HDR | ONE COMPANY *Many Solutions*℠

Technical Memo

To: Mark Pearson	
From: Peter Newell	Project: HOTETC Water Needs and Strategies
CC: David Dunn	
Date: 3/21/2014	Job No: 221724

Re: Heart of Texas Efficient Towns and Communities Water Needs and Strategies

Background

Heart of Texas Efficient Towns and Communities (HOTETC) is a consortium of communities from five counties currently implementing a Sustainable Communities Planning Grant administered by the Heart of Texas Council of Governments (HOTCOG). The HOTETC requested HDR Engineering, Inc. (HDR) to review existing regional water planning information, evaluate water needs and identify potential strategies for specific community water systems in Bosque, Hill, Limestone, Freestone and Falls counties.

This technical memorandum presents information gathered from the Brazos G and Region C planning data (2011 and 2016 plans), survey data and a November 22, 2013 workshop.

Objectives of the study are to:

- Identify water management strategies, including planned supplies, redundancies, possible local and regional solutions, drought resiliency and management, and conservation opportunities.
- Identify possible regional clusters as reasonable candidates to pursue regional water facility planning, and provide appropriate information that would support development of TWDB Regional Facility Planning Grant applications for Dec. 2013 cycle.
- Coordinate strategies with regional planning groups for the 2016 Brazos G and/or Region C Water Supply Plans by providing a letter to each planning group describing the water management strategies identified that the participants desire to be included in the regional plans.

Projection Methodology

Population

HOTETC identified 35 cities and utilities as participants of this study. Twenty of these entities are included as Water User Groups (WUGs) in either Brazos G or Region C and have TWDB-developed population and water demand projections. A municipal WUG is identified as a city or census designated place with a 2010 population greater than 500 or a water utility with municipal use greater than 280 acre-feet per year (acft/yr).

Population projections for the study participants that fell below the TWDB WUG definition were developed by allocating growth associated with TWDB "County-Other" projections down to these cities and towns. The 2010 census population for each city and town is utilized as the baseline population and subsequently, population projections are developed for each decadal year. The baseline population for water utilities that are not cities or towns is estimated as the number of people served by the water utility in 2012.

For each non-WUG participant, the projected "County-Other" population growth rate associated with each decade (e.g. year 2020 to year 2030) is applied in order to develop their population projections.

Demands and Supplies

Baseline per-person water use values are developed with population served and average consumption data obtained from the Texas Commission on Environmental Quality (TCEQ) Water Utility Database for most study participants. These values are expressed as Gallons Per Capita Daily (GPCD) for the year 2011. GPCD projections for study participants that are WUGs are developed from TWDB population and demand projections. The projected GPCD values for the non-WUG participants decrease over time at a rate that is proportional to the TWDB projected decreases in "County-Other" GPCD for each decade. In most instances, GPCD values for the entities evaluated are expected to decrease due to implementation of standards for water-efficient plumbing fixtures and appliances. The GPCD is held constant during the planning period for Aquilla WSC, Mount Calm, and Penelope due to the relatively low per-person water use that these entities have already achieved. In some cases, the total volume of water that the entity purchased or obtained in the year 2011as noted in their Water Use Survey is utilized to develop baseline per-person water use values.

Decadal water demands were projected for each entity by multiplying the population and GPCD projections and expressed in acre-feet per year.

Supplies for entities were identified through the regional water plans and TCEQ database research for well data and supply purchases. Water supply estimates are based on estimates of annual availability. A detailed description of surface water analysis, groundwater availability and infrastructure constraints as applied to WUGs in the Brazos G plan is located in Appendix A.

Survey

To refine the planning data, a survey was developed summarizing projected water demands, supplies, and needs for each city and town of interest. Survey participants were requested to review the information that has been collected and provide information regarding drought response measures, emergency connections, and their general concerns related to future water and infrastructure needs.

There were thirteen cities and towns that responded to the survey and provided information that is utilized to better understand future water needs and water management strategies.

Summary of Water Demands, Supplies, and Needs

Using the available information described previously, a summary is presented below by county of the total municipal and non-municipal water demands, compared to their available current water supplies and their resulting water surplus or need by decade. Appendix B includes a list of draft demands (including contractual demands) and balances for study participants. Although, non municipal needs are included in the analysis to present an overall picture of county water needs; this study does not consider how to meet those non-municipal needs.

The water surpluses or needs shown for each of the participants are developed using growth projections that are based on trends between 2000 and 2010 and do not show high growth rates. If communities begin to experience higher economic and population growth then water demands will increase and indicated water surpluses may not be adequate to meet the demand.

Bosque County

Figure 1 identifies cities, towns, and WUGs in Bosque County and their projected water balances (i.e. volumetric differences between demand and supply in acre-feet) in the year 2070. The City of Clifton provides water supply to the City of Meridian as indicated by the blue arrow on the figure.

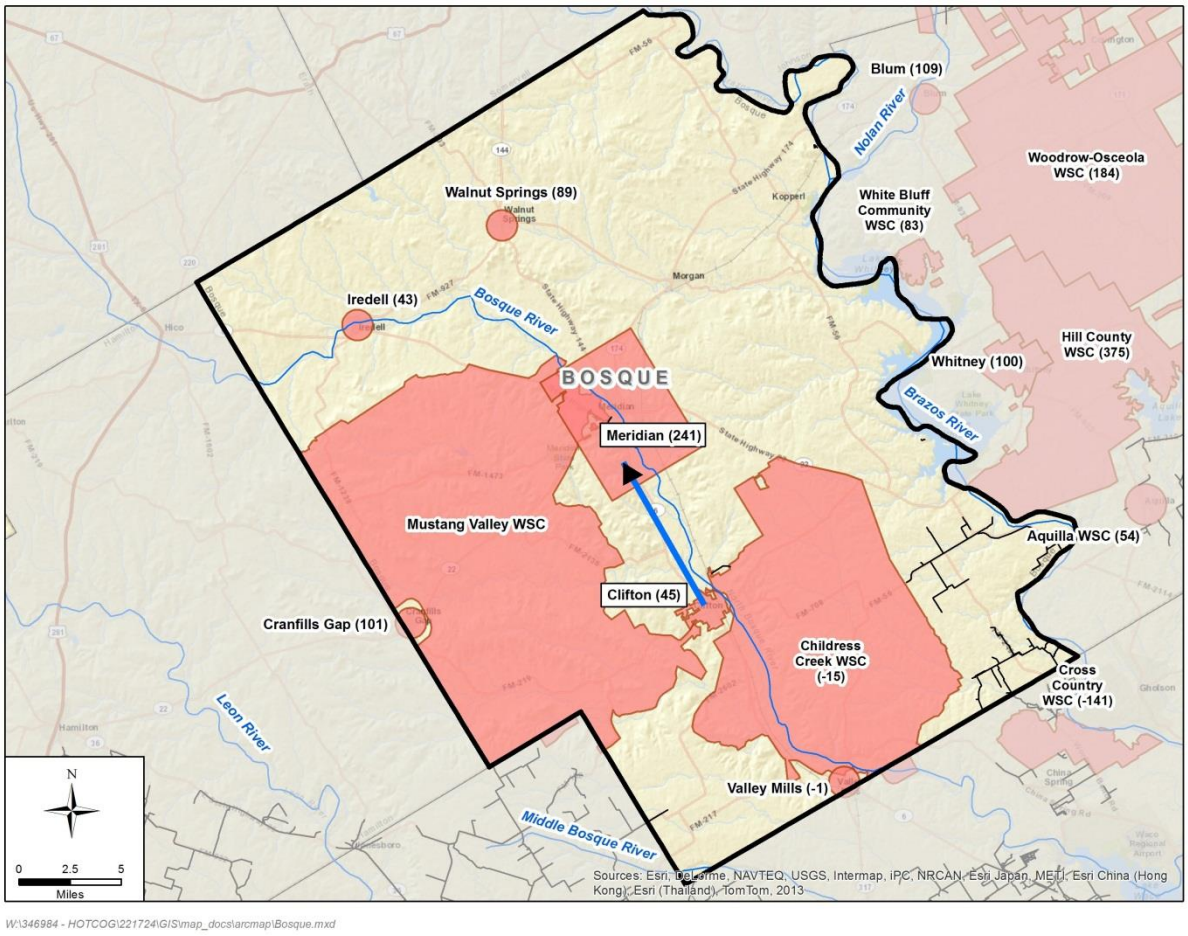

Figure 1. Bosque County Study Participants Water CCNs and 2070 Projected Water Balance (acft/yr)

Figure 2 identifies projected water demands, supplies, and needs for Bosque County from the year 2020 to the year 2070. Current supplies are estimated to be about 14,000 acft/yr with demands projected to increase from 17,202 to 26,905 acft/yr over 50 years. Total county water needs increase from 4,248 to 13,371 acft/yr, of which 157 acft represent municipal needs.

Table 1 lists each entity evaluated in Bosque County and their projected balances (i.e. difference between demand and supply) in each decade until the year 2070. Childress Creek WSC and Cross Country WSC are projected to experience water shortages by the year 2050. In addition, the City of Valley Mills may experience shortages before 2070.

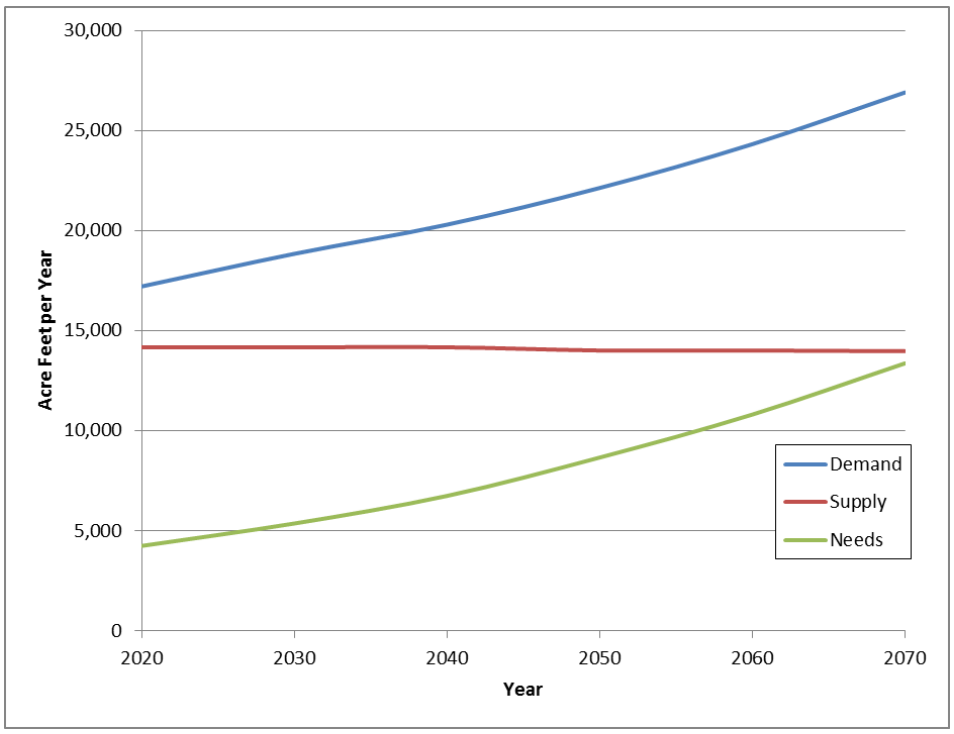

Figure 2. Bosque County Total Demand, Supply and Needs (acft/yr)

Bosque County is projected to experience water shortages associated with manufacturing, mining, and irrigation by the year 2020. Furthermore, water shortages associated with steam-electric power generation may occur by the year 2040. Some water systems relying on Trinity groundwater may require lowering pumps and/or construct deeper wells at some point in the future depending on the water level declines.

Table 1. Bosque County WUG Draft Water Balance

	DRAFT Balance (acft/yr)					
BOSQUE COUNTY WUG	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
CHILDRESS CREEK WSC	39	13	3	(4)	(10)	(15)
CLIFTON[1]	173	128	110	98	87	45
CROSS COUNTRY WSC[1]	37	29	26	(138)	(139)	(141)
MERIDIAN	265	253	249	246	243	241
VALLEY MILLS	35	18	10	6	1	(1)
WALNUT SPRINGS	98	94	93	92	90	89
City of Cranfills Gap	107	104	103	102	102	101
City of Iredell	49	46	45	44	43	43
City of Morgan	143	138	135	133	132	131
BOSQUE COUNTY-MANUFACTURING	(1,868)	(2,187)	(2,501)	(2,772)	(3,088)	(3,431)
BOSQUE COUNTY-SE	312	(735)	(2,010)	(3,565)	(5,461)	(7,714)
BOSQUE COUNTY-MINING	(1,843)	(1,942)	(1,763)	(1,743)	(1,704)	(1,692)
BOSQUE COUNTY-IRRIGATION	(536)	(502)	(468)	(438)	(407)	(377)
BOSQUE COUNTY-LIVESTOCK	0	0	0	0	0	0

1 – Groundwater supplies constrained based on Desired Future Condition (DFC) for Trinity groundwater levels. See Appendix A for more information on groundwater constraints.

Hill County

Figure 3 shows cities, towns, and WUGs in Hill County and their projected water balances in the year 2070. Brandon-Irene WSC provides water supply to the City of Bynum and Hill County WSC provides water supply to the City of Whitney.

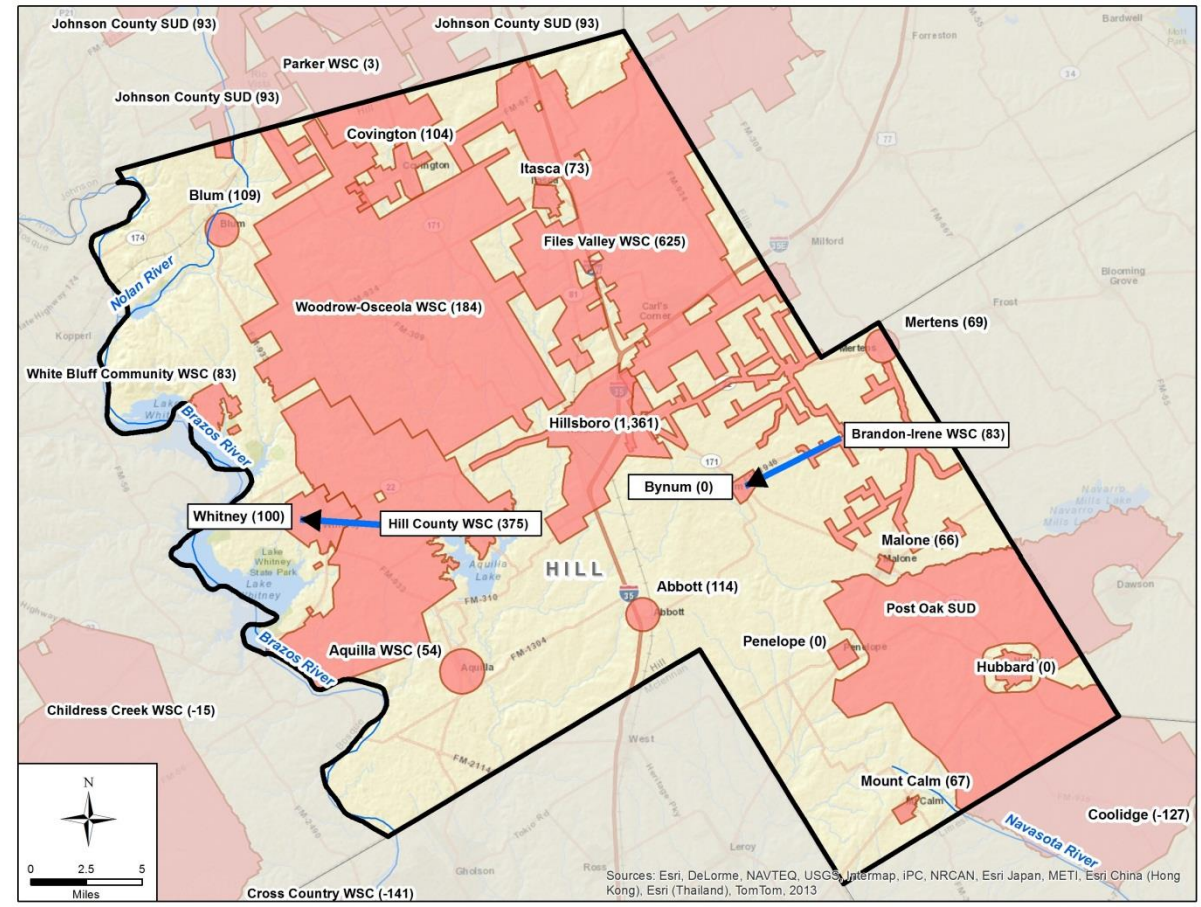

Figure 3. Hill County Study Participants Water CCNs and 2070 Projected Water Balance (acft/yr)

Figure 4 identifies projected water demands, supplies, and needs for Hill County from the year 2020 to the year 2070. Current supplies are estimated at about 12,700 acft/yr with demands projected to decrease from 9,561 to 9,300 acft/yr over the next 50 years. Total county water needs decrease from 771 to 149 acft/yr, all of which represent non-municipal needs.

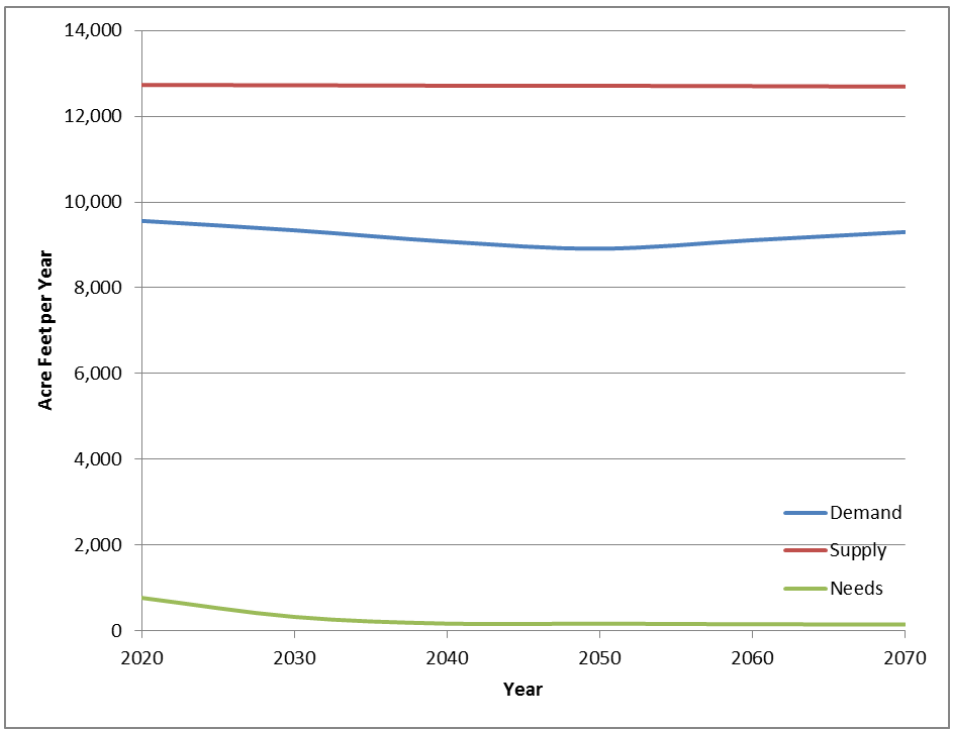

Figure 4. Hill County Total Demand, Supply and Needs (acft/yr)

Table 2 lists each entity evaluated in Hill County and their projected balances in each decade until the year 2070. Hill County is projected to experience water shortages associated with mining and irrigation by the year 2020, but no municipal needs are projected. Some water systems relying on Trinity groundwater may require lowering pumps and/or construct deeper wells at some point in the future depending on the water level declines.

Table 2. Hill County WUG Draft Water Balance

HILL COUNTY WUG	DRAFT Balance (acft/yr)					
	2020	2030	2040	2050	2060	2070
BRANDON-IRENE WSC	109	124	118	107	95	83
HILL COUNTY WSC	427	428	415	399	386	375
FILES VALLEY WSC	594	717	698	675	650	625
HILLSBORO	1,882	1,599	1,545	1,476	1,414	1,361
HUBBARD	0	0	0	0	0	0
ITASCA	85	83	83	80	76	73
JOHNSON COUNTY SUD	97	97	96	95	94	93
PARKER WSC	7	6	6	5	4	3
WHITE BLUFF COMMUNITY WS	166	142	126	109	95	83
WHITNEY	169	151	139	125	112	100
WOODROW-OSCEOLA WSC	221	220	217	203	193	184
HILL COUNTY-OTHER						
City of Abbot	124	122	120	117	115	114
Aquilla WSC	60	58	57	56	55	54
City of Blum	117	115	113	112	110	109
City of Bynum	0	0	0	0	0	0
City of Covington	113	110	108	106	105	104
City of Malone	77	74	71	69	68	66
City of Mertens	72	71	70	70	69	69
City of Mount Calm	73	71	70	69	68	67
City of Penelope	0	0	0	0	0	0
HILL COUNTY-MANUFACTURING	0	0	0	0	0	0
HILL COUNTY-SE	0	0	0	0	0	0
HILL COUNTY-MINING	(603)	(159)	256	628	595	559
HILL COUNTY-IRRIGATION	(168)	(168)	(168)	(168)	(154)	(149)
HILL COUNTY-LIVESTOCK	0	0	0	0	0	0

Limestone County

Figure 5 identifies study participants in Limestone County and their projected water balances in the year 2070. The City of Mexia provides water supply to the Cities of Wortham and Tehuacana as well as White Rock WSC. In addition, Post Oak SUD provides water to the City of Coolidge.

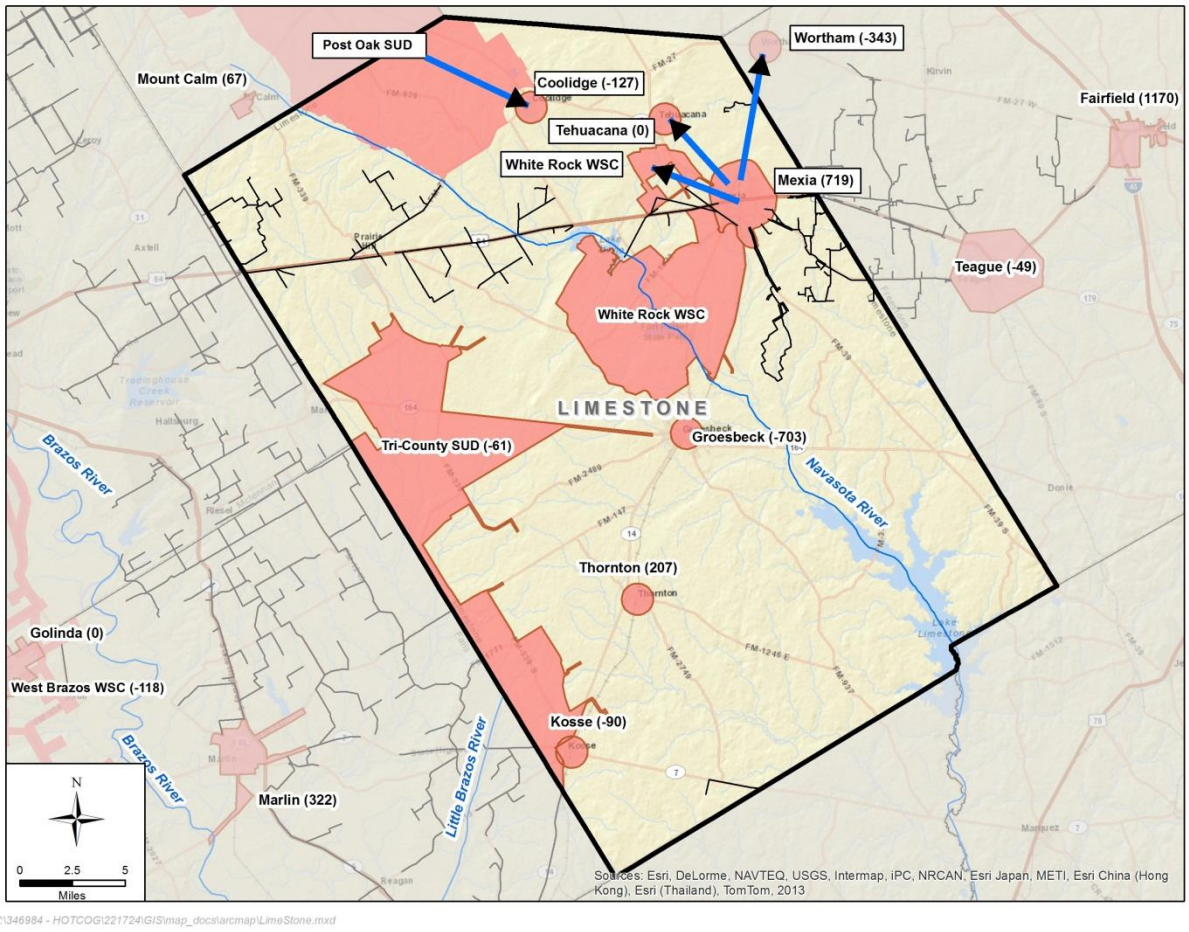

Figure 5. Limestone County Study Participants Water CCNs and 2070 Projected Water Balance (acft/yr)

Figure 6 shows projected water demands, supplies, and needs for Limestone County from the year 2020 to the year 2070. Current supplies are estimated at about 29,000 acft/yr with demands projected to increase from 38,000 to 69,000 acft/yr over 50 years. Total county water needs increase from 10,308 to 42,440 acft/yr, of which 932 acft represent municipal needs.

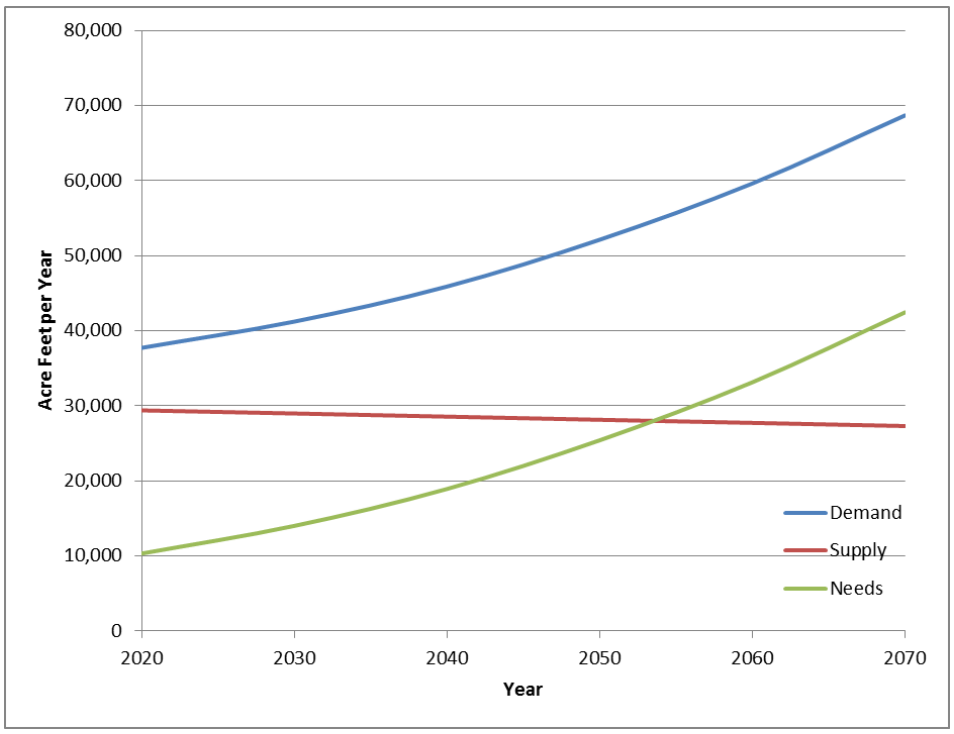

Figure 6. Limestone County Total Demand, Supply and Needs (acft/yr)

Table 3 lists each entity evaluated in Limestone County and their projected balances in decadal years until the year 2070. The Cities of Coolidge, Groesbeck, and Kosse, are projected to experience water shortages by the year 2020. In addition, Tri-County SUD and the City of Mart are projected to experience shortages by the year 2020 and 2030 respectively. Furthermore, Limestone County is projected to experience water shortages associated with mining and steam-electric power generation by the year 2020 and 2030 respectively.

Table 3. Limestone County WUG Draft Water Balance

	DRAFT Balance (acft/yr)					
LIMESTONE COUNTY WUG	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
COOLIDGE	(104)	(109)	(113)	(118)	(123)	(127)
GROESBECK	(705)	(697)	(690)	(690)	(696)	(703)
MART	0	(1)	(1)	(1)	(1)	(2)
MEXIA	1,447	1,289	1,144	992	853	719
THORNTON	202	204	206	207	207	207
TRI-COUNTY SUD[1]	(80)	(83)	(75)	(62)	(72)	(84)
City of Kosse	(80)	(83)	(85)	(87)	(89)	(90)
City of Tehuacana	0	0	0	0	0	0
LIMESTONE COUNTY-MANUFACTURING	(0)	1	(1)	(0)	1	0
LIMESTONE COUNTY-SE	78	(4,051)	(9,017)	(15,003)	(22,234)	(30,893)
LIMESTONE COUNTY-MINING	(9,508)	(9,116)	(9,056)	(9,530)	(9,996)	(10,616)
LIMESTONE COUNTY-IRRIGATION	14	14	14	14	14	14
LIMESTONE COUNTY-LIVESTOCK	0	0	0	0	0	0

[1] – includes combined shortage between Limestone and Falls Counties

Freestone County

Figure 7 identifies study participants in Freestone County and their projected water balances in the year 2070. The City of Mexia provides water supply to the City of Wortham.

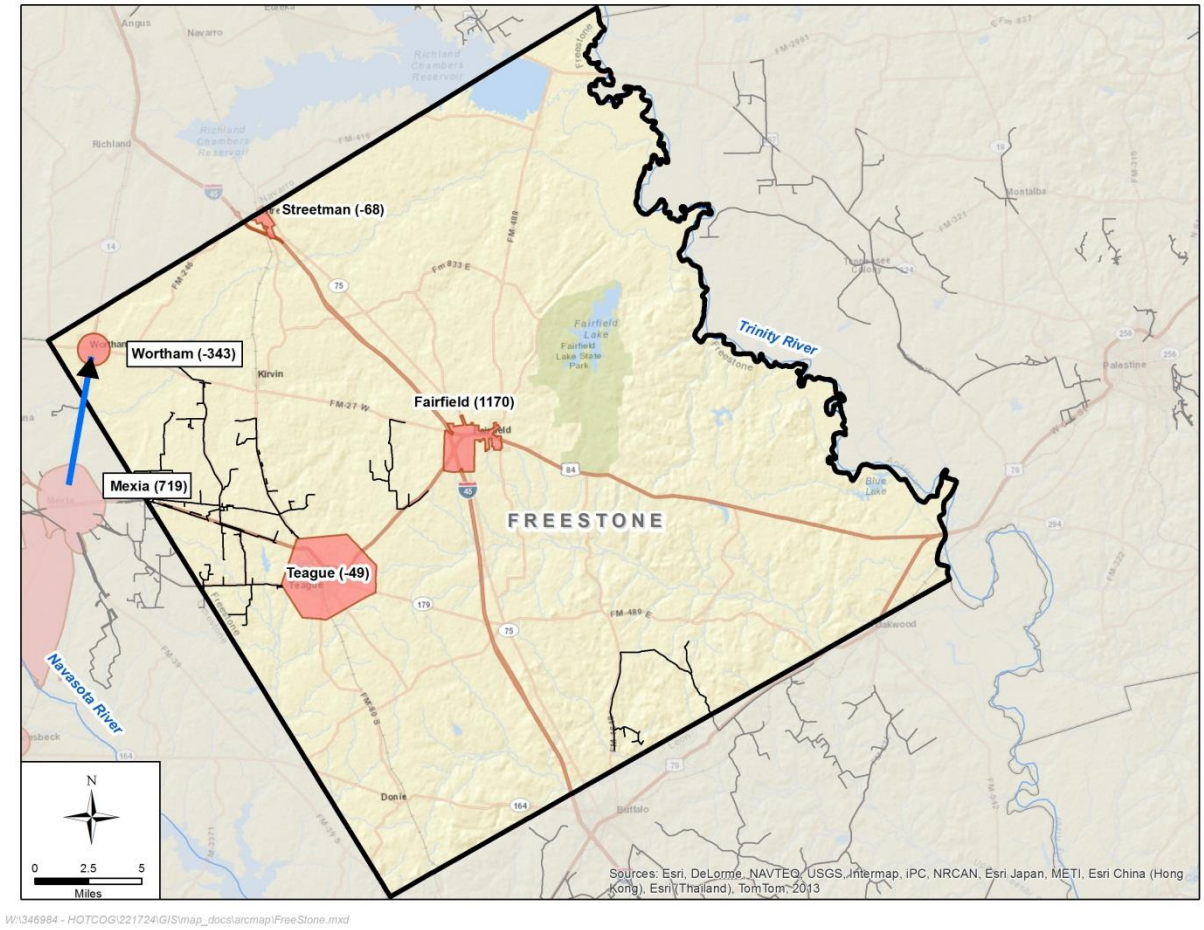

Figure 7. Freestone County Study Participants Water CCNs and 2070 Projected Water Balance (acft/yr)

Table 4 lists each entity evaluated in Freestone County and their projected balances in each decade until the year 2070. The Cities of Teague and Streetman are projected to experience water shortages by the year 2070. In addition, The City of Wortham is projected to experience shortages by the year 2020. Furthermore, Freestone County is projected to experience water shortages associated with manufacturing, mining, irrigation, and livestock by the year 2020. Water shortages associated with steam-electric power generation are projected by the year 2050.

Table 4. Freestone County WUG Draft Water Balance

FREESTONE COUNTY WUG	DRAFT Balance (acft/yr)					
	2020	2030	2040	2050	2060	2070
FAIRFIELD	2,927	2,801	2,688	1,941	1,655	1,170
FLO COMMUNITY WSC	488	487	487	486	485	485
TEAGUE	470	464	335	213	85	(49)
WORTHAM	(168)	(175)	(179)	(183)	(303)	(343)
FREESTONE COUNTY-OTHER						
City of Streetman	40	41	42	32	4	(68)
FREESTONE COUNTY-MANUFACTURING	(100)	(111)	(121)	(130)	(136)	(142)
FREESTONE COUNTY-SE	3,337	2,641	1,829	(2,531)	(8,367)	(14,579)
FREESTONE COUNTY-MINING	(5,147)	(4,915)	(5,051)	(5,086)	(5,156)	(5,382)
FREESTONE COUNTY-IRRIGATION	(173)	(173)	(173)	(173)	(173)	(173)
FREESTONE COUNTY-LIVESTOCK	(50)	(50)	(50)	(50)	(50)	(50)

Falls County

Figure 8 shows cities, towns, and WUGs in Falls County and their projected water balances in the year 2070. Central Texas WSC provides water supply to the Cities of Lott and Rosebud.

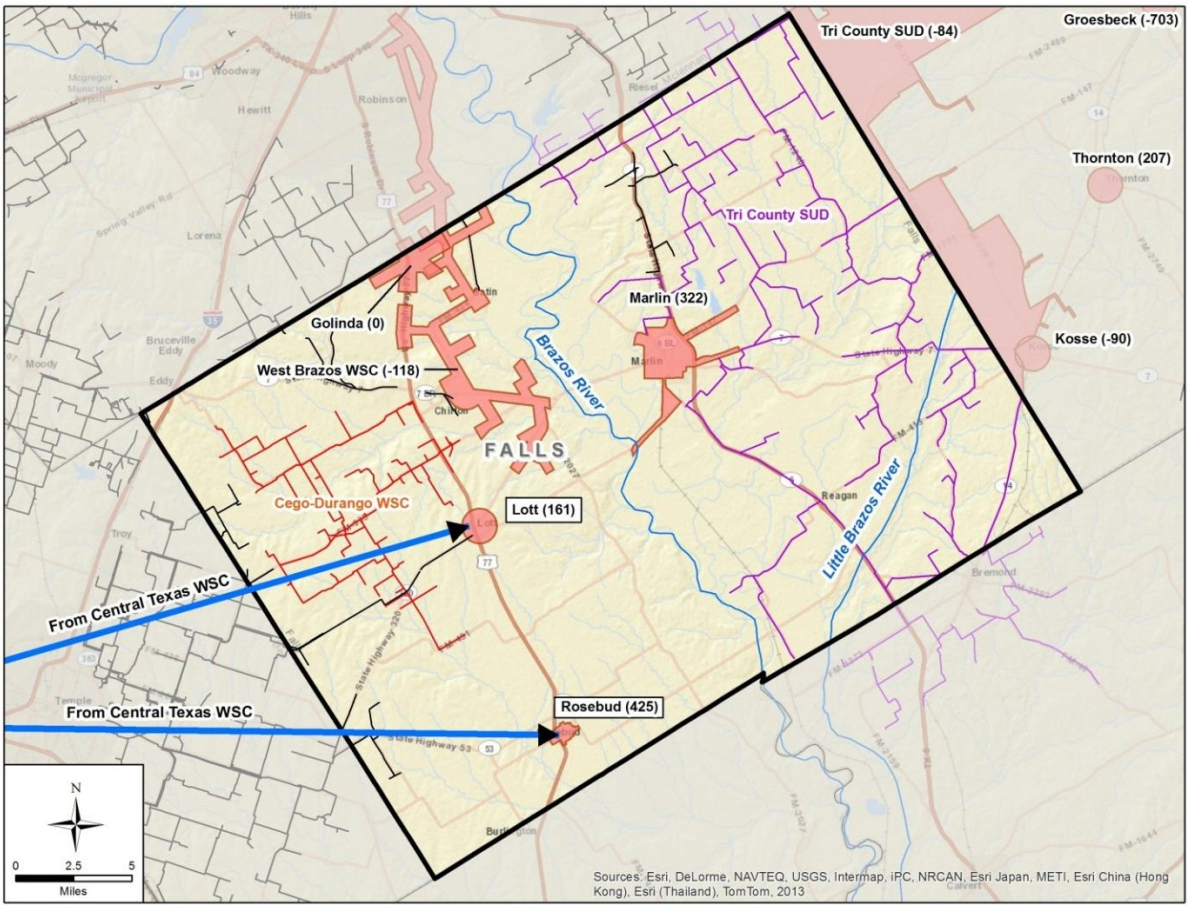

Figure 8. Falls County Study Participants Water CCNs and 2070 Projected Water Balance (acft/yr)

Figure 9 shows projected water demands, supplies, and needs for Falls County from the year 2020 to the year 2070. Current supplies are estimated at about 13,000 acft/yr with demand projected to decrease from 9,831 to 9,431 acft/yr over the next 50 years. Total county water needs increase from 393 to 512 acft/yr of which 180 acft represent municipal needs.

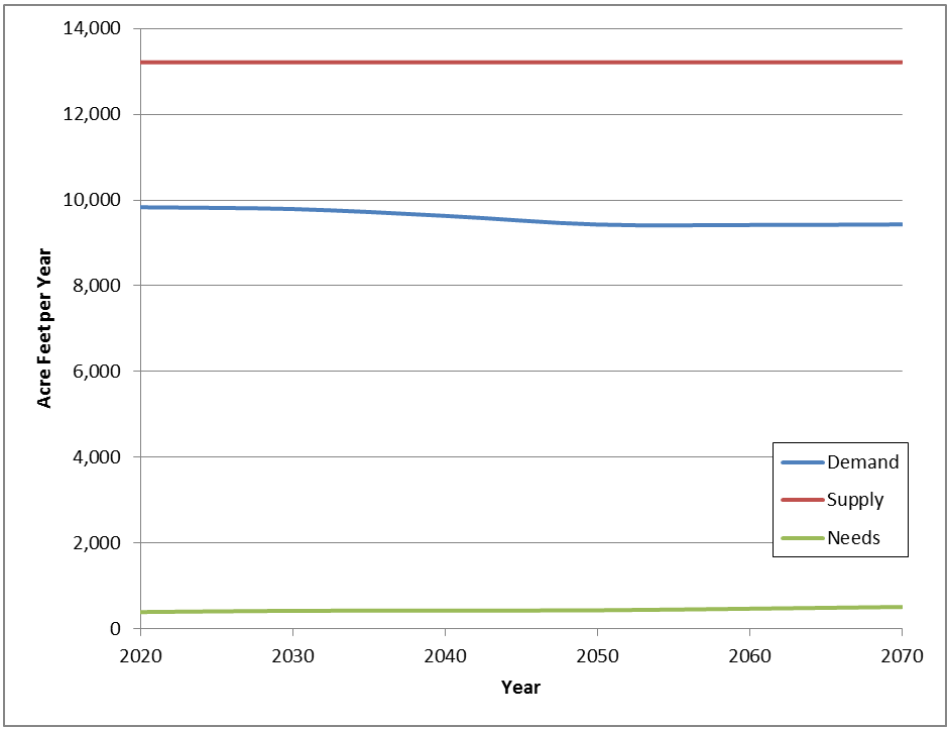

Figure 9. Falls County Total Demand, Supply and Needs (acft/yr)

Table 5 lists each entity evaluated in Falls County and their projected balances in decadal years until the year 2070. Tri-County SUD and West Brazos WSC are projected to experience water shortages by the year 2020. In addition, Falls County is projected to experience water shortages associated with manufacturing and mining by the year 2020. Some water systems relying on Trinity groundwater may require lowering pumps and/or construct deeper wells at some point in the future depending on the water level declines.

Table 5. Falls County WUG Draft Water Balance

FALLS COUNTY WUG	DRAFT Balance (acft/yr)					
	2020	2030	2040	2050	2060	2070
BELL-MILAM FALLS WSC	368	363	365	372	366	360
BRUCEVILLE-EDDY	3	3	3	3	3	3
FALLS COUNTY-OTHER	131	126	137	153	139	124
EAST BELL WSC	55	54	55	56	55	54
GOLINDA	0	0	0	0	0	0
LOTT	159	159	161	164	163	161
MARLIN	429	373	380	428	377	322
ROSEBUD	427	426	430	435	430	425
TRI-COUNTY SUD[1]	(80)	(83)	(75)	(62)	(72)	(84)
WEST BRAZOS WSC	(109)	(112)	(110)	(104)	(111)	(118)
FALLS COUNTY-MANUFACTURING	(1)	(1)	(1)	(1)	(1)	(1)
FALLS COUNTY-SE	0	0	0	0	0	0
FALLS COUNTY-MINING	(225)	(246)	(259)	(286)	(307)	(331)
FALLS COUNTY-IRRIGATION	2,204	2,342	2,478	2,607	2,733	2,847
FALLS COUNTY-LIVESTOCK	0	0	0	0	0	0

[1] – includes combined shortage between Limestone and Falls Counties

Wholesale Water Suppliers (WWP)

To consider available water supplies to study participants, projections for wholesale water providers that currently sell water to customers in the study area are summarized. Note that the shortages shown are based on full contracted supplies. Actual full use of those contracts is unlikely to occur until later years of the planning horizon and actual shortages are more likely to occur later.

Aquilla Water Supply District is located in Hill County, and obtains raw water from Lake Aquilla through a contract with the Brazos River Authority (BRA) for approximately 5,953 acft/yr. The District supplies treated water to five wholesale customers. Projected water demand in the year 2020 is 6,512 acft, resulting in a deficit of 559 acft. However, the demand associated with the City of Hillsboro is projected to decrease by 560 acft in the year 2030 resulting in a surplus of 1 acft after the year 2030.

The Central Texas Water Supply Corporation (WSC) provides water to a number of water supply corporations and cities in Bell, Williamson, Lampasas, and Falls Counties. The Central Texas WSC obtains water under contract with the BRA from Lake Stillhouse Hollow, with a total contracted supply of 10,744 acft/yr. Projected water demand through the year 2070 is 9,240 acft/yr resulting in a surplus of 1,504 acft/yr.

Bistone Municipal Water Supply District (MWSD) owns and operates Lake Mexia in Limestone County. The MWSD serves the City of Mexia and other entities in Limestone County. The District's largest customer is the City of Mexia. Other contract holders include Mexia State School, Coolidge and Whiterock WSC. While water demand projections are about 5,400 acft/yr from the year 2020 to the year 2070, water supply projections decrease from 2,823 acft/yr in the year 2020 to 2,288 acft/yr in the year

2070. Thus, water shortages of 2,582 acft/yr and 3,112 acft/yr are projected for the years 2020 and 2070, respectively.

The City of Waco water supplies come from Lake Waco and Lake Brazos and amount to 79,877 acft/yr and 5,600 acft/yr respectively. However, freshwater supply is constrained to about 50,400 acft/yr based on the existing Waco treatment plant capacity. The City of Waco also operates the Waco Metropolitan Area Regional Sewage System (WMARSS), which is projected to be a substantial source of reuse supply. A fresh water shortage of 2,341 acre-feet is projected in the year 2070.

The Brazos River Authority (BRA) is the region's largest water provider with contracts totaling nearly 700,000 acft/yr. The BRA manages the Lake Aquilla System, Little River System and the Main Stem/Lower Basin System. Supply analysis from the 2011 BGRWP indicated that full use of contracts exceeded firm supplies during the planning period.

Water Management Strategies

Based on the water needs identified in the previous section, a number of water management strategies were identified. Strategies include:

- Conservation
- Interconnections
- New or increase contract with WWP
- Groundwater development
- Bosque County Regional Project
- Lake Whitney Water Supply Project
- Groesbeck Off-Channel Reservoir
- Richland Chambers Reservoir
- Brushy Creek Reservoir

Conservation

To meet water demand for the next fifty years, utilities will have to consider a number of alternatives that may decrease demand, increase supply, and increase reliability of water supplies. Demand management could be one part of the equation, to reduce water demand by incentivizing water conservation. 2011 Brazos G Plan considered conservation for any utility that had a municipal consumption rate greater than 140 gpcd. There are 15 entities in the study area that could benefit from conservation activities. TCEQ now requires water conservation/drought contingency plans to be submitted with any new application or amendment to existing water rights. Each entity should have a plan that identifies specific, quantifiable 5- and 10-year targets for water savings.

Interconnections

Emergency/operational interconnections provide increased reliability for water systems to share supplies in emergency or non-emergency situations. The benefits of interconnections include providing reliability and backup supply during emergencies, sharing of water production capacities, and flexibility in meeting TCEQ minimum storage requirements.

An initial review of participant systems indicates that there are minimal interconnections throughout the five counties.

Wholesale Water Providers

Central Texas WSC provides supplies to Falls County and based on draft data has available supplies. Current customers include Rosebud and Lott. Tri-County SUD and West Brazos WSC may be potential customers that could meet their future needs. Other WWPs are developing strategies to firm up or augment current supplies and may be potential suppliers for future needs.

The 2011 Brazos G Plan included a strategy for West Brazos WSC to purchase supply (450 acft/yr) from the City of Waco. The project included a 23 mile 8 inch diameter pipeline to convey water between the City of Waco and The City of Chilton for a total project cost of $10.5 million and annual costs of $1.5 million.

Groundwater Development

Many of the participant water systems rely on groundwater as current and future supply. Groundwater availability as a future supply is evaluated based on the current level of pumping and the Modeled Available Groundwater (MAG). Table 7 identifies the various aquifers by county and if there is additional supply that could be available for future use. The excess or deficit is determined by comparing the MAG to the current groundwater pumping, which is the total annual pumping from active pumping potable water supply wells and an estimate of non-municipal pumping based on TWDB records. The Trinity Aquifer in Falls and Hill Counties (Trinity Basin) has current pumping that exceeds the MAG.

Needs in Bosque, Falls, Hill and Limestone County could be potentially addressed by development of groundwater supplies. Each utility would need to work with the groundwater conservation district to apply for a drilling and production permit. There has also been concern about declining Trinity groundwater levels. The Desired Future Condition (DFC) for the Trinity Aquifer as developed by the groundwater conservation districts in Groundwater Management Area 8 (GMA-8) anticipates a drawdown of 26 ft to 492 ft over the next 50 years (Table 6). Potable water supply systems that rely on wells in the Trinity Aquifer may need to lower their pumps and possibly replace wells with others completed to greater depths. Groundwater constraints have been applied to Clifton and Cross Country WSC in anticipation of the declining groundwater levels.

Table 6. Desired Future Conditions for GMA-8

	Average Drawdown over 50 yrs (ft)			
County	**Paluxy**	**Glen Rose**	**Hensell**	**Hosston**
Bosque	26	33	201	220
Falls	279	354	459	480
Hill	209	253	381	406
Limestone	328	392	475	492

Table 7. Draft Groundwater Availability by County and Aquifer (acft/yr)

County	Aquifer Name	Basin Name	MAG	Excess/(Deficit)					
			2020	2020	2030	2030	2050	2060	2070
BOSQUE	BRAZOS RIVER ALLUVIUM	BRAZOS	**830**	0	0	0	0	0	0
BOSQUE	TRINITY AQUIFER	BRAZOS	**5,849**	711	711	711	711	711	711
Bosque County Total			***6,679***	*711*	*711*	*711*	*711*	*711*	*711*
FALLS	BRAZOS RIVER ALLUVIUM	BRAZOS	**16,684**	10,353	10,353	10,353	10,353	10,353	10,353
FALLS	CARRIZO-WILCOX	BRAZOS	**867***	241	249	258	269	269	269
FALLS	TRINITY AQUIFER	BRAZOS	**169**	(1,040)	(1,040)	(1,040)	(1,040)	(1,040)	(1,040)
Falls County Total			***17,720***	*10,594*	*10,602*	*10,611*	*10,622*	*10,622*	*10,622*
FREESTONE	CARRIZO-WILCOX	TRINITY	**4,260***	(128)	(100)	(96)	(134)	(137)	(137)
FREESTONE	CARRIZO-WILCOX	BRAZOS	**885***	210	194	188	173	173	173
Freestone County Total			***5,145***	*210*	*194*	*188*	*173*	*173*	*173*
HILL	BRAZOS RIVER ALLUVIUM	BRAZOS	**632**	227	227	227	227	227	227
HILL	TRINITY AQUIFER	TRINITY	**61**	(694)	(694)	(694)	(694)	(694)	(694)
HILL	TRINITY AQUIFER	BRAZOS	**3,086**	230	230	230	230	230	230
HILL	WOODBINE AQUIFER	TRINITY	**1,012**	1,012	1,012	1,012	1,012	1,012	1,012
HILL	WOODBINE AQUIFER	BRAZOS	**1,249**	546	546	546	546	546	546
Hill County Total			***6,040***	*2,015*	*2,015*	*2,015*	*2,015*	*2,015*	*2,015*
LIMESTONE	CARRIZO-WILCOX	TRINITY	**988**	888	888	888	888	888	888
LIMESTONE	CARRIZO-WILCOX	BRAZOS	**11,306***	7,294	7,424	7,604	7,906	7,906	7,906
LIMESTONE	TRINITY AQUIFER	BRAZOS	**69**	0	0	0	0	0	0
LIMESTONE	TRINITY AQUIFER	TRINITY	**0**	0	0	0	0	0	0
LIMESTONE	WOODBINE AQUIFER	BRAZOS	**34**	34	34	34	34	34	34
LIMESTONE	WOODBINE AQUIFER	TRINITY	**0**	0	0	0	0	0	0
Limestone County Total			***12,397***	*8,216*	*8,346*	*8,526*	*8,828*	*8,828*	*8,828*

* MAG value changes by decade
(Deficits) indicate pumping beyond MAG resulting in prorated supplies to entities

Bistone MWSD is a major WWP for Limestone County entities. As mentioned previously, Bistone MWSD has contractual commitments in excess of its available supplies. Bistone MWSD has proposed to develop additional Carrizo supplies. The City of Coolidge is shown with water needs in 2070 mainly due to the limited reliability of Bistone's supplies. The 2011 Brazos G Plan describes a strategy to develop 3,600 acft/yr from eight Carrizo wells for Bistone MWSD. This project is estimated to cost $18.5 million, with an annual cost of $2 million to construct the well field, transmission system and expand the water treatment plant.

Generally local groundwater development is a favorable low-cost strategy to increase water supply if it is available and not of impaired water quality.

Regional Strategies

Considering the water shortages projected by county, a number of regional strategies have been identified. These include strategies previously identified in the regional water plans and are summarized in the following section.

Bosque County Regional Project

The Bosque County Regional Project (Figure 10) is described in the 2011 Brazos G Plan . The project envisioned the City of Clifton providing treated surface water to the cities of Meridian, Valley Mills, Walnut Springs, and Childress Creek WSC. The project would consist of expansion of the Clifton off-channel reservoir (OCR), expansion of Clifton's WTP, and treated water transmission systems to nearby utilities. The anticipated costs for the project without the expansion of the OCR was estimated at $16.4 million in the 2011 Brazos G Plan.

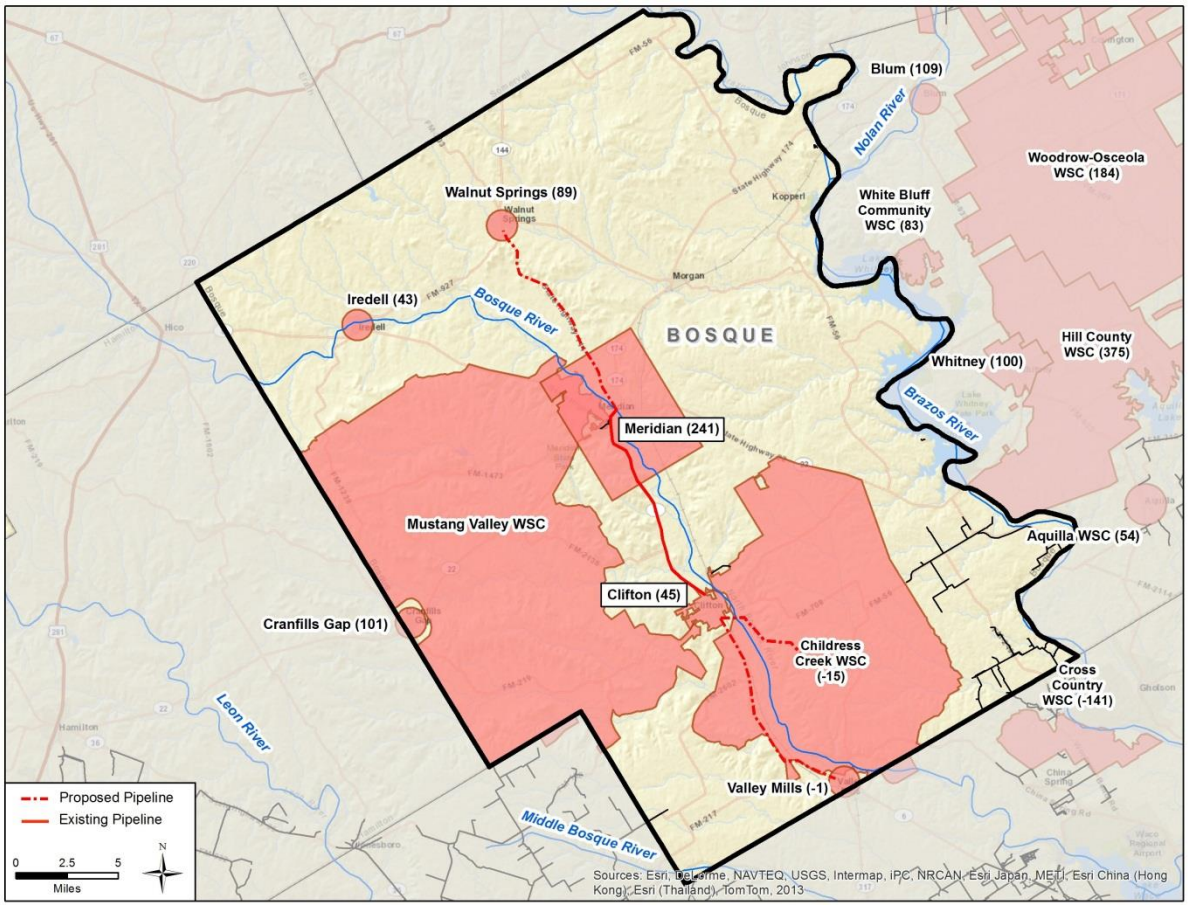

Figure 10. Bosque County Regional Project

In January 2013, HDR evaluated the costs to expand the OCR to its permitted capacity of 2,000 acft and expand the WTP capacity to 2 million gallons per day (MGD). These costs were estimated at $12.4 million. Considering that the pipeline to Meridian has been constructed and in light of the updated expansion costs, the remaining project costs would be $24.6 million. An alternative estimate was developed for increasing the OCR to 1,150 acft and treatment capacity to 2 MGD that totals $7.26 million.

Lake Whitney Water Supply Project

The City of Cleburne has developed the 1.9 MGD Phase I Lake Whitney Water Supply Project, which required a deep water intake, diversion pump station to take water out of Lake Whitney, an advanced water treatment facility for the Lake Whitney water, a booster pump station, and a pipeline to connect the Lake Whitney supply to the existing Barkman Pipeline for delivery to Cleburne.

The City of Whitney is participating in this project and there may be a possibility for other entities to participate in future phases of this project. Phase I of the project developed 2,128 acft/yr of treated supply and was estimated to cost $41.5 million. Future phases could develop up to 7,572 acft/yr for an additional $110.8 million.

Groesbeck Off-Channel Reservoir

The City of Groesbeck has surface water rights to 2,500 acft/yr from the Navasota River with a back up supply from Springfield Lake when flows in the river are not adequate to divert. However, Springfield Lake does not hold adequate supply for the City's need. Water availability modeling performed recently for Brazos G indicates that the minimum monthly diversion from the Navasota River and Springfield Lake are zero during extended drought periods. The City has taken emergency measures to provide water supply during the most recent drought by purchasing a nearby quarry. As a long term solution to firm up the water rights, the Groesbeck Off-Channel Reservoir (OCR) has been proposed as a new reservoir adjacent to the Navasota River, northeast of the City. The City is currently pursuing this strategy.

River flow would be diverted under the city's senior water right into the OCR, and stored for municipal use. The OCR will allow an increase in the minimum annual diversion by providing increase of storage of flows for use during drought periods. The dam would be an earthfill embankment that would be approximately 1,500 feet long and provide a conservation storage capacity of 2,317 acft.

The calculated firm yield of the Groesbeck Off-Channel Reservoir is 1,755 acft/yr. According to the 2011 BGRWP, the Groesbeck Off-Channel Reservoir project would cost approximately $10.4 million. The annual project costs are estimated to be $991,000.

Richland Chambers Reservoir

Regional strategies for participants in Freestone County include transmission of supplies from Richland Chambers Reservoir owned and operated by Tarrant Regional Water District (TRWD). The 2011 Region C Water Plan indicated that a 10-inch diameter, 5 mile transmission system with a water treatment plant could deliver 400 acft/yr of treated supply to Fairfield for a cost of $8.2 million. Annual costs were estimated at $817,000.

Brushy Creek Reservoir

The Brushy Creek Reservoir project includes the construction of three floodwater retarding structures and one multi-purpose reservoir on the Brushy Creek arm of the Big Creek Watershed in Falls County. The flood control portion of the project will benefit most of the eastern half of Falls County. Project participants include City of Marlin, Falls County WCID#1, and Natural Resources Conservation Service (NRCS).

The proposed multipurpose reservoir has a storage capacity of 6,560 acre-feet at the permitted conservation storage level of 380.5 feet above mean sea level (ft-msl). The firm yield is 2,090 acft/yr. The land required to create the reservoir has already been acquired by the City of Marlin.

The estimated cost of the project is $13.3 million (September 2008 prices). The annual costs of the project, which include debt service and operation and maintenance, are estimated to be $0.95 million.

Alternatives that were evaluated in the 1984 study included no action, the use of groundwater, a pipeline to a major reservoir, Dredging Lake Marlin, treating Brazos River water with reverse osmosis technology, building a new reservoir (i.e., the Brushy Creek project), and enlargement of Lake Marlin.

Summary and Potential Water Management Strategies

There are a number of local and regional opportunities available to the study participants to increase their future water supply and increase resiliency to future droughts. Table 8 summarizes cost and yield information for the strategies described in the preceding section. Except for the Bosque County Regional Project, all costs are in September 2008 dollars and based on information from the 2011 Brazos G and Region C Water Plans. These costs may not include all necessary infrastructure to deliver to entities that were not identified as original project participants in the 2011 plans. Other strategies, which include purchasing supplies from other wholesale water suppliers and aquifer development, have not been evaluated at this time.

Table 8. Costs and Yields of Summarized Water Management Strategies

Project	Yield (acft/yr)	Total Cost	Annual Cost	Unit Cost	
				$/acft/yr	$/1,000 gallons
Conservation				$475	$1.46
Supply from Waco	450	$10,452,000	$1,466,000	$3,258	$10.00
Bosque County Regional Project	1,772	$24,559,000	$1,549,000	$874	$2.68
Bistone MWSD Carrizo-Wilcox Aquifer Development	3,600	$18,500,000	$2,000,000	$556	$1.70
Groesbeck OCR	1,775	$10,400,000	$991,000	$558	$1.71
Supply from TRWD	400	$8,200,000	$817,000	$2,043	$6.27
Lake Whitney Water Supply	7,572	$110,800,000	$7,012,000	$926	$2.84
Brushy Creek Reservoir	2,090	$13,300,000	$950,000	$455	$1.39

There are twelve study participants that have projected water needs between 2020 and 2070. Considering the most cost effective measures, Table 9 summarizes potential strategies to help meet future water needs. Full evaluation of these strategies could be performed by the regional planning groups if the study participants make a request to the planning groups.

Table 9. Recommended Strategies for Study Participants with Projected Water Needs

WUG	County	Balance (acft/yr) 2020	Balance (acft/yr) 2070	Strategies
CHILDRESS CREEK WSC	Bosque	39	(15)	Bosque County Regional Project
CROSS COUNTRY WSC	Bosque	37	(141)	Conservation
VALLEY MILLS	Bosque	35	(1)	Conservation, Bosque County Regional Project
WEST BRAZOS WSC	Falls	(109)	(118)	System Interconnections, purchase from Waco or Central Texas WSC
Streetman	Freestone	40	(68)	TRWD/Carrizo-Wilcox Aquifer[1]
TEAGUE	Freestone	470	(49)	Conservation, Carrizo-Wilcox Aquifer[1] /TRWD /Groesbeck
WORTHAM	Freestone	(168)	(343)	increase contract with Mexia/ Corsicana/TRWD
COOLIDGE	Limestone	(104)	(127)	Bistone MWSD
GROESBECK	Limestone	(705)	(703)	Groesbeck OCR
MART	Limestone	0	(2)	System Interconnections, Carrizo-Wilcox Aquifer[1]
TRI-COUNTY SUD	Limestone	(80)	(84)	Groesbeck OCR, Carrizo-Wilcox Aquifer[1]
Kosse	Limestone	(80)	(90)	Groesbeck OCR, Carrizo-Wilcox Aquifer[1]

[1] Individual development of supplies from the Carrizo-Wilcox Aquifer System. Costs were not developed for this memorandum.

Appendix A - Methods to Estimate Available Water Supplies (Brazos G Regional Water Plan)

Surface Water Supplies

Surface water in the region available to meet projected demands consists of firm yield of reservoirs, dependable supply of run-of-river water rights through drought of record conditions. Contracts and/or rights to reservoirs, and run-of-river rights were allocated as supplies to their stated type of use: municipal, industrial (manufacturing, steam-electric, and mining), and irrigation. Additionally, municipal supply was further allocated among cities and other municipal water supply entities. This was done by obtaining water seller information (i.e., which contract/right holders – a wholesaler – are reselling water to other water supply entities) and water purchase contract limits between buyers and sellers. This information was obtained from TWDB files and follow-up queries to water supply entities. All water supply contracts were assumed to be renewed at their existing levels unless otherwise directed by local entities.

Water associated with a wholesaler that is not resold remains as an available supply to the wholesaler in the supply tables. In the case where a wholesaler's supply is deficient to meet its own demands and contractual commitments, it was assumed that contracts would not be met as well. In these cases, the supply available from each customer's contract was prorated down according to the contract amount.

In certain instances the entity's available water supply is constrained by lack of infrastructure. For example, an entity may hold a contract to divert water from a reservoir; however, the required pipeline has not been built. In this instance, the contract amount would not be included in the entity's available water supply or would be identified as a constrained supply.

In some instances, specific operational, contractual, or legal constraints required modifications to the general surface water allocation procedure.

Groundwater Allocation

Total groundwater availability in the region was determined based on the Managed Available Groundwater (MAG) for each aquifer. For each county, total available groundwater was allocated among the six user groups—municipal, manufacturing, steam-electric, mining, irrigation, and livestock.

For cities using groundwater sources, supply is based upon well capacities as catalogued in TCEQ's water utility database. For cases in which the total demand on that portion (i.e., county and river basin) of the aquifer exceeds the total availability, supply is prorated downward for every entity using that particular source.

For rural areas, it is assumed that the rural household (municipal type) demand would be met from aquifers underlying that river basin portion of the county. The rural supply is generally calculated as 125 percent of the year 2010 use from each particular aquifer. For cases in which the total demand on that portion (i.e., county and river basin) of the aquifer exceeds the total availability, supply is prorated downward for every entity using that particular source.

Constraints on Surface Water Supplies

In determining needs (shortages), an emphasis has been placed not only on a WUG's total raw water supply availability, but also on their infrastructure available to deliver and treat this supply.

Based on TCEQ records, the Normal Rated Design (NRD) of each surface water treatment plant of public water suppliers located in the Brazos G Area was used to determine the existing peaking capacities to treat and deliver surface water supplies. The average annual capacity (AAC) for the WTP was calculated as 50% of the NRD to account for peaking. For each WUG for which these data were available in the TCEQ database, the AAC was utilized to constrain the supply available from surface water sources, and was incorporated into the needs analysis for each WUG by utilizing a new term referred to as "constrained supply." Constrained supply is defined as the amount of water available to a WUG considering the limiting effects of existing infrastructure. This methodology allows for water management strategies to be identified and developed that specifically address these constraints caused by limited infrastructure capacity. These strategies could include pipelines to existing reservoirs, treatment plant expansions, or other infrastructure required to deliver and treat water for the end user of the WUG. Other constraints may have been added where the planning group was made aware of particular infrastructure capacity or lack of infrastructure. These infrastructure constraints were applied to the supply available for the WUG and to any contractual demands using that supply.

Constraints on Groundwater Supplies

Similar to surface water availability, the groundwater supplies assume that the wells will be able to continue producing the supply into the foreseeable future. However, some of the groundwater availability estimates adopted for use allow for substantial drawdown of aquifer levels, which would require that well pumps be lowered or, in some cases, that deeper replacement wells be drilled in order to continue to utilize the assumed supply available from the aquifer. This has been identified as a particularly crucial issue in the Trinity Aquifer, where the Managed Available Groundwater (MAG) adopted by the groundwater conservation districts allows for more than 400 feet of additional aquifer drawdown below current aquifer levels, and numerous WUGs depend largely on Trinity Aquifer supplies.

For groundwater supplies in the Trinity Aquifer, an additional analysis was performed using the Trinity Aquifer Groundwater Availability Model (Trinity GAM) to determine how future aquifer levels might constrain groundwater supplies to entities relying on Trinity Aquifer water. Pumping in the Trinity Aquifer GAM was modified to reflect expected future pumping as determined by water demands for municipal WUGs relying on the Trinity Aquifer. The resulting water levels were then compared to well data (location, depth, casing size) to determine if the expected future water levels would impact each WUG's wells. The wells potentially impacted by the future groundwater levels were identified, and the groundwater supply to the WUG was reduced correspondingly to reflect that the well would be no longer being useable in its present configuration. This groundwater supply is referred to as "constrained groundwater supply."