /furrow irrigation. Only small areas along the western county boundary are suitable for the row/furrow irrigation, so application (and therefore savings) is limited; Column S and T - project cost is difficult to quantify for irrigation conservation projects. Per Gateway UWCD, a new quarter mile pivot system costs approximately $100,000. Used systems are available starting at approximately $60,000. Well construction cost, if required, is additional and location dependent.
O	1152	IRRIGATION, PARMER	Irrigation water conservation		Self (cash)	Yes	Column R and S - a volume of water saved is difficult to quanitify for irrigation water conservation. This strategy involves numerous private landowners, not a single entity. Per the water conservation distrct for the county (High Plains UWCD), it is not feasible to quantify the prevalence of conservation practices in place. Furthermore, irrigation conservation practices typically improve the application efficiency (crop yield) rather than reduce the amount of water pumped.

Summary of WMSs Implementation

Sponsor Region	wmsSponsorEntityId	Sponsor	Recommended Water Management Strategy	Year project reaches maximum capacity?*	What is the project funding source(s)?*	Included in the 2016 Plan?*	Comments
O	1184	IRRIGATION, SWISHER	Irrigation water conservation		Self (cash)	Yes	Column R and S - a volume of water saved is difficult to quanitify for irrigation water conservation. This strategy involves numerous private landowners, not a single entity. Per the water conservation distrct for the county (High Plains UWCD), it is not feasible to quantify the prevalence of conservation practices in place. Furthermore, irrigation conservation practices typically improve the application efficiency (crop yield) rather than reduce the amount of water pumped.
O	1188	IRRIGATION, TERRY	Irrigation water conservation		Self (cash)	Yes	Column N - spoke with district manager - Since 2011, Terry county has not gone over their DFC (-1.15 ft/yr averaged over 5 years). Averaged -0.54 per year since 2011. Main way that they are conserving: Irrigating less land. No way to determine cost. Irrigation conservation efforts of South Plains UWCD: promote rain water harvesting, free flow tests on wells (test approx. 70 pivots per month - out of 1410 pivots + drip systems inthe county), publish newletters, radio shows, ag conference (annual), presentations, rain guages, web site .
O	1215	IRRIGATION, YOAKUM	Irrigation water conservation		Self (cash)	Yes	Column N - spoke with district manager - They do not have a specific number for cost or water savings. They do finance ag loans for new pivot systems. Sandy Land's DFC is set at 1.10 ft of drawdown per year. The average drawdown from 2011-2015 is -.94 feet.
O	1303	LAMESA	Municipal water conservation		Self (cash)	Yes	Column N - Lamesa has a Conservation plan. They do community programs for adult water awareness (i.e. Kiwanis, Rotary club, programs for senior citizens). This has been going on for several years. They also have water conservation brochures available for customers at city hall. Mr. Garza does not know how much water has been saved based on these programs. He said the city saves 15 million gallons a year through non-potable reuse. Use non-potable water for irrigation. Column R - not feasible to estimate water savings for municipal conservation. Column S and T - not feasible to estimate cost of project implementation for municipal conservation.
O	1330	LITTLEFIELD	Municipal water conservation		Unknown	No	
O	1589	LOCKNEY	Local groundwater development		Other	Yes	Column N - 2 Ogallala wells - depth 400 feet - project includes 1,800 foot of pipe to connect wells to the existing distribution system; Column R - yield is 260 gpm for one well and 150 gpm for the other - total project cost is $1.4, includes land acquisition; Column Z - $350,000 grant with the TDA, $350,000 from the county, and a cerificate of obligation for $700,000
O	1598	LORENZO	Local groundwater development		Unknown	No	

Summary of WMSs Implementation

Sponsor Region	wmsSponsorEntityId	Sponsor	Recommended Water Management Strategy	Year project reaches maximum capacity?*	What is the project funding source(s)?*	Included in the 2016 Plan?*	Comments
O	90	LUBBOCK	Lake Alan Henry Pipeline for the City of Lubbock	2020	Local (market issue)	Yes	Strategy is in 2016 Plan, but has been modified. Column P - Phase 1 is 'currently operating' and Phase 2 is in the 'acquistion and design' stage
O	90	LUBBOCK	Lubbock brackish groundwater desalination		Local (market issue)	Yes	Strategy is in 2016 Plan, but has been modified
O	90	LUBBOCK	Lubbock Jim Bertram Lake 7		Local (market issue)	Yes	Strategy is in 2016 Plan, but has been modified
O	90	LUBBOCK	Lubbock North Fork diversion operation (A)		Local (market issue)	Yes	Strategy is in 2016 Plan, but has been modified
O	90	LUBBOCK	Municipal water conservation		Unknown	Yes	Column R - not feasible to estimate water savings for municipal conservation. Column S and T - not feasible to estimate cost of project implementation for municipal conservation.
O	90	LUBBOCK	Post Reservoir - Delivered to Lake Alan Henry Pipeline		Local (market issue)	Yes	Strategy is in 2016 Plan, but has been modified
O	1808	MATADOR	Municipal water conservation		Unknown	Yes	Column N - DCP was in effect - asked customers to cut back - voluntary at first - then implemented conservation water rates. That helped. Roughly in effect for 1 year - ended this spring (not sure on the timing). Column R - not feasible to estimate water savings for municipal conservation. Column S and T - not feasible to estimate cost of project implementation for municipal conservation.
O	2085	MORTON	Local groundwater development		Unknown	Yes	Column N - drilled 1 Ogallala well - depth 297 feet; Column P and Q - they are still waiting on TCEQ to approve it so that it can be used; Column R - yield is 390 gpm; Column U - well completed on 11-7-2013

Summary of WMSs Implementation

Sponsor Region	wmsSponsorEntityId	Sponsor	Recommended Water Management Strategy	Year project reaches maximum capacity?*	What is the project funding source(s)?*	Included in the 2016 Plan?*	Comments
O	2085	MORTON	Municipal water conservation		Unknown	Yes	Column N - encouraging citizens to water on irrigation schedule outlined in their DCP (voluntary). Mayor addresses senior citizens occassionally about water conservation. They have posted conservation information in City Hall. They increased their water rates in 2013 - they have tiered water rates (tiered prior to 2011). Column R - not feasible to estimate water savings for municipal conservation; Column S and T - not feasible to estimate cost of project implementation for municipal conservation.
O	2093	MULESHOE	Municipal water conservation		Unknown	Yes	Column N - Muleshoe increased their water rates in 2012 and 2014 to encourage conservation. Muleshoe also has conservation brochures available at the counter of bill pay centers; Column R - not feasible to estimate water savings for municipal conservation. However, the City reported that higher water rates have resulted in lower water sales. In 2015, revenues were down 20-25% - but there was a lot of rain in 2015. To put this in perspective, the City of Muleshoe's water sales numbers for 2011-2015 (September estimated) are as follows: 2010-2011 – $302,701,000, 2011-2012– $287,012,000, 2012-2013 – $260,807,000, 2013-2014 – $237,027,000, 2014-2015 – $202,372,000. Total water sales from 2010-2011 to 2014-2015 decreased by -33.14%; Column S and T - not feasible to estimate cost of project implementation for municipal conservation.
O	2112	NEW DEAL	Local groundwater development		Unknown	No	Column Q - unknown - although the City reported that they do not have any immediate plans to drill additional wells
O	2156	OLTON	Municipal water conservation		Unknown	No	Column N - Olton has raised water rates and has found that to be very effective. Tiered rates were implemented on 1-8-13. Olton has also recently made an administrative change that requires landlords (property owners) to have the water account in their name - not in the renters name. This encourages landlords to properly fix leaks in a timely manner. It has also greatly reduced the number of unpaid water bills (tenants with high bills would simply leave town - now the bill is the responsibility of the landowner and the city can put a lien on the property if necessary). This has been in place for roughly a year. Column R - the city estimates that implementing these conservation practices has resulted in water savings of 35-40% on an annual basis (mostly from tiered rates).
O	2194	PETERSBURG	Local groundwater development		Unknown	No	
O	2194	PETERSBURG	Municipal water conservation		Unknown	Yes	Column N - updated their DCP and they monitor water usage - not currently in a drought phase. Received a grant for a wood chipper - chipped wood all winter - sent our fliers about the water conservation benefits of mulching. Held a demonstration on how to mulch - encourage use for gardens and garden paths - mulch is free for customers; Column R - not feasible to estimate water savings for municipal conservation - city reported that they did not know the amount of mulch used or the volume of water saved; Column S, T, and Z - recently completed the grant. They provided labor and equippment. Calculated this and counted it towards grant ($46000 for chipper) - 50% matching grant. Petersberg paid $24,000.
O	2206	PLAINS	Local groundwater development		Unknown	Yes	Column N - hoping to drill at least 1 new well by 2016 in the City's existing well field - dependent on funding; Column S and T - project scope and cost dependent on grant money received
O	2206	PLAINS	Municipal water conservation		Unknown	Yes	Column N - implemented a residential irrigation schedule in 2012 (even addresses water on M-W-F and odd addresses water on T-Th-Sat. Column R - not feasible to estimate water savings for municipal conservation; Column S and T - not feasible to estimate cost of project implementation for municipal conservation.

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O	2251	RANSOM CANYON	Municipal water conservation		Unknown	Yes	Column N - One day a week watering - in effect for 2 years. Tiered water rates (3 tiers) - in effect for approximately 5 years. Also send out newsletters/bill inserts and put conservation messages on their website; Column R - not feasible to estimate water savings for municipal conservation; Column S and T - not feasible to estimate cost of project implementation for municipal conservation.
O	2295	ROPESVILLE	Local groundwater development		Unknown	No	Column Q - unknown - public works director is new and reported that the city would like to drill an additional well in the near ; Column AA - project is included under Hockley County-Other groundwater development
O	2344	SEMINOLE	Municipal water conservation		Unknown	Yes	Column N - Tiered water rates - their rates have doubled in the last 2 years. Rates: 1,000-20,000 = $4.00, 21,000-50,000 = $4.25, 51,00 and up = $5.00; Column R - not feasible to estimate water savings for municipal conservation; Column S and T - not feasible to estimate cost of project implementation for municipal conservation.
O	2349	SHALLOWATER	Local groundwater development		Unknown	Yes	Column Q - unknown
O	2361	SILVERTON	Local groundwater development		Unknown	Yes	Column N - City is in the process of developing a new well field - they have been in the process since 3 years ago when the city purchased land in Swisher County with 3 agricultural wells - the wells are functional but not being used because the city needs funding to connect them to the existing system - wells are located 28 miles away from the city; Column R - the city was not sure about the well yields (although he said they are 'big wells') - 2 Ogallala and 1 Santa Rosa; Column S and T - city did not disclose cost for purchasing land - the bid to connect the wells to the existing system is approximately $7,500,000
O	2368	SMYER	Local groundwater development		Unknown	No	Column N - currently in the process of drilling one new Ogallala well - 120 feet; Column Q - waiting for 'okay' from TCEQ; Column R - yield is 45 gpm - 40 foot of water depth; Column S - unknown; Column T - cost of this new well is roughly $48,000 ($24,000 to drill the well + $14,000 for the pipeline + $10,000 for electrical, etc.)
O	2394	SPUR	Municipal water conservation		Unknown	No	Column N - Spur actively does leak repair and system maintenance. They implemented their DCP - reached stage 3 (no outside watering). Now that the lake levels in White River have come up, they are no longer in any drought stages. Column R - Spur's usage in 2010 was 25.867 million gallons, and in 2014 their usage was 23.336 million gallons. City secretary contributes the water savings to Spur's conservation efforts.; Column S and T - not feasible to estimate cost of project implementation for municipal conservation.
O	2492	SUDAN	Municipal water conservation		Unknown	Yes	Column N - currently in Stage 1 - voluntary conservation - conservation flyers/bill inserts. Tiered water rates - adjusted every year. Rates have been very effective in reducing water waste; Column R - not feasible to estimate water savings for municipal conservation; Column S and T - not feasible to estimate cost of project implementation for municipal conservation.
O	2496	SUNDOWN	Local groundwater development		Unknown	Yes	
O	2496	SUNDOWN	Municipal water conservation		Unknown	Yes	Column N - Sundown has a DCP in place. They were in stage 1 earlier this year, but are no longer in any stages. When the state declares a drought, they go into stage 1 (voluntary). They adjusted their DCP within the last 2 years as their wells have aged. They also utilize conservation flyers as needed. Column R - not feasible to estimate water savings for municipal conservation; Column S and T - not feasible to estimate cost of project implementation for municipal conservation.
O	2550	TULIA	Local groundwater development		Unknown	Yes	Column Q - unknown

Summary of WMSs Implementation

Sponsor Region	wmsSponsorEntityId	Sponsor	Recommended Water Management Strategy	Year project reaches maximum capacity?*	What is the project funding source(s)?*	Included in the 2016 Plan?*	Comments
O	2550	TULIA	Municipal water conservation		Unknown	Yes	Column N - tiered rates have been in effect for more than 5 years. Advertisements on website and a few lines on the bottom of the water bill; Column R - not feasible to estimate water savings for municipal conservation; Column S and T - not feasible to estimate cost of project implementation for municipal conservation.
O	159	WHITE RIVER MWD	Local groundwater development		Unknown	No	Column R - yield is 150 gpm; Column S and T - White River MWD had a different manager when this project was implemented. The current manager is unsure of the exact cost, but guess that the entire project (well, SCADA, electrical, etc.) was between $250,000-$350,000.
O	159	WHITE RIVER MWD	Reclaimed water - White River Municipal Water District		Unknown	No	
O	2628	WILSON	Local groundwater development		Unknown	No	Column Q - unknown
O	2639	WOLFFORTH	Local groundwater development		Unknown	Yes	Column N and P - Planning to drill 3-5 wells in the next 5 years (2 dependent on acquisition of land). The other 3 wells are located further from the city and will require construction of a 5-mile pipeline to connect them to the existing system. All Ogallala wells - approximately 200 feet deep with a yield of 150 gpm.