THE BRAZOS RIVER AUTHORITY

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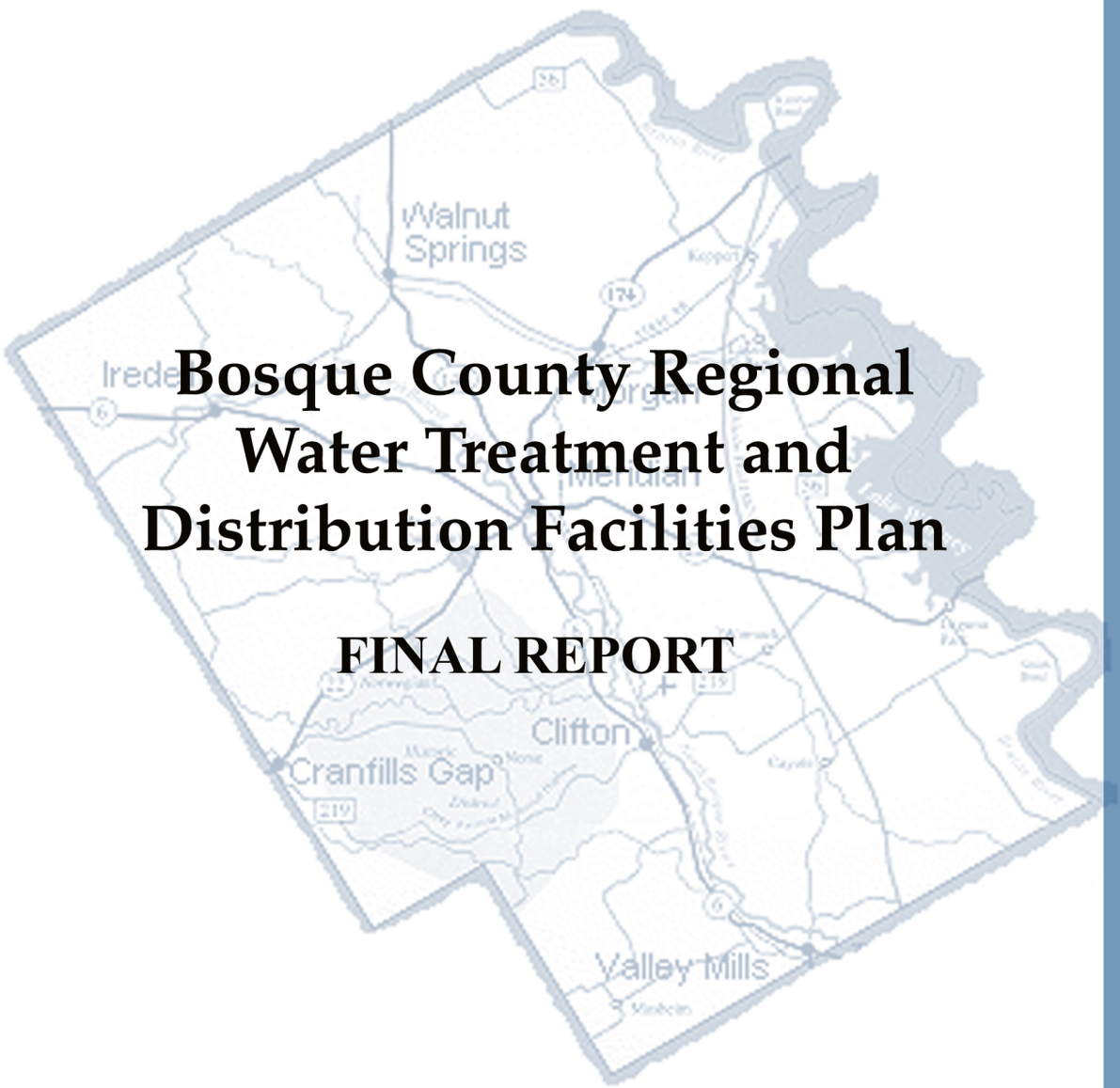

Bosque County Regional Water Treatment and Distribution Facilities Plan

FINAL REPORT

March 2004

THE BRAZOS RIVER AUTHORITY

Bosque County Regional Water Treatment and Distribution Facilities Plan

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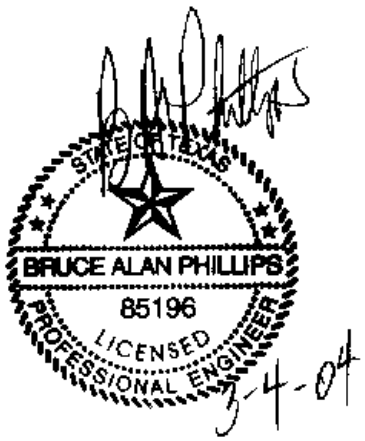

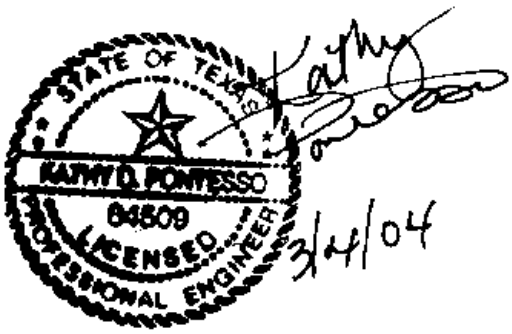

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Contents

Tables

Figures

Appendix

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Chapter 1
Introduction

1.1 Background

The Brazos River Authority, the Texas Water Development Board (TWDB), and the Cities of Clifton and Meridian have jointly sponsored a study to determine the regional water needs of Bosque County and to evaluate existing and proposed facilities to serve the Bosque County's long-term water needs. This facilities planning study is structured to address the water supply needs that exist in Bosque County and support the creation of a plan to efficiently transfer and distribute treated water through and between the existing public water supply systems using existing facilities or modifications to existing facilities. Bosque County encompasses an area of approximately 1,010 square miles. For the purposes of this study, the scope was narrowed to specifically address the major cities and water supply corporations within Bosque County. The following entities are included in this study:

- City of Clifton
- City of Meridian
- City of Valley Mills
- City of Walnut Springs
- City of Morgan
- City of Iredell
- City of Cranfills Gap
- Childress Creek Water Supply Corporation
- Mustang Valley Water Supply Corporation
- Aqua Pure Water Supply Corporation
- Mosheim Water Supply Corporation
- Aqua Source – Lame Duck Water Supply Corporation[1]

The entities included in this study are represented on **Figure 1-1**.

The current population in Bosque County is approximately 17,204 people with 30 percent of the population residing in Clifton and Meridian. It is anticipated that by the year 2030 the population will grow to nearly 25,000 people.

[1] It should be noted that the Scope of Work listed S&B Water Management Corporation and not Aqua-Source – Lame Duck Water Supply Corporation. The latter has purchased the former, S&B Water Management Corporation.

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1.2 Objectives

The purpose of this study is to determine the feasibility of providing treated surface water to Bosque County entities in the scope study, and to develop a plan for the necessary facilities to distribute future water supplies within the county.

Currently most of the potable water demands within the planning area are met with water wells. However, continued withdrawals of groundwater supplies within Bosque County and surrounding counties have resulted in lowering the static water level within the wells, and have raised concerns about water quality. Future water demands in the planning area require the development of alternative water supplies to preserve this limited natural resource and to allow continued growth in the area.

This study evaluates the current water usage and the projected water usage for each of the areas within the Bosque County. An evaluation of the water availability and water demands of each community is presented. This is performed in accordance with the Brazos G Regional Water Plan. The capacity of the existing facilities is estimated for the purpose of transferring water between cities. Major transmission facilities including pump stations, storage tanks, and pipelines are identified.

This plan presents alternative methods for transfer of water between public water supply systems including interconnections between cities and rural water supply corporations. Each alternative is analyzed to determine the supply and transmission system modifications and improvements needed to serve each community including pump station, pipeline, and treatment system capacity upgrades. A hydraulic model and analysis for each alternative was conducted to assist in the overall master plan. However, these analyses did not address distribution facilities within any of the study entities. An economic analysis is performed to identify the most financially feasible alternatives for transfer of water between public water supply systems to meet existing and projected water supply needs. Recommendations are presented based on the results of the study.

1.3 Stakeholder Involvement

Two public workshops were conducted as part of this study. The meetings were held to review the project scope, schedule, data needed, communication protocols, and to solicit input. The attendees included representatives of city mayors, municipal water utilities, water utility districts, water supply corporations, and other public stakeholders. Data acquisition packets were sent out asking entities to provide information on their individual water supply systems and infrastructure. Sign-in sheets from these meetings and copies of the information solicitation packets are included in the **Appendix**.

In some cases where information was unavailable, reasonable assumptions were made to arrive at the conclusions in the report. In general, the objectives of the study were met with a reasonable degree of confidence given the available data. In one instance, however, the requested deliverables in ArcView format were not developed due to the lack of available mapping and photography information in an ArcView compatible format.

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Chapter 2
Population Projections

The primary factors that influence water demands are the population, and the rate of consumption per person, also known as the consumption per capita. This chapter focuses on the population projections for Bosque County. Chapter 3 will address the rates of consumption for Bosque County.

Population increases can generally be attributed to two factors: migration and a net difference between birth and death rates. Migration rates depend largely on economic and employment factors in the county, and therefore, are subject to the greatest amount of variability.

The future population projections are based on the final TWDB Approved Population Projections for the year 2000 through 2060 as approved on March 19, 2003. **Table 2-1** presents those population projections. The 2000 Census was used as the basis for the 2000 population for cities and county totals. The TWDB estimated the utility corporation population totals based on the service provided by the utility in 2000. These approved projections are to be used in the 2006 Regional Water Plans. This study incorporates only the projections through 2030.

Water User Group	2000 [1]	2010	2020	2030
Clifton	3,542	3,980	4,450	4,780
Meridian	1,491	1,619	1,756	1,852
Valley Mills[2]	1,120	1,164	1,211	1,244
Walnut Springs	755	804	857	894
Childress Creek WSC	2,091	2,459	2,853	3,130
County-Other	4,733	6,205	7,783	8,890
Bosque County Total	17,204	19,831	22,646	24,622

[1] The year 2000 population for cities and county totals are from the 2000 Census. For utilities, TWDB staff estimated the population served by the utility in 2000. The Regional Water Planning Groups revised some of the 2000 population estimates for utilities. Summing all of the city and utility population within a county and subtracting it from the county total population derived the County-Other population.

[2]The Water User Group (WUG) is located in more than one county and the projections listed in the row represent only the WUG's population projections within that particular county, not the WUG's total population projections.

Table 2-1. Bosque County Population Projections for 2000 - 2030 (TWDB approved)

For the purpose of this study, a revised Bosque Population Projection Table was created. These projections are presented in **Table 2-2**. This table was revised to include population estimates for the city and utility corporations that were not accounted for in the original TWDB Projections presented in Table 2-1. The cities of Morgan, Iredell, and Cranfills Gap were added to the projections, as well as the water service corporations of Mustang Valley, Aqua Pure, Mosheim, and Aqua Source (Lame Duck).

The 2000 populations of these cities and utility corporations were referenced from *The Brazos G Regional Water Planning Area, Population and Water Demand Projections*, as adopted by Brazos G Regional Water Planning Group on September 20, 1999, and approved by Texas Water Development Board on October 20, 1999. These revised population totals were then projected through 2030 using the "County-Other" growth rate from Table 2-1 for each entity. The "County-Other" population on Table 2-2 is the resulting difference between the new communities added to Table 2-2 and the "County-Other" population total of Table 2-1.

The total Bosque County population projections, which are represented in Table 2-2, reflect a growth rate of 43% over the thirty-year period from 2000 to 2030. The year 2000 population of 17,204 is projected to increase by 7,418 persons over the thirty-year period to a total population of 24,622 in the year 2030.

The information in Tables 2-1 and 2-2 were presented during the public meetings described previously. **Figure 2-1** provides a graphic representation of the population projections through year 2030.

Water User Group	2000 [1]	2010	2020	2030
Clifton	3,542	3,980	4,450	4,780
Cranfills Gap [2]	440	577	724	826
Iredell [2]	415	544	682	779
Meridian	1,491	1,619	1,756	1,852
Morgan [2]	445	583	732	836
Valley Mills[3]	1,120	1,164	1,211	1,244
Walnut Springs	755	804	857	894
Aqua Pure WSC [2]	141	185	232	265
Aqua Source WSC (Lame Duck) [2]	433	568	712	813
Childress Creek WSC	2,091	2,459	2,853	3,130
Mosheim WSC [2]	238	312	391	447
Mustang Valley WSC [2]	1,492	1,956	2,453	2,802
County-Other	1,129	1,480	1,857	2,121
Bosque County Total	17,204	19,831	22,646	24,622

[1] This Table is based on The Texas Water Development Board's Approved Population Projections for the year 2000 through 2060 as approved on March 19, 2003. Summing all of the city and utility population within a county and subtracting it from the county total population derived the County-Other population.

[2] The above marked cities and water supply corporations have been added to the Revised Population Projection Table 2-2. These communities were not originally included in the TWDB's Approved Population Projections for the year 2000 through 2060 (Table 2-1).

[3] Water User Group (WUG) is located in more than one county and the projections listed in the row represent only the WUG's population projections within that particular county, not the WUG's total population projections.

Table 2-2. Revised Bosque County Population Projections For 2000 - 2030

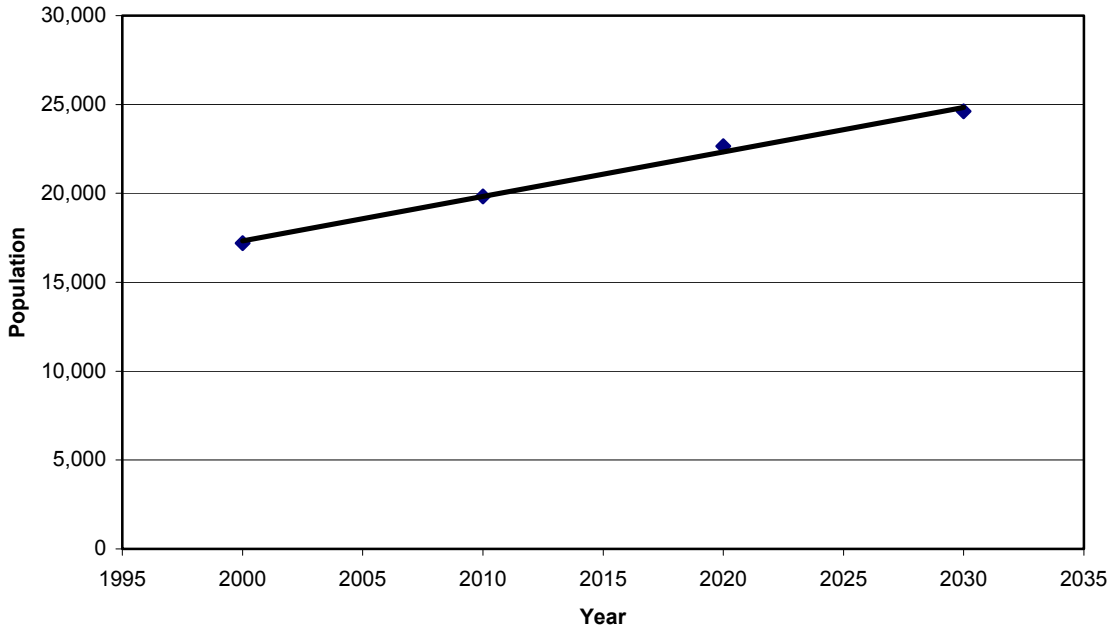

Figure 2-1. Bosque County Population Projections Through Year 2030

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Chapter 3
Water Demand Projections

Continued increases in water use in Bosque County have generated concerns about the reliability of ground water supplies to meet water consumption needs in the area. Currently most of the county's domestic water demands are met by ground water. Withdrawals exceed the rate at which groundwater can be replenished as demonstrated by a continual lowering of the water table. The overuse of this limited natural resource will not only result in a reduction of available water quantity, but it may also result in water of less than desirable quality.

In order to assess the ability of existing water supply systems to meet future needs and to evaluate various water supply alternatives, water demand projections have been developed for the planning period through the year 2030.

Ordinarily, consumptive water uses include municipal, industrial, mining, steam-electric cooling, and agricultural uses. For this study, it is assumed that only municipal demands will be satisfied by a regional treated water supply and delivery system. The amount of water used for municipal purposes in Texas depends primarily on population growth, climatic conditions, and water conservation practices. For planning purposes, municipal water use comprises both residential (single- and multifamily housing) and commercial and institutional water uses. Commercial water use includes business establishments, excluding industrial water use. Residential, commercial, and institutional uses are categorized together because of the similarity of uses; that is, they all require water primarily for drinking, cleaning, sanitation, air-cooling, and outdoor use.

3.1 Water Demand Projections and Methodology

Municipal water demand projections were based on the Texas Water Development Board's "Board-Approved Water Demand Projections for 2000-2060", as approved on September 17, 2003. These projections are presented in **Table 3-1**. For the basis of this study, only the projections thru 2030 are used. The TWDB has based these projections on reported water use and population estimates.

Municipal demand is the product of population times per capita usage and is typically reported in acre-feet (ac-ft) per year; 1 ac-ft equals 325,851 gallons. The TWDB projections have accounted for anticipated water savings resulting from conservation and an increase in the use of low-flow plumbing fixtures by factoring in a decrease in per capita water use, as illustrated on Table 3-1.

For the purpose of this study a Revised Bosque Municipal Water Demand Projection Table was created. These revised projections are presented in **Table 3-2**. This table was revised to include municipal water demand estimates for the city and utility corporations that were not accounted for in the original TWDB Projections. The cities of Morgan, Iredell, and Cranfills Gap have been added to the projections, as well as the water service corporations of Mustang Valley, Aqua Pure, Mosheim, and Aqua Source (Lame Duck). These revised demand projections were then estimated over the thirty-year study period by using the "Base GPCD" and the "Recommended Reduction from Base GPCD" for "County-Other" from Table 3-1. The "County-Other" demand on Table 3-2 is the resulting difference between the new communities added to Table 2-2 and the "County-Other" demand total of Table 3-1.

3.1.1 Peaking Factors

The Revised Bosque County Water Municipal Demand Projections also include the average day, max day, and peak hour demands. The average day demand was calculated by converting the TWDB demand from acre-feet per year (ac-ft/yr) to gallons per day.

Water use varies with the time of year and the time of day. To account for these variations, peaking factors are commonly used in evaluating water system operating characteristics. Peaking factors are multipliers that are applied to the average day demand to approximate other peak water demands. Peaking factors are often estimated because of the lack of detailed water use data. Peak water demands and associated peaking factors that are important in evaluating water system performance are discussed below.

The average day demand (ADD) is the total volume of water used during a year divided by 365 days, usually expressed in terms of million gallons per day (mgd) or gallons per minute (gpm). In order to estimate future demands based on population growth, ADD is also expressed in terms of gallons per capita per day (gpcd). Peaking factors are applied to the ADD to estimate the other peak demands.

The maximum day demand (MDD) is the highest daily water use rate during the year. The MDD peaking factor is the ratio of MDD to ADD. A good rule of thumb to use for MDD is assumed to be the product of the average day demand and a factor of 2.25. This rule of thumb is a standard assumption and is based on engineering experience.

The maximum hour demand (MHD) is the highest hourly water use rate during the year. The MHD peaking factor is the ratio of MHD to MDD. This factor is usually estimated based on engineering judgment, since it is difficult to determine the actual maximum hour demand in the system. Past experience with other water agencies indicates that a MHD peaking factor of 2.0 is appropriate.

Water User Group	Water Demand Projections (ACFT / YR)				Base GPCD	Recommended Reduction from Base GPCD for Plumbing Code Savings [2] (GPCD)		
	2000	2010	2020	2030	2000	2010	2020	2030
Clifton	647	709	773	819	163	4	8	10
Meridian	217	229	242	249	130	4	7	10
Valley Mills	236	241	246	248	188	3	7	10
Walnut Springs	94	97	100	101	111	3	7	10
Childress Creek WSC	283	322	361	389	121	4	8	10
County-Other	642	806	985	1,105	121	5	8	10
Bosque County Total	**2,540**	**2,829**	**3,138**	**3,342**	**-**	**-**	**-**	**-**

[1]This Table is based on The Texas Water Development Board's Approved Water Demand Projections for the year 2000 through 2060 as approved on September 17, 2003.

[2] The recommended reductions in Gallons-Per-Capita-Daily from the Base GPCD (2000) are due to the assumed replacement of toilets and faucets with new water-efficient fixtures as mandated in State and Federal legislation. These are recommended savings based on a state-wide formula; individual cities or utilities may have information to calculate a better schedule of savings. Changes in the schedule can be made during the water demand revision period.

Table 3-1. Bosque County Municipal Water Demand Projections for 2000 - 2030 (TWDB approved)

Water User Group	Water Demand Projections (ACFT / YR)				Average Day Demand (GPD x 1,000)				Max Day Demand (GPD x 1,000)				Peak Hour Demand (GPD x 1,000)			
	2000	2010	2020	2030	2000	2010	2020	2030	2000	2010	2020	2030	2000	2010	2020	2030
Clifton	647	709	773	819	578	633	690	731	1,300	1,424	1,553	1,645	2,599	2,848	3,105	3,290
Cranfills Gap [1]	60	75	92	103	53	67	82	92	120	151	184	206	240	301	368	413
Iredell [1]	56	71	86	97	50	63	77	87	113	142	174	195	226	284	347	389
Meridian	217	229	242	249	194	204	216	222	436	460	486	500	872	920	972	1,000
Morgan [1]	60	76	93	104	54	68	83	93	121	152	186	209	243	304	372	417
Valley Mills	236	241	246	248	211	215	220	221	474	484	494	498	948	968	988	996
Walnut Springs	94	97	100	101	84	87	89	90	189	195	201	203	378	390	402	406
Aqua Pure WSC [1]	19	24	29	33	17	21	26	29	38	48	59	66	77	97	118	132
Aqua Source WSC (Lame Duck) [1]	59	74	90	101	52	66	80	90	118	148	181	203	236	296	362	406
Childress Creek WSC	283	322	361	389	253	288	322	347	569	647	725	781	1,137	1,294	1,450	1,563
Cross Country WSC	30	36	44	49	27	32	39	44	60	72	88	98	121	145	177	197
Lake Whitney Water Company	391	389	387	382	349	347	346	341	785	781	777	767	1,571	1,563	1,555	1,535
Mosheim WSC [1]	32	41	50	56	29	36	44	50	65	81	100	112	130	163	199	223
Mustang Valley WSC [1]	202	254	311	348	181	227	277	311	407	510	624	700	813	1,021	1,247	1,399
County-Other	153	192	235	264	137	172	210	235	308	386	472	529	615	772	944	1,059
Bosque County Total	**2,119**	**2,404**	**2,707**	**2,911**	**1,892**	**2,146**	**2,417**	**2,599**	**4,256**	**4,829**	**5,437**	**5,847**	**8,513**	**9,658**	**10,875**	**11,694**

[1] These communities were not originally included in the TWDB's Approved Population Projections for the year 2000 through 2060

Table 3-2. Revised Bosque County Municipal Water Demand Projections for 2000 - 2030

Chapter 4
Water Supply And Treatment Capacity

4.1 Water Supply

Water supply sources available to Bosque County include both surface water and groundwater sources. Most water demands are met within the county through the use of groundwater wells. The City of Clifton is currently supplementing its groundwater supply with an off-channel reservoir on the Bosque River and a 1.0-MGD water treatment plant.

4.2 Groundwater

As stated previously, most of the demand in Bosque County is accommodated with ground water. The principal aquifer that provides ground water in Bosque County is the Travis Peak Formation. This formation, in much of the region, is composed of an upper sand unit (Upper Trinity Sand), a middle argillaceous unit (clay and shale layer) and a lower sand unit (Lower Trinity Sand). The upper sand layer is also termed the Hensell Member and consists of sand, sand stone, conglomerate, shale, clay and some limestone. The lower sand layer, termed the Hosston Member, generally consists of a similar group of sands and clays to the Hensell Member with the exception of the absence of the limestone layer.

The Travis Peak Formation outcrops in approximately ten counties within the Bosque County region. The more important occurrences are found in Erath, Eastland, Hamilton and Hood Counties.

The most important water bearing sand is the Hosston Member (Lower Trinity Sand). This formation dips in a southeast direction from its outcrop locations that are north and northwest of Bosque County. Within Bosque County, the elevation of the top of the Hosston Member is approximately elevation 600 msl in the northwest to about 500 feet below sea level in the southeast. This layer is about 700 feet below ground at Meridian and about 900 feet within the City of Clifton. The thickness of the Hosston unit varies widely over the entire region but ranges from approximately 50 feet in northwest Bosque County to about 150 feet in the southeast corner of the county.

Over the last 40 to 50 years historical well levels throughout the County have indicated a steady decline (Dannenbaum, 1990). Wells in the City of Clifton area indicate that the water level has steadily declined for the past 40 years in the range of 10-20 feet per year. Meridian area wells have experienced a decline of 10 to 12 feet per year (HDR, 1995). This decline in static water levels can be attributed to a disparity in the recharge rates versus the withdrawal rates from the aquifer. This problem could be accelerated due to the fact that the Travis Peak Formation underlies at least 15 other counties in Central Texas and has been heavily developed by other cities and rural areas in the region. Continued decline in the static water level into the water bearing strata of the aquifer could also contribute to a decline in the water quality produced from the wells.

An inventory of existing ground water production facilities owned and operated by cities and major water supply corporations (WSCs) in Bosque County is shown in **Table 4-1**.

	Well ID Number	Nominal Capacity	
		(GPM)	(MGD)
City of Clifton	2	160	
	4	180	
	5	180	
	6	245	
	7	179	1.36
City of Meridian	1 (Tower)	190	
	2 (Bosque)	210	
	3 (Powell)	165	0.81
City of Valley Mills	2	ABD	
	3	250	
	4	250	0.72
City of Walnut Springs	1	206	
	2	*	
	3	*	
	4	215	0.61
City of Morgan	2	139	
	3	156	0.42
City of Iredell	1	25	
	2	80	
	3	*	0.15
City of Cranfills Gap	1	ABD	
	2	25	
	4 (backup)	25	
	5	25	
	6 (main)	175	0.36
Childress Creek WSC	1	170	
	2	135	
	3 (pump station)	26	
	4	140	
	5	55	
	6	50	0.83
Mustang Valley WSC	1	100	
	2	100	
	2B	100	
	3	100	
	3B	100	
	5	100	
	7	100	1.01
Aqua Pure WSC	1	54	0.22
Mosheim WSC	1	40	
	2	92	0.19
Aqua Source Utility - Lame Duck WSC	1	75	
	*	*	0.11

* Indicates data not available

Table 4-1. Groundwater Production Facility Inventory

The approximate locations of the existing wells and surface water treatment plant are represented on figures of each city and major water supply corporation within the study area as follows:

- City of Clifton (**Figure 4-1**)
- City of Meridian (**Figure 4-2**)
- City of Valley Mills and Aqua Source – Lame Duck WSC (**Figure 4-3**)
- City of Walnut Springs (**Figure 4-4**)
- City of Morgan (**Figure 4-5**)
- City of Iredell (**Figure 4-6**)
- City of Cranfills Gap (**Figure 4-7**)
- Childress Creek Water Supply Corporation and Aqua Pure WSC (**Figure 4-8**)
- Mustang Valley WSC (**Figure 4-9**)
- Mosheim WSC (**Figure 4-10**)

4.3 Surface Water

The quality and quantity of groundwater available in Bosque County is highly variable. To produce a more reliable water supply, the City of Clifton has supplemented their groundwater supply with an off-channel reservoir on the Bosque River. The off-channel reservoir is 500 ac-ft and the City of Clifton has water rights to divert 2,004 acre-feet per year from the Bosque River. Clifton currently has a 1.0-MG surface water treatment plant to treat this water for distribution. According to the city of Clifton, this facility can be expanded to a capacity of 2.0 MGD with only equipment additions. Any expansion beyond 2.0 MGD would require modifications to the dam elevations of the existing off-channel reservoir.

4.4 Water Storage Facilities

The storage facilities in Bosque County generally consist of ground storage tanks. However, several of these tanks are located at elevations sufficiently greater than the area they service so as to function as elevated storage. An inventory of the storage facilities within the study area is shown on **Table 4-2**. The location of the storage facilities in the planning area are represented on figures of each city and major WSC within the study area as follows:

- City of Clifton (**Figure 4-1**)
- City of Meridian (**Figure 4-2**)
- City of Valley Mills and Aqua Source – Lame Duck WSC (**Figure 4-3**)
- City of Walnut Springs (**Figure 4-4**)
- City of Morgan (**Figure 4-5**)
- City of Iredell (**Figure 4-6**)
- City of Cranfills Gap (**Figure 4-7**)
- Childress Creek WSC and Aqua Pure WSC (**Figure 4-8**)
- Mustang Valley WSC (**Figure 4-9**)
- Mosheim WSC (**Figure 4-10**)

All infrastructure locations and sizes are based on information obtained by the Brazos River Authority and transmitted to Carter and Burgess. Information that was unclear or inconclusive was assumed. These assumptions are described in **Chapter 7 – Hydraulic Analysis**.

Water System	Tank No.	Designation[1]	Tank Capacity (Gallons)	Total System Capacity (Gallons)
	1	GST	200,000	
	2	GST	200,000	
	3	GST	100,000	
	4	GST	250,000	
	5	EST	200,000	
City of Clifton	6	GST	50,000	1,000,000
	1	GST	250,000	
	2	EST	100,000	
City of Meridian	3	EST	250,000	600,000
	1	GST	100,000	
City of Valley Mills	2	GST	100,000	200,000
	1	GST	200,000	
	2	EST	120,000	
City of Walnut Springs	3	GST	44,000	364,000
	1	EST	50,000	
City of Morgan	2	GST	50,000	100,000
	1	EST	50,000	
	2	GST	19,000	
City of Iredell	3	GST	19,000	88,000
	4	EST	50,000	
	5	GST	14,000	
City of Cranfills Gap	6	GST	42,000	106,000
	1-A	GST	40,000	
	1-B	GST	40,000	
	2	SP	141,000	
	4	SP	141,000	
	5-A	GST	50,000	
	5-B	PT	2,000	
Childress Creek WSC	6-A	GST	44,000	458,000
	1	ES	14,000	
	2-A	ES	83,000	
	3	ES	78,000	
	5	ES	170,000	
Mustang Valley WSC	7	ES	5,000	350,000
Aqua Pure WSC	1	GST	220,000	220,000
	1-A	GST	20,000	
Mosheim WSC	1-B	GST	20,000	40,000
Lame Duck WSC	1	GST	15,000	15,000

[1] GST = Ground Storage Tank; EST = Elevated Storage Tank; SP = Stand Pipe; Pressure tanks were not inventoried due to very small capacity.

Table 4-2. Water Storage Facility Inventory

Chapter 5
Comparison of Water Supplies and Projected Demands

5.1 Water Supplies, Projected Demands, and Treatment Capacities

The availability of adequate water supplies to meet future demands is essential to Bosque County and is a growing concern across the state. The future water needs of Bosque County can be determined by comparing the current water supplies and treatment capacities to the projected demands for the planning year 2010, 2020, and 2030. The supply, which was described in Chapter 4, is summarized in **Table 5-1**.

Water User Group	Supply (ACFT/YR)[2]				Supply (GPD)[2]			
	2000	2010	2020	2030	2000	2010	2020	2030
Clifton[1]	1373	1373	1373	1373	1,225,920	1,225,920	1,225,920	1,225,920
Cranfills Gap	79	79	79	78	70,724	70,724	70,312	69,599
Iredell	75	75	74	74	66,705	66,705	66,317	65,644
Meridian	119	119	119	119	106,252	106,252	106,252	106,252
Morgan	80	80	80	79	71,527	71,527	71,111	70,389
Valley Mills	63	63	63	63	56,251	56,251	56,251	56,251
Walnut Springs	38	38	38	38	33,929	33,929	33,929	33,929
Aqua Pure WSC	25	25	25	25	22,664	22,664	22,532	22,303
Aqua Source WSC (Lame Duck)	78	78	77	77	69,599	69,599	69,193	68,491
Childress Creek WSC	180	180	180	180	161,066	161,066	161,066	161,066
Mosheim WSC	43	43	43	42	38,255	38,255	38,032	37,646
Mustang Valley WSC	129	129	129	129	115,047	115,047	115,047	115,047
County-Other	77	77	77	77	69,028	69,028	69,028	69,028
Bosque County Total	**2360**	**2360**	**2358**	**2354**	**2,106,968**	**2,106,968**	**2,104,992**	**2,101,567**

[1] Clifton supplies listed above include surface water from a 1-million gallon per day (MGD) water treatment plant and 253 ACFT/YR from the Trinity Aquifer (1 MGD = 1120 ACFT/YR). Total WTP capacity is 2.0 MGD before additions to surface impoundment would be required. Clifton has surface water rights from the North Bosque River for 607 ACFT/YR (formal adjudication finalized January 5, 1982), and for 2,004 ACFT/YR (approved by TCEQ predecessor TNRCC December 13, 1996).

[2] Quantities reflect firm yield supplies in gallons per day (GPD) and are based on effective recharge of groundwater aquifers. Supplies lumped into "County Other" were distributed among the remaining entities. Attributed supplies are in some cases below installed well capacity

Table 5-1. Bosque County Water Supply

Water supplies are conventionally described in terms of acre-feet per year (acft/yr). However, it is also convenient to describe them in gallons per day (gpd), as will become apparent in the overall water balance for Bosque County. Also, it is important to point out that the above supplies are not indicative of the well capacities described in Chapter 4. The above supplies, the majority of which are groundwater, are considered to be firm yield supplies and are based on effective recharge of groundwater supply. These supplies are believed to be available during drought years, and are much more conservative, or lower, than the individual entities' groundwater well capacities.

The water demand projections for each entity were based on the Texas Water Development Board's water demand projections for Region G. For the purpose of this study a Revised Bosque Municipal Water Demand Projection Table was created as described in Chapter 3 of this report. The revised projections include municipal water demand estimates for the city and utility corporations that were not accounted for in the original TWDB Projections. The cities of Morgan, Iredell, and Cranfills Gap have been added to the projections, as well as the water service corporations of Mustang Valley, Aqua Pure, Mosheim, and Aqua Source (Lame Duck). **Table 5-2** summarizes the demand projections developed in Chapter 3, converted into gallons per day.

Water User Group	**Average Day Demand (GPD)**				**Max Day Demand (GPD)**			
	2000	2010	2020	2030	2000	2010	2020	2030
Clifton	577,600	633,000	690,100	731,200	1,299,600	1,424,100	1,552,700	1,645,100
Cranfills Gap	53,300	66,900	81,700	91,700	119,900	150,500	183,900	206,300
Iredell	50,300	63,100	77,100	86,500	113,100	142,000	173,500	194,600
Meridian	193,700	204,400	216,000	222,300	435,900	460,000	486,100	500,200
Morgan	53,900	67,700	82,700	92,700	121,200	152,200	186,000	208,700
Valley Mills	210,700	215,200	219,600	221,400	474,000	484,100	494,100	498,200
Walnut Springs	83,900	86,600	89,300	90,200	188,800	194,800	200,900	202,900
Aqua Pure WSC	17,100	21,400	26,200	29,400	38,400	48,200	58,900	66,100
Aqua Source WSC (Lame Duck)	52,400	65,800	80,400	90,200	118,000	148,100	181,000	203,100
Childress Creek WSC	252,600	287,500	322,300	347,300	568,500	646,800	725,100	781,400
Mosheim WSC	28,800	36,200	44,200	49,600	64,800	81,400	99,500	111,600
Mustang Valley WSC	180,700	226,800	277,200	311,000	406,500	510,400	623,700	699,700
County-Other	136,700	171,600	209,800	235,300	307,600	386,200	471,900	529,400
Bosque County Total	**1,891,700**	**2,146,200**	**2,416,600**	**2,598,800**	**4,256,300**	**4,828,800**	**5,437,300**	**5,847,300**

Table 5-2. Water Demand Projections for Bosque County

A water balance was developed based on supply versus average day demand to compare net available quantities for all entities in the planning group through the year 2030. **Table 5-3** summarizes the net available supplies or deficits.

Water User Group	**Balance -Supply vs. Demand (GPD)**			
	2000	**2010**	**2020**	**2030**
Clifton[1]	650,000	590,000	540,000	490,000
Cranfills Gap	20,000	0	(10,000)	(20,000)
Iredell	20,000	0	(10,000)	(20,000)
Meridian	(90,000)	(100,000)	(110,000)	(120,000)
Morgan	20,000	0	(10,000)	(20,000)
Valley Mills	(150,000)	(160,000)	(160,000)	(170,000)
Walnut Springs	(50,000)	(50,000)	(60,000)	(60,000)
Aqua Pure WSC	10,000	0	0	(10,000)
Aqua Source WSC (Lame Duck)	20,000	0	(10,000)	(20,000)
Childress Creek WSC	(90,000)	(130,000)	(160,000)	(190,000)
Mosheim WSC	10,000	0	(10,000)	(10,000)
Mustang Valley WSC	(70,000)	(110,000)	(160,000)	(200,000)
County-Other	(70,000)	(100,000)	(140,000)	(170,000)
Bosque County Total	**230,000**	**(60,000)**	**(300,000)**	**(520,000)**

[1] Clifton supply figure represents both surface and groundwater

Table 5-3. Net Available Supply or Deficit for Bosque County.

Table 5-3 shows all entities in planning year 2010 projecting water deficits except for the City of Clifton, which shows a surplus. This indicates that Clifton is a strong candidate as a regional water supplier. This will be evaluated as an alternative, among other alternatives, in the Chapters that follow in this report.

Maximum day demands far exceed supplies for each planning year. It is assumed that available storage infrastructure, combined with conjunctive use of groundwater will help offset maximum day demands.

Table 5-4 provides a summary of firm supply for planning year 2030, along with corresponding average day demand and peak day demand. Also shown is a side-by-side comparison of existing storage tank capacity and well capacity. Understanding that the City of Clifton supplies shown above include only 1.0 MGD of surface water (plus 225,000 GPD groundwater) and that Clifton's WTP is upgradeable to 2.0 MGD, it can be seen that 2030 supply deficits may be bridgeable using surface water from the City of Clifton. However, peak day demands must be buffered with a conjunctive use of groundwater wells and storage capacity.

Water User Group	2030 Firm Supply (GPD x 1,000)	2030 Demand (GPD x 1,000)		Surplus / Deficit		Capacity (Gallons x 1,000)	
		Average Day	Peak Day	Avg Day	Peak Day	Storage	Well
City of Clifton	1,226	731	1,645	495	(419)	1,000	1,400
City of Cranfills Gap	70	92	206	(22)	(136)	106	400
City of Iredell	66	87	195	(21)	(129)	88	200
City of Meridian	106	222	500	(116)	(394)	600	800
City of Morgan	70	93	209	(23)	(139)	100	400
City of Valley Mills	56	221	498	(165)	(442)	200	700
City of Walnut Springs	34	90	203	(56)	(169)	364	600
Aqua Pure WS Corp	22	90	66	(68)	(44)	220	200
Lame Duck WSC	68	90	203	(22)	(135)	15	100
Childress Creek WS Corp	161	347	781	(186)	(620)	458	800
Mosheim WS Corp	38	50	112	(12)	(74)	40	200
Mustang Valley WS Corp	115	311	700	(196)	(585)	350	1,000

Table 5-4. Comparison of Bosque Firm Supply, Demands, Surplus / Deficit and Storage / Well Capacity

Chapter 6
Water Supply Alternatives

In Chapter 5, it was shown that by planning year 2010, all cities and water supply corporations within Bosque County, aside from the City of Clifton, are projecting either water deficits, or marginal supplies. By planning year 2020, all entities with the exception of Clifton are projecting shortages. On this basis, the water supply plan for Bosque County should first center upon Clifton as being a regional supplier of treated water. As an alternative, the City of Meridian is reviewed for potential feasibility of producing and providing treated water to its residents as well as the entities in the northern portion of the county.

There is a number of Bosque County cities and water supply corporations (WSC) who may elect to participate in the Regional Water Supply Program. Depending on which cities or WSC join the program, there are many combinations of alternative routes that may be employed to deliver treated water. All alternative plans discussed in this chapter describe the minimum systems that could serve the cities and water supply corporations within Bosque County.

A total number of four water supply system alternatives were evaluated to allow municipalities and WSC within Bosque County to meet future water demands. A fifth possibility, involving demineralization of water from Lake Whitney, is briefly described separately at the end of this chapter. The water supply system alternatives evaluated are listed below in **Table 6-1**:

Alternative No. 1:	The Clifton WTP is expanded into a regional WTP, but only provides water to the City of Meridian. All other entities rely on ground water supply, which would become more reliable with the major users on surface water. Initial water supply system installed to meet year 2030 projected demands.
Alternative No. 2:	Build a new WTP for the City of Meridian. The Meridian WTP serves its own municipal users. The City of Clifton continues to serve only its municipal users. All other entities rely on ground water supply, which would become more reliable with the major users on surface water. Initial water supply system installed to meet year 2030 projected demands.
Alternative No. 3:	Build a new WTP for the City of Meridian. The Meridian WTP serves as a regional water provider for the northern Bosque County entities, and the City of Clifton would be the regional water provider to meet the southern entities.
Alternative No. 4:	Expansion of the Clifton Water Treatment Plant (WTP) into a Regional WTP. The City of Clifton supplies surface water to all county participants in Regional Program. Initial water supply system installed for year 2030 projected demands.

Table 6-1. Summary of Bosque County Water Supply Alternatives

Each of the alternatives evaluated in this study is based on meeting average daily demands because the maximum day demands far exceed the available supplies. It is believed that water demands exceeding average daily demands can most economically be met by the conjunctive use of existing water wells and storage facilities.

The alternatives evaluated may accommodate different time frames. For example, the Clifton WTP is already operational and readily expandable. A time period of five years is assumed for pumping and transmission infrastructure for land acquisition, permitting, design and construction. A time period of approximately ten years is assumed to allow time for issuance of a Meridian WTP project permit, land acquisition, dam and intake structure construction, off-channel impoundment, and design and construction of corresponding water supply system components.

6.1 Alternative 1
Clifton Provides Treated Water to Meridian

As observed previously, by planning year 2020, all entities with the exception of Clifton are projecting water shortages. With Clifton's current surface water treatment capacity of 1.0 mgd, the plant shows a 2020 surplus capacity of 540,000 gpd, which can be provided to other entities. On this basis, the water supply plan for Bosque County should first center upon Clifton as being a regional supplier of treated water. Under the Alternative No.1 scenario, the City of Clifton would supply surface water to the City of Meridian. In this scenario, all other entities would continue to rely on ground water supply, which would become more reliable with the cities of Clifton and Meridian on surface water.

Anticipated infrastructure under Alternative No. 1 would include:

- Additional Clearwell / Finished Water Storage Facilities
- Clifton-Meridian transmission line and
- Dedicated Pump Station

This infrastructure is described in further detail below.

The City of Meridian is projecting a 2020 water deficit of approximately 110,000 gpd, which indicates no required expansion of the Clifton WTP facilities, other than pumping and transmission. Additionally, the 250,000-gallon ground storage capacity at the Clifton WTP is considered marginal under Alternative 1. Storage capacity of at least one day's pumping requirement is desirable in the event that plant production is interrupted. Additional storage also allows for the plant to be operated at a constant rate and meet diurnal fluctuations in water demand. The proposed location of the 250,000-gallon ground storage tank would be in Meridian.

Figure 6-1 shows the transmission line involved in this concept. An 8-inch water transmission line would originate at the new pump station and parallel State Highway 6 to Meridian as shown. The scheme proposes a heavy-duty DR-14 PVC pipe for the transmission main, which is approximately one-half the cost of ductile iron pipe. Total estimated transmission length is approximately 62,000 linear feet.

To provide pumping flexibility and a reasonable equipment arrangement, it is recommended that pumping capacity be installed to fill the ground storage facilities within eight hours. This allows pumping overnight at reduced power costs and storage to meet peak diurnal demands. The preliminary pump recommendation is 250 gpm at approximately 260 feet total dynamic head (TDH). **Figure 6-2** shows the pump station layout, which includes a standby pump for alternate duty, providing higher pump station reliability for the City of Meridian.

6.2 Alternative 2
New Meridian Water Treatment Plant

The second alternative water supply scenario assumes construction of a new WTP for the City of Meridian. Under this alternative, the Meridian WTP would serve only its own municipal users. The City of Clifton would continue to serve only its municipal users. All other entities would rely on ground water supply, which would become more reliable with the major users on surface water. Initial water supply system would be installed for year 2030 projected demands.

The City of Meridian has been exploring the construction of its own water treatment plant for many years. In a study (Dannenbaum, 1990) evaluating construction of an on-channel reservoir

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known as Lake Bosque, Meridian was described as having contracted for 1,378 ac-ft (1.23 mgd) of the impounded water. That study evaluated surface water treatment and distribution from the North Bosque River. A later study evaluated a Meridian water treatment plant with both on and off-channel reservoirs (Brazos River Authority, 2000). The City of Meridian was described as having a planning year 2050 water requirement of 574 acre feet (0.5 mgd). To provide for a two-year drought, an impoundment capacity of 1,400 acre-feet was evaluated. The latter water requirement figures roughly concur with the requirements of this study, where it was concluded that the northern region of Bosque County would roughly require 0.25 mgd of additional water during planning year 2030. Therefore, the results of the 2000 study were incorporated into this study for planning purposes. A conceptual layout of the WTP is shown in F**igure 6-3**. The overall project concept is depicted in **Figure 6-4**. The project phases are described in more detail below.

6.2.1 Preliminary Design and Permitting

Preliminary design would include a more involved review, layout and costing of the proposed various components of the facility. The report would also include a rate study. The project components would include:

- A concrete river intake structure and pump station on the North Bosque River including three (3) 1,500 gpm vertical turbine pumps at 300 feet TDH, and two (2) 350 gpm vertical turbine pumps at 60 feet TDH.
- Raw water pipeline consisting of approximately 18,500 linear feet of DR14 PVC and appurtenances.
- Off-Channel Reservoir: The preliminary location was selected as summarized in the Brazos River Authority Report (2000), after TCEQ discouraged construction of an on-channel reservoir. The reservoir is shown in **Figure 6-4** and utilizes an earthen dam. As stated above, the proposed reservoir has an impoundment capacity of 1,400 acre-feet.
- Water Treatment Plant: The WTP location for planning purposes was assumed to be near a 250,000-gallon ground storage tank southeast of the off-channel reservoir. The proposed WTP capacity in the Brazos River Authority (2000) report was 1.0 mgd with a 0.5 mgd clearwell capacity.

Permits to be obtained during the preliminary design process include:

- Water Rights permit from the Texas Commission on Environmental Quality for the diversion of water from the North Bosque River and storage in an off-channel reservoir;
- Section 404 permit from the US Army Corps of Engineers for construction of the channel dam on the North Bosque River;
- General Land Office permit for the use of the State-owned streambed;
- Section 401 certification form the Texas Commission on Environmental Quality related to the Clean Water Act; and
- Any other permits as necessary for the completion of the project.

6.2.2 Design, Construction Documents, and Bidding

The following would be considered for the project design:

- Raw water intake pump station and pipeline to include a raw water intake and clear well, raw water pump station with room for expansion, pump station building, structure and ventilation system.

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- Off-channel reservoir to include earthen dam raw water pipe to off-channel reservoir and appurtenances, principal spillway and outlet conduit and cleaning plan, for City of Meridian demands.
- Water treatment plant to include water treatment plant components, water treatment plant building and related piping with room for expansion, raw water supply pipeline and pump station, clearwell storage reservoir, high service pipeline, chemical storage facilities, backwash holding tank and recycle sludge pump station, access road and parking lot, treated water pipeline and appurtenances to deliver the water to distribution or transmission.

6.3 Alternative 3
Two Regional Bosque County Water Plants

The third alternative assumes both Clifton and Meridian provide treated water to entities within Bosque County. It assumes the construction of the Meridian WTP as described above, and also assumes pumping and transmission infrastructure to provide treated surface water from the Meridian WTP to entities in northern Bosque County, and from the Clifton WTP to entities in southern Bosque County. **Figure 6-5** shows the transmission infrastructure required. The following paragraphs discusses the infrastructure required at each WTP, both Clifton and Meridian.

6.3.1 Infrastructure at Meridian WTP

As stated above, Alternative No. 3 would employ the same Meridian WTP as described for Alternative No. 2, with initial 1.0 mgd treatment and 0.5 mgd clearwell capacities. The pumping and transmission infrastructure would be increased. Under this scenario, the City of Meridian would provide water to its municipal users and to the following communities:

- Iredell
- Walnut Springs
- Morgan
- Cranfills Gap

6.3.1.1 Pipelines

The pipelines required for this alternative include a 16-inch diameter raw water pipeline from the North Bosque River to the off-channel reservoir, and back to the treatment plant discussed earlier, and transmission pipelines to each of the cities in the planning area. **Table 6-2** summarizes the individual transmission lines from the Meridian WTP to the northern Bosque County entities.

Entities Served	Pipe Diameter, inches	Material Specification	Length, linear feet
Iredell	6	PVC DR-14	72,900
Walnut Springs	6	PVC DR-14	60,900
Morgan	6	PVC DR-14	50,800
Cranfills Gap	6	PVC DR-14	72,600

Table 6-2. Meridian WTP Transmission Infrastructure - Alternative 3

Pipe sizes for each of these transmission mains shown above are based on the ability to covey average daily water demands for each entity as projected for the year 2030.

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Each of these pipelines can be installed within existing state highway rights-of-way, with the exception of the proposed raw water line. This will facilitate construction of these lines and eliminate the expense of easement acquisition.

6.3.1.2 Pump Stations

The raw water pump station will pump lake water from the proposed river intake to the off channel reservoir, as described previously. This pump station is considered part of the base Meridian WTP package. The high service pump station located at the treatment plant will consist of five (5) separate sets of pumping units due to the different hydraulic design conditions required to serve each entity. However, the individual pumping units can be physically located in the same structure to reduce construction costs. **Figure 6-6** shows one possible layout of this pump station. Each pumping unit will consist of a duty pump and a standby, offering firm design capacity for each pumping unit. This pump arrangement is summarized in **Table 6-3** below.

Pumping Unit Set No.	Entities Served	Year 2030 Design Conditions			
		Capacity (gpm)	Head Requirements (ft)	Total Number of Pumps[1]	Motor Size Per Pump (H.P.)
1	Meridian[2]	250	25	2	5
2	Iredell	80	125	2	5
3	Walnut Springs	125	300	2	15
4	Morgan	80	45	2	5
5	Cranfills Gap	80	165	2	5

[1]One pump for each pumping unit set serves as standby

[2]The pumping equipment for Meridian municipal distribution is considered part of the base WTP, although in Alternative 3 it would be built into a common pumping building for economies of scale.

Table 6-3. Meridian High Service Pump Station - Alternative 3

6.3.2 Infrastructure at the Clifton WTP

Alternative No. 3 would utilize the City of Clifton WTP as a regional purveyor of treated water to southern Bosque County. Those entities were shown to include:

- Valley Mills
- Aqua Pure WSC
- Aqua Source WSC (Lame Duck)
- Childress Creek WSC
- Mosheim WSC
- Mustang Valley WSC

In order to accommodate these additional demands, some minor increases in treatment capacity would need to be added to the Clifton WTP. Figures show that the 2030 treatment capacity excess at Clifton and the water deficits at the southern entities were 490,000 and 580,000 gpd, respectively. This indicates that only one 0.5 mgd treatment module and booster pump would

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need to be added at the existing plant. The plant has already been designed and constructed for this addition.

6.3.2.1 Pipelines

The pipelines required in the southern scheme of this alternative include pipelines to each of the WSCs in the planning area discussed above. **Table 6-4** summarizes the individual transmission lines from the Clifton WTP to the southern Bosque County entities.

Entities Served	Pipe Diameter, inches	Material Specification	Length, linear feet
Valley Mills / Aqua Source WSC	8	PVC DR-14	74,200
Aqua Pure WSC	6	PVC DR-14	14,000
Childress Creek WSC	8	PVC DR-14	37,700
Mosheim WSC	6	PVC DR-14	37,100
Mustang Valley WSC[1]	8	PVC DR-14	41,600

[1] Proposed pipeline terminates into Mustang Valley WSC Plant #5 stand pipe.

Table 6-4. Clifton WTP Transmission Infrastructure - Alternative 3

Pipe sizes for each of these transmission mains shown above are based on the ability to convey average daily water demands for each entity as projected for the year 2030. It is uncertain if these pipelines will require easement acquisition of private property, therefore, easement acquisition costs will not be included in this analysis. These costs will have to be evaluated on an individual basis later in the design process.

6.3.2.2 Pump Stations

The Clifton WTP would require an additional high service pump station under Alternative No. 3. The high service pump station located at the treatment plant will consist of three (3) separate sets of pumping units due to the different hydraulic design conditions required to serve each entity. However, the individual pumping units can be physically located in the same structure to reduce construction costs. **Figure 6-7** shows a conceptual arrangement of the Clifton Regional Pump Station. Each pumping unit will consist of a duty pump and a standby, offering firm design capacity for each pumping unit. One possible pump arrangement scenario for each pumping unit is shown in **Table 6-5** below. An additional booster pump station would be required at the Mosheim branch westward, which would consist of two pumps rated for 80 gpm at approximately 100 feet TDH.

Pumping Unit Set No.	Entities Served	Year 2030 Design Conditions			
		Capacity (gpm)	Head Requirements (ft)	Total Number of Pumps[1]	Motor Size Per Pump (H.P.)
1	Valley Mills / Aqua Source / Mosheim WSC	485	275	2	50
2	Aqua Pure / Childress Creek WSC	445	175	2	30
3	Mustang Valley WSC	420	390	2	60

[1]One pump for each pumping unit set serves as standby

Table 6-5. Clifton High Service Pump Station - Alternative 3

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6.4 Alternative 4
Clifton as Central Regional Treated Water Purveyor

The fourth alternative water scenario involves expansion of the Clifton Water Treatment Plant (WTP) into a Regional WTP. Under this scenario, the City of Clifton would supply surface water to all county participants in the Regional Program. **Table 6-6** summarizes planning year surpluses and shortages for each user group in Bosque County.

WATER USER GROUP	Balance -Supply vs. Demand [2] (GPD)			
	2000	2010	2020	2030
Clifton[1]	650,000	590,000	540,000	490,000
Cranfills Gap	20,000	0	(10,000)	(20,000)
Iredell	20,000	0	(10,000)	(20,000)
Meridian	(90,000)	(100,000)	(110,000)	(120,000)
Morgan	20,000	0	(10,000)	(20,000)
Valley Mills	(150,000)	(160,000)	(160,000)	(170,000)
Walnut Springs	(50,000)	(50,000)	(60,000)	(60,000)
Aqua Pure WSC	10,000	0	0	(10,000)
Aqua Source WSC (Lame Duck)	20,000	0	(10,000)	(20,000)
Childress Creek WSC	(90,000)	(130,000)	(160,000)	(190,000)
Mosheim WSC	10,000	0	(10,000)	(10,000)
Mustang Valley WSC	(70,000)	(110,000)	(160,000)	(200,000)
County-Other	(70,000)	(100,000)	(140,000)	(170,000)
Bosque County Total	230,000	(60,000)	(300,000)	(520,000)

[1] Clifton supply figure represents both surface and groundwater.

[2] Figures represent water demands presented in Chapter 3 and supplies presented in Chapter 4.

Table 6-6. Water Balance for Bosque County Assuming Clifton as Regional Purveyor

Planning year 2010 shows all entities projecting water supply deficits other than Clifton, which shows a surplus. This indicates that Clifton is a strong candidate for regional water supply However, even with Clifton's surplus, the county still requires an additional 60,000 gpd projected for 2010. Similarly, a 300,000-gpd deficit countywide is projected for planning year 2020. The Clifton WTP could meet this requirement with the addition of a pre-planned 0.5 mgd treatment module and other minor equipment being added prior to 2010.

Other anticipated infrastructure under Alternative No. 4 would include:

- Additional Clearwell / Finished Water Storage Facilities
- Transmission lines and
- Dedicated Pump Stations

This infrastructure is described in further detail below.

6.4.1 Pipelines

Table 6-7 summarizes the transmission requirements for Alternative No. 4. Pipe sizes for each of these transmission mains shown above are based on the ability to covey average daily water demands for each entity as projected for the year 2030. Each of these pipelines can be installed within existing state highway rights-of-way. This will facilitate construction of these lines and eliminate the expense of easement acquisition. **Figure 6-8** presents a graphical representation of the overall transmission infrastructure required in this alternative.

Entities Served	Pipe Diameter (Inches)	Material Specification	Length (linear feet)
Clifton – Meridian	12	PVC DR-14	62,000
Iredell	6	PVC DR-14	72,900
Walnut Springs	6	PVC DR-14	60,900
Morgan	6	PVC DR-14	50,800
Cranfills Gap	6	PVC DR-14	72,600
Valley Mills	8	PVC DR-14	74,200
Aqua Source WSC	6	PVC DR-14	3,800
Aqua Pure WSC	6	PVC DR-14	14,000
Childress Creek WSC	8	PVC DR-14	37,700
Mosheim WSC	6	PVC DR-14	37,100
Mustang Valley WSC	8	PVC DR-14	41,600

Table 6-7. Summary of Transmission Infrastructure Required for Alternative 4

6.4.2 Pump Stations

A total of 3 pump stations would be required for Alternative No. 4. These include:

- Clifton High Pump Service Station
- Meridian High Service Pump Station
- Mosheim WSC Booster Pump Station

These are described in further detail below.

6.4.2.1 Clifton Pump Station

The Clifton WTP would require an additional high service pump station under Alternative No. 4. The high service pump station located at the treatment plant would consist of four (4) separate sets of pumping units due to the different hydraulic design conditions required to serve each entity. However, the individual pumping units can be physically located in the same structure to reduce construction costs. **Figure 6-9** shows one possible layout of this pump station. Each pumping unit will consist of a duty pump and a standby, offering firm design capacity for each pumping unit. One possible pump arrangement scenario for each pumping unit is shown in **Table 6-8** below.

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Pumping Unit Set No.	Entities Served	Year 2030 Design Conditions			
		Capacity (GPM)	Head Requirements (FT)	Total Number of Pumps[1]	Motor Size Per Pump (H.P.)
1	Clifton-Meridian	615	225	2	45
2	Valley Mills / Aqua Source / Mosheim WSC	485	275	2	50
3	Aqua Pure / Childress Creek WSC	445	300	2	60
4	Mustang Valley WSC	420	530	2	90

[1]One pump for each pumping unit set serves as standby

Table 6-8. Clifton High Service Pump Station - Alternative 4

6.4.2.2 Meridian Pump Station

The Alternative No. 4 high service pump station located at Meridian will consist of five (5) separate sets of pumping units due to the different hydraulic design conditions required to serve each entity. However, the individual pumping units can be physically located in the same structure to reduce construction costs. This is the same arrangement proposed as shown in **Figure 6-6**. Each pumping unit will consist of a duty pump and a standby, offering firm design capacity for each pumping unit. This pump arrangement is summarized in **Table 6-9** below.

Pumping Unit Set No.	Entities Served	Year 2030 Design Conditions			
		Capacity (GPM)	Head Requirements (FT)	Total Number of Pumps[1]	Motor Size Per Pump (H.P.)
1	Meridian	250	25	2	5
2	Iredell	80	125	2	5
3	Walnut Springs	125	300	2	15
4	Morgan	80	45	2	5
5	Cranfills Gap	80	165	2	5

[1]One pump for each pumping unit set serves as standby

Table 6-9. Meridian High Service Pump Station - Alternative 4

6.5 Lake Whitney Demineralization

Treatment of water from Lake Whitney was evaluated in previous studies (HDR, 1982; CDM, 1986), and the costs were updated in a more recent study (HDR, 1995). Lake Whitney is located approximately 13 miles east of Clifton and Meridian, and is very high in dissolved minerals. The maximum-recorded level of 2,200 milligrams per liter of dissolved solids is sufficient for the water to be classified as brackish. The drinking water standard of 500 milligrams per liter is the federal recommended level. Therefore, the water would have to be treated with a demineralization process to remove the dissolved solids. The demineralization step would be in addition to the conventional treatment step normally necessary for the other study alternatives. This was reported to make the cost of water treatment excessive. In addition to the excessive costs of treatment, disposal of the waste brine was also reported to be problematic. Finally, transmission and pumping costs from Lake Whitney would be more costly than any of the other alternatives because of having to pump water approximately 15 miles to Meridian at a lift of approximately 430 feet. For ease of comparison, Alternative 1 would require approximately 11.5 miles of pipeline at a lift of approximately 200 feet. For the above reasons, Lake Whitney Demineralization was eliminated from further evaluation in this study.

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Chapter 7
Hydraulic Analysis

A hydraulic analysis of the proposed alternatives was performed using WaterCAD 6.0 software. Information for each entity within the study area was based on information obtained by the Brazos River Authority and transmitted to Carter and Burgess. Information that was unclear or inconclusive was assumed. The assumptions are described below.

Three modeling scenarios were developed to pump water from Clifton south to Valley Mills, Aqua Source, and Mosheim. Two modeling scenarios were developed to pump water east from Clifton to Childress Creek WSC and Aqua Pure. A scenario was developed to pump water from Clifton west to Mustang Valley WSC. The final scenarios required pumping from Clifton north to Meridian. A storage tank and pump station in Meridian served as a transfer point to pump to Walnut Springs, Morgan, Iredell and Cranfills Gap.

Transmission mains were sized to meet a requirement of less than 7 feet per second velocity with head losses of less than 5' per 1000' of pipe. Pumps capacities were determined by the supply deficit for each city or water supply corporation. Pump operating ranges were determined by curves that met the best operating point of the system curve produced by the storage tanks and transmission mains.

For design of any of the implemented alternatives, elevations, capacities, and locations of the existing infrastructure should be verified and confirmed to ensure exact pump station requirements.

7.1 Clifton

The water source for the model from Clifton was a reservoir at the Medium Service Pump Station established based on map received from Brazos River Authority and the elevation was established from USGS maps.

7.2 Meridian

Locations of existing structures were based on an electronic map and information as received from Brazos River Authority. Actual dimensions of existing tanks and overflow elevations were received from the Brazos River Authority. The supply tank used for the model was a 250,000-gallon ground storage tank south of the intersection of State Highway 6 and State Highway 22. The ground elevation for this tank was 899' with an overflow elevation of 926.

7.3 Valley Mills

The tank location and existing structures were based on a map received from Brazos River Authority. There were no dimensions specified for the existing ground storage tank. Therefore, the tank was assumed to be 16' in height with a 32.6' diameter was assumed for the tank geometry to equal the total volume of 100,000-gallons. The ground elevation for this tank was assumed based on USGS contours.

7.4 Walnut Springs

Locations of the existing structures within Walnut Springs were based on a map received from Brazos River Authority. A total volume of the elevated storage tank used to supply the demand

to Walnut Springs was 200,000-gallons. There were no dimensions specified for the existing elevated storage tank. The elevated tank was assumed to be 115' in height with an operating range of 25 feet. The resulting 31.8 -foot diameter was assumed to complete the tank geometry. The ground elevation of the elevated tank was assumed based on USGS contours.

7.5 Morgan

The locations of the existing structures for the City of Morgan were based on a map received from Brazos River Authority. (Insert A was cut off of map which detailed the storage tank information, but the location was assumed to be relative to the points indicated on the map) No dimensions were specified for the existing 50,000-gallon elevated storage tank. Thus, a tank height was assumed of 115' tall with a 20' operating range. The corresponding calculated diameter was 23' for the tank geometry. The ground elevation of the elevated storage tank was assumed based on USGS contours.

7.6 Iredell

A map of Iredell was received from Brazos River Authority and used to locate the existing 50,000-gallon ground storage tank south of State Highway 6. The information received from the City of Iredell indicated that this tank had a ground elevation of 900'. However, this information conflicted with the ground elevation of 970 based on USGS maps. Since an elevation of 970' was more conservative for modeling purposes, the ground elevation of the tank was assumed to be 970'. No dimensions were specified for the existing ground storage tank. Thus, the tank was assumed to be 16' in height with a diameter of 23 feet.

7.7 Cranfills Gap

The existing location of the 50,000-gallon elevated storage tank in Cranfills Gap was obtained on a map received from Brazos River Authority. Cranfills Gap supplied the existing diameter and height of the tank. The ground elevation of the tank was assumed based on USGS contours.

7.8 Childress Creek WSC

Information on the location of the storage tank and sizes for Childress Creek WSC was received from Brazos River Authority. For the purposes of the model, the existing approximately 141,000 -gallon storage tank at Plant No. 4 east of Clifton was used as the delivery point. This location was chosen due to the fact that it was geographically closest to the Clifton Plant.

7.9 Mosheim

No map was received for this community. The Mosheim facility location was assumed at the center of the Mosheim community as identified on the USGS map (**Figure 4-10**). The ground elevation of the tank was based on the USGS information based on the assumed location. The ground storage tank capacity of 20,000-gallon tanks was determined from records obtained at the Texas Commission on Environmental Quality (TCEQ). The dimensions of the tank were assumed to be 16' in height with a diameter of 15'.

7.10 Aqua Pure WSC

A map was not received from Aqua Pure. The location of this facility was derived based on maps received from Childress Creek WSC. The capacity of the storage facility was determined based on a review of information obtained from the TCEQ.

7.11 Aqua Source WSC

The location of the 15,000-gallon ground storage tank was obtained from maps obtained from Brazos River Authority. The geometry of the tank was assumed to be 12' in diameter with a height of 18.7 feet.

7.12 Mustang Valley WSC

The location of the delivery tank for Mustang Valley WSC was the 170,000-gallon stand pipe at Mustang Valley WSC Plant No. 5. This location was obtained from maps received from Brazos River Authority. The tank is located northwest of Clifton between Clifton and Cranfills Gap with close proximity to Ranch Road 219. The height of the existing tank and the ground elevation of the tank were provided. The calculated diameter of the tank based on the overall capacity was determined to be 11 feet.

The selection of the delivery tank at this location was based on both its capacity and its proximity to Clifton, and may not coincide with the Mustang Valley WSC service area. It was assumed that delivery infrastructure existed from Plant No. 5 to the service area. More detailed information on distribution infrastructure was not available for analysis.

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Chapter 8
Cost Evaluation

One objective of this study is to develop cost estimates to quantitatively evaluate the water supply system alternatives. The selection of the recommended project is dependent on the overall cost and affordability as well as the ability of the project to meet the County's long-term water supply needs. The water supply system costs include both capital as well as operating and maintenance costs.

Capital costs consist of the costs of construction of treatment plants, pumping station and transmission infrastructure. Operation and maintenance costs consist primarily of salaries for operation staff, electricity, treatment chemicals, and equipment maintenance. The cost estimates were prepared using a variety of sources including Brazos River Authority reports, construction costs of similar projects, conversations with contractors, and unit costs for individual items developed through engineering experience. The costs do not include land acquisition, legal or environmental remediation, nor do they include any debt service associated with the existing WTP at the City of Clifton. Contingencies were assumed to be 25% due to inherent uncertainties at the planning level. Engineering fees include preliminary and detailed design, surveying, and general representation during construction. These costs were assumed to be 15% of construction costs for pipelines and pump stations, while treatment plant design fees were assumed to be 18%.

8.1 Alternative 1
Clifton Provides Treated Water to Meridian

In Chapter 6, Alternative 1 discussed the proposed transmission pipeline, additional clearwell capacity and pump station required to provide treated surface water to Meridian from the Clifton WTP. **Table 8-1** presents the costs of the proposed pipeline and clearwell / ground storage tank. **Table 8-2** presents the cost of the proposed pump station.

Item Description	Quantity	Unit	Unit Cost	Total Cost
Pipe, 8" DR-18 C-905 PVC, Class 250, All Depths, Including Excavation And Backfill, Complete And In Place	62000	LF	$25	$1,550,000
Concrete Encasement For 8" Dia. Pipe	300	LS	$60	$18,000
Bore 8" Pipe and 16" Steel Encasement Complete In Place (Does Not Include Cost For 8" Pipe Material And Completion)	300	LF	$275	$82,500
Combination Air / Vacuum Release Valve, 4" Dia., Complete And In Place	8	EA	$12,500	$100,000
Valves, Resilient Seated Gate Valve Type, 8" Dia., Complete And In Place	6	EA	$1,200	$7,200
250,000 Gal Ground Storage Tank	1	EA	$125,000	$125,000
Subtotal				**$1,882,700**
Engineering (15%)				$282,400
Contingencies (25%)				$470,700
Total Clifton to Meridian Pipeline (2003 Dollars)				**$2,635,800**

Table 8-1. Cost Estimate of Clifton to Meridian Pipeline – Alternative 1

Item Description	Quantity	Unit	Unit Cost	Total Cost
Mobilization, Bonds and Insurance	1	LS	$25,000	$25,000
Site Work	1	LS	$15,000	$15,000
Foundation & steel building	1	LS	$60,000	$60,000
Piping, valves, fittings	1	LS	$27,000	$27,000
250 GPM vertical turbine pump	2	EA	$15,000	$30,000
Steel Pump Can w/ concrete casing	2	EA	$13,000	$26,000
Pump pads	2	EA	$1,000	$2,000
New Site Wiring and Electrical Service	1	LS	$80,000	$80,000
Telecommunications and SCADA	1	LS	$21,000	$21,000
HVAC for Pump Station	1	LS	$7,500	$7,500
Subtotal				**$293,500**
Engineering (15%)				$44,000
Contingency (25%)				$73,400
Total Clifton to Meridian Pump Station (2003 Dollars)				**$410,900**

Table 8-2. Cost Estimate of Clifton to Meridian Pump Station – Alternative 1

Cost Summary of Alternative 1

Table 8-3 presents the summary cost of Alternative 1.

Item	Summary Cost
Transmission and Ground Storage	$2,635,800
Pump Station	$410,900
Total Estimated Cost for Alternative 1 (2003 Dollars)	**$3,046,700**

Table 8-3. Cost Summary of Alternative 1

8.2 Alternative 2
New Meridian Water Treatment Plant

As introduced in Chapter 6, Alternative 2 would provide the City of Meridian with its own WTP to supply its municipal users solely. The WTP and associated complexes would include:

- Raw water intake pump station and pipeline to include a raw water intake, clear well, and raw water pump station
- Off-channel reservoir to include earthen dam, principal spillway and appurtenances,
- Water treatment plant with room for expansion, raw water supply pipeline, clearwell storage reservoir, high service pipeline, chemical storage facilities, backwash holding tank and recycle sludge pump station, access road and parking lot, treated water pipeline and appurtenances to deliver the water to distribution or transmission.

Table 8-4 Summarizes the Costs of the Meridian WTP and Raw Water Intake proposed for Alternative 2.

Item	Quantity	Unit	Unit Cost	Total Cost
WATER TREATMENT PLANT				
Mobilization, Bonds and Insurance	1	LS	$130,000	$130,000
Site Work and Fencing	1	LS	$70,000	$70,000
Septic System	1	LS	$30,000	$30,000
Building	1	LS	$500,000	$500,000
16" RW Transmission Line and Metering	1	LS	$301,000	$301,000
Chemical Feed Equipment and Metering Pumps	1	LS	$126,000	$126,000
High Service Pumps and Backwash Pumps	1	LS	$27,000	$27,000
Process, Chemical and Yard Piping	1	LS	$115,000	$115,000
0.5 MGD WTP Equipment and Installation	1	LS	$450,000	$450,000
0.5 MGD Ground Storage Tank	1	EA	$200,000	$200,000
Electrical, SCADA and HVAC	1	LS	$230,000	$230,000
Estimated Water Treatment Plant Cost				***$2,179,000***
RAW WATER INTAKE				
Mobilization, Bonds and Insurance	1	LS	$130,000	$130,000
Site Preparation, Grading, Access Road, Fencing	1	LS	$40,000	$40,000
Excavate Site for Drill Pit & Pump Station	1	LS	$70,000	$70,000
Environmental Protection	1	LS	$15,000	$15,000
Bore, Case, & Install Raw Water Intake Line	1	LS	$125,000	$125,000
Building	1	LS	$270,000	$270,000
Vertical Turbine Pumps, Piping and Valves	1	LS	$175,000	$175,000
Air Compressor and Piping	1	LS	$14,000	$14,000
Yard Piping	1	LS	$25,000	$25,000
Electrical and HVAC	1	LS	$78,000	$78,000
Estimated Raw Water Intake Cost				***$942,000***
Subtotal WTP and Raw Water Intake				**$3,121,000**
Engineering (18%)				$561,800
Contingency (25%)				$780,300
Total Estimated Cost for Meridian WTP and Raw Water Intake (2003 Dollars)				**$4,463,100**

Table 8-4. Costs for Meridian Water Treatment Plant and Intake Structure – Alternative 2

Table 8-5 presents the costs for the Off-Channel Dam and Reservoir.

Item	Quantity	Unit	Unit Cost	Total Cost
OFF-CHANNEL DAM & RESERVOIR				
Mobilization, Bonds and Insurance	1	LS	$130,000	$130,000
Diversion & Care of Creek	1	LS	$10,000	$10,000
Environmental Protection	1	LS	$10,000	$10,000
Site Preparation, Grading & Revegetation	1	LS	$34,000	$34,000
Cutoff Trench Excavation	1	LS	$100,000	$100,000
Dam Foundation Excavation	1	LS	$30,000	$30,000
Earthfill	1	LS	$600,000	$600,000
Finger Drains	1	LS	$28,000	$28,000
Grouting	1	LS	$30,000	$30,000
Riprap & Bedding	1	LS	$530,000	$530,000
Intake Structure	1	LS	$200,000	$200,000
Auxiliary Spillway	1	LS	$100,000	$100,000
30" CCP Spillway Outlet Pipe	1	LS	$150,000	$150,000
18" CCP Raw Water Line	11,200	LF	$100	$1,120,000
Estimated Off-Channel Dam & Reservoir Cost				***$3,072,000***
Engineering (15%)				$460,800
Contingency (25%)				$768,000
Total Estimated Costs for Meridian Off-Channel Dam and Reservoir (2003 Dollars)				**$4,300,800**

Table 8-5. Costs for Meridian Off-Channel Dam & Reservoir – Alternative 2

Table 8-6 summarizes the costs of the water treatment plant, raw water intake, off-channel dam and reservoir.

WTP and Raw Water Intake	$4,463,100
Off-Channel Dam and Reservoir	$4,300,800
Total Estimated Costs for Alternative 2 (2003 Dollars)	**$8,763,900**

Table 8-6. Cost Summary for Meridian WTP, Intake and Off-Channel Reservoir- Alternative 2

8.3 Alternative 3
Two Regional Bosque County Water Plants

In Chapter 6, it was proposed that Alternative 3 would provide Bosque County with two water treatment plants, one each in Meridian and Clifton. The Clifton plant would serve the southern entities in Bosque County while the Meridian Plant served the northern entities. Under this alternative, the raw water supply and treatment infrastructure in the north would consist of the same

Meridian off-channel reservoir and WTP discussed for Alternative 2. **Table 8-7** provides the estimated cost to expand the capacity of the Clifton WTP under Alternative 3. **Table 8-8** provides a cost estimate of the Meridian High Service Pump Station under Alternative 3. **Table 8-9** provides a cost estimate of the Clifton High Service Pump Station under Alternative 3. The transmission infrastructure cost for Alternative 3 is summarized in **Table 8-10**. The combined treatment, transmission and pumping infrastructure for Alternative 3 is summarized in **Table 8-11**.

Item	Quantity	Units	Unit Cost	Total Cost
Mobilization Bonds and Insurance	1	LS	$25,000	$25,000
Site Work	1	LS	$6,000	$6,000
Piping, Valves and Fittings	1	LS	$15,000	$15,000
Raw water booster pump, appurtenances	1	LS	$16,000	$16,000
Modular 0.5 MGD Water Treatment Unit	1	LS	$300,000	$300,000
New 250,000-gallon ground storage tank	1	LS	$200,000	$200,000
Electrical , I&C, LS	1	LS	$5,000	$5,000
Subtotal for Water Treatment Plant Expansion				**$567,000**
Engineering (15%)				$85,100
Contingency (25%)				$141,800
Total Estimated Costs to Expand Clifton WTP (2003 Dollars)				**$793,900**

Table 8-7. Costs to Expand Clifton WTP – Alternative 3

Item	Quantity	Units	Unit Cost	Total Cost
Mobilization, Bonds and Insurance	1	LS	$32,500	$32,500
Site Preparation & Grading	1	LS	$10,000	$10,000
Landscaping, Seeding and Fencing	1	LS	$5,000	$5,000
Foundation and Steel Building	1	LS	$150,000	$150,000
Pumps Assemblies and Appurtenances	1	LS	$205,000	$205,000
Piping, Valves and Fittings	1	LS	$191,300	$191,300
New Site Electrical Wiring and Service	1	LS	$80,000	$80,000
Telecommunications and SCADA	1	LS	$21,000	$21,000
HVAC for Pump Station	1	LS	$8,000	$8,000
Subtotal For Pump Station				**$702,800**
Engineering (15%)				$105,400
Contingency (25%)				$175,700
Total Estimated Costs of Meridian HSPS – Alternative 3 (2003 Dollars)				**$983,900**

Table 8-8. Meridian High Service Pump Station – Alternative 3

Item	Quantity	Units	Unit Cost	Total Cost
Mobilization, Bonds and Insurance	1	LS	$25,000	$25,000
Site Preparation & Grading	1	LS	$8,500	$8,500
Landscaping, Seeding and Fencing	1	LS	$5,000	$5,000
Foundation and Steel Building	1	LS	$101,000	$101,000
Pumps Assemblies and Appurtenances	1	LS	$123,000	$123,000
Piping, Valves and Fittings	1	LS	$116,000	$116,000
New Site Electrical Wiring and Service	1	LS	$80,000	$80,000
Telecommunications and SCADA	1	LS	$21,000	$21,000
HVAC for Pump Station	1	LS	$8,000	$8,000
Subtotal for Pump Station				**$487,500**
Engineering (15%)				$73,100
Contingency (25%)				$121,900
Total Estimated Costs of Clifton HSPS – Alternative 3 (2003 Dollars)				**$682,500**

Table 8-9. Clifton High Service Pump Station – Alternative 3

Item	Quantity	Units	Unit Cost	Total Cost
MERIDIAN TO NORTHERN ENTITIES				
Iredell – 6” DR-14 C-905 PVC	72,900	LF	$22.00	$1,603,800
Walnut Springs – 6” DR-14 C-905 PVC	60,900	LF	$22.00	$1,339,800
Morgan – 6” DR-14 C-905 PVC	50,800	LF	$22.00	$1,117,600
Cranfills Gap – 6” DR-14 C-905 PVC	72,600	LF	$22.00	$1,597,200
CLIFTON TO SOUTHERN ENTITIES				
Valley Mills / Lame Duck –12” DR-14 C-905 PVC	74,200	LF	$30.00	$2,226,000
Aqua Pure WSC– 6” DR-14 C-905 PVC	14,000	LF	$22.00	$308,000
Childress Creek WSC– 12” DR-14 C-905 PVC	37,700	LF	$30.00	$1,131,000
Mosheim WSC– 6” DR-14 C-905 PVC	37,100	LF	$22.00	$816,200
Mustang Valley WSC - 12” DR-14 C-905 PVC	41,600	LF	$30.00	$1,248,000
Subtotal				**$11,387,600**
Engineering (15%)				$1,708,100
Contingency (25%)				$2,846,900
Total Estimated Costs of Transmission Lines – Alternative 3 (2003 Dollars)				**$15,942,600**

Table 8-10. Cost Summary of Transmission Pipelines – Alternative 3

WTP and Raw Water Intake	$4,463,100
Off-Channel Dam and Reservoir	$4,300,800
Clifton WTP Expansion	$793,900
Meridian HSPS – For Northern Bosque County	$983,900
Clifton HSPS – For Southern Bosque County	$682,500
Transmission Pipelines	$15,942,600
Total Estimated Costs for Alternative 3 (2003 Dollars)	**$27,166,800**

Table 8-11. Cost Summary for Alternative 3- WTP, Pump Stations, Pipelines

8.4 Alternative 4
Clifton as Central Regional Treated Water Purveyor

As discussed in Chapter 6, Bosque County can take advantage of the Clifton WTP existing capacity, and eliminate the requirement for a WTP in Meridian. However, a plant expansion at Clifton would still be required. Additionally, pumping and transmission systems similar to Alternative 3 would still be required, and the Clifton to Meridian transmission pipeline discussed in Alternative 1 would be included, with the pipe diameter upsized to 12 inches. **Table 8-12** summarizes the Clifton WTP expansion costs.

Item	Quantiy	Units	Unit Cost	Total Cost
Mobilization, Bonds and Insurance	1	LS	$25,000	$25,000
Site Preparation & Grading	1	LS	$25,000	$25,000
Seeding, Fencing, Landscaping	1	LS	$8,000	$8,000
Steel Building and Foundation and Structure	1	LS	$164,000	$164,000
0.5 MGD WTP Module	1	LS	$250,000	$250,000
0.5 MGD raw water booster pump	2	EA	$10,000	$20,000
Chemical Equipment and Metering Pumps	1	LS	$13,000	$13,000
Building Process Piping	1	LS	$90,000	$90,000
New 250,000-gallon steel GST (Clearwell)	1	LS	$200,000	$200,000
Clearwell Painting	1	LS	$25,000	$25,000
Miscellaneous Equipment, Painting, Safety, Signage	1	LS	$42,500	$42,500
HVAC	1	LS	$20,000	$20,000
Electrical , I&C	1	LS	$150,000	$150,000
Subtotal				**$1,032,500**
Engineering (18%)				$185,900
Contingency (25%)				$258,100
Total Estimated Costs for Water Treatment Plant Expansion (2003 Dollars)				**$1,476,500**

Table 8-12. Clifton WTP Expansion - Alternative 4

Table 8-13 summarizes the costs for the Clifton pump station that would be required. The pump station required in Meridian would be identical to that described in Alternative 3.

Item	Quantity	Units	Unit Cost	Total Cost
Mobilization, Bonds and Insurance	1	LS	$25,000	$25,000
Site Preparation & Grading	1	LS	$9,000	$9,000
Landscaping, Seeding and Fencing	1	LS	$5,000	$5,000
Foundation and Steel Building	1	LS	$126,000	$126,000
Pumps Assemblies and Appurtenances	1	LS	$164,000	$164,000
Piping, Valves and Fittings	1	LS	$152,700	$152,700
New Site Electrical Wiring and Service	1	LS	$80,000	$80,000
Telecommunications and SCADA	1	LS	$21,000	$21,000
HVAC for Pump Station	1	LS	$7,500	$7,500
Subtotal for Pump Station				**$590,200**
Engineering (15%)				$88,500
Contingency (25%)				$147,600
Total Estimated Costs for Clifton Pump Station (2003 Dollars)				**$826,300**

Table 8-13. Clifton Pump Station Costs - Alternative 4

Table 8-14 summarizes the cost of Alternative 4.

Clifton WTP Expansion	$1,476,500
Clifton HS Pump Station to Southern Bosque County	$826,300
Meridian HSPS – For Northern Bosque County	$983,900
Transmission Pipelines (To Individual Entities)	$15,942,600
Clifton to Meridian Transmission Pipeline (12-inch DR-14)	$3,974,600
Total Estimated Costs for Alternative 4 (2003 Dollars)	**$23,203,900**

Table 8-14. Cost Summary - Alternative 4

8.5 Comparison of Alternative Costs

8.5.1 Capital Costs

Table 8-15 summarizes the capital costs of Alternatives 1 – 4, reviewed previously.

Alternative	Descriptions	Cost[1]
No. 1	The Clifton WTP provides water solely to the City of Meridian.	**$3,046,700**
No. 2	The City of Meridian builds a WTP to serve its own municipal users.	**$8,763,900**
No. 3	Two water plants to serve Bosque County, with pumping and piping infrastructure to participants in Regional Program (northern and southern entities in scope of study.)	**$27,166,800**
No. 4	Expansion of the Clifton Water Treatment Plant (WTP) into a Regional WTP. The City of Clifton supplies surface water to all county participants in Regional Program. Initial water supply system installed for year 2030 projected demands.	**$23,203,900**

[1] 2003 Dollars

Table 8-15 – Capital Cost Summary - All Alternatives

The above analysis has consisted to this point of capital costs only. On that basis, a simple evaluation of the two primary alternatives for providing treated surface water to the City of Meridian consists of comparing Alternatives 1 and 2 above. The analysis also shows that in order to provide the City of Meridian treated water, the Meridian WTP is approximately $5.7 million more expensive than using existing treated water from the Clifton WTP. In order to provide other Bosque County entities treated surface water, the Meridian WTP alternative is approximately $4.0 million more expensive.

8.5.2 Operation and Maintenance Costs

Treatment plant operation and maintenance (O&M) costs consist primarily of salaries for operation staff, electricity, treatment chemicals, equipment maintenance and maintenance costs for the dams, pipelines, and river intakes. These quantities and costs were estimated from experience with plants of similar size and technology. The budgetary analysis assumed one additional staff person for operation of the water treatment plant. The increased annual cost due to operation of the Meridian WTP is estimated to be approximately $115,000. Pump station O&M consists primarily of power costs and annual equipment wear and tear. Power costs were assumed to be $0.05/kilowatt-hour and replacement costs were assumed to be 5% of equipment costs annually. All costs assume year 2003 dollars.

O&M costs are detailed in the tables of **Section 8.7** as annual costs. It can be seen that the operation of an additional water treatment plant in the City of Meridian makes Alternatives 2 and 3 more expensive than Alternatives 1 and 4 on an annual basis. However, these costs must be incorporated with the costs of annual debt service, and the sum should in turn be compared to the overall quantity of water delivered for each entity and alternative. This analysis is accomplished in the following sections.

8.6 Analysis of Proportionate Costs

Because Alternatives 1 and 2 assume that the City of Meridian would provide only water to its municipal customers, Meridian would also bear 100% of the project costs in each of those scenarios. As is shown in **Tables 8-16** and **8-17**, the projects become more attractive economically with more participants in the water supply program.

Water User Group	Net 2030 Demand, GPD	% Of Total Demand	Proportionate Costs		Pipeline Cost[2]	Total Entity Cost
			WTP[1]	Pump Stations		
NORTHERN ENTITIES						
Meridian	120,000	50%	$4,382,000	$492,000	$0	$4,874,000
Iredell	20,000	8%	$730,300	$82,000	$2,245,300	$3,057,600
Walnut Springs	60,000	25%	$2,191,000	$246,000	$1,875,700	$4,312,700
Morgan	20,000	8%	$730,300	$82,000	$1,564,600	$2,376,900
Cranfills Gap	20,000	8%	$730,300	$82,000	$2,236,100	$3,048,400
Total Demand in North Bosque	**240,000**	**100%**	**$8,763,900**	**$983,900**	**$7,921,700**	**$17,669,600**
SOUTHERN ENTITIES						
Valley Mills / Lame Duck WSC	170,000	29%	$232,700	$200,000	$3,116,400	$3,549,100
Aqua Pure WSC	10,000	2%	$13,700	$11,800	$431,200	$456,700
Childress Creek WSC	190,000	33%	$260,100	$223,600	$1,583,400	$2,067,100
Mosheim WSC	10,000	2%	$13,700	$11,800	$1,142,700	$1,168,200
Mustang Valley WSC	200,000	34%	$273,800	$235,300	$1,747,200	$2,256,300
Total Demand in South Bosque	**580,000**	**100%**	**$793,900**	**$682,500**	**$8,020,900**	**$9,497,400**

[1] Total is equal to respective treatment plant construction or expansion costs.

[2] Individual transmission line costs, which include engineering and contingencies

[3] All costs in 2003 dollars

Table 8-16. Proportionate Costs of Alternative 3

Water User Group	Net 2030 Demand, GPD	% Of Total Demand	Proportionate Costs			Pipeline Cost[4]	Total Entity Cost
			WTP	Pipeline[2]	Pump Stations[3]		
Meridian	120,000	15%	$216,100	$1,987,300	$492,000	$0	$2,695,400
Iredell	20,000	2%	$36,000	$331,217	$82,000	$2,245,300	$2,694,517
Walnut Springs	60,000	7%	$108,000	$993,650	$246,000	$1,875,700	$3,223,350
Morgan	20,000	2%	$36,000	$331,217	$82,000	$1,564,600	$2,013,817
Cranfills Gap	20,000	2%	$36,000	$331,217	$82,000	$2,236,100	$2,685,317
Valley Mills / Lame Duck WSC	170,000	21%	$306,100	$0	$242,200	$3,116,400	$3,664,700
Aqua Pure WSC	10,000	1%	$18,000	$0	$14,200	$431,200	$463,400
Childress Creek WSC	190,000	23%	$342,100	$0	$270,700	$1,583,400	$2,196,200
Mosheim WSC	10,000	1%	$18,000	$0	$14,200	$1,142,700	$1,174,900
Mustang Valley WSC	200,000	24%	$360,100	$0	$284,900	$1,747,200	$2,392,200
Total Demand in Water Supply Project - Bosque County	**820,000**	**100%**	**$1,476,500**	**$3,974,600**	**$1,810,200**	**$15,942,600**	**$23,203,800**

[1] Total is equal to respective treatment plant construction or expansion costs.

[2] Costs of Clifton to Meridian pump station and transmission pipeline is proportioned

[3] Pump stations are proportioned per region (north / south) and include the Meridian HSPS ($983,900), and the Clifton HSPS ($826,300)

[4] Individual transmission line costs, which include contingency

[5] All costs in 2003 dollars

Table 8-17. Proportionate Cost of Alternative 4

8.7 Analysis of Debt Service and Unit Water Cost

Table 8-18 presents an analysis of the annual debt service for the proposed improvements for Meridian in each of Alternatives 1 and 2. Unit water costs are also summarized.

Alternative	Water User	Net 2030 Demand, GPD	Total Entity Cost	Annual Debt Service[1]	Annual O&M Costs	Unit Water Cost, $/1000 gal
1	Meridian	120,000	$3,046,700	$288,750	$4,200	$5.15
2	Meridian	120,000	$8,763,900	$636,688	$115,000	$17.16

[1] Debt service is assumed for 30 years at 6%

[2] All costs in 2003 dollars

Table 8-18. Debt Service, O&M and Unit Costs for Alternatives 1 and 2

Table 8-19 provides the debt service and unit water costs for each entity in Alternative 3.

Water User Group	Net 2030 Demand, GPD	Total Entity Cost	Annual Debt Service[1]	Annual O&M Costs	Unit Water Cost, $/1000 Gal
NORTHERN ENTITIES					
Meridian	120,000	$4,874,000	$354,091	$63,800	$9.54
Iredell	20,000	$3,057,600	$222,131	$10,600	$31.88
Walnut Springs	60,000	$4,312,700	$313,313	$31,900	$15.76
Morgan	20,000	$2,376,900	$172,679	$10,600	$25.11
Cranfills Gap	20,000	$3,048,400	$221,463	$10,600	$31.79
Total Demand in North Bosque	**240,000**	**$17,669,600**	**$1,283,677**	**$127,600**	**$16.11**
SOUTHERN ENTITIES					
Valley Mills / Lame Duck WSC	170,000	$3,549,100	$257,838	$39,300	$4.79
Aqua Pure WSC	10,000	$456,700	$33,179	$2,300	$9.72
Childress Creek WSC	190,000	$2,067,100	$150,173	$44,000	$2.80
Mosheim WSC	10,000	$1,168,200	$84,868	$2,300	$23.88
Mustang Valley WSC	200,000	$2,256,300	$163,918	$46,300	$2.88
Total Demand in South Bosque	**580,000**	**$9,497,400**	**$689,976**	**$134,200**	**$3.89**

[1] Debt service is assumed for 30 years at 6%

[2] All costs in 2003 dollars

Table 8-19. Debt Service, O&M and Unit Costs for Alternative 3

Table 8-20 provides the debt service and unit water costs for each entity in Alternative 4.

Water User Group	Net 2030 Demand, GPD	Total Entity Cost	Annual Debt Service[1]	Annual O&M Costs	Unit Water Cost, $/1000 Gal
Meridian	120,000	$2,695,400	$195,800	$22,400	$4.21
Iredell	20,000	$2,694,500	$195,800	$3,700	$26.55
Walnut Springs	60,000	$3,223,400	$234,200	$11,200	$10.43
Morgan	20,000	$2,013,800	$146,300	$3,700	$19.78
Cranfills Gap	20,000	$2,685,300	$195,100	$3,700	$26.47
Valley Mills / Lame Duck WSC	170,000	$3,664,700	$266,200	$31,700	$4.80
Aqua Pure WSC	10,000	$463,400	$33,700	$1,900	$9.75
Childress Creek WSC	190,000	$2,196,200	$159,600	$35,400	$2.81
Mosheim WSC	10,000	$1,174,900	$85,400	$1,900	$23.92
Mustang Valley WSC	200,000	$2,392,200	$173,800	$37,300	$2.89
Total Demand in Water Supply Project - Bosque County	**820,000**	**$23,203,800**	**$1,685,900**	**$152,900**	**$5.92**

[1] Debt service is assumed for 30 years at 6%

[2] All costs in 2003 dollars

[3] Does not include debt service from existing Clifton WTP

Table 8-20. Debt Service, O&M and Unit Costs for Alternative 4

From a unit water cost perspective, it can be seen that Alternative 4 is the most attractive for the Bosque County water supply program. It is reemphasized that none of the costs discussed in this chapter include land acquisition, legal or environmental remediation, nor do they include any debt service associated with the existing WTP at the City of Clifton.

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Chapter 9
Summary and Conclusions

This report was the result of a jointly sponsored study by the Brazos River Authority, the TWDB, and the Cities of Clifton and Meridian to determine the regional water needs of Bosque County and to evaluate existing and proposed facilities to serve the Bosque County's long-term water needs. The study was structured to address the water supply needs that exist in Bosque County and support the creation of a plan to efficiently transfer and distribute treated water through and between the existing public water supply systems using existing facilities and potential new facilities. For the purposes of this study, the scope was narrowed to specifically address the major cities and water supply corporations within Bosque County.

The future population projections were based on the TWDB Approved Population Projections for the years 2000 through 2060. The 2000 Census was used as the basis for the 2000 population for cities and county totals. This study is based on a planning horizon through 2030, therefore, projections through year 2030 were utilized.

The current population in Bosque County is approximately 17,204 people with 30 percent of the population residing in Clifton and Meridian. The total Bosque County population projections reflect a growth rate of 43% over the thirty-year period from 2000 to 2030. The year 2000 population of 17,204 is projected to increase by 7,418 persons over the thirty-year period to a total population of 24,622 in the year 2030.

Municipal demand was determined based on population projections for all entities in the scope of study. A revised version of the TWDB Bosque County municipal water demand projection was determined. This information was revised to include municipal water demand estimates for the city and utility corporations that were not accounted for in the original TWDB projections The Cities of Morgan, Iredell, and Cranfills Gap were added to the projections, as well as the Water Service Corporations of Mustang Valley, Aqua Pure, Mosheim, and Aqua Source (Lame Duck). These revised demand projections were then estimated over the thirty-year study period. The revised Bosque county water municipal demand projections also include the average day, max day, and peak hour demands.

Water supply sources available to Bosque County include both surface water and groundwater sources. Most water demands are met throughout the county through the use of groundwater wells. The City of Clifton is currently supplementing its groundwater supply with an off-channel reservoir on the Bosque River and a 1.0-MGD water treatment plant.

A water balance was performed to determine net water availability through year 2030 for each Bosque County planning entity. It was determined that the City of Clifton would have a net surplus of approximately 500,000 gpd, while all other entities would experience net water deficits for planning year 2030.

A total of four major infrastructure alternatives were developed and studied for feasibility of implementation. For each alternative, scenario descriptions and details were developed. Pipeline routings were identified, while treatment and pumping facilities were designed at the planning level. Capital as well as operating and maintenance costs were evaluated for each alternative. The four alternatives are summarized in **Table 9-1**.

Alternative	Descriptions	Cost
No. 1	The Clifton WTP provides water solely to the City of Meridian.	**$3,046,700**
No. 2	The City of Meridian builds a WTP to serve its own municipal users.	**$8,763,900**
No. 3	Two water plants to serve Bosque County, with pumping and piping infrastructure to participants in Regional Program (northern and southern entities in scope of study.)	**$27,166,800**
No. 4	Expansion of the Clifton Water Treatment Plant (WTP) into a Regional WTP. The City of Clifton supplies surface water to all county participants in Regional Program. Initial water supply system installed for year 2030 projected demands.	**$23,203,900**

Table 9-1 – Capital Cost Summary - All Alternatives

Alternatives 2 and 3 are significantly more expensive than Alternatives 1 and 4, respectively, mainly due to the cost of constructing the Meridian WTP. In a scenario where Meridian is the only other county participant besides Clifton in the use of surface water, then Alternative 1 would be the preferred option. However, in a scenario that promotes a countywide use of treated surface water in conjunction with wells, Alternative 4 is the preferred option. Common to Alternatives 1 and 4 is the concept of the Clifton WTP serving as a regional plant for Bosque County. This concept is significantly less expensive because it allows economies of scale to be realized on both capital costs and operation and maintenance costs. The savings apply to utilization of the following existing facilities in Clifton:

- Check Dam in the Bosque River
- Raw Water Intake and Pump Station
- Raw Water Transmission Main
- Off Channel Reservoir
- Water Treatment Plant

Based on information gathered about these facilities during this study, the capacity exists at each of these facilities to expand from 1.0 MGD to 1.5 MGD with only the addition of a parallel treatment train. The expansion to 2.0 MGD is also feasible with another treatment train, but would also require plant foundation and building additions. This offers significant cost savings to options where this infrastructure would have to be built in its entirety.

Table 9-2 provides a summary of Alternative 4. It can be seen that sharing the proportionate cost of the Clifton-Meridian transmission pipeline and pump station would provide the City of Meridian with the lowest unit water cost of approximately $4.47 per thousand gallons.

For some of the smaller entities, however, none of the alternatives are economically attractive. These entities are water users with small 2030 net demand, whose geographies would require long transmission mains to deliver the water.

Nevertheless, the foregoing study may be used as a planning tool for Bosque County. It is believed that some of the outlying entities may continue to use groundwater to meet their municipal needs, because those groundwater supplies would become more reliable as other entities began to rely on surface water.

Water User Group	Net 2030 Demand, GPD	Total Entity Cost	Annual Debt Service[1]	Annual O&M Costs	Unit Water Cost, $/1000 Gal
Meridian	120,000	$2,695,400	$195,800	$22,400	$4.21
Iredell	20,000	$2,694,500	$195,800	$3,700	$26.55
Walnut Springs	60,000	$3,223,400	$234,200	$11,200	$10.43
Morgan	20,000	$2,013,800	$146,300	$3,700	$19.78
Cranfills Gap	20,000	$2,685,300	$195,100	$3,700	$26.47
Valley Mills / Lame Duck WSC	170,000	$3,664,700	$266,200	$31,700	$4.80
Aqua Pure WSC	10,000	$463,400	$33,700	$1,900	$9.75
Childress Creek WSC	190,000	$2,196,200	$159,600	$35,400	$2.81
Mosheim WSC	10,000	$1,174,900	$85,400	$1,900	$23.92
Mustang Valley WSC	200,000	$2,392,200	$173,800	$37,300	$2.89
Total Demand in Water Supply Project - Bosque County	**820,000**	**$23,203,800**	**$1,685,900**	**$152,900**	**$5.92**

[1]Costs based on total infrastructure required for water user group; shared costs of some infrastructure based on proportion of total treated water distributed.

[2] Debt service is assumed for 30 years at 6%

[3] Does not include debt service from existing Clifton WTP

Table 9-2. Debt Service and Unit Costs for Alternative 4

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Chapter 10
Recommendations and Implementation Plan

Based on the alternative and economic analyses developed in previous chapters, a recommended plan for transfer of water between public water supply facilities in Bosque County has been developed. This chapter provides a description of the recommended alternative with an implementation and phasing plan for construction of new facilities. Also included in this chapter are descriptions of alternatives for financing the recommended plan.

10.1 Recommended Alternative

Construction costs and unit water costs were developed and presented in the previous chapters. From this analysis, it was determined that the unit water costs of the best alternative would present water rates that would be significantly higher than the current rates paid at each entity, and that the entities would probably not elect to participate in the program. Based on estimated rates, it was assumed that the communities of Morgan, Walnut Springs, Iredell and Cranfills Gap would not participate. On the same basis, the entities that might realistically elect to participate are believed to include:

- The City of Clifton,
- The City of Meridian,
- Valley Mills WSC,
- Childress Creek WSC, and
- Mustang Valley WSC.

Based on only the participation of the above entities mentioned, the revised alternative construction costs are presented in **Table 10-1**. The costs included the construction improvements required to implement each respective alternative described, such as pumping stations, pipelines, and new or expanded water treatment facilities.

Alternative	Descriptions	Cost
No. 1	The Clifton WTP provides water solely to the City of Meridian.	**$3,046,700**
No. 2	The City of Meridian builds a WTP to serve its own municipal users.	**$8,763,900**
No. 3	Two water plants to serve Bosque County: Clifton serves remaining participants in the south, while Meridian builds a WTP to serve its own municipal users.	**$17,098,300**
No. 4	Expansion of the Clifton Water Treatment Plant (WTP) into a Regional WTP. The City of Clifton supplies surface water to all remaining participants in Regional Program (those described above). Initial water supply system installed for year 2030 projected demands.	**$11,796,600**

Table 10-1. Revised Alternative Construction Costs Based on Realistic Program Participants

The costs do not include land acquisition, legal or environmental remediation, nor do they include any debt service associated with the existing WTP at the City of Clifton. Contingencies were assumed to be 25% due to inherent uncertainties at the planning level. Engineering fees include preliminary and detailed design, surveying, and general representation during construction. These costs were assumed to be 15% of construction costs for pipelines and pump stations, while treatment plant design fees were assumed to be 18%.

Likewise, the revised unit water costs per thousand gallons delivered are shown in **Table 10-2**.

Water User	Unit Water Cost, $/1,000 gallons[1]			
	Alt 1	Alt 2	Alt 3	Alt 4
Meridian	$5.15	$17.16	$17.25	$6.07
Valley Mills / Lame Duck WSC	NA	NA	$4.81	$4.95
Childress Creek WSC	NA	NA	$2.82	$2.96
Mustang Valley WSC	NA	NA	$2.90	$3.04

[1] Unit water costs includes annual O&M (salary, chemicals, power, & annualized replacement costs), and debt service assumed to be 6%.

Table 10-2. Revised Unit Water Costs Based on Realistic Program Participants

Table 10-2 shows that from a unit cost perspective, Alternative 4 would still be the most attractive of all the alternatives. The recommended alternative is therefore Alternative 4 presented above, or some hybrid of Alternative 4 whose entities choose to participate.

For the City of Meridian, the revised case Alternatives 1 and 4 are essentially the same. Meridian is the only entity served by the Clifton-Meridian pipeline in the revised Alternative 4 because it was assumed that the communities of Morgan, Walnut Springs, Iredell and Cranfills Gap would not participate due to prohibitive cost. The slight difference in unit water cost between Alternatives 1 and 4 is based on the fact that an expansion in treatment capacity would be required at the Clifton WTP for Alternative 4, for which Meridian would bear a proportionate cost. The unit cost for Alternative 4 discussed in Chapter 8 assumed that Meridian would only bear a proportionate burden of the pipeline expense, whereas, the figure cited above assumes Meridian will assume the full Clifton-Meridian Pipeline burden along with the proportionate cost of the Clifton WTP upgrade and O&M.

All non-participants in the regionalization program would remain on groundwater, which would be predicted to become more reliable after transition of the heavier groundwater users (e.g., those entities shown in Table 10-2) to surface water. Although the groundwater supplies to non-participants are believed to continue their reliability through the year 2030, these communities should continue to monitor their supplies for quantity and quality, and reevaluate their requirements for surface water should the need present itself.

10.2 Project Phasing

Surface water needs for the City of Meridian are considered to be immediate. Year 2000 deficits were determined to be 90,000 gallons per day increasing to 120,000 gallons per day in 2030.

Similarly, Valley Mills, Childress Creek and Mustang Valley WSCs are indicating year 2000 deficits of 150,000, 90,000, and 70,000 gallons per day, respectively. Their needs are also considered to be immediate.

Routing studies will soon be underway for the Clifton-Meridian pipeline and this project is proposed for Phase I. The remainder of the program is proposed for Phase II. **Figure 10-1** shows that if preliminary design were to begin during early 2004, construction could be complete by late 2006. Six months were estimated for project contracting and financing among entities.

10.3 Project Financing

The world of project financing encompasses a wide range of possibilities. Each regional project has its own set of circumstances, participant's needs and constraints, and political factors that must be carefully evaluated before a final recommendation can be made. All of the options cited herein are to be considered preliminary and could change once the process of negotiating the contracts with the participants is completed. Many of the possible funding alternatives are listed below.

- Bond Market
- Texas Water Development Board (TWDB)
- Rural Water Assistance Fund
- Texas State Office of Rural Community Affairs (ORCA)
- Texas Department of Agriculture - Texas Capital Fund
- USDC (Dept. of Commerce) Economic Development Administration (EDA)
- Private/Government Grants and Loans
- Legislative Appropriations (Direct Monies via Federal Legislator)
- USDA Rural Development (RD)
- Environmental Protection Agency
- Corp of Engineers
- Bureau Of Reclamation, Wastewater Reuse Programs

Not all of the funding mechanisms bulleted above will prove fruitful in providing monies or credit to the participating entities. The most important of those, however, are described in further detail below.

10.3.1 Bond Market

General obligation bonds are long-term debt instruments much like house mortgages. Ad valorem taxes generally fund improvements financed through these debt instruments. These projects include municipal facilities, park improvements, and street improvements. Financing for the annual program is provided by the "cash flow" approach, whereby bonds are sold each year to generate enough cash to pay the actual expenditures during the year for both existing and new projects. This approach provides the most efficient use of the public tax dollars by allowing multi-year projects to be initiated without issuing bonds for the full cost of the projects, and by keeping bond sales down to only the estimated cash outlay requirements.

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Revenue bonds may be issued on the open market or through the TWDB Drinking Water State Revolving Fund (DWSRF), and are funded by revenues from specific projects such as the Bosque County Regional Water Program. If bonds were to be issued to the TWDB through its DWSRF, such funds would be subject to the availability of funding from the State, the completion of a pre-application, the rating and ranking of the project by the TWDB, and other application requirements and approval procedures. The DWSRF funding is provided at interest rates lower than the market offers to political subdivisions and can be advantageous in certain instances involving economically distressed areas.

Contract revenue bonds are similar to general revenue bonds in that the Brazos River Authority issues them. However, the holders of these bonds would not be able to look to all Brazos River Authority revenues for payment; only to those revenues that the Brazos River Authority receives from the contract with the new program participants. The ratings would be determined by the credit of the participants rather than the credit of the Brazos River Authority. Contract revenue bonds are very common in Texas. Most river authorities issue contract revenue bonds rather than system revenue bonds. The TWDB has purchased numerous contract revenue bond issues over the years.

Individual member revenue bonds can also be used to fund the project. Under this scenario, the Brazos River Authority would contract to own and construct the project, but would not issue any bonds for the capital costs. Individual members would issue the bonds, and then pay cash for the project. The credit ratings would be determined on an individual issuer basis.

Generally, each of these options should be able to attain an investment grade bond rating and should additionally be qualified for triple-A rated bond insurance, if necessary. Each of these options should provide for the debt to be tax-exempt and should meet all qualifications for the DWSRF lending program offered by the TWDB.

10.3.2 Texas Water Development Board

In addition to the bonding role described previously, the TWDB sponsors other public water supply funding mechanisms such as:

- D Fund - State money loaned at variable interest rates for 25 years. The rate as of December 2003 was 5.5%.
- Drinking Water State Revolving Fund - This funding is still a loan but at a variable interest rate around 3% as of December 2003, with a 20-year loan; 30 yr loan if entity is disadvantaged. If a community wishes to be considered for this funding, they must complete a Priority List Application and return it to TWDB by February 2004. The applications are then sent the Texas Commission on Environmental Quality and ranked numerically according to need in the summer of 2004 and placed on the 2005 Priority List starting with most immediate need. The amount of funds from the Federal Government determines how many from the list are invited to receive financial assistance. Approximately $60 million/year of federal funding is available.
- State Participation Fund – TWDB assists local entities with construction of larger projects such as the Bosque County Regionalization Program because individual local entities cannot afford all program aspects. TWDB would hold the remaining project share until a future date, at which time the local entity would be required to buy the TWDB's share.

10.3.3 Rural Water Assistance Fund (RWAF)

To help meet rural area needs for clean, dependable and affordable water, Texas lawmakers created the Rural Water Assistance Fund (RWAF) program, and named the TWDB as program administrator. The RWAF program is designed to provide low-interest loans to rural political subdivisions for water projects. Rural political subdivisions may include nonprofit water supply corporations, water districts, or municipalities serving a population of up to 10,000, or that otherwise qualify for federal financing, or counties in which no urban area has a population exceeding 50,000.

According to federal law, a state is allowed to make tax-exempt private activity bonds available for certain types of privately-owned projects that benefit the public, such as those that would be financed through the RWAF. Federal law restricts the amount of these bonds available each year and they are awarded through a lottery system. At the October lottery, the TWDB received a reservation of private activity cap for $25 million. Staff developed rules and guidelines for the program, and issued and sold bonds with the intention of providing funding for the program.

RWAF loans may be used to fund capital construction projects that may include line extensions, overhead storage, the purchase of well fields, the purchase or lease of rights to produce groundwater, and interim financing of construction projects. A rural water utility may also use the fund to obtain water supplied by a larger utility or to finance the consolidation or regionalization of a neighboring utility.

This flexible term finance program provides borrowers with attractive interest rates, up to a 40-year maturity on loans (consistent with the useful life of the project), and quick turn-around time on loan applications. An additional significant benefit is a sales tax exemption to nonprofit water supply corporations for any RWAF-funded project. Since many of the service providers in rural areas are nonprofit water supply corporations that do not enjoy tax-exempt status, this particular provision makes the RWAF a very attractive funding source. In addition, a rural water utility may also enter into an agreement with a federal or state agency to submit a joint application for financial assistance. RWAF loans will be available on a first-come, first-served basis to qualifying rural entities.

10.3.4 Texas State Office of Rural Community Affairs

The Texas State Office of Rural Community Affairs (ORCA) has two project funding assistance mechanisms:

- Community Development Block Grant (CDBG)
- Urgent Need / Disaster Fund (Used For Catastrophic Events)

The U.S. Congress created the CDBG program in 1974. It is administered by the U.S. Department of Housing and Urban Development (HUD), and provides “non-entitlement” funding to Counties fewer than 50,000 in population and counties not eligible for entitlement status. Non-entitlement localities generally have to compete on a statewide basis for funding. In 1981, Congress transferred the responsibilities of many block grant programs to the states. The low authorized the states to administer the non-entitlement portion of the CDBG program. In 1983, the Texas Deportment of Housing and Community Development assumed administration of the program.

The Texas Community Development Program provides grants and loans on a competitive basis to non-entitlement cities in Texas. To qualify for eligibility, the entity must demonstrate that a serious and immediate threat to health and safety of the public exists, and the entity must have the authority and ability to levy local property and /or local sales taxes.

10.3.5 Texas Department of Agriculture – Texas Capital Fund

The Texas Capital Fund (TCF) program is administered by the Texas Department of Agriculture through an interagency agreement with the Office of Rural Community Affairs (ORCA). The TCF program encourages business development, retention, or expansion by providing funds to eligible applicants. Funds will be awarded for the express purpose of assisting in the creation of new permanent jobs or retention of existing permanent jobs. These funds are a part of the U. S. Department of Housing and Urban Development's (HUD) Community Development Block Grant (CDBG) program, which is also known as the Texas Community Development Program (TCDP) described above.

10.3.6 US Department of Commerce Economic Development Administration

The Economic Development Administration (EDA) was established to generate jobs, help retain existing jobs, and stimulate industrial, technological, and commercial growth in economically distressed areas of the United States. EDA assistance is available to rural and urban areas of the nation experiencing high unemployment, low income, or other severe economic distress. The program features public utility construction funds up to $1,000,000, with funding in 2004. However, the applicants must prove that funds used will keep jobs and / or businesses in the community or bring in more jobs.

10.4 Selecting a Financial Alternative

The financing alternative that provides sufficient funding for the project at the lowest interest cost should be selected. State and federal agencies generally add a premium on the base interest rate for facilitating the financing. In today's historically low interest bond market, the credit rating of the project participants may result in a lower interest costs than issuing the debt through a state or federal agency.

10.5 Other Funding Issues

There are no known contractual issues pending that might keep entities from immediately participating in the surface water regionalization program. However, entities that do choose to participate should be aware that surface water is typically more expensive than groundwater, and should begin to plan now for future needs. More importantly, residents should be educated on the benefits of a reliable water resource and that such a resource will inevitably require higher water utility rates. It is even recommended that those utilities begin to raise rates as soon as possible to both get customers used to higher rates, and to be able secure financing at the appropriate time.

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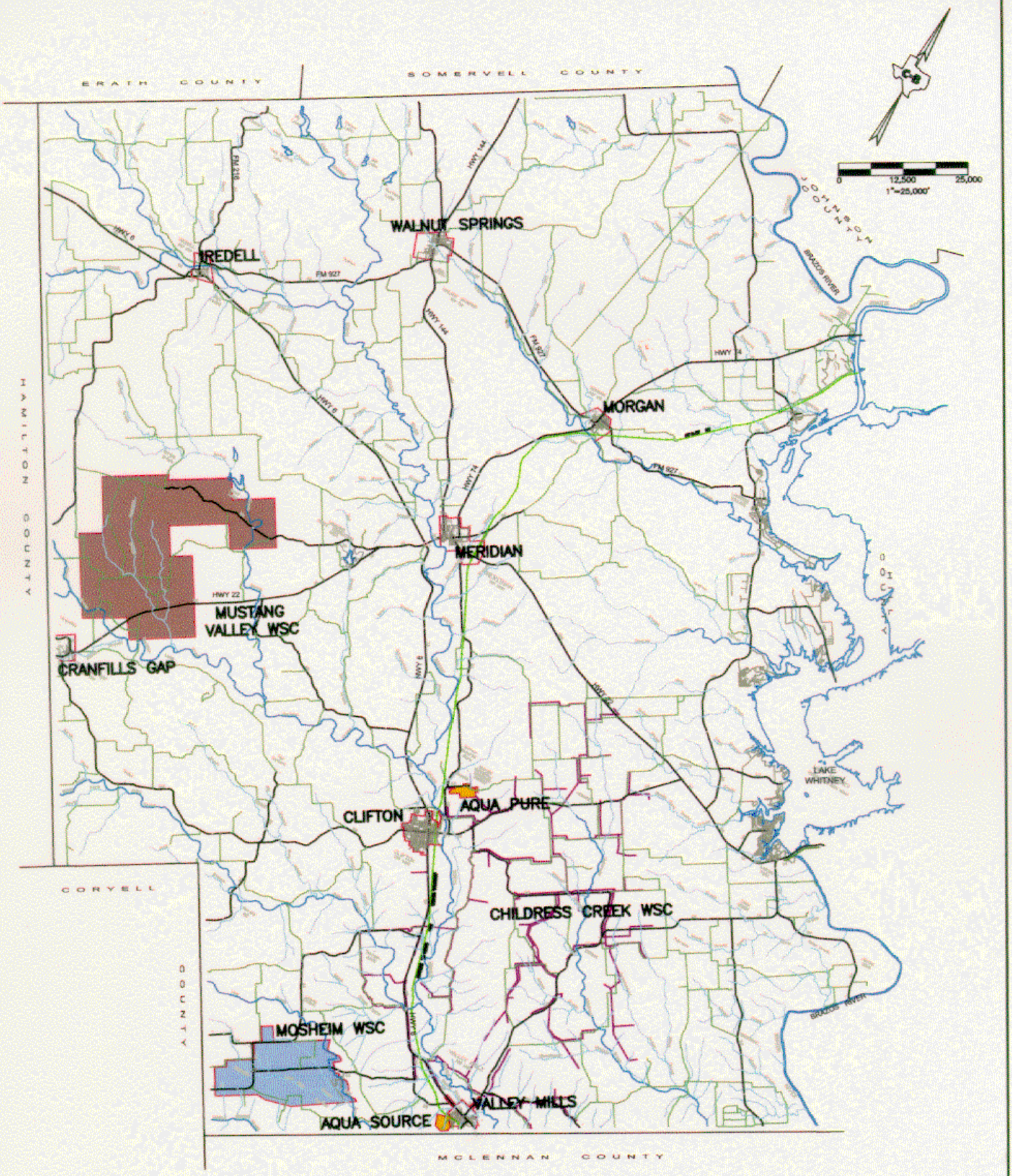
HDR Engineering, Inc. (HDR), "Brazos G Regional Water Planning Area, Regional Water Plan," Texas Water Development Board, January, 2001



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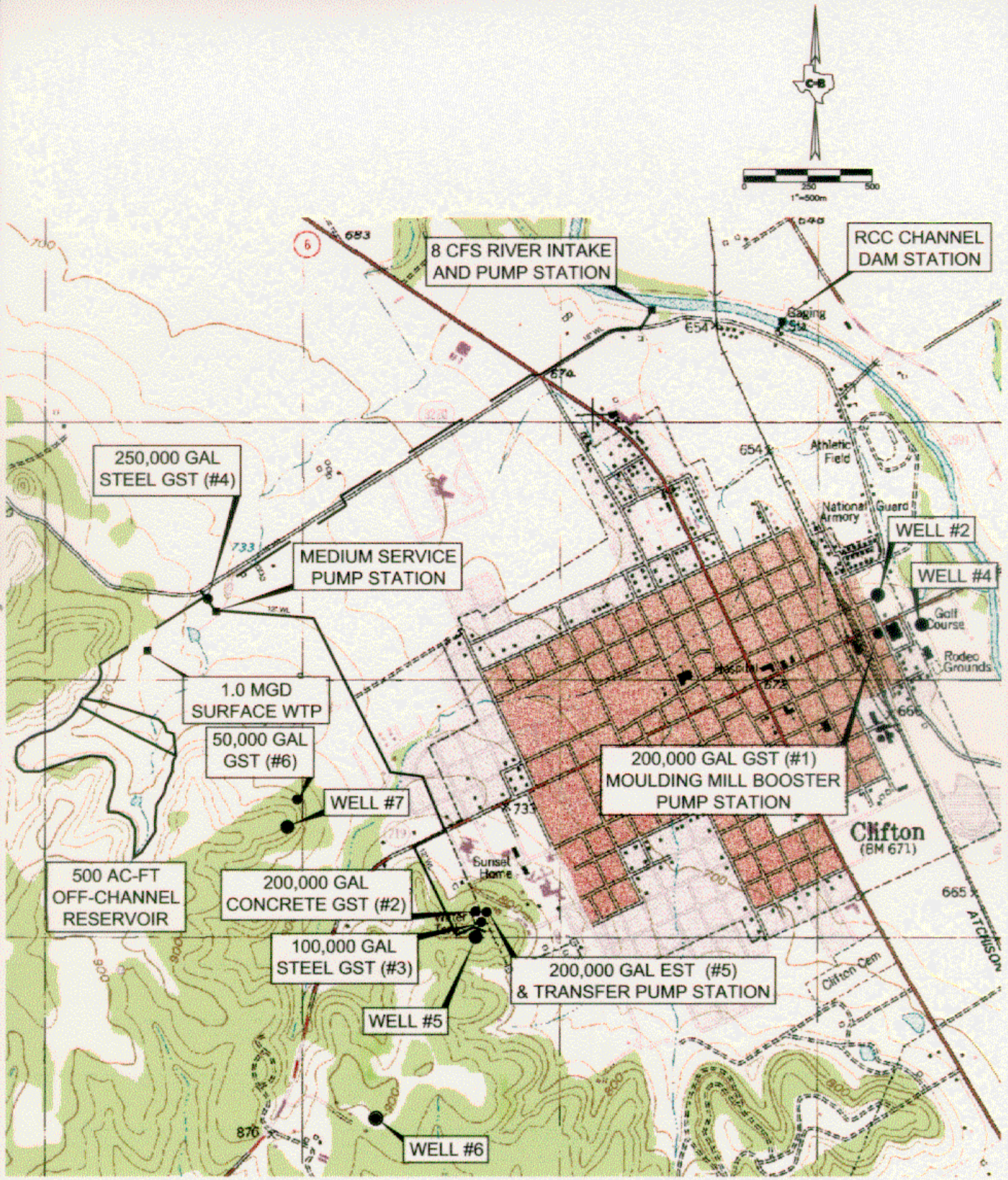
PLANNING ENTITY LOCATION MAP

BOSQUE COUNTY WATER SUPPLY MASTER PLAN

FIGURE 1-1

DATE: Mar. 03, 2004 | SCALE: 1"=25,000' | DRAWN BY: SHOPPADM | PROJECT No.: 050419

FILE: K:\2004\19 Bosque County\CAD\Submittals\Overall Plan Alt Fig 1-1.dwg



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CITY OF CLIFTON
WATER SUPPLY AND STORAGE FACILITIES

BOSQUE COUNTY WATER SUPPLY MASTERPLAN

FIGURE 4-1

DATE: Mar. 03, 2004 | SCALE: 1"=500m | DRAWN BY: SHOPPADM | PROJECT No.: 050419

FILE: N:\050419 Bosque County\GIS\GIS_Arcmap\Jan11-GIF004.dwg

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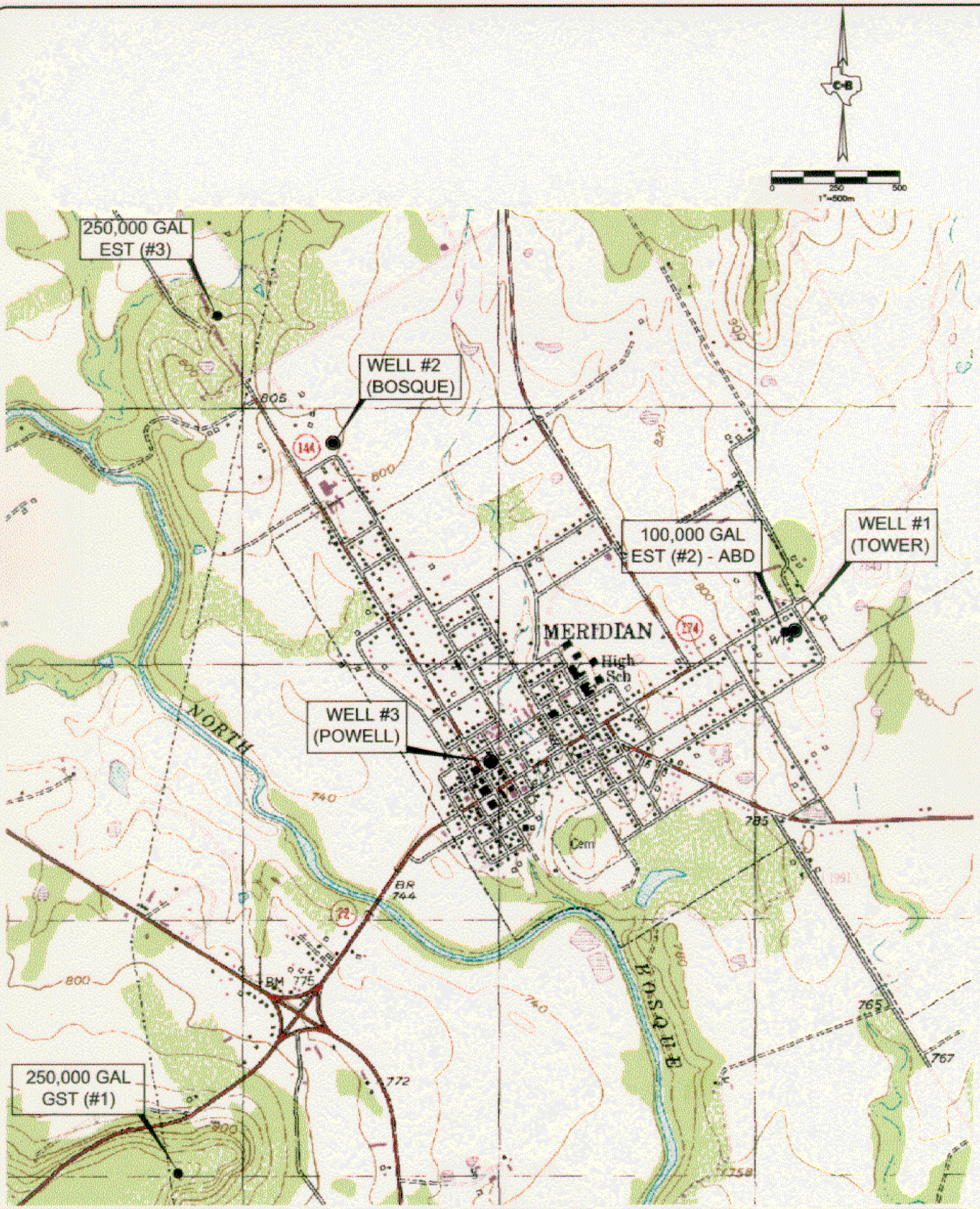
MOSHEIM WSC
WATER SUPPLY AND STORAGE FACILITIES

BOSQUE COUNTY WATER SUPPLY MASTER PLAN

FIGURE 4-10

DATE: Mar. 03, 2004 | SCALE: 1"=3000m | DRAWN BY: SHOPPADM | PROJECT No.: 050419



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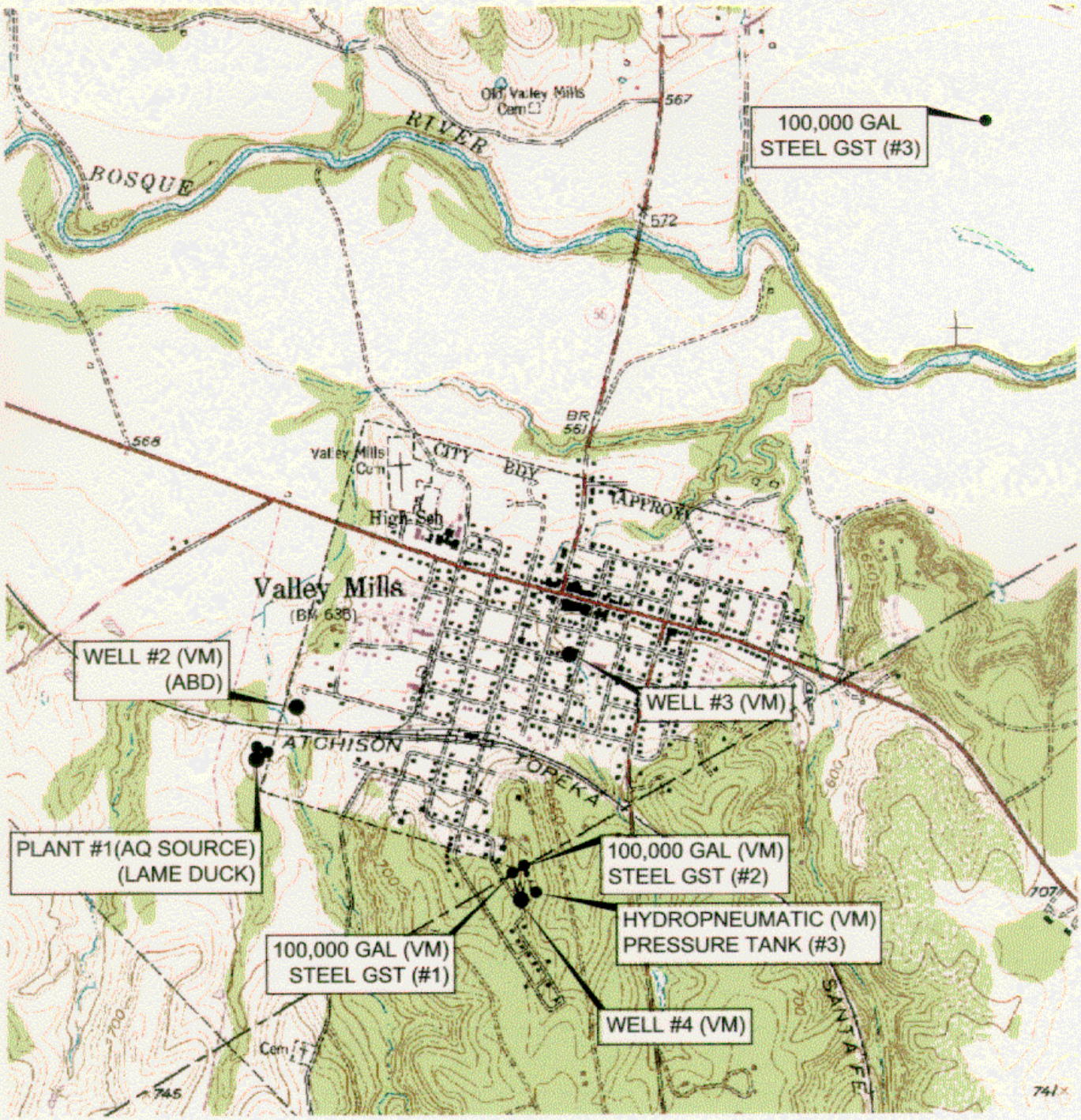
CITY OF MERIDIAN
WATER SUPPLY AND STORAGE FACILITIES

BOSQUE COUNTY WATER SUPPLY MASTER PLAN

FIGURE 4-2

DATE: Mar. 03, 2004	SCALE: 1"=500m	DRAWN BY: SHOPPADM		PROJECT No.: 050419



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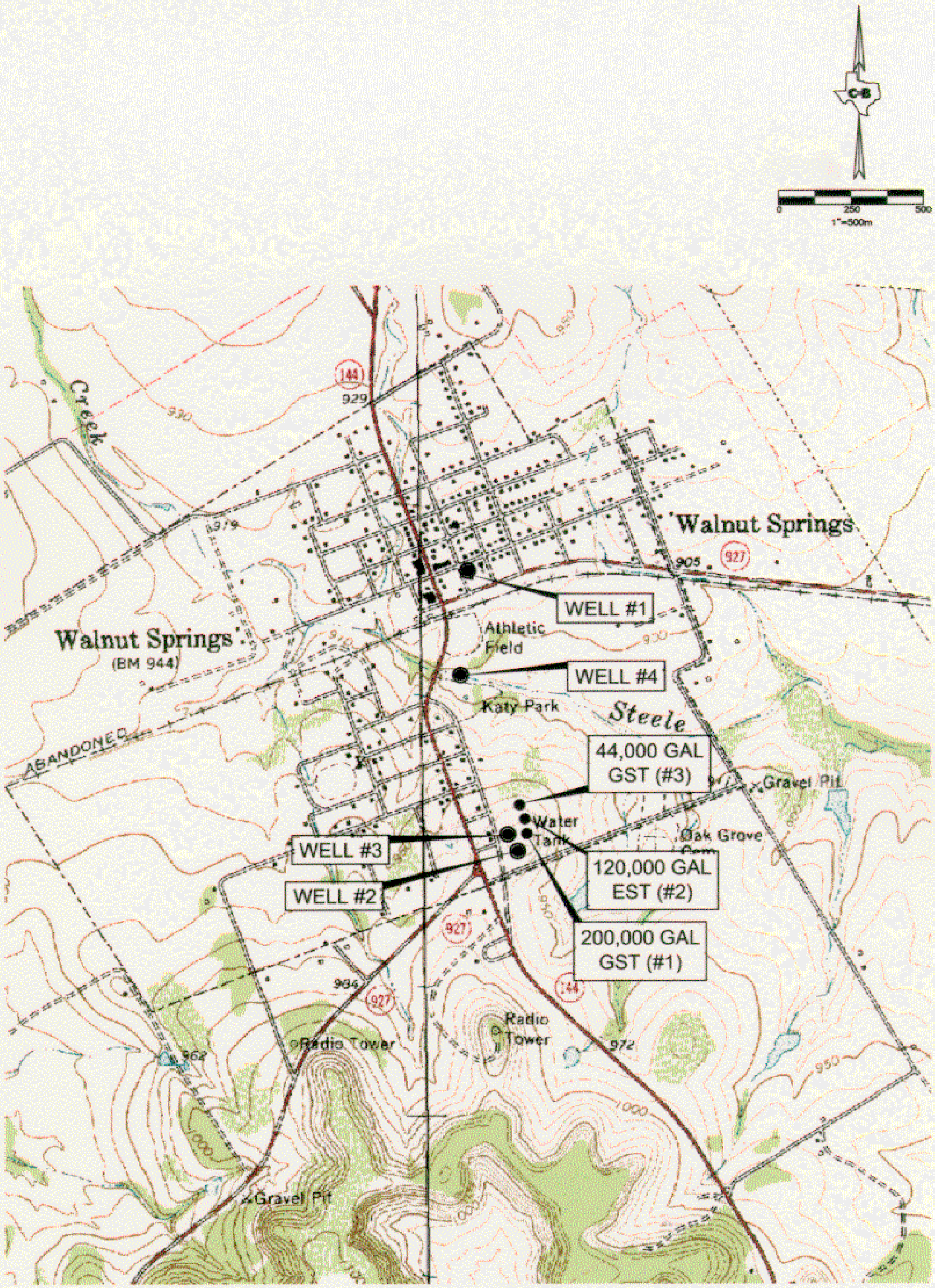
CITY OF VALLEY MILLS & AQUA SOURCE (LAME DUCK)
WATER SUPPLY AND STORAGE FACILITIES

BOSQUE COUNTY WATER SUPPLY MASTER PLAN

FIGURE 4-3

DATE: Mar. 03, 2004 | SCALE: 1"=500m | DRAWN BY: SHOPPADM | PROJECT No.: 050419

FILE: K:\050419 Bosque County\CADD\Arcgrid\Art1-VALLEY MILLS.dwg



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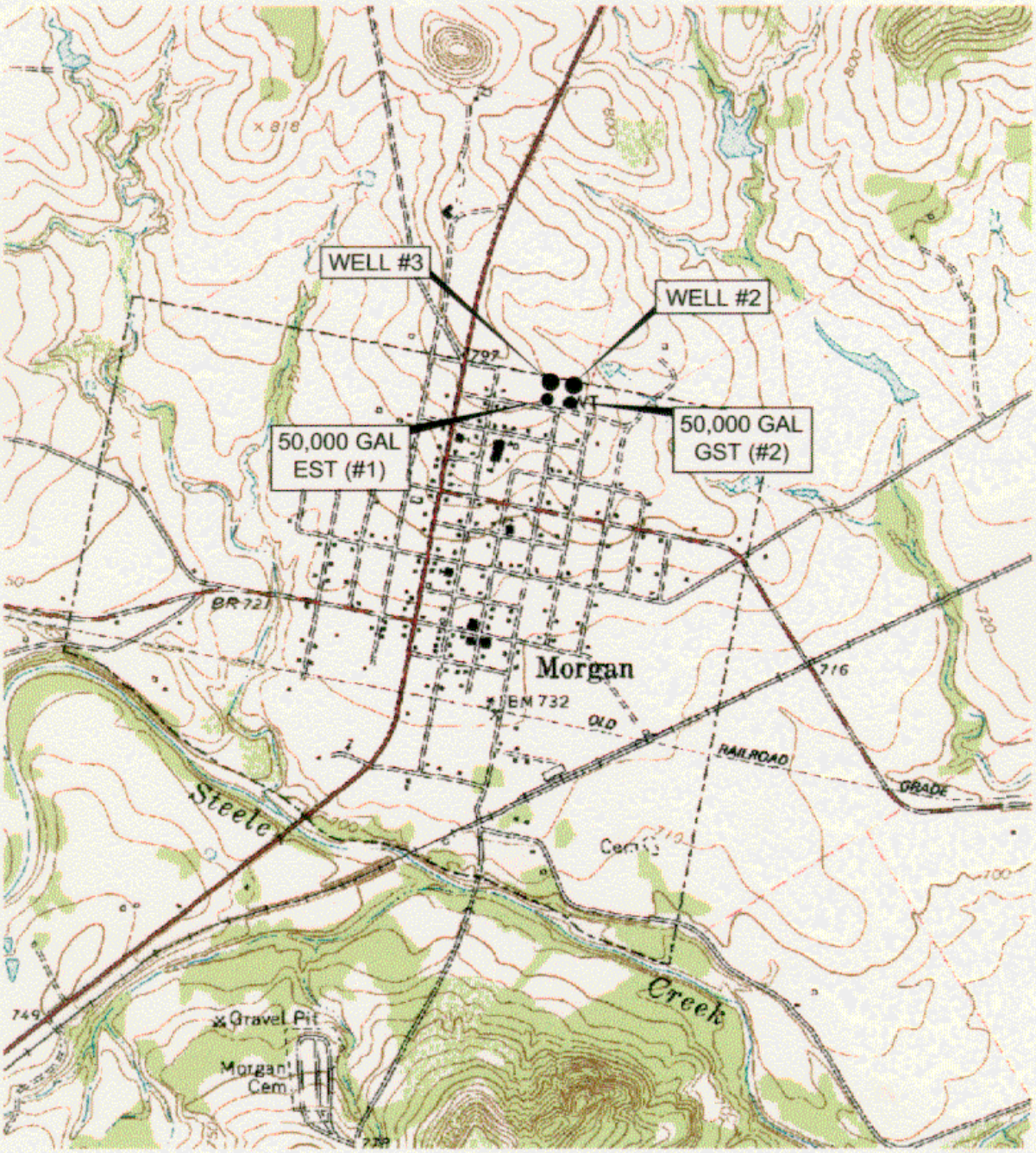
CITY OF WALNUT SPRINGS
WATER SUPPLY AND STORAGE FACILITIES

BOSQUE COUNTY WATER SUPPLY MASTER PLAN

FIGURE 4-4

DATE: Mar. 03, 2004 SCALE: 1"=500m DRAWN BY: SHOPPADM PROJECT No.: 050419



0 250 500
1"=500m

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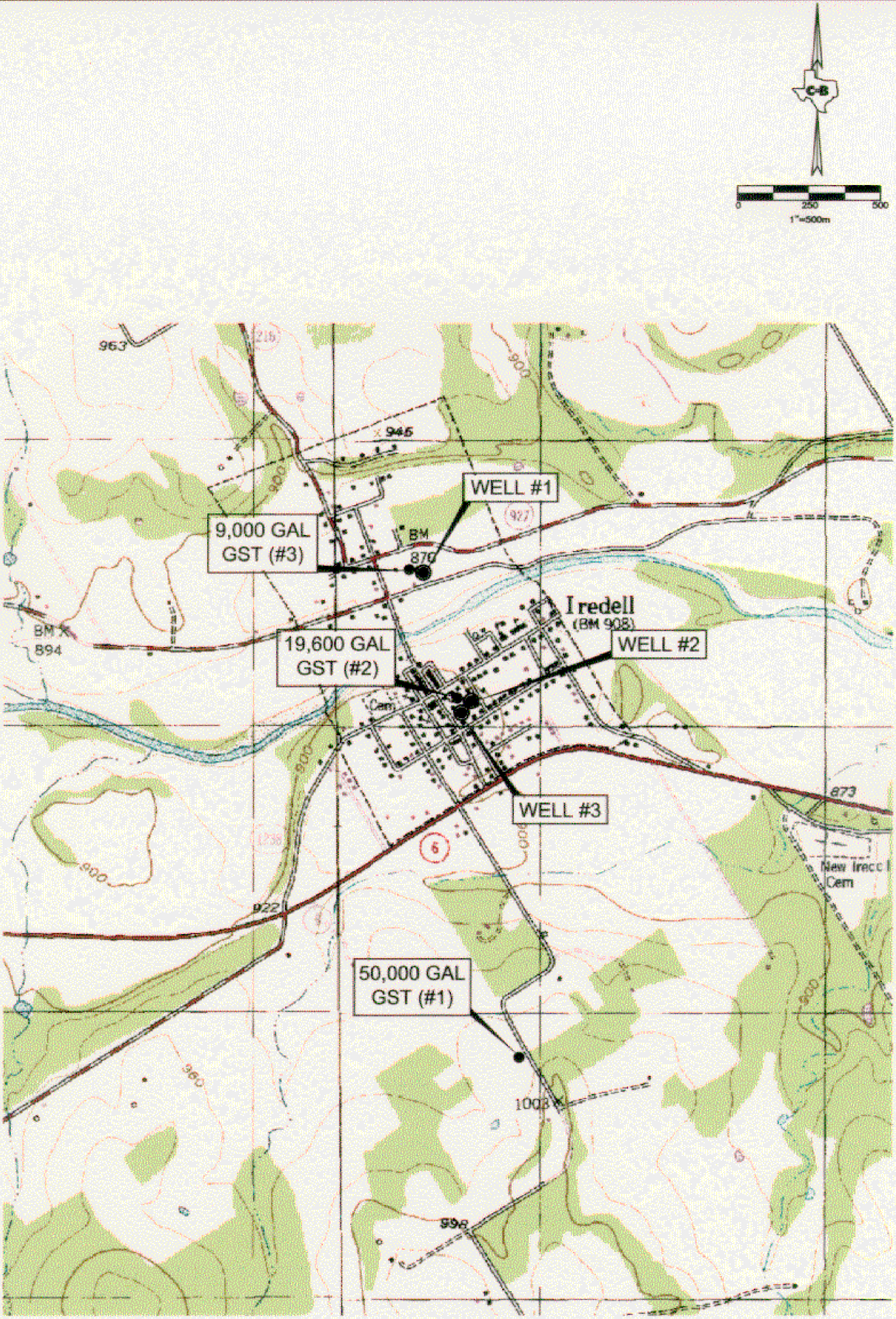
CITY OF MORGAN
WATER SUPPLY AND STORAGE FACILITIES

BOSQUE COUNTY WATER SUPPLY MASTER PLAN

FIGURE 4-5

DATE: Mar. 03, 2004 | SCALE: 1"=500m | DRAWN BY: SHOPPADM | PROJECT No.: 050419

FILE: K:\050419 Bosque County\GIS\Arcmap\fig4-5_MORGAN.dwg



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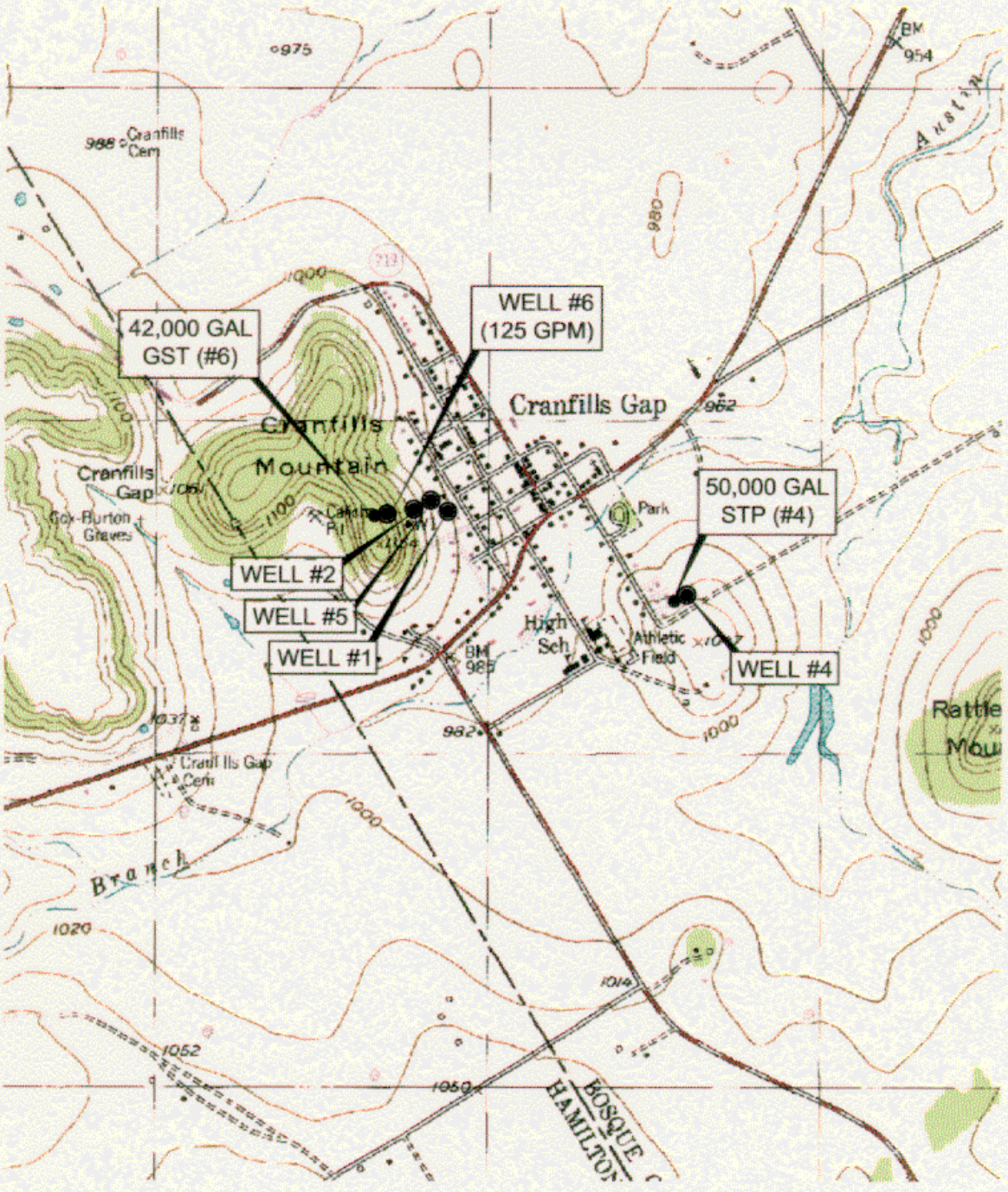
CITY OF IREDELL
WATER SUPPLY AND STORAGE FACILITIES

BOSQUE COUNTY WATER SUPPLY MASTER PLAN

FIGURE 4-6

DATE: Mar. 03, 2004 | SCALE: 1"=500m | DRAWN BY: SHOPPADM | PROJECT No.: 050419



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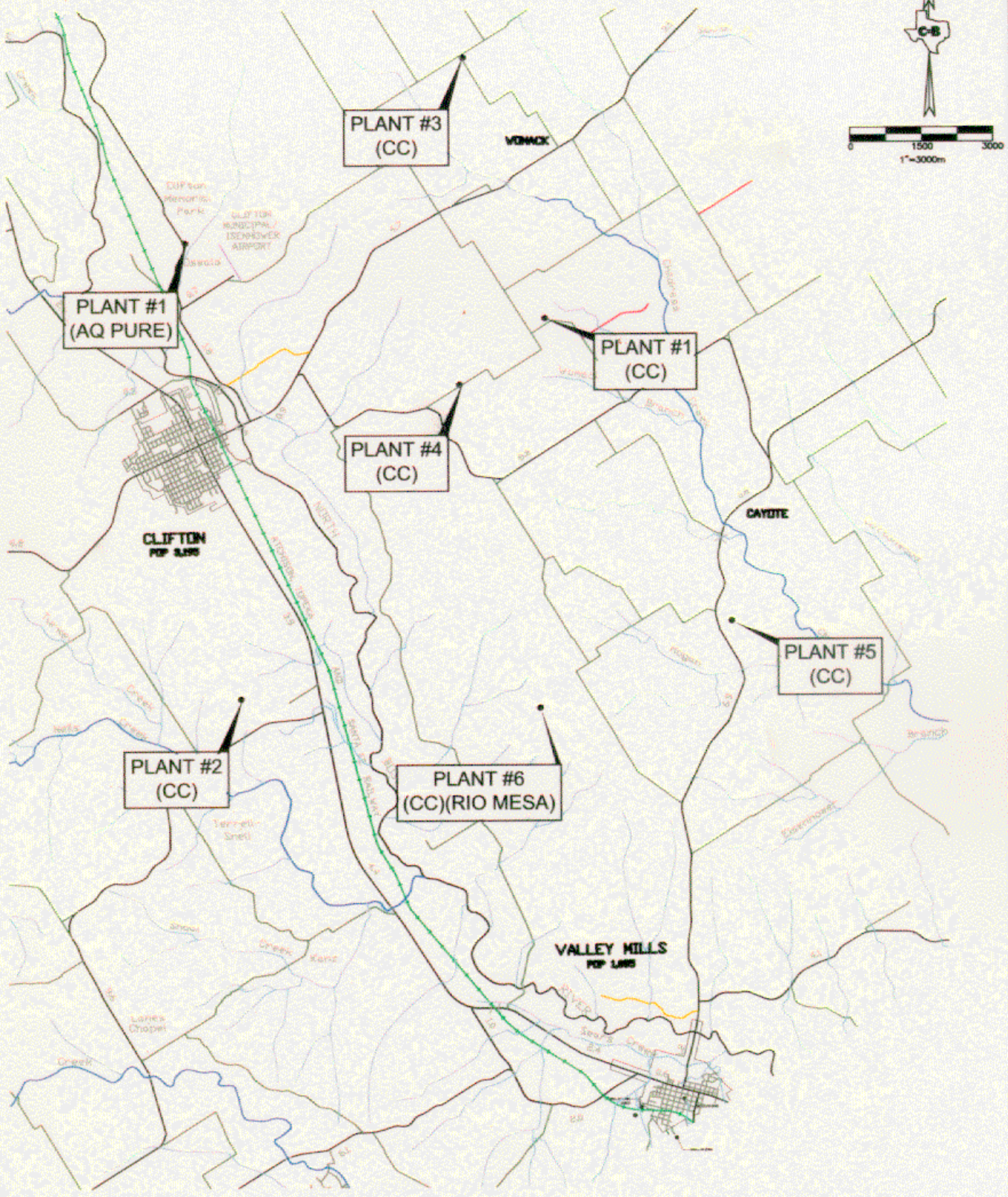
CITY OF CRANFILLS GAP
WATER SUPPLY AND STORAGE FACILITIES

BOSQUE COUNTY WATER SUPPLY MASTER PLAN

FIGURE 4-7

DATE: Mar. 03, 2004 | SCALE: 1"=500m | DRAWN BY: SHOPPADM | PROJECT No.: 050419



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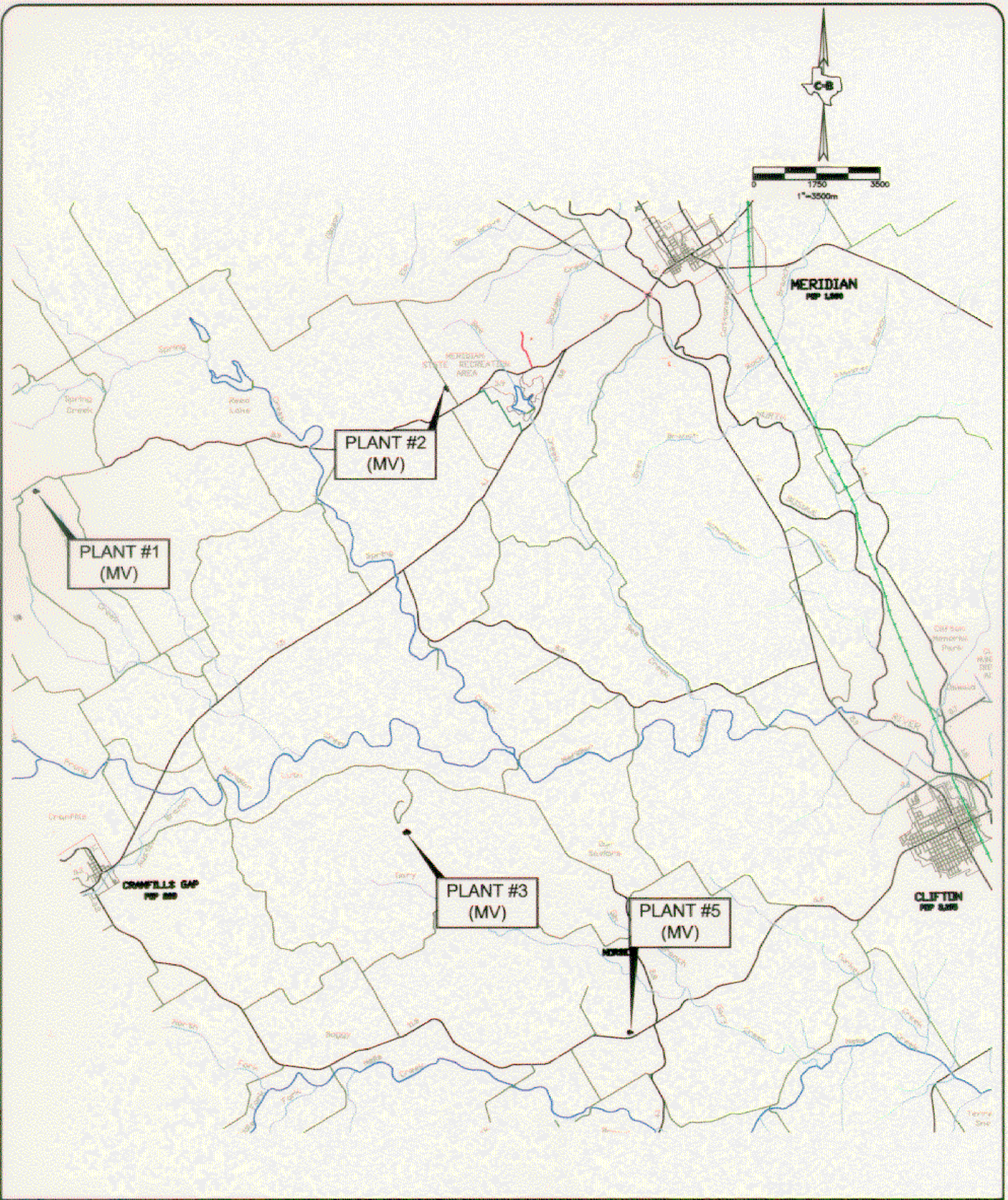
CHILDRESS CREEK & AQUA PURE
WATER SUPPLY AND STORAGE FACILITIES

BOSQUE COUNTY WATER SUPPLY MASTER PLAN

FIGURE 4-8

DATE: Mar. 04, 2004 | SCALE: 1"=3000m | DRAWN BY: SHOPPADM | PROJECT No.: 050419

FILE: K:\050419 Bosque County\CADD\Arcmpro\Job11-CHILDRESS CRK-2.dwg



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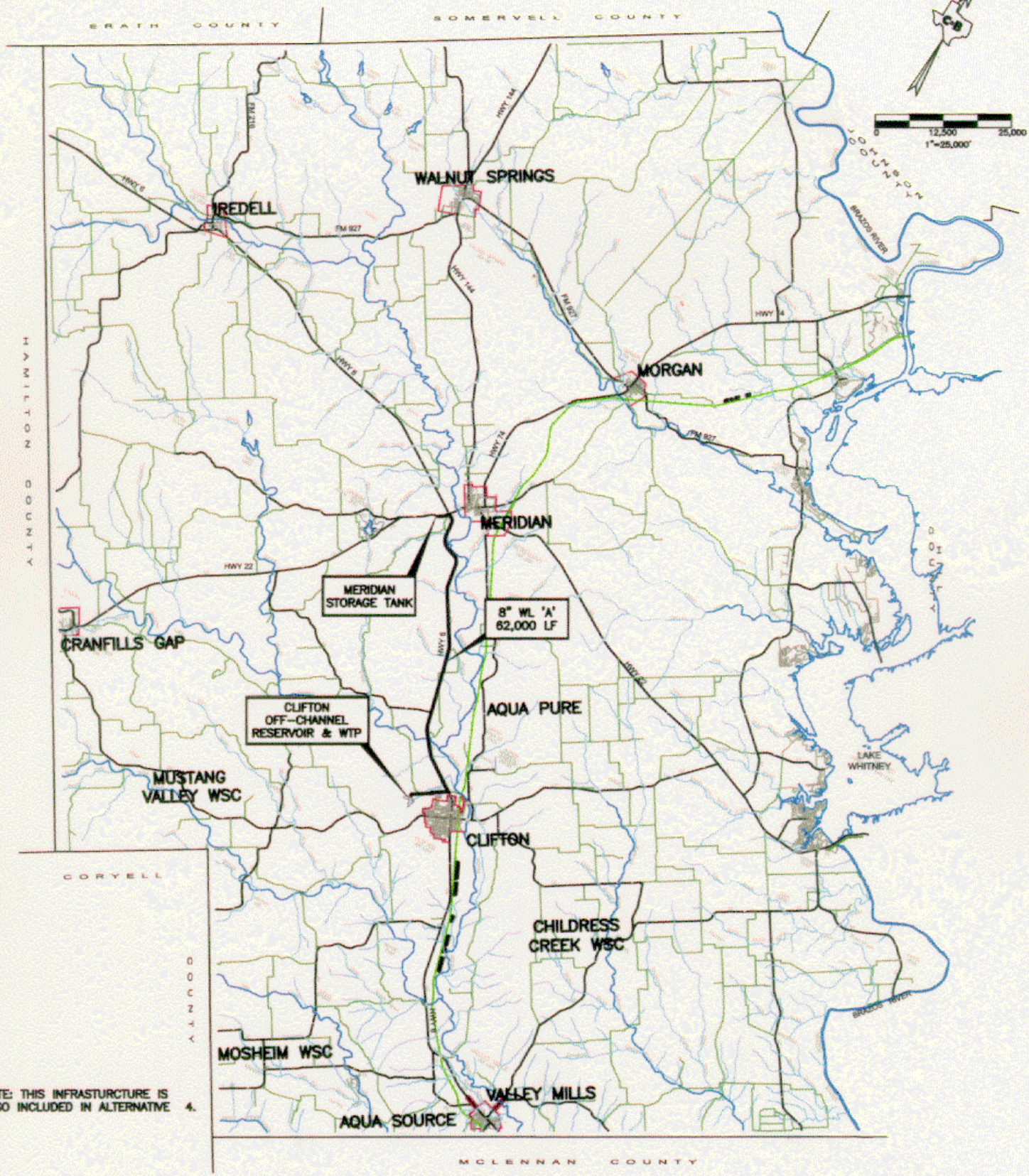
MUSTANG VALLEY WSC
WATER SUPPLY AND STORAGE FACILITIES

BOSQUE COUNTY WATER SUPPLY MASTER PLAN

FIGURE 4-9

DATE: Mar. 03, 2004	SCALE: 1"=3500m	DRAWN BY: SHOPPADM	PROJECT No.: 050419



NOTE: THIS INFRASTURCTURE IS ALSO INCLUDED IN ALTERNATIVE 4.

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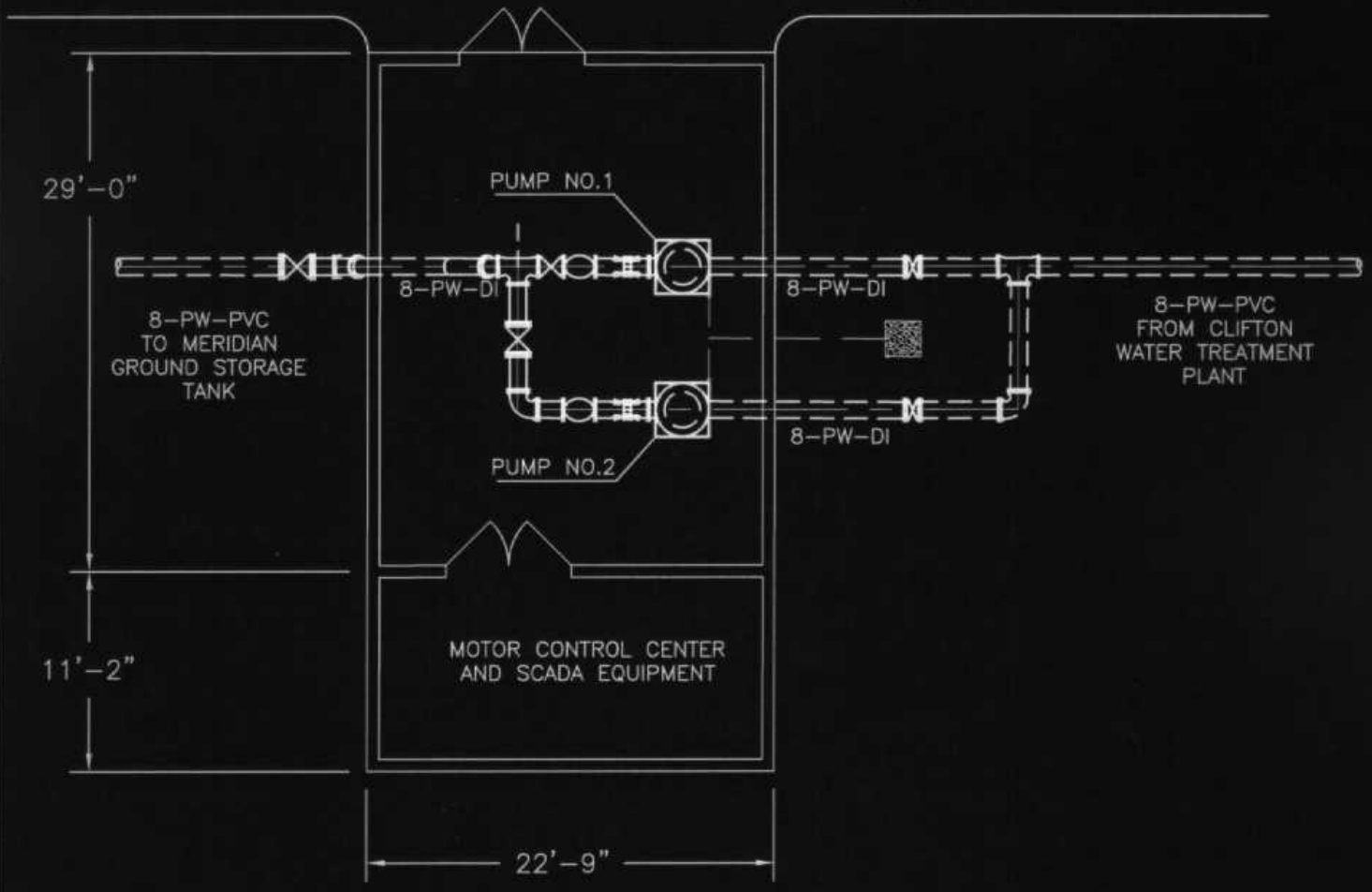
CLIFTON TO MERIDIAN TRANSMISSION LINE
(ALTERNATIVE 1)

BOSQUE COUNTY WATER SUPPLY MASTER PLAN

FIGURE 6-1

DATE: Mar. 03, 2004 | SCALE: 1"=25,000' | DRAWN BY: SHOPPADM | PROJECT No.: 050419

FILE: N:\050419 Bosque County\GIS\Arcgrid\Overall Plan.dwg



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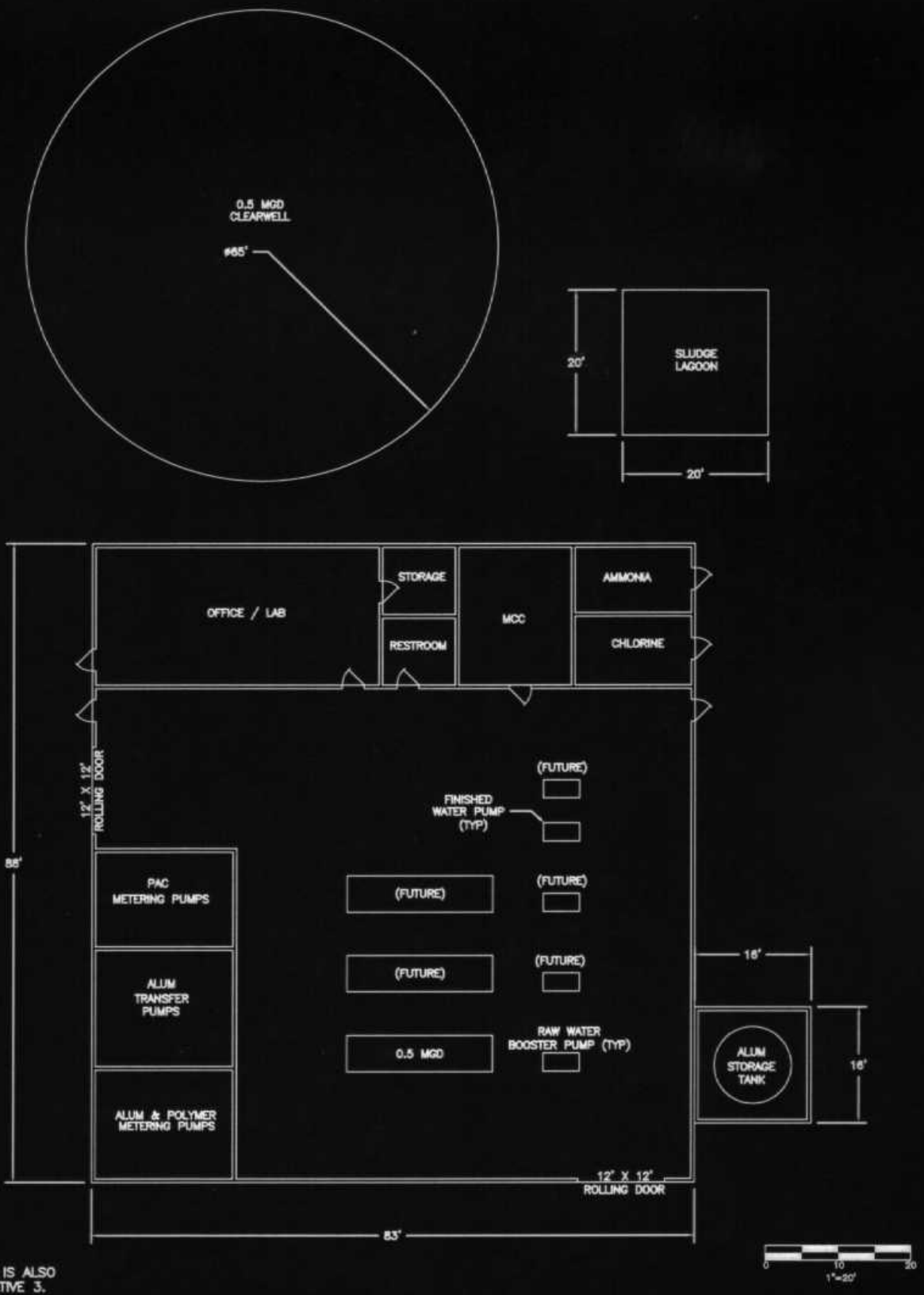
CLIFTON TO MERIDIAN PUMP STATION
(ALTERNATIVE 1)

BOSQUE COUNTY WATER SUPPLY MASTER PLAN

FIGURE 6-2

DATE: Mar. 03, 2004 | SCALE: 1"=10' | DRAWN BY: SHOPPADM | PROJECT No.: 050419



NOTE: THIS FACILITY IS ALSO INCLUDED IN ALTERNATIVE 3.

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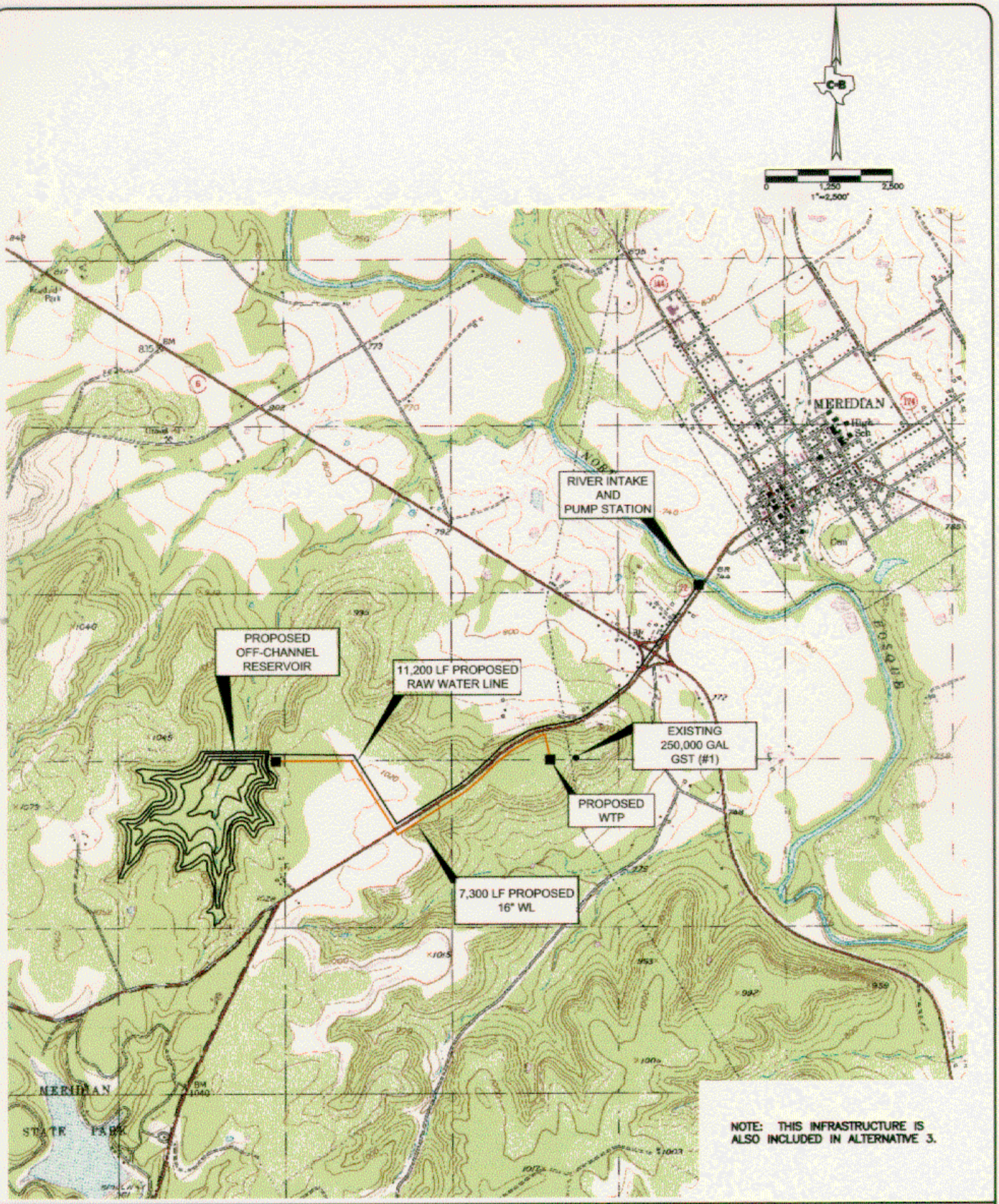
MERIDIAN REGIONAL WATER TREATMENT PLANT
(ALTERNATIVE 2)

BOSQUE COUNTY WATER SUPPLY MASTER PLAN

FIGURE 6-3

DATE: Mar. 03, 2004 | SCALE: 1"=20' | DRAWN BY: SHOPPADN | PROJECT No.: 050419

FILE: K:\050419 Bosque County\CADD\Arcview\MeridianWTP.dwg



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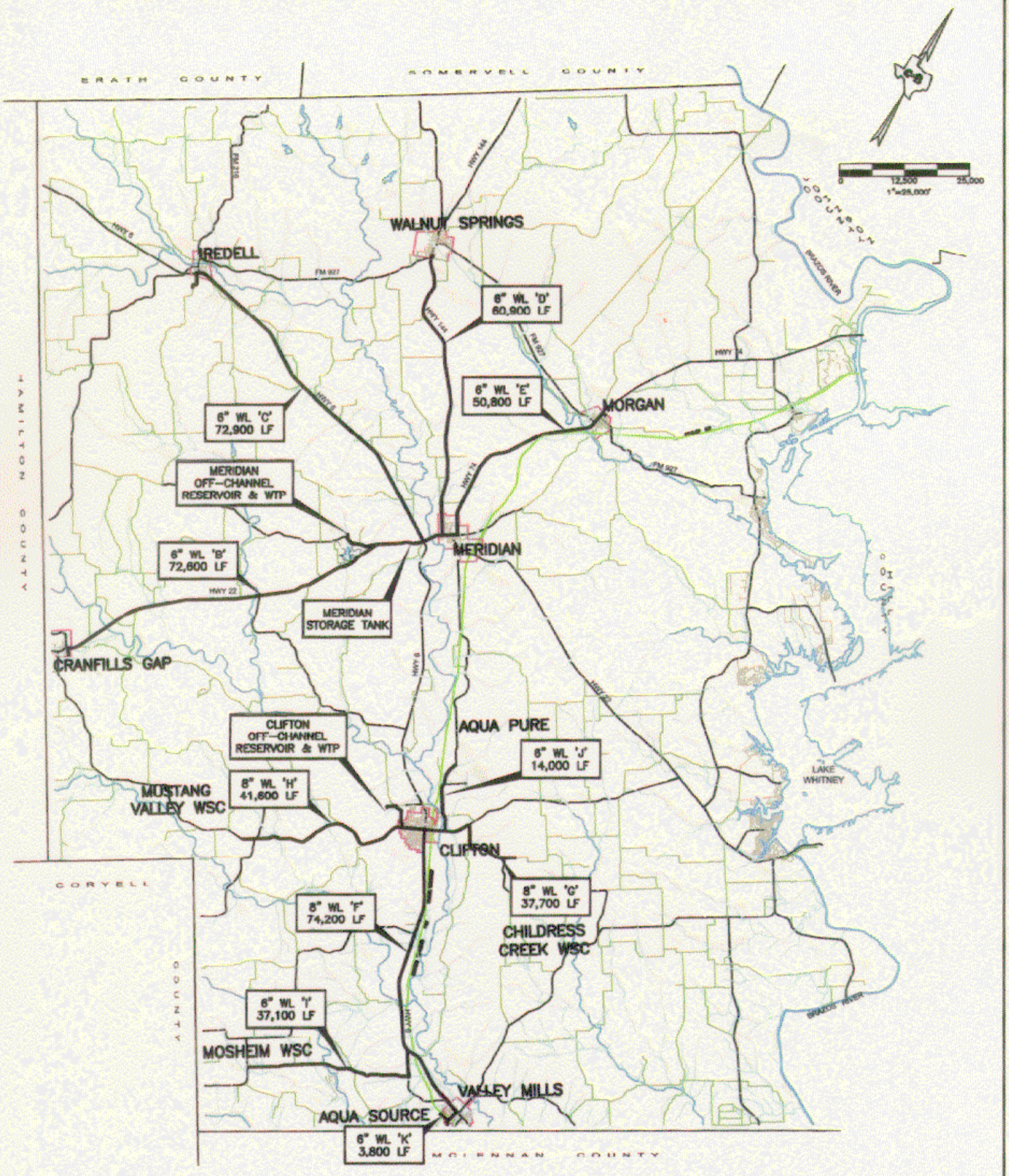
MERIDIAN OFF-CHANNEL RESERVOIR
(ALTERNATIVE 2)

BOSQUE COUNTY WATER SUPPLY MASTER PLAN

FIGURE 6-4

DATE: Mar. 03, 2004 | SCALE: 1"=2,500' | DRAWN BY: SHOPPADM | PROJECT No.: 050419

FILE: K:\050419 Bosque County\GIS\Arcgrid\Workfiles\ Off-Channel Res.dwg



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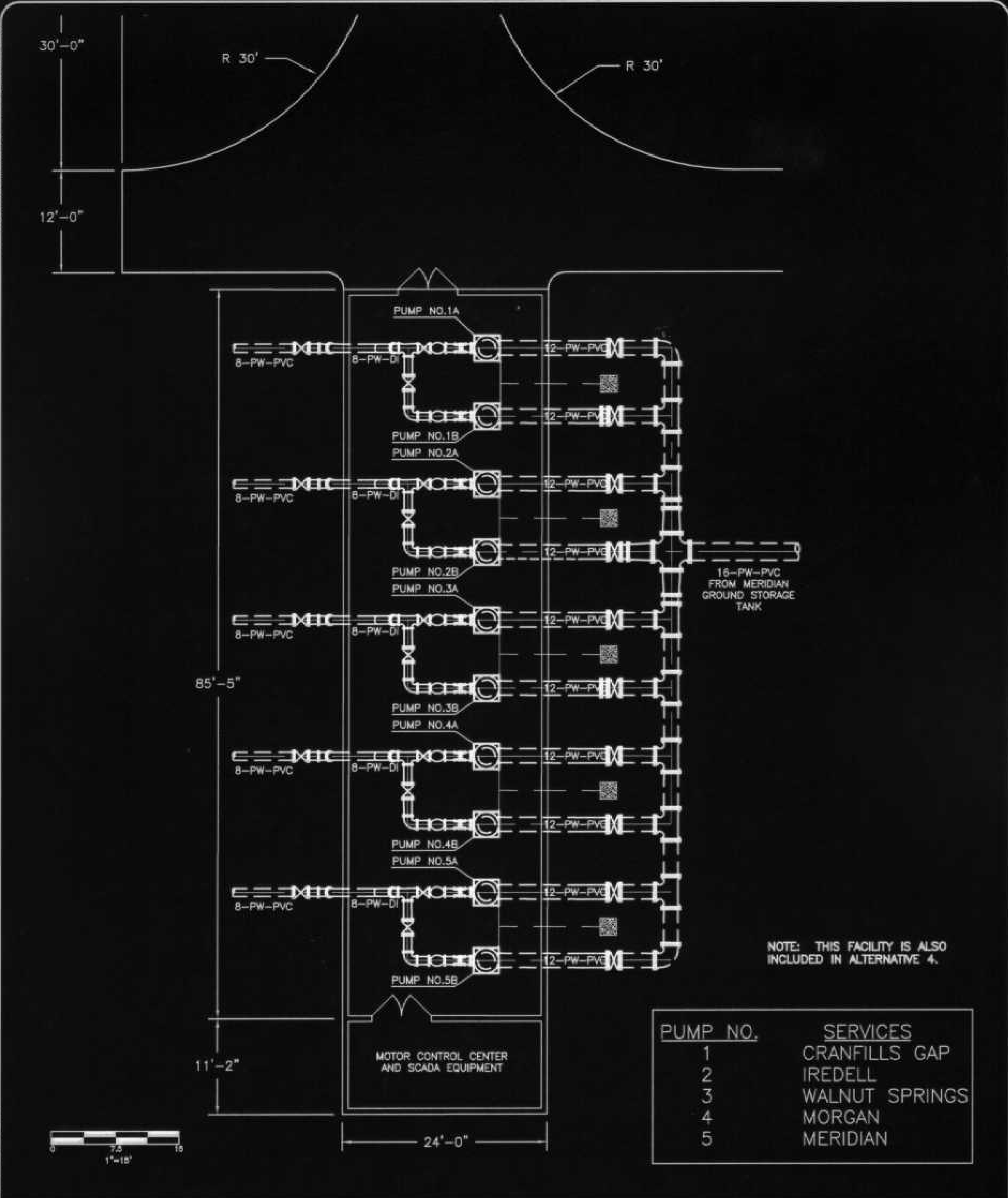
MERIDIAN REGIONAL WTP
SERVIING NORTH BOSQUE COUNTY
(ALTERNATIVE 3)

BOSQUE COUNTY WATER SUPPLY MASTER PLAN

FIGURE 6-5

DATE: Mar. 03, 2004 | SCALE: 1"=25,000' | DRAWN BY: SHOPPADM | PROJECT No.: 050419

FILE: K:\050419 Bosque County\GIS\ArcInfo\Overall Planning



NOTE: THIS FACILITY IS ALSO INCLUDED IN ALTERNATIVE 4.

PUMP NO.	SERVICES
1	CRANFILLS GAP
2	IREDELL
3	WALNUT SPRINGS
4	MORGAN
5	MERIDIAN

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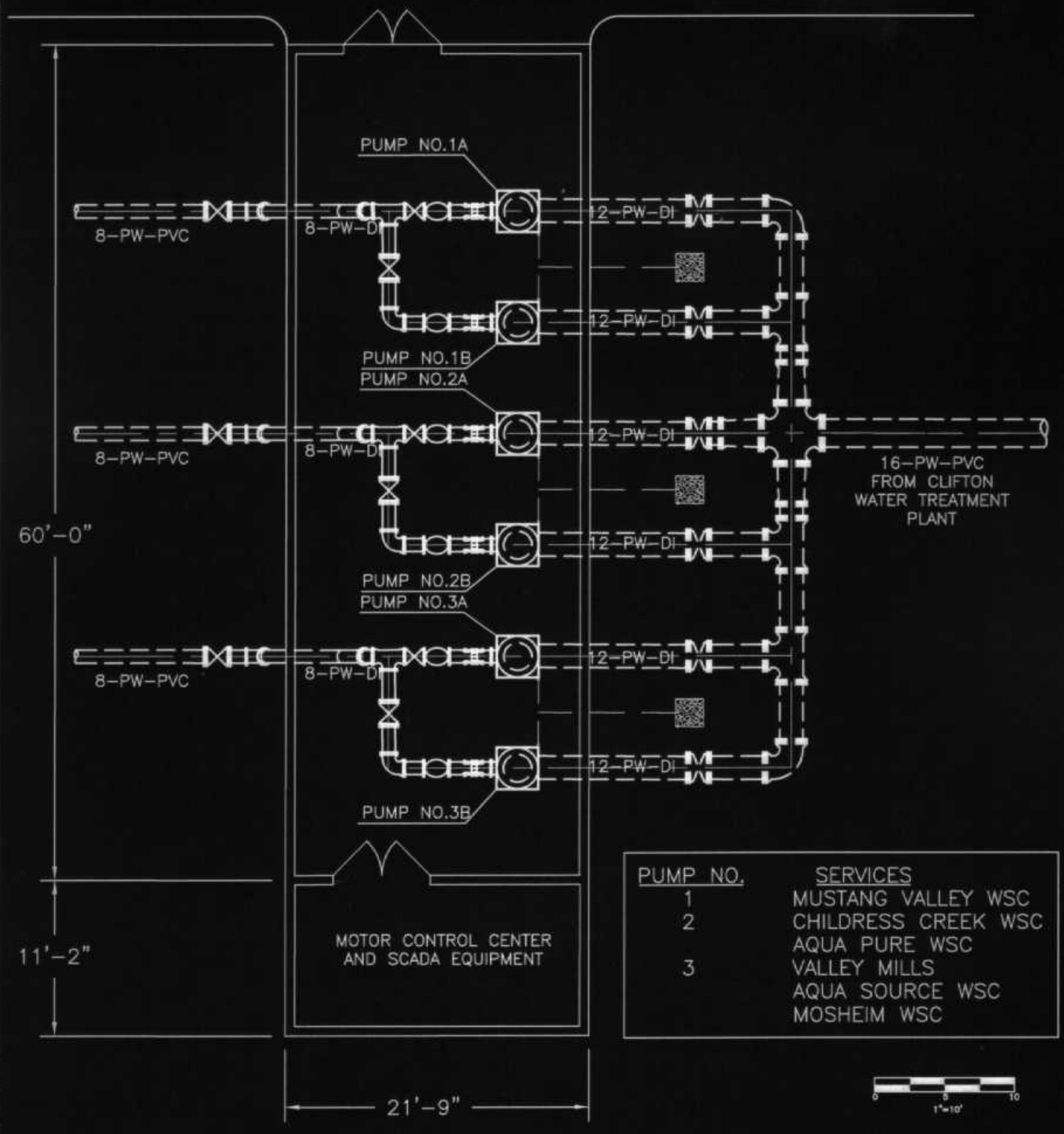
MERIDIAN REGIONAL PUMP STATION
(ALTERNATIVE 3)

BOSQUE COUNTY WATER SUPPLY MASTER PLAN

FIGURE 6-6

DATE: Mar. 03, 2004 | SCALE: 1"=15' | DRAWN BY: SHOPPADM | PROJECT No.: 050419



PUMP NO.	SERVICES
1	MUSTANG VALLEY WSC
2	CHILDRESS CREEK WSC
	AQUA PURE WSC
3	VALLEY MILLS
	AQUA SOURCE WSC
	MOSHEIM WSC

0 5 10
1"=10'

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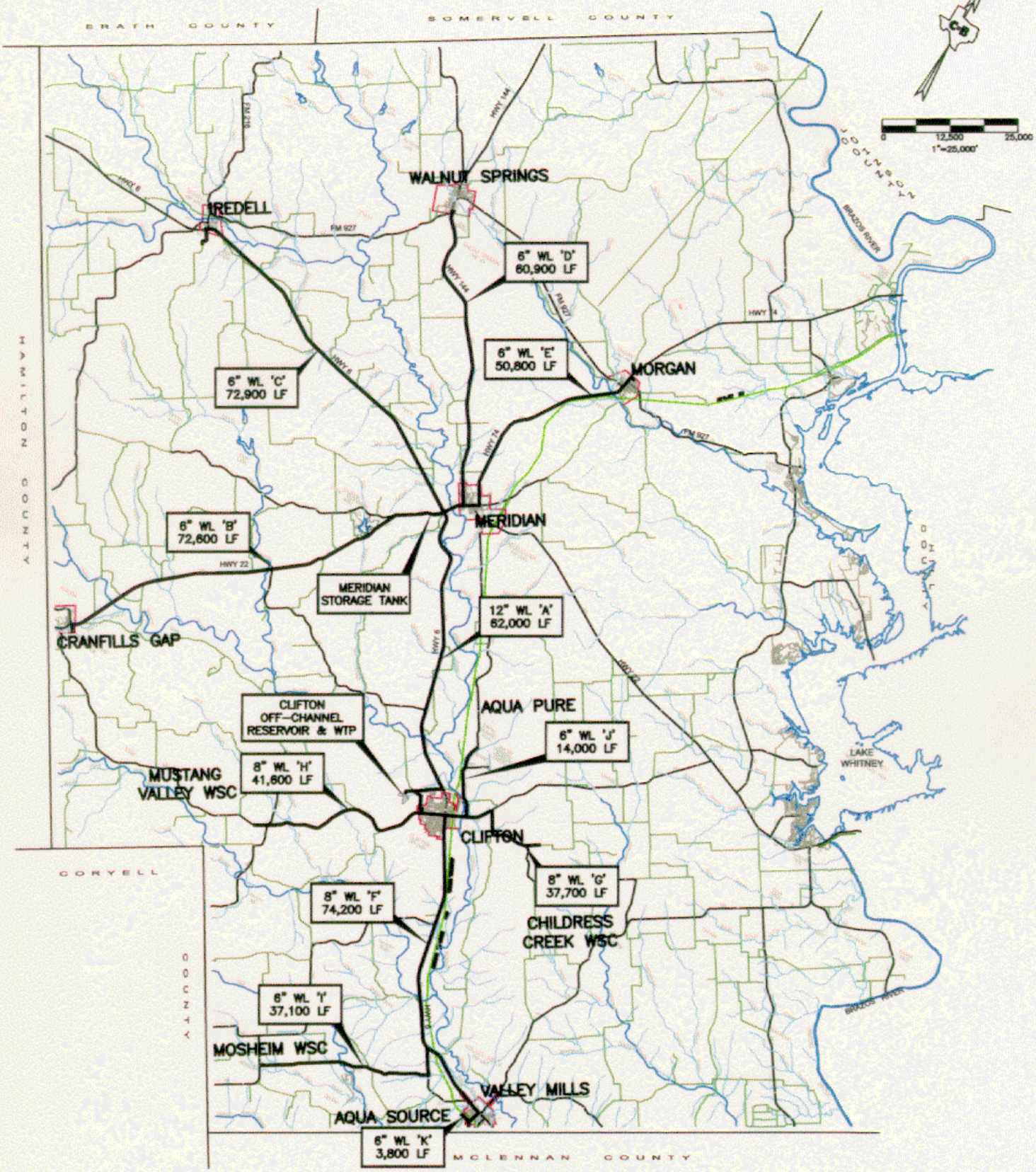
CLIFTON REGIONAL PUMP STATION
(ALTERNATIVE 3)

BOSQUE COUNTY WATER SUPPLY MASTER PLAN

FIGURE 6-7

DATE: Mar. 03, 2004 | SCALE: 1"=10' | DRAWN BY: SHOPPADM | PROJECT No.: 050419



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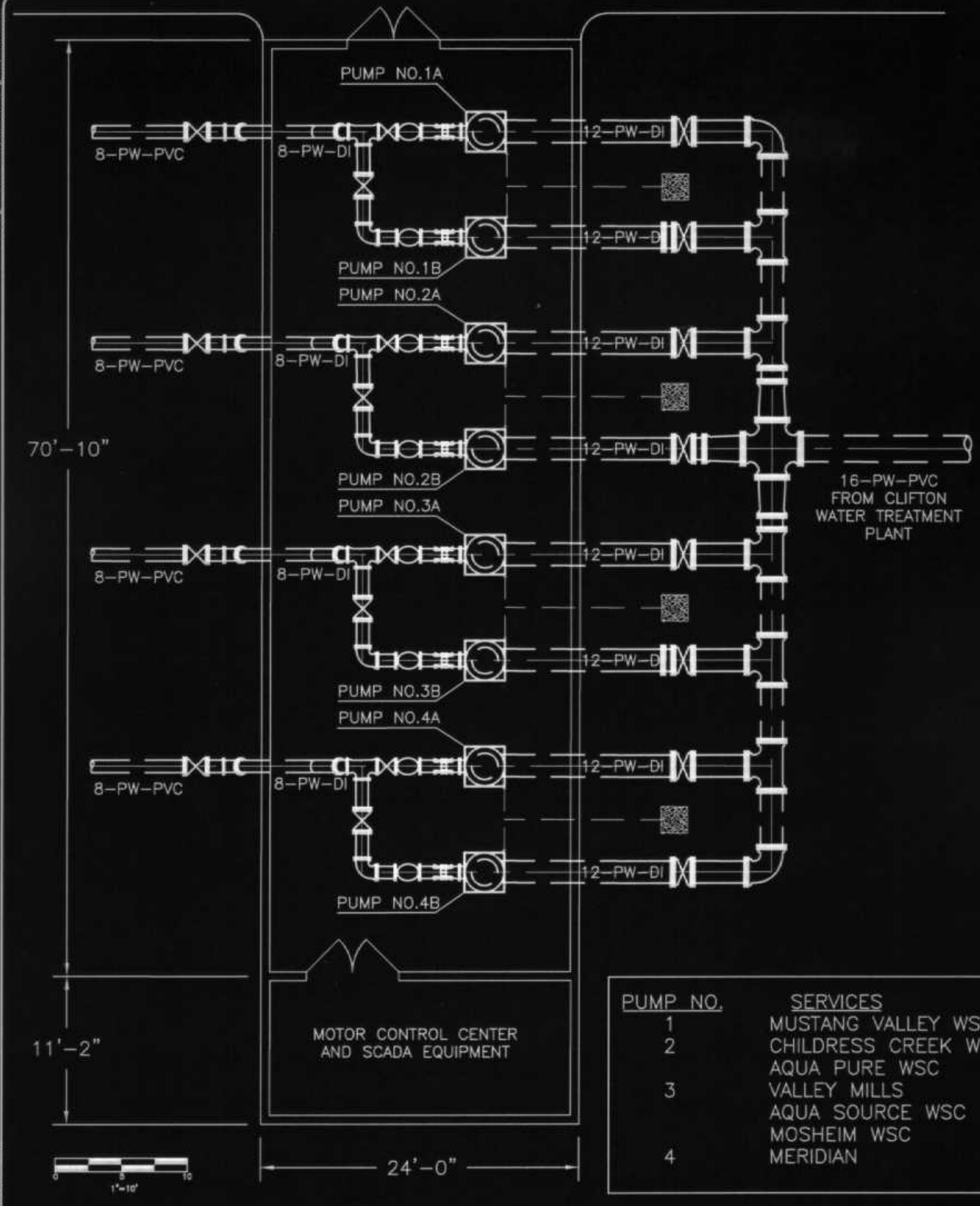
CLIFTON REGIONAL WTP
SERVIING ALL OF BOSQUE COUNTY
(ALTERNATIVE 4)

BOSQUE COUNTY WATER SUPPLY MASTER PLAN

FIGURE 6-8

DATE: Mar. 03, 2004 | SCALE: 1"=25,000' | DRAWN BY: SHOPPADM | PROJECT No.: 050419



PUMP NO.	SERVICES
1	MUSTANG VALLEY WSC
2	CHILDRESS CREEK WSC AQUA PURE WSC
3	VALLEY MILLS AQUA SOURCE WSC MOSHEIM WSC
4	MERIDIAN

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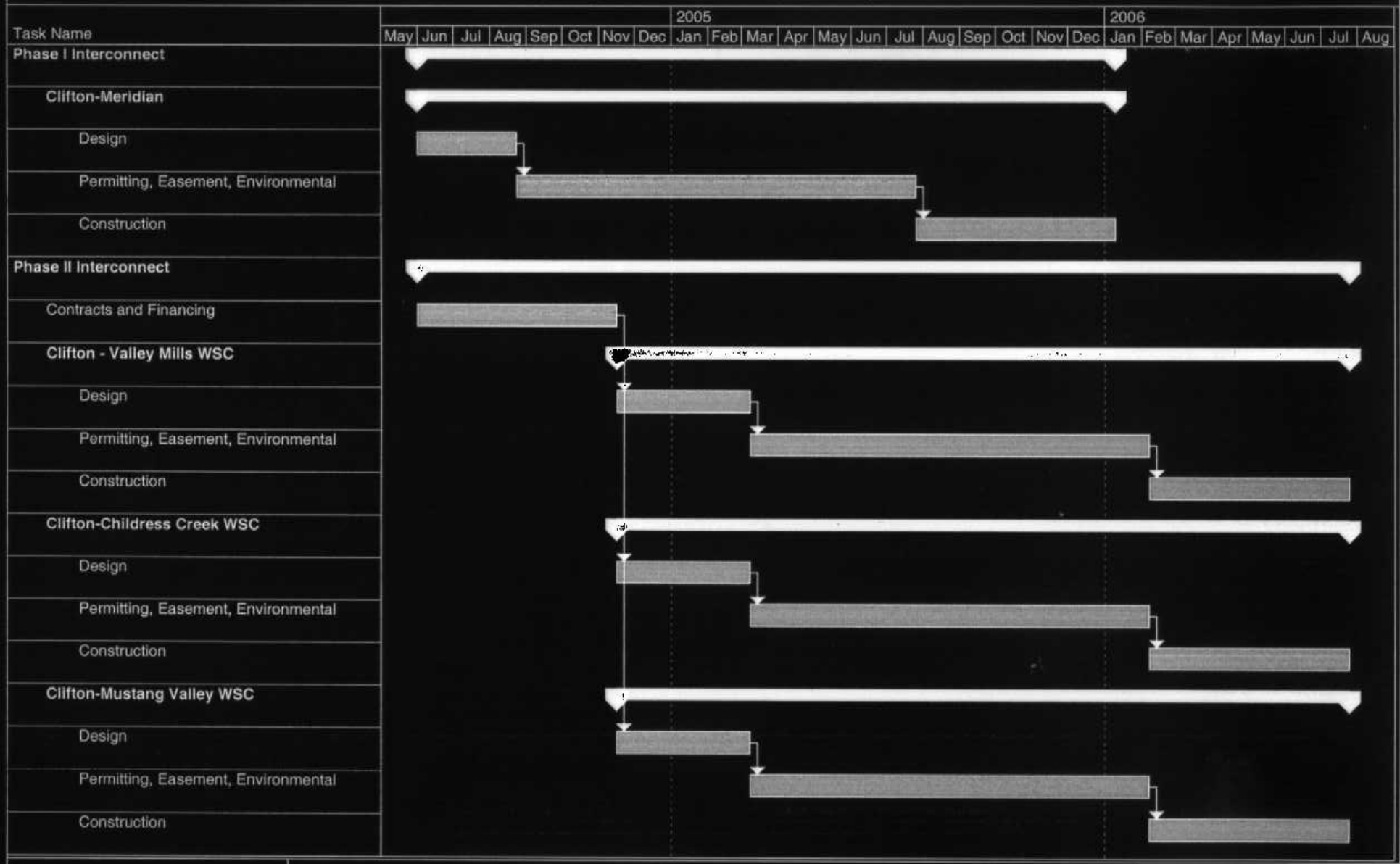
CLIFTON HIGH SERVICE PUMP STATION
(ALTERNATIVE 4)

BOSQUE COUNTY WATER SUPPLY MASTER PLAN

FIGURE 6-9

DATE: Mar. 03, 2004 | SCALE: 1"=10' | DRAWN BY: SHOPPADM | PROJECT No.: 050419

Figure 10-1. Bosque County Regional Water Program Implementation Phasing Plan



Note: Project timeline assumes approval by participant entities no later than June 1, 2004